UNITED STATES ARMY

TRAINING MANUAL No. 26

RADIO OPERATOR

STUDENTS MANUAL
FOR ALL ARMS

Part I. RADIO SETS

PREPARED UNDER THE DIRECTION OF
THE CHIEF SIGNAL OFFICER

1924

WASHINGTON
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CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *December 27, 1923.*

Manuals for training in the Army are to be prepared and revised from time to time by the branches of the service concerned, and when approved, published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Signal Corps a series of pamphlets relating to signal communication specialists.

The pamphlets in this series are titled as follows:

Training Manual No. 20—Basic Signal Communication, Students Manual.

Training Manual No. 21—Basic Signal Communication, Instructors Guide.

Training Manual No. 22—Telephone Switchboard Operator, Students Manual.

Training Manual No. 23—Telephone Switchboard Operator, Instructors Guide.

Training Manual No. 24—Message Center Specialist, Students Manual.

Training Manual No. 25—Message Center Specialist, Instructors Guide.

Training Manual No. 26—Radio Operator, Students Manual.

Training Manual No. 27—Radio Operator, Instructors Guide.

Training Manual No. 32—The Pigeoneer, Students Manual.

This pamphlet is published for the information and guidance of all concerned.

BY ORDER OF THE SECRETARY OF WAR:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
The Adjutant General.

PREFACE.

1. Part I, Training Manual No. 26, The Radio Operator, is a training course on radio sets.

2. The plan followed in the preparation of this manual is the established Signal Corps training policy, namely, instruction by means of the applicatory method.

a. In order that the manual may meet Army needs, the knowledge and ability which radio operators with tactical units must possess has been analyzed and arranged in teaching units called *Unit Operations.*

b. Each of these unit operations contains all the requisite information, together with the directions for obtaining a solution of the various applicatory problems contained therein. These problems are so arranged that the radio operator by following them in order will find himself equipped with the necessary knowledge and manual skill for proceeding from each unit operation to the next.

3. It is highly desirable that radio operators should receive instruction in an orderly way and that their ideas and stock of information about their specialty should be built up and added to in a logical fashion. It is especially important that they should be well grounded in the fundamental principles and practice of radio operation and that they should be thoroughly familiar with such elementary circuits as those involved in simple receivers, transmitters, and amplifiers. For these reasons the SCR-54-A, SCR-74, and SCR-61 sets are used in this manual as starting points for instruction. Although these sets are becoming obsolete, a thorough study of the minimum instructional equipment required by any unit for the illustration of basic radio principles has resulted in the selection of these sets as well adapted for this particular purpose. Where they can not be obtained, models can be made which will serve the purpose.

NOTE.—Recommendations have been made to include these sets in Equipment B, in the new tables of equipment for all units required to train radio operators. (Letter, O. C. S. O. Jan. 12, 1924.)

4. Since different arms are equipped with different radio sets, the unit operations are so arranged that the directions for any sets not used by a particular arm may be omitted without destroying the general plan of instruction.

5. The several unit operations constituting this manual have been prepared in accordance with the minimum specifications for the Radio Operator published by the Adjutant General of the Army. These specifications do not require instruction in radio theory. In this connection it should be noted that the Signal Corps policy with respect to instruction, as embodied in this manual, departs from the usual procedure which consists in teaching theory first and practice second, by teaching the practical first and permitting theoretical knowledge to grow spontaneously out of this practical training.

6. The essential element in training radio operators is the reduction of the time required for training to the minimum. What this minimum is and the best ways of attaining it must be determined in peace time and not left undecided until a national emergency arises. The second essential element in any program of training is the complement of the first, that the method adopted for war training shall be identical with that for peace training. The methods devised in peace must be so well tried and so trustworthy that they will not be abandoned when an emergency arises. At such a time to devise and install new methods and to spread these throughout the Army requires considerable time that had better be spent upon the actual training itself.

RADIO OPERATOR.

STUDENTS' MANUAL

FOR ALL ARMS.

PART I. RADIO SETS.

OPERATIONS INDEX.

UNIT OPERATIONS. Page.

1. Primary batteries used in radio communication 1
2. Series and parallel connections of dry cells and batteries 6
3. Storage batteries 12
4. Resistance 20
5. Magnets 27
6. The SCR–61 wave meter 34
7. The SCR–74–A transmitting set 50
8. The SCR–74–A transmitter (coupled circuits) 56
9. The SCR–54–A receiver 64
10. The SCR–95, SCR–125, and SCR–125–A wave meters 75
11. The SCR–105 set 83
12. The vacuum tube detector, DT–3–A 94
13. The SCR–72 amplifier 102
14. The SCR–121 amplifier 111
15. The SCR–79–A and SCR–99 sets 116
16. The SCR–67–A radio telephone set 136
17. The SCR–130 set 147
18. The SCR–127 set 165
19. The SCR–77–A set 184
    The SCR–77–B set 201
20. The SCR–109–A and SCR–159–A sets 208
21. The inverted "L" antenna 231
22. The "V" type antenna 234
23. The 40-foot umbrella antenna 236

INFORMATION TOPICS.

1. Definitions 243
2. The SCR–79–A and the SCR–99 sets 252
3. The SCR–67–A radio telephone set 256
4. The radio sets SCR–77–A and SCR–77–B 260
5. Hand generator, type GN–29–A 264
6. The SCR–109–A and SCR–159 sets 267

INDEX OF ILLUSTRATIONS.

Figure No.	Title.	RL-P-No.	Page.
1, A-B	Sectional view of primary cells, types BA-10 and BA-4	2883	2
2	Method of connecting type BA-4 cell to a voltmeter	2301	3
3, A-B-C-D	Types of dry cells and batteries used in signal communications	4036	4
4	Method of connecting four dry cells in series	4017	6
5	Method of making short-circuit test of type BA-4 cell	2303	8
6	Method of making short-circuit test of type BA-10 cell	4019	9
7	Parallel connections of four dry cells	4018	10
8	Various parts used in construction of type BB-14 storage battery	2113	12
9, A-B-C	Three types of lead cell storage batteries used in signal communication	4038	13
10	Method of measuring the voltage of one cell of a storage battery	2898	15
11	Edison storage battery, type BB-5	4037	17
12	Method of measuring the voltage at the filament terminals of a vacuum tube or lamp	4039	21
13	Method of connecting a resistor in series with a vacuum tube and storage battery	2899	23
14	Rheostat connected in series with a lamp and a storage battery	4022	24
15	Method of connecting a potentiometer	4023	25
16	A straight bar magnet and a horseshoe magnet	4027	27
17, A	Magnetic field produced around a straight wire conductor	4032	28
17, B	Magnetic field produced around a coil of wire carrying an electric current	4032	28
18	Head set, type P-11, with cap and diaphragm of one receiver removed	4040	30
19	Test buzzer with cap removed to show parts and method of connecting to dry cell	4043	32
20	The SCR-61 wave meter	2850	36
21	Panel of set box, BC-37, removed to show interior parts	2854	37
22	Details of inductance coils used in SCR-61 wave meter	2855	38
23	Schematic view of variable condenser used in the SCR-61 wave meter, showing minimum capacity position of plates	4026	------
24	Schematic view showing maximum capacity position of plates	4026-A	------
25	Schematic diagram of connections in the SCR-61 wave meter	2894	41
26	Method of obtaining close coupling between two SCR-61 wave meters	2861	46
27	Schematic view showing relative positions of inductance coils when two SCR-61 wave meters are closely coupled, as in Fig. 26	2735	46
28	Two SCR-61 wave meters loosely coupled	2862	47
29	Schematic view showing relative positions of inductance coils when two SCR-61 wave meters are loosely coupled, as in Fig. 28	2734	47

Figure No.	Title.	RL-P-No.	Page.
30	Set box, BC-18-A with lid open	2878	50
31	Set box, BC-18-A disassembled to show various parts	2882	52
32	Schematic wiring diagram of SCR-74-A transmitter	4016	52
33	Cording diagram of SCR-74-A transmitter	2259	54
34	Method of connecting inductance and condenser to SCR-74-A transmitter	2845	59
35	The SCR-74-A transmitter inductively coupled to the antenna circuit	2846	60
36	The SCR-74-A transmitter directly coupled to the antenna circuit	2843	62
37	Set box, BC-14-A with lid open	1935-C	64
38	Rear of panel, set box, BC-14-A	2031-C	65
39	Schematic diagram of connections in set box, BC-14-A	2842	66
40	Method of coupling the SCR-61 wave meter to the secondary coil of the SCR-54-A receiver	2875	68
41	Schematic diagram showing relative positions of the SCR-61 wave meter and the SCR-54-A when coupled as in Fig. 40	2736	68
42	Method of coupling the SCR-61 wave meter to the primary circuit of the SCR-54-A receiver	2874	71
43	Schematic diagram of coupling arrangement as in Fig. 42	2737	71
44	Top panel of SCR-95 wave meter	4021	75
45	Panel of SCR-95 wave meter removed from box to show interior parts	4030	76
46	SCR-95 wave meter with side door open	4027-A	77
47	Schematic diagram of connections in the SCR-95 wave meter	2872	78
48	Method of coupling the SCR-95 wave meter to an SCR-61 wave meter	2876	79
49	Set box, type BC-53-A	5036	83
50	Set box BC-53-A with back and top removed to show interior	2897	84
51	Top view of interior, set box BC-53-A	4031	84
52	Schematic diagram of connections SCR-105 set	2646	------
53	Method of coupling SCR-125-A wave meter to set box BC-53-A	2864-C	91
54	The DT-3-A detector unit	4048	94
55	Type VT-1 vacuum tube	2109	95
55, A	Details of VT-1 vacuum tube	2896	95
56	Panel of DT-3-A detector removed to show interior parts	4049	96
57	Schematic diagram of connections in the DT-3-A detector	2655	96
58	Method of connecting apparatus used in Experiment No. 1	2893	99
59	Set box, BC-17 of the SCR-72 amplifier	5035	103
60	Set box BC-17 with lid open to show location of batteries and tube sockets	5152	104
61	Panel of set box BC-17 removed to show interior parts	5038	104
62	Schematic diagram of connections in set box BC-17	2654	105
63	Cording diagram of connections when operating the SCR-54-A, type DT-3-A, and the SCR-72 sets together	2867-C	107
64	Set box BC-44-A of the SCR-121 amplifier	2680	111

INDEX OF ILLUSTRATIONS—Continued.

Figure No.	Title.	RL-P-No.	Page.
65	Panel of set box BC-44-A pulled forward to show interior parts	5153	112
66	Schematic diagram of connections in the BC-44-A amplifier	2727	113
67	Cording diagram of connections when operating the SCR-54-A, the DT-3-A, and the SCR-121 sets together	2868-C	114
68	Set box BC-32-A of the SCR-79-A set	1936	116
69	The type VT-2 vacuum tube	2111	117
70	Schematic diagram of connections in the receiver of the SCR-79-A set	2499	118
71	Schematic diagram of connections in the transmitter of the SCR-79-A set	2616	119
72	Relative positions of locking pins on type VT-1 and VT-2 vacuum tube bases	4025	120
73	Rear panel view of set box BC-32-A	4028	121
74	Details of the transmitting inductance of the SCR-79-A set	4029	122
75	SCR-125-A wave meter coupled to receiving circuit of SCR-79-A set	2880	123
76	SCR-125-A wave meter coupled to transmitting circuit of SCR-79-A set	2881	124
77	Front panel of set box BC-13-A of the SCR-67-A set	5037	136
78	Power board, type BD-1-A	5154	137
79	Schematic diagram of transmitter connections in the SCR-67-A set	2761-C	138
80	Schematic diagram of receiver connections in the SCR-67-A set	2760-C	140
81	Interior of set box, BC-13-A showing parts mounted on back of panel	5151	141
82	Method of coupling the SCR-125-A wave meter to the receiving circuit of the SCR-67-A set	2890	143
83	Method of coupling the SCR-125-A wave meter to the transmitting circuit of the SCR-67-A set	2891	144
84	Set box BC-7 with front cover lowered to show panel	2025	148
85	Schematic diagram of transmitter connections in SCR-130 set	5025	149
86	Rear view of panel and attached parts of set box BC-7	2035	149
87	Schematic diagram of transmitter and receiver connections in set box BC-7	2036-C	150
88	Wiring diagram of the receiver connections in the SCR-130 set	2034-C	151
89	Battery and spare parts box, type BC-102 of the SCR-130 set	2028	153
90	Cording diagram of transmitter connections in the SCR-130 set	2877	155
91	Cording diagram of receiver connections in the SCR-130 set	2892	157
92	Cording diagram of complete transmitter and receiver connections in the SCR-130 set	5290	158
93	Hand-driven generator, type GN-29	5155	167
94	The type VT-5 vacuum tube	2110	171
95	The SCR-77-A loop set	2143	184
96	Schematic diagram of connections in the SCR-77-A set	4034	186
97	Battery compartment of equipment case, type CS-17	2018	187
98	Head set and spare vacuum tube compartment of equipment case, CS-17	2016	188

Figure No.	Title.	RL-P-No.	Page.
99	Set box, type BC-9, with front cover removed	2107	189
100	Front panel of set box, BC-9, lowered to show interior parts	2175	189
101	Front panel of transmitter set box, type BC-86-A	2026	209
102	Type VT-4 vacuum tube	2112	210
103	Schematic diagram of connections when the BC-86-A transmitter is being used for the transmission of undamped wave signals	2759-C	212
104	Schematic diagram of connections when the BC-86-A is being used as a radio telephone transmitter	2758-C	213
105	Schematic diagram of connections when the BC-86-A is being used as a transmitter of buzzer modulated signals	2757-C	214
106	Rear view of BC-86-A transmitter panel	2263	214
107	Front panel of BC-98-A receiver set box	1938	215
108	Schematic diagram of connections in set box BC-98-A	2860-C	216
109	Rear of BC-98-A receiver panel	5156	217
110	Cording diagram of transmitter connections of SCR-109-A set and method of coupling the SCR-125-A wave meter to transmitter circuit	4050	218
111	Cording diagram of receiver connections of SCR-109-A set and method of coupling the SCR-125-A wave meter to receiver circuit	2879	222

RADIO OPERATOR.

STUDENTS MANUAL

FOR ALL ARMS.

PART I.—RADIO SETS.

UNIT OPERATIONS.

PRIMARY BATTERIES USED IN RADIO COMMUNICATION.

Information.

Effects of electricity.—The word electricity has been applied to a form of energy, but just exactly what electricity is we can not say. Electricity is known to exist for the simple reason that it can be observed and measured. For example, electricity lights lamps, drives motors, raises to a high temperature all sorts of electrical heating devices, and energizes the telephone, the telegraph, and the electric bell. It also makes radio communication possible.

Electricity produces these various effects only when it is in motion, just as air must be in motion in order that wind may be produced. Moving air causes the windmill to revolve, and propels the sailing vessel. However, if air is not in motion no such effects are produced. In a similar way, electricity at rest has few effects of practical value. Electricity in motion is spoken of as a *current* of electricity.

Conductors; nonconductors.—In order to transfer electricity from its source to the point at which it is to be used, a path or *conductor* must be provided. For convenience and efficiency this conductor usually consists of a copper wire. Gold, silver, iron, lead, brass, zinc, carbon, and the earth are also conductors of electricity. Certain substances, such as glass, porcelain, hard rubber, bakelite, mica, and sealing wax, are poor conductors of electricity and are therefore called *nonconductors* or *insulators*.

Questions.

(1) *What is energy?*

(2) *What are some forms of energy other than electrical energy?*

(3) *What is meant by "energizing the telephone"?*

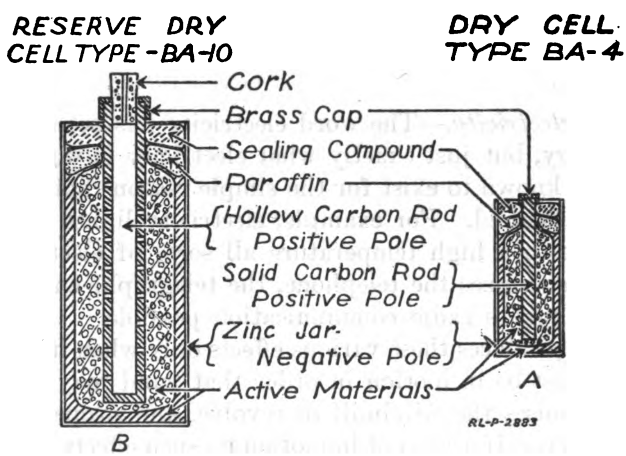
(4) *What are the usual sources of electricity?*

(5) *Why is it evident that such a thing as electricity exists?*

(6) *Will electricity produce any practical effects if no current is flowing?*

(7) *What is a conductor?*

Batteries.—The electricity necessary to operate the radio sets used in the Army is obtained from two sources, namely, an electric battery or a generator. For portable and small type sets the necessary electrical energy is supplied by a battery. Two types of batteries are used in general, one a primary battery and the other a secondary or storage battery.



Figures 1, A–B.—Sectional view of primary cells, types BA–10 and BA–4.

Primary batteries.—A primary battery consists of two or more units called *cells*. Each cell produces electricity by certain chemical actions which take place inside the cell. There are many types of primary cells. Those which contain a liquid which is easily spilled, or those in which the liquids are placed in glass containers are unsuitable for use where they are to be transported with radio sets accompanying troops in the field. The type of primary cell most practical for such use is known as the dry cell. The BA–4 cell is an example of this type of dry cell. (See Fig. 1, A, and Fig. 3, B.)

It consists of a small cylindrical zinc container, in the center of which a carbon rod is placed. The space between the carbon rod and the inner wall of the zinc container is filled with certain chemicals and absorbent materials. The top of the cell is sealed with sealing wax. The carbon rod is equipped with a small brass cap which acts as one terminal of the cell. The other terminal of the cell is formed by the zinc container itself.

EXPERIMENT NO. 1.

Equipment.

1 cell, type BA-4, serviceable, with leads soldered to terminals.
1 voltammeter, Weston model 280.

NOTE.—The voltammeter, Weston model 280, is a combination voltmeter and ammeter. When the voltammeter is used to measure voltage it will be spoken of as a voltmeter, and when it is used to measure amperes it will be spoken of as an ammeter.

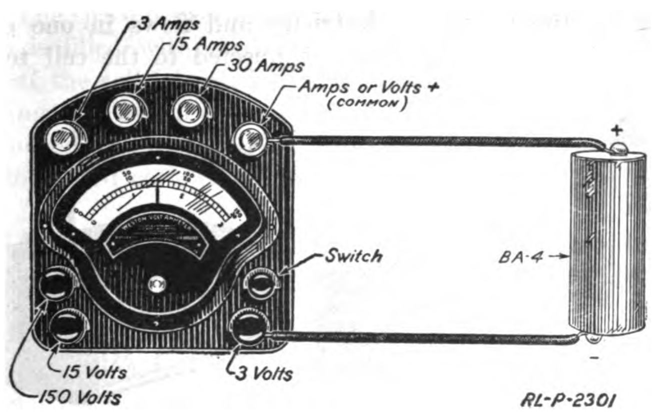


Fig. 2.—Method of connecting type BA-4 cell to a voltmeter.

Directions.

1. Connect the wire leading from the carbon rod or positive pole of the BA-4 cell to the terminal marked "Amps or Volts +" on the voltammeter. Connect the wire leading from the bottom of the zinc case or negative terminal of the cell to the terminal marked "3 Volts" on the voltmeter. (See Fig. 2.) Press the small button switch on the voltmeter and watch the indicating needle.

Questions.

(8) *In which direction does the indicating needle turn?*

(9) *Where does the needle come to rest?*

(10) *What is the voltage of the cell as indicated by the voltmeter?*

Directions.

2. Reverse the leads by connecting the lead from the positive terminal of the cell to the terminal on the meter marked "3 Volts,"

and the negative lead from the cell to the terminal on the meter marked " Volts." Again press the small button switch and observe the needle.

Questions.

(11) *When the connections are reversed, in which direction does the indicating needle move?*

(12) *Which is the proper way to connect the meter, as described in direction 1 or as in direction 2?*

Information.

Direction of current.—The electricity generated by a dry cell is known as *direct current* electricity and flows in one direction through the wires and apparatus connected to the cell terminals.

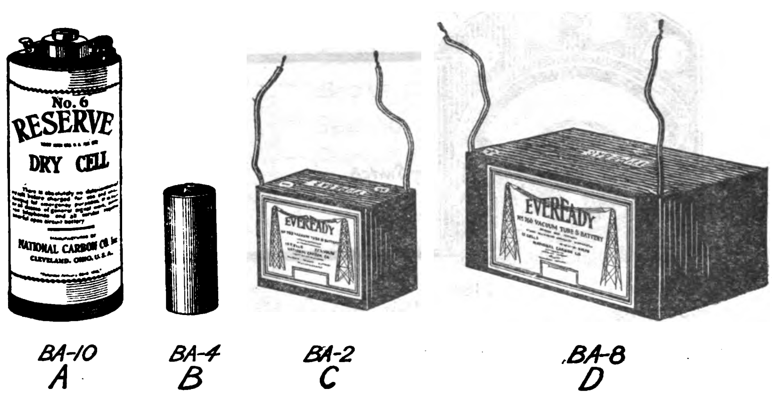


Fig. 3, A–B–C–D.—Types of dry cells and batteries used in signal communications.

The direction in which the current flows in a wire or piece of apparatus is determined by the connection to the cell terminals. The current generated by the cell is always considered as flowing outside the cell from the positive pole to the negative pole. It should be observed that if current flows from positive to negative *outside the cell*, in order to complete the electrical circuit it must flow from negative to positive *within the cell.* In referring to the direction of the current the *external* circuit is always referred to unless it is otherwise specifically stated.

Certain forms of electrical apparatus will not work unless the current flows through them in the proper direction. For this reason they must be correctly connected to the source of current supply, with respect to the positive and negative poles. The voltmeter in Experiment No. 1 is an example of this.

Question.

(13) *If the current generated by the cell flows from the positive to the negative terminal, why did the needle move to the left of the zero of the scale in Direction 2?*

Information.

BA–10 Dry Cell.—The BA–10 reserve dry cell is similar to the BA–4 cell. (See Fig. 1, B and Fig. 3, A.) It consists of a cylindrical zinc container in the center of which a hollow carbon rod is placed. The space between the carbon rod and the inner wall of the zinc case is filled with certain chemicals and absorbent materials. The top of the cell is sealed with an asphalt insulating compound. Two spring clip terminals are provided on the top of the cell, one being attached to the zinc case itself and the other to the carbon rod. A paraffin coated cork closes the opening in the top of the carbon rod.

The BA–10 cell differs from the BA–4 cell in that it must be charged by being filled with water before it is placed in service. (See U. O. No. 3, Basic Manual.)

A dry cell of the BA–4 type, when stored for a length of time, becomes useless due to certain reactions which take place inside the cell when it is not in use. The cell could be stored for a much longer period of time if during construction the water had been omitted from the chemical in the cell. This is done in the type BA–10 reserve cell, but the small size of the BA–4 cell, together with the manner in which it is used, prohibits the use of a device for adding water.

BA–2 Battery.—The type BA–2 battery shown in Fig. 3, C, consists of 15 dry cells, each cell being similar to the BA–4 type cell, but smaller. The cells are connected together in series and sealed in a cardboard container with sealing wax. Two wire terminals are brought out through the sealing compound at the top of the batteries. One of the wire terminals is covered with black insulation to indicate the negative pole, while the other wire is covered with red insulation to indicate the positive pole. It is important to remember these colors.

BA–8 Battery.—The type BA–8 battery (Fig. 3, B), is similar to the type BA–2 battery. The two batteries differ only in the size of the cells, those of the BA–8 battery being about twice the diameter of the cells of the BA–2.

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SERIES AND PARALLEL CONNECTIONS OF DRY CELLS AND BATTERIES.

Equipment.

1 type BA-4 cell (serviceable).
4 type BA-10 cells (serviceable).
2 type BA-2 batteries (serviceable).
1 type BA-8 battery (serviceable).
1 voltammeter, Weston, model 280.
1 ammeter, 0-50 scale.

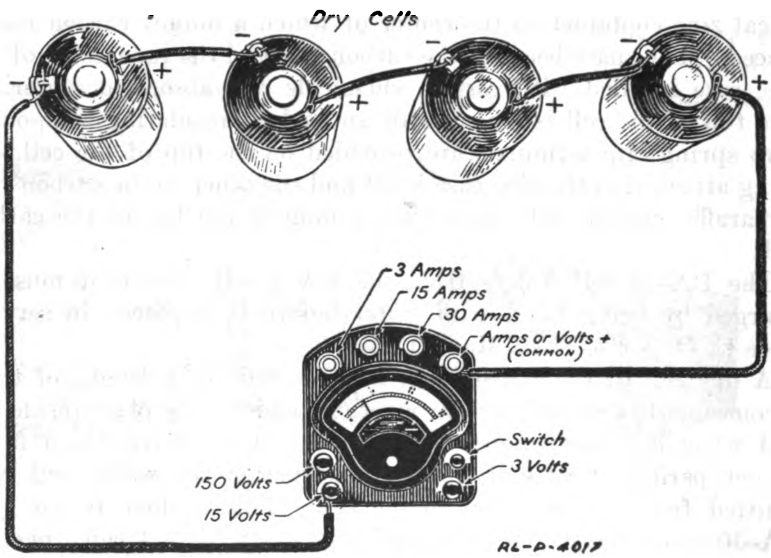


Fig. 4.—Method of connecting four dry cells in series.

Information.

Series connections.—At times it is necessary to use a voltage greater than the initial voltage of a single cell. As stated in the description of the BA-2 and BA-8 batteries, 15 cells are connected together in order to obtain 22 volts. When the cells are connected in this manner they are said to be connected in *series*. Fig. 4 shows how four type BA-10 reserve dry cells are connected in series for delivering current at a pressure of 6 volts.

Directions.

1. Measure the voltage of one of the BA-10 cells. Prepare a table similar to the one shown at the end of this Unit Operation. Record the reading obtained.

2. Connect four type BA–10 cells in series as shown in Fig. 4. The positive terminal of one cell is connected to the negative terminal of the second cell. The negative terminal of the second cell is connected to the positive terminal of the third cell and so on. Measure the voltage of the four cells in series using the terminals marked " 15 Volts " and " +Volts " on the voltammeter.

3. Record the reading in the table prepared.

Questions.

(1) *What voltage does the meter indicate?*

(2) *Multiply the voltage of one cell by the number of cells (4). What is the answer?*

(3) *Compare the answers to Questions 1 and 2. Would the same relation hold true if six cells were used in Direction 2?*

Information.

When measuring the voltage of a battery such as the type BA–2 or the type BA–8 battery, the terminals marked " Volts + " and " 150 Volts " are used. The " Volts + " terminal is connected to the positive terminal of the battery while the " 150 Volts " terminal is connected to the negative pole of the battery. With these connections the figures at the top above the scale are used. When measuring the voltage of a battery consisting of less than 10 dry cells, connections are made from the battery to the " Volts + " and the " 15 Volts " terminals on the meter. The " 3 Volts " terminal and the " Volts + " terminal are used when measuring the voltage of one or two dry cells. In this last case, the figures below the scales are used. When measuring the voltage of a battery, the voltmeter is always connected across the terminals of the battery.

Directions.

4. Measure the voltage of one of the BA–2 batteries using the terminals " 150 Volts " and " Volts + " on the meter.

5. Record the reading in the table prepared.

6. Connect two of the BA–2 batteries in series. The positive or red wire lead of one battery should be connected to the " Volts + " terminal of the meter. The black or negative lead should be connected to the red or positive terminal of the second battery. The remaining black lead should be connected to the " 150 Volts " terminal on the meter. Take the voltage reading and record it in the table prepared.

7. Measure the voltage of the BA–8 battery.

8. Record the reading in the table prepared.

Question.

(4) *What difference is there between the voltage of a BA–2 battery and a BA–8 battery?*

Information.

Ammeters.—When using the meter shown in Fig. 2, as an ammeter, the connections are made with the terminals at the top of the meter. (See Fig. 5 and Fig. 6.) The three terminals marked "3 Amps," "15 Amps," and "30 Amps" are the negative terminals. The positive or "Amps +" terminal is the same terminal used for the "Volts +" connection. When measuring the amperage of a dry cell or battery one terminal of the meter (usually the positive terminal) is connected directly to the positive terminal of the cell or

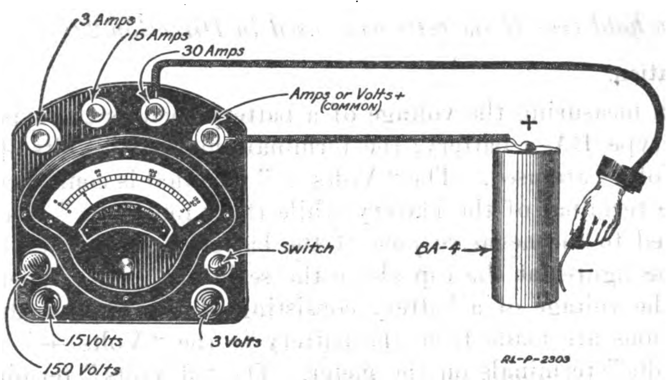


Fig. 5.—Method of making short-circuit test of type BA–4 cell.

battery. One end of the remaining wire is connected to the negative terminal of the meter. The other end of the wire is held against the negative terminal of the meter for an instant, just long enough to allow the needle to swing and come to a stop at the proper reading. This is important, for if the wire is held against the terminal too long the life of the battery will be shortened considerably.

Directions.

9. Measure the amperage of the BA–4 cell, making the connections as shown in Fig. 5. Take the readings quickly so as not to run down the cell. Record the reading in the table prepared.

10. Measure the amperage of the BA–10 cell using the terminal marked "30 Amps" and "Amps +" as shown in Fig. 6. Record the reading in the table prepared.

Questions.

(5) *Which cell gave the greater amperage reading, the BA–4 cell or the BA–10 cell? Note the difference in size between the two cells.*

(6) *Which of the two cells will deliver the same current for a longer period of time?*

Directions.

11. Using the "15 Amps" and "Amps +" terminals on the meter, measure the amperage of the BA–2 battery. Record reading in table prepared.

12. Using the same terminals as in Direction 11, measure the amperage of the BA–8 battery. Record the reading in the table prepared.

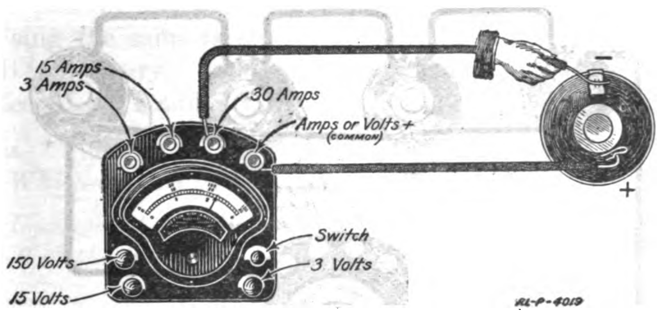


Fig. 6.—Method of making short-circuit test of type BA–10 cell.

Questions.

(7) *Which battery showed the higher reading?*

(8) *Why does one type of battery give a greater reading than the other?*

Information.

Parallel connections.—It is also possible to connect batteries in such a way that increased capacity in amperes may be obtained. Batteries connected in this way are said to be connected in *parallel.* Four reserve dry cells, connected in parallel are shown in Fig. 7. The positive terminals of the four cells are connected together and the negative terminals are connected together. One wire from the meter is connected to one of the positive poles while the other wire is connected to a negative pole, as shown. It is possible with this connection to draw four times the current which can be obtained from one cell.

Directions.

13. Take four cells and connect all the positive terminals together and all the negative terminals together. (See Fig. 7.) Cells connected in this manner are said to be connected in parallel. Test the voltage of this combination. Record the reading in the table prepared.

Question.

(9) *How does this voltage compare with the voltage of one of the cells?*

Directions.

14. Connect two cells in parallel. Using the 0–50 scale ammeter (or two model 280 voltammeters with their 30 Amp. terminals con-

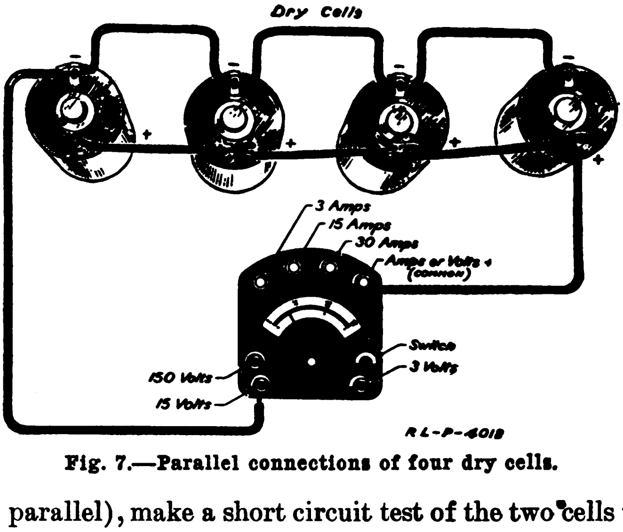


Fig. 7.—Parallel connections of four dry cells.

nected in parallel), make a short circuit test of the two cells thus connected. If the two model 280 voltammeters are used, the total current will be the sum of the readings of the two meters. Record the readings in the table prepared.

Questions.

(10) *How does this reading compare with the reading obtained when measuring the amperage of one cell?*

(11) *Multiply the reading obtained with one cell by the number of cells connected in parallel (two in this case). How does the answer compare with the meter reading of two cells in parallel?*

Directions.

15. Measure the voltage of the two cells connected in parallel. Record it in the table prepared.

Question.

(12) *How does this reading compare with the voltage of one cell?*

Information.

From the above experiments it may be seen that when cells are connected in series the voltage of the combined cells is equal to the voltage of one cell multiplied by the number of cells connected in series. The amperage of the cells in series, however, is the same as that of one cell.

When the cells are connected in parallel the voltage of the combined cells is the same as that of one cell, while the amperage is equal to the amperage of one cell multiplied by the number of cells.

Directions.

16. Using the "15 Amps" and "Amps +" terminals on the volt-ammeter measure the short circuit current of the BA–2 battery.

17. Using the same terminals measure the short circuit current of the BA–8 battery.

18. Record the readings in the table prepared.

Questions.

(13) *Which battery gave the higher reading?*

(14) *Upon what does the capacity in amperes of a battery such as the BA–2 or the BA–8 depend?*

Directions.

19. Using the information obtained in the above experiment, insert the correct values in the blank spaces in the table prepared as below.

Arrangement of cells.		Type of cell or battery.			
		BA-4.	BA-10.	BA-2.	BA-8.
1 cell	Volts				
	Amps				
2 cells in series	Volts				
	Amps				
4 cells in series	Volts				
	Amps				
15 cells in series	Volts				
	Amps				
30 cells in series	Volts				
2 cells in parallel	Volts				
	Amps				
4 cells in parallel	Volts				

STORAGE BATTERIES.

Equipment.

1 storage battery, type BB–14 (fully charged).
1 storage battery, type BB–28 (fully charged).
1 storage battery, type BB–41 (fully charged).
1 storage battery, type BB–5 (fully charged).
1 voltammeter, Weston model 280 (with leads).
1 pair battery leads, with clip terminals.
1 ruler.

Information.

Storage batteries.—The secondary battery or storage battery is somewhat similar to a primary battery. The storage battery, like the

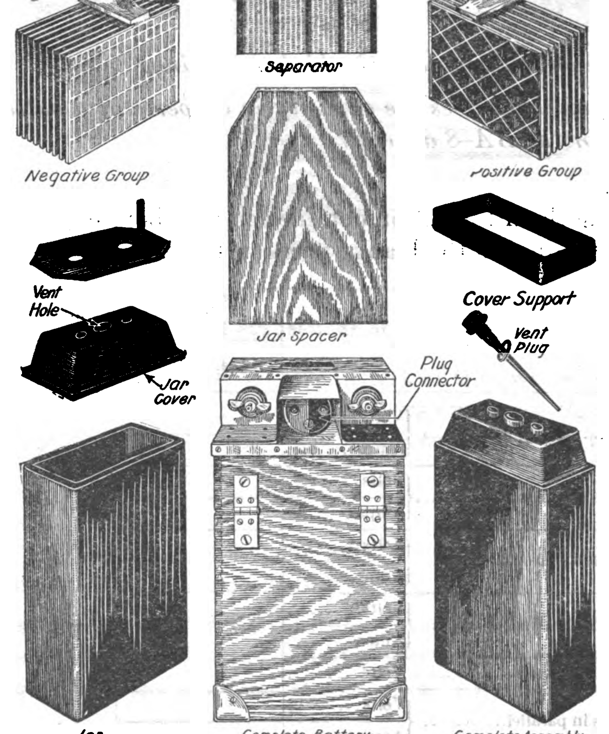
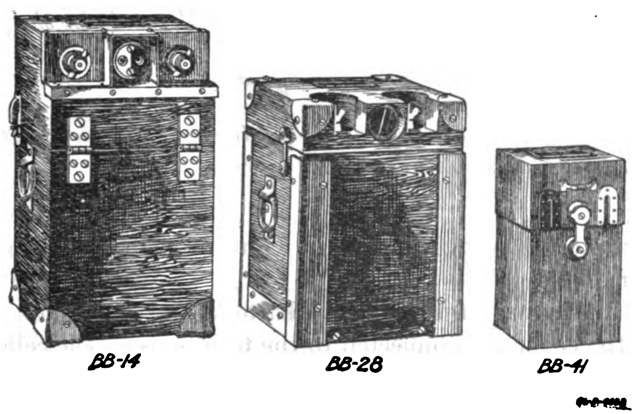


Fig. 8.—Various parts used in construction of type BB–14 storage battery.

primary battery, generates electricity by chemical reaction. The principal difference, however, is that before the storage battery can generate electricity it must first be *charged*. In other words, a direct current from an outside source of electricity, commonly a generator, must be sent through the battery. Usually this current is applied for a number of hours until the necessary chemical changes have taken place inside the battery. The battery is then ready for use. When current is taken from a storage battery, the battery is said to be *discharging*. After a battery has been used for a certain number of hours, it becomes discharged and can not be used again until the charging process is repeated.

Lead cell battery.—There are two types of storage batteries, one the lead cell type, and the other the Edison battery in which the



Figs. 9, A–B–C.—Three types of lead cell storage batteries used in signal communication.

plates are made of nickel and iron. A storage cell of the lead type consists of a hard rubber or composition jar in which are placed two sets of lead plates. (See Fig. 8.) The plates of one set fastened together to a common terminal form the negative pole of the battery, while the plates of the other set also fastened together to a common terminal, form the positive pole of the battery. The negative plates are made with small rectangular indentations or pockets on both sides. These pockets are filled with active chemical material. The positive plates are made in the same manner, but are filled with a different active chemical material. The group of negative plates are immeshed with the group of positive plates in such a manner that beginning from one side of the cell the first plate is negative in polarity, the next plate positive, the next negative, and so on. In order to keep the plates from touching one another, a wooden or a hard rubber separator is placed between the plates. The cell jar is filled with a dilute solution of sulphuric acid and water.

The majority of storage batteries used in the Signal Corps for radio purposes consist of two cells. In order to protect the cells against damage, they are inclosed in a strong wooden box at the top of which terminals for connections are provided. The battery shown in Fig. 8 and Fig. 9, A, is the type BB–14 storage battery.

The type BB–28 storage battery shown in Fig. 9, B, is similar in construction to the type BB–14 battery. The type BB–41 is a portable, two-cell, storage battery which is much smaller in size than the other type of batteries. This battery is shown in Fig. 9, C.

As the short circuit amperage of a storage battery is very high it is impractical to determine its serviceability by the short-circuit test. *Under no conditions should an ammeter be connected across the terminals of a storage battery, as this action will result in the burning out of the meter.*

Question.

(1) *When dry cells are replaced by storage batteries what additional equipment must be provided?*

Directions.

1. Measure the height, length, and width of each of the three lead type batteries.

2. Open the cover of the BB–14 battery and note how the terminals on the cover are connected to the terminals of the cells. Also note the connection between the two cells.

3. Using the leads without the clips, connect the voltmeter to the outside cover terminals of the battery. A strip of red fiber marks the positive terminal of the battery, and a strip of black fiber marks the negative terminal. Measure the voltage of the battery.

4. Prepare a table similar to the one shown below and record the readings taken in this experiment and those following.

Type of storage battery.	No. of cells.	Voltage of one cell.	Voltage of battery.	Ampere-hour capacity.
BB–14..........	....	....	....	....
BB–28..........	....	....	....	....
BB–41..........	....	....	....	....
BB–5..........	....	....	....	....

5. Using the leads provided with the clip terminals, connect the voltmeter to the inside battery terminals, being careful to get the polarity right. Measure the voltage of the battery and record it in the table.

6. Measure the voltage of one cell by clipping the meter leads to the cell terminals as shown in Fig. 10. Record the reading in the table.

7. Connect the voltammeter to the outside terminals of the BB-28 battery. The positive and negative poles are clearly marked on the cover. Read and record the voltage.

8. Open the cover of the BB-28 battery and connect the voltmeter to either one of the cells using the leads with the clip terminals. (See direction 5.) Measure and record the voltage.

9. Repeat directions 6, 7, and 8, using the BB-41 battery in place of the BB-28 battery.

Information.

Voltage and amperage.—The voltage of a lead storage cell when fully charged is about 2 volts. The capacity of a storage battery is represented by its rating in "ampere-hours." This rating theoreti-

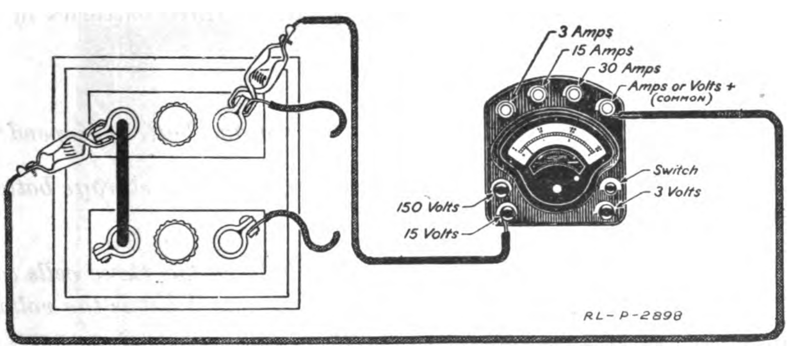


Fig. 10.—Method of measuring the voltage of one cell of a storage battery.

cally represents any discharge rate in amperes multiplied by the number of hours the battery may be discharged at that rate. For instance, a 100 ampere-hour battery will deliver 100 amperes for 1 hour, 50 amperes for 2 hours, 25 amperes for 4 hours, 10 amperes for 10 hours, or 2 amperes for 50 hours. It is not practical, however, to draw as many as 100 amperes for 1 hour from a storage battery of the small portable type, such as is used with radio sets. This rate of discharge is too great, and in a very short time would cause the battery to become completely ruined. It is necessary therefore to discharge the battery at a lower rate. A normal rate of discharge is usually specified by the manufacturer of the storage battery. The normal discharge rate is the rate at which experience has shown can not be exceeded without more or less injury to the battery. For instance, if the normal discharge rate of a 100 ampere-hour battery is

20 amperes, in no case should the battery be discharged at a higher rate than at 20 ampers.

The ampere-hour capacity of a battery depends mainly upon the size and number of plates in the cells. The greater the size and number of plates there are in a cell the greater will be the ampere-hour capacity of the battery.

The type BB-14 storage battery is a 100 ampere-hour battery consisting of two cells. Since the voltage of one cell is 2 volts and the cells are in series, the battery is rated at 4 volts.

The type BB-28 storage battery is a 90 ampere-hour battery. Since it contains two cells, the battery is rated at 4 volts.

The type BB-41 storage battery is a 2-cell, 4-volt, 16 ampere-hour battery. The plates are smaller in size and therefore the capacity of the battery is much less than the type BB-14 or BB-28 batteries.

Directions.

10. Fill in the ampere-hour capacity for all three batteries in the table prepared under Direction 4.

Questions.

(2) *Upon what does the voltage of a storage battery depend?*

(3) *Upon what does the ampere-hour capacity of a storage battery depend?*

(4) *A certain lead-cell type of storage battery has three cells connected in series and is rated at 60 ampere-hours. What is the voltage of the battery? For how many hours will it deliver 2 amperes of current?*

(5) *Which would be the easiest to carry in the field, the BB-14, BB-28, or BB-41?*

(6) (*a*) *A radio set which uses the type BB-41 battery is to be placed in service for continuous use with a combat unit in the field. This set requires 4 amperes for operation. Batteries can be delivered only once each night. How many batteries should be supplied in order to operate the set?*

(*b*) *If a BB-28 is used, how many batteries should be supplied for the same set?*

(*c*) *If a BB-14 is used, how many batteries should be supplied for the same set?*

(7) (*a*) *How many men would be required to carry the batteries in question* (6) (*a*)*?*

(*b*) *How many men would be required to carry the batteries in question* (6) (*b*)*?*

(*c*) *How many men would be required to carry the batteries in question* (6) (*c*)*?*

(8) *Which type of battery would a radio section chief decide to carry for the set in Question* (6) *if he were given his choice? Why?*

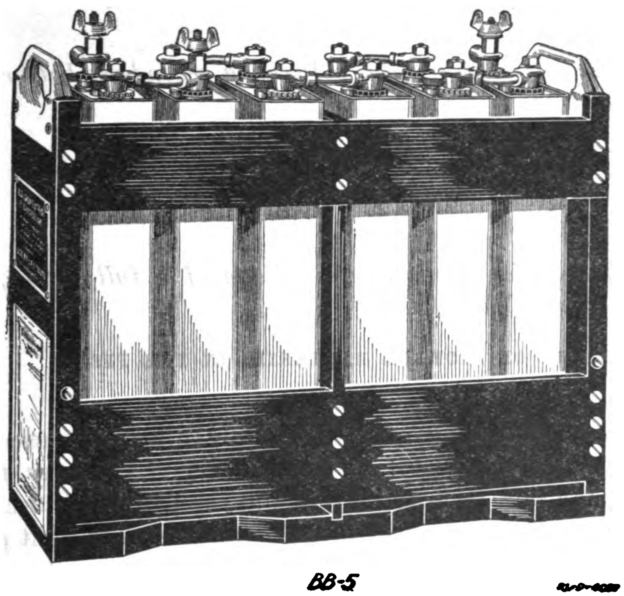


Fig. 11.—Edison storage battery, type BB–5.

Information.

Edison battery.—The Edison battery generates electricity in the same manner as the lead cell type of battery; that is, by chemical reaction. The Edison battery differs from the lead battery in construction, however, the positive plates of the Edison cells being composed of nickel while the negative plates are of pure iron. The cell jars are made of nickel-plated sheet steel. The solution used in the cells consists of caustic soda and water. The type BB–5 storage battery is an Edison battery having 6 cells. (See Fig. 11.) For situations requiring a portable battery, the Edison cells are contained in sheet-steel boxes, while for permanent installations a wooden rack is provided as a container for the cells.

Questions.

(9) *What is the chief advantage of the storage cell?*

(10) *What is the chief disadvantage?*

Directions.

11. Measure the voltage of the type BB–5 Edison battery. Measure the voltage of any one cell. Record the measurements in the table prepared under Direction 4.

The type BB–5 storage battery is a 6-cell, 8-volt, 100 ampere-hour Edison battery. The voltage of each cell is about 1.25 volts. Since there are 6 cells, the battery is rated at 7.5 volts.

Questions.

(11) *What is the difference between a secondary battery and a primary battery?*

(12) *How is a storage battery charged?*

(13) *How does the Edison storage battery differ from the lead cell type of battery?*

(14) *What is the approximate voltage of a fully charged lead type cell? Of an Edison cell?*

CARE OF STORAGE BATTERIES IN THE FIELD.

Information.

Spilling of acid.—Some of the lead storage batteries used by the Army for field service are of the nonspill type. However, this will not prevent the acid from leaking should the battery be overturned. To avoid this always keep the storage battery in an upright position. If any acid should spill or leak from the cell it must be carefully wiped off at once as it causes corrosion of the cell terminals. Take care never to get the acid on the hands or clothes as it may cause a burn or eat holes in the clothing.

Keeping terminals clean.—The action of the acid on the terminals of the cell is such as to cause a green insulating material to collect upon them. Should this material collect to too great a degree it will thoroughly insulate the terminal thus making it impossible to secure a good contact. Care must be taken that both terminals of the storage battery are kept clean as all times.

Testing.—Never short-circuit a storage battery to determine its state of charge as this may buckle the plates and permanently ruin the battery. The testing of a storage battery in the field should be by means of a voltmeter. When the battery is fully charged the voltage should be from about 2.0 to 2.2 volts per cell. The voltage drops as the battery is used until at discharge it is about 1.8 volts per cell.

Using one cell.—Sometimes it may be necessary to use only two volts instead of four volts. If only one cell of the battery is used the cells should be used alternately so as to discharge the cells to the same degree. This is to facilitate charging.

Dropping of batteries.—The case of each cell is made of hard rubber which if subjected to severe usage will crack and allow the acid to leak. Never throw the battery down on the ground or drop it.

RESISTANCE.

Equipment.

1 4-volt storage battery.
1 VT-1 vacuum tube.
1 VT-1 vacuum tube socket, attached to small board; the filament terminals on the socket should be wired to Fahnestock terminals on the board.
1 voltammeter, Weston model No. 280.
2 5-foot lengths No. 18 B. & S. magnet wire.
2 1-foot lengths No. 18 B. & S. magnet wire.
1 5-foot length No. 32 B. & S. magnet wire.
1 10-foot length No. 32 B. & S. magnet wire.
2 battery clips.
1 resistor (approx. 0 to 20 ohms).

Information.

Electrical resistance and conductors.—It is well known that pipes offer opposition or resistance to the flow of water through them, due to the friction between the running water and the sides of the pipes. In a somewhat similar way all bodies offer some opposition to the passage of an electric current through them. Hence all conductors of electricity, even the best, offer some opposition to the flow of an electric current. This opposition is termed the electrical resistance of a substance. Electrical resistance is measured in units called *ohms*. The resistances of different conductors vary according to the substances of which the conductors are composed. A pure silver conductor, for instance, offers less resistance to a flow of current than any other conductor of the same size. Due to its low resistance, silver makes the best conductor of electricity. For this reason silver is used as a standard with which to compare the resistances of other conductors. Next in order to silver in its readiness to conduct electricity ranks copper. While its resistance is higher than that of silver, yet it is somewhat lower than the resistance of any other substance. Because of this low resistance, together with its comparatively small cost, copper wire is the most commonly used conductor of electricity in general use. Other substances which may be used as conductors, but which offer higher resistances than do silver and copper, are mentioned here in the order in which their resistances compare with that of silver beginning with the material having the least resistance. These substances are: Aluminum, zinc, brass, platinum, iron, nickel, tin, lead, German silver, and carbon.

Resistance of wire.—The resistance of a conductor depends not only upon the nature of the substance of which it is made but also upon the size and length of the conductor. Thus the resistance of a copper wire depends upon its size (or cross sectional area) and its length. If two pieces of copper wire have the same length, but the diameter of the one is greater than the diameter of the other, then the resistance of the larger wire will be less than will that of the smaller wire. That is, the resistance of a wire conductor decreases with any increase in the size (or cross sectional area) of the wire. Also a piece of copper wire of a certain diameter and 10 feet long

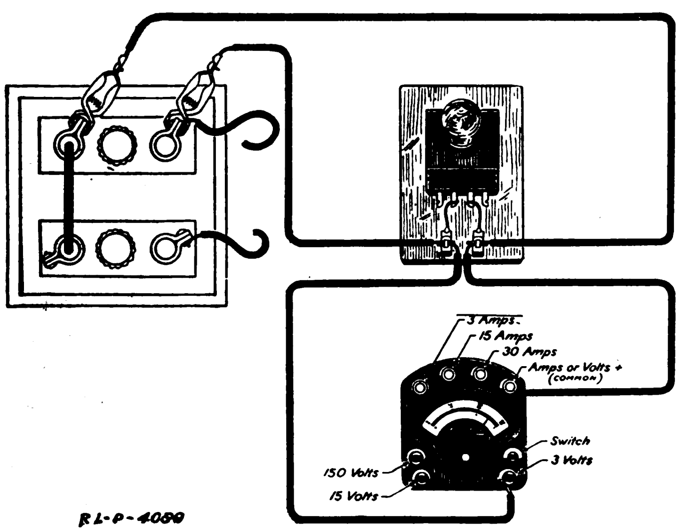


Fig. 12.—Method of measuring the voltage at the filament terminals of a vacuum tube or lamp.

will have a greater resistance than another piece of copper wire of the same diameter but only 1 foot long. In other words the resistance of a wire conductor increases with the length of the wire.

Directions.

1. The object of the following experiments is to show the effect of resistance in an electrical circuit. Attach a battery clip to one end of each of the two 5-foot lengths of No. 18 magnet wire. Open the 4-volt storage battery box and attach one of the clips to the positive terminal of one cell and the other clip to the negative terminal of the same cell. Connect the wires leading from the cell to the two Fahnestock terminals leading to the vacuum tube socket. (See Fig.

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12.) Using the two short lengths of No. 18 magnet wire, connect the 3-Volt terminals of the voltmeter across the two socket terminals.

2. Measure the voltage of the cell to be used by pressing the small button on the meter. The meter should then read about "2 volts."

3. Prepare a table similar to the one shown below and record the results that are obtained in the experiments that follow.

Direction No. in the text.	The experiment.	The question.	The answer.
2	Measurement of the voltage of cell...........................	Voltage is?.................	....
4	Measurement of voltage with tube in socket (leads, No. 18 wires)........................	Voltage at tube terminals is?	....
		Does tube light?...........	....
5	Measurement of voltage with tube in socket (leads, 5 feet No. 18 wire; 5 feet No. 32 wire).......................	Voltage at tube terminals is?	....
		Does tube light?...........	....
6	Measurement of voltage with tube in socket (leads, 5 feet No. 18 wire; 10 feet No. 32 wire).........................	Voltage at tube terminals is?	....
		Does tube light?...........	....

4. Place the vacuum tube in the socket. To do this properly, turn the tube until the pin on the side of the base clips into the slot in the side of the socket. Press the tube down and turn to the right until it is locked in place. Notice whether or not the filament of the tube is lighted. (The filament when properly lighted glows a dull red.) Press the button on the voltmeter and note the reading. Record observations in the table that has been prepared.

5. Remove one of the 5-foot No. 18 wire leads from the circuit and replace it with the 5-foot No. 32 wire. Note whether or not the filament of the tube lights. Press the button on the meter and note the reading. Record the observations in the table.

6. Remove the 5-foot length of No. 32 wire from the circuit and replace it with the 10-foot length of No. 32 wire. Note whether or not the filament of the tube lights. Again take a voltmeter reading. Record the observations in the table.

7. The amount of current flowing through the vacuum tube filament is indicated by its brilliancy. The more current the greater the brilliancy. Any change in brightness clearly demonstrates that the current in the circuit has changed. Thus the vacuum tube in these experiments shows us at once relative amounts of current flowing through it.

Questions.

(1) *Look at the table which you have completed. Is there a difference in the readings of the voltmeter in Directions 2 and 4? If there is a difference, to what is it due?*

(2) *Why did the filament light up in the experiment under Direction 4, but not light in the experiment under Direction 5?*

(3) *What does the voltmeter show regarding two pieces of wire which are of the same length but of different sizes?*

(4) *Which wire delivers the smallest amount of current to the tube, the 5-foot No. 32 wire or the 10-foot No. 32 wire?*

(5) *What is the object in placing a resistance in a circuit?*

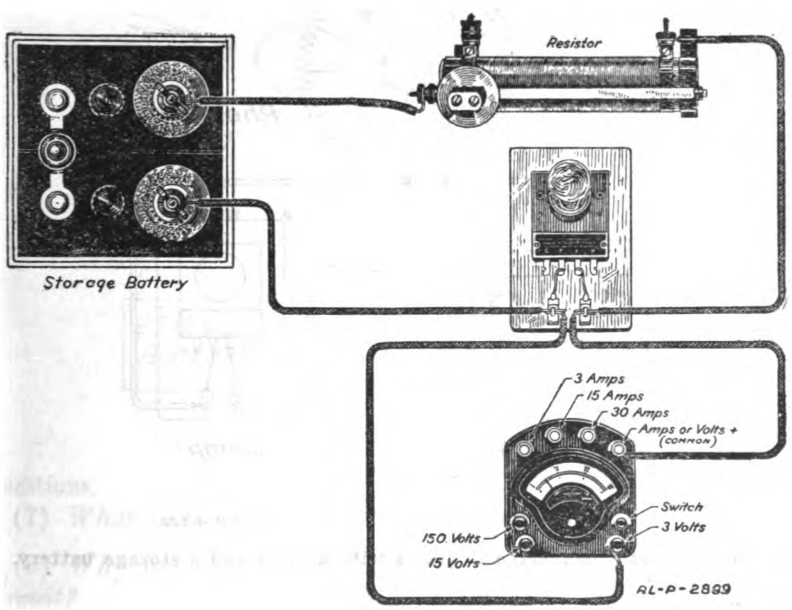


Fig. 13.—Method of connecting a resistor in series with a vacuum tube and storage battery.

Information.

Resistors.—If a certain length of resistance wire, for example, German silver wire, is inserted in a vacuum tube circuit in which a current is flowing, the pressure at the terminals of the tube will be reduced, and at the same time the flow of current through the tube will be reduced. If the length of the resistance wire is increased the voltage and current will be still further reduced. Fig. 13 shows a resistance inserted in series with a VT–1 vacuum tube and battery. The resistance in this case is a device known as a *resistor* or *rheostat.*

The resistor consists of a tube of insulating material upon which is wound a number of turns of German silver or composition resistance wire. The ends of the coil thus formed are fastened to connecting terminals attached to the ends of the tube. A fastening device at each end of the tube supports a slide rod placed above the coil. A slider makes connection between the slide rod and the resistance wire by means of a contact spring attached to the slider. The number of turns of resistance wire, in other words the length of the wire in use, may be varied by moving the slider. The storage battery in Fig. 13, is a 4-volt battery. The filament of the tube shown requires only 2.5 volts in order to burn at proper brilliancy.

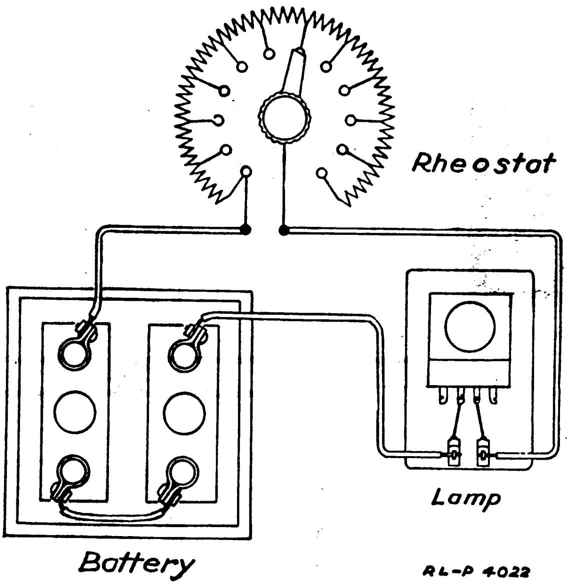


Fig. 14.—Rheostat connected in series with a lamp and a storage battery.

Directions.

8. Replace the 10-foot No. 32 wire with the 5-foot No. 18 wire so that the connections will be the same as originally made in Direction 4. Cut one of the 5-foot leads in the middle and remove the insulation from the ends of the wires. Connect these ends to the resistor exactly as shown in Fig. 13, making sure the slider on the resistor is placed at the terminal end of the rod. Press the button switch on the meter and note the reading. Note whether or not the filament of the tube is lighted.

Question.

(6) *What is the reading of the voltmeter?*

Directions.

9. Move the slider about one-fourth of an inch toward the opposite end of the rod and notice any change in the voltmeter reading as well as any change in the lighting of the filament.

10. Move the slider gradually in the same direction until the filament of the tube glows a bright red. *Caution:* Do not move the slider beyond a point at which the voltmeter needle swings to the end of the scale (3 volts), as there will then be danger of burning out the filament of the tube.

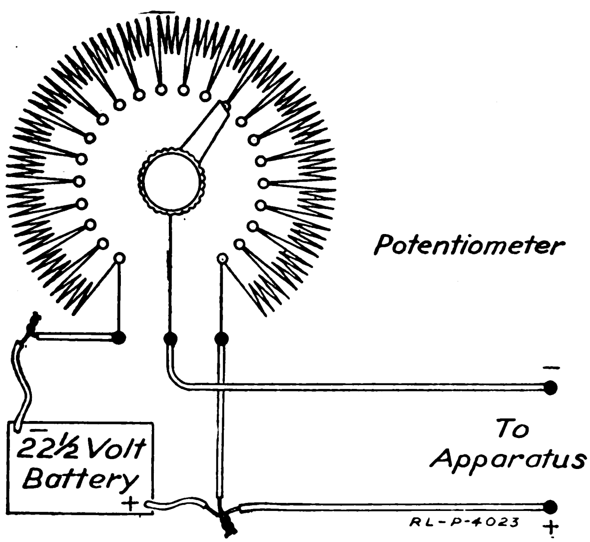


Fig. 15.—Method of connecting a potentiometer.

Questions.

(7) *What voltage was indicated by the voltmeter in Direction 10?*

(8) *Why does the filament burn brighter with less resistance in the circuit?*

(9) *Why is it necessary to use a resistor in this circuit?*

(10) *Does the voltage reading of the meter increase or decrease as the filament of the tube burns brighter?*

Information.

Resistances, Rheostats, Potentiometers.—Resistances or rheostats are also made in a circular form. Taps are taken off from a resistance winding and connected to switch points. The amount of resistance included in a circuit is varied by turning a rotary switch arm which makes contact with the switch points. A rheostat of the circular type properly connected in series with a VT–1 vacuum tube and battery is shown in Fig. 14.

Another method of connecting resistance in a circuit is shown in Fig. 15. The resistor when used in this manner is called a *potentiometer.* With the connections shown, it is possible to obtain any voltage desired from zero up to the full voltage of the battery. The potentiometer is similar in construction to the rotary type of rheostat. The resistance wire of the potentiometer is much greater than that of the rheostat. This high resistance is necessary due to the fact that the wire is connected directly across the terminals of the battery. As shown in Fig. 15, the resistance winding of the potentiometer is connected directly across the 22½-volt battery. The switch arm is connected to one terminal of the apparatus to be used while the other terminal is connected to one side of the battery. By turning the switch arm the voltage delivered to the terminal of the apparatus is varied accordingly.

Questions.

(11) *Why is the circular form of rheostat more practical for use in a radio set than the straight type resistor?*

(12) *Why could not a potentiometer, used as in Fig. 15, be constructed with a low resistance similar to a rheostat?*

MAGNETS.

Equipment.

30 feet No. 24 copper magnet wire.
1 small bobbin or spool (with removable iron core).
1 type BA–10 reserve dry cell (charged).
1 small piece of iron (iron nail).
1 head set, type P–11.
1 test buzzer.

Information.

Two sorts of magnets will be discussed in this Unit Operation: Permanent magnets and electromagnets.

Permanent Magnets.—Nearly every one is familiar with the permanent type of magnet. Usually, it consists of a magnetized steel

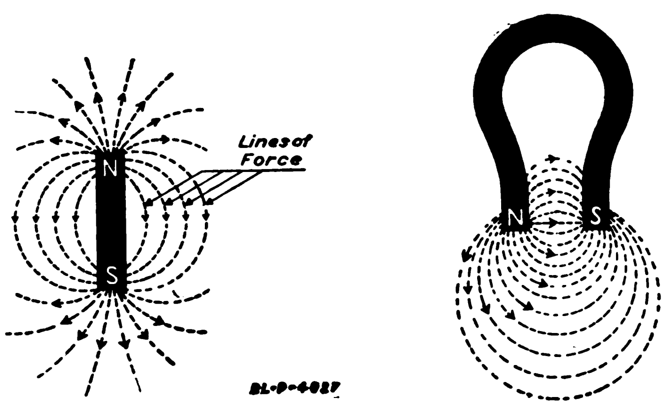


Fig. 16.—A straight bar magnet and a horseshoe magnet.

bar bent in the shape of a horseshoe. If this magnet is held near other small pieces of iron or steel the latter will be attracted and cling to it. This attraction is due to the magnetic lines of force which extend about the ends of the magnet. The area surrounding the magnet which includes these magnetic lines of force is known as the *magnetic field.* Fig. 16 shows a horseshoe type of magnet and also a bar magnet with the magnetic fields which surround each. The ends of a magnet are called the *poles.* One end is known as the *north* pole and the other end as the *south* pole.

If a piece of steel is placed across the poles of a permanent magnet and then forcibly pulled away it will be found that the piece of steel has itself also become slightly magnetized and that it will attract other pieces of iron or steel. In other words, if a piece of steel comes in contact with the poles of a magnet or is placed within the fields of a magnet, it will still retain some of the magnetism after it has been removed. In this respect steel differs from pure iron. A piece of pure iron which has been placed across the poles of a magnet will at once lose all traces of magnetism when it is pulled away.

Electromagnets.—When a wire conductor is carrying a current, a magnetic field is produced around the wire as shown in Fig. 17, A. Fig. 17, B shows the magnetic field produced when an insulated wire is wound in the form of a coil and connected to a battery. In addition to the magnetic field immediately around the circumference of the wire itself, a general magnetic field is produced about the coil formed by the wire.

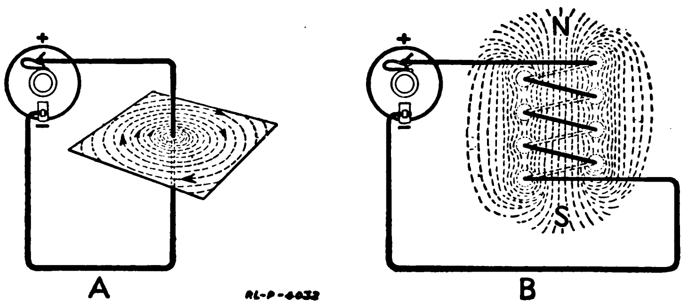


Fig. 17, A.—Magnetic field produced around a straight wire conductor.
Fig. 17, B.—Magnetic field produced around a coil of wire carrying an electric current.

Directions.

Construction of an Electromagnet.—1. Take the spool or bobbin and wind it full with magnet wire. To do this start winding at one end of the spool, leaving about 8 inches of the wire free at the beginning for a connection. Wind the turns close together and evenly until one layer has been completed. Then wind the second layer back over the first layer. Continue winding in this manner in layers until all the wire has been wound on the spool but about 8 inches, which is to be left for a connection or lead wire. Scrape off the insulation at the ends of the two short lengths of wire which have been left extending from the winding.

2. Hold the small piece of iron or the iron nail close to one end of the iron core provided and note whether or not there is any magnetic attraction between the two.

3. Place the iron core inside of the spool of wire and repeat Direction 2.

Question.

(1) *Was there any magnetic attraction between the iron core and the piece of iron in the above experiment?*

Direction.

4. Connect the leads from the coil to the terminals on the battery. Repeat Direction 2.

Questions.

(2) *Does the flow of current through the coil have any effect on the iron core? Explain.*

(3) *Why is the piece of iron not attracted by the iron core when no current is flowing through the coil? (See Direction 3.)*

Information.

Electromagnet.—If a bar of iron is placed inside a coil of wire which is connected to a battery, the iron will be found to be magnetized and will attract other pieces of iron or steel. Now if the current passing through the coil is switched off, the field around the coil will disappear or collapse and the iron bar will be found to be no longer magnetized. The iron bar will remain magnetized just so long as the current is turned on, but as soon as the current is turned off the iron loses its magnetism. A bar of iron surrounded by a coil of insulated wire, as described above, is an example of an *electromagnet.* The principle of the electromagnet is made use of every day in the construction and operation of electric bells, telephones, arc lamps, motors, generators, etc.

Question.

(4) *If an unmagnetized steel core were placed inside a coil and a current sent through the coil, would the steel core retain any magnetism after the current was turned off?*

Information.

Telephone receivers.—Telephone receivers, which are necessary with every type of radio receiving set used in the Signal Corps, depend both upon the electromagnet and the permanent magnet for their operation. One of the standard types of telephone receivers for radio work is illustrated in Fig. 18.

Directions.

5. Remove one of the telephone receivers from the head band and examine it closely. Notice the two wires leading into the receiver through the holes in the case.

6. Unscrew the hard rubber cap. Carefully remove the thin iron disk (the diaphragm) by sliding it from the receiver case. Note carefully that the two sides of the disk are not colored the same and that the light colored side is toward the magnets.

Question.

(5) *Are the coils of the receiver wound with coarse or with fine wire?*

Directions.

7. Notice the permanent horseshoe magnet at the bottom of the receiver case.

NOTE.—The soft iron cores of the two coil magnets are attached by steel supports to the poles of the permanent magnets located at the base of the receiver.

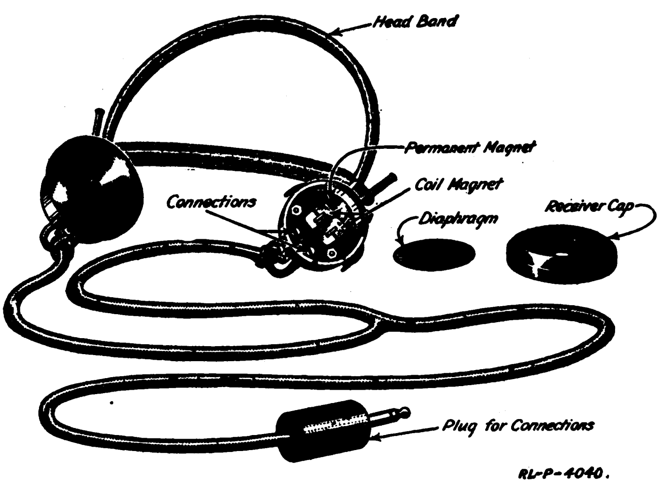


Fig. 18.—Headset, type P-11, with caps and diaphragm of one receiver removed.

Question.

(6) *If the cores of the two small electromagnets are made of soft iron, why is it that they exert a pull upon the diaphragm of the receiver?*

Directions.

8. Carefully replace the diaphragm making sure the light colored side is toward the magnets. Screw the cap on the receiver case.

Information.

The Telephone Receiver.—The action of a telephone receiver is as follows: Whether there is any current passing through the coils or not the poles of the permanent magnet exert a steady pull upon the diaphragm. This causes the diaphragm to be curved slightly inward toward the poles of the magnet, but without quite touching them. If a small current is now passed through the coils, the magnetic field produced by the coils will either help or hinder the magnetic effect of the permanent magnet, depending upon the direction of current through the coils. If the permanent magnet field is strengthened by the field of the coils, a stronger pull will be exerted upon the diaphragm causing it to move closer to the magnet poles. If the permanent magnet field is weakened by the field of the coils the magnetic pull on the diaphragm will be reduced, thus causing the diaphragm to move away from the poles of the magnet. The rapid opening and closing of a switch placed in series with a telephone receiver and battery will cause an intermittent or broken-up current to pass through the coils of the magnet. This intermittent current in turn will produce a series of back and forth motions of the diaphragm. The motions of the diaphragm will set up vibrations in the air and these vibrations will become noticeable to the ear in the form of a series of clicks. By substituting in place of the switch a make-and-break device which will interrupt the current very rapidly, a note will be heard in the receiver, the pitch of which will depend upon how rapidly the current is being interrupted.

Since only very small currents are available, from a radio receiving set, a great many turns of insulated wire must be wound on the telephone receiver magnets in order to produce a magnetic field strong enough to cause a movement of the diaphragm. A fine wire is used in order that the necessary number of turns may be wound in the small space provided. Since the wire is very fine the resistance of the coils is high. For example, the resistance of the type of receivers shown in Fig. 18, is approximately 1,100 ohms.

The receivers used in a head set are connected in series. In this case the total resistance of the receivers is 2,200 ohms.

Directions.

9. Connect one of the phone cord terminals to one of the dry-cell terminals. Place the receivers on the head. Touch the other terminal of the dry cell several times with the remaining cord terminal.

Question.

(7) *What happens when this is done?*

Information.

The Electric Buzzer.—The buzzer is another electrical device which utilizes the electromagnet. The buzzer shown in Fig. 19 is the type used in conjunction with radio sets. It consists of a composition base, upon which is mounted a small two-coil electromagnet, the core of which is made of soft iron. Directly in front of the poles of the magnet is a strip of spring steel which is fastened to a part of the magnet support. A set-screw terminal is provided on this part of the support. A small piece of silver or alloy metal is fastened to a spring structure attached to the strip of spring steel. This small piece of low-resistance metal is known as a contact. The spring-steel strip is called the vibrator or armature of the buzzer. A second contact is provided on the end of a thumbscrew mounted directly in front of the contact on the vibrator. The support of this contact screw is provided with a small-screw terminal. A third thumbscrew is used to adjust the tension of the spring vibrator.

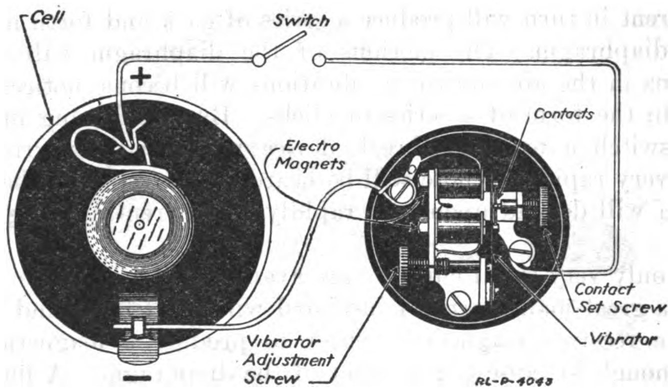


Fig. 19.—Test buzzer with cap removed to show parts and method of connecting to dry cell.

The wire connections of the buzzer are as follows: One end of one of the coils is connected to the screw terminal at the base of the buzzer. The other end of this coil is connected to an end of the second coil, thus placing the two coils in series. The other end of the second coil is connected to the vibrator.

Directions.

Connecting and Operating a Buzzer.

10. Examine the buzzer thoroughly. Trace the connections from the coils. Notice the various adjustment screws.

11. Adjust the thumbscrew controlling the tension of the vibrator arm, so that about one thirty-second of an inch space exists between the poles of the magnets and the vibrator. Adjust the contact thumbscrew in front of the vibrator so that it just makes contact

with the vibrator. Connect one terminal of the dry cell to one terminal of the buzzer as shown in Fig. 19. Connect one end of a lead wire to the other terminal of the battery. Touch the vibrator terminal with the other end of the lead wire.

Question.

(8) *What happens when the vibrator terminal is touched with the end of the lead wire?*

Direction.

12. Connect the lead wire to the terminal of the contact screw located in front of the vibrator.

Question.

(9) *What happens when the above connection is made?*

Direction.

13. With the buzzer still running try adjusting the set screws on the buzzer and notice the pitch of the note obtained with each adjustment.

Information.

The Action of a Buzzer.—The action of a buzzer is as follows: When the switch in Fig. 19 is closed, the current passes through the positive lead to the contact screw, through the contact screw and vibrator, then through the coils in series, and back through the negative lead to the dry cell. When the current passes through the magnet coils the iron cores of the magnet become magnetized and attract the vibrator or armature. This attraction pulls the armature away from the contact thumbscrew and thus causes the circuit to be broken. As soon as the circuit is broken the electromagnets lose their magnetism and no longer attract the armature. The tension of the armature causes it to return to its original position, that is, resting against the contact screw. This movement results in the circuits again being completed and the armature again is attracted to the magnets. This action is repeated over and over again, causing the armature to emit a sound or note.

Question.

(10) *Upon what does the speed at which the armature vibrates depend?*

THE SCR-61 WAVE METER.

Equipment.

2 wave meters, type SCR-61.
1 small screw driver.
1 head set, type P-11.

Information.

ELECTROMAGNETIC WAVES.

It is a well-known fact that when a stone is thrown into a pond a series of ripples or waves is created. Similarly, if air is disturbed by the vibrating of a bell or the blowing of a whistle, sound waves are produced in the air. Light and heat are also transmitted by waves. In fact, many of the most familiar phenomena of everyday life are caused by wave motion.

The particular form of waves which have to do with radio communication are known as *electromagnetic* or *radio* waves. Electromagnetic waves travel through a medium called the ether which, though it is invisible, is supposed to exist everywhere throughout all space. Electromagnetic waves may be produced in the ether by electrical disturbances such as are caused by the electrical currents of a radio transmitting set. These waves possess energy and are capable of doing work. In other words, a radio transmitting set sends out energy in the form of wave motion. A radio receiving set placed at a considerable distance from the transmitting set intercepts the waves of the transmitter. The energy which has been transmitted over this distance by means of the wave motion operates the radio receiver and causes it to produce a perceptible signal.

Every wave has a length and this length can be measured. For instance, in the case of water waves, the wave length is usually determined as the distance between the tops of the crests of two successive waves. The wave length of any other kind of wave can be determined in the same way. It is common practice to use the symbol λ (the Greek letter lambda, pronounced lam-da) to represent wave length. This length is generally expressed in meters instead of feet.

A radio transmitting set is usually designed to send out waves of different lengths. For instance, a message may be sent on a wave length of 250 meters. By properly adjusting the transmitter the length of the wave may be changed to 300 meters, 500 meters, or some other desired length. The series of wave lengths over which a set will transmit is known as the wave-length range of the transmitter. The wave-length range is also spoken of as the wave-length band.

Questions.

(1) *How are sound, light, and heat transmitted?*

(2) *What kind of wave is used in radio communication?*

(3) *How is this wave produced?*

(4) *How is it known that the waves from a radio transmitting set possess energy?*

(5) *Between what two points is the length of a wave measured?*

(6) *In what units is the length of a wave usually expressed?*

(7) *Can a radio transmitting set be made to transmit on more than one wave length?*

(8) *What is meant by the wave-length range of a radio transmitting set?*

DETAILS OF THE WAVE METER.

Information.

General construction of the wave meter.—If, on an ordinary telephone party line, all of the subscribers attempted to carry on a conversation at the same time, considerable confusion would arise due to the fact that each party would be talking over the same circuit. In the same way if all radio transmitting stations were allowed to use any wave length they pleased at random, there would be considerable interference at the radio receiving stations due to the fact that a number of transmitting stations would probably be transmitting on the same wave length and the received signals would consequently be so jumbled together that it would be impossible to read them. To overcome this sort of interference in radio communication certain wave lengths are assigned to the various classes of transmitting stations in operation.

For instance, amateur radio stations are limited to a wave-length band of from 150 to 200 meters; Government stations are allotted certain wave lengths, such as 300, 600, 900, 1,200, 5,000 meters, etc. Radiophone broadcasting stations are confined to a wave-length band of from 250 to 700 meters.

In order to keep within the limits of these wave-length allocations and to facilitate efficient radio communications it is necessary to measure the wave length of a radio transmitter. As electromagnetic waves are invisible and can not be measured with ordinary measuring instruments an electrical instrument known as a *wave meter* is used.

The wave meter is an instrument by means of which it is possible to measure the length of electromagnetic waves generated by some outside agency, such as a transmitting set. The wave meter may also be used to generate and to emit (send out) waves of a known length. The radio operator uses the wave meter for both of these purposes when he measures the wave length of transmitting sets (both local and distant), and when he calibrates transmitting and receiving sets.

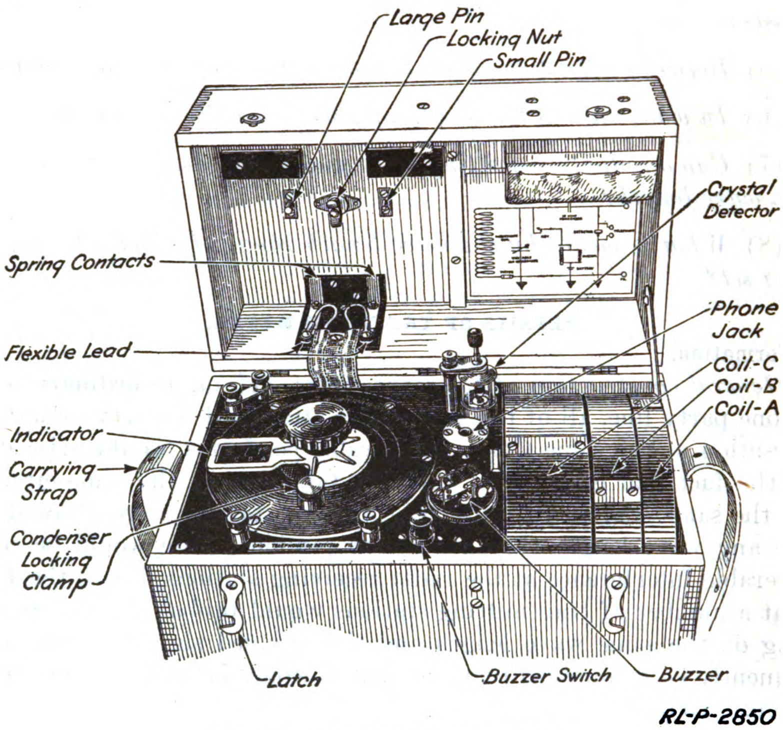


Fig. 20.—The SCR-61 wave meter.

The most important parts of an SCR-61 wave meter are the rotary condenser, inductance coil, buzzer, crystal detector, and the dry cell. See Figs. 20, 21, and 22.

Directions.

1. Unbuckle the leather carrying strap. Release the two latches on the front of the box and raise the cover. Study Figs. 20, 21, and 22 to learn the names of the important parts of the meter which can

be seen when the cover is raised. Learn the names of these parts so that they can be given promptly when required.

2. Take the three coils out of the right-hand compartment of the box. Note on just which coils the letters A, B, and C appear. Look in the cover of the box and locate the clamp by which the coils are fastened in place. Using this clamp, fasten coil A in place. (See Fig. 21.) Be careful that the coil is fastened firmly. Then remove coil A and try the other two coils in position, making sure that they fit.

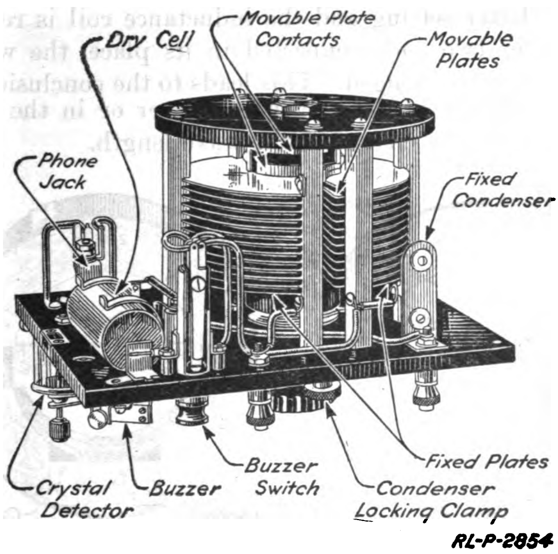


Fig. 21.—Panel of set box BC–37 removed to show interior parts.

Questions.

(9) *Why is it important to know the length of an electromagnetic wave?*

(10) *What is the purpose of the wave meter?*

(11) *How is the wave meter inductance coil constructed?*

(12) *What is the approximate size of each of the three coils?*

(13) *Which coil (A, B, or C) is the largest? Which is the smallest?*

(14) *Why were the two holes in the coil support made different in size?*

(15) *How is contact made with the wire on the coils?* (*See Figs. 20 and 22.*)

Information.

The Inductance Coils.—The two main parts of the wave meter are the *inductance coil* and the *rotary condenser.* These two parts control the length of the wave emitted by the wave meter and measure the waves emitted by a radio transmitter. For example, suppose one of the three inductance coils supplied with the wave meter is correctly inserted and connected in its proper place. If now the setting of the rotary condenser is changed to another setting the length of the emitted wave will be changed. If the rotary condenser is left at this latter setting and the inductance coil is removed and one of the other two coils connected in its place, the wave length emitted will again be changed. This leads to the conclusion that any change in the setting of the rotary condenser or in the size of the inductance will cause a change in the wave length.

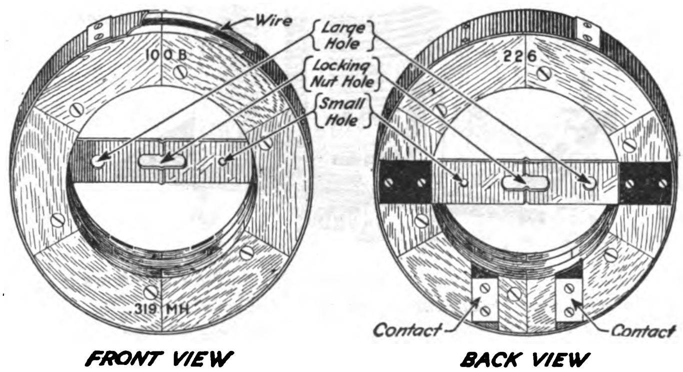


Fig. 22.—Details of inductance coils used in SCR–61 wave meter.

As stated above three inductance coils are furnished with each wave meter of the SCR–61 type. Each coil covers a certain band of wave lengths. Any wave length within this band may be obtained by adjusting the rotary condenser according to the scale on the meter. If after using any one of the three inductance coils in the wave meter, the desired wave length is not found within the wave-length band of the coil, it will be necessary to substitute the one of the two remaining coils which includes the desired wave length within its band. Using the three inductance coils a wave-length band of from 150 to 2,600 meters may thus be covered.

Questions.

(16) *What are the two main parts of the wave meter?*

(17) *What do these parts control?*

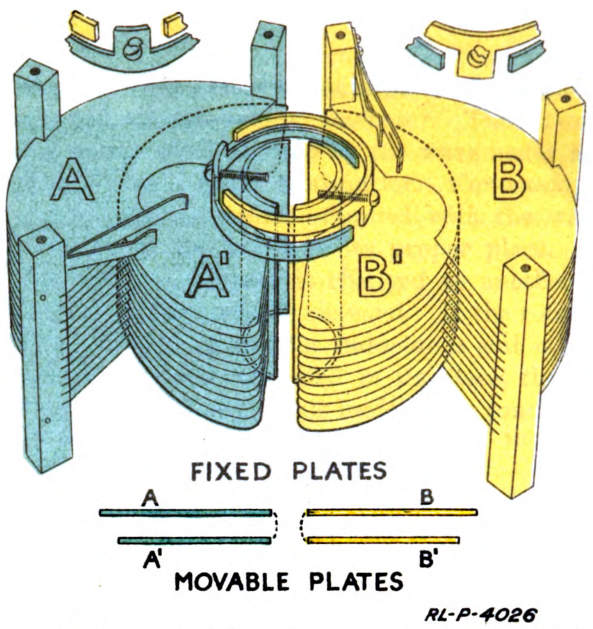


Fig. 23.—Schematic view of variable condenser used in the SCR-61 wavemeter, showing minimum capacity position of plates.

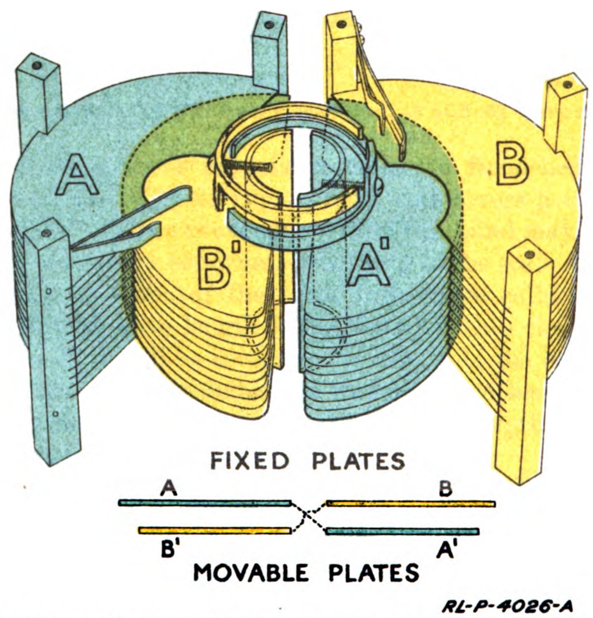


Fig. 24.—Schematic view, showing maximum capacity position of plates.

(18) *What does each inductance coil limit?*

(19) *Why are three inductance coils supplied with the meter?*

(20) *What is the purpose of the rotary condenser?*

Directions.

3. Remove the four screws from the corners of the panel and lift the panel from the box by means of the binding posts marked "FIL" and "METER." It will be necessary to disconnect the canvas covered wires leading up to the lid of the box. This is done by removing the three screws holding the wires in position. Put all the screws in the right hand compartment of the box in order that they will not be lost.

Questions.

(21) *Why was the panel lifted out by certain binding posts?*

(22) *How is the box lined?*

(23) *Do the screws holding the panel in place serve to make an electrical connection between the lining of the box and the wiring on the panel? Look under the panel where the screws go through and see how many connections are made in this way.*

Directions.

4. Hold the panel on edge and study the construction of the rotary condenser. Rotate the knob on the front of the panel and notice what turns behind the panel. Trace the connection between the fixed and movable plates. (See Figs. 23 and 24.)

Information.

The Rotary Condenser.—A rotary condenser usually consists of a number of stationary or fixed semicircular plates together with a number of movable or rotary semicircular plates. The movable plates rotate in such a way as to slip into the spaces between the stationary plates. A pointer moving over a circular scale indicates the position of the movable set of plates. (See Fig. 20.)

A condenser has the property of governing the flow of certain forms of electricity which occur in a radio set. This property is expressed interms of *capacity*. The unit for expressing the capacity of a condenser is the *farad*. A subdivision of the farad is known as a *microfarad*, which is $\frac{1}{1{,}000{,}000}$ of a farad.

As a close relationship exists between wave length and capacity, any change in the capacity of the rotary condenser in the SCR-61 wave meter will cause a change in the length of the wave emitted by the wave meter. The capacity of the rotary condenser may be changed by changing the position of the rotary plates with respect to the position of the fixed plates.

The details of the mechanical construction of the rotary condenser employed in the SCR–61 wave meter are rather complicated and do not come within the scope of this course. An understanding of the general principle involved will be sufficient.

From a careful study of the condenser in the wave meter itself together with the illustrations in Figs. 23 and 24, it will be evident that the condenser consists of two sets of fixed plates and two sets of movable plates. In the illustrations the sets of fixed plates are marked "A" and " B " while the movable plates are marked "A′" and " B′." The two sets of fixed plates have been separated at one end to show more clearly the details of the movable plates. Connections to the wave meter circuit are made from the two sets of fixed plates. The set of fixed plates marked A is connected to the set of movable plates marked A′ through a contact device. In the same manner the other set of fixed plates B are connected to the movable plates B′ through a similar contact device. When the movable plates A′ are entirely covered by the fixed plates A and the movable plates B′ are entirely covered by the fixed plates B the capacity of the condenser is at a minimum. (See Fig. 22.) When the movable plates are rotated to the opposite position so that the plates A′ are entirely covered by the fixed plates B and the plates B′ are entirely covered by the fixed plates A, the capacity of the condenser is at a maximum.

Questions.

(24) *How many sets of fixed plates are there in the rotary condenser of the SCR–61 wave meter?*

(25) *How many fixed plates are there in each set?*

(26) *How many sets of movable plates are there in the condenser?*

(27) *How many movable plates are there is each set?*

(28) *Are the movable and fixed plates connected together?*

(29) *How is the position of the movable plates varied?*

(30) *What is meant by the capacity of a condenser?*

(31) *What is the unit used for expressing capacity? What is a microfarad?*

(32) *What is the purpose of the rotary condenser in the SCR–61 wave meter?*

WAVE METER AS A TRANSMITTER.

Information.

In order that the wave meter may be used as a low power transmitter, a small buzzer is provided. The buzzer consists of two small electromagnets, an adjustable armature or vibrator, and an adjustable contact screw. The longer of the two thumbscrews on the buzzer is used to adjust the armature, while the shorter thumbscrew is used to adjust the contact with the armature.

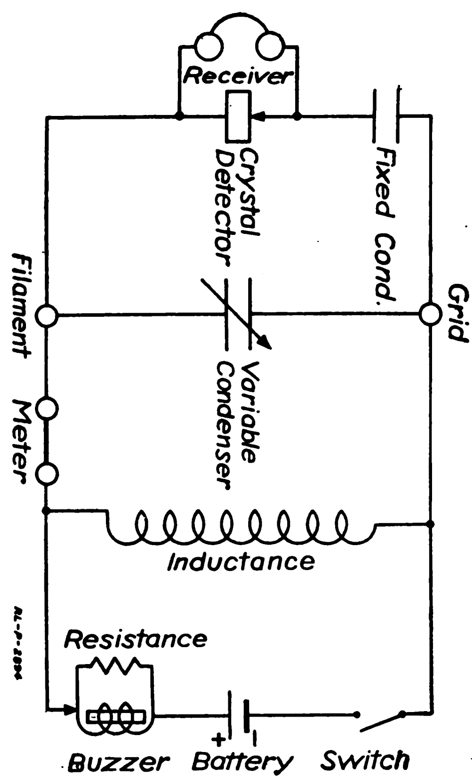


Fig. 25.—Schematic diagram of connections in the SCR–61 wave meter.

The buzzer is operated by a dry cell of the BA–4 type. It should be noticed that the support for the BA–4 dry cell is so arranged that the positive or center terminal of the cell makes contact with the spring terminal located close to the rotary condenser. The negative pole (the outside of the cell itself) makes contact with the brass lug located at the edge of the panel. The dry cell should never be put in the support backwards. In some types of wave meters if this is done, the dry cell will become short-circuited and run down in a short time.

A push-pull buzzer switch is provided on the panel of the wave meter to turn the current from the dry cell on or off. On some wave meters the buzzer is operated by pulling out the switch button. On others the button must be pushed in.

Sometimes an operator leaves the switch closed so that the current flows through the buzzer circuit. The wave meter may then be stored away without this fact being detected. Later some other operator may try to use the wave meter, but will be unable to do so for the reason that the cell will have become corroded and the contacts destroyed. To prevent an occurrence of this kind, *always see that the buzzer switch is open or else remove the battery.*

Directions.

5. Trace the wiring diagram of the wave meter with particular reference to the buzzer, buzzer switch, battery, small resistance, leads to the inductance coils, meter connections, and the variable condenser. Omit the wiring to the detector, fixed condenser, and phones. Remember that there must be a complete metallic circuit in order that the buzzer may operate.

Questions.

(33) *Will the circuit from the battery to the buzzer be complete if there is no inductance coil in place in the top of the set? Explain your answer.*

(34) *Why are the leads going to the inductance coils made flexible? Why are they inclosed in canvas?*

(35) *Will the buzzer operate if the two binding posts marked* "METER" *are not connected by the brass strap?*

(36) *What must be the position of the buzzer switch in order that current may pass through the buzzer?*

(37) *Could the battery be put in the meter backwards? If so, what damage would result?*

WAVE METER AS A RECEIVER.

Information.

When the wave meter is used to receive signals, the circuit must include, in addition to the inductance coil and the variable condenser, a fixed condenser, a detector, and a pair of telephone receivers.

The purpose of the telephone receivers is to convert interrupted or vibrating electrical currents into sound waves, as explained in Unit Operation No. 5. However, the electrical currents picked up by the inductance coil of a wave meter from a transmitting set are vibrating at an exceedingly high rate of speed. These vibrations are much too rapid for the diaphragm of the telephone receiver to follow. Due to this fact it becomes necessary to use a device which will alter the rapidly interrupted or high-frequency currents so that they will cause the diaphragm of the telephone receiver to respond and produce sound waves. The device used for this purpose is known as a *detector*.

There are various types of detectors. The one used in the SCR–61 wave meter is called a *crystal detector*. The crystal detector consists of two essential parts—a piece of mineral or crystal and a contact wire or point. The mineral or crystal is mounted in soft metal at the base of the detector, while the contact is fastened to an adjusting device just above the crystal. By the use of the adjustment knob, the contact wire may be brought to bear upon any point on the exposed surface of the crystal. This adjustment is provided for the reason that some points on the crystal are more sensitive to the tiny currents than are others.

Directions.

6. Trace the connection of the wave meter with respect to the detector, telephone jack, variable condenser, fixed condenser, and the inductance coils.

7. Turn the panel over and look at the top. Notice how the detector is constructed. Unscrew the nut at the top and take the detector apart. Remove the mineral and notice how it is mounted. Do not touch the surface of the mineral, since grease, dust, or other foreign matter on the surface of the crystal will impair its sensitivity.

Questions.

(38) *Why should the student be careful not to touch the surface of the mineral?*

(39) *Describe in detail the construction of the small fixed condenser, and name its principal parts.*

(40) *Are all the joints soldered firmly in place? Why?*

(41) *How are telephones connected to the wave meter?*

(42) *Why is the crystal detector used in this set?*

(43) *Why is the metallic contact or "cat whisker" mounted in a ball-and-socket joint?*

(44) *Why is the detector inclosed in a glass case?*

NOTE.—There are times when an operator using a wave meter or crystal receiver experiences difficulty in locating a sensitive spot on the surface of the crystal, due to the fact that it has become covered with a film of dirt, grease, or other foreign matter. If the operator is unable to obtain a new crystal it is possible to restore the original sensitivity of the old one by cleaning it with gasoline or alcohol. The solution used in Pyrene fire extinguishers may also be used for this purpose with good results. The crystal should first be immersed in the solution for about one minute. It should then be brushed thoroughly with an old toothbrush and allowed to dry. Damp weather also has a tendency to impair the sensitivity of a crystal. In this case the crystal should be dried thoroughly and then covered with a thin film of oil, such as paraffin oil or linseed oil. This film will keep out the moisture.

A CALIBRATION OF WAVE-METER SCALE.

Information.

The dial on the variable condenser has four different scales. The outer scale is marked in degrees and the three inner scales are marked in meters. Each of the three inner scales has a letter at the left-hand end showing with which inductance coil it should be used. The hair line in the center of the pointer indicates the reading corresponding to any wave-meter setting.

It is difficult to obtain an accurate reading near the ends of the scales on the variable condenser. For this reason, part of the maximum readings on scale "A" are included in scale "B" and part of the maximum readings on scale "B" are included in scale "C." This is called the "overlapping" of the wave-length ranges.

Directions.

8. Look at the dial on the variable condenser and carefully notice the markings.

Questions.

(45) *In what kind of units are the three inner scales calibrated?*

(46) *Which scale would be used if coil "A" was fastened in the lid?*

(47) *What is the lowest wave length that can be read with coil "C"?*

(48) *What is the highest wave length that can be read with coil "B"?*

(49) *For what is the small locking nut used?*

Directions.

9. Replace the panel in the box. Fit the screws in their proper holes and tighten them up. Connect the flexible leads as they were before.

10. Examine the buzzer and its adjustment. Put one of the coils in the lid of the box and turn on the switch to start the buzer. Be

sure that there is a serviceable battery in the wave meter and that it has been correctly inserted. Now adjust the buzzer until it vibrates with a low pitched musical note. With the buzzer vibrating the set becomes a transmitter of a very low power.

Questions.

(50) *What is the wave length of the transmitted wave with the "B" coil in and the pointer over the 300-meter mark on the "A" scale?*

(51) *Set the points of the wave meter on the 85 degree mark of the degree scale. What wave length does this correspond to when the "A" coil is used? When the "B" coil is used? When the "C" coils is used?*

Directions.

11. Put the telephone plug in the jack, with the buzzer vibrating, and move the contact wire about upon the surface of the mineral in the detector until a clear distinct note is heard in the telephone receivers. It may be necessary to search very carefully for the sensitive spot. Stop the buzzer as soon as a good spot is found, being careful not to jar the meter.

Questions.

(52) *When the buzzer is cut off after a sensitive spot is found on the crystal, will the set act as a radio receiving set?*

(53) *What is a band of wave lengths?*

(54) *What band of wave lengths can be received with the "A" coil in position?*

EXPERIMENT No. 1.

COUPLING.

Directions.

12. Take two SCR-61 wave meters and using one as a transmitter and the other as a receiver, perform the following experiments. Call the transmitter meter No. 1, and the receiver meter No. 2.

13. Open the two wave meters and put a coil A in each one. Start the buzzer on the receiver (No. 2) and carefully adjust the detector. Now put the No. 2 meter close to the No. 1 meter with their lids back to back. (See Figs. 26 and 27.) Test the detector again and see if it is still in adjustment. The meters placed in this way are said to be closely coupled and the effect of the No. 1 meter should be felt very strongly on No. 2 meter. Now start the buzzer to vibrating

on the No. 1 meter and set the pointer to 300 meters. Rotate the variable condenser on the No. 2 meter until the signal given out by the No. 1 meter is heard at maximum strength. Carefully check the wave length readings on both meters.

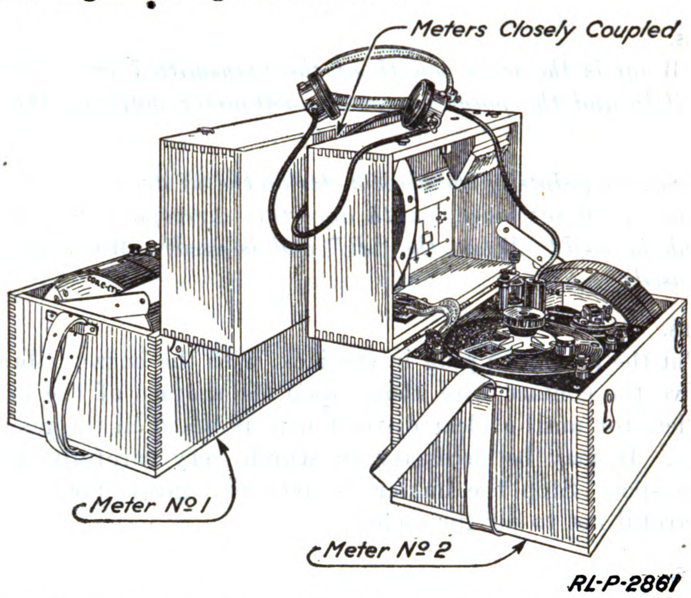


Fig. 26.—Method of obtaining close coupling between two SCR–61 wave meters.

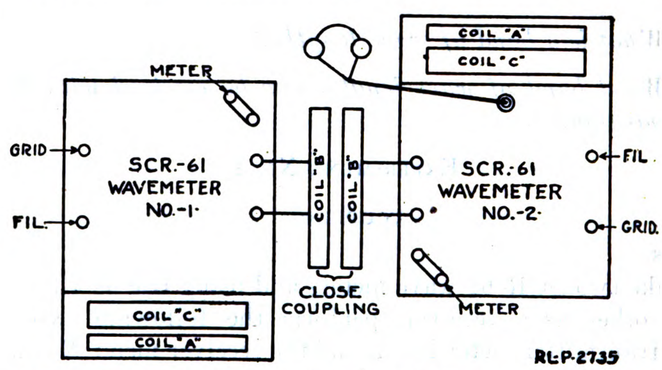


Fig. 27.—Schematic view showing relative positions of inductance coils when two SCR–61 wave meters are closely coupled as in Fig. 26.

14. Do not disturb the No. 2 meter in any way since this will destroy the adjustment of the detector. Loosen the coupling between the two meters by moving the No. 1 meter farther away from the No. 2 meter or by turning it so that its coil is not parallel with the coil of the No. 1 meter. In Figs. 28 and 29 the coil of the No. 1

meter is at right angles to the coil of the No. 2 meter. When two coils are closely coupled, the magnetic lines of force from one will pass through the other in large numbers; when they are loosely coupled very few of the lines of one coil will affect the other coil.

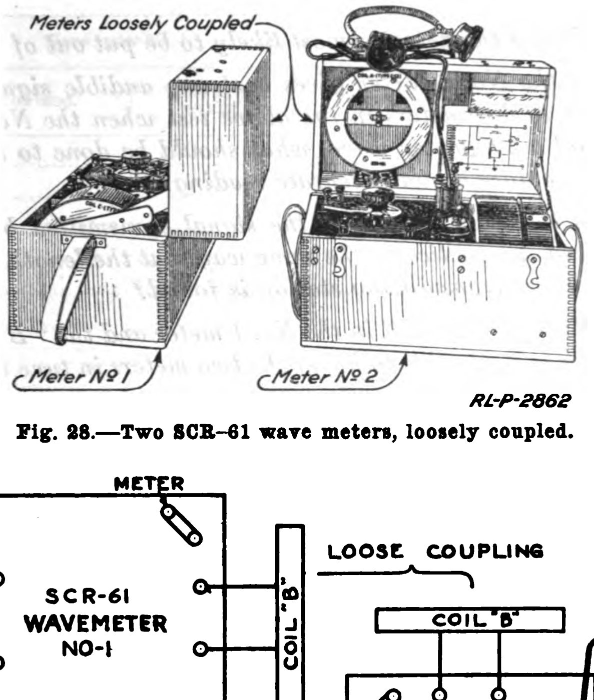


Fig. 28.—Two SCR-61 wave meters, loosely coupled.

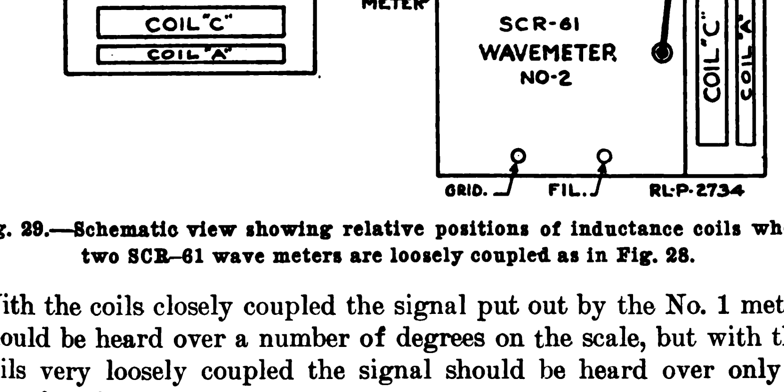


Fig. 29.—Schematic view showing relative positions of inductance coils when two SCR-61 wave meters are loosely coupled as in Fig. 28.

With the coils closely coupled the signal put out by the No. 1 meter should be heard over a number of degrees on the scale, but with the coils very loosely coupled the signal should be heard over only a very few degrees.

15. Put the "B" coil in meter No. 1 and set its pointer at 450 meters. Now rotate the condenser of meter No. 2 until a maximum

sound is heard. Compare the readings on the two meters. Be sure to read the scale corresponding with the coil used. When the maximum sound is heard in the No. 2 wavemeter, its circuit is said to be in tune with the circuit of the No. 1 meter.

Questions.

(55) *How is the detector most likely to be put out of adjustment?*

(56) *If the No. 2 meter gives a strong audible signal from say 250 meters to 350 meters in the above test when the No. 1 meter is putting out a 300-meter wave, what should be done to the coupling in order to obtain a more accurate reading?*

(57) *Is the wave length of the signal transmitted by the No. 1 meter found in practically the same way that the length of the wave emitted by any transmitting station is found?*

(58) *With the "A" coil in the No. 1 meter and the "B" coil in the No. 2 meter is it possible to bring the two meters in tune by adjusting them?*

EXPERIMENT No. 2.

MEASURING THE LENTH OF A TRANSMITTED WAVE.

Directions.

16. Have some one insert any one of the coils in the No. 1 meter and start the buzzer vibrating. Do not look to see which coil is put in nor what wave length the pointer is over. Adjust the detector of the No. 2 meter very carefully. Couple the meters closely. Put the "A" coil in the No. 2 meter and search the scale to see if the length of the wave that the No. 1 meter is emitting can be found. If it is not found with the "A" coil, try the "B" coil, and, if still unsuccessful, try the "C" coil. Always follow this plan of using the "A" coil first, then the "B" coil, and then the "C" coil. As soon as an audible signal is heard, loosen the coupling between the meters and take an accurate reading. Check this reading with the reading on the No. 1 meter.

17. Get some one to change the wave length of the transmitting meter and try the above experiment several times. Get at least six readings of this kind and make a table similar to the one shown below, including the readings of both wave meters. In this way it can be determined whether or not accurate values are being obtained.

Questions.

(59) *Why is it better to make the coupling close to start with?*

(60) *Can the No. 1 meter emit a wave that the No. 2 meter can not pick up?*

(61) *If it is desired to measure the length of a wave put out by a transmitting set which is transmitting on an unknown wave length, how would it be done?*

Adjustments of the wave meters.

	Wave meter No. 1.		Wave meter No. 2.	
	Coil used.	Wave length setting.	Coil used.	Wave length setting.
1	....	....	....	....
2	....	....	....	....
3	....	....	....	....
4	....	....	....	....
5	....	....	....	....
6	....	....	....	....

EXPERIMENT No. 3.

MEASURING THE WAVE LENGTH TO WHICH A RECEIVER IS TUNED.

Directions.

18. Set the No. 2 meter, with the detector adjusted, to some unknown wave length. Do not look at the scale to see what it reads. Adjust the No. 1 meter until it is putting out the wave for which the No. 2 meter is adjusted. Remember to use close coupling and then to loosen it for accurate results. Have some one else set the No. 2 meter in order to disguise which coil is being used. Use the "A," "B," and "C" coils, one after the other, and tune the No. 1 meter to put out the wave required. Try this on at least six settings of the No. 2 meter. A table of results should be made similar to the one used in Experiment No. 2.

Questions.

(62) *How can a transmitting station be tuned to a specified wave length within its range?*

(63) *When would a wave meter be required for use as a transmitter in field operations?*

(64) *How would the wave length of a transmitting station be measured by an operator at a receiving station?*

(65) *When putting a wave meter in storage, what is the last thing an operator inspects to see if it has been done? What will happen if this is not done?*

THE SCR–74–A TRANSMITTING SET.

(SET BOX BC–18–A.)

Equipment.

1 set box, BC–18–A only.
1 wave meter, type SCR–61.
1 head set, type P–11.
1 storage battery, 10 volts, type BB–3; or 3 batteries, type BB–14.

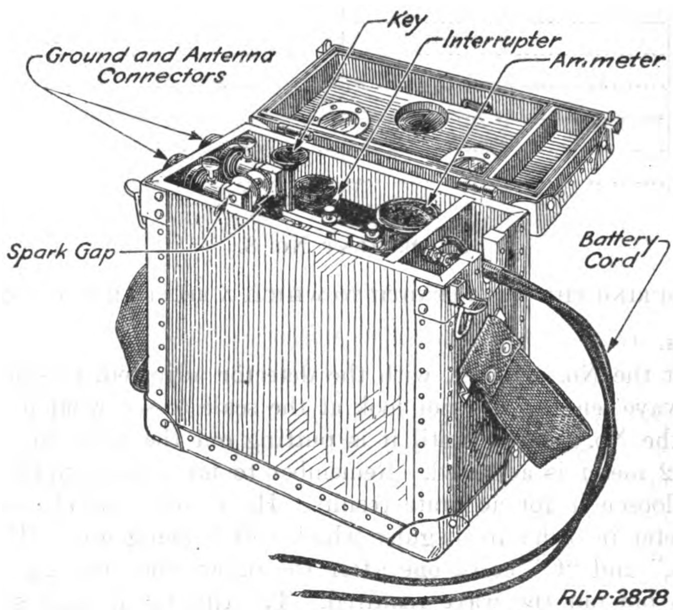


Fig. 30.—Set box, BC–18–A, with lid open.

GENERAL CONSTRUCTION OF THE SCR–74–A SET.

Information.

The SCR–74–A is an *induction coil* transmitting set of low power. (See Fig. 30.) The power supply is obtained from a 10-volt storage battery, which is connected to the primary of the induction coil through an ammeter and a key.

The induction coil is composed of two separate coils which are designated the *primary* and the *secondary.* These two coils are wound around a soft iron core. The primary winding, or coil, is formed of large wire wound directly on the core. The secondary winding is built outside the primary, in such a way that it incloses both the core and primary, and is constructed of small wire with many more turns than the primary. After the winding has been completed the two coils and the core are dipped in wax, paraffin, or some other good insulator. One end of the primary winding is connected to one of the battery terminals through an interrupter, similar to the one on an ordinary buzzer, and a telegraph key. The other end of the primary winding is connected to the other side of the battery. (See Fig. 30.) The ammeter connected in the primary circuit is used to indicate when the coil is working properly. The ends of the secondary winding are connected to the sparking surfaces or *electrodes* of the *spark gap.*

The function of the induction coil is to change the low voltage *direct current* from the storage battery in the primary coil to a high voltage *alternating current* in the secondary. It suffices to say here that an alternating current is an electric current which flows first in one direction and then reverses and flows in the opposite direction. This reversal of the direction in which the current flows occurs with great frequency—many times per second.

Briefly the change in current from direct to alternating is effected as follows: The *interrupter* alternately breaks and makes the electrical circuit of the primary, thereby causing a *pulsating current* to flow whenever the current is stopped and started with the opening and closing of the circuit. The *magnetic fields* created by this pulsating current cut the secondary coil winding and induce in it an alternating current. There are more turns of wire on the secondary than on the primary. Consequently the induced voltage is much higher than that supplied to the primary since the voltage induced in the secondary depends upon how many more turns there are in the secondary than in the primary. As an example, if there are ten times as many turns on the secondary as there are on the primary, the voltage of the secondary will be about ten times as great as that supplied to the primary. Some idea can be had of the secondary voltage of this coil from the fact that 20,000 volts will cause a spark to jump a gap of 1 inch.

Questions.

(1) *What does each of the following mean? Interrupter, spark gap, electrode, function, magnetic field.*

(2) *What is the difference between a direct current and an alternating current?*

Directions.

1. Open the set box by undoing the latches and throw back the lid. (See Fig. 30.) Unscrew the two thumbscrews and remove

the two round bakelite nuts which hold the antenna and ground insulators in the box. Observe how these insulated connectors make contact with opposite sides of the spark gap. At the opposite end of the box remove the screws connecting the battery leads to the

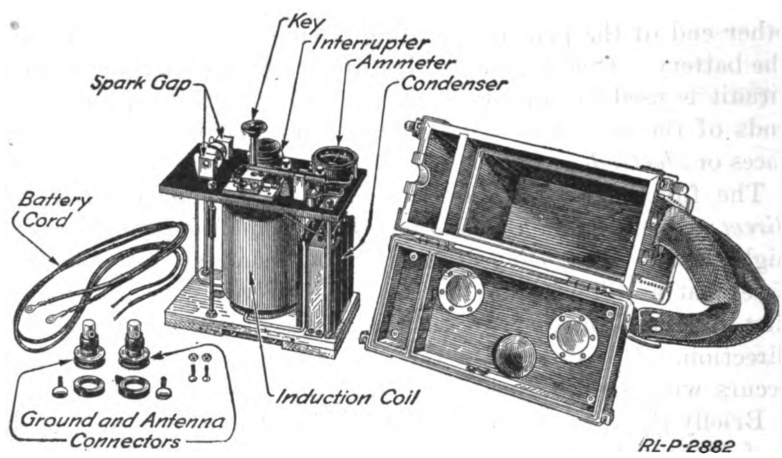


Fig. 31.—Set box, BC–18–A, disassembled to show various parts.

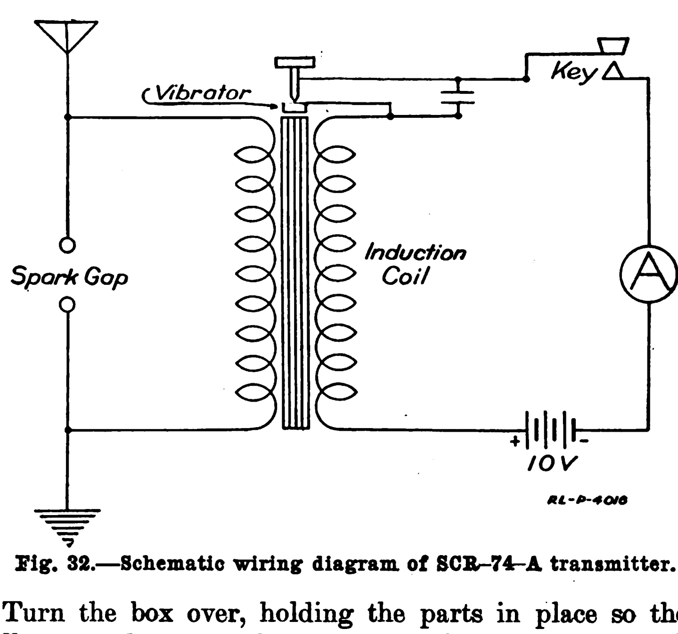


Fig. 32.—Schematic wiring diagram of SCR–74–A transmitter.

box. Turn the box over, holding the parts in place so they will not fall out, and remove the two screws in the bottom of the box. The panel and attached parts should now come out easily. (See Fig. 31.) Check the wiring with the diagram in the lid of the set box or with the diagram shown in Fig. 32. Compare the size of the wire coming out near the center of the coil with that on the outside. Note which winding is connected in the primary circuit and which is connected to the spark gap. Examine the interrupter and note how it is constructed and how it operates. Note how the key is connected, constructed, and adjusted, and how the condenser is connected in the primary circuit.

Questions.

(3) *What is the meaning of each of the following? Bakelite, ground, insulators, antenna, ground lead.*

(4) *How is the key operated when the box is closed?*

(5) *Is the ammeter in the primary or secondary circuit?*

(6) *For what purpose is the fixed condenser used?*

(7) *What is the purpose of the interrupter?*

(8) *How is contact made between the spark gap and the antenna and ground leads?*

(9) *How is the spark gap adjusted?*

(10) *How is the interrupter adjusted? Does the lock nut on the interrupter contact screw up or down to lock the contact screw in position?*

(11) *Can the spark gap be seen when the lid is closed?*

(12) *Why are there thumbscrews on the antenna and ground lead in terminals?*

(13) *For what is the little compartment on the right of the box used?*

(14) *How is the distance between the contacts of the key adjusted?*

(15) *Does it make any difference which battery lead is connected to the positive pole of the battery?*

(16) *Which coil is wound with the larger wire, the primary or the secondary?*

(17) *Why are the windings of the induction coil dipped in wax or paraffin?*

(18) *Which two screws hold the apparatus in the set box?*

(19) *What is the voltage of the storage battery used with this set?*

(20) *What would be the effect of connecting a 20-volt battery in the primary instead of the 10-volt battery?*

Directions.

2. Put the set back in the box, and replace all the screws, nuts, and leads.

Information.

When the SCR–61 wave meter is used as a transmitter, the inductance coil acts as a radiator of the rapidly vibrating or high frequency currents. The distance over which the wave meter is effective is limited to a matter of only a few inches. If a wire, suspended above the ground between two supports, were connected at one end to one of the coil terminals on the wave meter, the transmitting range would be increased considerably. A large

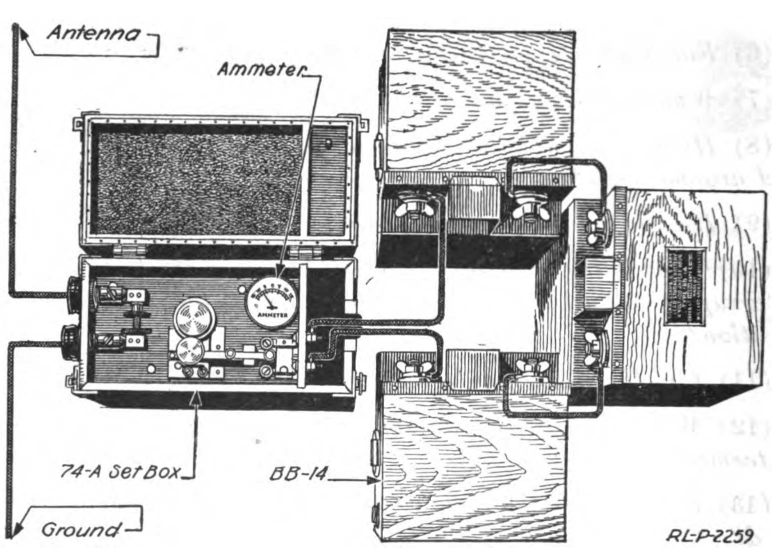


Fig. 33.—Cording diagram of SCR–74–A transmitter.

radiator or antenna of this type is necessary when using the SCR–74–A transmitter in order to reach the maximum distance range of the set.

EXPERIMENT No. 1.

MEASURING THE WAVE LENGTH RADIATED.

Directions.

3. Take the set box, battery, and wave meter over to the lead-in of the antenna indicated by the instructor. Connect the antenna lead, and ground or counterpoise lead to the set box. Set the spark gap to about one-eighth inch. Connect the battery leads to the battery. (See Fig. 33.) *Do not touch the spark gap or antenna, while*

there is current in the primary, as there is danger of receiving a severe shock.

4. Never close the key until both the antenna and counterpoise are connected to the set, and be sure that the length of the spark gap is not over one-eighth inch. If the gap is greater than this there is danger of breaking down the insulation in the secondary winding of the spark coil.

5. Close the key and adjust the interrupter until it is giving a clear steady pitched note and the ammeter registers about 5 to 7 amperes. Adjust the spark gap, being careful not to touch it while the current is on, until it has a good blue-white spark playing steadily between the sparking surfaces.

6. By means of the wave meter take a reading of the wave length being transmitted by the set. Begin by trying to obtain this reading close to the set and then move out toward the end of the antenna until the reading is fairly sharp. Record the results.

EXPERIMENT No 2.

7. Repeat the work performed in Experiment No. 1 on another antenna indicated by the instructor. Measure the wave length as in Experiment No. 1 and compare this wave length with the wave length measured on the antenna of Experiment No. 1.

Questions.

(21) *Why is it dangerous to touch the antenna when the key is down?*

(22) *On which antenna was the largest wave length reading obtained?*

(23) *Is the wave length on which this set transmits dependent on the antenna used?*

(24) *Is the signal readily tuned out?*

(25) *Could many of these sets work close together without interference?*

(26) *What is a high frequency current?*

THE SCR-74-A TRANSMITTER.

(COUPLED CIRCUITS.)

Equipment.

1 Set box, type BC-18-A.
1 antenna equipment, type A-3-A.
2 helical inductances with clips (bare wire or a copper strip).
1 hot-wire ammeter, scale 0-0.5.
1 wave meter, type SCR-61.
1 transmitting condenser, fixed, capacity approximately 0.004 mfd. (microfarad).
1 storage battery, type BB-3; or 3 storage batteries, type BB-14.

Information.

The SCR-74-A is an *untuned* induction coil or spark coil transmitter. This means that no provisions are made in the set box itself for tuning to any particular wave length. The only way in which the wave length of this set can be changed is by altering the dimensions of the antenna provided with the set. However, the set box of the SCR-74-A may be used with some additional apparatus to form different types of transmitting circuits which may be operated on more than one wave length.

The method of tuning certain circuits in conjunction with the SCR-74-A is somewhat similar to that used in tuning the wave meter to transmit any given wave length. In the wave meter three inductance coils are used which are not variable; that is, the number of turns of wire in each coil can not be varied. The capacity of the rotary condenser, however, can be varied, and thereby cause the wave meter to be tuned to a given wave length. In tuning the SCR-74-A to a given wave length one or two variable inductances and a condenser which can not be varied are used. In construction the inductance coils used with the SCR-74-A differ from the coils used in the SCR-61 wave meter. The coils of the wave meter are wound with small wire for the reason that the current carried is very small. The large coils used with the SCR-74-A are wound with large wire or brass strips in order to carry the large currents.

Directions.

1. Examine one of the large inductance coils.

Questions.

(1) *How does the manner in which the larger coil is wound differ from the winding of the wave meter coils?*

(2) *What part of a clock or watch is wound similar to the large coil?*

(3) *Why is the coil constructed of such heavy wire or strip?*

(4) *What means are provided to make the inductance coil variable?*

Information.

Coupling.—When a radio set contains more than one circuit there must be a way provided to transfer the energy from one circuit to the other. This transfer of energy from one circuit to another is accomplished by what is known as *coupling.* Two circuits are said to be coupled when it is possible for the energy of one circuit to be transferred to the other circuit. Transfer of energy may be accomplished in any one of the following methods of coupling:

Direct coupling.—Two circuits are directly coupled when a part of one circuit is also a part of the other circuit.

Inductive coupling.—Two circuits are inductively coupled when the energy of one circuit is transferred to the other by means of a magnetic field.

Capacitive coupling.—Two circuits are capacitively coupled when the energy of one circuit is transferred to the other by means of condensers.

NOTE.—This form of coupling is limited in use and will therefore not be discussed further.

In some radio sets the coupling used between two circuits is a combination of all three of the above methods.

The degree of coupling between the two circuits is measured by the amount of energy that is transferred from one circuit to the other. When the greater part of the energy in one circuit is transferred to the other circuit the coupling is referred to as *close* or *tight* coupling. When only a small part of the energy is transferred the coupling is referred to as *loose* coupling.

The SCR–74–A set contains only one high frequency circuit; consequently no coupling is involved. In the experiments which follow, the set box, type BC–18–A, of the SCR–74–A, will be used with some additional apparatus to illustrate the subject of coupling.

Questions.

(5) *How many high frequency circuits are there in the SCR-74-A?*

(6) *Can the wave length on which the SCR-74-A transmits be changed?*

(7) *What is inductive coupling?*

(8) *What is direct coupling?*

(9) *What is capacitive coupling?*

(10) *How is inductive coupling varied?*

(11) *How is direct coupling varied?*

(12) *How many inductance coils are needed in a direct coupled set?*

(13) *In what two ways may the coils of an inductively coupled set be moved in order to change the coupling?*

(14) *When an SCR-61 wave meter is used, what kind of coupling exists between it and the circuit which is being measured?*

EXPERIMENT No. 1.

TUNING.

Information.

As previously mentioned a circuit may be tuned by changing either the capacity or the inductance. In high power spark transmitting circuits it is impractical to construct the condensers so that they may be continuously varied. It is therefore necessary to tune the transmitting circuit by changing the inductance of the circuit. In the following experiment the set box, type BC-18-A is used to set up radio currents in the circuit to which it is connected. This was done similarly in Unit Operation No. 7 when the set box was connected to the antenna system. The circuit used in this experiment can be considered as equivalent to the antenna circuit, with the exception that this circuit can be varied while the antenna circuit can not.

Directions.

2. Make the following connections as shown in Fig. 34.

a. Connect the antenna terminal on the set box, type BC-18-A, to one side of the transmitting condenser.

b. Connect the remaining side of the transmitting condenser to one of the clips which fit on the helix and place the clip on the fourth or fifth turn (counting from the center) of the helix.

c. Connect the center of the helix to the terminal marked "Ground" on the set box.

d. Connect the three storage batteries, type BB-14, in series, and connect the battery leads from the set box to the 12-volt battery thus formed.

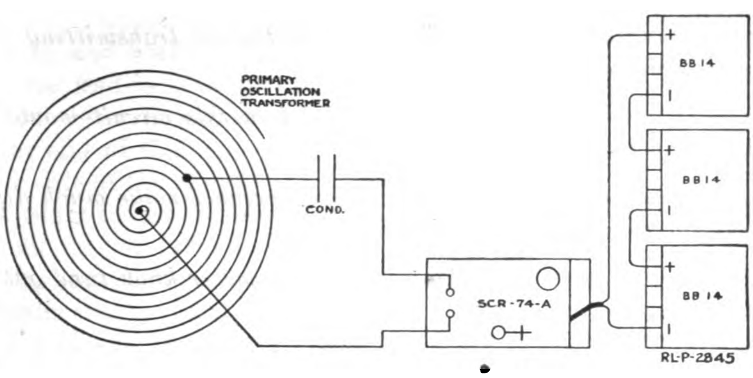


Fig. 34.—Method of connecting inductance and condenser to SCR-74-A transmitter.

3. Set the spark gap on the set box to about 1/16 of an inch, close the key, and adjust the interrupter until it is operating smoothly and the ammeter shows a current of from 5 to 7 amperes.

4. Using the SCR-61 wave meter measure the wave length on which the set is transmitting and tabulate the result in the following table:

Wave length.	Number of turns of inductance.
....	....
....	....
....	....
....	....
....	....

5. Increase the number of turns of inductance in the circuit by moving the helix clip out three or four turns and again measure the wave length and record in the above table.

6. Tune the circuit to transmit on a wave length of 200 meters by setting the wave meter to 200 meters and moving the helix clip until maximum signal strength is obtained in the wave meter. Record in the above table the number of turns required.

Questions.

(15) *As the number of turns of the inductance which are in the circuit is increased, what happens to the wave length on which the set is transmitting?*

(16) *Do the inductance and capacity in this circuit take the place of the standard antenna with respect to the set transmitting on a definite wave length?*

(17) *If a smaller condenser were used in this circuit would the wave length be greater or less?*

(18) *Does one-half of a turn of the inductance make much difference in the transmitted wave length?*

(19) *Will a small variation of the wave-meter knob tune out the signal?*

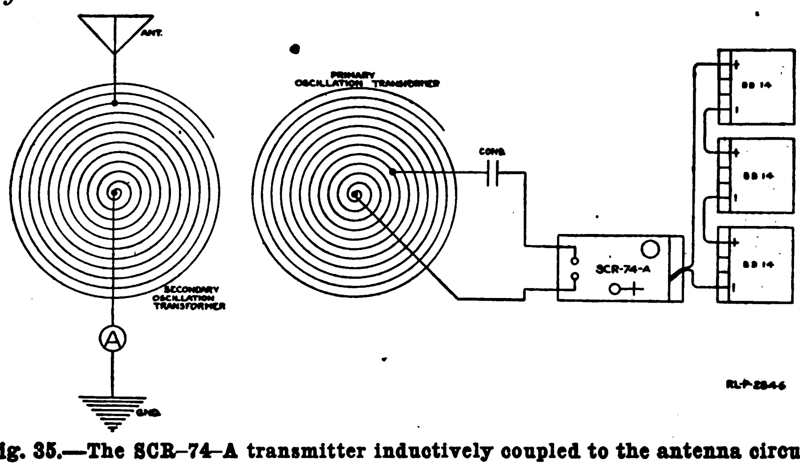


Fig. 35.—The SCR–74–A transmitter inductively coupled to the antenna circuit.

EXPERIMENT No. 2.

INDUCTIVE COUPLING.

Information.

It was probably noted in Experiment No. 1 that the signals could be heard over a considerable portion of the scale of the wave meter. A transmitter which produces signals of this character is said to be *broadly* tuned. If such signals were used in radio communication, there would be a great deal of interference between different stations transmitting at the same time. A receiving station would be unable to tune out the undesired transmitters. This difficulty may be, to a large extent, overcome by coupling the antenna or radiating circuit to the circut in which the signals are generated, instead of having them generated directly in the radiating circuit. In the following experiment inductive coupling is used to accomplish this result.

Directions.

7. With the inductance coil, set box, and batteries connected the same as in Experiment No. 1, place the second helical inductance coil close to and with its plane parallel to the first coil. Connect the antenna lead-in wire to the clip on the second coil and place the clip on about the eighth or ninth turn from the center. Connect the center end of the coil to one side of the hot-wire ammeter and the other side of the ammeter to the ground. (See Fig. 35.)

8. Start the set and observe the ammeter in the ground lead. Vary the number of turns in the secondary or antenna inductance until the highest possible reading is obtained on the ammeter. When the ammeter reads a maximum, the antenna or secondary circuit is in tune with the primary or closed circuit. Couple the SCR–61 wave meter to the antenna circuit by wrapping a turn of the ground wire around the lid of the wave-meter box and measure the wave length on which signals are being transmitted. Note particularly over how much of the wave-meter scale the signals can be heard. Vary the amount of inductance in the primary circuit without changing the antenna circuit, and note what happens to the signal strength.

9. With the planes of the two inductance coils still parallel, move the antenna circuit coil until they are about 3 inches apart and again adjust the number of turns in the antenna coil until the ammeter reads a maximum. Measure the wave length and again note over how much of the wave-meter scale the signals can be heard. Note how the signal strength compares with that obtained when the two coils were close together.

10. Adjust the set to transmit on a wave length of 250 meters with the greatest possible current as indicated by the ammeter in the ground lead. Have the coupling fairly loose.

Questions.

(20) *Could the signals be heard over as much of the wave meter scale in this experiment as in Experiment No. 1?*

(21) *Were the signals heard in the wave meter in this experiment as loud as those obtained in Experiment No. 1?*

(22) *When Directions 7, above, were followed, were the signals heard over as much of the wave meter scale as when Directions 6 were followed?*

(23) *Bearing in mind the answer to the preceding question, state whether close or loose coupling should be used in order to reduce interference.*

(24) *Would the signals sent out in Experiment No. 2 cause more or less interference than those sent out in Experiment No. 1?*

EXPERIMENT No. 3.

DIRECT COUPLING.

Information.

It will be noted that the direct-coupled set requires only one inductance coil. For this reason this method of coupling insures lightness and portability of the set. However, there are certain dis-

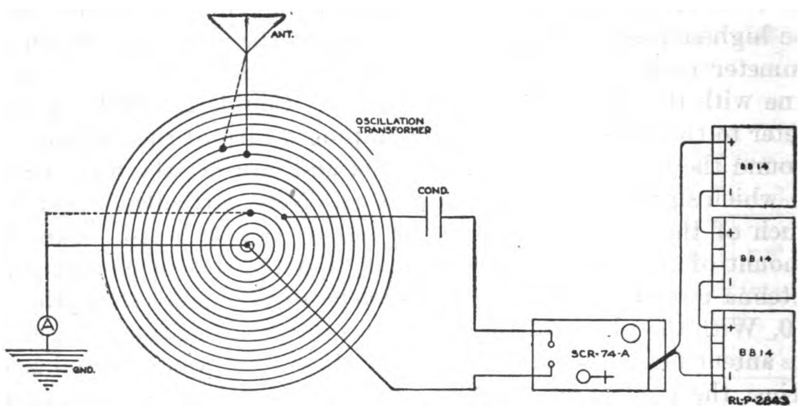


Fig. 36.—The SCR–74–A transmitter directly coupled to the antenna circuit.

advantages in direct coupling, which in most cases more than offset the above advantages. In the following experiment an attempt will be made to show some of the results obtained with direct coupling.

Directions.

11. With the inductance coil, set box, and batteries connected, the same as in Experiment No. 1, make the following additional connections:

a. Connect the ground lead to one side of the hot-wire ammeter.

b. Connect the remaining side of the hot-wire ammeter to the center end of the inductance coil.

c. Connect the antenna lead to a helix clip and place the clip on the eighth or ninth turn from the center of the coil. The completed connections are shown in Fig. 36. In this figure the dotted lines show how the antenna circuit leads are shifted in order to obtain loose coupling. When the connections used are the same as those shown by the solid lines, all of the turns of the inductance of the closed circuits are also included in the antenna circuit, while with the dotted line connections only a part of the closed circuit inductance is common to the antenna circuit.

12. With the connections given by the solid lines in Fig. 36, adjust the antenna lead clip until the hot-wire ammeter shows a maximum reading. Using the SCR–61 wave meter, measure the wave length on which the set is transmitting, and carefully note over how much of the wave meter scale the signals can be heard.

13. Place a heliz clip on the lead from the hot-wire ammeter to the center of the coil, and connect the lead to the third or fourth turn from the center instead of to the center. Vary the position of the antenna lead clip until the ammeter gives a maximum reading. Using the wave meter, again measure the wave length and note over how much of the scale the signal can be heard.

14. Disconnect the antenna and ground clips and vary the clip on the lead from the antenna side of the spark gap until the wave meter when coupled to the inductance coil shows a wave length of 250 meters. Connect the ground lead clip to the third or fourth turn from the center and vary the position at which the antenna clip is connected until the ammeter shows a maximum reading. The set is now transmitting on 250 meters with loose coupling. Couple the wave meter to the ground lead of the set and measure the wave length, noting over how much of the wave meter scale the signal can be heard.

Questions.

(25) *When measuring the wave length of a direct coupled transmitter, over approximately what number of degrees on the wave meter scale can the signals be heard when the coupling is loose? When the coupling is close?*

(26) *Which signal was heard over a greater portion of the wave meter scale when direct, loose coupling was used or when inductive, loose coupling was used?*

(27) *Was more antenna current obtained with direct coupling or with inductive coupling?*

(28) *What type of coupling should be used in order to produce the minimum of interference?*

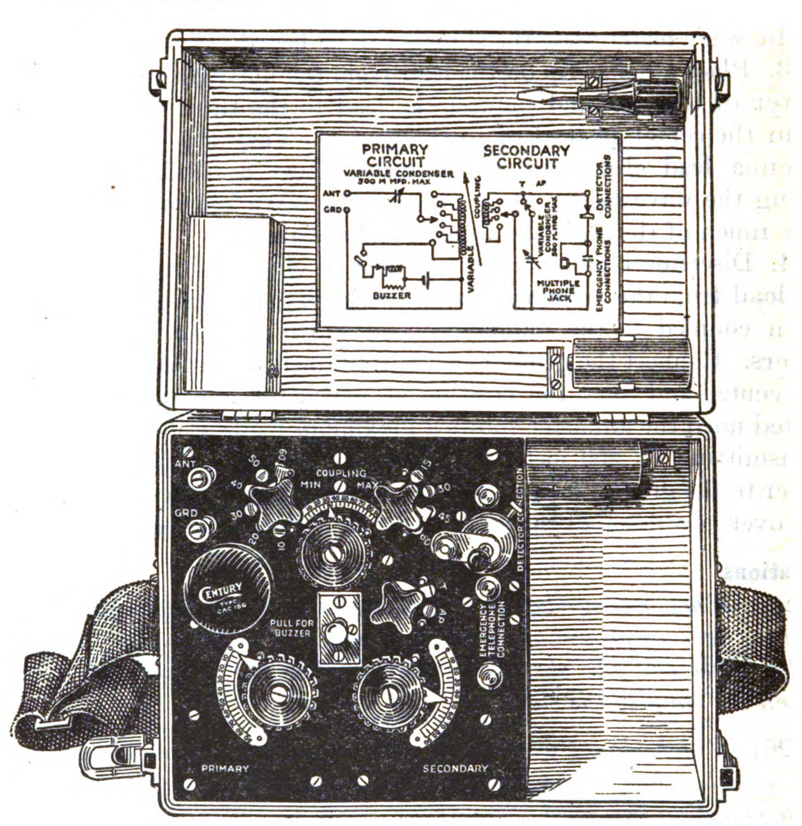
(29) *Is it as easy to change the degree of coupling with direct coupling as it is with inductive coupling?*

(30) *How is a direct-coupled set tuned to transmit on a given wave length?*

THE SCR–54–A RECEIVER.

Equipment.

1 SCR–61 wave meter.
1 SCR–54–A receiving set. (Set box BC–14–A only.)
1 antenna equipment, type A–2–A.
1 head set, type P–11.



RL-P-1935-C

Fig. 37.—Set box, BC–14–A with lid open.

Information.

The SCR–54–A (see Fig. 37) is one of the simplest types of radio receivers, designed for portable work in the field. It differs in construction from the SCR–61 wave meter, in that it has two tuning circuits instead of one. One circuit, called the *primary* circuit, includes the antenna, ground, and the primary tuning circuit; while the other circuit, called the *secondary* circuit, includes the secondary tuning circuit, the detector, and telephones. Both the primary and secondary tuning circuits consist of a tapped inductance coil and a variable condenser. The primary coil is stationary while the secondary coil is movable, the coupling between the two being changed by rotating the secondary.

The method of tuning the SCR–54–A differs slightly from that used in tuning the SCR–61 wave meter or the SCR–74–A transmitter. To tune the SCR–74–A transmitter the inductance is varied. In the SCR–54–A both the inductance and capacity of the primary and

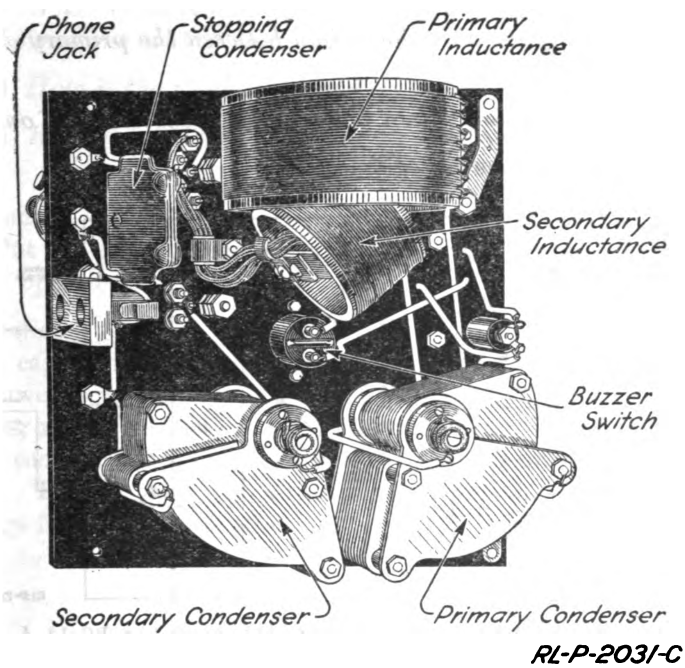


Fig. 38.—Rear of panel, set box, BC–14–A.

secondary circuits are varied when tuning the set to a certain wave length.

The *crystal detector* used in this set is similar to the one provided in the SCR–61 wave meter.

Directions.

1. Release the latches and raise the lid of the set box. Take out the four screws in the corners of the panel and remove the panel from the box. (See Fig. 38.) Place the panel in some convenient position, and trace the wiring of both the primary and secondary circuits. Compare with schematic circuit diagram shown in Fig. 39.

Questions.

(1) *How is the battery in the set box connected to the buzzer on the panel?*

(2) *How are the two head sets connected, when their plugs are inserted in the jacks, in parallel or series?*

(3) *Is the buzzer circuit connected to the primary or the secondary circuits?*

(4) *Why is the buzzer provided?*

(5) *Is there any metallic connection between the primary and the secondary of the set?*

(6) *In which position* (up or down) *is the buzzer swtich on?*

(7) *How is the coupling changed?*

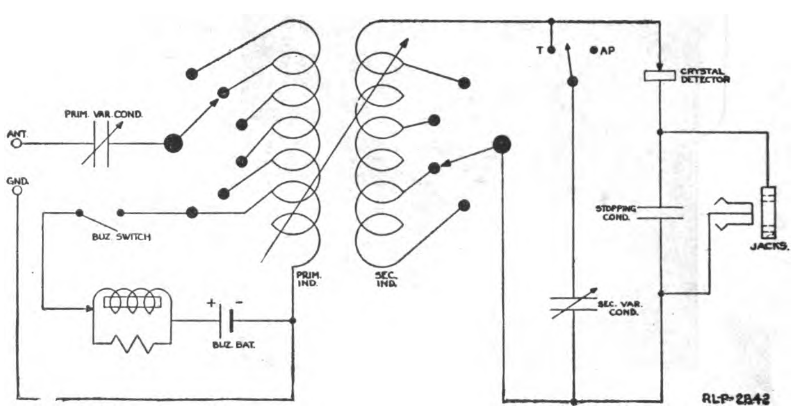


Fig. 39.—Schematic diagram of connections in set box, BC–14–A.

(8) *Why are leads brought out from the different points of the winding on the primary and the secondary coils?*

(9) *Why are the leads to the secondary inductance made flexible? Can the secondary be rotated or is it fixed in position?*

(10) *Count the number of turns on the primary inductance. See if the contact point numbers are the same as the number of turns connected in the circuit up to that point. What difference do you note?*

(11) *When the coupling scale on top of the panel indicates* "MAX" *what is the position of the secondary with respect to the primary? When it indicates* "MIN"*?*

(12) *Is the primary inductance parallel with the back edge of the box?*

(13) *Examine the two variable condensers. How do they differ? Why? Examine the fixed condenser. How is the connection made with the fixed plates of the variable condenser?*

(14) *How is the connection made with the movable plates?*

(15) *Are the movable plates insulated from the stationary plates?*

(16) *What connection is changed when the "T–AP" switch is moved from one contact to the other?*

(17) *How is the fixed condenser constructed?*

(18) *How many telephones can be used simultaneously in this set?*

Directions.

2. Put the panel in the box and replace the screws. See that the buzzer operates.

Information.

The calibration of the set consists in determining the settings of the various variable switches and condensers for different wave lengths, so that the set can be readily adjusted to any desired wave length each time it is operated, without the necessity of using a wave meter. This is done by adjusting the variable members to the settings found by calibration.

EXPERIMENT No. 1.

CALIBRATING THE SECONDARY.

Directions.

3. Put the wave meter with its coil as close to the back of the set box as possible. (See Figs. 40 and 41.) Set the "T–AP" switch to "T" (abbreviation for "tuned"). Adjust the detector of the set by means of the buzzer test. Turn the coupling knob until the indicator points to the 90° or maximum mark, and set the secondary inductance on tap 15. Adjust the wave meter to emit a 200-meter wave. Rotate the secondary variable condenser until the signal is heard. If the signal can not be picked up with the secondary inductance switch on tap 15, advance the switch to tap 30 or higher. If the signal comes in too loudly over a large part of the condenser scale, loosen the coupling between the wave meter and set box by moving the wave meter away from the set box. It should be moved

far enough away so that the signal can be heard over only a few degrees on the condenser scale.

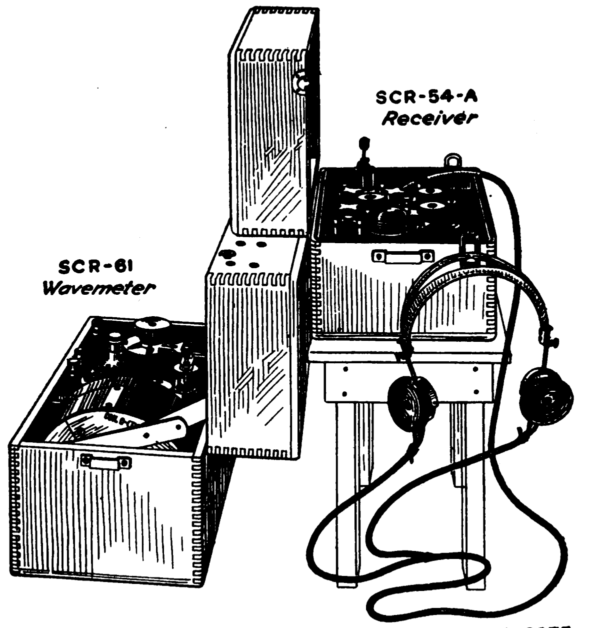


Fig. 40.—Method of coupling the SCR-61 wave meter to the secondary coil of the SCR-54-A receiver.

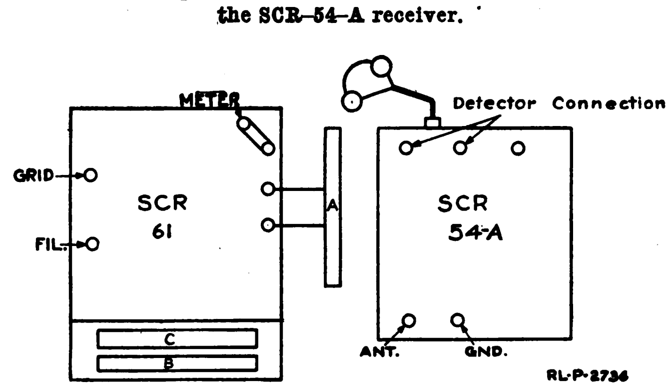


Fig. 41.—Schematic diagram showing relative positions of the SCR-61 wave meter and the SCR-54-A receiver when coupled as in Fig. 40.

4. Move the "T-AP" switch to "AP" (abbreviation for "aperiodic," meaning "untuned"), and endeavor to tune out the signal with the variable condenser. From the diagram of connections it will be seen that in the "AP" position the condenser is out of the

circuit. Therefore the secondary circuit can not be tuned to the primary circuit. When a circuit can not be tuned it will respond to all wave lengths. For the same reason that the SCR–74–A transmits over a number of wave lengths when connected directly to the antenna and ground, the secondary circuit of the SCR–54–A will respond to a number of wave lengths when the variable condenser is disconnected from the circuit. This is very useful when the set is used to pick up a signal on an unknown wave length.

5. Make up a calibration table for the secondary of the SCR–54–A similar to the No. 1 shown at the end of this Unit Operation. Part of the table will be used in the next experiment. Start at 200 meters and determine the settings of the inductance tap and condenser to tune the secondary to this wave length. Next set the wave meter at 225 meters and determine the settings for this wave length. Similarly determine the settings for 250 meters, 275 meters, etc., until all the wave lengths listed have been covered. Record the readings in the table prepared. Remember to change inductance coils in the wave meter when receiving.

Questions.

(19) *Why was the wave meter put back of the set box instead of to one side? (See answer to Question 12.)*

(20) *What is the wave length range of the secondary of this set?*

(21) *What is the wave length range of the set?*

(22) *With the switch thrown to "AP" why is it impossible to tune out the signal of the wave meter?*

(23) *What is the difference in the position of the secondary coil when turned to "MAX," with respect to the back edge of the box?*

EXPERIMENT No. 2.

CALIBRATING THE PRIMARY.

Directions.

6. As the wave meter is not to be used in this experiment it should be placed several feet away from the BC–14–A set box. Connect the antenna and ground leads to the proper terminals on the set box. The "T–AP" switch should be turned to the "T" position. Adjust the coupling control so that the indicator points to the 20° mark. Adjust the secondary inductance switch and the secondary condenser to the settings for 200 meters as recorded in Experiment No. 1. Start the buzzer operating and adjust the crystal detector until a sensitive spot is found. With the buzzer still in operation

vary the primary inductance switch and the primary condenser until the signal of the buzzer is heard in the headset with maximum intensity. Record the settings in Table No. 1. (See Direction 5.)

Questions.

(24) *In what way does the method used in calibrating the primary circuit differ from that used in calibrating the secondary circuit with the wave meter? Explain.*

(25) *Was the tuning of the primary circuit found to be fairly sharp?*

(26) *Why was the antenna and ground connected in calibrating the primary circuit?*

EXPERIMENT No. 3.

EFFECT OF CHANGE IN COUPLING.

Directions.

7. Wind a complete turn of the antenna lead around the cover of the wave meter as shown in Fig. 42. This provides coupling between the antenna circuit and the inductance coil of the wave meter as shown in Fig. 43.

8. Adjust the coupling of the BC–14–A set box so that the indicator points to the 90° or maximum mark.

9. Adjust the primary and secondary controls to the settings recorded for 300 meters.

10. Start the buzzer of the wave meter in operation and slowly vary the control knob of the wave meter condenser until the signal of the buzzer is heard with maximum intensity in the head set. Note the wave length indicated on the wave meter scale.

11. Reduce the coupling in the BC–14–A set box by turning the coupling knob until it points to the 40° mark. Again vary the wave meter condenser until the buzzer signal is heard with maximum intensity in the head set. Note the wave length indicated on the wave meter scale.

Questions.

(27) *Was the wave length indicated by the wave meter in the experiment under Direction 11, the same as recorded in Table No. 1 for the control settings used?*

(28) *Were any of the following three changes noticed when the coupling was reduced in the experiment under Direction 12?*

a. Was the wave length changed?
b. Was the sharpness of tuning changed?
c. Was the intensity of the signal changed?

(29) *When tuning an SCR–54–A receiver to a signal of known wave length using predetermined calibrations, what effect has a change in coupling upon the tuning of the primary and secondary circuits?*

(30) *Judging from the results of this experiment would you say, that the methods used in calibrating the primary and secondary circuits in Experiments 1 and 2 were accurate?*

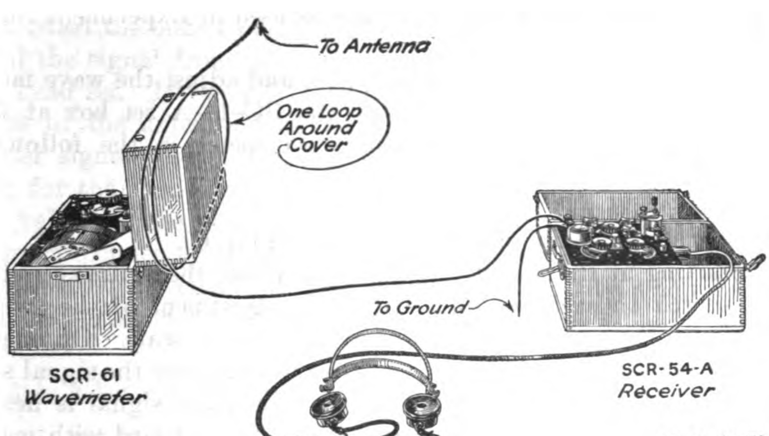


Fig. 42.—Method of coupling the SCR–61 wave meter to the primary circuit of the SCR–54–A receiver.

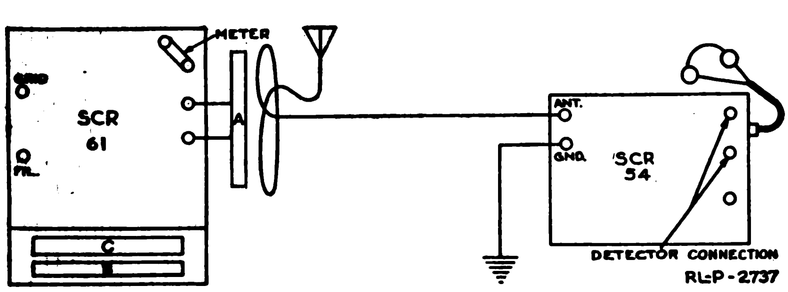


Fig. 43.—Schematic diagram of coupling arrangement as in Fig. 42.

Information.

The methods used in calibrating the primary and secondary of the SCR–74–A receiver in Experiments 1 and 2 produced only approximate results. In actually using any radio receiving set for the reception of messages or other information it is very important that the operator be able to set his adjustments, so that he knows that the set is accurately in tune on any given wave length. In order to accomplish this it is necessary to calibrate the set so that the calibration covers all of the adjustments of the set which have any influence on the wave length on which it receives.

EXPERIMENT No. 4.

CALIBRATING THE SCR–54–A SET FOR USE IN THE FIELD.

Directions.

12. Use the same set up of apparatus as used in Experiment No. 3. (See Fig. 42.)

13. Start the buzzer of the wave meter and adjust the wave meter to 200 meters. Set the coupling on the BC–14–A set box at 40°. Tune in the signal emitted by the wave meter in the following manner:

a. Set the "T–AP" switch on "AP."

b. Set the secondary inductance switch on tap 60.

c. Starting at the lowest tap, successively set the primary inductance switch on each tap and with each adjustment of the switch slowly turn the primary condenser over its entire scale. On one of the taps and at some setting of the primary condenser the signal sent out by the wave meter will be heard. When the signal is heard, carefully adjust the primary condenser until it is heard with maximum intensity.

d. Without changing the adjustments of the primary circuit, place the "T–AP" on "T." Starting at the lowest tap, successively set the secondary inductance switch on each tap, and with each adjustment of the switch slowly turn the secondary condenser over its entire scale. On one of the taps and at some setting of the secondary condenser the signal emitted by the wave meter will be heard. When the signal is heard, slightly vary both the primary and secondary condensers until the maximum possible intensity is obtained. The set is now tuned accurately to receive on 200 meters, which is the wave length on which the wave meter is transmitting. Note the settings of the primary and secondary inductance switches and the primary and secondary condensers. Prepare a table similar to Table No. 2 shown at the end of this Unit Operation and record in it the settings obtained.

14. Repeat the above directions for each of the remaining wave lengths in the table.

15. Due to slight changes which may occur each time the antenna system is erected or when a different antenna system is used the cali-

brations of the antenna circuit may vary somewhat. However, the calibrations obtained in this experiment will be nearly right for the standard antenna. Each time a different standard antenna is used the calibrations of the primary circuit may be readjusted in the following manner:

a. Using the settings recorded in Table No. 2, adjust the primary and secondary controls to any desired wave length. Set the coupling to the reading given in the table.

b. Start the buzzer on the set box and vary the primary condenser until the signal from the buzzer is heard with greatest intensity in the head set. If the values of the antenna system are the same as those of the antenna used when the calibrations were made, the buzzer signal should be heard with maximum intensity on the setting for the condenser given in the table for that wave length. If the values of the antenna system are different, the settings of the primary condenser (and possibly the primary inductance switch) will be different from the settings given in the calibration table, but will be correct for that wave length and the new antenna system.

Questions.

(31) *What is the wave-length range of this set?*

(32) *Why was the wave meter coupled to the ground lead?*

(33) *With the "T–AP" switch on "AP" did the primary condenser tune very sharply?*

(34) *Why was the "T–AP" switch placed on "T" before attempting to tune the secondary circuit?*

(35) *Why was the coupling left in one position?*

(36) *What would be the effect on the sharpness of the tuning of the set if the coupling were decreased?*

(37) *If the set is used with other than the standard antenna equipment, would the calibrations of the primary circuit be absolutely accurate?*

TABLE No. 1.

Settings for Experiment No. 1.			Settings for Experiment No. 2.			
Wave length.	Secondary inductance tap.	Secondary condenser.	Primary inductance tap.	Primary condenser.	Secondary inductance tap.	Secondary condenser.
200						
225						
250						
275						
300						
325						
350						
375						
400						
425						
450						
475						
500						
525						
550						
575						
600						

TABLE No. 2.

Settings for Experiment No. 4.					
Wave length.	Primary inductance tap.	Primary. condenser.	Coupling. (degrees).	Secondary inductance tap.	Secondary condenser.
200			40		
225			40		
250			40		
275			40		
300			40		
325			40		
350			40		
375			40		
400			40		
425			40		
450			40		
475			40		
500			40		
525			40		
550			40		
575			40		
600			40		

THE SCR-95, SCR-125, AND SCR-125-A WAVE METERS.

Equipment.

1 SCR-95 wave meter.
1 SCR-125 wave meter.
1 SCR-125-A wave meter.
1 SCR-61 wave meter.

GENERAL CONSTRUCTION OF THE SCR-95 WAVE METER.

Information.

The SCR-95 is a small portable wave meter covering a range from 500 to 1,100 meters. (See Fig. 44.) Unlike the SCR-61 in which the condenser is continuously variable and the inductance fixed, the SCR-95 wave meter has the inductance continuously vari-

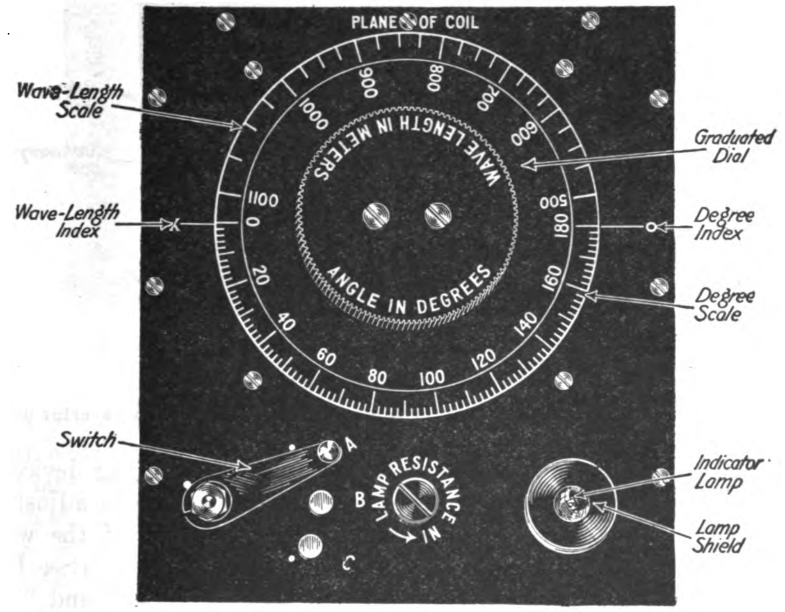


Fig. 44.—Top panel of SCR-95 wave meter.

able and the condenser fixed. The variable inductance consists of two windings connected in series, one within the other. (See Fig. 45.) The inner winding can be rotated through 180°, that is through one-half of a complete turn. When the inner winding is in such a position that the reading on the scale is 500 meters, the inductance is at lowest value. Similarly when the inner winding is rotated 180° to the position at which the scale reading is 1,100 meters, the inductance is at its highest value. The inductance value varies with different positions of the movable winding due to the magnetic effect between the fields produced by the two windings. This magnetic effect is increased or decreased according to the position of the inner winding with respect to the position of the outer winding. It will thus be seen that the inductance is continuously variable between the highest and lowest value, depending upon the position of the inner winding. A variable inductance of this form is called a *variometer*.

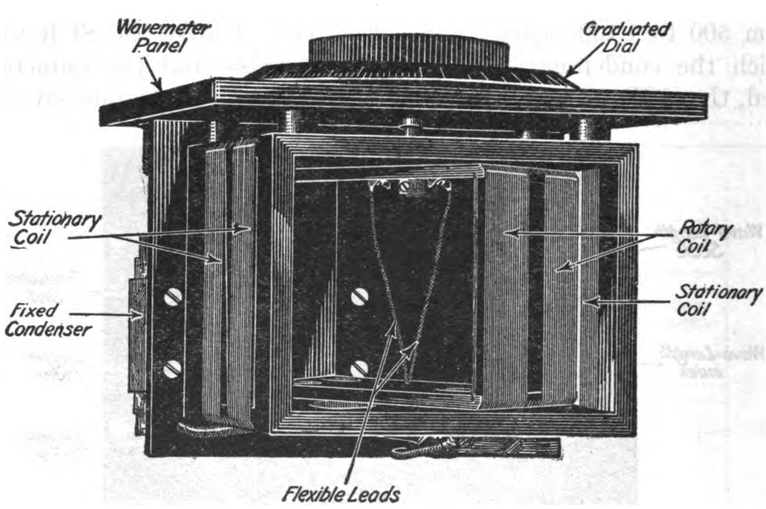


Fig. 45.—Panel of SCR–95 wave meter removed from box to show interior parts.

A buzzer is provided in the wave meter as an exciting device to make the meter act as a low-power transmitter for use in adjusting receiving circuits. A switch mounted on the panel of the wave meter controls the starting and stopping of the buzzer. (See Fig. 44.) The three switch contacts are marked "A," "B," and "C," respectively. In the illustration the switch arm is shown resting on contact A. In this position of the switch arm no current flows through the buzzer circuit. To start the buzzer, the switch is placed on contact B.

The wave meter is also provided with a small low-voltage lamp which is lighted by the same dry cell used to operate the buzzer. To light the lamp the switch arm on the wave meter panel must be placed on contact C. The amount of current flowing through the lamp is controlled by a special type of rheostat, which is in turn controlled by an adjustment knob on the wave meter panel, marked "lamp resistance."

A small specially-wound inductance, known as a "choke coil," is inserted in the lamp circuit to prevent the high frequency currents from passing through the battery circuit.

To find the wave length of a transmitting set, the switch on the panel is turned to contact C, and the resistance is adjusted so that the filament of the lamp just begins to get red hot. The wave meter is then coupled closely with the transmitting set. The indicating

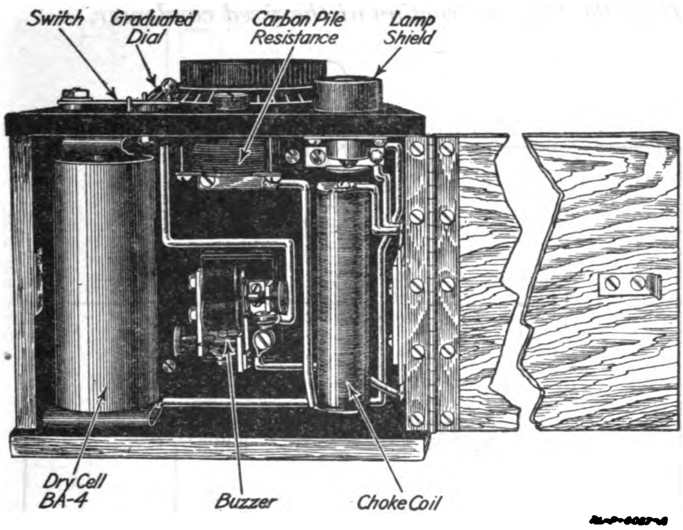


Fig. 46.—SCR–95 wave meter with side door open.

dial which varies the inductance is now turned slowly, and when the lamp glows brightly it indicates that the wave meter is in tune with the transmitting set. The wave length is read directly from the edge of the variometer dial. The SCR–95 wave meter, due to the nature of its indicating device, can be used to measure the wave length of all transmitting sets of the more powerful type. Its use in this connection will be taken up later.

Directions.

1. Examine the meter, noting all the markings on the panel. Open the door at the side and notice how the battery is inserted and the buzzer adjusted. (See Fig. 46.) Note the construction of the choke coil, the carbon pile resistance, and the small fixed condenser.

2. Remove the nine screws from the edge of the panel. Remove the panel and attached parts from the box.

3. Note the construction of the variometer and how connections are made to the moving coil.

4. Check the wiring with the wiring diagram shown in Fig. 47.

Questions.

(1) *Describe the construction of the carbon pile resistance.*

(2) *How does this wave meter differ electrically from the SCR-61?*

(3) *Describe the construction of the fixed condenser.*

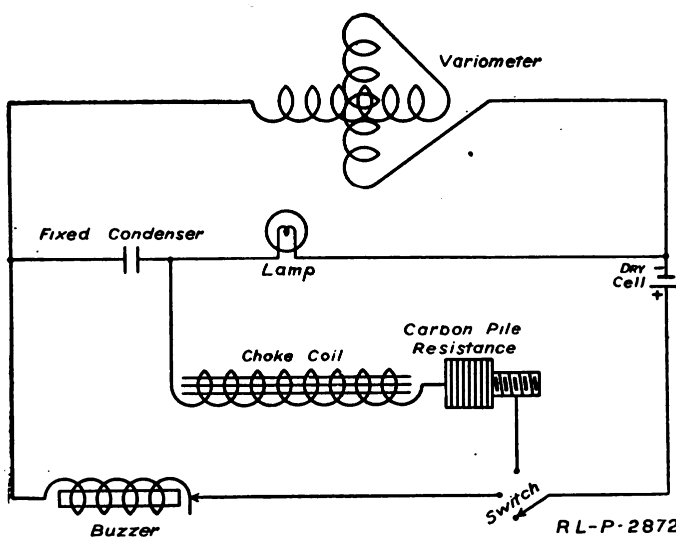


Fig. 47.—Schematic diagram of connections in the SCR-95 wave meter.

(4) *Can the battery be put in backwards, and would this damage it?*

(5) *Is there any current flowing from the battery when the small switch is on A? On B? On C? Where in each case? (Trace the circuit in detail.)*

(6) *Describe the construction of the variable inductance.*

Directions.

5. Replace the panel and parts in the box. Put the screws in place.

EXPERIMENT No. 1.

CHECKING THE SCR–95 WAVE METER WITH THE SCR–61 WAVE METER.

Directions.

6. Set up the SCR–61 with the " B " coil in place. Set the switch of the SCR–95 on B and adjust the buzzer. Set the dial at 500 meters. Couple the SCR–95 closely with the SCR–61. (See Fig. 48.) Adjust the SCR–61 until the signal comes in loud in the head set and loosen the coupling until the tuning of the SCR–61 wave meter is fairly sharp. The coupling should be as loose as possible

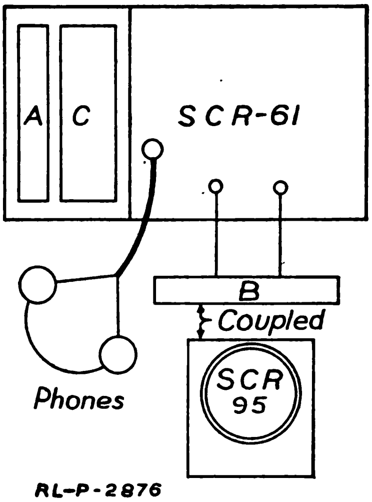


Fig. 48.—Method of coupling the SCR–95 wave meter to an SCR–61 wave meter.

to secure accurate results. Prepare a table similar to the one shown below. Take readings every 50 meters and record the results in the table.

TABLE.

Reading SCR–95 wave meter.	Reading SCR–61 wave meter.
500	....
550	....
Etc.	....

7. When the experiment is completed remove the battery from the SCR–95 wave meter.

Questions.

(7) *How do the readings of the SCR–95 wave meter compare with the readings of the SCR–61 wave meter?*

(8) *Can the SCR–95 wave meter be used to receive the buzzer signals from the SCR–61 wave meter? Explain your answer.*

THE SCR–125 WAVE METER.

Information.

The SCR–125 wave meter is very similar to the SCR–95 wave meter both in appearance and construction. The main difference is in the wave-length ranges, the SCR–125 meter having three wave-length ranges which are as follows: 70 to 140 meters, 140 to 280 meters, and 280 to 560 meters. Thus the total range of the meter is 70 to 560 meters.

Close to the dial on the panel of the SCR–125 wave meter is a 3-point switch, marked "Multiply λ." The three positions of the switch are marked "2," "1," and "½," respectively. When the switch is adjusted to the middle position, marked "1," the 140 to 280 meter range is in use and the wave length is read directly on the dial. The wave-length dial reads directly in meters and its divisions are marked 140, 180, 200, 220, 240, 260, and 280 meters, respectively.

If the 70 to 140 meter wave-length range is desired, the switch must be placed in the position marked "½" and the reading on the wave-length dial multiplied by "½" (the same as dividing by 2). For example, if the wave length to be measured lies within the 70 to 140 meter range, the switch is placed in the position marked "½" and the dial is adjusted until the indicating lamp glows brightest. The wave-length reading on the dial may be, say 220 meters. Dividing this reading by 2, the correct wave-length reading is obtained—110 meters.

When the wave meter is being used to emit a wave within the 70–140 meter range, the desired wave length must be multiplied by 2 and the dial adjusted accordingly. For example, the desired wave length is 130 meters, which, multiplied by 2, is 260 meters. The wave-length dial is then adjusted so that the 260-meter mark is exactly opposite the "λ" mark on the panel.

If the wave length desired lies within the 280 to 560 meter range, the switch is placed in the position marked "2" and the reading on the wave-length dial must be multiplied by 2.

Directions.

8. Repeat directions 1, 2, 3, and 5, using the SCR–125 wave meter in place of the SCR–95 wave meter.

Questions.

(9) *Describe the construction of the carbon pile resistance.*

(10) *How does the SCR–125 wave meter differ from the SCR–95 wave meter?*

(11) *Locate the three small fixed condensers. Describe this construction and use.*

(12) *Can the battery be put in backwards and would this damage it?*

(13) *Is there any current flowing from the battery when the small switch is placed on A? On B? On C? Where in each case? (Trace the circuit in detail.)*

(14) *Describe the construction of the variable inductance.*

Directions.

9. Replace the panel and parts in the box. Put the screws in place.

THE SCR–125–A WAVE METER.

Information.

The SCR–125–A wave meter is similar to the SCR–95 and SCR–125 wave meters both in appearance and construction. This meter has three wave-length ranges, 50 to 150 meters, 150 to 450 meters, and 450 to 1,350 meters, making the total wave-length range 50 to 1,350 meters. The three positions of the multiplier switch are marked "$\frac{1}{3}$," "1," and "3," respectively. If the wave length desired lies within the 150 to 450 meter range the multiplier switch is placed in the position marked "1" and the wave length is read directly on the dial. The wave-length dial reads directly in meters and is marked in divisions from 150 to 450 meters consecutively. When the 50 to 150 meter range is desired the multiplier switch is placed in the position marked "$\frac{1}{3}$." The wave length reading on the dial is then multiplied by "$\frac{1}{3}$" (the same as dividing by 3). Similarly, if the 450 to 1,350 meter range is desired the multiplier switch is placed in the position marked "3" and the wave length reading on the dial must be multiplied by 3.

Directions.

10. Repeat directions 1, 2, 3, and 5, using the SCR–125–A wave meter in place of the SCR–95 wave meter.

Questions.

(15) *Describe the construction of the carbon pile resistance.*

(16) *How does the SCR–125–A wave meter differ from the SCR–125 wave meter?*

(17) *Locate the three small fixed condensers. Describe their construction and use.*

(18) *What type of switch is used to control the current to the buzzer and indicator lamp?*

(19) *Is the battery entirely disconnected from the buzzer and lamp circuits when the switch is in the middle position? (Trace the wiring and see.)*

(20) *Describe the construction of the variable inductance.*

Directions.

11. Replace the panel and parts in the box. Put the screws in place.

THE SCR-105 SET.

Equipment.

1 SCR-105 (set box BC-53-A).
1 wave meter SCR-61.
1 antenna equipment, type A-10-A.
1 10-volt storage battery.

THE TRANSMITTER.

Information.

The SCR-105 (see Fig. 49) is a compact transmitting and receiving quenched spark radio set. It is designed to be used in communication over a distance of 5 miles. The set is intended for intermittent duty only and should not be used for continuous sending. The power necessary to run the set is supplied by a 10-volt storage battery.

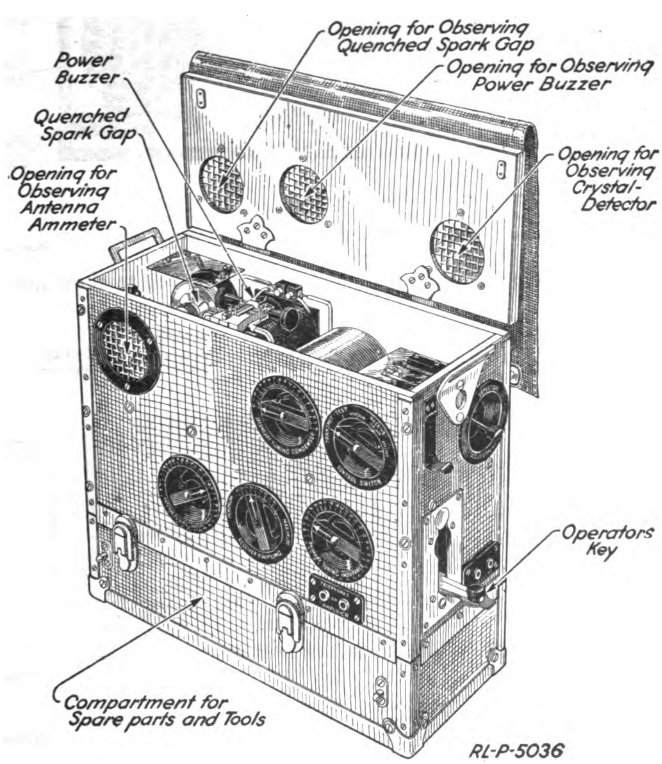


Fig. 49.—Set box, type BC-53-A.

The parts of the transmitter consist of a special buzzer transformer, a quenched spark gap, an oscillation transformer, a thermoammeter, a transmitting condenser, and a key. The purpose of the buzzer transformer is to change the low voltage direct current, supplied by the storage battery, into a high-voltage alternating current.

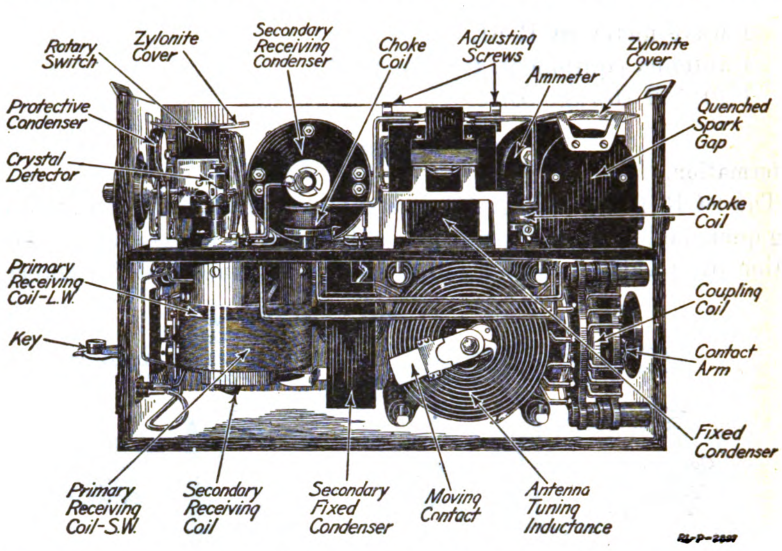


Fig. 50.—Set box BC-53-A with back and top removed to show interior.

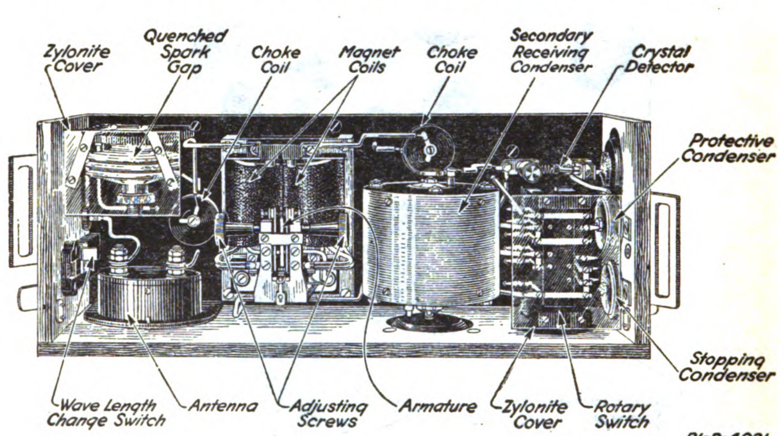


Fig. 51.—Top view of interior, set box BC-53-A.

The primary circuit of the transmitter includes the secondary or high-voltage spark gap, the transmitting condenser, and part of the oscillation transformer. The secondary or antenna circuit consists of the antenna, a series of inductance coils, a part of the oscillation transformer, the antenna thermoammeter, and the ground. Direct

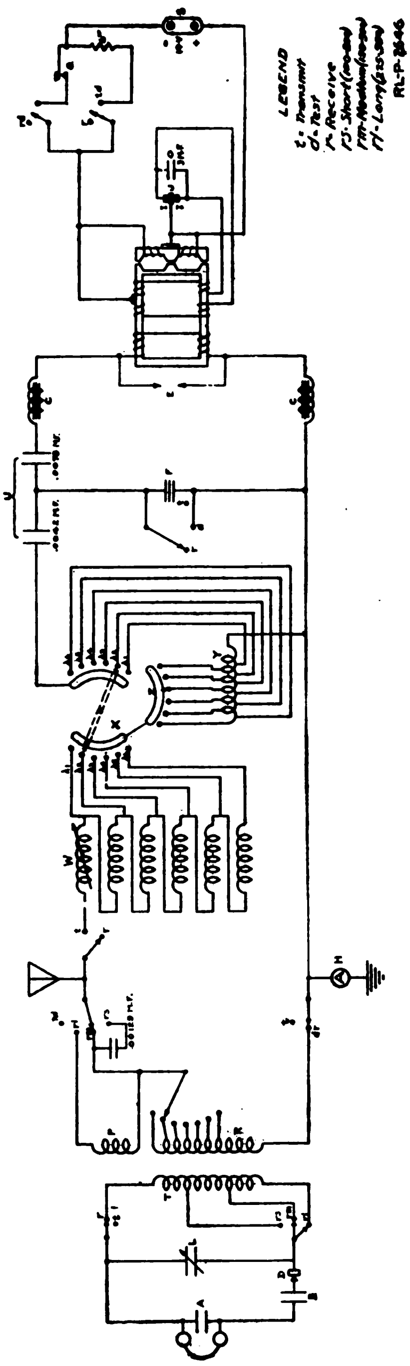


Fig. 52.—Schematic diagram of connections, SCR-105 set.

coupling is employed between the primary and secondary circuits of the transmitter. One of the inductance coils is permanently connected in the antenna circuit and is made continuously variable over its entire range by means of an adjustment controlled from the panel of the set. The primary and secondary are both tuned to the same wave length at the same time, by one switch, known as a "wave-change" switch. The primary circuit is accurately tuned to the desired wave length by this switch, but the secondary circuit is only roughly tuned to the same wave length. For this reason the calibrations of the wave-change switch refer to the wave length settings of the primary circuit. The fine tuning of the antenna circuit is accomplished by means of the variable antenna inductance. A handle located on the left side of the set box controls the coupling between the primary and antenna circuits.

Directions.

1. Remove the eight screws from the back of the set box, also the canvas cover from the front of the box. Unlatch the lid of the box and remove the top, back, and bottom of the set box. This will expose the parts to view as shown in Fig. 50 and in Fig. 51.

2. Move the various adjusting knobs on the front of the box and note carefully what they control inside of the box.

3. Observe the various parts in Figs. 49, 50, 51, and the wiring diagram in Fig. 52. Answer the following questions:

Questions.

(1) *Locate the wave-change switch inside the set box. What are the calibrations marked on the indicator of this switch?*

(2) *What contacts move when the wave-change switch is adjusted?*

(3) *Locate the antenna tuning inductance. How is it made continuously variable?*

(4) *Locate the control switch. What is its purpose?*

(5) *Locate the antenna ammeter. What is the range of its scale? How is it connected in the circuit?*

(6) *How are the transmitting inductances constructed?*

(7) *Why are the coils of the oscillation transformer insulated so heavily?*

(8) *How many turns has the antenna tuning inductance?*

(9) *How is the coupling of the transmitting circuit varied?*

(10) *How many coils are there in the primary of the oscillation transformer?*

(11) *How is the key connected in the circuit?*

(12) *Can the key be adjusted easily? How?*

(13) *How many sections form the primary winding of the buzzer transformer?*

(14) *How many sections in the secondary winding?*

(15) *To what is the moving armature of the interrupter connected?*

(16) *How many stationary contacts has the interrupter?*

(17) *Of what material are the contacts made?*

(18) *Why are the adjustment screws of the stationary contacts heavily insulated?*

(19) *What is the purpose of the safety gap?*

(20) *Where and how are the secondary condensers connected?*

(21) *How is the quench gap constructed?*

(22) *How are the spark disks insulated from each other?*

(23) *How is the quench gap connected in the circuit?*

(24) *How many contacts has the rotary switch? (Count them on the instrument).*

(25) *How are they insulated from the pin passing through them?*

THE RECEIVER.

Information.

The receiving side of the set contains two tuned circuits, one, the antenna or primary circuit, and the other, the secondary circuit. The antenna circuit consists of the inductance (which is varied by the handle on the front of the set marked "primary tuning inductance"); either a small fixed condenser or another inductance known as a loading coil, depending on the position of the "change over" switch; and the antenna system. For the reception of short waves the change over switch is placed on the receiving position marked "100–200." In this position the loading coil is not used and the small fixed condenser is connected in series with the antenna. For the reception of medium length waves the switch is placed on the receiving position, marked "150–300." In this position the series condenser is cut out and the antenna is connected directly to the primary inductance coil. The third position on the receiving side, marked "275–550," is the long wave position, and when used the loading coil is connected in series with the antenna.

The secondary circuit of the receiver consists of a secondary inductance and a variable condenser. Connected across the variable condenser are the crystal detector, two small fixed condensers, and the head set. The secondary inductance has two taps so that approximately one-third, two-thirds, or all of the inductance may be used. The amount of inductance used is controlled by the change over switch. The switch positions correspond to the three positions used to control the primary inductance. Inductive coupling is employed between the primary and secondary circuits and is varied by the handle on the front of the set box marked "Receiver coupling." A head set is connected in the circuit by means of a plug supplied with the set which fits in the double jack in the front of the set box marked "Telephone or Amplifier." The adjusting handle of the crystal detector protrudes from the right side of the set box so that the detector may be adjusted with the lid of the box closed.

Directions.

4. Note the various receiving controls and their markings.

Questions.

(26) *Locate the control switch. What are the wave-length markings?*

(27) *How many points has the receiver primary inductance switch?*

(28) *How is the receiver coupling control calibrated?*

(29) *How is the secondary condenser control calibrated?*

(30) *How is the crystal detector adjusted from the outside of the set box?*

(31) *How many headsets may be used with the receiver of the SCR–105 set?*

Directions.

5. Turn the various controls and note what moves in the rear of the panel. Note the various stationary parts.

6. From observations made and a careful study of the diagram shown in Fig. 52 answer the questions below.

Questions.

(32) *How is the crystal detector adjusted?*

(33) *How is a new crystal put in?*

(34) *How is the long wave coil of the receiving circuit wound and where is it located?*

(35) *From the diagram of connections (Fig. 52) when is the long-wave coil in the circuit?*

(36) *Where is the short-wave condenser?*

(37) *When is the short-wave condenser in the circuit?*

(38) *Would the coils of the set be damaged if the battery was plugged in the wrong place?*

(39) *Is it possible to put the battery lead plug in the telephone or amplifier jack?*

(40) *How would you connect other telephone receivers if it were necessary?*

(41) *How is connection made with the movable plates of the secondary condenser?*

Directions.

7. Replace the back and bottom of the set. Replace the screws. Leave the top open.

EXPERIMENT No. 1.

TRANSMITTING.

Information.

Successful transmission with the SCR–105 set depends to a very great extent upon the ability of both the transmitting and receiving operators. The transmitter must be properly adjusted and tuned for steady, reliable operation. Also great care must be exercised when tuning the transmitter in order to obtain a sharp wave of a desired length and thus avoid interference.

Other than tuning adjustments, the only adjustment needed in the transmitting side of the set is that of the buzzer transformer. This instrument is adjusted by means of the two large insulated thumbscrews on either side of the vibrating contact and by means of the small screw near the upper pivot of the armature which controls the position of the armature. The buzzer transformer should be so adjusted that it will operate smoothly and evenly with very little sparking. When the control switch is placed in the *test* or *transmit* position the buzzer transformer should start operating and should not require tapping on the armature.

The control switch in addition to changing from transmit to receive, also has a position marked "Test." When in this position the receiving side of the set is in operation and the buzzer transformer should be vibrating feebly. The reason for this is to allow adjustment of the crystal detector. The switch should be left in this position only when the detector is being adjusted.

Directions.

8. To place the transmitting side of the set in operation and to tune it for transmission on a given wave length proceed as follows:

a. Erect the standard antenna system of the set.

b. Place the set box on the ground in one of the three following positions:

(1) If it is desired to transmit in one direction only, the antenna wire should be erected pointing in that direction with the lead-in end toward the station with which it is desired to communicate. The lead-in wire should be stretched out as a continuation of the antenna wire in the direction of the desired station and the set box placed on the ground at the end of the lead-in wire.

(2) Where directional effects not quite so pronounced (as in direction 1) are required, the set box should be placed on the ground near the foot of the mast supporting the lead-in end of the antenna wire.

(3) Where transmission in all directions is desired the set box should be placed on the ground underneath and as near the center of the antenna wire as the length of the lead-in wire will permit.

c. Connect the antenna lead-in to the post on the left side of the set box marked "Ant." and ground lead to the post marked "Gnd."

d. Connect the battery terminals of the battery cord to the 10-volt storage battery and insert the plug in the jack just below and to the right of the key on the right side of the box. Open up the key.

e. Set the wave-length change switch inside of the box to the desired wave length.

f. Set the antenna coupling switch on the left side of the box to the No. 1 position.

g. Throw the control switch to the transmit position. The buzzer transformer should now start operating, and when the key is pressed sparks should be visible in the quenched spark gap.

h. Keeping the key closed, vary the antenna tuning inductance until the maximum possible reading is obtained on the thermoammeter. (Remember that in order to cover the entire range of the antenna tuning inductance approximately eight complete turns of the controlling handle are required.) The set should now be transmitting on the desired wave length with the sharpest possible wave, that is, the wave which will produce a minimum amount of interference.

9. Closely couple the SCR–125–A wave meter to the ground lead of the set and measure the wave length which is being transmitted. (See Fig. 53.) Note carefully over how much of the wave-meter scale the signal can be heard.

10. Change the coupling to No. 6, readjust the antenna tuning inductance until a maximum reading is obtained on the ammeter, and again measure the wave length with the SCR–125–A wave meter, noting over how much of its scale the signal can be heard.

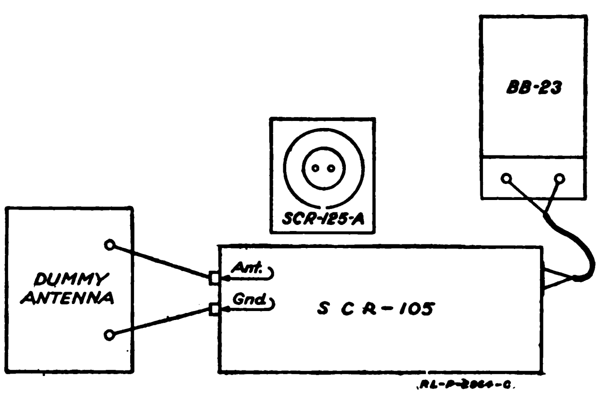


Fig. 53.—Method of coupling the SCR–125–A wave meter to set box BC–53–A.

Questions.

(42) *Does this set cause less or more interference than the signals obtained with loose coupling in Experiment No. 2 of Unit Operation No. 3?*

(43) *What is the advantage of using the spark gap of the quenched type?*

(44) *In what position of the coupling control should this set be operated? Why?*

(45) *Are the wave lengths, as marked on the wave length change switch, accurate according to the wave meter?*

(46) *Was greater antenna current obtained with close coupling or with loose coupling?*

EXPERIMENT No. 2.

CALIBRATING THE RECEIVER.

Directions.

10. With the antenna, ground, and battery connected to the set as in Experiment No. 1, proceed with the following directions:

a. Insert the plug of a head set in the jack marked "Telephone or Amplifier" and adjust the head set to fit the head comfortably.

b. Turn the control switch to the test position. The buzzer should operate feebly.

c. Adjust the crystal detector until a sensitive spot is found on the surface of the crystal.

d. Turn the control switch to the 100–200 wave-length mark in the receive position.

e. Couple an SCR–125–A wave meter to a few turns in the ground lead of the set. Start the buzzer of the wave meter in operation. Set the wave meter to transmit on 150 meters.

f. Set the receiver coupling control so that the arrow points to the 30° mark.

g. Turn the primary tuning inductance switch to about the No. 5 mark.

h. Slowly rotate the secondary tuning condenser control until the wave-meter signal is heard with maximum intensity in the head receivers.

i. Readjust the coupling, primary inductance, and secondary condenser in the order mentioned until any small change in the adjustment of any one of the controls will cause the signal to disappear.

j. Prepare a table similar to the one shown below. Readjust the wave meter to the next wave length indicated in the table and tune the receiver to the signal using the method outlined in the above directions. Proceed in this manner until adjustments have been made for each of the wave lengths listed. Record the control settings in the table.

Wave length (wave meter).	Wave length setting "control" switch.	Receiver coupling.	Primary tuning inductance.	Secondary tuning condenser.
150..........	....	....	....	....
180..........	....	....	....	....
210..........	....	....	....	....
240..........	....	....	....	....
270..........	....	....	....	....
300..........	....	....	....	....

Questions.

(47) *Was there any change in the signal strength when the primary inductance switch was slightly readjusted?*

(48) *When final tuning adjustments were being made, was the signal heard over a large or a small portion of the secondary condenser scale?*

(49) *Does the test position of the control switch give an indication as to the sensitivity of the detector?*

THE VACUUM TUBE DETECTOR, DT-3-A.

Equipment.

1 vacuum tube VT-1.
1 detector, DT-3-A.
1 wave meter, SCR-61.
1 SCR-54-A (set box BC-14-A only).
1 4-volt storage battery (BB-14).
2 batteries, type BA-2 (or BA-8).
1 voltammeter, model 280.
1 rule.

Information.

When using the SCR-54 or SCR-54-A receiving sets for receiving long distance signals, it may be found that the crystal detector of the set is not sensitive enough to detect the faint signals received. A

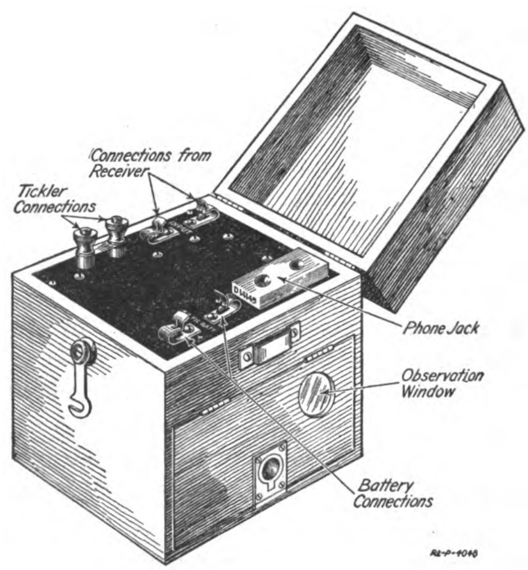


Fig. 54.—The DT-3-A detector unit.

more sensitive device, known as a vacuum tube detector may then be used to receive these very faint signals. This type of detector is provided in the DT-3-A equipment. (See Fig. 54.)

After this detector is once connected and adjusted no further adjustment is required and the operation of tuning in the receiving set is not altered in any way.

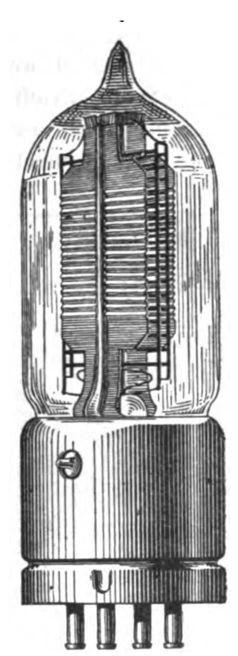


Fig. 55.—Type VT-1 vacuum tube.

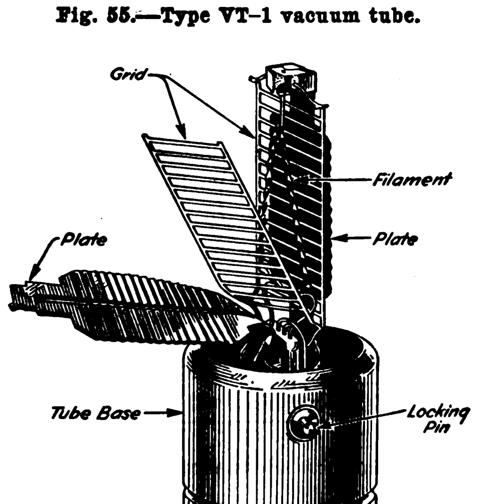


Fig. 55-A.—Details of VT-1 vacuum tube.

The VT–1 vacuum tube (See Figs. 55 and 55–A) consists of three elements, namely the filament, the grid, and the plate which are all inclosed in a sealed glass tube from which the air has been pumped out. Leads from the filament, grid, and plate are brought out through one end of the tube and connected to four prongs. This

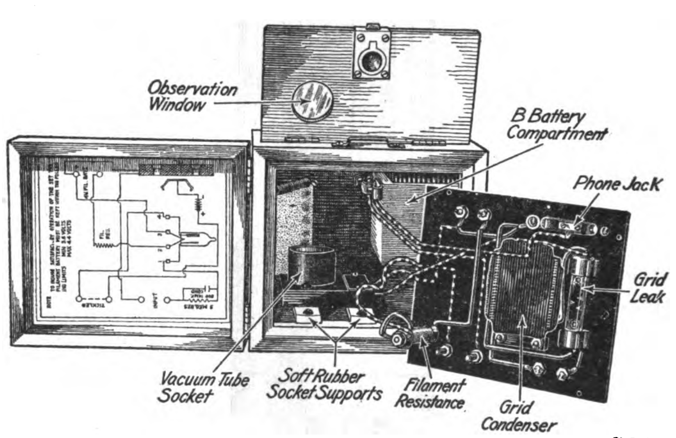


Fig. 56.—Panel of DT–3–A detector removed to show interior parts.

end is called the base of the tube. Two of the prongs are connected to the filament, the third prong to the grid, and the fourth to the plate.

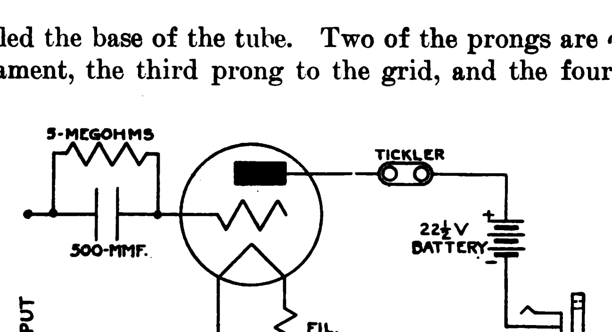


Fig. 57.—Schematic diagram of connections in the DT–3–A detector.

Directions.

1. Remove the four screws from the corners of the panel of the DT–3–A detector. Lift out the panel, being careful not to break the flexible wires attached to it. (See Fig. 56.) Trace the wiring and compare it with the diagram in the lid of the box and also with the schematic diagram in Fig. 57.

2. Examine the resistance in series with the filament battery. Also examine the resistance across the grid condenser. Note how these resistances differ.

Questions.

(1) *What kind of clips are used to make the connection to the input circuit and the battery circuits?*

(2) *How many telephones can be plugged into this detector unit?*

(3) *How is the grid leak resistance constructed? What is its resistance?*

(4) *How is the filament resistance constructed? What is its resistance?*

(5) *How is the vacuum tube socket fastened in the box? Why?*

(6) *Which contacts on the vacuum tube socket make contact with the filament leads? Which with the plate? Which with the grid?*

(7) *How is the fixed condenser constructed?*

(8) *Which lead of the plate battery goes to the plate?*

(9) *Can the filament current be varied? How?*

Information.

When properly connected, the vacuum tube, type VT–1, has the property of conducting current in one direction only. The amount of current which it will conduct depends upon the amount of plate battery used and the filament current. These values vary with different tubes.

Directions.

3. Examine the VT–1 vacuum tube and note exactly how it is constructed. The filament is in the center and on each side of it are the grids. Outside of the grids can be seen the two plates. Both grids are connected together and the two plates are also connected together. (See Fig. 55–A.)

Questions.

(10) *Why is there a pin on the side of the base?*

(11) *Which two contacts on the bottom of the base go to the filament leads?* (*Insert the tube in the socket if necessary to discover this. Use the pin on the side as a reference point.*)

(12) *Which contact goes to the grid? Which contact goes to the plate?*

(13) *How many cross bars are there in each side of the grid?*

(14) *Is there a grid on each side of the filament? Is there a plate on each side?*

Information.

The results obtained in the following experiments will depend upon the hearing ability of the student. Inasmuch as the sensitivity of the ear varies with different individuals the results recorded will only be approximate. However, they will be sufficiently accurate to bring out the idea intended.

EXPERIMENT No. 1.

COMPARISON OF SIGNAL STRENGTHS BETWEEN THE CRYSTAL DETECTOR AND THE VACUUM TUBE DETECTOR.

Directions.

4. Set up the SCR–61 wave meter as a transmitter and the SCR–54–A as a receiver, as shown in Fig. 40 of Unit Operation No. 9. Plug in a pair of receivers in the jacks of the SCR–54–A set. Start the buzzer of the SCR–54–A operating and locate a sensitive spot on the crystal detector. Turn off the current to the buzzer. Adjust the SCR–61 wave meter to a wave length of 250 meters and start its buzzer in operation. Tune the secondary of the SCR–54–A set so that the signal from the wave meter can be heard with maximum volume. Without changing any other adjustments reduce the coupling between the SCR–54–A set and the wave meter until the wave meter signal is just faintly heard in the telephone receivers. Try increasing the signal strength by readjusting the detector of the SCR–54–A set and by retuning the secondary. If an increase in signal strength is obtained, again reduce the coupling between the receiver and the wave meter until the signal is just faintly heard. This signal may be compared to the faint signal of a distant transmitting station which is received by an SCR–54–A receiver using a crystal detector. Measure the distance between the wave meter and the BD–14–A set box with the rule.

5. Without disturbing the tuning adjustments or the location of either the wave meter or the SCR–54–A set open the crystal detector circuit in the latter by removing the contact from the surface of the crystal. Remove the head set plug from the SCR–54–A set and insert it in the jack of the DT–3–A detector. Connect the input

terminal of the DT–3–A to the extra detector terminals of the SCR–54–A. (See Fig. 58.)

6. Connect a 4-volt battery in series with the low reading ammeter (0-3 scale) and a small rheostat to the filament battery terminals of the set. Be sure to get the positive lead connected to the plus (+) binding post and the negative lead to the minus (—) binding post. Set the rheostat so all the resistance is in the circuit.

7. See that a serviceable type BA–2 battery is properly connected in the set box.

8. Open the side door of the DT–3–A and connect the proper leads from the " B " or 22½-volt battery to the binding posts.

9. Insert a VT–1 vacuum tube in the socket.

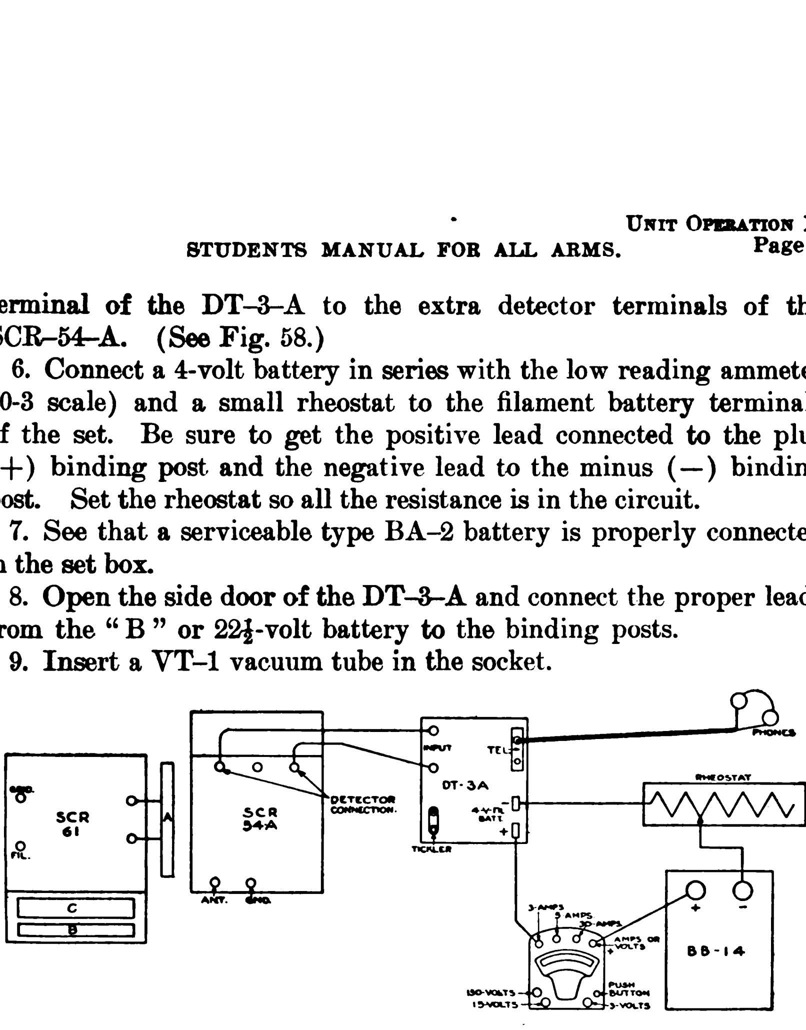


Fig. 58.—Method of connecting apparatus used in Experiment No. 1.

10. Increase the current in the filament of the VT–1 by cutting out the resistance of the rheostat until the ammeter reads 1.1 amperes.

11. Retune the secondary of the SCR–54–A receiver until the signal from the wave meter is heard with maximum strength in the telephone receivers.

12. Decrease the coupling between the wave meter and the BC–14–A set box until the signal from the wave meter is just faintly heard in the telephone receivers. Again measure the distance between the wave meter and the BC–14–A set box.

13. Leave the apparatus adjusted in this manner for the next experiment.

Questions.

(15) *What was the distance measured between the wave meter and the set box under Direction 4 in the above experiment?*

(16) *What was the distance measured between the wave meter and the set box under Direction 12 above?*

(17) *From your observations in the above experiment, which is the more sensitive to a weak signal, the vacuum tube detector or the crystal detector?*

(18) *Which detector requires the more adjustment? Explain.*

(19) *Why was the coupling between the wave meter and the SCR-54-A set loosened?*

(20) *Is the tuning of the set any sharper when using a vacuum tube detector than when using a crystal detector?*

EXPERIMENT No. 2.

SIGNAL STRENGTH WITH DIFFERENT VALUES OF FILAMENT CURRENT.

Directions.

14. Increase the coupling between the wave meter and the set box until the signal from the wave meter is fairly loud in the telephone receivers.

15. Decrease the current in the filament of the VT-1 by increasing the resistance of the rheostat until the ammeter reads about 0.1 ampere.

16. Start decreasing the resistance of the rheostat until the point is reached where the wave meter signal is just faintly heard in the telephone receivers. Note the reading of the ammeter and the brightness of the detector tube filament.

17. Again slowly decrease the resistance until all of the resistance is cut out of the circuit. Note the reading of the ammeter at the point where no increase in signal strength is perceptible. Also note the brightness of the detector filament.

18. Turn off the filament current and be careful not to disturb any of the other adjustments as the same set-up will be used in the next experiment.

Questions.

(21) (*a*) *What is the lowest value of filament current for which the VT-1 will act as a detector?*

(*b*) *Did the filament burn with a bright red color or with a very dull red color at this value?*

(22) (*a*) *What value of filament current gives a signal of greatest strength?*

(*b*) *How bright did the filament burn at this value?*

(23) *What is the value of the filament current with the rheostat resistance cut out?*

(24) *What is the best value of filament current?*

(25) *Would it be safe to connect a 4–volt battery direct to the filament battery contacts of the set? Does the small resistance in the set box, in series with the filament, protect it from being burned out?*

EXPERIMENT No. 3.

SIGNAL STRENGTH WITH DIFFERENT VALUES OF PLATE VOLTAGE.

Directions.

19. Adjust the rheostat until the ammeter shows the reading which was found to be the best value of filament current in Experiment No. 2.

20. Reduce the coupling between the wave meter and the SCR–54–A set until the signal from the wave meter is just faintly heard in the telephone receivers.

21. Connect a serviceable type BA–2 battery in series with the BA–2 battery in the set box. To do this remove the negative lead of the BA–2 battery from the clip binding post on the side of the container. Connect this lead by means of a short piece of wire to the positive lead of the second BA–2 battery. With another piece of wire connect the remaining lead from the second battery to the negative clip binding post.

22. Note any change in the strength of the signal from the wave meter when the additional battery is used.

23. Turn off the filament current and disconnect the apparatus.

Questions.

(26) *Was there an increase in signal strength when the plate voltage was increased to 45 volts?*

(27) *From the observations made what would you say is the best plate voltage to use in conjunction with a VT–1 vacuum tube as a detector?*

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THE SCR-72 AMPLIFIER.

Equipment.

1 SCR-72 amplifier (set box BC-17 only).
1 SCR-61 wave meter.
1 SCR-54-A receiver (set box BC-14-A only).
1 SCR-55 detector (set box DT-3-A).
1 headset, type P-11.
1 4-volt battery, storage type BB-14.
1 plug with cord.
3 VT-1 vacuum tubes.
1 small rheostat.
5 22½-volt "B" batteries.
1 ammeter (0-5 amps. scale).
1 rule.

GENERAL CONSTRUCTION OF THE AMPLIFIER.

Information.

Radio signals are often so weak, due to the distance they are transmitted or for other reasons, that, although the detector will respond feebly, the converted currents from the detector are too weak to actuate the diaphragm of the telephone receivers. In such cases it is necessary to use some device which will increase the strength of the weak signals in the detector circuit in order that they may be heard in the telephone receivers. The device used for this purpose is known as an amplifier.

A vacuum tube when properly connected is an amplifier as well as a detector; accordingly the strength of the signals from a vacuum tube detector can be increased by the addition of one or more vacuum tubes connected as amplifiers. An amplifier consisting of one vacuum tube is known as a one-stage amplifier, while an amplifier consisting of two vacuum tubes is known as a two-stage amplifier.

When the currents in a radio circuit are vibrating slow enough to produce a sound in a pair of telephone receivers connected in the circuit, the currents are said to be vibrating at low or *audio frequency*. For this reason an amplifier, used to increase the values of the slowly vibrating currents in a detector circuit, is termed an "Audio Frequency Amplifier."

The SCR-72 amplifier is a two-stage audio frequency amplifier which will increase materially the strength of detected signals. (See Fig. 59.) A telephone jack is connected in the circuit of each stage; consequently the amount of amplification may be varied by plugging the telephone receivers in either jack. In addition, a third jack is provided which is connected indirectly through binding posts on the panel to the DT-3-A detector by means of a cord and plug. If amplification is not desired, the phones may be connected to the detector circuit by inserting the phone plug in this jack.

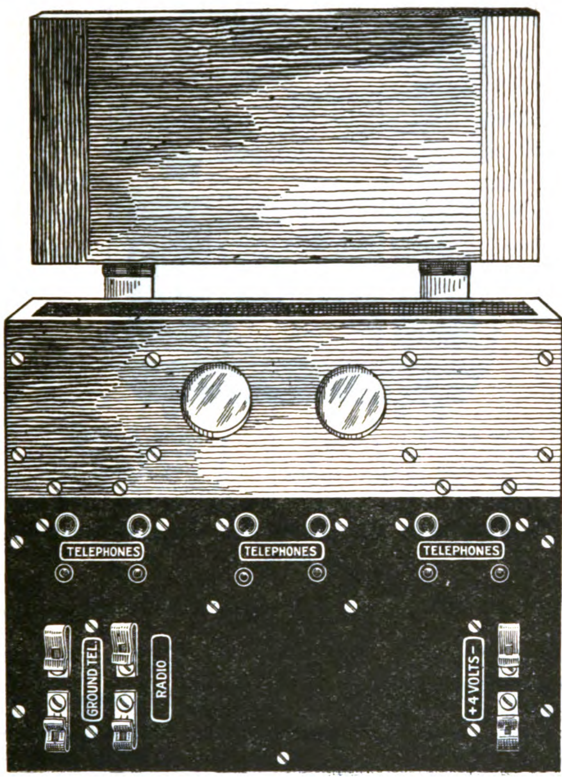

Fig. 59.—Set box, BC-17 of the SCR-72 amplifier.

The filaments of the two VT-2 vacuum tubes in the SCR-72 amplifier are lighted by a 4-volt storage battery. The amount of current supplied to each filament is limited by small fixed resistances connected in series with the filaments. The plate or "B" batteries are in a compartment inside the set box.

The SCR-72 amplifier may also be used in the circuits of ground telegraphy by connecting to the proper terminals.

Directions.

1. Examine the front of the set box. (See Fig. 59.) Notice the type of terminals used for making connections. Open the lid of the box and see how the "B" batteries are put in and how the

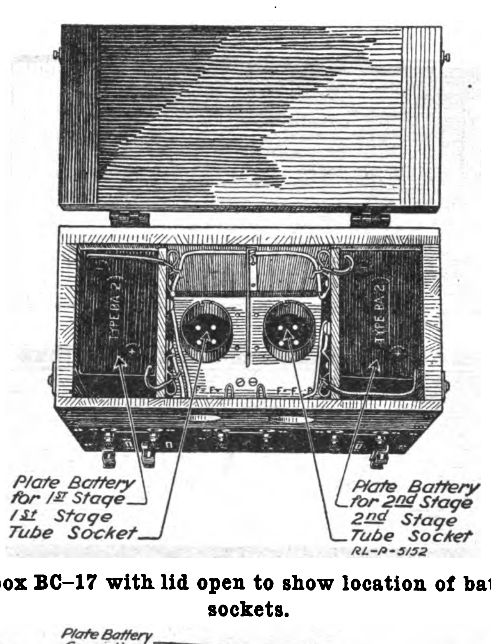

Fig. 60.—Set box BC-17 with lid open to show location of batteries and tube sockets.

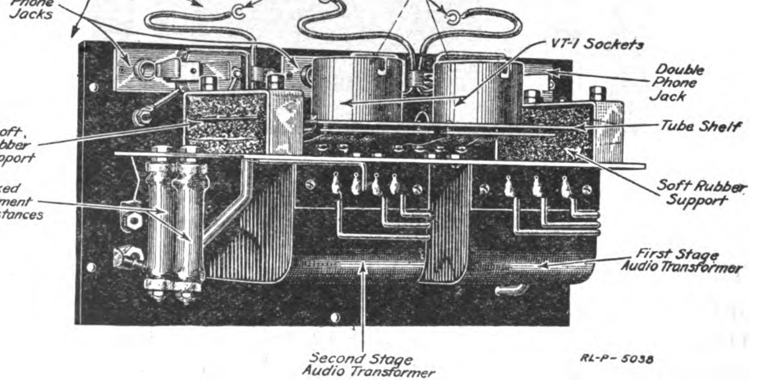

Fig. 61.—Panel of set box BC-17 removed to show interior parts.

vacuum tubes are inserted in their sockets. (See Fig. 60.) Note the three wires coming up to the "B" battery clip terminals. Remove these wires from beneath the screws and leave them loose so that the front panel may be removed. Take out the five screws from the edges of the bakelite panel. Carefully remove the panel and attached parts from the box. (See Fig. 61.) Check the wiring diagram shown in Fig. 62 with the wiring in the set itself.

Information.

It will be noticed in Fig. 61 that there are two iron covered parts marked "First Stage Audio Transformer" and "Second Stage Audio Transformer." Inclosed in each of the iron cases is a special type of transformer which consists of an iron core, a primary winding, and a secondary winding. Both windings are wound directly on the iron core. The purpose of the transformers is to provide coupling between the amplifier tube circuits. The first stage audio frequency transformer is used to couple the plate circuit of the detector tube to the grid circuit of the first stage amplifier tube. The second stage audio frequency transformer is used to couple the

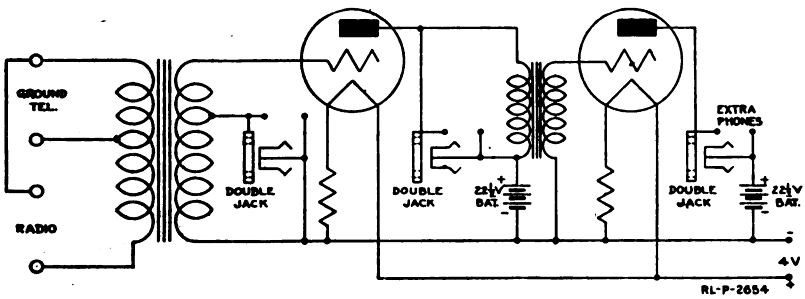

Fig. 62.—Schematic diagram of connections in set box BC–17.

plate circuit of the first stage amplifier tube to the grid circuit of the second stage amplifier tube.

Questions.

(1) *What is an amplifier? An audio-frequency amplifier?*

(2) *What is the purpose of the SCR–72 amplifier?*

(3) *Is it possible to vary the amount of amplification in the SCR–72 amplifier? Explain.*

(4) *How many telephone head sets can be connected to each stage of amplification?*

(5) *Can several head sets be connected to more than one stage at a time?*

(6) *What is the purpose of each of the small resistances located at the left of the amplifying transformers in Fig. 61?*

(7) *How many volts are used in the plate circuit of this amplifier?*

(8) *For what type vacuum tube is this amplifier constructed?*

(9) *How many stages of amplification are provided?*

(10) *Does the amplifier contain any device for varying the filament current?*

(11) *How is the filament current kept low enough so as not to damage the vacuum tubes?*

(12) *How are the tube sockets mounted? Why are they mounted in this manner?*

(13) *What type of coupling is used in the amplifier circuits?*

(14) *What is the name of the device which provides this coupling?*

(15) *Why are two of these devices necessary in the SCR–72 amplifier?*

EXPERIMENT NO. 1.

AMPLIFICATION WITH 22½ VOLTS IN PLATE CIRCUIT

Directions.

2. Replace the panel of the set box, being sure to get the leads to the "B" batteries back properly. If these leads are reversed the amplifier will not operate.

3. Make the same set-up of apparatus as in Unit Operation No. 11, with the following exceptions: (Also see Fig. 63.)

a. Connect leads from the telephone jack of the DT–3–A detector to the terminals marked "Radio" on the SCR–72 amplifier.

b. Connect a 4-volt storage battery direct to the DT–3–A detector. Also connect the positive terminal of the same battery direct to the positive terminal of the "4 Volts" terminal on the SCR–72 panel. Connect the negative terminal on the SCR–72 panel to one of the rheostat terminals and the remaining rheostat terminal to the positive terminal of the ammeter. Connect the negative terminal of the ammeter to the negative terminal of the 4-volt battery.

c. See that the plate or "B" batteries are connected in the set box with due regard to polarity.

4. Start the wave meter transmitting on 250 meters. Plug a head set in the first jack at the left on the SCR–72 amplifier. Adjust the rheostat so that no current flows through the amplifier tube filaments.

5. Tune the SCR–54–A receiver until the signal from the wave meter is heard with maximum intensity in the head set. Loosen the

coupling between the wave meter and the SCR–54–A receiver until the wave meter signal is just faintly heard in the head set. With the rule provided, measure the distance between the wave meter and the SCR–54–A receiver. Prepare a table similar to Table No. 1 shown at the end of this Unit Operation. Record the measurement just made in the proper place in the prepared table.

6. Adjust the small rheostat so that the ammeter reads about 2.2 amperes. Disconnect the head set from the detector jack and plug it in the first stage jack (the middle jack on the SCR–72). Again loosen the coupling between the wave meter and the SCR–54– set until the signal from the wave meter is just faintly heard in the head

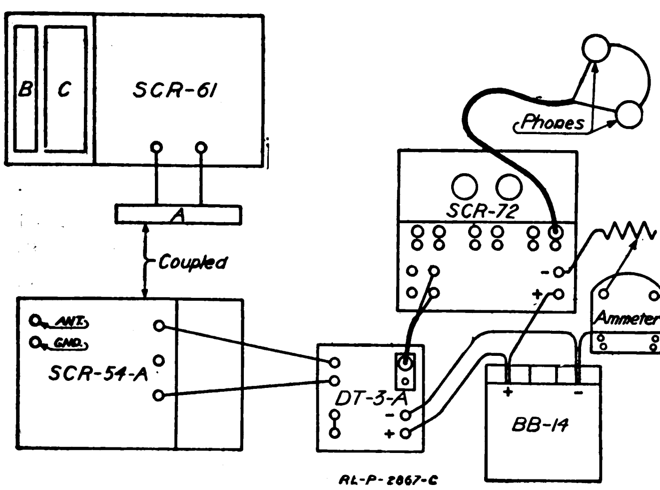

Fig. 63.—Cording diagram of connections when operating the SCR–54–A, the DT–3–A, and the SCR–72 sets together.

set. Measure the distance between the wave meter and the SCR–54–A set with the rule. Record this measurement in the table prepared.

7. Disconnect the head set from the first stage jack and plug it in the second stage jack (the jack at the right). Loosen the coupling between the wave meter and the SCR–54–A set until the signal from the wave meter is just faintly heard in the head set. Measure the distance between the wave meter and the SCR–54–A set and record this measurement in the table prepared.

8. Slowly decrease the filament current flowing through the amplifier tubes by adjusting the rheostat until a point is reached where the wave meter signal disappears. Note the reading of the ammeter as well as the brightness of the filaments.

Questions.

(16) *Was the distance between the wave meter and the SCR–54–A set greater in Direction 6 than in Direction 5?*

(17) *Does this distance increase as the number of amplifier tubes is increased?*

(18) *What does the increase in this distance indicate regarding the action of the SCR–72?*

(19) *What reading did the ammeter show when the filament current was reduced according to Direction 8?*

(20) *When receiving a weak signal, what effect is produced in the SCR–72 amplifier if the filament current is slightly lowered?*

EXPERIMENT No. 2.

EFFECT OF CHANGING VACUUM TUBES.

Directions.

9. Interchange the vacuum tubes in the detector and amplifier units by placing the detector tube in the first stage socket, the first stage tube in the second stage socket, and the second stage tube in the detector socket. Repeat Directions 4, 5, 6, and 7 and record observations in the table prepared.

Questions.

(21) *Are the measurements recorded in this experiment different from those recorded on Experiment No. 1?*

(22) *If there is a difference, what does this indicate?*

(23) *Judging from the results obtained, what is a good plan to follow when using radio equipment provided with several vacuum tubes?*

EXPERIMENT No. 3.

AMPLIFICATION WITH 45 VOLTS IN PLATE CIRCUITS.

Directions.

10. Repeat Experiment No. 1, using 45 volts in the plate circuit of each amplifier tube. The additional voltage may be obtained as follows: Remove the two 22½-volt batteries from the container in the SCR-72 amplifier. Connect these two batteries in series, and with short pieces of wire connect their two remaining wire terminals to the clip terminal used for the first stage plate connections. Connect the two spare 22½-volt batteries in series and connect the two

remaining leads to the clip terminals used for the second stage plate connections. Care should be taken that the connections are correct in polarity. Prepare a table similar to Table No. 2, shown at the end of this Unit Operation, and record all observations made in this Experiment.

Questions.

(24) *Do the results recorded in the table for this experiment show that there is an increase in amplification when the additional plate voltage is used?*

(25) *Is the increase in amplification sufficient to warrant using the 45-volt plate battery, if the signals are weak when using the 22½-volt battery?*

EXPERIMENT No. 4.

EFFECT OF WRONG CONNECTIONS ON AMPLIFIER.

Directions.

11. Increase the coupling between the wave meter and the SCR-54-A receiver until the signal from the wave meter is heard with fair volume in the head set. Reverse the filament connections to the amplifier and note any change in the signal strength in the head set.

12. Again reverse the filament connections to the amplifier, so that they are correct in polarity. Reverse the plate battery connections and note any effect on the signal strength.

13. Again reverse the plate battery connections, so that they are correct in polarity. Remove the second stage amplifier tube from its socket and note whether or not the wave meter signal can be heard. Replace this tube in its socket and remove the first stage tube from its socket. Note whether or not the signal can be heard. Replace the first stage tube in its socket.

14. Insert the head set plug in the first stage jack. Remove the first stage tube from its socket and note any effect on the signal strength. Replace this tube and remove the second stage tube from its socket. Note whether or not the signal can be heard.

Questions.

(26) *What is the effect of reversing the filament connections to the amplifier?*

(27) *What is the effect of reversing the amplifier plate battery leads?*

(28) *Will the amplifier operate with the head set plugged in the second stage jack if either tube is removed?*

(29) *If the head set is plugged in the first stage jack, will the amplifier operate when the second stage tube is removed?*

(30) *If when using the SCR-72 amplifier the second stage tube suddenly burns out and a new tube is not available, what should the operator do?*

TABLE No. 1.

Observations (ammeter reading 2.2 amperes).		Brightness of filaments.	Distance between wave meter and SCR-54-A receiver.
Detector	Experiment No. 1		
	Experiment No. 2		
First stage	Experiment No. 1		
	Experiment No. 2		
Second stage	Experiment No. 1		
	Experiment No. 2		

TABLE No. 2.

Observations (ammeter reading 2.2 amperes).		Brightness of filaments.	Distance between wave meter and SCR-54-A receiver.
Detector	Experiment No. 3		
First stage	Experiment No. 3		
Second stage	Experiment No. 3		

THE SCR-121 AMPLIFIER.

Equipment.

1 SCR-121 amplifier (BC-44-A set box only).
1 SCR-61 wave meter.
1 SCR-54-A receiver (BC-44-A set box only).
1 SCR-55 (DT-3-A) detector.
1 head set, type P-11.
1 plug with cord.
3 VT-1 vacuum tubes.
1 4-volt storage battery, type BB-14.
3 22½-volt " B " batteries, type BA-2.
1 rule.

GENERAL CONSTRUCTION OF THE AMPLIFIER.

Information.

The SCR-121 is a two-stage audio frequency amplifier similar to the SCR-72 amplifier. (See Fig. 64.) It has a filament rheostat for regulating the filament current and uses 45 volts on the plates of the tubes. Means are provided for plugging in phones on the second stage only.

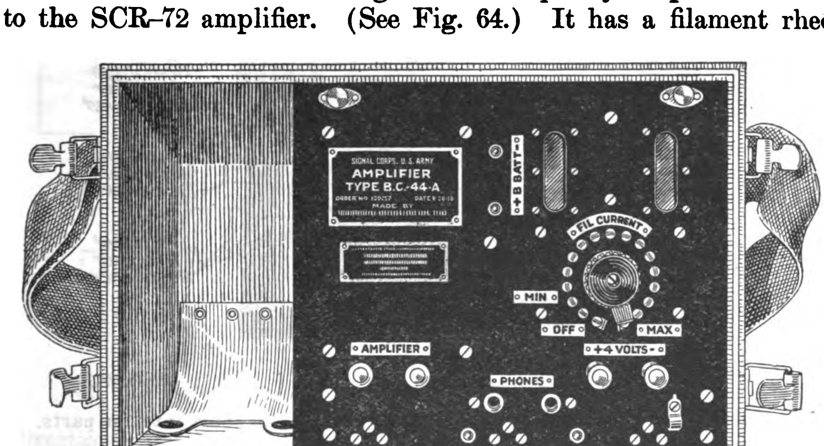

Fig. 64.—Set box, BC-44-A, of the SCR-121 amplifier.

Directions.

1. Examine the exterior of the set. Note the name plates, marking each separate set of binding posts. Also note the rheostat arrangement.

2. Unscrew the two thumbscrews at the top of the panel and pull the panel outward. (See Fig. 65.) Note the position of the various parts inside the set. Notice how the rheostat resistances are constructed and fastened to the panel. Examine the small resistance between the tube sockets and the panel.

3. Examine the wiring of the set and compare it with the wiring diagram shown in Fig. 66. Note that the same "B" battery is used for both plate circuits.

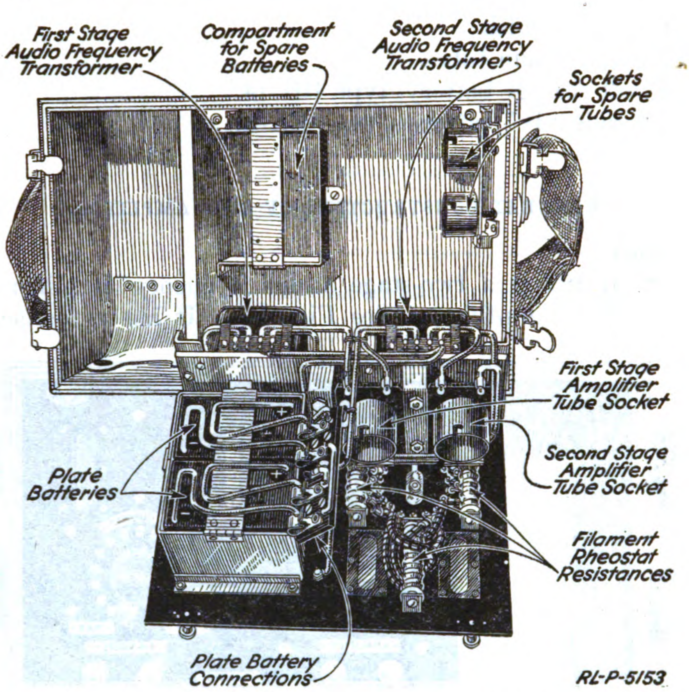

Fig. 65.—Panel of set box BC–44–A pulled forward to show interior parts.

Questions.

(1) *How are the leads to the rheostat insulated? Why?*

(2) *How are the rheostat resistances constructed?*

(3) *Why are the tube sockets mounted on sponge rubber cushions?*

(4) *How many transformers are used in this set?*

(5) *Is this set easier to repair than the SCR–72?*

(6) *How are the "B" batteries fastened in the case?*

(7) *Can extra "B" batteries be carried in the box? How?*

(8) *Can extra tubes be carried? How?*

(9) *For what is the compartment at the left end of the set box used?*

10) *How is it ascertained that both tubes are burning when the panel is in its proper position?*

(11) *If one of the tubes was removed from its socket would the other still burn? Explain.*

(12) *If BA–8 batteries were provided instead of BA–2 batteries could the set be used? Where would connections be made?*

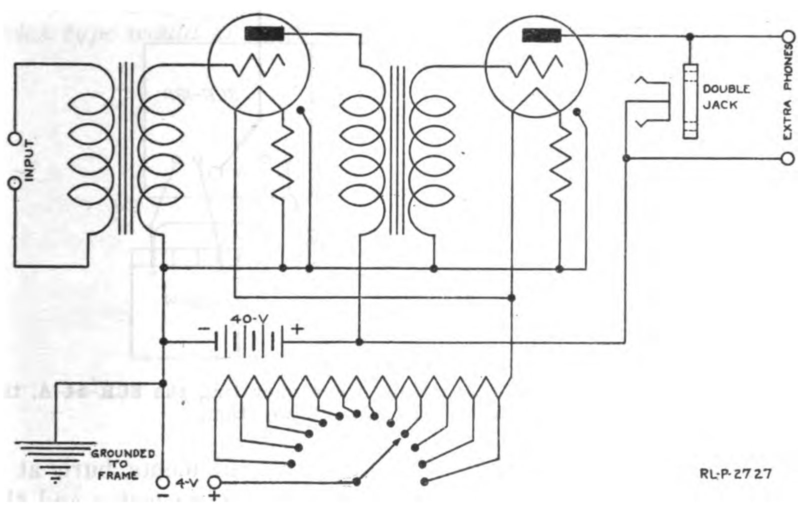

Fig. 66.—Schematic diagram of connections in the BC–44–A amplifier.

Directions.

4. Make a set-up of apparatus similar to the one used in Unit Operation No. 12, using the SCR–121 amplifier in place of the SCR–72 amplifier. (See Fig. 67.) To do this connect the leads from the jack of the DT–3–A detector to the binding posts marked "Amplifier" on the SCR–121. Connect the 4-volt terminals on the SCR–121 panel to the terminals of the storage battery with due regard to polarity. Turn the filament current rheostat to the "OFF" position. See that the two 22½ volt "B" batteries are properly connected in the set box. Insert a VT–1 tube in each socket (including the socket of the DT–3–A detector).

5. Start the wave meter transmitting on a wave length of 200 meters. Remove the plug from the DT-3-A detector jack and insert the head set plug in the jack. Tune the SCR-54-A receiver to the wave meter signal. Reduce the coupling between the wave meter and the SCR-54-A receiver until the wave meter signal is just faintly heard in the head set. Measure the distance between the wave meter and the SCR-54-A with the rule provided.

6. Remove the head set plug and insert it in the SCR-121 amplifier jack. Insert the plug connected to the "Amplifier" terminals in the detector jack. Turn the rheostat control knob in the direction toward "Max," until the amplifier tube filaments burn at a bright red. Reduce the coupling between the wave meter and the SCR-54-A set until the wave meter signal is just faintly heard in the head set. Measure the distance between the wave meter and the SCR-54-A with the rule.

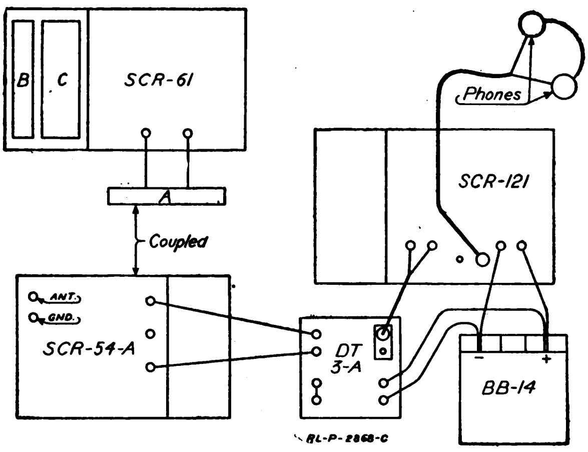

Fig. 67.—Cording diagram of connections when operating the SCR-54-A, the DT-3-A, and the SCR-121 sets together.

7. Reduce the filament current in the amplifier tubes until the faint signal from the wave meter just disappears. Note the brightness of the filament at this point; also the adjustment of the rheostat control knob.

8. Increase the filament current in the amplifier tubes until the signal is heard with maximum intensity. Note the brightness of the filament and the position of the rheostat control knob.

Questions.

(13) *How does the SCR–121 amplifier compare with the SCR–72 amplifier?* (*Compare the measurements taken in the above experiment with those taken in the experiment using both stages in Unit Operation No. 13.*)

(14) *How bright do the filaments of the amplifier tubes burn when the amplifier ceases to operate?*

(15) *How bright do the filaments burn when maximum amplification is obtained?*

(16) *How many pairs of phones can be plugged in the SCR–121 amplifier?*

(17) *If a choice of amplifiers were left to the radio operator, which type would he most likely use, the SCR–72 or the SCR–121?*

THE SCR-79-A AND THE SCR-99 SETS.

Equipment.

1 SCR-79-A (set box BC-32-A only).
1 SCR-125-A wave meter.
3 4-volt storage batteries (BB-14).
3 VT-1 vacuum tubes.
2 VT-2 vacuum tubes.
2 22½-volt batteries (BA-2).
1 antenna system, type *A9A* (complete).
1 dynamotor, type DM-1.
1 head set, type P-11.
2 cords, type CD *38* (battery connectors).
1 cord, type CD *48* (12-V lead).
1 cord, type CO *49* (key lead).

GENERAL CONSTRUCTION OF THE SCR-79-A.

Information.

The SCR-79-A and SCR-99 sets differ from each other only in wave-length range, the SCR-99 set having a range of from 900-1,900 meters. For this reason the SCR-79-A set only will be described.

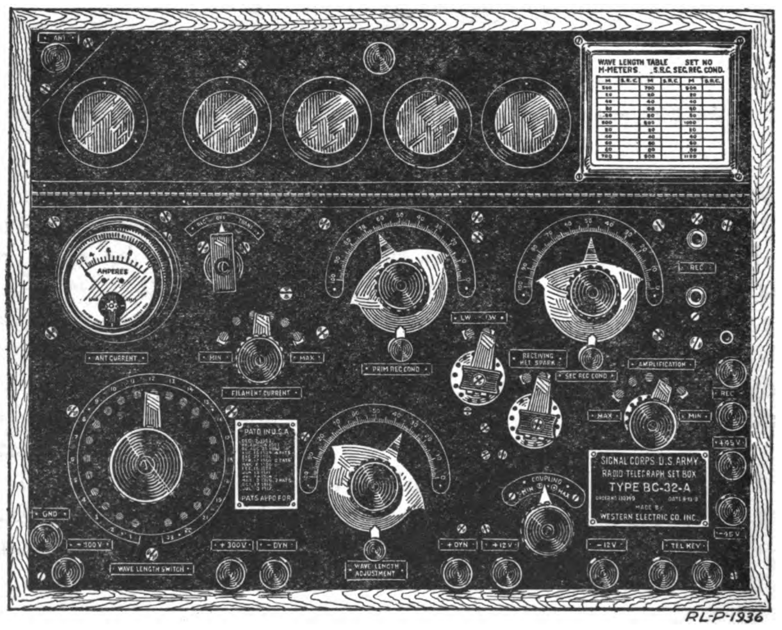

Fig. 68.—Set box BC-32-A of the SCR-79-A set.

In addition to using a vacuum tube as a detector and amplifier of radio signals, one may also use it to generate currents of a high frequency when it is connected to the proper apparatus. In this capacity the vacuum tube, known as an *oscillator*, may be used in a radio transmitter to generate the high-frequency current which is radiated from the antenna system as electromagnetic waves. The waves sent out by a spark transmitter, such as the SCR–74 and the SCR–105, are called "damped" waves. The waves emitted by a vacuum tube transmitter are called "undamped" or continuous waves.

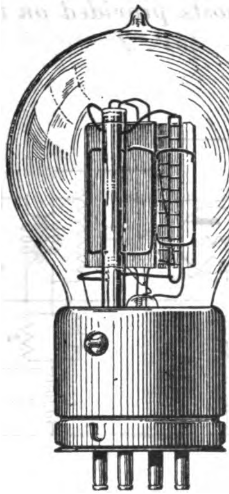

Fig. 69.—The type VT–2 vacuum tube.

The SCR–79–A is a vacuum tube set (see Fig. 68) designed for transmitting undamped wave signals and for receiving either damped or undamped signals. The wave length range of the set, for both transmitting and receiving, is from 500 to 1,100 meters. Two VT–2 vacuum tubes (see Fig. 69) are used in the transmitter and three VT–1 tubes are used in the receiver. Two sets of this type can communicate over a distance of about 30 miles.

Directions.

1. Examine the front of the panel of the BC–32–A. Carefully note the markings of all binding posts, knobs, dials, and meters. Pull the small knob in the center of the top edge and open the door. Note the construction of the tube socket mountings. (The VT–2 sockets have the slot in the socket offset about 45° from the

position of the slot in the VT–1 socket.) Note how the " B " batteries are connected and carried.

Questions.

(1) *Which sockets are used for the transmitting tubes? Which sockets are used for the receiving tubes?*

(2) *How are the " B " batteries carried in this set?*

(3) *How is the connection made between the " B " batteries and the receiving set?*

(4) *Why are binding posts provided on the front of the set box marked " + 45V." and " — 45V."?*

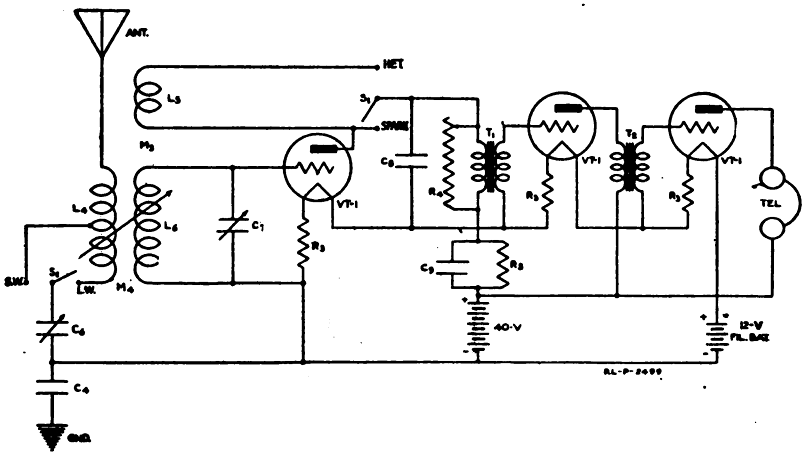

Fig. 70.—Schematic diagram of connections in the receiver of the SCR–79–A set.

(5) *To which binding post is the antenna connected? The ground?*

(6) *Where is the storage battery connection made? Does this supply the filaments of both transmitting and receiving tubes?*

(7) *Why does the storage battery have a voltage of 12 volts with this set when the VT–1 requires only a 4-volt battery to light its filament?*

(8) *What controls are varied on the front of the panel to change the primary receiving wave length?*

(9) *Which controls are varied to change the secondary receiving wave length?*

(10) *Which controls are varied to change the receiving set from a damped wave receiver to an undamped wave receiver? What does this switch do to the receiving set?* (*See Diagram, Fig. 70.*)

(11) *How is the strength of the received signal varied?*

(12) *What is the purpose of the two binding posts marked* "REC"?

(13) *How many pairs of telephones can be plugged into this set?*

(14) *Can the filament current of the receiving tubes be varied or is it constant? Explain the answer.*

(15) *Why are rubber mountings used for the tube socket strip?*

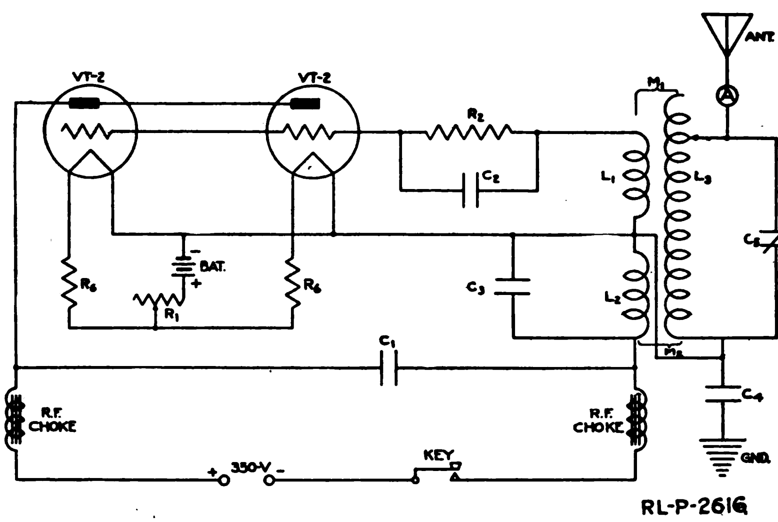

Fig. 71.—Schematic diagram of connections in the transmitter of the SCR–79–A set.

(16) *What is the purpose of the switch* "S_2" *on the front of the panel?*

(17) *How is the transmitted wave length varied?*

(18) *Is the filament current of the transmitting tubes fixed? Explain the answer.*

(19) *For what are the two binding posts marked* "+300 V" *and* "—300 V" *used?*

(20) *What connection is made to the two binding posts marked* "+Dyn" and "—Dyn"?

(21) *To what binding posts is the key connected and what circuit is it in?*

(22) *What is the purpose of the "Wave length adjustment" condenser? (See Fig. 71.)*

Directions.

2. Look at the VT–2 vacuum tube (See Fig. 69) and note how it is constructed. The filament, grid, and plate are somewhat similar to the elements of the VT–1. Notice, however, that they are spaced differently. The wide spacing of the plate in the VT–2 is necessary on account of the high voltage used. Compare the base of the VT–2 with the base of the VT–1. (See Fig. 72.)

NOTE.—The amount of current consumed by the filament of the type VT–2 vacuum tube is approximately 1.3 amperes.

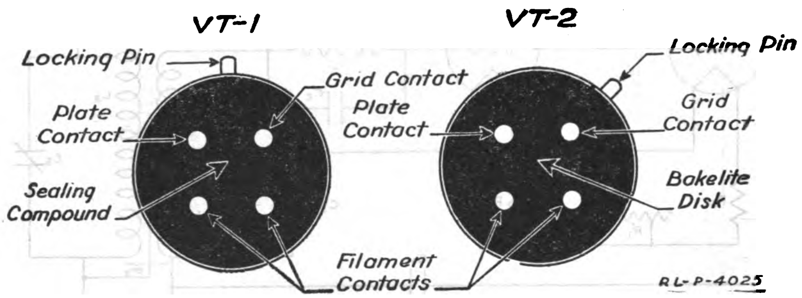

Fig. 72.—Relative positions of locking pins on type VT–1 and VT–2 vacuum tube bases.

Questions.

(23) *Is the position of the locking pin on the side of the VT–2 base different from the position of the locking pin on the VT–1 with respect to the four contact prongs?*

(24) *Will a VT–1 vacuum tube fit in a VT–2 socket? Explain the answer.*

(25) *Why were the tubes and sockets designed as explained in your answer to the preceding question?*

Directions.

3. Open the door at the top of the panel and remove the two screws holding the panel frame to the bracket. Remove the two screws from the lower corners of the panel. Lift the panel out of the box. Inspect the parts in the rear of the panel carefully. (See Fig. 73.) Move the control knobs on the front of panel and note what moves in the rear.

Questions.

(26) *Where is the primary inductance of the receiving circuit?*

(27) *How many taps are there on the primary receiving coil? What switch varies the number of turns being used?*

(28) *Which is the secondary receiving coil? How many taps on it?*

(29) *Which is the tickler coil? To which coil is it most closely coupled? Why?*

(30) *What kind of coupling is used in this receiving set? How is it varied?*

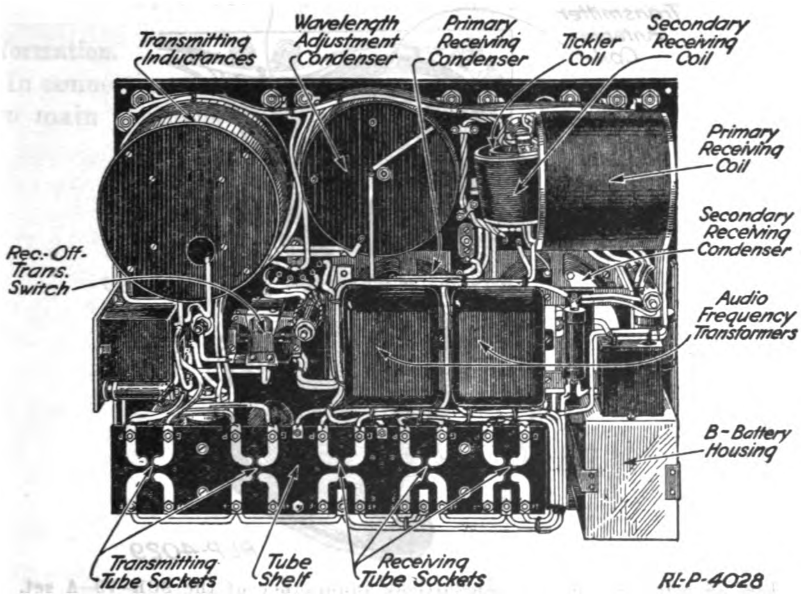

Fig. 73.—Rear, panel view of set box BC–32–A.

(31) *Why are stops placed on the coupling controls on the front of the panel?*

(32) *Where is the resistance and condenser unit in series with the plate of the detector and the "B" battery?*

(33) *What is the purpose of the above resistance and condenser?*

(34) *Where are the resistances R_2? Why are they placed in the circuit?*

(35) *Where is the ground lead condenser? Why is it used?*

(36) *Where are the primary and secondary variable condensers?*

(37) *Where are the transformers of the first and second stages of audio frequency?*

(38) *Which is the detector tube socket? Which are the amplifier sockets?*

(39) *How many tubes are used for receiving in this set?*

(40) *How many stages of amplification are used?*

(41) *What type of tubes should be used in the receiving circuit?*

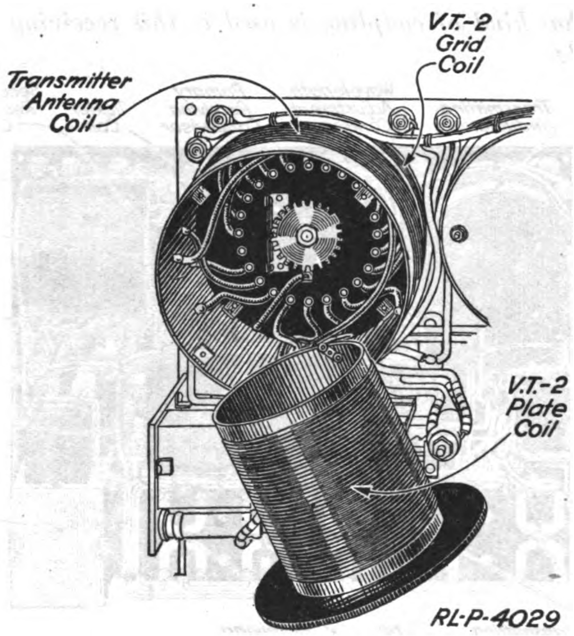

Fig. 74.—Details of the transmitting inductance of the SCR–79–A set.

(42) *What type tube is used in the sockets of the transmitting side?*

(43) *How many transmitting tubes are used?*

(44) *Which are the transmitting tube sockets?*

Directions.

4. Remove the four screws nearest the center of the rear of the transmitting inductance and lift out the end. (See Fig. 74.)

Questions.

(45) *Which is the grid coil, the plate coil, and the antenna coil?*

(46) *What does the "wave length switch" do?*

(47) *What kind of coupling is used between the plate and grid coils?*

(48) *Can the filament current of the receiving tubes be varied? Explain the answer.*

(49) *Locate the resistance R_2 and the condenser C_2.*

(50) *Explain exactly what circuits the switch S_2 makes and breaks in each of its three positions.*

EXPERIMENT No. 1.

TO CONNECT UP AND TUNE THE SCR–79–A SET.

Information.

In connecting up the SCR–79–A set ready for operation there are two main divisions of the work, namely, the set connected as a

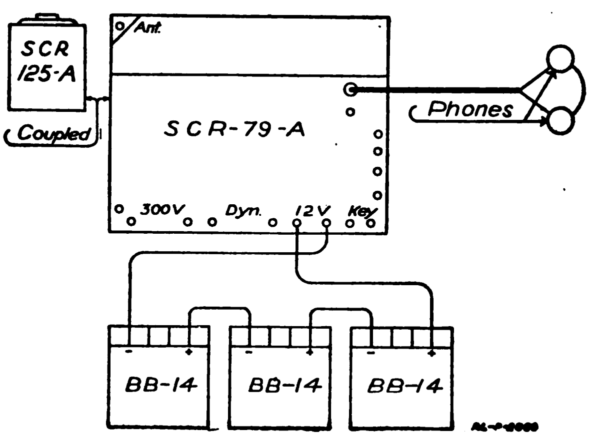

Fig. 75.—SCR–125–A wave meter coupled to receiving circuit of SCR–79–A set.

receiver and the set connected as a transmitter. The set may be connected up as a transmitter without fully connecting it up as a receiver, and vice versa. (See Figs. 75 and 76.) In like manner the tuning of the set as a receiver is separate and different from the tuning as a transmitter. A definite method must be followed in performing of these various operations.

Directions.

1. To connect up the set as a transmitter:

a. Place three BB–14 batteries in the form of a triangle on the ground near the foot of the mast holding the point of the "V" antenna. Connect the three batteries in series. To the negative terminal of the 12-volt battery thus formed connect the longer black lead of the cord, type CD-48. Do not connect the red lead.

b. Place the carrying chest of the set on top of the three storage batteries so that it is firmly supported and open up the top and front of the chest. (One of the storage batteries should be partly under the operating shelf formed by the front cover of the chest when open.)

c. Open up the top hinged portion of the panel by pulling on the knob in its center and insert two VT-2 tubes in the two left-hand sockets. Close the panel.

d. Place the "Trans.-Rec." switch on the "Off" position.

e. Connect the high voltage dynamotor leads (with the proper polarity) to the binding posts marked "+ 300 V" and "— 300 V."

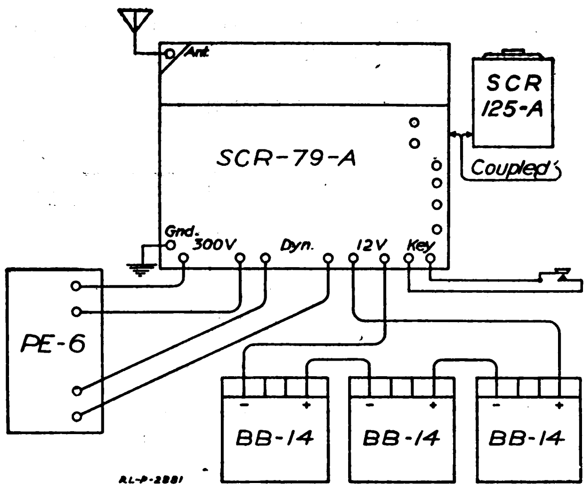

Fig. 76.—SCR-125-A wave meter coupled to transmitting circuit of SCR-79-A set.

f. Connect the low voltage dynamotor leads to the two binding posts marked "+ Dyn." and "— Dyn." with the correct polarity.

g. Connect the antenna lead-in wire to the post marked "Ant."

h. Connect the wire from the counterpoise or other ground system used to the post marked "Gnd."

i. Connect the short red lead of the cord, type CD-48, to the binding post marked "+ 12 V" and the short black lead of the same cord to the post marked "— 12 V."

j. Insert the key in its holder on the operating shelf and using the cord, type CD-48, connect it to the two binding posts marked "Key."

k. Check all connections to see that they are correct.

l. See that the double-pole single-throw switch on the dynamotor is closed.

m. Connect the long red lead of the cord, type CD-48, to the positive terminal of the 12-volt battery. The set should now be ready to transmit by throwing the "Trans.-Rec." switch to the "Trans." position and by pressing the key.

Questions.

(1) *Why is it necessary to follow certain steps in a definite and particular order when connecting up this set?*

(2) *Why is the proper polarity important on any radio set?*

(3) *Why is the 12-volt battery circuit left incomplete until the last step in connecting up the set?*

(4) *Why is the "Trans.-Rec." switch placed on the "Off" position while connecting up the set?*

(5) *Why is the carrying chest placed on top of the storage batteries?*

Information.

The transmitter of the SCR-79-A is of such a type that the wave length on which it transmits is dependent upon the antenna system with which the set is used. It is therefore impossible to calibrate the transmitter permanently, and it is consequently necessary to use a wave meter to set it for any one of a number of wave lengths each time the antenna system is moved or changed in any way. Moreover, it is advisable to determine the settings of the transmitter for the different wave lengths on which it may be required to work before actually starting to handle traffic in a net.

Directions.

2. To tune the transmitter to a given wave length:

a. Set the filament rheostat at "Max."

b. Set the "Wave Length Switch" approximately at the wave length desired. (Suppose that the wave length desired is 700 meters. Seven hundred meters is a little less than halfway along the wave-length range of the set. Therefore, place the "Wave Length Switch," as a trial setting, a little less than halfway around toward "Max.")

c. Set the control of the "Wave Length Adjustment" condenser at the middle point of the scale.

d. Light the lamp in the SCR-125-A wave meter and adjust it to a dull red glow.

e. Close the key and throw the "Trans.-Rec." switch to the "Trans." position.

f. Couple the wave meter to the transmitter by holding the side marked "Plane of coil" against the knob of the "Wave Length Switch" with the dial of the wave meter up.

g. Slowly turn the wave meter dial until the lamp glows most brightly.

h. If the wave meter lamp glows brightly at a wave length greater than that desired, decrease the antenna inductance by turning the "Wave Length Switch" down two or three taps; and if it glows brightly at a shorter wave length than the desired value, increase the antenna inductance by turning the "Wave Length Switch" up two or three taps.

i. Again turn the wave meter dial until the lamp glows most brightly. Continue this process until two inductance taps are found, one of which is above and the other below the desired wave length.

j. Set the "Wave Length Switch" on either of the two taps found in Direction *i* above. Set the wave meter to the exact wave length desired and vary the "Wave Length Adjustment" condenser until the lamp on on the wave meter glows brightly. The set is now transmitting on the desired wave length.

Questions.

(6) *Why is the "Wave Length Switch" first set on approximately the correct position?*

(7) *Why is the control of the "Wave Length Adjustment" condenser first set at the middle point of the scale?*

(8) *What condition exists when the wave meter lamp glows most brightly?*

(9) *Why is the transmitter of this set not calibrated for use at all times?*

(10) *Why must the key be closed when tuning the transmitter?*

Information.

Although the receiver of the SCR-79-A is built in the same box as the transmitter and some of the parts are common to both, yet it is possible to connect up the set for receiving only when it is so desired. (See Fig. 75.) However, it is only for some special purpose that the receiver alone is connected up. The following directions explain how to connect up the receiver after the transmitter has been connected. Connections of the complete set are a combination of the operations involved in connecting up the receiver and the transmitter, and will be given later.

Directions.

3. To connect up the set as a receiver: After having made all of the connections given under the directions for connecting up the set as a transmitter the following additional connections will be needed in order to place the receiver in operation:

a. Open up the top hinged portion of the panel and insert three VT–1 tubes in the three right-hand sockets. Place two BA–2 batteries in the compartment, which is on the right side of the opening, and connect the leads from the batteries to the Fahnstock clips on the side of the compartment, making sure that the connections are correct in polarity. The two BA–2 batteries are thus connected in series in the receiver circuit. Close the panel.

b. Plug in one or two head sets, type P–11, into the jacks provided on the face of the panel. (If the cords of available head sets are not provided with plugs, the cord tips may be connected to the two binding posts marked "Aux. Tel.")

c. Put on one of the head sets and adjust it to fit the head comfortably. (The stirrups holding each receiver should slant "in" and not "out." If they slant "out," remove the receiver from its stirrup and turn the stirrup halfway around and replace the receiver.)

d. If the receiver only of the set is to be used, omit the items given under directions *c*, *e*, *f*, *j*, and *l*, describing the connections of the set as a transmitter.

Questions.

(11) *Why are the items given under Direction d, above, omitted where the set is to be used as a receiver only?*

(12) *For what reason are the two binding posts on the edge of the panel marked + and — 45 volts?*

(13) *Must the VT–2 tubes be placed in their sockets when the set is used as a receiver only?*

Directions.

4. *To connect up the set both as a transmitter and as a receiver*—

a. Place three BB–14 batteries on the ground in the form of a triangle near the foot of the mast holding the point of the "V" antenna. Connect the three batteries in series; and to the negative terminal of the 12-volt battery thus formed, connect the longer black lead of the cord, type CD–48. Do not connect the red lead.

b. Place the carrying chest of the set on top of the three storage batteries so that it is firmly supported and open up the top and the front of the chest. (One of the storage batteries should be partly under the operating shelf formed by the front cover of the chest when open.)

c. Open up the top hinged portion of the panel by pulling on the knob in its center and insert two VT–2 tubes in the two left-hand sockets. Insert three VT–1 tubes in the three right-hand sockets. Place two BA–2 batteries in the compartment which is on the right side of the opening and connect the leads of the batteries to the Fahnstock clips on the side of the compartment, making sure that the connections are correct in polarity.

d. Place the "Trans.-Rec." switch on the "Off" position.

e. Connect the high voltage dynamotor leads (with the correct polarity) to the binding posts marked + and — 350.

f. Connect the low voltage dynamotor leads to the two binding posts marked "+ Dyn." and "— Dyn." with the correct polarity.

g. Connect the antenna lead-in wire to the post marked "Ant."

h. Connect the wire from the counterpoise or other ground system used to the post marked "Gnd."

i. Connect the short red lead of the cord, type CD–48, to the binding post marked "+ 12 volts" and the short black lead of the same cord to the post marked "— 12 volts."

j. Plug in one or two head sets, type P–11, into the jacks provided on the face of the panel. (If the cords of available head sets are not provided with plugs, the cord tips may be connected to the two binding posts marked "Aux. Tel.")

k. Put on one of the head sets and adjust it to fit the head comfortably.

l. Check all connections to see that they are correct.

m. See that the double-pole single-throw switch on the dynamotor is closed.

n. Connect the long red lead of the cord, type CD–48, to the positive terminal of the 12-volt battery. The set is now completely connected and ready to operate both as a transmitter and as a receiver.

Information.

In tuning the receiver to pick up desired signals several different cases will occur. They are as follows:

a. Tuning in a C. W. signal of known wave length.
b. Tuning in a damped wave signal of known wave length.
c. Tuning in a C. W. signal of unknown wave length.
d. Tuning in a damped wave signal of unknown wave length.

Each of the above cases will be taken up separately and the necessary operations given under each case.

In the following tuning operations it will be noted that nothing is said about either the "Coupling Control" or the "Amplification" switch. The coupling control should be set on "Max." in all cases and only placed on "Min." after the desired signal has been tuned in and it is necessary to get rid of interference. When the coupling is changed from "Max." to "Min." it will require some little readjustment of the primary and secondary condensers. The "Amplification" switch should normally be left on "Max." and only turned toward "Min." when signals come in with so much volume that wearing the head set or reading the signals is uncomfortable.

Directions.

5. To tune the receiver of the set to a C. W. signal of known wave length proceed as follows. After the receiving side has been connected up as directed above:

a. Throw the "Trans.-Rec." switch to the "Rec." side.

b. Place the "Spk.-Het." switch on "Het."

c. Set the "LW-SW" switch and the secondary condenser to the desired wave length as given by the calibration of the set.

d. Vary the primary condenser until a distinct double click is heard and set the primary condenser about 5° to either side of the point where this double click is heard.

e. The receiving side of the set should now be in tune on the desired wave length, but due to inaccuracies which may occur the setting may not be exact enough to pick up the signal sought. It is therefore advisable to swing the secondary condenser slowly over an arc of about 10° (the middle point of which is the setting given by the set's calibration) until the sought for signal is heard.

f. A small further adjustment of the primary condenser may now be made in order to increase the loudness of the signal.

6. To tune the receiver to a damped wave signal of known wave length proceed as follows:

a. Same as *a* above.

b. Same as *b* above.

c. Same as *c* above.

d. Same as *d* above.

e. Place the "Spk.-Het." switch on "Spk."

f. Same as *e* above.

g. Same as *f* above.

7. To tune the receiver to a C. W. signal of unknown wave length proceed as follows:

a. Same as *a* under Direction 5.

b. Same as *b* under Direction 5.

c. Set the " LW–SW " switch on " SW." Set the secondary condenser on about 5° and vary the primary condenser until the double click indicating resonance is heard.

NOTE.—For every position of the secondary condenser there should be a corresponding position of the primary condenser at which the primary or antenna circuit is in tune with the secondary circuit. In searching for a signal of unknown wave length the method should be to vary both condensers at the same time, attempting always to keep the primary condenser close to that point where its circuit is in tune with the secondary.

d. Starting with the secondary condenser at about 5° and the primary condenser at the point where it is in tune, slowly turn both condensers as outlined above over their entire scale. Repeat this several times until you are sure that the signal is not obtainable. (The primary condenser should increase as the secondary is increased.)

e. Set the " LW–SW " switch on " LW " and repeat *d.*

f. When the desired signal is found under either *d* or *e*, adjust very carefully the primary and secondary condensers for a loud, clear signal of a readable pitch.

8. To tune the receiver to a damped wave signal of unknown wave length proceed as follows:

a. Follow exactly the procedure outlined under Direction 3 until the desired signal is found. When found the natural tone of the damped wave will be badly distorted.

b. Throw the " Spk.-Het." switch to " Spk." and if necessary retune slightly both the primary and secondary condensers. The damped wave signal should not be heard with its natural tone but much weaker than when heard under *a.*

NOTE.—Damped waves may be received with the " Spk.-Het." switch on " Het.", if change in tone is not objectionable. The receiver will be far more sensitive than with the switch on " Spk."

Questions.

(14) *Why is it necessary to use different methods in tuning " known " and " unknown " wave lengths?*

(15) *If your receiver is not calibrated, what method would you use to tune in a C. W. signal of known wave length?*

(16) *After setting the secondary circuit of a receiver to any given wave length, why is it necessary to vary the primary circuit until a double click is heard in the head set?*

(17) *In tuning in a signal of unknown wave length, why is it necessary to vary both primary and secondary controls at the same time?*

(18) *In tuning in a damped wave signal, why is the "Spk.-Het." first turned to the "Het." position?*

EXPERIMENT No. 2.

CALIBRATION OF RECEIVER.

Directions.

9. Connect up the SCR–79–A set for receiving only as outlined under Direction 3 *d*, of this Unit Operation. Throw the "Trans.-Rec." switch to "Rec."

METHOD "A."

About 5 feet away from the set, couple the SCR–125–A wave meter to the ground lead by wrapping one or two turns of the lead around the wave meter. Set the wave meter on 500 meters and start the buzzer going with a smooth even note. Return to the set and place the coupling on maximum with the "Het–Spark" switch on "Het." Place the "SW–LW" switch on "SW" for wave lengths up to 800 meters and on "LW" for the wave lengths above 800 meters unless it is found impossible to tune in the primary circuit on the position stated. Vary the secondary condenser until the note of the wave meter is heard and then vary the primary condenser until a maximum signal strength is obtained. After adjusting the primary condenser it will be found that the secondary condenser will need a slight readjustment. In a table similar to the one shown below fill in the settings of the primary and secondary condenser and the "LW–SW" switch which have been found to give the greatest signal strength with the wave meter.

Wave length.	Primary condenser setting.	Secondary condenser setting.	Setting of "SW-LW" switch.
500			
550			
600			
650			
700			
750			
800			
850			
900			
950			
1000			
1050			
1100			

Adjust to 500 meters. Repeat the above operations with the wave meter adjusted successively to wave lengths 50 meters apart until the entire wave length range of the set has been covered.

METHOD " B."

Set the SCR-125-A wave meter on 500 meters and start the buzzer going. With the various switches set as given in " Method A," hold the wave meter about 1 foot in front of the panel of the set. Vary the secondary condenser until maximum signal strength is attained. Shut off the wave meter buzzer and without moving the secondary condenser vary the primary condenser until a sharp and definite double click is heard. This click indicates that the primary circuit is now in tune with the secondary. Prepare a table similar to the one prepared under "Method A." Repeat the above operations for successive settings of the wave meter, 50 meters apart, and record in the table. Proceed until the entire wave-length range of the set has been covered.

Information.

In " Method A" both the primary and secondary circuits are tuned by reference to the wave meter, while in " Method B " the secondary circuit only is tuned to the wave meter, and the primary circuit is then tuned to the secondary. The normal way of tuning or calibrating the receiving side of the set should be by " Method B." However, if it is found impossible to obtain the definite click indicating that the primary circuit is in tune then " Method A " should be used. If, in " Method B," trouble is experienced in finding the point of maximum strength, due to interference from other radio sets, the antenna may be disconnected while the secondary circuit is being calibrated, but it must be connected again for calibration of the primary circuit.

Questions.

(19) *Can the primary circuit be set to a given wave length by holding the wave meter in front of the panel of the set?*

(20) *Why is the receiver calibrated with the coupling control on maximum?*

(21) *Why is the receiver calibrated with the " Spk.-Het." switch placed on the " Het." position?*

(22) *Why is the wave meter coupled to the ground lead when calibrating a set by "Method A"?*

(23) *Which, "Method A" or "Method B," gives the more accurate setting of the primary condenser?*

EXPERIMENT No. 3.

TO TUNE THREE OR MORE SETS TO THE SAME WAVE LENGTH.

Information.

A number of SCR–79–A sets are operating in a net. They are all operating on the same wave length. In other words, all the sets are adjusted to transmit and to receive on exactly the same wave length. Any set in the net may start transmitting. All of the remaining sets in the net will receive the transmitted signals without readjustments of the secondary condenser control.

A number of SCR–79–A sets are being operated in a net on slightly different wave lengths. In other words all of the transmitters are not adjusted to exactly the same wave length. As a result, every time a different set starts transmitting, it is necessary for the remaining sets to readjust the secondary condenser control when receiving the transmission.

Questions.

(24) *Which of the two conditions, as outlined above, is the better for rapid and accurate exchange of messages in a net?*

(25) *If an operator is listening in under the second condition (as outlined above) during a silent period, what does he have to do constantly in order to receive any communications which may be transmitted?*

Information.

In tuning the SCR–79–A receiver it was noticed that the slightest movement of the secondary condenser caused the beat note to disappear. From this fact an idea may be obtained as to the amount of accuracy necessary when tuning to the same wave length all SCR–79–A transmitters in a net. There is sometimes a variation of as much as 25 or 30 meters between the readings of different SCR–125–A wave meters when they are used to measure the same wave length. For this reason it is not possible to tune all the transmitters in a net to exactly the same wave length by using a different wave meter for

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each set. In the following experiment a method will be used by which it is possible to adjust all sets in a net to exactly the same wave length.

Directions.

10. Set up and place in operation three or more SCR–79–A sets at a distance of at least 300 yards between each set.

11. One set is designated as the NCS (net control station) of the net and all stations are advised regarding the wave length to be used. Call signs are assigned to each station.

12. The NCS uses his SCR-125–A wave meter and tunes his transmitter to the designated net wave length (explained under "Tuning the transmitter" in Experiment No. 1). The NCS station then transmits as follows: $\overline{\text{VE}}$ ZVL ZVL V NCS NCS II ZVL ZVL ZVL (transmit signal ZVL for one minute) II $\overline{\text{AR}}$.

13. Each of the other or "secondary" stations must tune in the above transmission on the NCS in such a way that the best possible signal will be received.

14. The operator at each secondary station, without disturbing the adjustments of his receiver in any way, now tunes his transmitter to the designated net wave length in the usual way, that is by the use of a wave meter. The "Trans.-Rec." switch is then thrown to "Rec." and the buzzer on one SCR–125–A wave meter started. The wave meter is held in front of the panel and its dial slowly turned until the maximum sound is heard in the head set. Without changing the adjustment or position of the wave meter, throw the "Trans.-Rec." switch to the "Trans." position. Since the transmitter is already on about the correct wave length, it will only require a slight readjustment to make it exact. The "Wave Length Adjustment" condenser is therefore turned until the wave meter lamp glows most brightly and is then locked in this position. The adjustment of the transmitter and receiver should now be exactly on the wave length on which the NCS station is transmitting. Since all of the secondary stations are adjusted to the wave length of the NCS station, they should all be on the same wave length.

15. The NCS station will call each secondary station in turn, and when the secondary station replies, will note the position of the secondary condenser on which the reply is received. All secondary stations other than the transmitting station will also note the position of their secondary condenser dials where the transmission is received.

16. If all stations are received on the same setting of the secondary condenser by the NCS station, the experiment will be considered complete; if not, it will be repeated until they are so received.

Questions.

(26) *Why is it important that when a net is working on one wave length all of the stations in the net transmit on exactly the same wave length?*

(27) *Are the calibrations on the SCR-95 wave meters at secondary stations used in making the final accurate setting of their transmitting wave length?*

(28) *Did your wave meter check with the calibrations of the wave meter used by the NCS?*

(29) *Were you able to hear all of the stations in the net without moving the secondary condenser?*

(30) *How much was it necessary to move the "Wave Length Adjustment" condenser from the position on which it was set with the wave meter when it was changed to the wave length of the NCS?*

THE SCR-67-A RADIO TELEPHONE SET.

Equipment.

1 SCR-67-A (set box BC-13-A only).
1 power board (BD-1-A).
1 SCR-125-A wave meter.
1 SCR-61 wave meter.
3 storage batteries, 4-volt, type BB-14.
2 dry batteries, 22½-volt, type BA-2.
2 VT-1 vacuum tubes.
2 VT-2 vacuum tubes.
1 transmitter, type T-3.
1 control button and cord (CD-25).
1 extension cord (CD-23).
1 headset, type P-11.
1 antenna system, type A-9-A.

GENERAL CONSTRUCTION OF THE SCR-67-A.

Information.

The type SCR-67-A set is a two-way radio telephone set for use on the ground in communication with a similar set or with airplane

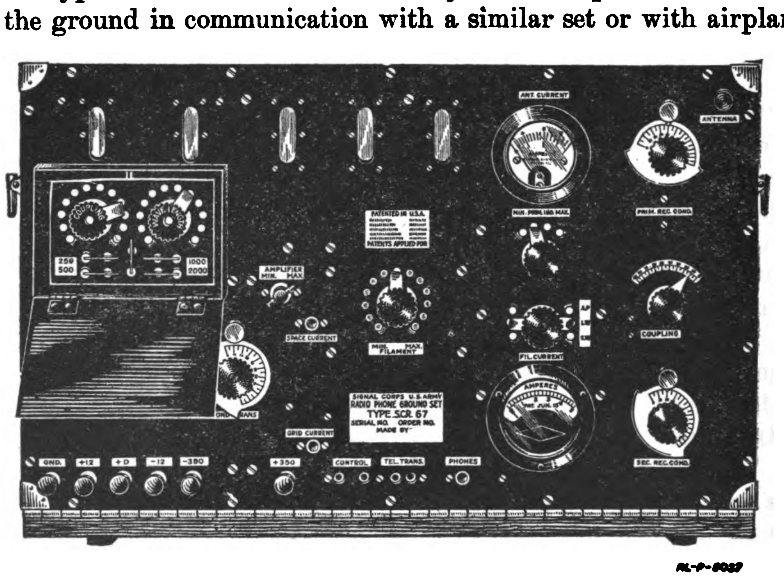


Fig. 77.—Front panel of set box BC-13-A of the SCR-67-A set.

radio telephone sets. Communication between two sets of this type may be carried on over a distance of from 5 to 7 miles. When used with a suitable antenna, the range of wave lengths of the set is from

250 to 450 meters when transmitting, and from 200 to 700 or 800 meters when receiving.

The SCR-67-A consists of two units: the BC-13-A set box and the BD-1-A power board. (See Figs. 77 and 78.) The BC-13 set box contains a vacuum tube, radio telephone transmitter, and receiver. The transmitting and receiving circuits are adjusted by the various controls on the front panel.

In order to operate the transmitter vacuum tubes properly, it is necessary to use 350 volts on the plates of the tubes. This voltage is

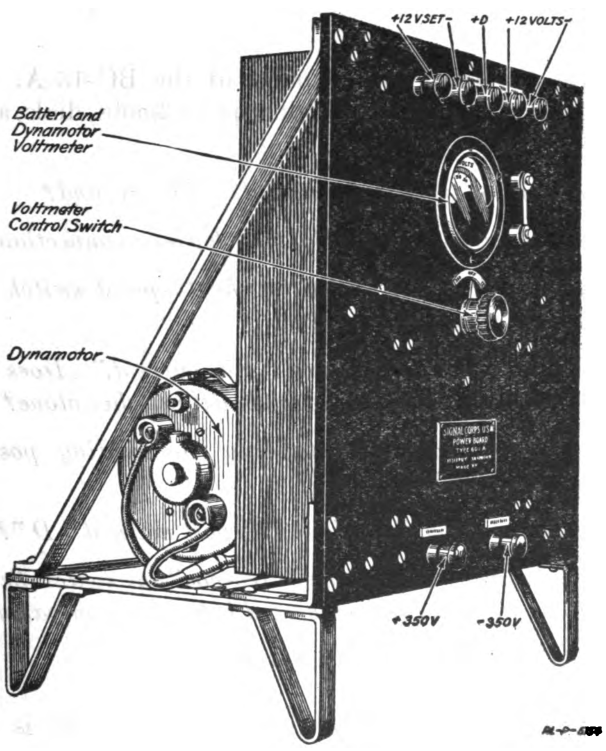


Fig. 78.—Power board type BD-1-A.

supplied by a dynamotor mounted in the rear of the BD-1-A power board unit. The 12-volt storage battery which is used to light the filaments of the transmitting and receiving tubes, also provides the current necessary to run the dynamotor.

Notice in the cording diagram that the two leads from the storage battery do not run directly to the set box but are directly connected to terminals on the power board. Thus a flexible extension cord may be used for all connections from the power board to the set box.

With this arrangement the apparatus can be easily set up in a short time.

A voltmeter which reads from 0–50 volts is mounted on the power board. When the switch directly underneath the meter is turned to the position marked " 12 volts " the meter will indicate the voltage of the storage battery. When the switch is turned to the position marked " 350 V " the meter will indicate the high voltage of the dynamotor. It will be necessary to multiply the latter reading by 10, as only one scale is provided on the meter. The meter is disconnected from the circuits when the switch is in the " Off " position.

Directions.

1. Look at the front of the panel of the BC–13–A. Carefully observe the marking of all the binding posts, knobs, dials, and meters.

Questions.

(1) *Where is the antenna connected? The ground?*

(2) *Where are the filament lighting battery connections made?*

(3) *What circuit is controlled by the 13–point switch located at the center of the panel? Explain.*

(4) *Locate the ammeter marked " Fil. current." Does it indicate the filament current used by the transmitting tubes alone? Explain.*

(5) *What connections are made to the binding posts marked* "+ 350 " *and* " —350 "?

(6) *What connection is made to the post marked " D "?*

(7) *What position should the three-position switch be in for reception only? (This switch is located below the compartment on the left of the panel.)*

Information.

In the SCR–67–A transmitter, the antenna circuit is coupled to the vacuum tube circuit through a single inductance coil. (See Fig. 79.) A wave-length change switch controls the number of turns in the inductance coil and thus controls the wave-length range of the transmitter. A variable condenser, marked "Antenna Cond.," connected directly between the antenna and ground terminals, provides a means for fine adjustment of the wave length.

There are two VT–2 vacuum tubes used in the transmitting circuit. The vacuum tube which is coupled to the antenna circuit is called the *oscillator tube.* The term " oscillator " implies that the tube is a generator of electrical impulses. As long as the filament of

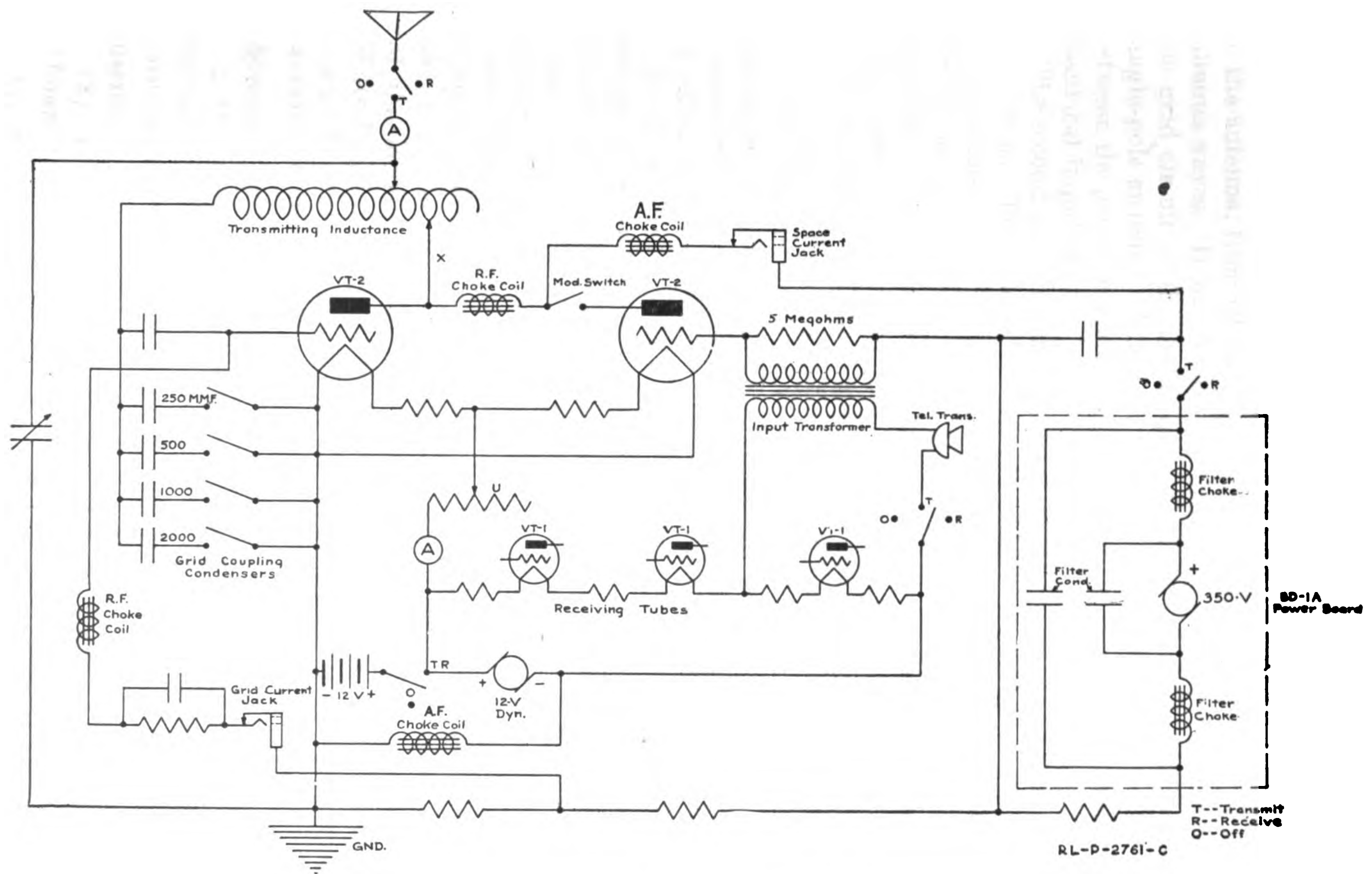


Fig. 79.—Schematic diagram of transmitter connections in the SCR-67-A set.

the oscillator tube remains lighted and the proper plate voltage is applied with proper coupling between grid and plate circuit, a continuous stream of electrical impulses will be generated and conveyed to the antenna, from which they will be radiated in the form of continuous waves. It will be noticed that there are four condensers in the grid circuit of the oscillator tube which are controlled by four single-pole switches. They are used to obtain the proper coupling between the grid and plate circuits, so that the tube will generate the electrical impulses.

The second vacuum tube in the transmitter is known as the *modulator tube.* The grid circuit of this tube is connected with a telephone transmitter through an induction coil or *modulation transformer* as it is called. When the telephone transmitter is spoken into, the voice vibrations are converted or changed into electrical voice currents. The modulator tube amplifies these currents and then combines them with the impulses generated by the oscillator tube. This is done in such a way that the combined currents are radiated from the antenna in the form of waves, the continuous waves formed serving as a carrier for the voice current waves. This process of impressing the voice currents upon the continuous or carrier wave is called *modulation.*

It will be noticed in the schematic diagram that the microphone or telephone transmitter is connected across the filament terminals and resistances of the detector tube in the receiving circuit. This was done to obtain the current required to operate the telephone transmitter. It is necessary, therefore, to have the filaments of the receiver tubes lighted or the telephone transmitter can not be made to operate. Notice also that there is a switch called the modulator switch in the plate circuit of the modulator tube. The operation of the modulator tube may be stopped by opening this switch. Wave length readings of the transmitter are taken with this switch open. It is also an aid in locating trouble if the transmitter is not working properly.

Directions.

2. Observe the transmitting controls on the panel of the BC–13–A set box. Pull the knob in the upper left-hand corner and open the door to the wave length adjusting compartment.

Questions.

(8) *How many points has the "Wave-length" switch? The "Coupling" switch?*

(9) *What is the purpose of the four small horizontal knife switches in the compartment?*

(10) *What connections are made in the transmitting circuit when the small vertical knife switch is closed?*

(11) *Locate the "Con.-Trans." condenser. What is its purpose?*

(12) *What is the use of the meter marked "Ant. Ammeter"? Why is the red line drawn on its scale?*

Information.

The receiving circuit of the SCR-67-A is of the inductively coupled type. (See Fig. 80.) The primary circuit comprises the antenna, a variable condenser, an inductance coil variable in four steps, and the ground. The secondary circuit consists of an inductance coil (inductively coupled to the primary), variable in two steps, and a variable condenser. A three-position switch is provided so that for short waves one-half of the secondary coil is used, while for the longer waves the entire coil is used.

When the switch is in the "AP" (aperiodic or untuned) position, the secondary circuit is entirely disconnected and the primary circuit is directly connected to the detector. This position of the switch is used when searching for signals of unknown wave length.

A vacuum tube detector is used in the receiver. In addition, two stages of audio frequency amplification are provided. The 40-volt "B" battery (made up of two type BA-2 batteries in series), necessary to operate the receiver tubes, is contained in a holder inside the set box. In the amplifier circuit, choke coils are made use of instead of amplifying transformers. While the choke coils have only one winding and are connected differently in the circuit, the effect produced is similar to that when using transformers.

An "amplifier" switch is provided in the circuit between the two amplifier tubes. When this switch is closed, a high grid lead resistance is shunted by a comparatively low resistance, thereby decreasing amplification of the second stage.

Directions.

3. Observe the receiver controls on the panel of the BC-13-A set box.

Questions.

(13) *Locate the primary and secondary condenser dials. How many degrees are marked on each?*

(14) *How many switch points has the primary inductance switch?*

(15) *How many positions has the short and long wave switch?*

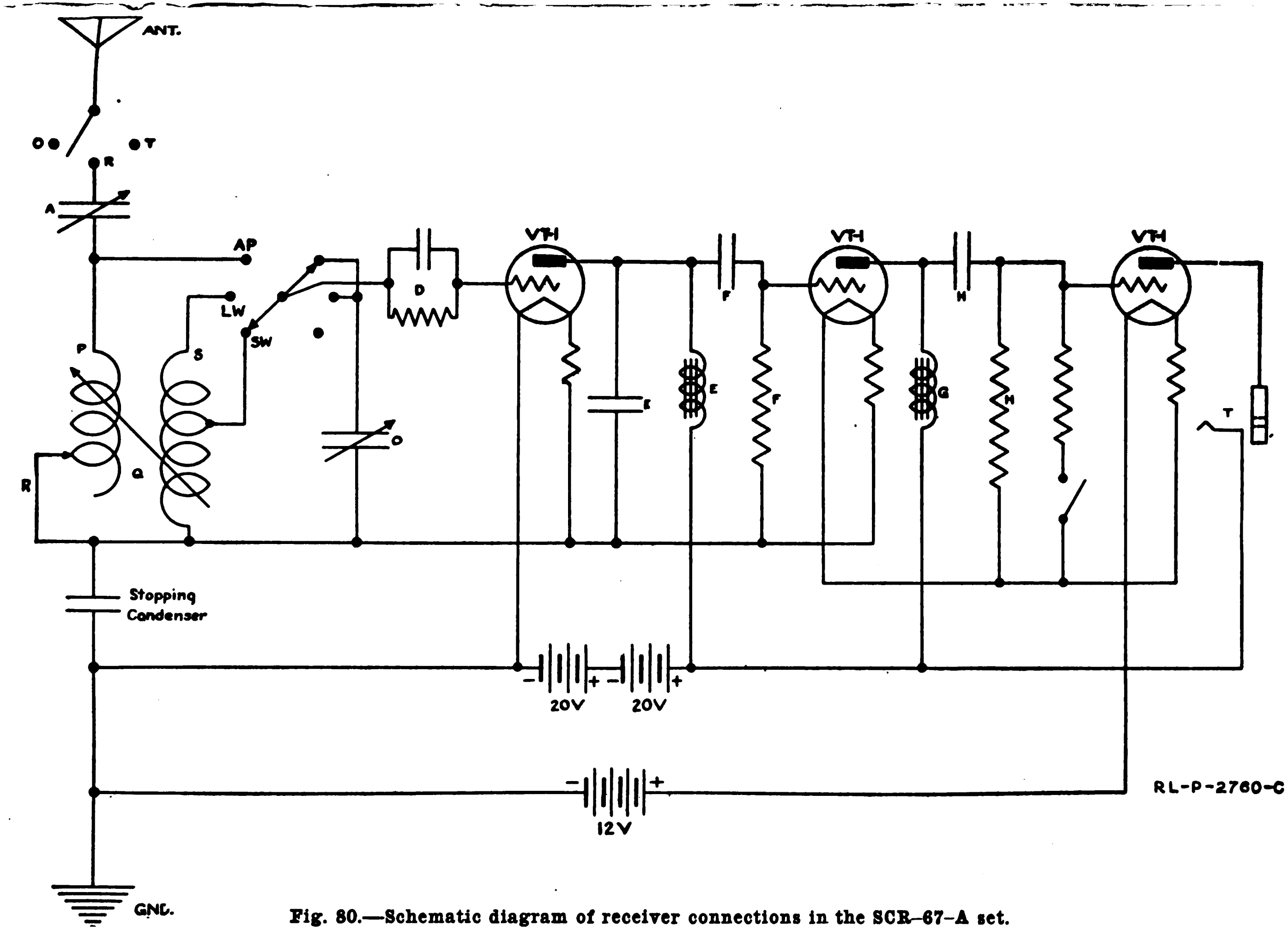


Fig. 80.—Schematic diagram of receiver connections in the SCR–67–A set.

(16) *What happens in the circuit when the switch is in the "AP" position?*

(17) *Locate the coupling control. Why is it provided?*

(18) *How many positions has the amplifier switch?*

(19) *How many pairs of phones can be plugged into this set?*

Information.

To carry on two-way communication between two sets of the SCR–67–A type, it is necessary to provide some means by which a change from transmit to receive can be made rapidly. This is accomplished by the use of the control push button, which is plugged

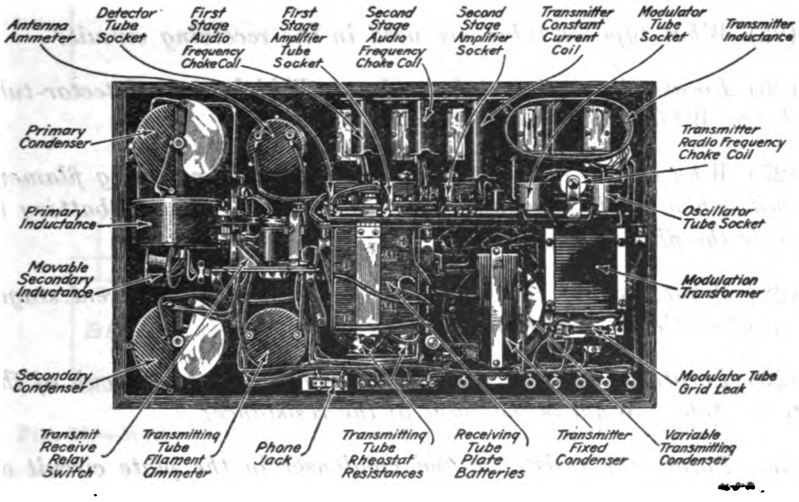


Fig. 81.—Interior of set box BC–13–A, showing parts mounted on back of panel.

into the jacks marked "Control." When the button is pressed, a relay switch is operated inside the set box which connects the "+ 350 V" to the plates of the transmitter tubes, connects the telephone transmitter in the circuit, and makes connection between the transmitting circuit and the antenna.

When the control button is released, the relay switch arm returns to its original position. This automatically connects the antenna to the receiving circuit.

Directions.

4. Unfasten the hooks on the side of the set box and pull the panel forward. (See Fig. 81.) Inspect the parts in the rear of the panel carefully. Move the control knobs on front of the panel and note what moves in the rear.

Questions.

(20) *Locate the relay switch. What connections are made to the contacts on the movable arm?*

(21) *Which is the primary receiving coil? How many taps on it?*

(22) *Which is the secondary receiving coil? How many taps on it?*

(23) *Locate the primary and secondary variable receiving condensers. What is the purpose of each condenser?*

(24) *Locate the receiving grid condenser and grid leak. How are they connected in the circuit?*

(25) *What type of tubes are used in the receiving circuit?*

(26) *Locate the receiver-tube sockets. Which is the detector-tube socket? Which are the amplifier sockets?*

(27) *Why is a 12-volt battery connected in the receiving filament circuit, when a VT–1 vacuum tube requires only a 4-volt battery to operate the filament?*

(28) *What kind of coupling is used between the different stages of amplification? Locate these choke coils.*

(29) *Locate the resistance and condenser in the plate circuit of the detector tube. What is the value of the resistance?*

(30) *Locate the resistance and condenser in the plate circuit of the first amplifier tube. What is the value of the resistance?*

(31) *Locate the transmitter inductance coil.*

(32) *Which socket is the oscillator-tube socket? The modulator-tube socket?*

(33) *Locate the oscillator-tube grid condenser. Why are there a number of small condensers provided? How are they connected with respect to each other?*

(34) *Locate the modulation transformer and the resistance connected across its secondary winding. What is the value of this resistance?*

EXPERIMENT No. 1.

RECEIVING WAVE LENGTH RANGE.

Directions.

5. Insert three VT–1 vacuum tubes in the receiving sockets. Insert and connect properly two BA–2 batteries. Close up the front panel of the set and fasten the hooks at the sides. Connect a 12-volt storage battery to the +12 and —12 binding posts. (See Fig. 82.) Throw the three-position switch to "Receive only."

6. Start the buzzer on the SCR–125–A wave meter vibrating as evenly as possible. Couple the SCR–125–A to the secondary receiv-

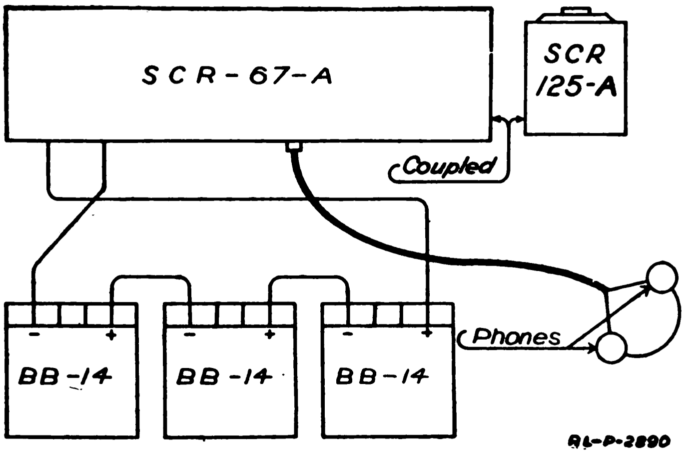


Fig. 82.—Method of coupling the SCR–125–A wave meter to the receiving circuit of the SCR–67–A set.

ing coil of the SCR–67–A. Set the secondary switch on "SW" and the secondary receiving condenser at 0. Plug in a pair of phones in the SCR–67–A and take a wave length reading.

a. Change the setting of the secondary variable condenser to "100" and take a wave length reading.

b. Change the setting of the secondary inductance switch to "LW" and the secondary variable condenser to 0. Take a wave length reading.

c. Change the setting of the secondary condenser to "100" and take a wave length reading.

d. Change the setting of the secondary inductance switch to "AP" and vary the secondary variable condenser, noting the point at which it is in tune.

Questions.

(35) *From the above four wave length readings, what would you say was the receiving wave length range of the SCR–67–A?*

(36) *Does varying the secondary variable condenser change the received wave length of this set when the switch is on "AP"? Explain.*

(37) *Why is the "AP" circuit used in this set?*

Directions.

7. Disconnect the 12-volt storage battery from the set box BC–13–A.

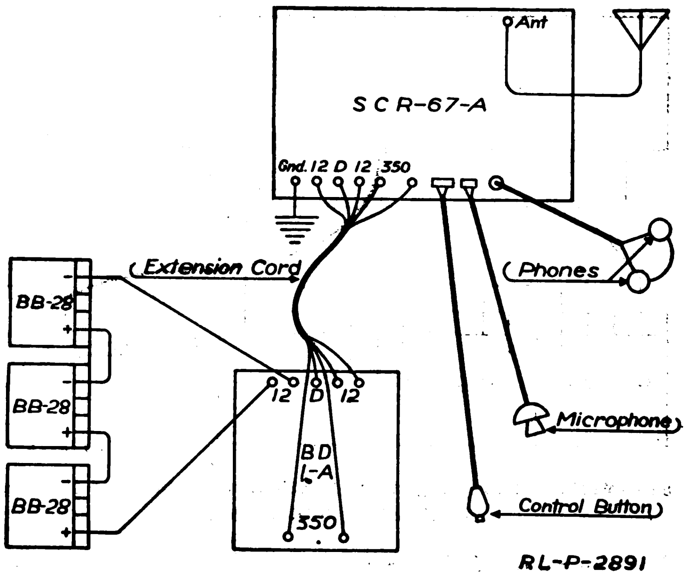


Fig. 83.—Method of coupling the SCR–125–A wave meter to the transmitting circuit of the SCR–67–A set.

EXPERIMENT No. 2.

TRANSMITTER CALIBRATION.

Directions.

8. Connect the 12-volt storage battery to the proper binding posts on the BD–1–A power board. (See Fig. 83.) Using the connection cord CD–23, connect the proper terminals on the BD–1–A power board to the corresponding terminals on the set box, BC–13–A. Plug in the telephone transmitter and the control button in the proper jacks. Open up the front of the set and insert two VT–2 tubes in the transmitting sockets. Close the front and fasten the hooks.

Connect the antenna and ground leaks to the proper binding posts on the set box. Throw the three-position switch to " Power on."

9. Throw the switch on the power board to the 12 volts position and check the storage battery voltage. This should be at least 12 volts and may be 14 volts without damage to the set. After checking the voltage, throw the switch to " Off." Turn the filament current switch on the set box panel all the way to the left, to the position "Minimum." Open the modulator switch in the compartment.

10. Turn the three-position switch on the set box panel to " Trans.-Rec." This should light the filaments of all the vacuum tubes and start the dynamotor. Adjust the filament current so that the filament current ammeter reads 2.6 to 2.7.

11. Set the coupling switch at maximum. Set the wave length switch to " Minimum " and the " Trans. Cond." to 0. Adjust the grid condenser knife switches for 750 mfds. of capacity. Press the control button and, using an SCR–125–A wave meter, take a wave length reading. Observe the radiation reading on the " Ant. ammeter." Prepare a table similar to the one shown below and record the reading and adjustments in the proper columns.

12. Change the setting of the wave-length switch to maximum and set the " Trans. Cond." to 100. Take the wave length reading, remembering that the control button must be kept depressed. Note the radiation on the ammeter.

13. Adjust the wave meter to the different wave lengths listed in the table below. Adjust in rotation and in the order mentioned, the "Wave length " switch, " Cond. Trans." condenser, and the " Coupling " switch until maximum readings are indicated by the antenna ammeter. Record in the table the settings and readings for each wave length under the proper heading.

14. It will be necessary to readjust several times the " Coupling " switch, grid coupling knife switches, and antenna transmitting condenser to secure adjustments which will give a maximum reading on the antenna ammeter at the desired wave length. The radiation should be from 0.3 to 0.6 amp.

TABLE.

Wave length.	Antenna switch point.	Coupling switch. point.	Antenna transmitting.	Grid coupling condenser.	Antenna ammeter reading.
250........	....	....	....	....	....
300........	....	....	....	....	....
350........	....	....	....	....	....
400........	....	....	....	....	....
450........	....	....	....	....	....

Questions.

(38) *From the above operation, what is the transmitting wave length range of the SCR-67-A?*

(39) *On what wave length tap, condenser settings, and grid capacity was the highest radiation obtained? What was this radiation?*

EXPERIMENT No. 3.

MODULATION.

Directions.

15. Adjust the transmitter to the wave length which gave the greatest radiation in Experiment No. 2. Close the modulator switch in the wave length adjustment compartment. Press the control button. With lips close to the telephone transmitter, whistle into it and note the movement if any of the radiation ammeter needle. Speak into the transmitter in an even tone of voice, not too high or loud, and note the action of the ammeter needle. Adjust the set to other wave lengths and note in each case the modulation indicated by the ammeter. Whistle and talk into the transmitter, listening carefully in the phones for clear and sustained speech modulation.

Questions.

(40) *Does the needle of the ammeter rise or fall as the transmitter is whistled into?*

(41) *Compare the movement of the needle when speaking into the transmitter with the movement made when whistling.*

(42) *Does the needle fluctuate more or less violently as the sound of the voice becomes clear and even in the phones?*

(43) *Is the set modulating well or poorly when the needle fluctuates a great deal and the sound in the phones is clear and even?*

CAUTION.—*Do not touch the modulator and grid condenser switches with bare hands when the power is on. A severe shock will result unless the operator is careful in this respect.*

THE SCR-130 SET.

Equipment.

1 SCR-130 (set box BC-7 only).
4 legs for set box, type BC-7.
3 vacuum tubes, type VT-1.
4 vacuum tubes, type VT-2.
3 storage batteries, type BB-14 or BB-28.
1 set box, type BC-102 with BA-8 batteries.
1 dynamotor, type PE-6.
1 head set, type P-11.
1 cord, type CD-88.
1 cord, type CD-90.
1 cord, type CD-91.
1 cord, type CD-92.
1 antenna system, type A-1-A.
1 wave meter, type SCR-95 or SCR-125-A.

GENERAL CONSTRUCTION OF THE SCR-130 SET.

Information.

The SCR-130 set is designed to transmit continuous wave radio telegraph signals and to receive continuous wave radio telegraph and telephone signals. The wave-length range for both transmitting and receiving is from 550 to 1,100 meters. The SCR-130 is intended for use with such organizations as require a set of this power and have ample motor or animal-drawn transportation to carry it.

The transmitting and receiving circuits are connected to the antenna, as desired, by a triple-pole, double-throw switch, mounted on the front of the set box panel. (See Fig. 84.)

Directions.

1. Place the set box, type BC-7, on some convenient support. Unfasten the canvas cover and the three latches and lower the front door. (See Fig. 84.) Study the various controls on the panel and their markings. Notice the four large tuning knobs on the lower edge of the panel and determine the use of the smaller knobs located under the large knobs.

Questions.

(1) *What current does the ammeter on the panel indicate?*

(2) *What are the maximum and minimum amounts this meter will read?*

(3) *Locate the "antenna tuning" and the "transmit" wave length control knobs. What is the purpose of the small knob located beneath the "antenna-tuning" knob?*

(4) *Locate the antenna and ground binding posts?*

(5) *What are the binding posts on the right-hand side of the panel used for? Those on the left?*

Information.

Four VT–2 vacuum tubes are used in the transmitter of the SCR–130. One of the tubes is used as an oscillator or generator of elec-

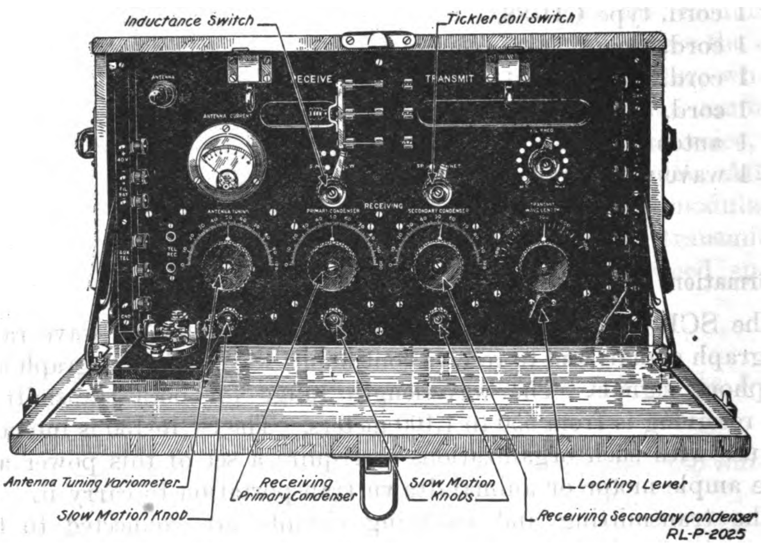


Fig. 84.—Set box BC–7 with front cover lowered to show panel.

trical impulses. The other three tubes, connected in parallel, are used to amplify the impulses generated by the oscillator tube. By using the tubes in this manner the antenna system does not affect in any way the wave length on which the set transmits. This is quite important for two reasons: 1. The set may be permanently calibrated for transmitting wave lengths. 2. The tone of the received signal will not vary when the transmitting antenna is swinging violently in the wind.

The amplifying vacuum tubes of the transmitter are inductively coupled to the antenna circuit. (See Fig. 85.)

The wave length of the transmitter is controlled by a variometer which is located in the right side of the set box. The antenna circuit is tuned by a variometer, located in the left side of the set box, When the "Antenna tuning" variometer is adjusted so that the antenna circuit is tuned to the same wave length to which the "Transmit wave length" variometer is adjusted, the "Antenna current" meter will give the highest reading, and the set will be transmitting

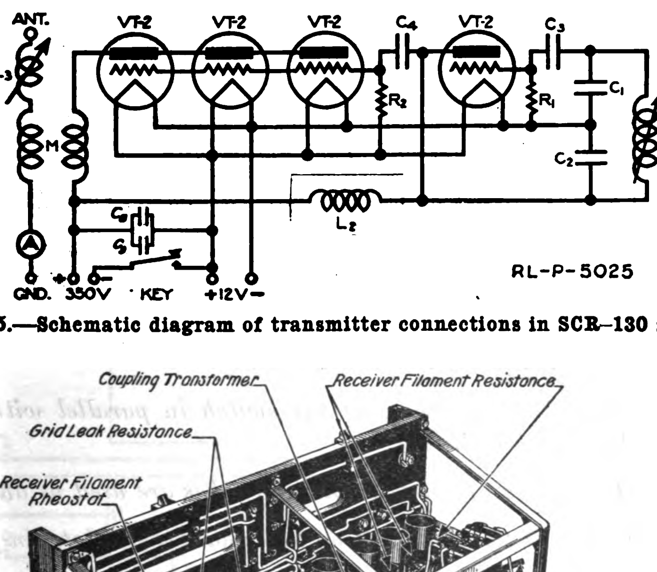


Fig. 85.—Schematic diagram of transmitter connections in SCR–130 set.

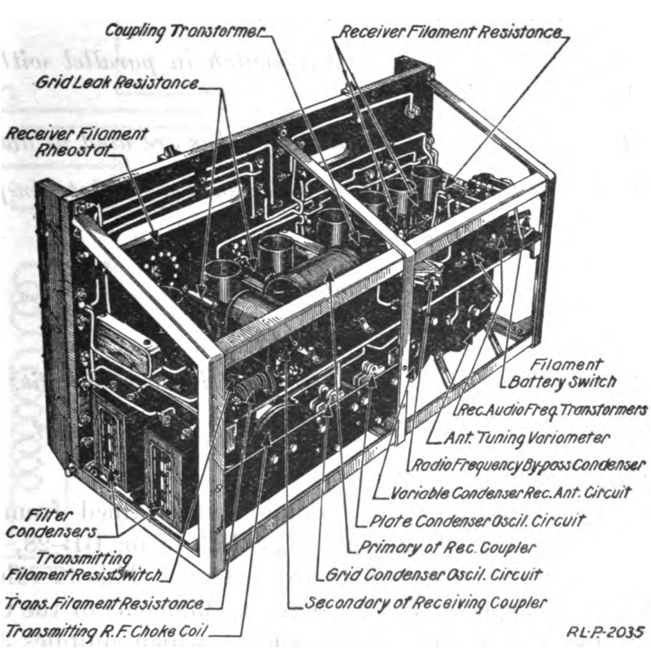


Fig. 86.—Rear view of panel and attached parts of set box BC–7.

efficiently on the wave length indicated on the "Transmit wave length" dial.

Directions.

2. Remove the four screws holding the two brackets to the operating table formed by the front of the set box and allow the front to

drop. Remove the leads from the binding posts marked "Key" at the lower right-hand side of the panel. Release the latches at the top and pull the panel out, then with an outward and upward motion remove the panel and the attached parts from the box. This leaves all of the parts exposed as in Fig. 86. From the diagram (Fig. 87) and the set box itself answer the following questions:

Questions.

(6) *Where is the antenna tuning variometer? How is it constructed? Is it in the circuit when receiving?*

(7) *Where is the wave-length change variometer? What is its use?*

(8) *Where is the transformer which couples the antenna circuit with the power amplifier? Does it use fixed or variable coupling? Is it inductively or directly coupled?*

(9) *Which is the oscillator tube socket?*

(10) *What is the purpose of the switch in parallel with the resistance* R_3? (*See Fig. 87.*)

(11) *How many of the transmitting tubes are used as amplifiers?*

(12) *Which of the transmitting tubes have their plates in parallel?*

(13) *In what circuit is the key?*

(14) *In what circuit is the ammeter?*

(15) *Is the frame of the set grounded?*

(16) *Is there a grid leak in the transmitting tube circuit?*

(17) *How is the change from transmit to receive made?*

Information.

The power supplied for transmission is obtained from storage batteries. Three 4-volt batteries, type BB–14 or BB–28, are connected in series thus forming a 12-volt battery. This 12-volt battery is used for two purposes: (1) To light the filaments of the transmitting tubes and (2) to run the dynamotor, which supplies 350 volts to the plates of the transmitting tubes. The circuit is so arranged that when the "Transmit-Receive" switch is placed in the transmit position the dynamotor will start running and the filaments of the VT–2 tube will light. Since the VT–2 tube requires approximately 8 volts across its filament and the storage battery supplies 12 volts, it is necessary to place in series with the filament a resistance of such value that when the normal filament current is flowing the

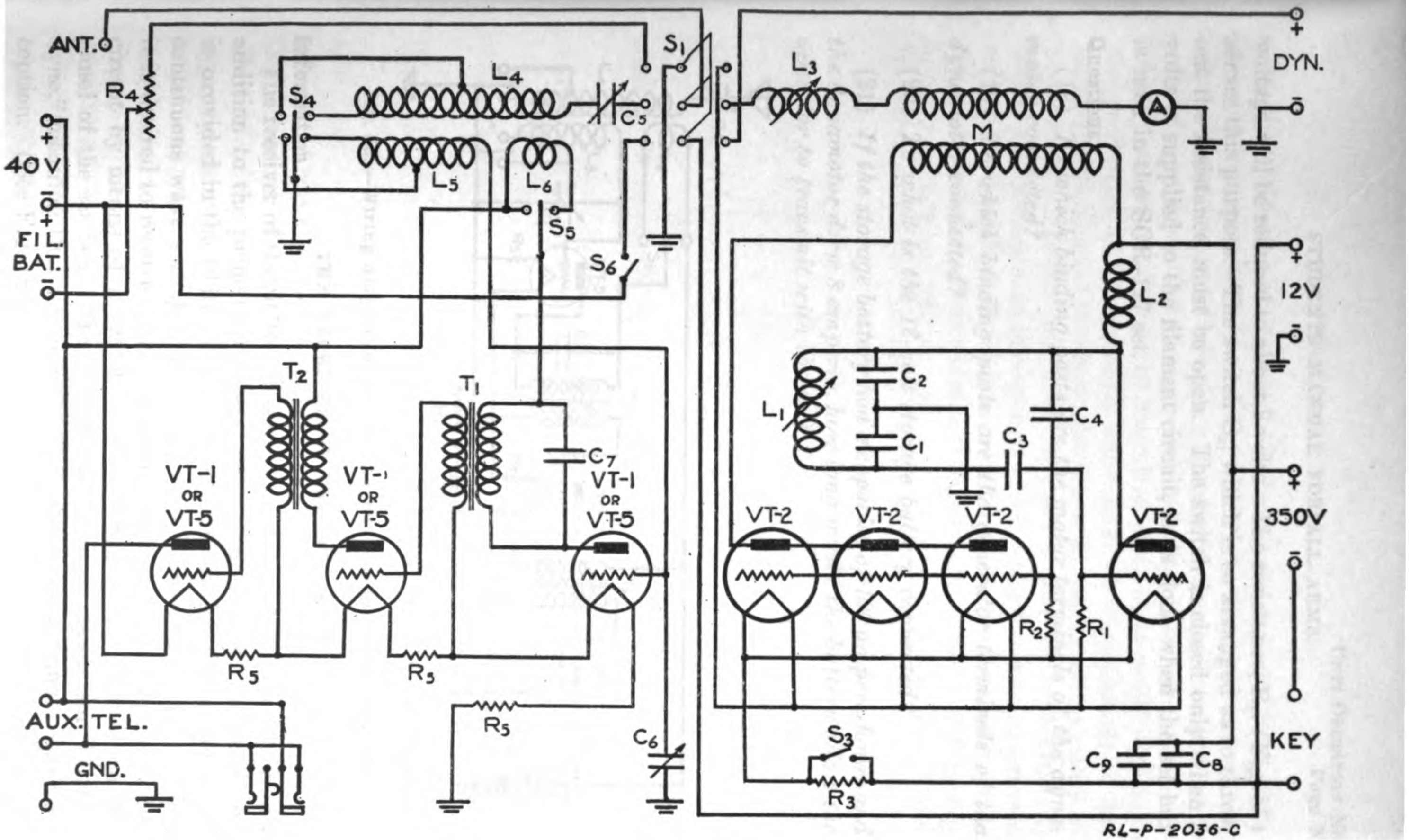


Fig. 87.—Schematic diagram of transmitting and receiver connections in set box BC-7.

voltage will be reduced to about 8 volts. The resistance, R_3. (Fig. 87) serves this purpose. The switch S_3, which is so arranged as to throw out the resistance, must be open. The switch is closed only when 8 volts is supplied to the filament circuit, as is done when the set box is used in the SCR–127 set.

Questions.

(18) *To which binding posts are the motor terminals of the dynamotor connected?*

(19) *To which binding posts are the generator terminals of the dynamotor connected?*

(20) *To what is the 12-volt storage battery connected?*

(21) *If the storage battery had a capacity of 100 ampere-hours and the dynamotor drew 8 amperes, how long would the battery allow the operator to transmit with the set?*

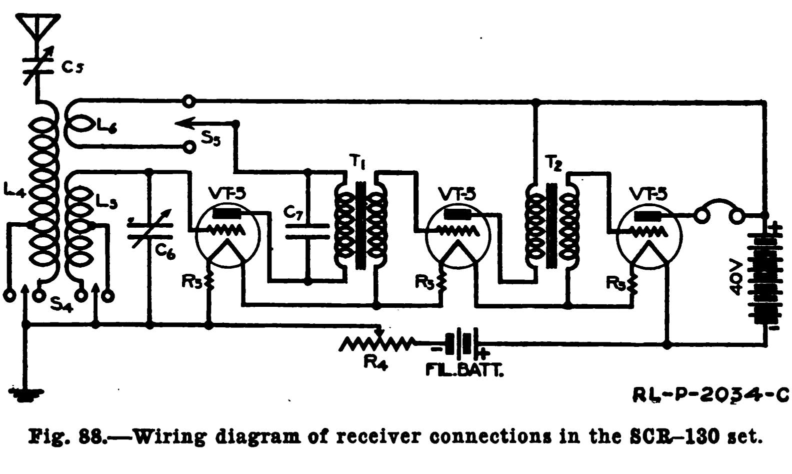


Fig. 88.—Wiring diagram of receiver connections in the SCR–130 set.

THE RECEIVER OF THE SCR–130.

Information.

The receiver of the SCR–130 is of the inductively coupled type. In addition to the primary and secondary receiving coils a third coil is provided in the plate circuit of the detector for the reception of continuous wave signals. This third coil is the *tickler coil.* When it is desired to receive spark signals the tickler coil is cut out of the circuit by means of a switch marked "Spk.-Het." located on the panel of the set box. The abbreviation "Het." stands for "Hetrodyne," meaning that the circuit is adjusted for continuous wave reception. (See Fig. 88.)

The primary circuit is tuned by adjusting the variable condenser, which is in series with the primary coil, and by adjusting the amount of inductance in the primary coil. The primary coil has one tap, which is connected to a switch on the panel of the set box. (See S_4, Fig. 88.) When the switch is thrown to "SW" (short wave) only part of the coil is in use, and when thrown to "LW" (long wave) the entire coil is in use. The secondary circuit is tuned by adjusting the variable condenser, connected across the secondary coil. In a later model of this set box the secondary coil also has one tap, which is connected to the same switch provided for the primary coil. (See S_4, Fig. 88.) This is so arranged that when the switch is in the position "S. W" only parts of each of the primary and secondary coils are in use. When it is in the "LW" position the entire circuits of the primary and secondary coils are in use.

Questions.

(22) *Locate the primary and secondary condenser controls. How are the scales marked?*

(23) *What is the purpose of the small knob located beneath the large condenser control knob?*

(24) *To which side must the large three-pole switch be thrown when using the set as a receiver?*

(25) *Locate the "SW–LW" switch. What is the purpose of this switch?*

(26) *Locate the "SP–HET" switch. What is the purpose of this switch?*

(27) *For what are the binding posts located at the left of the panel used?*

Information.

Two stages of audio frequency amplification are provided in the receiver, the coupling between stages being provided by audio frequency transformers. The filaments of the three receiving tubes are connected in series. In the SCR–130 set, VT–1 tubes are used for receiving. Since the filament voltage required by the VT–1 tube is 4 volts, the three tubes in series will require 12 volts which is just the amount furnished by the storage batteries which supply power for transmitting. It is therefore possible to use the 12 volts from the storage battery directly on the receiving tube filaments. The plate voltage is supplied by two batteries, type BD–8, connected in series, thus giving 45 volts for the plate. In field operations the

BA–8 batteries are carried in a battery box, type BC–102. (See Fig. 89.) Connections are made from the battery box terminals to the terminals on the BC–7 set box by means of a cord and receptacle.

The filament circuit of the receiving tubes is completed through the "Transmit-Receive" switch so that the tubes are only lit when the switch is on the receive position. Since the BC–7 set box is used both in the 127 and 130 sets, and when used in the 127 set receiving filament current is supplied from a separate source, it becomes necessary to have a switch which will connect or disconnect the receive tube filament from the source which supplies the transmitting tube filament. This is accomplished by the switch S_6. (See Fig.

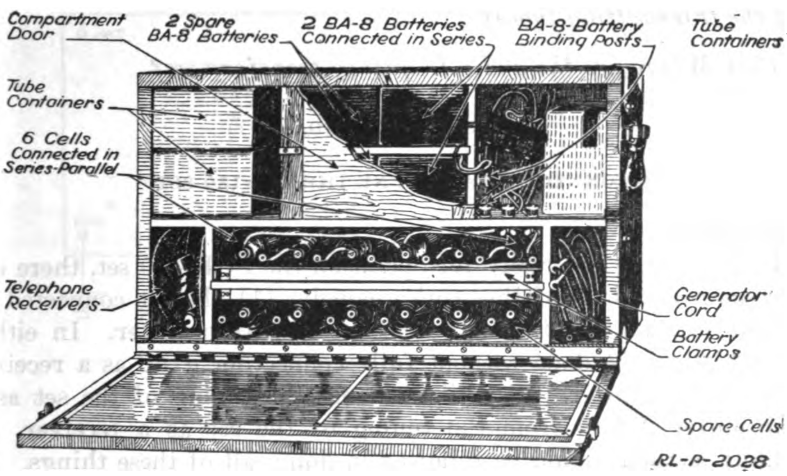


Fig. 89.—Battery and spare parts box, type BC–102 of the SCR–130 set.

87.) This switch must be closed when the set box is used in the SCR–130 set.

Directions.

3. Observe the various receiver parts mounted back of the set box panel. As far as possible trace the wiring of the receiver, using the wiring diagram shown in Fig. 88.

Questions.

(28) *Locate the receiving tube sockets. Which is the detector tube socket? Which are the amplifier tube sockets?*

(29) *Where are the fixed resistances that are in series with the receiving tube filaments?*

(30) *Where is the primary receiving inductance? How many taps are taken from it? To what do they go on the panels?*

(31) *Where is the secondary receiving inductance? Is it coupled inductively or conductively with the primary? Is the coupling variable or fixed?*

(32) *Where is the tickler coil? Where are its terminals? Is it fixed in position with respect to the secondary?*

(33) *How many headsets can be connected to this set?*

(34) *What is the plate potential of the receiving tubes? Of the transmitting tubes?*

(35) *How are the filaments of the receiving tubes connected? Of the transmitting tubes?*

(36) *Where are the audio frequency transformers?*

EXPERIMENT No. 1.

TO CONNECT UP AND TUNE THE SCR–130 SET.

Information.

In connecting up, ready for operation the SCR–130 set, there are two main divisions of the work; namely, (1) the set connected as a receiver, and (2) the set connected as a transmitter. In either case this may be done without fully connecting it up as a receiver or as a transmitter. In a like manner the tuning of the set as a transmitter differs from the tuning of the set as a receiver. A definite method should be followed in doing all of these things.

Directions.

4. *To connect up the set as a transmitter.*—Erect the set box on its legs. The set box should be so placed that the antenna and ground leads will easily reach the proper binding posts on the panel. (See Fig. 90.) Place the dynamotor and storage batteries under the set.

a. Open up the front cover of the set box, pull down on the catches which hold the panel closed, and open the panel.

b. Insert four VT–2 tubes in the four transmitting tube sockets in the set. Open switch "S_3" (Fig. 87).

c. Close the panel, being sure that the catches are properly locked, and open the "Trans.-Rec." switch so that it does not make contact on either side.

d. Connect the high voltage dynamotor leads (with the proper polarity) to the binding posts marked "+ 350" and "— 350."

e. Connect the low voltage dynamotor leads to the two binding posts marked "+ Dyn" and "— Dyn" with the correct polarity.

f. Connect the antenna lead-in wire to the post marked "Ant."

g. Connect the wire from the counterpoise or other ground system used to the post marked "Gnd."

h. Connect the receptacle of the cord, type CD–90, to the two plugs on the side of the set box marked "+ 12 V." "— 12 V." (It will only go on with the correct polarity.)

i. Connect the three 4-volt storage batteries in series.

j. Check all connections to see that they are correct.

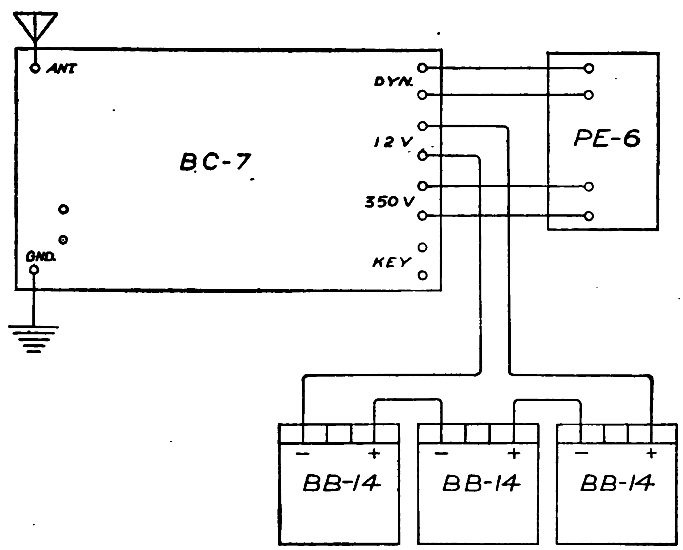


Fig. 90.—Cording diagram of transmitter connections in the SCR–130 set.

k. Connect the red terminal of the cord, type CD–90, to the positive terminal of the 12-volt battery formed by the three 4-volt batteries in series and the black terminal of the cord to the negative terminal of the 12-volt battery.

l. See that the double-pole, single-throw switch on the dynamotor panel is closed.

Questions.

(37) *Why is it necessary to follow certain steps in their proper order when connecting up the SCR–130 set?*

(38) *Why is it important to have the connecting leads connected with proper polarity?*

Directions.

5. *To tune the transmitter.*—The next step after having made all of the connections as previously given is to tune the transmitting side to the desired or specified wave length. In order to do this properly the following steps are gone through:

a. Turn the "Transmit Wave Length" pointer to *exactly* the desired wave length and lock it in that position by means of the small lever under the knob.

b. Throw the "Trans.-Rec." switch to the "Trans." side. The dynamotor should now start running and the filaments of the VT-2 tubes should glow a dull red.

c. Close the key.

d. Turn the "Antenna tuning" knob slowly and watch the antenna ammeter. As the knob is turned the ammeter will start indicating and will gradually increase in reading up to a certain point. As the knob is turned still further the reading of the ammeter will decrease. That position of the "Antenna tuning" knob which gives the greatest reading on the antenna ammeter is the correct adjustment. The final adjustment to obtain the greatest reading should be made with the small knob just under the "Antenna tuning" knob. This small knob is a vernier or fine adjustment of the larger knob.

e. Open the key.

f. Open the "Trans.-Rec." switch. The set is now adjusted for transmitting on the wave length to which the pointer of the "Transmit wave length" adjustment is set.

Questions.

(39) *Why is the "Transmit Wave Length" pointer locked after it is set to the desired wave length?*

(40) *If, when the "Trans.-Rec." switch is thrown to "Trans." the vacuum tubes light but the dynamotor fails to start, what is the probable trouble?*

(41) *Why is it necessary to adjust the "Antenna tuning" knob so that a maximum reading occurs on the ammeter?*

Directions.

6. *To connect up the receiver side of the set.*—After having made all of the connections given under connecting up the transmitter side of the set, the following additional connections will be needed in order that the receiving side of the set be ready for operation. (See Fig. 91.)

a. Open the panel to the set and insert 3 VT–1 tubes in the receiving tube sockets. (Be sure that the "Trans.-Rec." switch is open.)

b. Close the switch S_6 (Fig. 87) and close the panel, being sure that it locks into place.

c. Connect two batteries, type BA–8, in series and connect the positive terminal of the 45-volt battery thus formed to the binding post on the edge of the panel marked "+40." Connect the negative terminal to the post marked "—40."

NOTE.—If the battery box, type BC–102, is used, then the BA–8 batteries will be placed in that box and connections made from batteries by means of the cord, type CD–88, to the two plugs on the side of the panel marked "+40 volts" and "—40 volts."

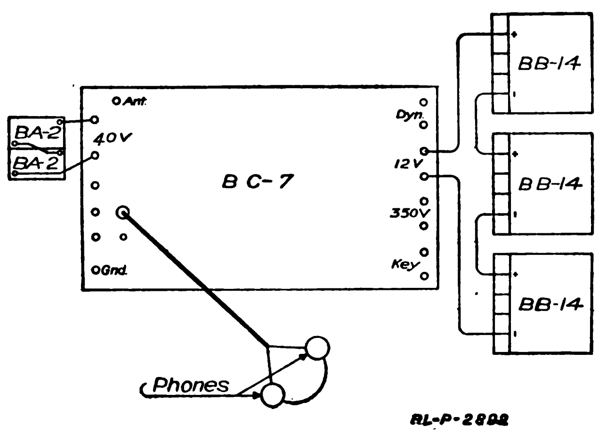


Fig. 91.—Cording diagram of receiver connections in the SCR–130 set.

d. Plug one or two head sets, type P–11, into the jacks provided on the left side of the panel. (If available head sets are not provided with cord plugs, the cord tips may be connected to the two binding posts marked "Aux. Tel.").

e. Put on one of the head sets and adjust it to fit the head comfortably.

f. If the receiving side only of the set is to be used, omit the items given under *b.*, *c.*, *d.*, and *e.* in direction 1.

7. *To connect up both as a transmitter and as a receiver.*—After the set has been properly erected:

a. Open up the front cover of the set box, pull down on the catches holding the panel closed, and open the panel.

b. Insert four VT–2 tubes in the transmitting sockets and three VT–1 tubes in the receiving sockets. Open switch S_3 and close switch S_6. (Fig. 87.)

c. Close panel, being sure that the catches are properly locked, and open the " Trans.-Rec." switch so that it does not make contact on either side.

d. Connect the high voltage dynamotor leads (with the proper polarity) to the binding posts marked " + 350 " and "— 350." (See Fig. 92.)

e. Connect the low voltage dynamotor leads to the two binding posts marked "+ Dyn " and "— Dyn " with the correct polarity.

f. Connect the antenna lead-in wire to the post marked "Ant."

g. Connect the wire from the counterpoise or other ground system used to the post marked " Gnd."

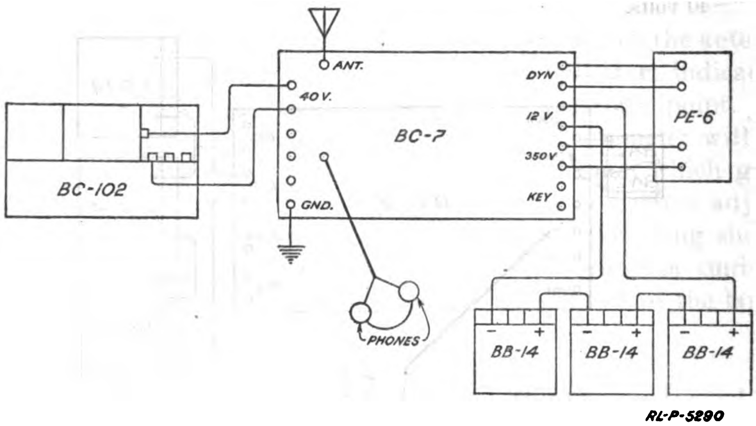


Fig. 92.—Cording diagram of complete transmitter and receiver connections in the SCR–130 set.

h. Connect the receptacle of the cord, type CD–90, to the two plugs on the side of the set box marked "+ 12 " and "— 12 " volts. (It will only go on with the correct polarity.)

i. Connect two batteries, type BA–2 or type BA–8, in series and connect the positive terminal of the 45-volt battery thus formed to the binding post on the edge of the panel marked "+ 40." Connect the negative terminal to the post marked "— 40."

NOTE.—If the battery box, type BC–102, is used, then the BA–8 batteries will be placed in that box and connection made from them to the two plugs on the side of the panel marked "+ 40 " and "— 40 " volts by means of the cord, type CD–88.

j. Plug one or two head sets, type P–11, into the jacks provided on the left side of the panel. (If head sets are to be used that do not have plugs on the ends of their cords, they may be connected to the two binding posts marked " Aux. Tel.")

k. Connect the three 4-volt storage batteries in series.

l. Check all connections to see that they are correct.

m. Connect the red terminal of the cord, type CD–90, to the positive terminal of the 12-volt battery formed by the three 4-volt batteries in series and the black terminal of the cord to the negative terminal of the 12-volt battery.

n. See that the double-pole, single-throw switch on the dynamotor panel is closed.

o. Put on one of the head sets and adjust it to fit the head comfortably.

Question.

(42) *Why is it necessary to have the "Trans.-Rec." switch open as in Direction 3, a?*

Information.

To tune the receiver.—In tuning the receiver several different cases will occur. They are as follows:

a. Tuning in a C. W. signal of known wave length.
b. Tuning in a damped wave signal of known wave length.
c. Tuning in a C. W. signal of unknown wave length.
d. Tuning in a damped wave signal of unknown wave length.

8. To tune the receiver of the set to a C. W. signal of known wave length proceed as follows. After the receiving side has been connected up as directed above:

a. Throw the "Trans.-Rec." switch to the "Rec." side.

b. Place the "Spk.-Het." switch on "Het."

c. Set the "LW–SW" switch and the secondary condenser to the desired wave length as given by the calibration of the set.

d. Vary the primary condenser until a distinct double click is heard, and set the primary condenser about 5° to either side of the point where this double click is heard.

e. The receiving side of the set should now be in tune on the desired wave length, but due to inaccuracies which may occur the setting may not be exact enough to pick up the signal sought. It is therefore advisable to swing slowly the secondary condenser over an arc of about 10° (the middle point of which is the setting given by the set's calibration, until the sought-for signal is heard.

f. Upon hearing the desired signal, stop turning the secondary condenser by its knob and make the final accurate adjustment by means of the small vernier knob located just under the secondary condenser knob.

g. A small further adjustment of the primary condenser may now be made in order to increase the loudness of the signal.

9. To tune the receiver to a damped wave signal of known wave length proceed as follows:

a. Same as *a* above.

b. Same as *b* above.

c. Same as *c* above.

d. Same as *d* above.

e. Place the "Spk.-Het." switch on "Spk."

f. Same as *e* above.

g. Same as *f* above.

h. Same as *g* above.

10. To tune the receiver to a C. W. signal of unknown wave length proceed as follows:

a. Same as *a* under Direction 4.

b. Same as *b* under Direction 4.

c. Set the "LW–SW" switch on "SW." Set the secondary condenser at about 5° and vary the primary condenser until the double click is heard, indicating the primary circuit is in tune with the secondary circuit.

NOTE.—For every position of the secondary condenser there should be a corresponding position of the primary condenser at which the primary or antenna circuit is in tune with the secondary circuit. In searching for a signal of unknown wave length the method should be to vary both condensers at the same time, attempting at all times to keep the primary condenser close to that point where its circuit is in tune with the secondary.

d. Starting with the secondary condenser at about 5° and the primary condenser at the point where it is in tune, slowly turn both condensers as outlined above, over their entire scale. Repeat this several times until you are sure that the signal is not obtainable. (The primary condenser should increase as the secondary is increased.)

e. Set the "LW–SW" switch on "LW" and repeat *d*.

f. When the desired signal is found under either *d* or *e*, engage the vernier knobs of the primary and secondary condensers and make the final adjustments for a loud, clear signal for a readable pitch with these knobs.

11. To tune the receiver to a damped wave signal of unknown wave length for Direction 4, proceed as follows:

a. Follow exactly the procedure outlined under Direction 3 until the desired signal is found. When found, the natural tone of the damped wave will be badly distorted.

b. Throw the "Spk.-Het." switch to "Spk." and if necessary retune slightly both the primary and secondary condensers. The damped wave signal should now be heard with its natural tone but much weaker than when heard under *d*.

NOTE.—Damped waves may be received with the "Spk.-Het." switch on "Het." if the change in tone is not objectionable. The receiver will be far more sensitive than with the switch on "Spk."

EXPERIMENT No. 2.

CALIBRATION OF THE RECEIVER SECONDARY.

Directions.

12. Erect two complete antenna systems, separated by about 300 yards, for the SCR–130 set. On the first antenna (set A) connect up, ready for transmission, one SCR–130 set, and on the other antenna another SCR–130 set (set B) which is to have its receiver secondary calibrated.

13. Start transmitting with set A on 500 meters. Tune set B to receive the signal. Set B is now tuned to receive 500 meters. Read, in degrees, the setting of the secondary receiving condenser and put it down in a table similar to the one shown below.

Wave length.	Secondary condenser setting.	Settings of SW-LW switch.
500		
525		
550		
575		
600		
625		
650		
675		
700		
725		
750		
775		
800		
825		
850		
875		
900		
925		
950		
975		
1,000		
1,025		
1,050		
1,075		
1,100		

Transmit with set "A" on 525 meters and again tune in with set "B" and record the reading in the table. Continue this process in steps of 25 meters until the entire wave length range has been covered.

Information.

The SCR–130 set must primarily receive from another SCR–130 set; therefore it is desirable that its receiving side be calibrated with an SCR–130 transmitter. It would be easier to calibrate it by the use of a wave meter, but in that case the wave meter calibrations and those of other SCR-130 transmitters might not be identical. As a variation of about 1° on the secondary condenser is sufficient to tune out the desired signal it may be seen that accuracy is very important.

EXPERIMENT No. 3.

CHECKING THE CALIBRATIONS OF THE TRANSMITTER OF SEVERAL SETS.

Information.

When three or more sets are to operate in a net it is very important that the transmitting wave length calibrations of all of the sets be identical; that is, any one set should receive all other sets operating on the same wave length, on the same setting of the secondary receiving condenser. In order to accomplish this it is sometimes necessary to check or recalibrate all of the sets involved. Although the oscillator of the SCR-130 set is originally quite accurately calibrated, sometimes due to rough handling, or to other causes, the calibrations may be thrown off.

Directions.

14. Set up two antenna systems. Pick out one set to be known as the "master set" and connect it up ready for transmitting to one antenna. To the other antenna connect another set ready for receiving. With the master set transmit successively on wave lengths from 500 to 1,100 meters in steps of 25 meters.

15. Receive each of these transmissions on the other sets and fill out accurately a table similar to the one shown below, showing all receiving adjustments on which each of the transmissions is received.

Wave length.	Primary condenser.	Secondary condenser.	Setting of SW-LW switch.
500			
525			
550			
575			
600			
625			
650			
675			
700			
725			
750			
775			
800			
825			
850			
875			
900			
925			
950			
975			
1,000			
1,025			
1,050			
1,075			
1,100			

Disconnect the master set and place it aside. Connect. to the antenna of the master set one of the sets whose calibrations have been checked and start it transmitting on 500 meters according to its new calibration. Tune in the transmitted signal with the remaining receiving set. If it is received on the same adjustments used for the master set when it was transmitting on 500 meters, then the 500-meter calibration of the set under test is correct. If it is received on a different adjustment the calibration is inaccurate and must be corrected.

16. To do this, adjust the receiving sets to the settings on which the master set was received on 500 meters. Gradually vary the transmitted wave length of the set under test until it is heard by the adjusted receiving sets. It will then be transmitting on 500 meters by the calibrations of the master set. A piece of paper should be pasted over the scale of the master oscillator and a mark made on the paper exactly opposite the end of the pointer, this mark being labeled " 500 ". The above process is repeated in steps of 25 meters until the entire wave length range of the set has been covered. The next set to be checked is then put through the same process.

EXPERIMENT No. 4.

TUNING A SET HAVING A BURNT OUT ANTENNA AMMETER.

Directions.

17. Connect up the set properly for transmitting, and if the burnt out antenna ammeter has not been short-circuited, do so with a piece of fairly heavy copper wire. Throw the " Trans.-Rec." switch to the " Trans." and hold down the key.

METHOD " A."

Slowly turn the antenna variometer (with the wave length variometer set at the desired wave length) until on listening to the dynamotor a very perceptible slowing up is noticed. As the antenna variometer is still further turned the dynamotor will again increase its speed. At the position of the antenna variometer half way between the points where the slowing up is first noticed and where the dynamotor again speeds up, the antenna circuit is approximately in tune with the master oscillator circuit. The set is then transmitting fairly well on the desired wave length.

METHOD " B."

Light and adjust the lamp on an SCR–95 wave meter and couple the wave meter to the master oscillator circuit of the set by holding the side of the wave meter marked "Plane of coil" against the knob of the wave length variometer. Start the set transmitting and close the key. Set the wave meter to the desired wave length and vary the wave length variometer until the wave meter lamp burns brightest. Then, without disturbing the adjustments of either the wave meter or the wave length variometer, move the wave meter over and couple it to the antenna circuit by wrapping one or two turns of the lead-in wire around it. Slowly turn the "Antenna tuning" variometer until the wave meter lamp again indicates that the circuits are in tune. The set is then transmitting on the desired wave length with all circuits in tune.

Information.

With the SCR 127 and 130 sets, tuning the set to transmit on a given wave length is entirely dependent on readings of the antenna ammeter. Accordingly some method becomes necessary to tune the set when this meter is out of service. Of the two methods given, the first may be employed with no additional apparatus and will give fairly good results. The second method is dependent on the availability of an SCR–125–A wave meter, but when properly used will give excellent results. Sometimes, in using the second method, trouble is experienced in getting an indication that the circuits are in tune with the wave meter coupled to the wave length variometer. This is due to weak oscillations in the oscillator tube of the set and may be overcome by tuning the set by the first method and then coupling the wave meter to the antenna circuit for the final adjustment. It is to be remembered that the calibrations on the SCR–125–A wave meter and the master oscillator variometer may not be the same, due to inaccuracies in manufacture, and therefore a set transmitting on, say, 800 meters by the wave meter may not be on exactly the same wave length as one which was set by the calibrations on the set. It will be noticed that in both of the above methods the calibrations on the set are used in determining the wave length. In general, the calibrations on the set are more accurate than those on the SCR–125–A wave meter.

THE SCR–127 SET.

Equipment.

1 set, type SCR–127 less the following equipment:
- 3 cincha bands, type ST–7.
- 1 equipment, type LE–1.
- 3 frames, type M–1.
- 6 straps, with snap hooks at each end.

1 wave meter, type SCR–125–A.
1 head set, type P–11.

GENERAL CONSTRUCTION OF THE SCR–127 SET.

Information.

The SCR–127 set is designed to transmit and to receive continuous wave radio telegraph signals. It is intended for communication between cavalry organizations and is built to be packed and transported on mules. The wave length range for both transmitting and receiving is from 550 to 1,100 meters.

The transmitting and receiving circuits are connected to the antenna, as desired, by a triple-pole, double-throw switch, mounted on the front of the set box panel. (See Fig. 84.)

Directions.

1. Place the set box type BC–7 on some convenient support. Unfasten the three latches and lower the front door. (See Fig. 84.) Study the various controls on the panel and their markings. Notice the four large tuning knobs on the lower edge of the panel.

Questions.

(1) *Which current does the ammeter on the panel read?*

(2) *Locate the " antenna tuning " and the " transmit " wave length control knobs. What is the purpose of the small knob located beneath the " antenna tuning " knob?*

(3) *What is the purpose of the lever located beneath the transmit wave length knob?*

(4) *Locate the antenna and ground binding posts.*

(5) *For what are the binding posts on the right-hand side of the panel used?*

Information.

Four VT–2 vacuum tubes are used in the transmitter of the SCR–127. One of the tubes is used as an oscillator or generator of electrical impulses. The other three tubes, connected in parallel, are used to amplify the impulses generated by the oscillator tube. In this way the power supplied to the antenna is more than that generated by one tube. In addition, the antenna in no way affects the frequency of the impulses generated by the oscillator tube so that the wave length on which the set transmits is entirely independent of the antenna used.

The vacuum tube circuit of the transmitter is inductively coupled to the antenna circuit. (See Fig. 85.)

The wave length of the transmitter is controlled by a variometer which is located in the right of the set box. The antenna circuit is tuned by a variometer located at the left of the set box. When the " Transmit Wave length " variometer is adjusted to a certain wave length, it is necessary to tune the antenna circuit to this wave length. When the two circuits are in tune the " Antenna Current " meter will give the highest reading.

Directions.

2. Remove the four screws holding the two brackets to the operating table formed by the front of the set box and allow the front to drop. Remove the leads from the binding posts marked " Key " at the lower right-hand side of the panel. Release the latches at the top and pull the panel out; then with an outward and upward motion remove the panel and the attached parts from the box. This leaves all the parts exposed as in Fig. 86. From the diagram (Fig. 87) and the set box itself answer the following questions.

Questions.

(6) *Where is the antenna tuning variometer? How is it constructed? Is it in the circuit when receiving?*

(7) *Where is the wave-length change variometer? What is its use?*

(8) *Where is the transformer which couples the antenna circuit with the power amplifier? Does it use fixed or variable coupling? Is it inductively or directly coupled?*

(9) *Which is the oscillator tube socket?*

(10) *What is the purpose of the switch in parallel with the resistance R_3?* (See Fig. 87.)

(11) *How many of the transmitting tubes are used as amplifiers?*

(12) *Which of the transmitting tubes have their plates in parallel?*

(13) *In what circuit is the key?*

(14) *In what circuit is the ammeter?*

(15) *Is the frame of the set grounded?*

(16) *Is there any grid leak in the transmitting tube circuit?*

(17) *How is the change from transmit to receive made?*

Information.

Power is supplied to the transmitter of the set by the hand-driven generator, type GN–29. (See Fig. 93.) This unit consists of

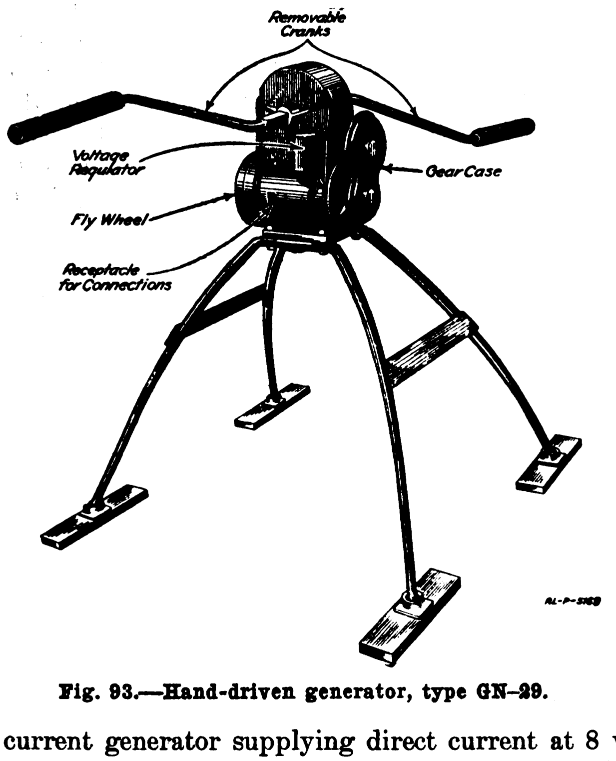


Fig. 93.—Hand-driven generator, type GN–29.

a double current generator supplying direct current at 8 volts and at 350 volts pressure. The 8-volt side of the generator is used to light the filaments of the transmitting tubes, while the 350-volt side supplies the plate current for the same tubes. When the set box, type BC–7, is used in the SCR–130 set, 12 volts are supplied to the transmitting tube filaments; while as stated above, only 8 volts are supplied when used in the SCR–127 set. To make up for this difference in voltage the switch S_3 (Fig. 87) must be closed when the set box is used with the hand generator and opened when used in the

SCR–130 set. The generator is driven through a train of gears at high speed. The gear train is turned by two cranks which are slipped on the squared shaft protruding from the sides at the top of the gear box. The cranks should be placed on this shaft so that they are opposite each other as shown in Fig. 93. Two men standing beside the generator, but facing in opposite directions, operate the cranks, one man at each crank. Marked on the top of the gear box of the generator is an arrow which shows the direction in which the cranks are to be turned. For the proper operation of the generator the cranks should be turned at a steady speed of not less than 35 revolutions per minute. Mounted on the side of the generator is a voltage regulator. The purpose of this regulator is to hold the voltage of the generator constant over a wide range of speed. It will do very well at crank speeds from 35 to 60 revolutions per minute, but at speeds under 35 revolutions per minute the voltage of the generator is too low and can not be brought up by the regulator. The high and low voltage sides of the hand generator are connected to the set box by two cords having plugs which are not interchangeable and can be inserted only with the correct polarity. It is therefore impossible to make wrong connections. The jacks in which these plugs fit are mounted in the frame of the generator and properly marked. The remaining plugs on the two cords contain two holes which fit the connecting pins on the edge of the set box. In operating the set the generator should be brought up to proper speed before any load is placed on it.

Directions.

3. Set up the hand generator on its stand and using the proper cords connect it to the set box. Open the panel of the set box and insert four tubes, type VT–2, in the transmitting tube sockets. Connect a voltmeter, type I–10, to the two binding posts corresponding to the two pins on the edge of the panel on which the plug of the low voltage lead of the generator fits. Be sure that the connections are correct in polarity.

4. Open the "Trans.-Rec." switch on the panel and have two men turn the hand generator cranks at 25 revolutions per minute. Read the voltage as indicated by the type I–10 voltmeter. Close the "Trans.-Rec." switch to the "Trans." side of the switch. Press the key and again read the voltage.

5. Repeat the above for each of the following crank speeds, putting down your results in a rough table: 30, 35, 40, 45, and 50.

Questions.

(18) *Was the voltage high enough to light the tube filaments properly at a crank speed of 25 revolutions per minute?*

(19) *What change took place in the voltage reading when the "Trans.-Rec." switch and the key were closed?*

(20) *With the "Trans.-Rec." switch and the key closed when the crank speed was changed from 35 to 50 revolutions per minute, was there much change in the voltage?*

(21) *Did the generator turn much harder when the "Trans.-Rec." switch and key were closed than when they were open? Why?*

(22) *Should the "Trans.-Rec." switch be closed before or after the generator has reached full speed? Why?*

(23) *How many revolutions does the generator make for a complete revolution of the crank?*

THE RECEIVER OF THE SCR-127.

Information.

The receiver of the SCR-127 is of the inductively coupled type. In a later model, however, conductive coupling as well as the secondary receiving coil, is provided in the plate circuit of the detector tube for the reception of continuous wave signals. When it is desired to receive spark signals the tickler coil is cut out of the circuit by means of a switch marked "Spk–Het" located on the panel of the set box. The abbreviation "Het." stands for "Heterodyne," meaning that the circuit is adjusted for continuous wave reception. (See Fig. 88.)

The primary circuit is tuned by adjusting the variable condenser which is in series with the primary coil and by adjusting the amount of inductance in the primary coil. The primary coil has one tap which is connected to a switch on the panel of the set box. When the switch is thrown to "SW" (short wave) only part of the coil is in use, and when thrown to "LW" (long wave) the entire coil is in use. The secondary circuit is tuned by adjusting the variable condenser, connected across the secondary coil. In a later model of the SCR-127 set the secondary coil also has one tap which is connected to the same switch provided for the primary coil. This is so arranged that when the switch is in the position "SW" only parts of each of the primary and secondary coils are in use. When it is in the "LW" position the entire circuits of the primary and secondary coils are in use.

Directions.

6. Note carefully all of the receiver controls on the panel of the set box.

Questions.

(24) *Locate the primary and secondary condenser controls. How are the scales marked?*

(25) *What is the purpose of the small knobs located beneath the large condenser control knobs?*

(26) *To which side must the large three-pole switch be thrown when using the set as a receiver?*

(27) *Locate the "SW–LW" switch. What is the purpose of this switch?*

(28) *Locate the "SP–Het" switch. What is the purpose of this switch?*

(29) *For what are the binding posts located at the left of the panel used?*

Information.

Two stages of audio frequency amplification are provided in the receiver, the coupling between stages being provided by audio frequency transformers. The receiving tube sockets are for the standard base receiving tubes, but adapters are provided and VT–5 tubes are used. (See Fig. 94.)

The VT–5 tube is used on account of the fact that its filament may be lighted for a long time on one battery, type BA–10, and therefore do away with storage batteries for lighting the receiving tube filaments. In this set the three receiving tubes used have their filaments in series so that three batteries, type BA–10, connected in series, are required to light the filaments of the receiving tubes.

Set box, BC–7, is used both in the SCR–127 and 130 set. In the latter set the voltage supplied to the receiving tubes is 12 volts, while in the former it is only 4.5 volts. Accordingly, some means must be provided to keep the filament circuit of the receiving tubes separate from any higher voltage circuit when the set box is used in the SCR–127 set. This is accomplished by opening the switch S_6. (Fig. 87.)

Directions.

7. Observe the various receiver parts mounted back of the set box panel. As far as possible, trace the wiring of the receiver using the wiring diagram shown in Fig. 88.

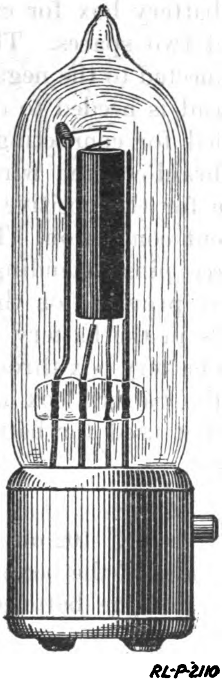
Questions.

(30) *Locate the receiving tube sockets. Which is the detector tube socket? Which are the amplifier tube sockets?*

(31) *Where are the fixed resistances that are in series with the receiving tube filaments?*

(32) *Where is the primary receiving inductance? How many taps are taken from it? To what do they go on the panel?*

(33) *Where is the secondary receiving inductance? Is it coupled inductively or conductively with the primary? Is the coupling variable or fixed?*



RL-P-2110

Fig. 94.—The type VT-5 vacuum tube.

(34) *Where is the tickler coil? Where are its terminals? Is it fixed in position with respect to the secondary?*

(35) *How many head sets can be connected to this set?*

(36) *What is the plate potential of the receiving tubes? Of the transmitting tubes?*

(37) *How are the filaments of the receiving tubes connected? Of the transmitting tubes?*

(38) *Where are the audio frequency transformers?*

Information.

Power for the receiver is supplied entirely by dry cells so that no storage batteries are needed. This is made possible by the fact that the normal filament current of the VT-5 tube is 0.2 of an ampere, and that this amount of current can be supplied by the dry cell for some length of time. The battery box, type BC-102 (see Fig. 89) is designed to carry 12 batteries, type BA-10. Three of these batteries are connected in series and used to supply the filament current to the VT-5 tubes. The remaining nine batteries are spares and are used as needed. The plate current for the receiving tubes is supplied by two batteries, type BA-8 in series. Space is provided in the battery box for carrying type BA-8 batteries, the two in use and two spares. The negative side of the 45-volt plate battery is connected to the negative side of the filament battery so that only one lead is needed to connect this point to the set box. The cord provided for connecting the battery box to the set box consists of three braid-covered wires, one for the common lead mentioned above, one for the positive 45-volt connection, and one for the positive filament connection. This cord has a plug on one end which fits on three pins extending out from the edge of the set box. Terminals are provided on the other end of the cord for connecting to terminals in the battery box. A small groove is provided in the end of the battery box through which this cord may be laid when the lid of the battery box is closed. The compartments of the battery box not used for batteries are to be used for carrying tubes, head sets, etc.

Directions.

8. Place the battery box type BC-102 on some convenient support. Release the catches on the sides of the box and drop down the front cover. Notice the positions of the batteries and parts (including spare parts).

Questions.

(39) *Where are the terminals to which the BA-10 batteries are connected?*

(40) *Where are the terminals to which the BA-8 batteries are connected?*

(41) *How are the BA-10 cells held in place?*

(42) *Where are spare vacuum tubes kept?*

(43) *Is it possible to close the cover of the battery box when the battery cord is connected from the box to the receiver? Explain your answer.*

EXPERIMENT No. 1.

TO CONNECT UP AND TUNE THE SCR–127 SET.

Information.

In connecting up the SCR–127 set, ready for operation, there are two main divisions of the work; namely, connecting the set as a receiver and connecting the set as a transmitter. The set may be connected up as a transmitter without fully connecting it up as a receiver and vice versa. In like manner the tuning of the set as a transmitter differs from the tuning of the set as a receiver. A definite method should be followed in doing all these things.

Directions.

9. *To connect up the set as a transmitter.*—Erect the set box on its legs. The set box should be so placed that the antenna and ground leads will easily reach the proper binding posts on the panel. Place the hand generator on the right side of the set box and the battery box on the left.

a. Open up the front cover of the set box, pull down on the catches which hold the panel closed, and open the panel.

b. Insert four VT–2 tubes in the four transmitting tube sockets in the set. Close switch "S_3." (Fig. 87.)

c. Close the panel, being sure that the catches are properly locked, and open the "Trans.-Rec." switch so that it does not make contact on either side.

d. Connect the high voltage generator lead to the two pins marked "+350" and "—350."

e. Connect the low voltage generator lead to the two pins marked "+12" and "—12" volts.

f. Connect the antenna lead-in wire to the post marked "Ant"

g. Connect the wire from the counterpoise or other ground system used to the post marked "Gnd."

Questions.

(44) Why is it necessary to follow certain steps in their proper order when connecting up the SCR–127 set?

(45) Why is it important to have the connecting leads connected with proper polarity? Can this be done incorrectly? If so, how?

Directions.

(10) *To tune the transmitter.*—The next step, after having made all of the connections as previously given, is to tune the transmitting

side to the desired or specified wave length. In order to do this properly the following steps are gone through:

a. Turn the "Transmit Wave Length" pointer to *exactly* the desired wave length and lock it in that position by means of the small lever under the knob.

b. Have the generator cranks turned at 35 to 40 revolutions per minute.

c. Throw the "Trans.-Rec." switch to the "Trans." side. The filaments of the VT-2 tubes should glow a dull red.

d. Close the key.

e. Turn the "Antenna Tuning" knob slowly and watch the antenna ammeter. As the knob is turned the ammeter will start indicating and will gradually increase in reading up to a certain point. As the knob is turned still further the reading of the ammeter will decrease. That position of the "Antenna Tuning" knob which gives the greatest reading on the antenna ammeter is the correct adjustment. The final adjustment to obtain the greatest reading should be made with the small knob just under the "Antenna Tuning" knob. This small knob is a vernier or fine adjustment of the larger knob.

f. Open the key.

g. Open the "Trans.-Rec." switch and have the generator stopped. The set is now adjusted for transmitting on the wave length to which the pointer of the "Transmit Wave Length" adjustment is set.

Questions.

(46) *Why is the "Transmit Wave Length" pointer locked after it is set to the desired wave length?*

(47) *How long did it take the men turning the generator to bring it up to the required speed?*

(48) *Why is it necessary to adjust the "Antenna Tuning" knob so that a maximum reading occurs on the ammeter?*

Directions.

11. *To connect up the set as a receiver.*—After having made all of the connections given under the paragraphs entitled "To Connect Up the Set as a Transmitter," the following additional connections will be needed in order that the receiving side of the set maybe ready for operation:

a. Open the panel to the set and insert three VT–5 tubes and adapters in the receiving tube sockets. (Be sure that the "Trans.-Rec." switch is open.)

b. Open the switch S_6 (Fig. 87) and close the panel, being sure that it locks into place.

c. Open the battery box, type BC–102, and then remove the lid of the " B " battery compartment, placing the box so that it appears as in Fig. 89. Insert a battery, type BA–8, in the lower of the " B " battery compartments. The battery should be inserted with its top up and with the negative lead toward the back of the box. Guide the negative lead through the hole in the bottom of the right side of the compartment and pull the battery up aganst that side. Insert another battery, type BA–8, in the upper "B " battery compartment with its top down and with the positive lead toward the back of the box. Guide the positive lead through the hole in the bottom of the right side of the compartment and pull the battery up against that side of the compartment. Connect the positive and negative leads coming through the holes to the binding post marked " Black —" " Red +." Connect the remaining red lead to the post marked "+ 40 V Red " and the remaining black lead to the post marked "— 40 V Black." When spare batteries, type BA–8, are carried, they are placed alongside the two just connected in the " B " battery compartment. Replace the cover to the " B " battery compartment.

d. After having prepared six cells, type BA–10, for service, place them in the upper long narrow compartment in the battery box. Numbering the six cells from left to right, connect them in series-parallel as follows, using pieces of insulated wire cut to the necessary lengths:

(1) Carbon of No. 1 to carbon of No. 4.
(2) Zinc of No. 1 to carbon of No. 2.
(3) Zinc of No. 2 to carbon of No. 3.
(4) Zinc of No. 3 to zinc of No. 6.
(5) Carbon of No. 4 to wing nut back of binding post marked " Carbon +."
(6) Zinc of No. 4 to carbon of No. 5.
(7) Zinc of No. 5 to carbon of No. 6.
(8) Zinc of No. 6 wing nut back of binding post marked " Zinc —."

NOTE.—If only three cells are used, connect them in series and make connections to the wing nut terminals with proper polarity. The remaining cells should be left disconnected as spares.

When the six cells, type BA–10, have been connected as described above clamp them in place by means of the wooden rod which fits over their tops. If spare batteries, type BA–10, are to be carried, they should be placed in the lower compartment and clamped in place with the wooden rod provided.

e. The cord, type CD–88, has a connecting block on one end and three leads of different colors on the other end. Connect the red and white lead to the binding post marked "+ 40 V Red," the white lead to the post marked "Carbon +," and the black lead to the post marked "Zinc —." Lay the cord in the groove in the upper edge of the right side of the battery box and close the lid of the box, clamping it shut.

f. Plug the connecting block of the cord, type CD–88, on the three pins marked "+40 V," "+Fil.," and "—Fil." into the receptacle on the left edge of the panel of the set box.

g. Plug one or two head sets, type P–11, into the jacks provided on the left side of the panel. (If available head sets are not provided with cord plugs, the cord clips may be connected to the two binding posts marked "Aux. Tel.")

h. Put on one of the head sets and adjust it to fit the head comfortably.

i. If the receiving side only of the set is to be used, omit the items given under *b*, *c*, *d*, and *e*, in Direction 9.

12. *To connect up the set both as a transmitter and as a receiver.*—After the set has been properly erected:

a. Open up the front cover of the set box, pull down on the catches holding the panel closed, and open the panel.

b. Insert four VT–2 tubes in the transmitting tube sockets and three VT–5 tubes and adapters in the receiving tube sockets. Close switch S_3 and open switch S_6. (Fig. 87.)

c. Close the panel, being sure that the catches are properly locked, and open the "Trans.-Rec." switch so that it does not make contact on either side.

d. Connect the high voltage generator lead to the pins marked "+350" and "—350."

e. Connect the low voltage generator lead to the two pins marked "+ 12" and "— 12" volts.

f. Connect the antenna lead-in wire to the post marked "Ant."

g. Connect the wire from the counterpoise, or other ground system used, to the post marked "Gnd."

h. Open the battery box, type BC–102, and then remove the lid of the "B" battery compartment, placing the box so that it appears as in Fig. 89. Insert a battery, type BA–8, in the lower of the "B" battery compartments. The battery should be inserted with its top up and with the negative lead toward the back of the box. Guide the negative lead through the hole in the bottom of the right side of the compartment and pull the battery up against that side. Insert another battery, type BA–8, in the upper "B" battery compartment with its top down and with the positive lead toward the back of the box. Guide the positive lead through the hole in the bottom of the right side of the compartment and pull the battery up against that side of the compartment. Connect the positive and negative leads coming through the holes to the binding post marked "Black—" "Red +". Connect the remaining red lead to the post marked "+ 40 V Red" and the remaining black lead to the post marked "—40 V Black." When spare batteries, type BA–8, are carried, they are placed alongside the two just connected in the "B" battery compartment. Replace the cover to the "B" battery compartment.

i. After having prepared six cells, type BA–10, for service, place them in the upper long narrow compartment in the battery box. Numbering the six cells from left to right connect them in series-parallel as follows, using pieces of insulated wire cut to the necessary lengths:

(1) Carbon of No. 1 to carbon of No. 4.
(2) Zinc of No. 1 to carbon of No. 2.
(3) Zinc of No. 2 to carbon of No. 3.
(4) Zinc of No. 3 to zinc of No. 6.
(5) Carbon of No. 4 to wing nut back of binding post marked "Carbon +."
(6) Zinc of No. 4 to carbon of No. 5.
(7) Zinc of No. 5 to carbon of No. 6.
(8) Zinc of No. 6 wing nut back of binding post marked "Zinc —."

NOTE.—If only three cells are used, connect them in series and make connections to the wing-nut terminals with proper polarity. The remaining cells should be left disconnected as spares.

When the six cells, type BA–10, have been connected as described above, clamp them in place by means of the wooden rod which fits over their tops. If spare batteries, type BA–10, are to be carried, they are placed in the lower compartment and clamped in place with the wooden rod provided.

j. The cord, type CD-88, has a connecting block on one end and three leads of different colors on the other end. Connect the red and white lead to the binding post marked "+ 40 V Red.", the white lead to the post marked "Carbon +," and the black lead to the post marked "Zinc —." Lay the cord in the groove in the upper edge of the right side of the battery box and close the lid of the box, clamping it shut.

k. Plug the connecting block of the cord, type CD–88, on the three pins marked "+40 V", "+Fil.," and "−Fill." into the receptacle on the left edge of the panel of the set box.

l. Plug one or two head sets, type P–11, into the jacks provided on the left side of the panel. (If head sets are to be used not having plugs on the end of their cords they may be connected to the two binding posts marked "Aux. Tel.")

m. Check all connections to see that they are correct.

n. Put on one of the head sets and adjust it to fit the head comfortably.

Question.

(49) *Why is it necessary to have the "Trans.-Rec." switch open as in Direction 11, a?*

Information.

To tune the receiver.—In tuning the receiver several different cases will occur. They are as follows:

a. Tuning in a C. W. signal of known wave length.

b. Tuning in a damped wave signal of known wave length.

c. Tuning in a C. W. signal of unknown wave length.

d. Tuning in a damped wave signal of unknown wave length.

Directions.

13. To tune the receiver of the set to a C. W. signal of known wave length proceed as follows. After the receiving side has been connected up as directed above:

a. Throw the "Trans.-Rec." switch to the "Rec." side.

b. Place the "Spk.-Het." switch on "Het."

c. Set the "LW–SW" switch and the secondary condenser to the desired wave length as given by the calibration of the set.

d. Vary the primary condenser until a distinct double click is heard, and set the primary condenser about 5° to either side of the point where this double slick is heard.

e. The receiving side of the set should now be in tune on the desired wave length, but due to inaccuracies which may occur, the setting may not be exact enough to pick up the signal sought. It is therefore advisable to swing the secondary condenser slowly over an arc of about 10° (the middle point of which is the setting given by the calibration of the set) until the sought-for signal is heard.

f. Upon hearing the desired signal, stop turning the secondary condenser by its knob and make the final accurate adjustment by means of the small vernier knob located just under the secondary condenser knob.

g. A small further adjustment of the primary condenser may now be made in order to increase the loudness of the signal.

14. To tune the receiver to a damped wave signal of known wave length proceed as follows:

a. Same as *a* above.

b. Same as *b* above.

c. Same as *c* above.

d. Same as *d* above.

e. Place the "Spk.-Het." switch on "Spk."

f. Same as *e* above.

g. Same as *f* above.

h. Same as *g* above.

15. To tune the receiver to a C. W. signal of unknown wave length proceed as follows:

a. Same as *a* under Direction 12.

b. Same as *b* under Direction 12.

c. Set the "LW–SW" switch on "SW." Set the secondary condenser on about 5° and vary the primary condenser until the double click is heard, indicating that the circuits are in tune.

NOTE.—For every position of the secondary condenser there should be a corresponding position of the primary condenser at which the primary or antenna circuit is in tune with the secondary circuit. In searching for a signal of unknown wave length, the method should be to vary both condensers at the same time, attempting at all times to keep the primary condenser close to that point where its circuit is in tune with the secondary.

d. Starting with the secondary condenser at about 5° and the primary condenser at the point where it is in tune, slowly turn both condensers, as outlined above, over their entire scale. Repeat this several times until you are sure that the signal is not obtainable. (The primary condenser should increase as the secondary is increased.)

e. Set the "LW–SW" switch on "LW" and repeat *d*.

f. When the desired signal is found under either *d* or *e*, engage the vernier knobs of the primary and secondary condensers and make the final adjustments for a loud, clear signal of a readable pitch with these knobs.

16. To tune the receiver to a damped wave signal of unknown wave length, proceed as follows:

a. Follow exactly the procedure outlined under Direction 11 until the desired signal is found. When found, the natural tone of the damped wave will be badly distorted.

b. Throw the "Spk.-Het." switch to "Spk.", and, if necessary, retune slightly both the primary and secondary condensers. The damped wave signal should now be heard with its natural tone, but much weaker than when heard under *a*.

NOTE.—Damped waves may be received with the "Spk.-Het." switch on "Het.", if the change in tone is not objectionable. The receiver will be far more sensitive than with the switch on "Spk."

EXPERIMENT No. 2.

CALIBRATION OF THE RECEIVER SECONDARY.

Directions.

17. Erect two complete antenna systems, separated by about 300 yards, for the SCR–127 set. On the first antenna (set A) connect up, ready for transmission, one SCR–127 set, and on the other antenna another SCR–127 set (set B) which is to have its receiver secondary calibrated.

18. Start transmitting with set A on 500 meters. Tune set B to receive the signal. Set B is now tuned to receive 500 meters. Read in degrees the setting of the secondary receiving condenser and put it down in a table similar to the one shown below.

Wave length.	Secondary condenser setting.	Setting of SW-LW switch.
500		
525		
550		
575		
600		
625		
650		
675		
700		
725		
750		
775		
800		
825		
850		
875		
900		
925		
950		
975		
1,000		
1,025		
1,050		
1,075		
1,100		

Transmit with set "A" on 525 meters and again tune in with set "B." Record the reading in the table. Continue this process in steps of 25 meters until the entire wave length range has been covered.

Information.

The SCR–127 set must primarily receive from another SCR–127 set; therefore it is desirable that its receiving side be calibrated with an SCR–127 transmitter. It would be easier to calibrate it by the use of a wave meter, but in that case the wave meter calibrations and those of other SCR–127 transmitters might not be identical. As a variation of about 1° on the secondary condenser is sufficient to tune out the desired signal it will be seen that accuracy is very important.

EXPERIMENT No. 3.

CHECKING THE CALIBRATION OF THE TRANSMITTERS OF SEVERAL SETS.

Information.

When three or more sets are to operate in a net it is very important that the transmitting wave-length calibrations of all of the sets shall be identical; that is, any one set should receive all other sets operating on the same wave length, on the same setting of the secondary receiving condenser. In order to accomplish this it is sometimes necessary to check or recalibrate all of the sets involved. Although the oscillator of the SCR–127 set is originally quite accurately calibrated, sometimes, due to rough handling, or to other causes, the calibrations may be thrown off.

Directions.

19. Set up two antenna systems. Pick out one set, to be known as the "master set," and connect it up to one antenna ready for transmitting. To the other antenna connect another set ready for receiving. With the master set transmit successively on wave lengths from 500 to 1,100 meters in steps of 25 meters.

20. Receive each of these transmissions on the other sets and fill out accurately a table similar to the one given below, showing all receiving adjustments on which each of the transmissions is received.

Wave length.	Primary condenser.	Secondary condenser.	Setting of SW-LW switch.
500			
525			
550			
575			
600			
625			
650			
675			
700			
725			
750			
775			
800			
825			
850			
875			
900			
925			
950			
975			
1,000			
1,025			
1,050			
1,075			
1,100			

Disconnect the master set and place it aside. Connect to the antenna of the master set one of the sets whose calibrations have been checked and start it to transmitting on 500 meters according to its new calibration. Tune in the transmitted signal with the remaining receiving set. If it is received on the same adjustments used for the master set when it was transmitting on 500 meters, then the 500-meter calibration of the set under test is correct. If it is received on a different adjustment, the calibration is inaccurate and must be corrected.

21. To do this, adjust the receiving sets to the settings on which the master set was received on 500 meters. Gradually vary the transmitted wave length of the set under test until it is heard by the adjusted receiving sets. It will then be transmitting on 500 meters by the calibrations of the master set. A piece of paper should be pasted over the scale of the master oscillator and a mark made on the paper exactly opposite the end of the pointer, this mark being labeled "500". The above process is repeated in steps of 25 meters until the entire wave length range of the set has been covered. The next set to be checked is then put through the same process.

EXPERIMENT No. 4.

TUNING A SET HAVING A BURNED OUT ANTENNA AMMETER.

Directions.

22. Connect up the set properly for transmitting, and if the burned out antenna ammeter has not been short-circuited, do so with a piece of fairly heavy copper wire. Throw the "Trans.-Rec." switch to "Trans.", have the generator turned, and hold down the key.

METHOD "A".

Slowly turn the antenna variometer (with the wave length variometer set at the desired wave length) until the men turning the generator notice a very perceptible increase in the load. As the antenna variometer is still further turned the generator load will again become lighter. At the position of the antenna variometer half way between the points where the increased load is first noticed and where the load again becomes lighter, the antenna circuit is approximately in tune with the master oscillator circuit. The set is then transmitting fairly well on the desired wave length.

METHOD "B".

Light and adjust the lamp on an SCR–125–A wave meter and couple the wave meter to the master oscillator circuit of the set by holding the side of the wave meter marked " Plane of Coil " against the knob of the wave length variometer. Start the set to transmitting and close the key. Set the wave meter to the desired wave length and vary the wave length variometer until the wave meter lamp indicates that the circuits are in tune. Then, without disturbing the adjustments of either the wave meter or the wave length variometer, move the wave meter over and couple it to the antenna circuit by wrapping one or two turns of the lead-in wire around it. Slowly turn the "Antenna Tuning" variometer until the wave meter lamp again indicates that the circuits are in tune. The set is then transmitting on the desired wave length with all circuits in tune.

Information.

With the SCR-127 and 130 sets, tuning the set to transmit on a given wave length is entirely dependent on readings of the antenna ammeter. Accordingly, some method becomes necessary to tune the set when this meter is out of service. Of the two methods given, the first may be employed with no additional apparatus and will give fairly good results. The second method is dependent on the availability of an SCR-125-A wave meter, but when properly used will give excellent results. Sometimes, in using the second method, trouble is experienced in getting an indication that the circuits are in tune, with the wave meter coupled to the wave length variometer. This is due to weak oscillations in the oscillator tube of the set and may be overcome by tuning the set by the first method and then coupling the wave meter to the antenna circuit for the final adjustment. It is to be remembered that the calibrations on the SCR-125-A wave meter and the master oscillator variometer may not be the same, due to inaccuracies in manufacture, and therefore a set transmitting on, say, 860 meters by the wave meter, may not be on exactly the same wave length as one which was set by the calibrations on the set. It will be noticed that in both of the above methods the calibrations on the set are used in determining the wave length. In general, the calibrations on the set are more accurate than those on the SCR-125-A wave meter.

THE SCR-77-A LOOP SET.

Equipment.

1 set box, type BC-9.
1 equipment box, type BE-48.
1 loop, type LP.
1 battery case, type CS-17.
1 head set, type P-11.
6 tubes, type VT-1 (two good oscillators).
9 batteries, type BA-2.
1 battery, type BB-41.

Information.

The SCR-77-A set (see Fig. 95) provides undamped or continuous wave, two way, telegraph communication over the distances ordinarily separating regiments and battalions. The wave length range of the set, both transmitting and receiving, is from 74 to 76 meters. Within this range of two meters it is possible to work on nine different wave lengths without interference.

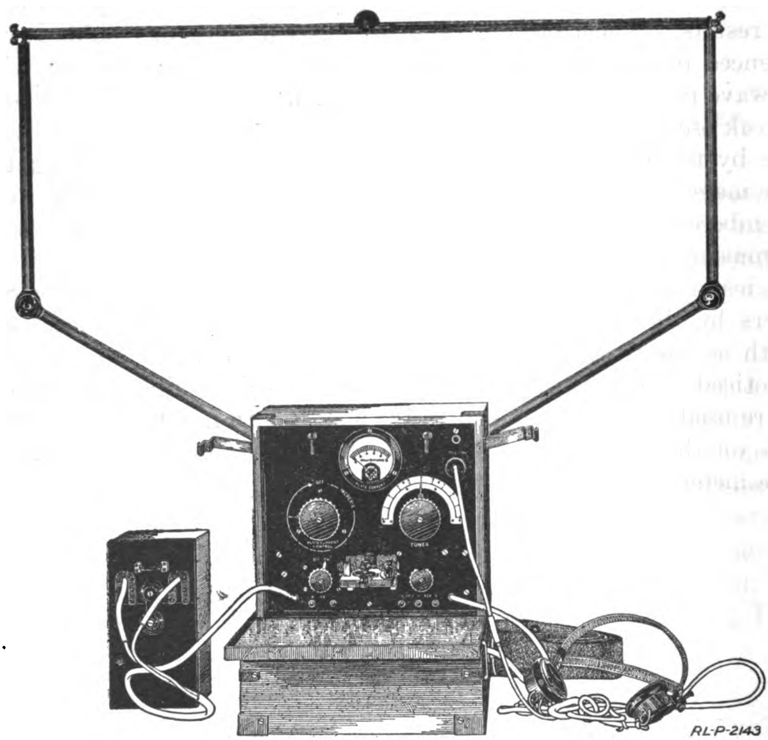


Fig. 95.—The SCR-77-A loop set.

The type of antenna used with the SCR-77-A set is called a *loop antenna.* This consists of a single turn of metallic tubing the ends of which are provided with suitable connection lugs for mounting the loop on the set box and making contact to the circuits in the box. The loop is assembled in three sections which are joined together by bolts and wing nuts. Each section is hinged so that it may be folded for packing.

Directions.

1. Look at the front, top, and rear of the set box. Note carefully how the various controls are marked, how the ammeter is marked, how the key is constructed, and how the sockets for the loop antenna in the rear are constructed.

Questions.

(1) *Into how many positions is the tuner scale divided?*

(2) *How is the filament lighting current connection made?*

(3) *How many pair of telephones can be connected to this set?*

(4) *Why are the luminous paint lines placed on the ammeter scale?*

(5) *Why are these lines placed at the scale markings 4, 5, and 6?*

(6) *Where is the loop connection made to the inside of the set box?*

Directions.

2. Look at the loop antenna of this set. Note the construction and the method of attachment to the set box.

Questions.

(7) *Of how many distinct parts does the loop consist?*

(8) *Why is this type of construction preferred in this case?*

(9) *How is the loop fastened on to the set box proper?*

(10) *Why are wing nuts used on this antenna instead of ordinary hexagonal nuts?*

(11) *Where is the antenna carried during transportation of the set?*

(12) *Why is the antenna given a black finish?*

Information.

In the SCR-77-A the same circuit is used for both transmitting and receiving. (See Fig. 96.) In other words, the oscillator tube which furnishes power for transmitting serves as a detector when receiving signals. These two functions may operate at the same time. The receiving circuit is provided with two additional tubes which are used as audio-frequency amplifiers. These tubes, combined with audio-frequency transformers amplify the signals from the detector-oscillator. When the set is operating, a special filter circuits from entering the amplifier tubes or the potentiometer circuit, but allows the direct and audio-frequency currents to flow.

The oscillator tube circuit consists of an inductance (the loop), several fixed condensers, and two variable condensers. The plate and grid circuits of the oscillator tube are coupled by the two fixed con-

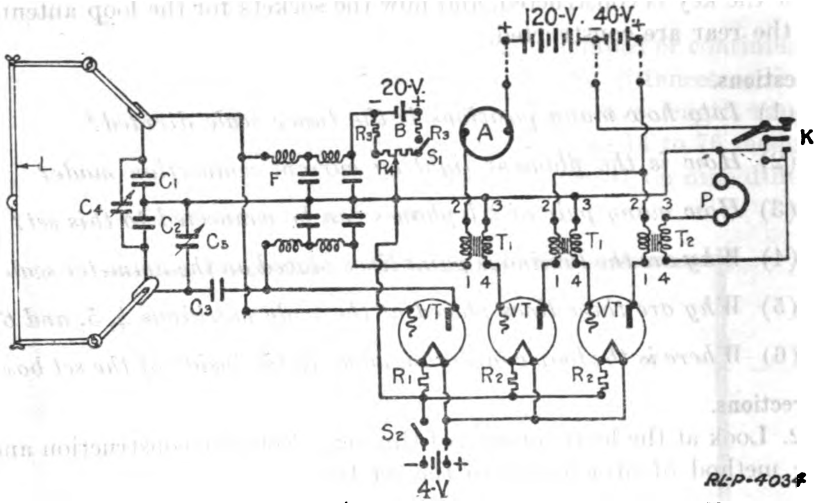


Fig. 96.—Schematic diagram of connections in the SCR–77–A set.

densers connected in series across the loop antenna terminals. A single moveable-plate variable condenser is connected across one of the fixed coupling condensers and enables the oscillator tube circuit to be tuned over a narrow band of wave lengths. A specially constructed two-plate variable condenser is connected directly across the loop terminals. This condenser, called the "screw driver" condenser, is mounted on the inside of the back of the set box with a large slotted head machine screw projecting through the back of the box, so that the condenser may be adjusted or varied without opening the panel of the set. The object of the "screw driver" condenser is to make the calibration of several sets agree at one point on their respective tuner scales.

A 4-volt storage battery supplies the necessary current for lighting the filaments of the 3 VT–1 tubes used in the SCR–77A set. The necessary plate potential for the detector-oscillator tube is supplied by the 120-volt battery (6 BA-2 batteries in series) carried in the equipment box, type CS-17. The plate potential for the amplifier tubes is supplied by a 40-volt battery (2 BA-2 batteries in series), which is also contained in the equipment box. (See Fig. 97.) In order to operate the set it is also necessary to supply the grid of the detector-oscillator tube with a potential. This voltage is obtained

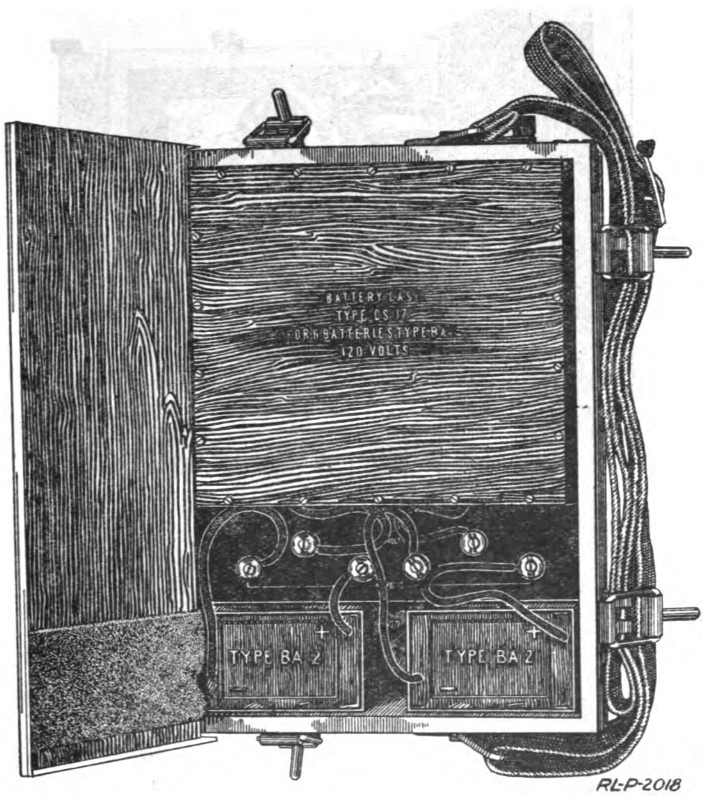


Fig. 97.—Battery compartment of equipment case, type CS-17.

from 1 BA-2 battery which is mounted in a special container on the rear of the panel of the set. As this voltage must be closely regulated or controlled, a variable resistance called a "Potentiometer" or "Controller" is connected across the grid battery. By careful adjustment of this controller the proper potential is supplied to the grid. A switch, used for turning the filament current on and off, also provides a means for opening the controller circuit, so that the grid battery will not have current drawn from it when the set is not in use. The battery box also contains compartments for 3 spare VT–1 vacuum tubes and a head set. (See Fig. 98.)

In the circuit diagram of the SCR–77–A set (see Fig. 96) it will be noticed that the phones are in series with the secondary winding of a special transformer the primary of which is in the plate circuit of

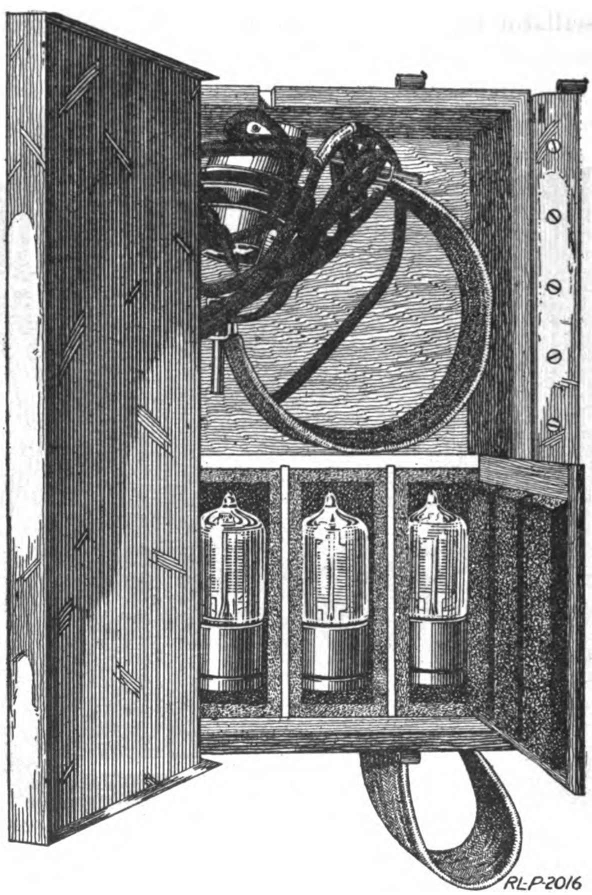


Fig. 98.—Head set and spare vacuum tube compartment of equipment case, type CS–17.

the last amplifier tube. The phones and the secondary of this transformer are across the lower contact and a special middle contact of the telegraph key. The middle contact is also connected to the negative filament terminal. The contact in the key arm is connected to the negative side of the 120-volt and 40-volt "B" batteries. The purpose of this arrangement is to eliminate the loud noise that otherwise would be produced in the phones whenever the telegraph key is operated.

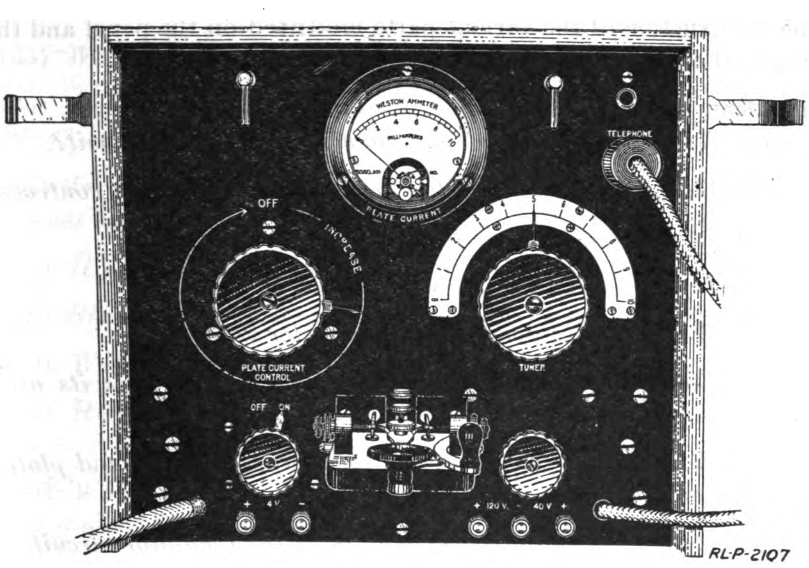


Fig. 99.—Set box, type BC-9 with front cover removed.

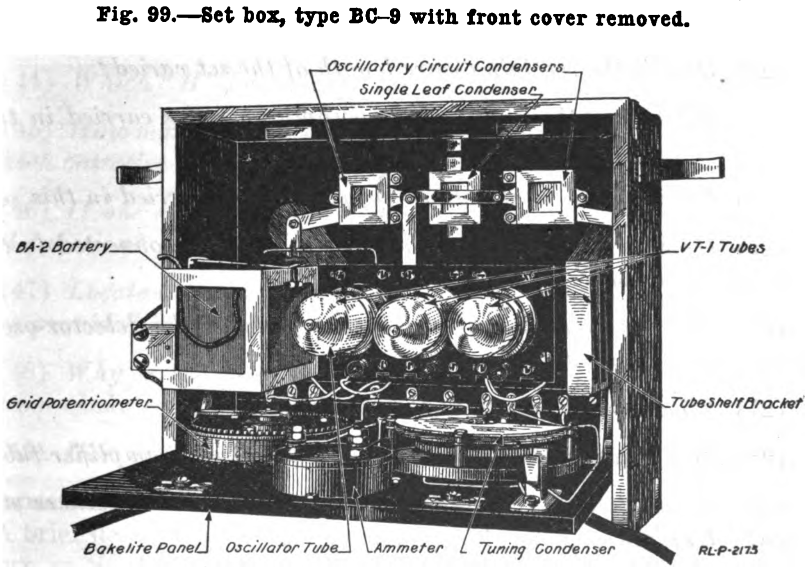


Fig. 100.—Front panel of set box, BC-9, lowered to show interior parts.

Directions.

3. Turn the two catches on the upper edge of the panel and swing the panel forward. (See Figs. 99 and 100.) Reach inside the set box and on the bottom will be found three thumb nuts. Remove these

thumb nuts and lift off the wires connected to the bolts. The panel may now be lifted up and forward and removed from the box. Note the construction of the various parts mounted on the panel and those mounted on the inside of the back of the set box.

Questions.

(13) *How is the loop antenna connected into the circuit?*

(14) *How is the key connected to the circuits which it controls?*

(15) *In which circuits is the key?*

(16) *In what circuit is the milliammeter?*

(17) *What current does the milliammeter read?*

(18) *Locate the "screw driver" condenser. What is its use in this set?*

(19) *What kind of coupling is used between the grid and plate of the oscillator tube?*

(20) *Locate the coupling condensers of the oscillator circuit.*

(21) *How is the transmitting wave length of the set varied?*

(22) *How is the receiving wave length of the set varied?*

(23) *Where are the plate voltage supply batteries carried in this set?*

(24) *Where is the grid voltage supply battery carried in this set?*

(25) *How are the plate voltage supply batteries connected to the circuits of the set?*

(26) *How many volts are used on the plate of the detector-oscillator tube in this set?*

(27) *What batteries supply this voltage?*

(28) *How many volts are used on the plate of each amplifier tube?*

(29) *If one tube is removed from its socket, will the others still burn? Explain.*

(30) *Locate the potentiometer and the fixed resistances in series with it.*

(31) *Why are the fixed resistances used?*

(32) *What kind of coupling is used between the different stages of the amplifier?*

(33) *Locate the audio frequency transformers?*

(34) *Which is the oscillator tube socket?*

(35) *Which are the amplifier tube sockets?*

(36) *Are the amplifier tubes being used when the set is transmitting? Explain.*

(37) *In general, what circuit is mounted on the inside of the back of the set box?*

(38) *How should the contacts of the key be adjusted?*

(39) *Should the joints of the loop be kept tight? Why?*

(40) *Where are the "B" batteries carried in this set?*

(41) *How are the "B" batteries connected to the circuits of the set?*

(42) *Which binding posts are positive and which are negative, as the student looks from the front of the set?*

(43) *How many volts are used on the plate of the oscillator tube in this set?*

(44) *Which "B" batteries in the set supply this?*

(45) *How many volts are used on the plate of each amplifier tube? Which batteries supply this?*

(46) *If one amplifier tube is removed from its socket will the set still function? Explain.*

(47) *Locate the grid resistances and the potentiometer. Why are they provided in this set?*

(48) *Why is the piece of varnished cambric placed between the bottom choke coil and the aluminum of the battery container?*

(49) *How is the receiving wave length of this set varied?*

Information.

A brief description of the operation of the SCR–77–A set follows: When an SCR–77–A set, which is called "A," for example, is set up and properly connected and the key is closed, the set will transmit and receive at the same time. In other words, the oscillator tube is generating impulses which leave the the loop antenna in the form of continuous waves, while at the same time, the tube is acting as a detector of incoming waves. If another SCR–77–A set, "B," is erected and put in operation at a suitable distance from set A and its key closed, it will send out continuous waves and detect incoming signals at the same time.

If set B is now tuned to almost the same wave length as set A, a musical or whistling note, called a "beat" note, will be heard in the telephone receivers of both sets. The action taking place in set B is as follows: The impulses generated by the oscillator tube of set B are combined with the impulses received from set A. This combination of impulses is detected by the oscillator tube of set B and causes a musical beat note to be heard in the telephone receivers of the set. The action in set A takes place in the same way. The impulses generated by the oscillator tube of set A are combined with the impulses received from set B and a beat note is heard in the receivers of set A due to the detector action of the oscillator tube in this set. When the two sets are operating as described above a beat note will be heard in the telephone receivers of both sets at the same time. If the key of either set is opened the beat note in the telephone receivers of both sets will cease.

If communication is to be established between the two sets, the levers on the sides of the keys of both sets are first closed. The tuner knob of one set is adjusted to any given setting on the dial and is left in that position. The tuner knob of the other set is adjusted until a strong beat note is heard. This beat note should be heard in the telephone receivers of both sets except under certain conditions which will be described later. If the operator of set A desires to send a message, he opens his key lever and proceeds to transmit. When he has finished, he closes the key lever and is ready for receiving. The operator at set B opens his key lever as soon as the operator at set A has finished and proceeds to answer. In this way it may be seen that in order to transmit the key lever must be open and to receive it must be closed.

This method of operation of the SCR–77–A set makes possible the "break-in" system. Either operator, when two sets are in communication, may interrupt or "break-in" on the sending of the other. For instance, if the operator of set A is sending a message and the operator of set B misses a word, the operator of set B immediately opens his key lever and after waiting a few seconds advises the operator at set A of that fact. As the operator of set A can not hear his own transmitted signals when the key switch of set B is opened, he will thus know that the operator of set B is breaking in, and will accordingly close the key switch of set A and stand by for signals from set B. In the same way the operator of set A can break-in when set B is transmitting.

In order to obtain maximum efficiency in the operation of the SCR-77-A set it is necessary to use a VT-1 tube in the oscillator socket which has been especially selected for this purpose. Since this tube must fulfill two functions, i. e., as an oscillator and as a detector, two sets of conditions will be given for selecting the tube. These two sets of conditions are opposed to each other so that the best that can be done is to compromise between the two in the final selection.

The best oscillator tube, that is, the one which will transmit the best, is the tube which, when placed in the oscillator socket and with the set in operation can be made (by adjusting the controller) to draw the greatest plate current and at the same time to show the greatest drop in plate current when the loop is touched with the bare hand. If one tube can be made to draw 8 milliamperes and drops to 6 milliamperes when the loop is touched, it is a better oscillator than a second tube which will draw 6 milliamperes and drops to 4 milliamperes when the loop is touched. However, if the second tube drew 6 milliamperes and dropped to 3 milliamperes when the loop was touched it would probably be a better transmitter tube than the first tube.

The best detector tube, that is, the one which will receive the best, is the tube which, when placed in the oscillator tube socket and with all connections properly arranged, can be made (by adjusting the controller) to draw the least plate current and still show a slight drop when the loop is touched. Thus a certain tube may draw only one milliampere. The meter needle indicates a slight decrease in reading when the loop is touched and returns to the one milliampere reading when the hand is removed from the loop. Another tube can not be made to draw less than 2 milliamperes. The meter needle indicates a slight decrease in reading when the loop is touched and returns to the 2 milliampere reading when the hand is removed from the loop. The first tube is the better detector of the two and since it is a poorer oscillator than the second tube it will cause less interference on any tuner setting when listening in on the transmission of another station.

The tube, therefore, finally selected for the oscillator should be one which will best fulfill both the oscillator and detector conditions with different settings of the controller.

Due to the fact that the plate current is supplied by BA-2 batteries and that these batteries will not supply over 6 milliamperes without greatly shortening their life, it is best to use in transmitting not more than the above value of plate current. Occasionally, when a distant station can not be reached with signals loud enough scale slowly, and if there is another SCR–77–A set transmitting only, to 8 or 9 milliamperes, provided that the tube used is a better oscillator at that value of plate current.

To place the set in operation, insert and connect the necessary batteries in the equipment box. (See Fig. 95.) Place the set box on top of the equipment box and clamp the two together; and connect, with the proper polarity, a 4-volt storage battery to the battery leads from the set. Open the panel and insert a selected oscillator tube in the oscillator tube socket, insert two amplifier tubes in the amplifier tube sockets. Close the panel. Insert the plug of the plate-battery connecting cord in the jack provided in the equipment box and plug in a headset. With the key lever closed, turn the filament switch to the "On" position and adjust the controller until the tube is oscillating strongly as shown by touching the loop and noting the meter deflection. Turn the tuner over its scale slowly, and if there is another SCR-77A set transmitting within range, a beat note will be heard in the headset.

EXPERIMENT No. 1.

THE SELECTION OF OSCILLATOR TUBES FOR THE SCR–77–A.

Information.

Oscillator tubes for the SCR–77–A must be selected before the set is sent into the field for operation. At the most, only one out of every ten or fifteen tubes tested will prove satisfactory for use in the oscillator tube socket of this set. Every SCR–77–A set going into the field should have with it at least two and, if possible, three or four selected oscillator tubes.

The selection of the oscillator tubes should be based on the information given on this subject earlier in this Unit Operation, and should be carried out in the following manner:

Directions.

4. To connect up the set ready for operation proceed as follows:

a. Open up the rear compartment of the equipment box, type BE–48, and insert a battery case, type CS–17, which shows a reading of at least 110 volts when tested with a voltmeter. Connect the positive and negative leads to the two binding posts marked "+ 120" and "— 120" volts, with the proper polarity. Place two BA–2 batteries in the small compartment and connect their leads with the correct polarity to the four binding posts marked "40 volts." Close the compartment.

b. Place the set box on top of the equipment box in the correct position and clamp the two together.

c. Remove the loop from its carrying bag, straighten out the three pieces to their correct shape, and clamp their hinged joints tightly. Place the two sides of the loop in their respective sockets on the back of the set box and put the top bar in place, at the same time tightening up the wing nuts which hold it. Go over the entire loop and see that all joints are tight.

d. Open up the front cover of the set box sufficiently to pull out the plate battery connecting cord and plug and lay it to the right of the set. Open up the front compartment of the equipment box, remove the tubes and head sets which are to be used in operating the set, and plug in the plate battery connecting plug into the jack provided. Lay the cord in the little notch on the right side of the compartment and close the compartment.

e. Let down the front cover of the set box all the way and open the panel. (See Fig. 100.) Place a BA–2 battery in the compartment attached to the panel and connect the leads from this battery to the two binding posts on the side of the compartment with the polarity as marked. Place two VT–1 tubes in the two amplifier tube sockets.

f. Connect the red terminal of the storage battery cord which extends from the panel to the positive terminal of a 4-volt storage battery and the black terminal of the cord to the negative terminal of the battery.

g. See that the filament current switch is in the "On" position.

h. The set is now ready to operate with the exception of placing a selected oscillator tube in the oscillator tube socket, closing the panel, and plugging in a head set.

5. The student will be supplied with 20 VT–1 tubes out of which the tubes suitable for use in the SCR–77–A set must be selected. Each tube has a number written on a small piece of paper pasted on the glass of the tube. Refer to the tubes by their number in stating the qualifications of each tube in this experiment.

6. Insert one of the tubes in the oscillator tube socket of the set, close the panel and see that the key lever is closed. Vary the controller and determine if the tube will oscillate at any value of plate current within the range of the set. If it does oscillate (as shown by the decrease in plate current when the loop is touched) determine the points at which it is the best oscillator and the best detecor. Re-

peat the above for each of the 20 tubes given you and fill out a table similar to the one shown below.

Tube No.	For best oscillations.		For best detection.	
	Plate current.	Deflection.	Plate current.	Deflection.
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....
....	....	....	....	....

NOTE.—If a tube can not be made to oscillate with any adjustment, write down its number and put an x in each of the columns opposite that number.

Questions.

Study carefully the table which has been filled out and answer the following questions:

(50) *State by number, in the order of your choice, the three tubes which are the best oscillators.*

(51) *State by number, in the order of your choice, the four tubes which are the best detectors.*

(52) *State by number, in the order of your choice, the three tubes which best fulfill both qualifications as a detector and an oscillator.*

(53) *State your reasons for choosing the tubes selected in response to question 52.*

(54) *If all of the stations which are to be communicated with are very close to each other, which tube would you use? State the number of the tube.*

(55) *Which tube would you use in order to cover the extreme range of an SCR–77–A set? State the number of the tube.*

(56) *Suppose that the plate current milliammeter shows no reading, but that otherwise the set is working, could you tell by listening in the headset whether or not a tube was oscillating? If so, how?*

(57) *Out of the 100 VT–1 tubes, how many would you expect to be suitable for use in the SCR–77–A set as oscillators?*

EXPERIMENT No. 2.

CHOOSING A "MASTER" SET AND CALIBRATING ALL SETS.

Information.

With the SCR-77-A set the different wave lengths are referred to as "tuner settings." Due to the fact that these tuner settings are very close together and that the set always works on a tuner setting which is not assigned to any other set within range, it is of extreme importance that the tuner settings of all sets within range check together. Whenever intercommunicating radio sets are working on different wave lengths it becomes very important that the different wave length settings on all of the sets be exactly alike, so that when one of the sets tunes to the wave length of another it is really on the wave length desired.

As mentioned before, the SCR-77-A set covers a wave length range of 2 meters, but due to slight and unavoidable differences which arise in manufacture, some sets will cover a slightly greater and some a smaller wave length range. Therefore it is necessary when selecting a set as the "master set," with which all other sets are to be oscillated, to choose the one which covers the smallest or shortest wave length range. This is necessary, for the reason that, if some of the sets to be checked cover a smaller range than the master set, it would be impossible to check them on all of the calibrations of the scale of the master set. After the master set has once been chosen the same set should be kept as the master set as long as it operates or does not become damaged in any way which affects its calibration.

Directions.

7. *To choose the "master set."*—1. Set up any one set as a temporary master set and place it in operation. Turn the adjustment screw of the screw driver condenser in a clockwise direction as far as it will go and then give the screw exactly four complete turns in a counter-clockwise direction. With the screw in this position the screw driver condenser is adjusted at one-half its total capacity, which is the correct adjustment for the master set.

8. Set up one of the sets to be tested about 200 yards from the master set and place it in operation. Turn the tuner knob of the master set to tuner setting No. 5. Slowly turn the tuner knob of the set being calibrated until the beat note is heard. If the beat note is

heard on a setting below the No. 5 setting, the adjustment screw of the screw driver condenser of the set under test must be turned in a counterclockwise direction. If the beat note occurs above the No. 5 setting, the adjustment screw of the screw driver condenser must be turned in a clockwise direction. The adjustment screw of the screw driver condenser must be turned in the directions stated until a "zero" beat note is obtained with the tuner knob set on exactly the No. 5 setting. The explanation of the term "zero beat note" is as follows:

9. When one set is being tuned to another the beat note is at first heard in the form of a very high pitched whistle as the tuner dial is slowly turned. If the operator continues turning the dial in the same direction, the whistle will become lower and lower in pitch until a point is reached where no sound is heard at all in the receivers. When the beat note disappears at this point, it is at zero value and is known, therefore, as the "zero beat note." If the dial is turned beyond this point, the whistle or beat note will again be heard, first as a very low whistle, and then gradually going higher in pitch until it is inaudible.

10. When the set under test has been adjusted to a zero beat note on tuner setting No. 5, turn the tuner knob of the master set to the No. 1 setting and vary the tuner knob of the set under test until a zero beat note is again obtained. Note whether the zero beat note is obtained above or below the No. 1 setting on the scale of the set under test.

11. Repeat Direction 10 with the tuner of the master set on setting No. 9.

Questions.

(58) *If in Direction 10 and 11 the zero beat note settings were below setting No. 1 and above setting No. 9, has the set under test a smaller wave-length range than the set selected for the temporary master set or greater?*

(59) *If the zero beat note settings were above setting No. 1 and below setting No. 9, has the set under test a smaller or greater wave length than the temporary master set?*

(60) *If both zero beat note settings of the set under test were either above or below Nos. 1 and 9, has the set under test a smaller or greater wave-length range than the temporary master set?*

Directions.

12. If settings are obtained as outlined under either Question 59 or Question 60 above, place the set tested to one side. Proceed to test another set, following the instructions as given in Directions 7, 8, and 9.

13. If settings are obtained as outlined under Question 58 above, take the set tested and substitute it in place of the temporary master set. Adjust the new temporary master set as explained in Direction 7, and continue the testing of sets.

14. If, while testing the remaining sets, another set is found which has a shorter wave-length range than the sets which have already been tested, substitute this set as before in place of the temporary master set. This process should be repeated until a set is found which has the shortest wave-length range of all the sets tested. The set having the shortest wave-length range should be chosen as the permanent master set.

15. *To calibrate all sets.*—Set up the master set and place it in operation. Adjust the screw-driver condenser of the master set as explained in Direction 1 above.

16. About 200 yards away set up and place in operation one of the sets to be calibrated. No sets other than the two already mentioned should be in operation.

17. Adjust the tuner knobs of both the master set and the set to be calibrated to setting No. 5 and vary the screw-driver condenser of the set to be calibrated until a zero beat note is obtained.

18. Adjust the tuner knob of the master set to setting No. 1 and turn the tuner knob of the set under calibration until a zero beat note is obtained. When adjusting the tuner knob of the set under calibration, the zero beat note may not occur exactly on the No. 1 setting. If this happens, mark the exact position of the tuner pointer where the beat note does occur by drawing a single pencil mark on the scale of the tuner extending from the black line in the center of the scale to the inner edge of the scale. Opposite the outer end of this mark place the figure "1."

19. Repeat Direction 18 above, with the tuner of the master set adjusted successively set on tuner settings Nos. 2, 3, 4, 6, 7, 8, and 9. The result should show that the set being calibrated checks with the master set setting on No. 5 and either checks or has a pencil calibration which does check with all other settings on the master set.

NOTE.—SCR-77-A sets are never calibrated on settings Nos. 0 and 10, due to the fact that at these positions of the tuner the amount of change obtained by turning the tuner is very little and quite erratic.

20. Repeat directions 15 to 19 above for all sets which have to be calibrated, taking one set at a time and completing its calibration before going to the next.

Questions.

(61) *Why is it necessary to select a set as the master set?*

(62) *What should be the qualifications of the set to be used as the master set?*

(63) *If the movable plate of the master set tuner condenser should become bent, would a new master set have to be selected?*

(64) *Does the position of the controller affect the tuner settings of a set?*

(65) *In selecting a master set, why are the sets first made to agree on the No. 5 setting?*

(66) *As the screw-driver condenser adjustment is turned clockwise does the capacity of the condenser increase or decrease?*

(67) *In checking calibrations by means of the screw-driver condenser, why is it necessary to turn the screw-driver condenser adjustment in a clockwise direction if the position of the tuner pointer of the set being calibrated is too high?*

(68) *Why can only one set be calibrated at a time?*

(69) *If only a few of the tuner settings were to be used, would it be necessary to calibrate all of them?*

(70) *Why are the sets separated by several hundred yards while calibration is going on?*

THE SCR-77-B SET.

Equipment.

1 set box, type BC-9-A.
1 equipment box, type BE-48.
1 loop type LP-2.
1 battery case, type CS-17.
1 head set, type P-11.
3 tubes, type VT-1.
9 batteries, type BA-2.
1 battery, type BB-41.

Information.

Purpose of Set.—The SCR-77-B set is a modification of the SCR-77-A set. It was designed to furnish radio telegraph communication between units whose headquarters are usually from three to five miles apart. Reliable communication may be maintained up to three miles. Under favorable conditions, such as open terrain, etc., this distance is increased to approximately five miles. The average working wave length of this set is about 65 meters (about 4,600 kilocycles) and the set is so arranged that there are nine different wave-length settings available. It will be noted that the working wave length has been changed, and that the modified sets will therefore not work with the original SCR-77-A set which use the 74 to 76 meter band.

Reasons for Modification.—The original SCR-77-A set has been modified in order to remedy certain faults. As the sets were transmitting at full power at the time they were receiving, only nine sets (corresponding to nine available tuner settings) could be operated at one time within the distance range of the set, without setting up excessive interference. Due to the constants of the circuits the sets were very critical in operation and only a small percentage of tubes would operate satisfactorily as oscillators. Also trouble was experienced with the mechanical adjustment of the key. The modified sets have been developed overcoming these difficulties and are now being issued for service trial.

Special Features of the Set.—Similar to the SCR-77-A set the SCR-77-B set is very portable and is quickly set up. A moving unit furnished with the SCR-77-B set can keep in constant communication within its transmitting range, with every unit furnished with a like set. The break-in system of the SCR-77-B set is more efficient and reliable than the SCR-77-A set, especially at maximum distances. This greatly facilitates communication. There is no change in adjustment needed to reverse the direction of communication. The set is oscillating weakly with the key up and strongly when the key is pressed. This reduces interference while receiving. Consequently it is possible to operate all stations in a net on a common tuner setting. As an entire net requires only one tuner setting it is possible to operate a number of sets simultaneously.

Questions.

(1) *What is the purpose of the SCR–77–B set?*

(2) *For what reasons was the SCR–77–A set modified?*

(3) *State the two most important features of the SCR–77–B set.*

Information.

Principles of operation.—Similar to the SCR–77–A set the SCR–77–B set uses three type VT–1 vacuum tubes. One of these is connected as an oscillator, using capacity coupling between the plate and grid. The other two tubes are used as audio frequency amplifiers. The oscillating circuit is so designed that when receiving it is oscillating weakly, consequently the oscillator tube will act as a detector. It is evident from this that the SCR–77–B set does not emit strong continuous waves at all times but only when the key is pressed.

Connected across the loop is the grid condenser and the plate condenser, which supply the coupling between the plate and grid. A condenser of large capacity is connected in the lead from the plate to the oscillating circuit. This condenser prevents the 120-volt direct current potential from passing through the loop to the grid. A small, single leaf or screw-driver condenser is connected across the loop to permit an adjustment for calibration. A variable condenser is also connected across the plate coupling condenser. This condenser, controlled by the tuner knob on the front of the panel, is used to vary the wave-length adjustment of the set.

The plate voltage of the oscillator tube is supplied by a 120-volt battery which is also connected to the filament. When the transmitting key is up for receiving the plate current passes through a 100,000 ohm resistance. This greatly reduces the voltage on the plate so that very weak oscillations will be obtained. The small plate current thus obtained passes through the transformer primary and the milliammeter. Across the resistance is connected a fixed condenser which acts as a by-pass for the audio frequency current. When the transmitting key is pressed the circuit, including the 100,000 ohm resistance, the primary and the milliammeter becomes short-circuited. The full plate voltage is then impressed on the plate. The short-circuiting of the transformer primary avoids passing the large current through the winding which might cause the winding to become open-circuited in time. It is necessary to short-circuit the milliammeter when transmitting because of the low range of the meter.

A potentiometer or controller on the panel of the set box controls the grid potential of the oscillator tube. A change in this grid potential will produce a change in the plate current of the oscillator tube. This adjustment is needed so that the plate current in the oscillator tube, when receiving, will be as weak as possible. When transmitting the potentiometer has very little effect on the power.

A single-pole knife switch is mounted on the face of the panel. When closed the switch short-circuits the 0.5 ohm resistance in series with the oscillator tube. This has very slight effect on the receiving adjustment but greatly influences the transmitted signal. This is particularly helpful when the storage battery is nearly discharged as the switch may be closed in order to make use of the additional current. However, with the filament resistance short-circuited when using a fully-charged battery, the filament current is high and as a consequence the life of the tube filament will be considerably shortened. The switch should therefore only be closed when it is necessary, as in working with a distant station.

The SCR–77–B set is operated in much the same manner as the SCR–77–A set, the beat note method of reception being used. It is not necessary, however, to close the lever on the side of the key for reception. To establish communication it is only necessary to set the wave-length control to the allocated tuner setting and to begin sending. If for any reason it is desired to interrupt or "Break" the sending operator, simply send a series of dots with the key. The sending operator will hear the dots during the intervals when his key is up. He then immediately stops sending to receive the message from the interrupting station.

SETTING UP THE SCR–77–B SET.

Directions.

1. *Preparing the Equipment Box.—a.* Place the battery case (type CS–17) containing the 120-volt unit in its compartment in the equipment box. Connect the terminals of the binding post marked "—120 volts+," being sure to observe the correct polarity and make firm connections.

b. Place two BA–2 batteries in the smaller compartment on the same side of the equipment box. Connect the terminals of one battery to the left-hand pair of binding posts marked "—20 volts+," and the terminals of the other battery to the right-hand pair of connectors. Close and fasten the cover of this side of the equipment box.

c. Open the other side of the equipment box, remove the telephone headset and also the vacuum tube (if same are not already in the operating chest). Plug in the plate battery cord (the one attached to the lower right side of the operating chest). Having run the cord through the slot provided in the cover of the equipment box, close and fasten it. Place the box on a level spot of ground with its fasteners up.

2. *Preparing the Operating Chest.—a.* Place the operating chest on the top of the equipment box and fasten it in place by means of the catches provided. If the operating chest is not absolutely firm it will rock when the key is operated, causing an unsteady beat note. Open the cover of the operating chest, allowing it to rest on the end of the equipment box. Turn the "Off-On" switch to the "Off" position. Turn the handles of the two fasteners at the top of the box to a horizontal position and pull the panel forward. Place a BA-2 battery in its holder alongside of the vacuum tube. Connect its terminal to the binding posts located alongside the holder. Observe the correct polarity and make tight connections. Secure the battery in place by means of the clamp. Place a VT-1 vacuum tube in each of the three sockets. Close the front panel and lock it in place by turning the handles of the fasteners downward. Pull the top of the telegraph key downward to its operating position. Plug in the telephone headset.

b. Place the storage battery carrying case near the operating chest and connect to one of the storage batteries the terminals of the cord which extend from the left-hand side of the operating chest. Observe the correct polarity as marked. The cover of the operating chest should then be closed.

c. Remove the loop from its case and unfold it. Jam the ends of the loop firmly into the sockets in the end of the operating chest. Tighten up all wing nuts on the loop. The set is now ready for operation.

3. *Adjustment For Reception.*—Turn the filament circuit switch to the "On" position. Slowly turn the potentiometer adjustment in a clockwise direction from the "Off" position until the circuit starts oscillating. When the circuit is oscillating a click is heard in the head set when the loop is touched with the bar finger and an equally loud click is heard when the finger is removed. If the circuit is os-

cillating strongly a slight decrease in reading of the plate current milliammeter is obtained when the loop is touched. If the circuit is oscillating weakly the decrease of plate current obtained when the loop is touched is too small to be perceptible. Even this weak oscillation will be radiated and will cause interference over a considerable distance and it is therefore desirable that the oscillation be made as weak as possible. If necessary, while receiving signals, the potentiometer can be turned back until the signal just begins to weaken. This precaution is necessary only when one station is located near another station in the same net and consequently uses the same tuner setting. The set should now be in proper adjustment for receiving. Turning the tuner adjustment slowly will bring in the signals transmitted from other modified SCR-77-A sets within the distance range of the sets. Slight readjustment of the potentiometer is necessary from time to time as the storage battery is discharged.

4. *Adjustment for Transmission.*—The only operating adjustment of the set is that required for receiving, described in Direction 3. In order to transmit after this adjustment has been obtained it is simply necessary to press the key.

Questions.

(4) *Why is it necessary to have the oscillator tube oscillating very weakly when receiving?*

(5) *Has the adjustment of the controller, any effect on the transmitted signal?*

Information.

Operation of a Single Net.—When only one net is to be operated no special tuner calibration is required. All stations in a net work on the same tuner setting. The Net Control Station operator should adjust his tuner to the number 5 setting and should then send a series of long dashes. All other station operators should adjust their tuners until the signal from the NCS is picked up and a beat note of readable pitch obtained. This adjustment can be marked on the white celluloid dial by means of a lead pencil. Each station then reports in regular order to the NCS and the net is ready for traffic, which is carried on in accordance with specified net regulations. Any station can then work with the NCS without readjustment of the tuner. When working a station other than the NCS it may be desirable to slightly readjust the tuner in order to obtain a beat note of readable pitch. Only one message at a time is handled in the net.

Operation of a number of nets.—When a number of nets are required to operate at the same time each net is assigned an individual tuner setting. All stations in each net are then to be tuned to the same tuner setting. All sets to be used as Net Control Stations should be brought together for calibrations. One set should be placed in operation, oscillating weakly with the key up. The tuner pointer should be adjusted to the number 5 position. The other sets should be operated, one at a time, not less than 20 feet from the master set and with the loop at right angles to the loop of the master set. Each of these sets, as they are operated, should also be adjusted to oscillate weakly with the key up. The tuner of each set should be adjusted carefully until a very low beat note or zero beat adjustment is obtained. The single plate condenser should then be adjusted by means of the screw provided in the back of the set, until beat adjustment is obtained as near as possible to the number 5 mark on the scale. The exact point located should be marked by a pencil on the white celluloid dial. The tuner of the master set can then be placed on points 1 to 4 and 6 to 9 in turn and corresponding points marked in pencil on the tuner dial of the set being calibrated. It will be noted that a total of nine nets can be operated at once, all operating on different tuner settings. Use of a greater number of nets than nine makes necessary the use of more than one net having a certain tuner setting. Care must then be taken that two nets using the same tuner setting are not located sufficiently close to each other to cause mutual interference. It may be found by experience that some other set is more satisfactory for use as a master set than the one first selected. This would be true if most of the sets tune in with the master set when their tuners are either above or below the number 5 mark. All sets in each net can be calibrated by the NCS to operate at the tuner setting assigned the net as described previously. If it is required that any set in a net other than the NCS be able to communicate with a set in a different net, the additional calibration required can be obtained by comparison with the NCS.

Trial Operation.—After all sets that may be required to work have been calibrated it is well to try out intercommunication between the different sets while the sets are all in the same vicinity. Any faulty calibration can then be checked up and corrected without the confusion that would result if the sets were taken into the field before the faulty calibration were discovered.

Permanency and Limits of Calibration.—The calibration of the set, as described above, is quite permanent and reliable. However, any heavy jar or shaking up of the set is liable to disarrange the adjustment. If the set is operated at a station where the surroundings or earth conditions are different from those under which the set was calibrated the wave length adjustment of the set will probably be slightly altered. This is most apt to occur when the loop of the set is near some object. The position of the set should be changed if practicable. In some cases it will be necessary to recalibrate the set in the location at which it is to be used. This should be done under the direction of the officer in charge of the net. In extended operations the calibration of the sets should be checked up at least every day by comparison with the master set. This may be done by the operator transmitting for a definite length of time with his tuner upon each position. The other stations should then, one at a time, make any corrections to the markings on their scale that may be necessary.

Questions.

(6) *How many SCR–77–B sets can be operated, each with a different tuner setting?*

(7) *Is it possible to operate more than one set in the same net on the same tuner setting? Explain.*

(8) *Is it possible to have more nets in operation than there are tuner settings on the tuner dial? Explain.*

THE SCR-109-A AND SCR-159-A SETS.

Equipment.

1 transmitter, type BC-86-A.
1 receiver, type BC-98-A.
1 antenna equipment type A-9-A.
1 dynamotor, type DM-13.
3 batteries, type BB-14.
4 batteries, type BA-2.
1 headset, type P-11.
3 tubes, type VT-1.
1 tube, type VT-2.
2 tubes, type VT-4.
1 microphone transmitter, type T-3.
1 key, type J-12 or J-2.
1 cord, type CD-48.
2 cords, type CD-38.
3 cords, type CD-49.
1 wave meter, type SCR-125-A.
1 wave meter type SCR-61.

GENERAL CONSTRUCTION OF THE SCR-109-A AND SCR-159 SETS.

Information.

The SCR-109-A and SCR-159 are ground radio sending and receiving vacuum tube sets providing three means of communication; undamped or continuous wave radio telegraphy, buzzer modulated radio telegraphy and radio telephony. The two sets are identically the same, differing only in the antenna equipment. Their transmitting wave-length range is from 300 to 500 meters and the receiving wave-length range is frome 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.

NOTE.—As the SCR-109-A set and the SCR-159 set differ only in antenna equipment only one of the sets, the SCR-109-A will be referred to in this Unit Operation.

TRANSMITTER SET BOX, TYPE BC-86-A.

Three 4-volt storage batteries, connected in series, are required to furnish the necessary power to operate the BC-86-A transmitter. In practice two groups of batteries are connected in parallel, there being three batteries in series in each group. This grouping of batteries is necessary if the sets are to be operated any length of time, as a considerable amount of current is consumed by the vacuum tubes and dynamotor in the set. A dynamotor is provided for changing the 12-volt direct current furnished by the storage batteries to a 750–800-volt direct current. The motor takes about 27 amperes at 12 volts, while the output of the generator is approximately 0.2 of an ampere at 750 volts.

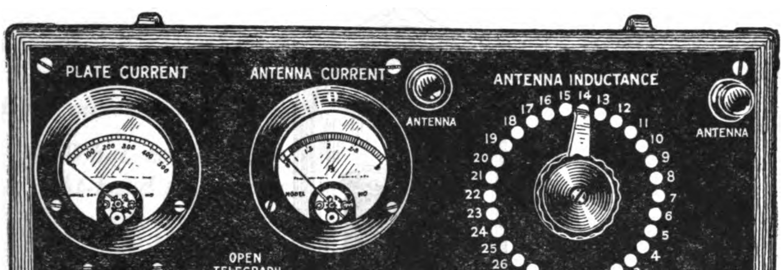


Fig. 101.—Front panel of transmitter set box, type BC–86A.

The BD–86–A set box (see Fig. 101) contains the necessary apparatus for the three methods of transmission. At the upper left-hand corner of the front panel is a milliammeter which indicates the plate current of the vacuum tubes used in the transmitter. To the right of this meter is a thermoammeter, 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 transmitted wave length. Below this dial switch is a large four-pole, double-switch marked "Transmit-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 to the dynamotor, thus causing it to start up; and the bottom blade closes the filament circuit of the transmitting tubes. When thrown to "Receive," the upper

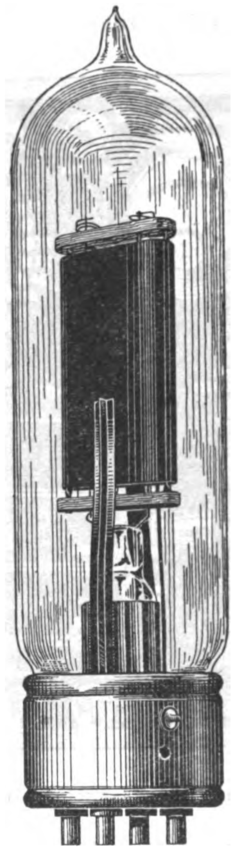


Fig. 102.—Type VT-4 vacuum tube.

blade connects the antenna to the receiving apparatus (in the BD-98-A set 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 controls the three methods of transmission which are properly marked on the switch positions. The buzzer used in buzzer modulated telegraphy is mounted just below the three-pole switch. The necessary binding posts for connections are mounted along the edges of the panel and are plainly marked.

Directions.

1. Examine the panel of the BC–86–A (see Fig. 101), and note the marking of the various switches, knobs, and controls. Also observe carefully the positions and markings of the various binding posts.

Questions.

(1) *What is the range of the meter marked "Plate Current"? Of the meter marked "Antenna Current"?*

(2) *What connections are made to the four binding posts on the right-hand side of the panel?*

(3) *Where is the key connected to the set?*

(4) *For what purpose are the two binding posts marked "+ and Dynamotor?"*

(5) *Where are the filament current connections made for the transmitting tubes?*

Information.

Three vacuum tubes are used in the BC–86–A transmitter—two type VT–4 tubes and one type BT–2 tube. The VT–4 vacuum tube is a high-power tube. (See Fig. 102.)

Its output is rated at 50 watts. One of the VT–4 tubes is used as an oscillator while the other is used as a modulator. The purpose of the VT–2 tube in this circuit is to amplify the voice or buzzer currents which are impressed upon the grid of the oscillator tube. The proper grid potential for the modulator and VT–2 amplifier tubes in the transmitter is obtained from a 40-volt battery (two type BA–2 batteries in series), which is placed in a container inside the set box.

Capacity coupling is used between the grid and plate circuits of the oscillator tube. The antenna circuit acts as part of the capacity coupling, and therefore is a factor in determining the wave length of the transmitter. The plate circuit of the oscillator tube is directly coupled to the antenna circuit through the antenna inductance. The coupling is varied by means of an 8-point switch. This switch is located at the rear of the antenna inductance inside the set box. The coupling between the oscillator, modulator, and amplifier tubes is obtained by the use of audio frequency transformers.

When the large three-position switch on the front of the panel is thrown to "Open," the proper connections are made for transmitting undamped wave signals. (See Fig. 103.) In this case the VT-4 modulator tube and the VT-2 amplifier tube are not connected in the transmitting circuit. The impulses delivered to the antenna circuit by the oscillator tube are controlled by the telegraph key. For instance, when the key is depressed the impulses are being generated by the VT-4 and radiated from the antenna in the form of continuous waves. When the key is released the generating

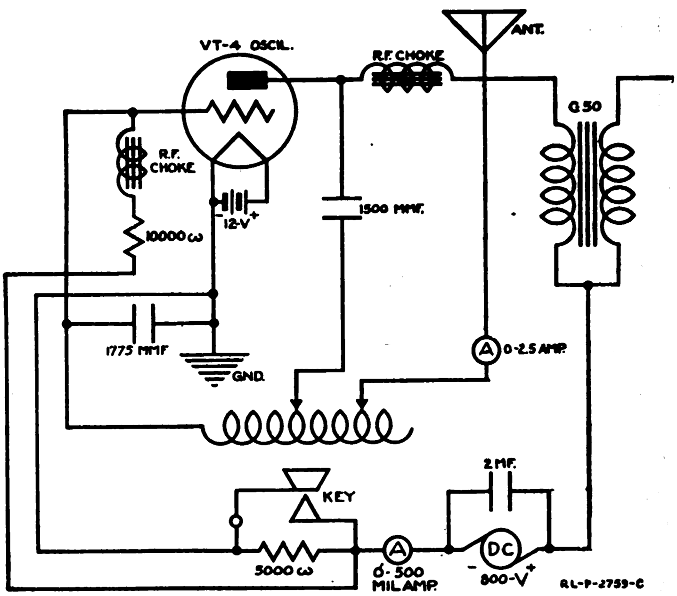


Fig. 103.—Schematic diagram of connections when the BC-86-A transmitter is being used for the transmission of undamped-wave signals.

action ceases. In this way signals are sent by the usual manipulation of the key.

When the three-position switch is thrown to the "Telephone Modulated" position, all three transmitting tubes are connected in the circuit. (See Fig. No. 104.) A microphone is connected to the proper terminals, and when spoken into it conducts the voice currents to the coupling transformer which is connected to the grid circuit of the VT-2 amplifier tube. Here the voice currents are amplified and then impressed upon the grid of the modulator tube through the second coupling transformer. The modulator tube in turn amplifies the voice currents again and impresses them upon the impulses generated by the oscillator tube through the third amplifying transformer.

The result is that the continuous waves radiated from the antenna are modulated to conform to the voice currents of the microphone.

With the three-position switch thrown to the "Buzzer Modulated" position, the proper connections are made for transmitting buzzer modulated radio telegraph signals. (See Fig. 105.) The three tubes of the transmitter are again in use, the same as for radio telephony. The small buzzer is connected across a small resistance and, therefore, obtains enough current to operate steadily. The interrupted currents from the buzzer are amplified in the same manner as the voice currents from the microphone and are impressed upon the impulses generated by the oscillator tube. The oscillator tube, however, is connected the same as it is when transmitting undamped wave telegraph

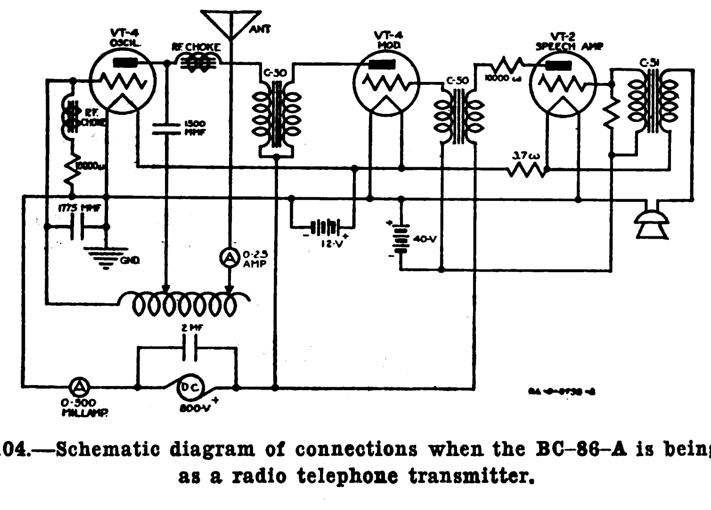


Fig. 104.—Schematic diagram of connections when the BC-86-A is being used as a radio telephone transmitter.

signals. In other words the oscillator tube generates impulses only when the key is depressed. When the key is held down the impulses generated by the oscillator tube are modulated by the buzzer currents. When the transmitter is used as a radio telephone, the oscillator tube is generating impulses continuously, and these impulses are modulated signals are transmitted the reverse of this is true, as the modulated only when the microphone is spoken into. When buzzer modulated signals are transmitted, the reverse of this is true, as the modulator is operating continuously and the oscillator generates only when the key is depressed. The buzzer modulated wave radiated by the antenna may be received by any receiving set which uses a crystal detector or a simple vacuum tube detector circuit. The note heard in the telephone receivers will be exactly the same as the original note of the buzzer in the transmitter.

Directions.

2. Remove the four screws in the corners of panel and the screws in the center of the horizontal edges of the panel. This allows the

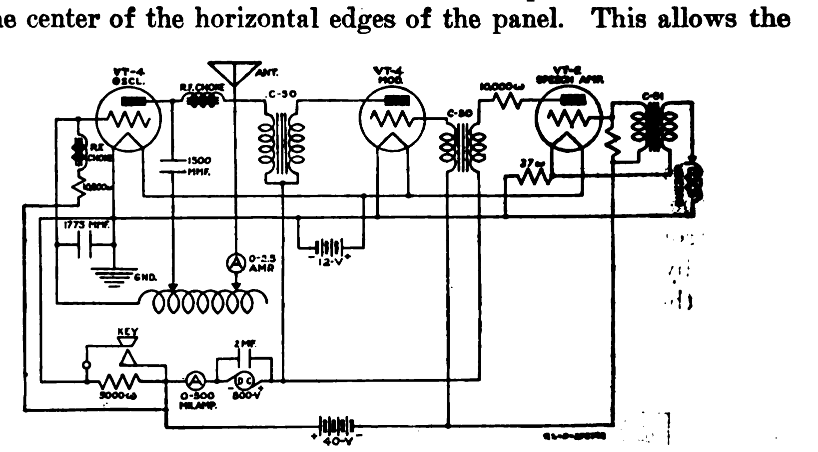


Fig. 105.—Schematic diagram of connections when the BC-86-A is being used as a transmitter of buzzer modulated signals.

panel to be removed from the wooden box frame. Using Fig. 106, locate the various parts of the apparatus on the rear of the panel.

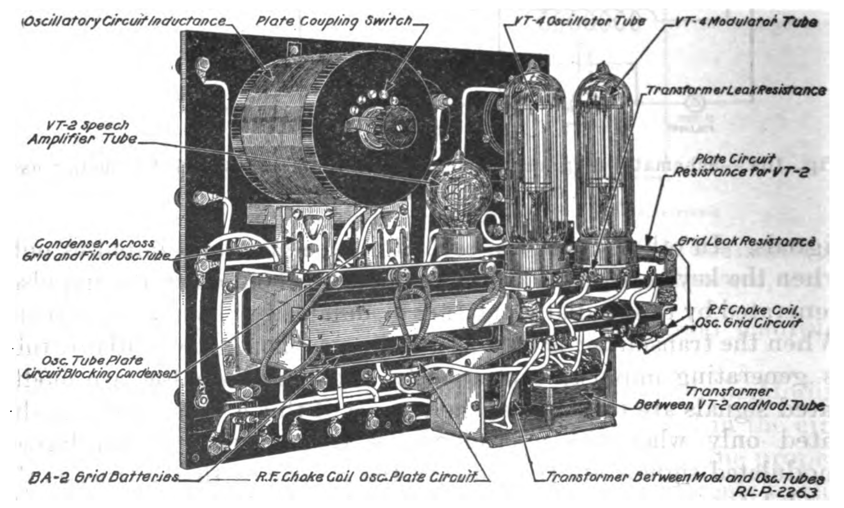


Fig. 106.—Rear view of BC-86-A transmitter panel.

Questions.

(6) *Locate the antenna inductance. How is it varied?*

(7) *Does this variation affect the wave length of the transmitter?*

(8) *How is the coupling between the antenna current and the oscillator circuit varied? What kind of coupling is used?*

(9) *Locate the oscillator, modulator, and VT–2 tube sockets. What difference is there in the sockets?*

(10) *Where is the container for the grid battery located?*

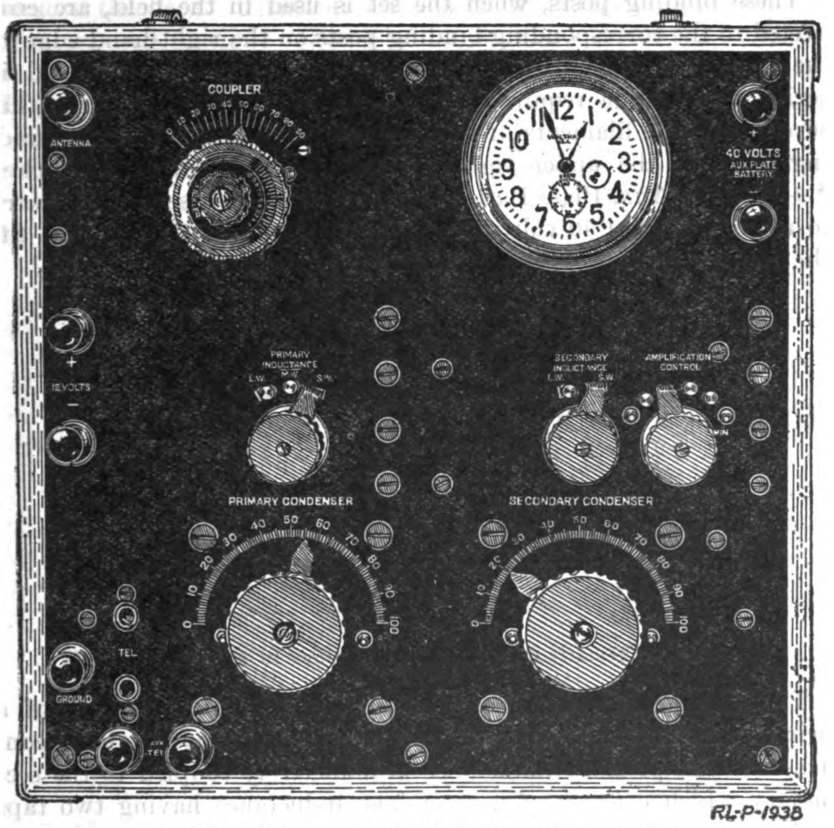


Fig. 107.—Front panel of BC–98–A receiver set box.

(11) *Locate the transformer used for coupling the oscillator and modulator tubes.*

(12) *What is the use of the buzzer in this set?*

(13) *Does the buzzer operate continuously when buzzer modulated telegraph signals are being transmitted?*

Information.

The receiving apparatus of the SCR–109–A is contained in the BC–98–A set box. (See Fig. 107.) It is similar in size to the transmitter set box. The necessary controls for operating the receiver are mounted on the front panel. The receiver is equipped with a vacuum tube detector and two stages of audio frequency amplification. Along the left-hand edge of the panel are four binding posts marked "Antenna," "+ 12 Volts," "— Volts," and "Ground," respectively.

These binding posts, when the set is used in the field, are connected to the corresponding binding posts on the right-hand edge of the transmitter panel. As the three VT–1 tubes are connected in series, the voltage required for the filaments is the same as that supplied to the filaments of the transmitting tubes. The two binding posts on the upper right edge of the receiver panel marked "+40 Volts Aux. Plate Battery" are provided in case it is necessary to use an external 40-volt plate battery instead of the one that fits the compartment provided in the inside of the set box.

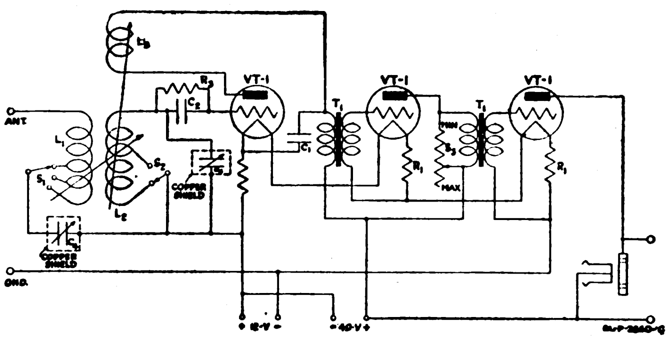


Fig. 108.—Schematic diagram of connections in set box BC–98–A.

The antenna circuit of the receiver (see Fig. 108) consists of a primary inductance having three taps and a primary variable condenser. The primary inductance is inductively coupled to the secondary which consists of a secondary inductance having two taps and a secondary variable condenser. The coupling between the primary and secondary inductances is varied by turning the larger of the two knobs mounted together on the upper left-hand corner of the panel.

The plate circuit of the detector tube (see Fig. 108) contains a tickler coil which is coupled to the secondary inductance coil. This coupling is varied by means of the knob marked "Tickler" which is mounted, together with the secondary coupler knob, on the upper left-hand corner of the panel.

The adjustment of the tickler is especially important in the BC–98–A receiver. The tickler in this set provides a means for adjusting the receiving circuit so that C. W. signals as well as damped wave signals may be received. The proper adjustment of the tickler also makes possible an increase in signal strength and greater selectivity when receiving damped wave signals.

Directions.

3. Release the two latches at the top of the BC–98–A set box and remove the back. This leaves the back of the panel and attached part exposed to view. (See Fig. 109.) Turn the various controls and the parts on the rear of the panel that move. Check wiring diagram as far as possible.

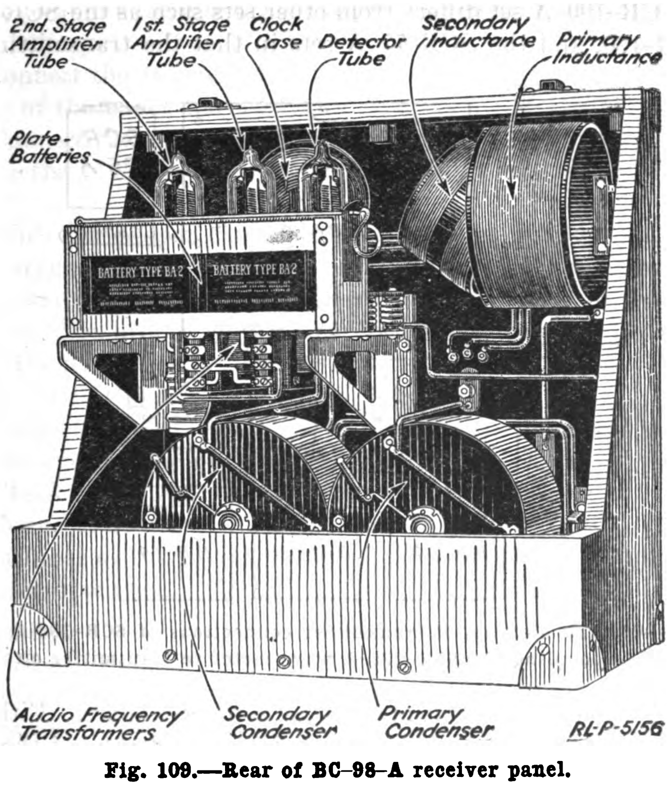


Fig. 109.—Rear of BC–98–A receiver panel.

Questions.

(14) Note how the primary, secondary, and tickler inductance coils are mounted. Which is the secondary? Which the tickler?

(15) What is the purpose of the switch marked "Amplification Control"?

(16) How is the wave length of the primary circuit varied? Of the secondary circuit?

(17) Locate the "B" battery container. How many terminals are provided on it?

(18) How many pairs of phones can be plugged into this set?

(19) What connections are made to the binding posts marked "Aerial" and "Ground"?

EXPERIMENT No. 1.

TO CONNECT UP AND TUNE THE SCR–109–A.

Information.

The SCR–109–A set differs from other sets such as the SCR–79–A, the SCR–130, and the SCR–77–A sets in that the transmitting and

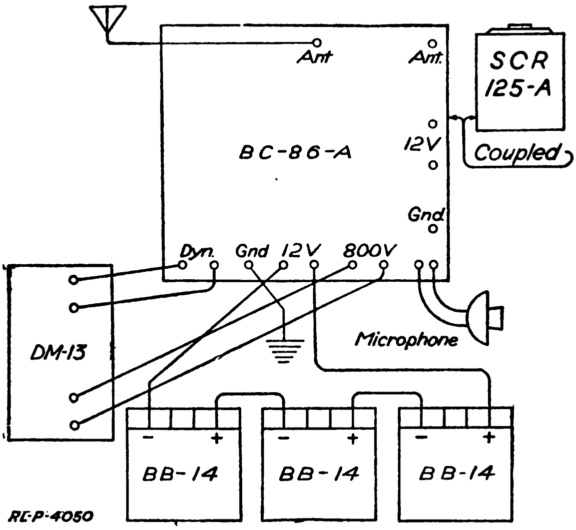


Fig. 110.—Cording diagram of transmitter connections of SCR–109–A set and method of coupling the SCR–125–A wave meter to transmitter circuit.

receiving apparatus are contained in separate boxes. Either set box may be connected up and operated independently of the other. Also the receiver set box may be connected up in conjunction with the transmitter set box so that the receiver may be placed in operation when desired by manipulating the proper switches on the transmitter panel. The transmitter and receiver are tuned separately.

Directions.

4. To connect up the transmitter. (See Fig. No. 110.)

a. Place the BC–86–A set box on the surface on which it is to be operated. Remove the cover of the set box.

b. Insert two VT–4 tubes in the two large sockets on the tube shelf and insert a VT–2 tube in the small socket.

c. Place two BA–2 batteries in the compartment back of the tube shelf and connect the leads from the batteries to the four binding posts provided in the correct order indicated. Make sure that the connections are correct in polarity.

d. Open the "Trans.-Rec." switch.

e. Connect three 4-volt storage batteries in series and using the cord, type CD–48, connect the 12-volt battery thus formed to the two binding posts on the lower edge of the panel marked "— 12 volts +." Do not complete the circuit, but leave the negative lead disconnected at the battery.

f. Connect the antenna lead-in to the binding post in the center of the top of the panel marked "Ant."

g. Connect the wire from the counterpoise or other ground system used to the binding post on the lower edge of the panel marked "Gnd."

h. With the proper cord connect the motor (or low voltage side of the dynamotor) to the two binding posts on the panel marked "— Dynamotor +," with the correct polarity.

i. With the proper cord connect the generator (or high voltage side of the dynamotor) to the two posts on the panel marked "— 800 volts +" with the correct polarity.

j. Connect the key to the proper binding posts on the panel and plug the microphone in the jack provided.

k. Check all connections to see that they are correct.

l. Connect the negative lead of the cord, type CD–48, to the negative terminal of the 12-volt battery. The transmitter should now be ready for operation.

Information.

The transmitter of the SCR–109–A besides having an adjustment for wave length, also has one for coupling. This coupling adjustment is made by the 8-point switch located on the rear of the antenna inductance. Its position has some influence on the transmitting wave length, so that, it is necessary to note its position if it is desired to return to any given wave length.

The wave length on which the BC–86–A set box transmits is dependent on the type of antenna used and it is, therefore, impossible to calibrate it for use with any antenna. It is necessary to make a table of settings corresponding to the wave lengths on which the set will be required to transmit for each antenna system used. The settings for each of these wave lengths should be obtained in the manner explained below.

Directions.

5. To tune the transmitter to a given wave length.

a. Set the antenna inductance switch approximately at the wave length desired. (Suppose that the wave length desired is 400 meters. Four hundred meters is halfway along the wave-length range of the set. Therefore, as a trial setting, place the antenna inductance switch halfway around "Max.")

b. Throw the small double-pole switch on the panel to the "C. W." position and the "Trans.-Rec." switch to the "Trans." position. The dynamotor should now start running and the filament of the oscillator tube should light with a dull red glow.

c. Close the key and vary the coupling switch (on the back of the of the antenna inductance) until the plate milliameter on the panel reads about 125 milliamperes.

d. Light the lamp of the SCR–125–A wave meter and adjust it to a dull red glow.

e. Couple the SCR–125–A wave meter to the antenna inductance and vary the wave meter dial until the lamp glows brightly. If this occurs at a wave length greater than that desired, reduce the antenna inductance. If it occurs at a wave length less than the wave length desired, increase the antenna inductance.

f. After adjusting the antenna inductance, measure the wave length again and continue this process until the inductance tap is found which gives the wave length nearest that desired.

g. If the plate milliammeter does not indicate a reading of about 125 milliamperes, readjust the coupling until this value is obtained. If the coupling switch is adjusted in order to get the correct plate current, the antenna inductance switch may require readjustment in order to maintain the correct wave length.

h. After the above adjustments have been made the transmitter should be sending continuous waves on the desired wave length. If it is desired to send buzzer or telephone modulated waves, the small double-pole switch on the panel is thrown to the proper position for the type of modulation desired and the wave length again checked and adjusted if necessary.

Questions.

(20) *Why is the "Trans.-Rec." switch left open until all connections have been made?*

(21) *Would the set transmit any kind of signal without the key being connected?*

(22) *What is the range of the antenna current ammeter?*

(23) *Why can not the transmitter be permanently calibrated?*

(24) *What is the wave length range of the SCR–125–A wave meter?*

(25) *What is the purpose of the coupling switch?*

(26) *What plate current does the oscillator tube normally draw?*

(27) *Does the plate milliammeter read only the plate current of the oscillator tube?*

(28) *How much difference in wave length does one tap of the antenna inductance make?*

(29) *When the coupling switch is varied, does it vary the transmitting wave length?*

(30) *When transmitting continuous waves, do the filaments of all three tubes light?*

(31) *What value of antenna current did you obtain in tuning the transmitter?*

Information.

The receiver of the SCR–109–A is contained in a separate box known as set box, type BC–98–A. It may be used either separately or with its transmitter. When connected up with the transmitter it forms a complete unit for transmission and reception. The transmitter is provided with the necessary binding post for connecting the receiver. In the following directions it is assumed that the transmitter has already been connected up and that it is desired to complete the set by connecting up the receiver.

Directions.

6. To connect up the receiver. (See Fig. 111.)

a. Place the set box, type BC–98–A on the right side of the transmitter and with their panels in line. Open up the cover to the receiver.

b. Place two BA-2 batteries in the compartment back of the panel and connect the leads of the batteries to the binding posts provided in the correct order and with the proper polarity. Insert three VT-2 tubes in the three sockets and close the cover of the receiver.

c. On the left edge of the panel of the receiver are four binding posts marked "Antenna," "+ 12 volts", "— 12 volts," and "Ground." On the right edge of the transmitter panel are four binding posts corresponding to the first four. After making sure that the "Trans.-Rec." switch is open, connect the corresponding binding posts together, that is, the "Antenna" post on the receiver to the "Antenna" post on the transmitter and so on.

d. Insert the plugs of one or two head sets, type P-11, in the jacks provided on the receiver panel and adjust one of the head sets to fit the head comfortably. (If the head sets available have no plugs, they may be connected to the two binding posts on the receiver panel marked "Aux. Tel.") The receiver is now completely connected and ready for operation.

e. If it is desired to connect up the receiver only, and not the transmitter, the four binding posts on the left edge of the receiver panel are

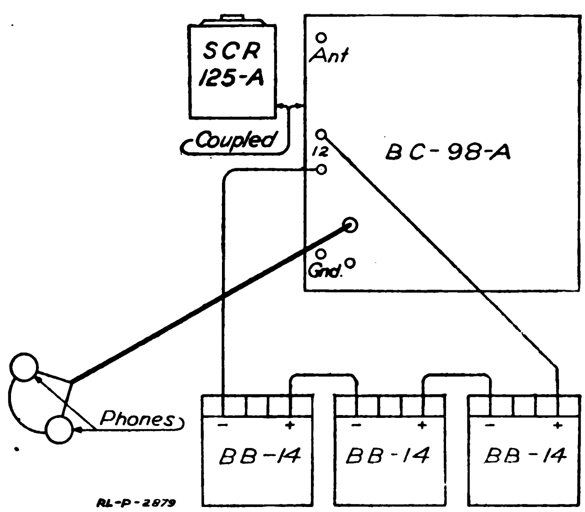


Fig. 111.—Cording diagram of receiver connections of SCR–109–A set and method of coupling the SCR–125–A wave meter to the receiver circuit.

connected directly to the "Antenna", "Ground," and "+ and — 12-volt" leads from the storage battery and *not* to the corresponding posts on the transmitter panel.

Questions.

(32) *Why do the antenna, ground, and filament battery connections for the receiver go through the transmitter when both units are connected up?*

(33) *For what reason are the two binding posts on the receiver panel marked "+ and — 40 volts Aux. plate battery"?*

(34) *When the receiver alone is used, how can you turn off the filament current?*

(35) *What kind of connectors did you use between the corresponding binding posts on the receiver and transmitter panels?*

(36) *What is the advantage of having the transmitter in a separate box?*

(37) *What is the disadvantage of having the receiver in a separate box?*

Directions.

7. To connect up the complete set.

a. Connect up the transmitter as previously given.

b. When the transmitter has been completely connected up, connect up the receiver as given above and the complete set will be ready for operation.

Information.

In tuning the receiver, several different cases will occur. They are as follows:

a. Tuning in a C.W. signal of known wave length.

b. Tuning in a damped wave signal of known wave length.

c. Tuning in a C.W. signal of unknown wave length.

d. Tuning in a damped wave signal of unknown wave length.

Directions.

8. To tune the receiver to a C.W. signal of known wave length.

a. Throw the "Trans.-Rec." switch to the "Rec." position (if the transmitter is connected up).

b. Set the secondary coupling on the 20° mark.

c. Set the secondary "LW-SW" switch and the secondary condenser to the desired wave length as given by the calibration of the set.

d. Beginning at "0" on the scale, increase the tickler coupling until a distinct double click is heard in the head set, and then set the coupling adjustment two scale divisions beyond the point where the click is heard.

e. Vary the primary inductance switch and the primary condenser at the same time until a distinct double click is heard. Without moving the secondary condenser, set the primary condenser about 5° to either side of the point where this click was heard.

f. The receiver should now be in tune on the desired wave length, but due to inaccuracies which may occur, the tuning may not be exact enough to pick up the signal desired. If the signal is not heard, the secondary condenser control should be slowly rotated, covering an arc of 10°, about 5° either side of the setting given by the calibration of the set.

g. A small further adjustment of the primary condenser, the secondary coupling, and the tickler coupling should now be made in order to increase the loudness of the signal.

9. To tune the receiver to a damped wave signal of known wave length:

a. Same as *a* above.

b. Same as *b* above.

c. Same as *c* above.

d. Same as *d* above.

e. Same as *e* above.

f. Decrease the tickler coupling to a point just below where the double click is heard.

g. Same as *f* above.

h. Same as *g* above.

10. To tune the receiver to a C.W. signal of unknown wave length:

a. Same as *a* under Direction 8.

b. Same as *b* under direction 8.

c. Set the primary inductance switch on "SW."

d. Set the secondary inductance switch on "SW."

e. Set the secondary condenser on about 5° and increase the tickler coupling until a click is heard.

f. Vary the primary inductance switch and the primary condenser until the double click indicating resonance is heard.

NOTE.—For every adjustment of the secondary circuit there should be a corresponding adjustment of the primary circuit at which the two are in tune. In searching for a signal of unknown wave length, both condensers should be varied at the same time, attempting always to keep the primary condenser close to that point where its circuit is in tune with the secondary.

g. Starting with the secondary condenser at about 5° and the primary condenser at the point where it is in tune, slowly turn both condensers as outlined in the note above, over their entire scale. It may be necessary to increase the primary inductance as the secondary condenser reaches the higher part of its scale in order that the primary circuit may remain in tune with the secondary.

h. If the desired signal is not heard as under Direction *g* above, set the secondary inductance switch on "LW" and repeat Direction *g*, being sure that at all times the primary circuit is in tune.

i. When the desired signal is found, adjust very carefully the primary and secondary condensers, and the secondary and tickler couplings for a loud clear signal of good readable pitch.

11. To tune the receiver to a damped wave signal of unknown wave length:

a. Follow exactly the procedure outlined under Direction 10 above until the desired signal is found. When found the natural tone of the damped wave will be very badly distorted.

b. Decrease the tickler coupling until the natural tone of the damped wave appears and if necessary readjust the primary and secondary condensers and the secondary coupling.

NOTE.—Damped waves may be received with the tickler coupling adjusted so that the receiver is oscillating, if the change in tone is not objectionable. In receiving telephone signals the tickler coupling must be reduced until the distortion of signals is eliminated.

Questions.

(38) *Why is a different method of tuning followed when looking for a signal of unknown wave length than when looking for one of known wave length?*

(39) *If your receiver were not calibrated how would you tune in a signal of known wave length?*

(40) *Which condenser has the greatest effect on the tuning?*

(41) *When you tune in a telephone signal with the tickler coupling to near maximum, what happens?*

(42) *Is the adjustment of the secondary condenser as critical when tuning in a telephone signal as when tuning in a C. W. signal?*

EXPERIMENT No. 2.

OPERATION OF TRANSMITTER.

Directions.

12. Place the BC-86-A transmitter in operation as given in Experiment No. 1. (See Fig. No. 110.)

a. Pull open the small 3-pole switch. Throw the large switch to the "Transmit" position. The dynamotor should start and the oscillator tube should light up. Turn the "Antenna Inductance" switch to stud No. 1 (Min.). Close the key of the transmitter and adjust the 8-point coupling switch until the "Plate Current" ammeter shows a reading of 125 milliamperes or as near this value as can be obtained. With this adjustment the "Antenna Current" meter should show a reading of over one ampere.

b. Throw the small switch to the "Buzzer Modulated" position and note any changes in the reading of the two meters on the panel when the telegraph key is alternately opened and closed *c*. Throw the small switch to the "Telephone Modulated" position and note any further changes in the reading of the two ammeters. Speak and whistle into the microphone and note variation of the plate current reading, if any.

Questions.

(43) *Is there any difference between the readings of the two meters when using the modulated methods of transmission and when using the continuous wave method?*

(44) *Do the readings of the meters change when the key is opened and closed while using "Buzzer Modulation"?*

(45) *Does any change take place in the reading of the "Plate Current" ammeter when using telephone modulation?*

(46) *Which method of transmission would cover the greatest distance?*

EXPERIMENT No. 3.

DETERMINING THE WAVE LENGTH RANGE OF THE TRANSMITTER.

Information.

The transmitter of the SCR–109–A, like that of the SCR–79–A, is dependent on its antenna system for the wave length on which it transmits. It is accordingly impossible to calibrate permanently the transmitter, and it is therefore necessary to calibrate it each time the antenna is erected and the set put in operation. This calibration will hold only so long as no change is made in the antenna or ground systems. In actual operation in the field it will not be necessary to calibrate the set for all possible wave lengths but only for those upon which it may be necessary to communicate. It is to be noted with this set that it is impossible to set the transmitting wave length exactly on any given wave length within its range unless the given wave length happens to fall on one of the taps of the antenna inductance.

Directions.

13. Throw "Transmit-Receive" switch to "Transmit" and open the small three-pole switch. Adjust the coupling switch so that the plate current meter shows a reading of about 125 milliamperes. Turn the "Antenna Inductance" switch to the No. 1 stud.

14. With the telegraph key closed take a reading of the wave length using the SCR–125–A wave meter.

15. Take wave length readings for the remaining adjustments of the "Antenna Inductance" switch and record in the table below.

Also record the readings of the two meters and the plate coupling tap used for each wave length setting. Remember that the plate coupling may have to be readjusted when changing the wave length adjustment in order to keep the reading of the "plate current" meter around 125 milliamperes.

16. Throw the small three-pole switch to the "Buzzer Modulated" position. Using the SCR–61 wave meter, check a few of the wave length readings taken in the above experiment. Also check the wave length readings with the small switch thrown to the "Telephone Modulated Position."

Wave length.	Primary inductance tap.	Plate coupling tap.	Plate current.	Antenna current.
	1.			
	2.			
	3.			
	4.			
	5.			
	6.			
	7.			
	8.			
	9.			
	10.			
	11.			
	12.			
	13.			
	14.			
	15.			
	16.			
	17.			
	18.			
	19.			
	20.			
	21.			
	22.			
	23.			
	24.			
	25.			
	26.			
	27.			
	28.			

Questions.

(47) *From Experiment No. 3, what is the wave length range of the set?*

(48) *Was there any difference in the wave length readings for the same setting of the antenna inductance when the continuous wave system was used, and when the buzzer and telephone modulated systems were used?*

(49) *If an SCR–125–A wave meter were not on hand, would it be possible to adjust the transmitter to a certain wave length for all three systems by using an SCR–61 wave meter? Explain.*

EXPERIMENT No. 4.

CALIBRATION OF THE RECEIVER.

Information.

Where possible the receiver of any radio set should be permanently calibrated over its entire wave length range. With the receiver of the SCR-109-A this is possible only for the secondary circuit and for fixed adjustments of the secondary and tickler couplings.

Directions.

17. Connect up the receiver ready for operation as given in Experiment No. 1.

a. Set the secondary coupling on 20°.

b. Set the secondary inductance switch on "SW."

c. With an SCR-125-A wave meter measure the wave length of the secondary circuit for each 10° of the secondary condenser. For each setting of the secondary condenser set the tickler coupling 5° beyond the point where a double click is heard.

d. Record the settings obtained in table similar to the one shown below.

Secondary inductance switch on "SW."

Secondary condenser.	Wave length.
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

e. Set the secondary inductance switch on "LW."

f. Repeat *c.* above.

g. Record the settings obtained in a table similar to the one shown below.

Secondary inductance switch on "LW."

Secondary condenser.	Wave length.
0	
10	
20	
30	
40	
50	
60	
70	
80	
90	
100	

Questions.

(50) *From the above experiment what is the wave length range of the receiver of the SCR-109A?*

(51) *At what wave length was the change made from "SW" to "LW" on the secondary inductance?*

(52) *Did the tickler coupling vary with the wave length?*

EXPERIMENT No. 5.

RECEIVING.

Directions.

18. Set up and connect for operation the transmitter of an SCR-109-A, using the standard antenna. Three or four hundred yards away set up and connect for operation the receiver of an SCR-109-A, using either the standard antenna supplied with the set or a 150-foot "V" type antenna.

19. The operator of the transmitter will send buzzer modulated signals on a given wave-length. Tune the receiver to the transmitted signals.

Questions.

(53) *After tuning the primary and secondary circuits, did the signal strength increase with increase of the tickler coupling?*

(54) *With the tickler coupling below the point where a click is obtained, do the received sgnals sound exactly like the buzzer on the transmitter?*

(55) *As the tickler coupling was changed, did the secondary condenser need any readjustment?*

(56) *Was the sound of the signal greatly changed as the tickler coupling was increased beyond the point where the click was obtained?*

Directions.

20. The operator of the transmitter will send continuous wave signals. Tune the receiver to these signals.

Questions.

(57) *Where was the tickler coupling when the continuous wave signals were first heard?*

(58) *Can these signals be heard with the tickler coupling below the point where the click is obtained?*

(59) *When these signals are properly tuned in, what is the effect of slight changes in the tickler coupling?*

(60) *If the tickler control is adjusted anywhere between the point where the click is heard and its maximum position, can the signals still be heard?*

Directions.

21. The operator of the transmitter will change over to telephone modulated signals. Tune the receiver to these signals.

Questions.

(61) *What is the best position of the tickler for the reception of these signals?*

(62) *Can you recognize the voice of the transmitting operator?*

(63) *Can you understand all of his words?*

(64) *With the tickler coupling beyond the point where the click is heard, what do you hear?*

(65) *Tune the set as though you were looking for a continuous wave signal. What do you hear?*

(66) *With the tuning as in Question (65) decrease the tickler coupling below the point where the click is obtained. What do you hear?*

(67) *Based on your answers to Questions (65) and (66), what would be a good method of tuning the set when trying to pick up a weak telephone signal?*

THE INVERTED "L" ANTENNA.

Equipment.

1 inverted "L" antenna, type AN–7, consisting of 75 feet, type W–24 wire, attached insulators (IN–10), and 25 feet lead-in type W–4 wire.
4 mast sections, type MS–14.
2 guys, rope, double, type GY–4.
1 counterpoise, wire, insulated, 75 feet long, type CP–5.
2 ground mats, copper screening, type MT–5.
2 insulators, type IN–7 (for mast tops).
4 stakes, ground, type GP–8.
1 hammer, type HM–1.

GENERAL CONSTRUCTION OF THE ANTENNA.

Information.

This type antenna is used with the SCR–105 radio telegraph set. The erection of the inverted "L" antenna requires the above listed material. The mast sections are carried strapped together, while the rest of the equipment is carried in a canvas bag.

The mast sections are fastened together by using the metal clamps provided. The top of each mast section is so prepared that the mast top insulator may be screwed in place. When the mast is raised, the guy rope should make an angle of about 45° with the direction of the antenna. The antenna is made of stranded insulated wire because of its greater flexibility and less liability to become kinked as compared with single wire. Each of the type IN–10 insulators used between the antenna and masts consists of a 7 by ½ by ¼ inch micarta strip with galvanized steel clevises and harness hooks at each end.

For a ground with this antenna either the insulated counterpoise wire or the ground mats may be used. Where the ground is dry, or the installation only temporary, the counterpoise is used. In case the ground is moist, and consequently a good conductor, or where the installation is semipermanent, the ground mats may be used. When the counterpoise wire is used, care must be taken to ascertain that it is well insulated and that it will not become grounded. The counterpoise or ground mats connect to the "ground" binding post of the set which is in use. Ground mats and counterpoise wires will not both be used at the same time. The antenna and counterpoise as well as the guys are placed on hand reels for transportation.

Questions.

(1) *What kind of wire is used with this antenna? Why?*

(2) *What insulators are used with this antenna? Where are they used?*

(3) *Where is the "lead in" and what is its purpose?*

(4) *How many mast sections are used at each end of the antenna, and how are the sections fastened together?*

(5) *Why are sectional masts used instead of one mast 20 feet long for each end of the antenna?*

(6) *Why is a copper wire screen used for the ground mat?*

(7) *What is the purpose of the insulation on the counterpoise wire?*

(8) *Explain how the counterpoise wire replaces a ground connection.*

Information.

Two men are required to erect efficiently the inverted "L" antenna. The antenna equipment is taken to the field and removed from the carrying bags. The mast sections are assembled and connected into two masts with the clamps and the mast insulators screwed into place. One guy and the lead-in end of the antenna is connected to the mast insulator of one mast. While one man (No. 1) holds this mast erect, the other man (No. 2) should stake down the guys, so that they will make an angle of about 45° with the direction of the antenna. Lean the pole so that its weight pulls against the guys. Then man No. 2 takes the reel on which the antenna is to extend, unreeling the antenna as he goes. No. 1 follows with the other mast, guys, two ground stakes, and the hammer. Connect the guys and antenna to the mast as was done at the first mast. The guys are tightened enough to take up the slack of the antenna after which the first mast is straightened up.

While the operator connects up the set and gets it adjusted, the other man should unroll the counterpoise wire, stretching it on the ground directly underneath the antenna. If the ground mats are used they should be spread out on the ground, or buried lightly, under the antenna.

A convenient method of placing the ground mats is to have them rolled up and then to start a trench about 8 inches deep and the width of the mats. The trench can be dug for about 2 feet and then a start made to unroll the mats in it. As the digging proceeds, the loose earth is thrown back on that portion of the mats which is unrolled. The operation is kept up until the mats are completely unrolled and covered by the loose earth. This saves handling the earth more than once. The ground mats should be connected together with wire, leaving a space about the width of one mat between them. When the antenna has been erected, the work will be inspected by the instructor, after which it will be taken down and prepared for transportation.

EXPERIMENT No. 1.

TO ERECT AN INVERTED "L" ANTENNA.

Directions.

1. Erect the inverted "L" antenna assigned by the instructor in accordance with the procedure outlined above. One man of the team will act as No. 1 and the other as No. 2.
2. After the work has been inspected, remove the antenna and prepare it for transportation.
3. Unpack the equipment and again erect the antenna with man No. 1 now assuming the duties of No. 2, and former No. 2 assuming the duties of No. 1.
4. Remove the antenna and pack the equipment for transportation as before.

THE "V" TYPE ANTENNA.

Equipment.

1 "V" type antenna—type A-N-8, including wire, attached insulators (IN-10), and lead-in.
6 mast sections, type MS-14.
3 guys, rope, double, type GY-4.
1 counterpoise wire, insulated, double, type CP-4.
2 ground mats, copper screening, type MT-3.
3 insulators for mast tops, type IN-7.
6 stakes, ground, type GP-3.
1 hammer, type HM-1.

GENERAL CONSTRUCTION OF THE ANTENNA.

Information.

The "V" antenna is used with SCR-79-A, SCR-99, SCR-109-A, and SCR-67-A sets. Each leg of the V is 150 feet long and requires a double counterpoise wire of the same length. Insulated stranded wire is used rather than single wire in this antenna because of its greater flexibility and its less liability to become tangled. The type IN-10 insulators used between the ends of the antenna and the masts are micarta strip 7 by ½ by ¼ inch, with galvanized steel clevises and harness hooks at each end.

The stranded "V" antenna may be erected rapidly and efficiently by two men. Generally a two-wire counterpoise is used, but sometimes three wires may be used. In this case, one wire is laid on the ground, midway between the antenna wires, while the other two are laid outside the antenna wires, making angles of about 30° with the antenna legs. When the ground mats are used they should be spread out on the ground in the space bounded by the legs of the antenna.

The two-wire "V" antenna is used with the above sets instead of the one-wire inverted "L" antenna, since due to the two wires in parallel, the antenna has greater capacity and less resistance than would one wire having a length equal to the two wires together. Therefore it radiates stronger signals in the direction of the point of the "V" than would be the case if an inverted "L" antenna were used.

Questions.

(1) *Why is stranded wire used in this antenna?*

(2) *What type of insulators are used with the "V" antenna?*

(3) *Could the antenna be used without insulators on the antenna wires?*

(4) *Why is this type antenna used rather than the inverted "L"?*

(5) *Into how many sections is each mast divided? Why not use a single section mast 20 feet long?*

(6) *Why are counterpoise wire and ground mats both provided?*

Information.

The various parts of the equipment should first be examined and their functions understood. After this the equipment is taken into the field and the antenna is erected. A convenient method for the erection of the "V" antenna is to treat is as two inverted "L's." First the mast at the lead-in end is raised, and then each leg in turn, as was done in raising the end of the inverted "L." After the two end masts are erected, the mast at the lead-in end is straightened up, if necessary. While the operator connects up the set, the second man should lay out the counterpoise wires or the ground mats, whichever it has been decided to use.

After the antenna has been erected, the work will be inspected by the instructor. When this inspection has been completed, the equipment should be taken down and prepared for transportation.

EXPERIMENT No. 1.

TO ERECT A "V" ANTENNA.

Directions.

1. Go to the equipment assigned by the instructor and inspect it carefully, checking up the parts. Then take it into the field, unpack the equipment required, and erect the antenna. One man will act as No. 1 of the group and the other as No. 2.
2. After the work has been inspected, remove the antenna and prepare it for transportation.
3. Unpack the equipment and again erect the antenna, reversing the positions of the No. 1 and No. 2 men in the operation.
4. Remove the antenna and pack the equipment for transportation.

THE 40-FOOT UMBRELLA ANTENNA.

Equipment.

1 equipment, type A–1–A consisting of: 1 antenna, type AN–4; six 75-foot lengths and antenna cord, complete with insulators and guy ropes.
1 counterpoise, type CP–3; six 90-foot lengths of counterpoise wire.
1 cord, type CD–89; set box to counterpoise block, type BL–2 on one cord.
13 reels, type RL–3; 6 for antenna, 6 for counterpoise, 1 for antenna lead-in.
6 stakes, type CP–2.
2 hammers, engineer's, 2-pound, 2-face.
2 bags, BG–6.
1 bag, BG–7.
2 connectors, type M–6, spares for antenna wires.
1 mast section, type MS–1.
12 mast sections, type MS–2.
1 mast section, type MS–3.
1 mast cap, type MF–4; complete with 50-foot lead-in wire.

GENERAL CONSTRUCTION OF THE ANTENNA.

Information.

The umbrella antenna is used with the SCR–127, SCR–159, and SCR–130 sets. The antenna equipment consists of a 40-foot sectional mast, antenna wire, counterpoise, guy ropes, and ground stakes. The mast consists of 10 sections of wooden tubing each 4 feet 2 inches long. With the metal coupling tube this length is increased to 5 feet 2 inches over all. Of the 10 sections used for the mast there are 8 central sections, 1 bottom section, and 1 top section. The central sections have a metal coupling tube on one end and a hole in the other end. The top section has a hole in both ends. One end of the top section slips on the coupling tube of the upper central section. A mast cap (coupling block for the antenna wires) is fitted into the other end. The bottom section has a coupling tube similar to those of the central sections, while its lower end is fitted with an electrose insulator.

The antenna is of the umbrella type with six radiating wires, each 75 feet long, suitably insulated at the open ends, and held as nearly horizontal as possible by guy-rope extensions, 90 feet long, the outer ends of which are made fast to ground stakes. The standard counterpoise has six radiating insulated wires. Both antenna and counterpoise wires are carried on hand reels for convenience in packing for quick reeling and unreeling when setting up and taking down the mast.

Directions.

1. Examine the various parts of the antenna equipment and determine the relation of the various parts to one another.

Questions.

(1) *How many radiating wires are there in the antenna?*

(2) *What is this type of antenna called?*

(3) *How many sections are used in the 40-foot mast? How do the top and bottom sections differ from the others? How are the sections connected together?*

(4) *How are the antenna wires supported at the end away from the mast?*

(5) *How are the antenna wires fastened to the mast?*

(6) *How is the mast insulated from the ground?*

(7) *How many counterpoise wires are used? What types of wires are used for the counterpoise?*

(8) *How is the counterpoise system placed?*

(9) *How are the counterpoise and the antenna wires carried?*

(10) *How are the antenna wires insulated from the mast?*

(11) *How is the mast raised, and how are the sections added?*

(12) *How many men are needed to erect the 40-foot umbrella antenna?*

(13) *With which sets is the 40-foot umbrella antenna used?*

Information.

The antenna should be erected in a clear space at least 225 feet in diameter. The antenna wires must not touch an object such as a tree, building, etc., nor should they cross over any power lines or roads. The lead-in wires must be run as directly to the set as possible. In case of severe climatic conditions, such as strong winds, a guy plate may be placed between the fourth and fifth sections of the mast (counting from the top) and additional guy ropes attached.

In rainy weather, it is advisable to loosen the guy ropes. If this is not done, the water will shrink the guy ropes, and this will cause the mast either to buckle or to break.

The minimum number of men that can erect the 40-foot mast for the antenna is five. Six or more should be used whenever possible. Three men are stationed at the end of the antenna and guy ropes, two men raise the mast and add the sections, while one man directs the operations so that the mast will be erect and straight at all times. The procedure is as follows:

a. Before going into the field, the men are numbered from 1 to 6; No. 1 is the section chief, No. 2 the key operator, and No. 3 the log operator. The other three men may be assigned at will.

b. When the suitable location is selected, No. 1 will order the truck stopped near the point at which the mast is to be erected. All of the men will then get off the truck except No. 6 who will hand out the equipment to the others. No. 2 arranges the mast sections in the order in which they are to go up, being sure the bottom insulator is screwed on. Nos. 3, 4, and 5 open the bags and place the antenna wires, counterpoise wires, and stakes in separate piles. No. 2 takes the top section, and placing the mast cap on one end of it, puts the other end on the ground. The mast cap has eight sockets which hold the metal balls on the ends of the antenna wires. The antenna lead-in wire is permanently fastened to it. Men, Nos. 4, 5, and 6 will each attach an antenna wire to the mast cap by means of the ball and socket provided. No. 2 puts his in the second socket from the lead-in; No. 5 in the second from that of No. 4's; No. 6 two sockets from that of No. 5. Nos. 4, 5, and 6 unreel and lay out on the ground these three antenna wires and the guy ropes fastened to them. The antenna wires extend radially from the mast and should divide the circle into three equal parts, that is, they should make angles of 120° with each other. While Nos. 4, 5, and 6 are laying out the first three wires, No. 2 holds the top section and No. 3 attaches the other three antenna wires to the mast cap. There will be one vacant socket. Nos. 4, 5, and 6 lay out the last three antenna wires and remain in position at the end of their guy ropes. The last wires should go half way between the other wires, thus dividing the circle into six equal parts. Each time Nos. 4, 5, and 6 lay out an antenna wire, they will also take a stake with them and leave it at the end of the wire. The guy ropes will be fastened to these stakes after the mast is erected. All hand reels should be left at the ends of the wires.

c. It is the duty of the three men at the end of the guy ropes to keep the mast upright while the sections are being added. They do this by keeping the correct strain on the guy ropes, walking toward or away from the mast as directed by No. 1.

d. The mast is set up by adding the sections. No. 2 raises the mast, and No. 3 adds the sections. Having added all the sections, including the bottom one, the base of the mast is permitted to rest on the ground. No. 2 now takes out both hammers, one of which he lays down for No. 4. No. 2 then drives the stake for No. 4, who ties down his attenna. No. 2 then goes toward No. 5, driving stakes and tying down, while No. 4 takes the second hammer and goes toward No. 6, driving stakes and tying down the antenna wires. Stakes should be driven at an angle slanting away from the mast. After all the stakes have been driven, No. 2 and No. 4 bring the hammers back and leave them near the base of the mast. No. 2 will then connect up the set that is to be used. No. 3 lays out the counterpoise connection block and attaches the counterpoise wires. He will then assist No. 2 in connecting up the net. Nos. 4, 5, and 6, after all the guy ropes are tied down, will lay out the counterpoise wires directly under the antenna wires which they have carried out.

e. In taking down the antenna, it is not necessary to untie the guy ropes from the stakes. Nos. 4, 5, and 6 take their positions at the ends of the guy ropes which they held before. They will steady the mast while No. 2 raises it and No. 3 withdraws the sections. No. 2 holds the top section until all antenna wires are reeled in and the connectors removed from the mast cap. The antenna wires and guy ropes are untied and reeled up by the men who laid them. Each time Nos. 4, 5, and 6 reel up an antenna wire, they will bring a stake with them. After they have completed the antenna wires, they will reel up the counterpoise wires. Nos. 2 and 3 disconnect the set and pack the equipment.

EXPERIMENT No. 1.

SETTING UP THE 40-FOOT MAST.

Directions.

2. Erect the 40-foot mast for the umbrella antenna as described in the procedure given above. The duties of each member of the group will be in accordance with this procedure.

3. Remove the mast and antenna and prepare them for transportation.

4. Repeat this experiment acting each time as a different number in the group, the particular assignment of numbers being designated by the instructor.

5. Dismantle the equipment and prepare it for transportation.

INFORMATION TOPICS

INFORMATION TOPICS.

DEFINITIONS.

NOTE.—The definitions given below are the common meanings of words *as used in this Manual.*

Alternating current.—An electric current which flows first in one direction, reverses, reverses again, and continues flowing in this manner regularly, first in one direction and then in the other.

Ammeter.—A device for measuring the number of amperes which are passing through a circuit and showing the same by a direct reading on a scale. Similarly a milliammeter and microammeter show the number of milliamperes and microamperes passing through the circuit. (See thermo ammeter.)

Ampere.—The practical unit of electric current; it is the current produced by an electric pressure of one volt in a circuit having a resistance of one ohm.

Amplifier.—The means by which signals are amplified. In radio sets, vacuum tubes used in connection with transformers serve this purpose.

Amplify.—To increase the strength of signals received or transmitted.

Antenna.—Usually a wire conductor or a group of wire conductors supported on masts or towers for the purpose of radiating into space or receiving the electromagnetic waves conveying the signals. Also constructed in other forms. (See Loop antenna.)

Aperiodic.—A circuit is said to be aperiodic when it can not be tuned; a receiving circuit which will respond to a number of different wave lengths at the same time.

Audible.—Capable of being heard; perceptible to the ear.

Audio frequency.—A vibration falling within the limits of audibility that is between 40 and 20,000 cycles. The average person can hear all vibrations within these limits.

Bakelite.—An insulating, moisture-proof material made of a hard-pressed, artificial composition, and which is used especially for the front panels of radio sets.

"*B*" *Battery.*—The battery placed in the plate circuit of a vacuum tube receiving set specially made up in 22½-volt units.

Battery.—Two or more primary or secondary cells connected in series or parallel, or both.

Beat note.—The resultant audible note heard in the headset in continuous wave reception. The electrical vibrations of the incoming continuous waves are combined with the electrical vibrations produced locally by the vacuum tube detector, thereby resulting in an electrical beat vibration which is in turn converted by the detector action of the vacuum tube to an audible beat note.

Binding post.—A connection device used to secure the end of a connecting wire; usually mounted on the front panels of radio sets.

Buzzer.—An electromagnetic vibrating device. Used in radio sets for testing purposes. Also used in wave meters as producing rapidly vibrating currents.

By-pass.—An auxiliary path to provide means for the outlet of radio or audio frequency.

Calibrate.—To ascertain by special measurement, or by comparison with a standard, variations in the readings of an instrument used for electrical or radio measurements.

Capacity.—The quantity of electricity which a condenser is able to store or condense is known as its electrostatic capacity, and is measured in farads or microfarads.

Carbon pile resistance.—A variable resistance which depends for its operation on the compactness of small carbon granules or carbon disks. When the carbon granules or disks are pressed tightly together the resistance is much less than when loosely packed.

Cell.—A single element of an electric battery, either primary or secondary, usually the former. It generally consists of a container filled with a liquid or pasty electrolyte in which two electrodes, usually carbon and zinc, are inserted.

Choke coil.—A coil of wire usually provided with an iron core, used to impede the passage of high frequency currents in radio circuits.

Circuit.—The entire course traversed by an electric current. It consists usually of a source of electricity, as a battery or dynamo, the conductors for conveying the current, and the devices in which it is utilized, lamps, bell, motors, etc. When it is complete, so that current will flow, it is said to be *made* or *closed;* when interrupted, so that the current stops, it is *broken* or *open.*

Clevis.—A loop galvanized iron clasping the end of a pole. beam, etc.

Condenser.—An accumulator of electrical energy, and is always made up of two conductors separated by some nonconducting medium such as air, mica, glass, etc.

Conductive coupling.—A means of transferring energy from one circuit to another. Two circuits are said to be conductively coupled when they have a part of each circuit common to both, or are joined together electrically.

Connection.—Two or more conductors touching each other in such manner as to close an electric circuit.

Continuous waves.—Waves which are all of the same electrical dimensions. Waves emitted by a vacuum tube radio telegraph set. Continuous waves are also called undamped waves.

Cording diagram.—A diagram which shows how the external apparatus, such as storage batteries, dynamotor, etc.. are connected to the set box, by the operator.

Counterpoise.—Metallic conductors placed either on or a few feet above or below the ground, directly under and parallel to the antenna wires, and used in place of the earth as a ground.

Coupling.—The term applied to the method in which electrical energy is transferred from one circuit to another. Coupling may be direct, inductive, capacitive, or resistance.

Crystal detector.—A form of detector which uses certain kinds of crystals, as carborundum, galena, which have the property of allowing current to flow in one direction, but oppose the current flow in the opposite direction to a greater or less degree. A means of converting a high frequency current to a low or audio frequency current.

Current.—A flow of electricity usually measured in amperes.

Cycle.—The term applied to a complete vibration in an alternating current when the current starting first in one direction rises to maximum value, falls to zero value, reverses, rises again to maximum value and returns to zero value.

Damped waves.—Waves which are not all of the same electrical dimensions. Waves emitted by a spark transmitter. Also called discontinuous waves.

Detector.—A device used to convert the high frequency currents to low or audio frequency currents.

Dielectric.—Any nonconducting medium.

Direct current.—A current flowing in one direction.

Double-throw switch.—A knife switch which may be thrown over into either of two opposite sets of contacts.

Dynamotor. — A combination of dynamo and motor on the same shaft, one receiving current or voltage and the other delivering current or voltage, usually of different value.

Electrodes.—The term applied to the metal parts immersed in the active material of a primary cell, also the spark terminals of a spark gap.

Electrose.—A trade name for a substance manufactured into high-power transmission insulators. It has a brown, smooth polished surface, is very strong, does not absorb moisture, and possesses good insulating properties.

Fahnstock clip.—A form of binding post involving a spring catch in which a wire is placed and held.

Farad.—The unit of capacity.

Filament current.—The electric current which flows in the filament circuit and which causes the filament to light up.

Filter circuit.—A circuit containing inductance and capacity in series, which serves as a trap for some certain frequency, thus "filtering" it out of the rest of the circuit.

Fixed resistance.—An electrical resistance which is of constant value and can not be varied.

Frequency.—The number of cycles per second made by an alternating current.

Grid circuit.—That part of a vacuum tube circuit which is included between the filament and grid, both internally and externally.

Grid circuit.—That part of a vacuum tube circuit which is included between the filament and grid, both internally and externally.

Grid leak.—A resistance of the order of a megohm, which allows electricity to leak away slowly, usually placed around the grid condenser, but sometimes connected between the filament and the grid lead at the point between the grid condenser and the grid of the tube.

Ground.—A connection with the earth, either intentional or accidental.

Ground telegraphy.—Exactly the same as radio telegraphy except that the ground is used as a medium which carries the waves instead of the ether, or air.

Henry.—A unit of measure of inductance.

High frequency.—Radio frequency.

Induction coil.—A coil having two separate coils wound about a common iron core. The primary consists of a few turns of coarse wire, and the secondary of many turns of fine wire, the two coils being insulated from each other. The primary is connected to a battery through a contact breaker which magnetizes and demagnetizes the core at a rate governed by a spring. The lines of force thus created cut the secondary and set up in it an induced voltage which may be great enough to cause sparks of considerable length to jump between the electrodes of a spark gap.

Inductive coupling.—Two circuits are inductively coupled when the energy of one circuit is transferred to the other by means of a magnetic field.

Input.—The terminals of an electrical instrument which receive current from some other instrument, or the entering point for incoming current from another instrument.

Insulate.—To safeguard an instrument, wire, or other part against the escape of electricity from them or the conduction of electricity to them.

Insulation.—Material used in insulating.

Insulator.—A contrivance usually made of glass or porcelain or bakelite for supporting wires and at the same time preventing escape of current; a nonconductor.

Interference.—Noises heard in a receiving set due to several stations transmitting on the same wave length or to static or other undesirable noise which decreases the clearness of the particular incoming signal which it is desired to receive.

Interrupter.—An apparatus for producing sudden interruptions in the primary of an induction coil or similar type of step-up transformer.

Jack (*telephone*).—A form of metallic spring contact receptacle which is adapted to fit the plug of the telephone receiver and connects the latter in the circuit.

Lead.—A conducting wire which leads from an electric source to any instrument or circuit. The leads from a storage battery to a radio set, etc.

Lead-in.—The wire which connects the antenna to the radio set.

Long waves.—Six hundred meters and up, usually.

Loop antenna.—An antenna with two separate vertical "legs" connected at the top by a more or less horizontal wire; the lower ends of the legs are usually connected through the apparatus in the set box. These antennæ are extremely directive.

Magnetic field.—Magnetic lines of force produced about a conductor carrying current. Any change in this current, as in intensity, direction, or make and break, will cause corresponding changes in the magnetic field.

Megohm.—One million ohms.

Meter.—A measure of length; 39.37 inches.

Micarta.—An insulating composition made of paper impregnated with mica.

Microampere.—One one-millionth of an ampere.

Microfarad.—One one-millionth of a farad; the unit of capacity more commonly used.

Micro-microfarad.—One one-millionth of a microfarad; the unit of measure of very small capacities encountered in radio work.

Microphone.—An electrical device for converting sound waves into corresponding electrical currents or waves.

Milliampere.—One one-thousandth of an ampere.

Modulation.—The process of impressing variations due to the voice, buzzer, etc., upon a continuous or carried wave.

Modulator.—A device which serves to vary in tone, inflection, pitch, or other quality of sound; a modulator tube in a radiotelephone transmitting set.

Net.—A group of two or more radio stations, which may or may not operate on the same wave length, and which habitually intercommunicate with each other.

Ohm.—The practical unit of electrical resistance.

Oscillation.—When the frequency of an alternating current rises to the value included in radio-frequency the current is termed an *electric oscillation.*

Oscillator.—A device for creating electrical impulses or oscillations, such as a vacuum tube.

Panel.—The front side usually of a radio set, made of bakelite or some similar insulating material, and on which are mounted the knobs, switches, etc., used in the operation of the set.

Parallel.—An electric circuit is said to be connected in *parallel* when all the positive poles, terminals, etc., in the circuit are connected to one conductor, and all the negative terminals to the other.

Pitch.—The highness or lowness of a musical note; the vibration frequency of a note.

Plate battery.—See " B " battery.

Plate circuit.—The complete electric circuit from the filament to the plate, both externally and internally.

Plate potential.—See " plate voltage."

Plate voltage.—The voltage measured across filament and plate.

Plug.—A terminal, consisting of a metal tip and sleeve, insulated from each other, and connected to a flexible cord, for inserting in a spring jack, thus placing the instrument to which the plug is attached in the circuit.

Polarity.—The quality of having opposite poles. In a cell or battery the terminals from which the current flows is of positive polarity, and the other terminal is of the negative polarity.

Positive pole (of a battery).—That terminal of a battery from which the electric current flows; usually marked with a " + " sign.

Potentiometer.—A variable resistance shunted around a battery by means of which any desired voltage can be obtained within the limits of the voltage of the battery.

Primary battery.—A group of primary cells connected in series, or parallel, or both, each of which is a device for transforming chemical energy into electric current.

Primary inductance.—The inductance placed in the antenna circuit of a receiving set, or in the closed circuit of a transmitting set which is coupled electromagnetically to the inductance in the antenna circuit.

Pulsating current.—An electric current whose intensity changes at fixed intervals, but whose direction is constant.

Quenched spark.—The result of any type of spark gap which employs some method for extinguishing the spark quickly. It can be done by providing a large cooling surface on the electrodes, or by inclosing the spark in a vacuum, etc.

Radiation (current).—The current in the antenna of a transmitting set when transmitting.

Radio frequency.—A frequency of 20,000 cycles and up.

Radio telegraphy.—A system of telegraphy in which signals are transmitted by means of electromagnetic waves set up by an instrument for generating impulses at the sending station, passing through free space, and received by a delicate detecting instrument at the receiving station.

Relay switch.—A switch which depends for its operation on an armature being attracted to a pole piece of an electromagnet when the latter is energized by current flowing through it.

Resistance.—That property of a substance which opposes the flow of an electric current, usually measured in or spoken of as ohms.

Rheostat.—A variable resistance.

Secondary inductance.—The inductance coil in the secondary circuit of a receiving set which is electromagnetically coupled to the primary inductance coil, or the inductance in the antenna circuit of a transmitting set.

Selectivity.—Property of a receiving circuit which can be tuned sharply.

Series.—An electric circuit is said to be connected in series when all the sources or utilizers of electricity in the circuit are arranged in succession. Cells are said to be in series when the positive terminal of one cell is connected to the negative terminal of the next.

Set box.—The box or container which contains the radio set, usually all the parts which are permanently connected and are not to be changed.

Sharp (in tuning).—A receiving set is said to tune sharply when a slight variation of inductance or capacity will entirely tune out a signal or is capable of tuning out all undersirable signals except the one which is being received.

Short waves.—Up to 600 meters, usually.

Signals.—The sound vibrations heard in the telephone receivers, radio telegraph, or telephone.

Signal strength.—The degree of audibility or loudness of signals heard in the receivers of a radio receiving set. Also in reference to the intensity of a signal before it is converted into sound waves.

Socket.—The cuplike base in which a vacuum tube is placed, and which makes contact connections with the four terminals in the base of the tube.

Spark gap.—The space between two electrodes through which a spark discharge takes place.

Spark signals.—Signals sent out by a spark transmitter.

Spark transmitter.—A radio sending set which employs the use of an electric spark discharging through inductance and capacity in series to produce electric impulses or oscillations.

Stage (of amplification).—An amplifier contains from one to six tubes, each of which, with its transformer, amplifies the signal a certain amount, and is called a *stage* of amplification.

Storage battery.—A type of battery in which electricity may be stored up in the form of chemical energy, as a secondary battery distinguished from a primary battery. A direct current must be passed through the battery for a certain length of time before the reaction of the chemicals will cause a flow of current from the battery.

Switch.—Any device by means of which an electric circuit may be opened or closed.

Tap.—A connection made to any turn of an inauctance coil. By making a number of these connections any portion of a coil may be included in a circuit as desired.

Thermoammeter.—An ammeter which depends for its operation on the heating of a wire by the current passing through it.

Traffic.—Business handled in a radio net, consisting of official messages, or radio service messages necessary to the maintenance of the system.

Transformer.—An apparatus similar to the induction coil commonly used in radio sets to raise the voltage from one circuit to another, also as a means of coupling between amplifier circuits.

Tuning.—The adjusting of the receiving apparatus of one station to the sending apparatus of another, so that the detector at the receiving station shall respond only to the waves sent from that particular transmitter, without interference of waves of other frequencies; or to adjust two circuits to the same wave length.

Untuned.—See "aperiodic."

Vacuum.—A container from which the air has been exhausted to a very high degree by means or an air pump of some other efficient device.

Variable resistance.—An electrical resistance whose value can be varied by any device which will serve to use any part as desired.

Variometer.—A variable inductance coil.

Volt.—The unit of electrical pressure.

Voltage.—The electrical pressure of circuit measured in volts.

Voltammeter.—An instrument which will measure either volts or amperes, depending on the manner in which the binding posts thereon are used.

Voltmeter.—An instrument of high resistance for measuring differences in potential in volts.

Wave length.—The distance in meters covered by one cycle, measured in a straight line.

Wave meter.—A device for measuring the wave length of transmitted waves.

Winding.—Any part of an electrical circuit which is in the form of a coil.

Wiring diagram.—A diagram which shows in detail the manner in which the parts of any circuit are connected up.

THE SCR-79-A AND THE SCR-99 SETS.

1. *Antenna Equipment, Type A-9-A.*—The same antenna equipment is used with the SCR-79-A and SCR-99 sets. The essential component parts are the antenna, masts, counterpoise, ground mats, guys, and stakes. The antenna itself is a V with a 60-degree opening, 20 feet high, 100 feet long on each side, and with a 25-foot lead-in wire. Under some conditions, such as a limited space or for short-distance work, an inverted L may be used. This should be 20 feet high, 100 feet long, and with a 25-foot lead-in wire. The V antenna is supported on three masts, 20 feet high, each with two guys. The antenna wire is a bare stranded wire, and the lead-in is a lightly insulated wire or lamp cord. One end of both legs of the antenna wire forms the point of the V and to this is joined the lead-in wire. The two outer ends of the antenna and the point of the V are provided with strain insulators, which have a snap or harness hook for fastening them to the tops of the masts. The antenna, lead-in, etc., are wound on two hand reels for convenience in storing away in transportation. The masts are of spruce and in three sections, each about 6¾ feet long, all sections being interchangeable. Each section is fitted at one end with a spike and at the other end with a steel tube that is tapered slightly to take the spike of the next section, and is pierced with three holes to take the snap hooks of the antenna insulators and guy ropes. The mast sections are carried in a carrying roll, which has both a handle and a shoulder strap of nonelastic webbing. The guys are of No. 5 sash cord, 40 feet long, provided at one end with a snap or harness hook, for fastening in the holes in the steel tube of the topmast section and at the other end with a tent slide for adjusting the tension on the guy after it has been passed around the ground stake. In storing away they are wound on the same type of hand reels as the antenna. The ground stakes are of galvanized pipe, 18 inches long, and are provided with a binding post that makes it possible to use them as a ground rod if desired.

The counterpoise consists of two lengths of 150 feet of heavily insulated wire which is laid out on the ground in a V shape with a 60-degree opening under the antenna. In storing away they are wound on two hand reels. As an alternative for the counterpoise, three ground mats, which are of a fine copper gauze, each 13 feet long and 3 feet wide are furnished. These have wood strips at both ends to keep the mats flat and are provided with binding posts at both ends for convenience in making quick connections. The mats are generally rolled up for transportation and carried in the roll with the mast sections. The antenna and counterpoise wires, guys, stakes, hammer, etc., are carried in a carrying bag. The essential electrical constants of the V antenna are approximately: Inductance, 0.04 millihenry; capacity, 0.0004 microfarad; fundamental wave length, 240 meters; and average resistance, 50 ohms.

2. *The Dynamotor, Type DM-1.*—The dynamotor, type DM-1, is a combined motor and generator that, together with certain accessories, is contained in a cast aluminum alloy case. With the motor running light—that is, with no generator load—it takes a current of about 4 amperes at 10 or 12 volts from the storage battery. At full load the motor takes about 10 amperes at 10 or 12 volts, and the generator delivers about one-sixth ampere (167 milliamperes) at 300 to 350 volts to the plate circuit of the vacuum tubes of the transmitter. The motor input is therefore about 120 watts, the generator output about 50 watts, and the over-all efficiency is between 40 and 50 per cent. The machine is a converter from a low to a high direct-current voltage. It has separate motor and generator armature windings and commutators mounted on the same shaft, revolving in a single common magnetic field. The speed of the machine is 2,550 R. P. M. (revolutions per minute). The motor end is marked but can still further be identified by the heavier wires at the brushes. Generator ends are marked on the end shield. The necessary wiring from the motor and generator is brought up onto a bakelite panel that carries a fuse block, with 15-ampere fuse wire, a switch in the motor leads extension cords, oiling holes, etc. Spare fuse wire is wound on a small spool in the cover of the box. On the panel the motor terminals are marked "10 Volts," "Plus," and "Minus." An extension cord is provided to connect them to the binding posts on the operating chest (set box) marked, respectively, "Plus 10 V" and "Minus 10 V." The generator terminals are marked "300 Volts," "Plus," and "Minus." An extension cord is provided to connect them to the binding posts on the operating chest (set box) marked, respectively, "Plus 300 V" and "Minus 300 V." In both cords the red wire is positive and the black is negative. Both cords are permanently fastened to the dynamotor terminals and are to be stored away on top of the panel. The polarity of the dynamotor terminals is marked on the panel, but in both cases they can be identified by noting that with the cover of the case opened away from the operator the right-hand post of each pair is positive. The dynamotor is secured in place in the lower part of its carrying case by two heavy machine screws through the bottom. The approximate over-all dimensions are 7 by

11 inches by 9 inches high, its weight is about 24 pounds, and it is provided with a carrying strap.

PARTS LIST OF SETS FOR FIELD OPERATION.

Equipments in 79–A Set.—The SCR–79–A comprises the following equipment:

One equipment, Type PE–7.
One equipment, Type RE–5–A.
One equipment, Type A–9–A.

Equipments in 99 set.—The SCR–99 comprises the following equipment:

One equipment, Type PE–7.
One equipment, Type RE–7.
One equipment, Type A–9–A.

Parts Comprising Above Equipments.—These equipments are made up of parts as noted below:

Equipment, Type PE–7.
Battery, Type BB–14 (9).
Box, type BC–25 or BC–25–A (1).
Dynamotor, Type DM–1 (1).

Equipment, Type A–9–A.
Antenna, Type AN–8 (2).
Bag, Type BG–12 (2).
Cord, sash, No. 5, olive drab (300 feet).
Guy, Type GY–4 (8).
Hammer, 2-face, 2-pound (1).
Insulator, Type IN–10 (4).
Mast section, Type MS–14 (12) 9 in use; 3 spare.
Mat, Type MT–5 (3).
Pliers, combination, 6-inch (1 pair).
Reel, Type RL–3 (8).
Roll, Type M–15 (1).
Stake, Type GP–8 (12).
Tape, friction (1 roll).
Wire, Type W–4 (50 feet).
Wire, Type W–6 (300 feet).
Wire, Type W–24 (750 feet).

Equipment, Type RE–5–A.
Battery, Type BA–2 (4), 2 in use; 2 spare.
Battery, Type BA–4 (4), 1 in use; 3 spare.
Chest, Type BC–43 (1).
Clock, Type I–15 (1).

Cord, Type CD–15 (3).
Cord, Type CD–38 (5).
Cord, Type CD–47 (2).
Cord, Type CD–48 (2).
Cord, Type CD–49 (2).
Head set, Type P–11 (2).
Key, Type J–12 (1).
Lamp, Type LM–4 (4) (for wavemeter), 1 in use; 3 spare.
Pliers, combination, 6-inch (1 Pair).
Screw driver, 2½-inch blade (1).
Set box (operating chest), Type BC–32–A (1).
Set box (wavemeter), Type BD–40 (1).
Tape, friction (½ pound).
Tube, Type VT–1 (6), 3 in use; 3 spare.
Tube, Type VT–2 (4), 2 in use; 2 spare.
Voltmeter, Type I–10 (1).
Wire, Type W–7 (2 pounds).
Radio Communication Pamphlet No. 17 (1).

Equipment, Type RE–7.

Battery, Type BA–2 (4), 2 in use; 2 spare.
Battery, Type BA–4 (4), 1 in use; 3 spare.
Chest, Type BC–43 (1)
Clock, Type I–15 (1).
Cord, Type CD–15 (3).
Cord, Type CD–38 (5).
Cord, Type CD–47 (2).
Cord, Type CD–48 (2).
Cord, Type CD–49 (2).
Head set, Type P–11 (2).
Key, Type J–12 (1).
Lamp, Type LM–4 (4) (for wavemeter), 1 in use; 3 spare.
Pliers, combination, 6-inch (1 pair).
Screw driver, 2½-inch blade (1).
Set box (operating chest), Type BC–45 (1).
Set box (wavemeter), Type BC–49 (1).
Tape, friction (½ pound).
Tube, Type VT–1 (6), 2 in use; 3 spare.
Tube, Type VT–2 (4), 2 in use; 2 spare.
Voltmeter, Type I–10 (1).
Wire. Type W–7 (2 pounds).

THE SCR–67–A RADIOTELEPHONE SET.

POSSIBLE SOURCE OF TROUBLE.

1. Frequently the set does not operate satisfactorily on account of incomplete adjustment of the transmitting circuit. In making adjustments, each setting affects all the others, and it is therefore necessary to go over all adjustments in the same order until proper conditions are obtained. Once the set is adjusted, it will therefore save time to record the settings and corresponding wave length. These settings will, of course, change if the antenna is changed.

2. With a set properly adjusted, the results are still dependent on the voice of the operator. The speech should be clear, rather slow, and in an even, moderate tone, and with the lips close to the telephone transmitter.

3. In general, it may be said that the set is operating properly when, with the switch on " Power on " and the control push button closed and the amplification switch on " Minimum," the operator hears himself distinctly in the telephone receiver while talking in the transmitter in a low tone of voice. The test is a check on the working condition of the circuits, but may not be considered as a conclusive proof that the circuits are perfectly adjusted.

4. *Noise in Receiver.*

a. Worn-out dry batteries. Voltage should not be less than 17.5 volts per battery.

b. Noisy leak resistance.

c. Loose connections in plate, filament, or grid circuits. Inspect soldered connections, especially of long wires which may vibrate loose. Inspect connection clips of grid leak and telephone jack.

d. Poor contact between vacuum tube and spring contacts in socket.

e. Broken-down grid leak condenser. Remove condenser and test for click, using telephones.

f. Noisy detector vacuum tube.

g. Sparking at dynamotor commutator, due to poor brushes or dirty commutator.

5. *Failure to Receive.*

a. Tap on the detector tube. If a loud ringing noise is heard, the trouble is probably in the antenna primary and secondary circuits. If no noise is heard, the trouble is probably between the detector and telephones.

b. Failure of filaments to light; due to broken filament in one of the receiver tubes (VT–1) or open in filament circuit. May also be due to broken-down antenna stopping condenser.

c. Blocking of detector tube; due to too high resistance grid leak or open in grid circuit. Examine grid leak connecting clips.

d. Receiving condenser short-circuited, due to buckled plates; or antenna stopping condenser broken down.

6. *Failure of Amplifier.*

a. Amplifier resistances may be burned out, or short-circuited, or the connections may be broken.

b. Condenser terminals grounded to metal frame.

c. Loose connections. Condenser terminal connections broken off.

7. *Failure to Oscillate.*

a. Failure to have any plate current with modulator switch open may be due to a failure to impress the plate voltage on the tube. Test direct current plate circuit for an open by shunting the plate and filament terminals of the tube socket with a buzzer or receiver. Test dynamotor voltage on power board. The milliammeter circuit may be open. Inspect plate current jack and plug. The contacts on the control relay may not operate properly. Too small a plate current may be due to too small a filament current.

b. Failure to have any grid current may be due to a burned-out grid resistance. Test the latter by clicking through with the telephones. It may also be due to an imperfect grid current jack or burned-out ammeter.

c. Oscillator tube filament may not light due to an open in the filament circuit.

d. No reading on antenna ammeter, may be due to an open in the antenna circuit. Ammeter may be burned out or antenna inductance coil may be open. Test by buzzer. Antenna condenser may be shorted. Antenna switches may be faulty.

e. Test grid coupling condenser by buzzer.

f. Circuit may not be adjusted properly.

g. Antenna insulator may leak or antenna may be grounded.

8. *Overheating of Oscillator Tube.*

a. Too much plate voltage.

b. Improper adjustment of circuit.

c. Lack of grid current or excessive grid current due to improper adjustment of circuit.

d. Faulty tube.

9. *Failure to Modulate.*

a. Receiving tube filaments may not light.

b. Control relay contacts may not work.

c. Open in modulator plate circuit. Modulator knife switch should be closed. If the latter is open, plate current ammeter should read 40 to 50 milliamps. When closed, space current should be 60 to 70 milliamps.

d. Iron core choke coil may be short-circuited.

e. Faulty or burned-out input transformer.

f. Short circuit on input transformer secondary.

g. Open circuit between transformer and grid of modulator tube.

h. Faulty telephone transmitter.

i. Faulty tube.

j. Blocking of modulator may be due to too high or too low a plate current or to improper resistance in plate circuit. A tendency of the tube to block will be evidenced by a high and unsteady reading on the plate current ammeter when blowing or whistling on the telephone transmitter. Blocking of the modulator is also evidenced by the fact that when the operator talks into the transmitter while sending he hears his speech interruptedly. A remedy, if the tube is not faulty, is to interchange the oscillator and modulator tubes.

PARTS LISTS OF SET FOR FIELD OPERATION.

SET, RADIOTELEPHONE, TYPE SCR-67-A.

1 Equipment, Type PE-2-A; power.
- 6 Batteries, Type BB-5 or Type BB-14.
- 1 Powerboard, Type BD-1-A.
- 1 Cord, Type CD-48.
- 2 Cords, Type CD-38; 1 in use, 1 spare.

1 Equipment, Type RE-2-A; radio.
- 1 Set Box, Type BC-13-A.
- 1 Cord, Type CD-23; powerboard to set box.
- 1 Cord, Type CD-25; set box to operator's cut-in switch.
- 1 Cord, Type CD-24; set box to operator's jack.
- 2 Head sets, Type P-11; 1 in use, 1 spare.
- 1 Radio Communication Pamphlet No. 22.
- 2 Transmitters, Type T-3; 1 in use, 1 spare.
- 16 Tubes, Type VT-1; 3 in use, 13 spare.
- 16 Tubes, Type VT-2; 2 in use, 14 spare.
- 8 Batteries, Type BA-2; 2 in use, 6 spare.

1 Equipment, Type A-9; antenna.
- 6 Insulators, Type IN-5.
- 6 Insulators, Type IN-7.
- 6 Couplers, Type FT-2.
- 3 Mats, Type MT-3.
- 750 feet Wire, Type W-1.
- 2 Reels, Type RL-3.
- 300 feet Wire, Type W-6.

6 Mast Sections, Type MS–5.
2 Bags, Type BG–14.
12 Stakes, Type GP–3.
1 Bag, Type BG–8.
50 feet Wire, Type W–4.
1 Hammer, Type HM–1.
½ pound Marlin, Type RP–2.
300 feet, Cord Type RP–3.

THE RADIO SETS SCR-77-A AND SCR-77-B.

THE SCR-77-A SET.

1. *Carrying Units of set—Weight and bulk.*—The whole set is assembled in five carrying units, each provided with a carrying strap. The loop antenna folds up and is carried in a bag, which is $28\frac{1}{2}$ inches long, $4\frac{1}{2}$ inches in diameter, and weighs 6 pounds with the loop in it. The transmitting and receiving apparatus is in an operating chest measuring $14\frac{5}{8}$ inches by $9\frac{15}{32}$ inches by $12\frac{9}{32}$ inches high and weighs $20\frac{1}{2}$ pounds complete. The four-volt storage batteries are carried in a case measuring $5\frac{5}{32}$ by $10\frac{9}{16}$ inches by $8\frac{13}{16}$ inches high and weighing 27 pounds with the batteries in it. The equipment box has two distinct compartments, one of which carries the dry batteries and the other the spare vacuum tubes and the telephone head set. Its dimensions are 13 by $4\frac{5}{8}$ inches by $15\frac{5}{16}$ inches high, and when filled it weighs $17\frac{1}{2}$ pounds. The spare transmitting dry batteries, which like those in use are contained in a wooden case, are carried in a carrying bag which measures 10 by $3\frac{1}{2}$ inches by 8 inches, and weighs $7\frac{1}{2}$ pounds with the case in it. The case containing the transmitting dry batteries in use is contained in the equipment box. There is room for two extra BA-2 dry batteries in the carrying bag in addition to the case. It is a wise precaution to carry these two extra batteries, though they are not provided in the parts list. They weigh only 15 ounces each.

2. *Troubles and remedies.*—*a.* If the set is inoperative after being installed, go over carefully all connections made in installing the set. Especially examine the loop joints to see that they are clear and bright and make electrical contact. If the set is still inoperative, pull forward the operating chest panel and see if all their filaments are lighted. If not, trace out the circuit for poor or broken connections. The tube socket contact springs sometimes make poor contact with the contact pins of the tube, due to dirty contacts or weak-spring tension. Of course, a run-down storage battery may be the cause of the failure of the tubes to light up.

b. If the instrument still fails to operate properly, as indicated by failure of meter to read as much as 5 milliamperes and by failure to obtain a marked drop in plate current when the left-hand side of the loop is touched with the bare hand, note whether the telephone click produced in this manner is louder while operating the key when the meter is shunted. If so, the meter is burned out. If the clicking is the same and quite weak, the trouble probably lies in faulty or run-down BA-2 batteries or faulty connections between the batteries or otherwhere in this circuit.

c. If the milliameter is burned out or otherwise becomes open-circuited, it can be shunted until replaced or repaired. To shunt the meter, connect its two terminal posts together by a piece of wire. To test whether or not the set is oscillating when there is no meter, touch the left-hand side of the loop with the bare hand. A distinctive click in the telephone receiver is heard if the set is oscillating.

d. If it is impossible to cause the meter to read as low as 5 milliamperes by adjustment of the plate-control current knob, it is due either to reverse polarity of storage-battery connections or a run-down or wrongly-connected grid potentiometer battery. It may happen, however, that an exceptionally good oscillator tube will cause a plate current that can not be reduced to the proper value.

3. *General care of the set.*—The sets are made as rugged as possible with this type of apparatus. However, they should not be subject to any heavy jars or severe shaking, as this will break connection or injure the apparatus. The set should not be unnecessarily exposed to rain or dampness. If it becomes wet it should be thoroughly dried out but not exposed to intense direct heat. Care should be taken to keep all terminals bright and clean, including the joints of the loop. If the sets are stored they must be kept in a dry place.

PARTS LISTS OF SET FOR FIELD OPERATION.

4. *Equipments in the SCR–77–A set.*—There are two equipments in the set, as follows:

Power equipment, type PE–37.
Radio equipment, type RE–23.

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

Power Equipment, Type PE–37:

3 batteries, type BB–41; 1 in use, 2 spare.
1 case, type CS–19.

Radio equipment, type RE–23, comprises:

1 bag, type BG–13; for carrying battery case, type CS–17.
1 bag, type BG–18; for carrying loop.
15 batteries, type BA–2; 9 in use, 6 spare.
2 battery cases, type CS–17; 1 in use, 1 spare.
1 equipment box, type BE–48.
2 head sets, type P–11.

1 loop, type LP–2.
1 radio transmitter and receiver, type BC–9.
6 tubes, type VT–1: 3 in use, 3 spare.

THE SCR–77–B SET.

TROUBLES AND REMEDIES.

1. If the set is inoperative after being installed, go over carefully all connections made in installing the set. Especially examine the loop joints to see that they are clean and bright and make good electrical contact. If the set is still inoperative, pull forward the operating chest panel and see if all their filaments are lighted. If not, trace out the circuit for poor or broken connections. The tube socket contact springs sometimes make poor contact with the contact pins of the tube, due to dirty contacts or weak-spring tension. Of course, a run-down storage battery may be the cause of the failure of the tubes to light up.

2. If no reading of the milliammeter can be obtained with the key up by adjusting the potentiometer, the milliammeter or the C–21–A transformer primary may be open. Or the trouble may be due to faulty connection with the 120-volt " B " battery, or the battery may be run down. If the milliammeter is burned out or otherwise becomes open-circuited, it can be shunted until replaced or repaired. To shunt the meter, connect its two terminal posts together by a piece of wire.

3. If it is impossible to cause the meter to read as low as 0.5 milliampere by adjustment of the plate control knob, it is due either to reverse polarity of storage battery connections or a run-down or wrongly connected grid potentiometer battery.

4. When the amplifier stages are operating, a ringing sound will be heard when the oscillator tube or the panel is tapped. When the storage battery runs down, the set will usually continue oscillating even after the amplifier has ceased functioning as evidenced by the tapping test.

5. A small percentage of tubes will not oscillate with key up for any position of the potentiometer. Another tube should then be tried. Tubes which have a gas leak will ionize when the key is pressed. This is evidenced by a blue glow in the tube when the key is pressed.

6. If the set becomes noisy the following procedure is suggested as useful in locating the trouble. When the key is pressed the noise practically always stops since this shorts the primary of the first C–21 transformer. If it is still heard the noise is in the two-stage

amplifier, the 40-volt amplifier plate battery, or the storage battery circuit. If the noise largely disappears when the key is closed, it is due to irregularity of the oscillator plate current passing through the C–21 primary when receiving. One side of the grid BA–2 battery should be disconnected. If the noise is still heard, the grid potentiometer circuit is probably working normally. If the noise disappears when the oscillator tube socket plate terminal is connected to filament, the noise is then either in the tube or in the plate 1,000 mmf. R. F. by-pass condenser or the 20,000 mmf. stopping condenser. Then, removing the special connection to filament, if the noise continues when the tube is removed from the socket the noise is located in one of the two condensers mentioned. Several of the plate 1,000 mmf. condensers have been found to cause noise because of low insulation resistance due to corrosion. When the sets are working normally the most frequent source of noise is the oscillator tube. Often pressing the key momentarily will reduce the noise. Some tubes are very noisy when jarred. All tubes developing unusual noise should of course be replaced. The discarded tube will probably work satisfactorily in one of the audio amplifier sockets. The new set is found to be considerably more quiet than the BC–9, due to careful test of condensers before installation, and because the D. C. voltage impressed on the oscillator tube and condenser while receiving is much reduced.

7. The sets are made as rugged as possible with this type of apparatus. However, they should not be subjected to any heavy jars or severe shaking, as this will break connections or injure the apparatus. The set should not be unnecessarily exposed to rain or dampness. If it becomes wet it should be thoroughly dried out but not exposed to intense direct heat. Care should be taken to keep all terminals bright and clean, including the joints of the loop. If the sets are stored they must be kept in a dry place.

HAND GENERATOR, TYPE GN-29-A.

1. *Purpose.*—The hand generator type GN-29-A (to replace the type GN-29) is designed for use with the SCR-127 set. The necessary filament and plate voltage for the transmitter is supplied by this generator. The cording diagram (Fig. 112) shows the method of connecting the type GN-29-A generator.

2. *Improvements.*—The GN-29-A generator differs from the type GN-29 in that the voltage regulator of the former is mounted in the set box instead of on the side of the generator, also the new voltage regulator, type MC-62, is an improvement over the old type. The location of the voltage regulator was changed due to the fact that when it was mounted on the generator it was subjected to vibrations which tended to disturb the contact adjustments, consequently causing an

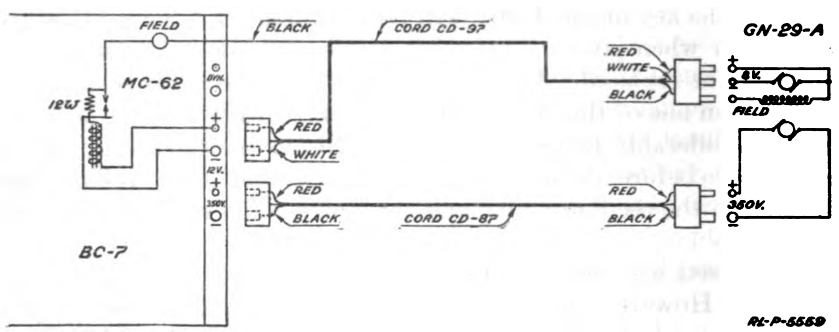


Fig. 112.—Cording diagram showing connections between the type GN-29-A hand generator and the set box of the SCR-127 set.

improper regulation of the voltage. Mounted in the set box the regulator is free from disturbances and therefore gives more satisfactory operation.

3. *Details and Operation of Regulator.*—*a.* All regulators are carefully adjusted by the manufacturer so as to maintain the generator low voltage between 8 and 9 volts. The adjustments are securely locked. The operator is cautioned against tampering with the regulator, as no readjustment is necessary. If it is found impossible to maintain the generator voltage between the limits of 8 and 9 volts, a *readjustment should be made by a radio electrician at the direction of an officer.*

b. After a set has been operated for a long period of time the regulator may need attention due to the sticking of the contacts. This trouble is made evident by the sudden brightening of the VT-2 tube filaments or by sudden increase of antenna current. Excessive sparking will also be caused at the same time at the telegraph sending key contacts. The transmit-receive switch should be opened momentarily, which will probably correct the trouble. If the trouble still persists and the generator fails to develop the proper voltage it is probable that the regulator contacts have become roughened. If this is the case, the contacts should be lightly smoothed with a very fine file or very fine emery paper. *The work should be done by a radio electrician at the direction of an officer.*

c. The operation of the regulator is as follows: The electromagnet winding is connected across the generator low-voltage brushes. A resistance of 12 ohms is connected across the contacts of the regulator, so that when the contacts are closed the resistance is short-circuited. The contacts are connected in series with the generator field. When the generator is turned at slow speed the voltage developed is insufficient to cause the electromagnet to pull the armature separating the contacts. When the generator speed is above a certain minimum value (about 35 revolutions per minute of the handles) the voltage developed pulls the armature closer, thus opening the contacts. This places the resistance in series with the shunt field and reduces the generated voltage sufficiently so that the electromagnet allows the armature to move back again, thus closing the contacts. This process occurs at a sufficient rate to maintain the voltage at a value practically unchanged by an increasing generator speed. The regulator, therefore, operates to maintain the generator voltage at a fixed value for all generator speeds above a certain minimum value.

4. *Voltage adjustment.*—*a.* The curved spring adjusts the air gap between armature and core. Decreasing the air gap will cause a lower voltage to exert the same pull on the armature as previously obtained with a higher voltage.

b. When the contact screw barely touches the armature contact, a slight pull will open the circuit. When the screw is turned in further, the pressure at the contacts is greater, consequently making greater the magnetic pull necessary to open the circuit.

c. The transmit-receiver switch of the radio set must be open during the adjustment of the regulator in order to prevent damage which may be caused by excessive filament and plate voltage. A direct-current voltmeter, having a range of not less than 0–10 volts, should be connected to the 12-volt binding posts on the radio set.

d. The adjustment screw which bears on the small curved spring should be turned in until the air gap between the armature and the core is about 1/16″; the contact screw should then be turned in (with the generator running at high speed) until the contact adjustment giving the highest voltage is found. It is desired that the maximum voltage thus tested be 9½ volts.

(1) If the voltage is *greater* than 9½ volts, it is necessary to turn in the screw bearing on the curved spring, about one turn, decreasing the air gap slightly. Another test should be made to see if the maximum voltage obtainable is, 9½ volts. If the maximum voltage is still above 9½ volts, it is necessary to turn in still further, the screw bearing on the adjusting spring.

(2) If the voltage is *less* than 9½ volts, it is necessary to turn out the screw bearing on the curved spring, about one turn, increasing the air gap slightly. Again a test should be made to see if the maximum voltage obtainable is 9½ volts. If the maximum voltage is still below 9½ volts, it is necessary to turn out, still further, the screw bearing on the adjusting spring.

e. The maximum voltage adjustment having been obtained at 9½ volts, the contact screw should be turned outward until the voltage has decreased to 8½ volts.

f. This process insures proper spring tension. A certain minimum tension is necessary in order to prevent sticking at the contacts. The screw adjustments should be secured by means of the lock nuts provided.

THE SCR-109-A AND SCR-159 SETS.

DESCRIPTION OF ANTENNA EQUIPMENT.

1. *a 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.

b 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.

2. *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 supported 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.

3. *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 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.

4. *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.

In transmitting, if any of the three tubes fail 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.

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 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.

5. *Care of sets.*—*a* 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.

b The storage batteries must receive proper attention and care. 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.

c 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.

d 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. The microphone must be carefully handled and packed. It should need no other attention.

PARTS LISTS OF SETS FOR FIELD OPERATION.

6. *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.

7. *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.

8. *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, electrician's 3-inch blade; 1.
Tape, friction, ¾-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.

9. **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 antenna E.
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.

10. **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.

INDEX.

Subject.	Unit Operation.	Page No.
A.		
"A" batteries. (*See* Batteries.)		
Alternating current	7	51
Ammeter (*see also* Voltammeter)	1	3
How connected	2	8, 9
Milliammeter	19	190
Thermo	11	83, 90
Ampere-hour capacity, batteries	3	15
Amplification, audio frequency	13	102
Amplification control	16	140
Amplifier:		
Purpose of	13	102
Use of telephone jacks in	13	102
Use of transformer in	13	105
Vacuum tube	13	102
Power	17	147
Speech	20	212
Antennæ:		
The inverted "L" antenna, type AN-7	22	234
General construction	22	234
How erected	22	235
The 40-foot umbrella antenna, type A-1-A	23	236
General construction	23	236
How erected	23	237
The "V" antenna, type AN-8	21	231
General construction	21	231
How erected	21	232
Why necessary	7	54
Aperiodic circuit	9	68
	16	140
Armature, buzzer	5	32
Automatic filament control	20	210
B.		
"B" batteries. (*See* Batteries.)		
Batteries:		
Dry cell	1	4, 5
Care of in the field	3	18
How to measure amperage of	2	11
How to measure voltage of batteries	1	3
	2	10
	3	14
Primary	1	2
Secondary or storage	1	2
	3	12
Types of dry cells	1	4, 5
Types of storage	3	14, 16, 17
Beat note	19	192
Break-in	19	192
Buzzers:		
Action of	5	32
Construction of	5	32
How connected	5	32
Modulation	20	213
Transformer	11	83, 89

Subject.	Unit Operation.	Page No.
C.		
Calibrations:		
Receiving sets	9, 11, 17, 20	72, 92, 161, 228
Transmitting sets	15, 17, 20	133, 162, 226
Wavemeter	6	34
Capacity:		
Condenser	6	39
Storage battery	3	15
Carbon pile resistance	10	77
Cells:		
Dry	1	4, 5
How to determine + and − terminals of	1	4
How to measure short-circuit amperage of	2	8
How to measure voltage of	1	3
Storage	3	13, 17
Types of	1	4, 5
Charge, storage battery	3	13
Choke coils	10, 16	77, 140
Condenser:		
Fixed type	6, 8	43, 56
Rotary or variable type	6	40
Use of, in radio circuits	6	39
Conductance	4	20
Conductor	1	1
Connections:		
Ammeter	2	8
Parallel	2	9
Series	2	6
Voltmeter	2	6
Continuous waves	15, 20	117, 213
Counterpoise	21	231
Coupled circuits	8	56
Coupling:		
Capacitive	8	57
Direct	8	57, 62
Inductive	8	57, 60
What it is	8	57
Coupling coil	20	211
Crystal detector	6, 11	43, 88
Current:		
Alternating	7	51
Direct	1	4
Direction of	1	4
High frequency	6	43
Low frequency	13	102
Short circuit of cells in parallel	2	10
Short circuit of cells in series	2	11
D.		
Damped waves	15	117
Detectors:		
Comparison of	12	98
Crystal type	6	43

Subject.	Unit Operation.	Page No.
Detectors—Continued.		
Purpose of	6	42
Vacuum tube type	12	94
Diaphragm	5	30
Direct current	1 7	4 51
Directional effect of antennae	22	234
Discharge of storage batteries	3	15
Dry cells. (*See* Cells).		
Dynamotor	16 20	137 209
E.		
Edison storage batteries	3	17
Electricity:		
Conductors and nonconductors of	1	1
Effects of electricity	1	1
Electromagnetic waves	6 15	34 117
Electromagnets	5	28
Ether	6	34
F.		
Farad	6	39
Filament	12 15	120
Filament control, automatic	20	210
Filament resistance, fixed	13 17	103 150
Filament rheostat	14	111
Flow, current, direction of	1	4
Frequency	6 17	42 152
G.		
Generator, hand	18 I. T.	167 264
Grid	12	96
Grid coupling	16	139
Grid leak	12	97
Ground	21 22	231 234
Ground, telegraphy	13	103
Guy ropes	21	232
H.		
Heterodyne	17	151
I.		
Inductance coils	6 8 16	38 56 138
Induction coils	7	50
Inductive coupling	16	140
Insulators	1 21 22	1 231 234
Interference	6	35
Interrupter	7	51
J.		
Jacks, telephone	13	102

Subject.	Unit Operation.	Page No.
L.		
Lead cells	3	13
Lead-in. (*See* Antennæ.)		
Loop	19	184
M.		
Magnets	5	27
Electric buzzer	5	31
Electro	5	28
Permanent	5	27
Telephone receivers	5	30
Magnetic field	7	51
Master set	19	197
Masts	21 22 23	231 234 236
Microfarad	6	39
Microphone:		
How connected	16	141
Use of	16	139
Milliammeter	20	209
Modulation	16	139
Buzzer	20	213
Transformer	16	139
N.		
Negative:		
Lead, color representing	1	5
Pole	1	3
Nonconductor	1	1
O.		
Oscillator	15 16 17 18 19 20	117 138 148 166 185 211
P.		
Parallel connections	2	9
Plate battery. (*See* "B" battery.)		
Plate coupling	16	139
Plate current	19	193
Plate voltage	16 17	137 150
Poles:		
Magnetic	5	27
Positive and negative	1	4
Positive, color representing	1	5
Potentiometer:		
Construction and use of	4 19	25 187
Power board	16	137
Primary batteries (*see* Dry cells)	1	2
Pulsating current	7	51
Q.		
Quenched spark	11	83, 90

Subject.	Unit Operation.	Page No.
R.		
Radiotelephone	20	208
Receiver, telephone	5	30
Resistance	4	20
Of all conductors	4	20
Of wire	4	21
Of wires of different sizes	4	21
Unit of	4	20
Resistors:		
Construction of	4	23
Potentiometer	4	25
Rheostat	4	25
Rheostat:		
Construction and use	4	25
Rotary condenser	6	39
S.		
Series connections	2	6
Sets:		
Type DT-3-A	12	94
Action of	12	97
Comparison with crystal detector	12	98
Construction of	12	96
Purpose of	12	94
Signal strength with different values of filament current	12	100
Signal strength with different values of plate voltage	12	101
Type SCR-54-A	9	64
Calibrating for use in the field	9	72
Calibrating of primary circuit	9	69
Construction	9	64
Effect of change in coupling	9	70
How connected	9	69
Type SCR-67-A	16	136
Calibration of transmitter	16	137
Description of power board, type BD-1-A	16	137
Description of receiving circuit	16	140
Description of transmitting circuit	16	138
General construction	16	136
Modulation	16	139
Parts list of sets for field operation	I. T.	258
Possible sources of trouble	I. T.	256
Type SCR-72—		
Amplification with 22½ volts in plate circuits	13	106
Amplification with 45 volts in plate circuits	13	108
Effects of changing vacuum tubes	13	108
Effects of wrong connection on amplifier	13	109
General construction of	13	102
How connected	13	106
Use of telephone jacks	13	102
Why necessary	13	102
Type SCR-74-A—		
How connected	7	54
How constructed	7	50
Measuring the wave length radiated by	7	54
Principles of operation	7	50
Used to demonstrate tuning	8	58
Used to show methods of coupling	8	56
Type SCR-77-A—		
Carrying units of set—weight and bulk	I. T.	260
Description of equipment case Type CS-17	19	187

Subject.	Unit operation.	Page No.
Sets—Continued		
Type SCR-77-A—Continued		
Description of the loop antenna	19	184
Description of the operation	19	191
Description of transmitting and receiving circuits	19	185
General construction	19	184
How to calibrate all sets with the master set	19	197
How to choose a master set	19	197
How to connect the set ready for operation	19	194
How to select oscillator tubes	19	194
Parts lists of set for field operation	I. T.	261
Troubles and remedies	I. T.	260
Type SCR-77-B	19	201
Adjustment for reception	19	204
Adjustment for transmission	19	205
Operation of a number of nets	19	206
Operation of a single net	19	205
Permanency and limits of calibration	19	206
Preparing the equipment box	19	203
Preparing the operating chest	19	204
Principles of operation	19	202
Purpose of set	19	201
Reasons for modification	19	201
Special features of set	19	201
Trial operation	19	206
Troubles and remedies	I. T.	262
Types SCR-79-A and SCR-99—		
Antenna equipment	I. T.	252
Calibration of the receiver	15	131
Description of the receiving circuit	15	121, 128
Description of the transmitting circuit	15	117
Dynamotor, type DM-1	I. T.	253
How to connect up the receiver	15	127
Parts list of sets for field operation	I. T.	254
To connect up the set both as a transmitter and as a receiver	15	127
To tune the transmitter to a given wave length	15	125
To tune three or more sets to the same wave length	15	133
Use of vacuum tube in transmitting circuit	15	116
Type SCR-105—		
Calibrating the receiver	11	92
Construction of receiver	11	87
Construction of transmitter	11	83
How connected	11	90, 92
Operating the transmitter	11	90
Types SCR-109-A and SCR-159-A—		
Antenna equipment	I. T.	267
Calibration of the receiver	20	228
Care of sets	I. T.	271
Description of receiving circuit	20	215
Description of transmitting circuit	20	211
Determining the wave-length range of the transmitter	20	226
General construction	20	208
How to connect up and tune the receiver	20	221
How to connect up and tune the transmitter	20	218
Notes on operation	I. T.	270
Parts lists of sets for field operation	I. T.	272
Operation of the transmitter	20	220
Use of vacuum tube, type VT-4	20	211

Subject.	Unit operation.	Page No.
Sets—Continued.		
Type SCR-121	14	111
Construction of	14	111
How connected	14	113
Use of telephone jacks	14	111
Type SCR-127—		
Calibration of the receiver secondary circuit	18	180
Checking the calibration of several transmitting circuits	18	181
Description of hand generator, type GN-29	18	167
Description of receiving circuit	18	169
Description of set box, type BC-102	18	172
Description of transmitting circuit	18	165
General construction	18	165
Hand generator, type GN-29-A	I. T.	264
How to connect up the set as a receiver	18	174
How to connect up and tune the transmitter	18	173
How to connect up and tune the receiver to a C. W. signal of known wave length	18	178
How to connect up and tune the receiver to a damped wave signal of unknown wave length	18	178
Tuning a set having a burned-out antenna ammeter	18	182
Use of vacuum tube, type VT-5	18	172
Type SCR-130—		
Calibration of the receiver secondary circuit	17	161
Checking the calibration of the transmitters of several sets	17	162
Description of receiving circuit	17	151
Description of set box, type BC-102	17	153
Description of transmitting circuit	17	148
General construction	17	147
How to connect up the receiver	17	156
How to connect up and tune the transmitter	17	154
How to connect up the set both as a transmitter and a receiver	17	157
How to tune the receiver to a C. W. signal of a known wave length	17	159
How to tune the receiver to a C. W. signal of an unknown wave length	17	160
How to tune the receiver to a damped wave signal of known wave length	17	160
How to tune the receiver to a damped wave signal of unknown wave length	17	161
Tuning a set having a burned-out antenna ammeter	17	163
Spark gap	7	51
Spark, quenched	11	83, 90
Speech amplifier	20	212
Storage batteries:		
Care of storage batteries in the field	3	18
Edison	3	17
How to determine positive and negative terminals of	3	14
Lead-cell battery	3	13
Types of lead cell	3	14
Using one cell of	3	15
T.		
Telegraphy, ground	13	103
Telephone, radio	20	208
Telephone receivers:		
Action of	5	30
Construction of	5	29

Subject.	Unit operation.	Page No.
Terminals:		
Buzzer	5	
Corrosion of cell and battery	3 6	18 42
How to determine positive and negative battery	3	14
How to determine positive and negative cell	1	3
Phone	5	
Voltmeter	2	6
Thermoammeter	11 20	83 209
Transformer:		
Audio frequency	13 17	102 152
Buzzer	11	83, 89
Oscillation	11	83, 86
Tuning	8 9 15 17 18	58 65 123 154 173
U.		
Undamped waves	15	117
V.		
Vacuum tube:		
General construction	12	94
Type VT-1	12 13	94 102
Type VT-2	15	116, 120
Type VT-4	20	211
Type VT-5	18	172
Variable condenser	6	39
Variometer	10 17 18	76 149 166
W.		
Waves, damped	15	
Waves, direction for measuring	6 10	48 79
Waves, electromagnetic	6 15	34 117
Wave length	6 17	34 148
Wavemeters:		
Type SCR-61—		
Calibration of scale	6	44
Construction of	6	35
How coupled to a set	6	45
Used as a receiver	6	42
Type SCR-95—		
Checking with an SCR-61 wavemeter	10	79
Construction of	10	75
How used to measure wave length of radio transmitter	10	77
Type SCR-125—		
Construction of	10	80
How used	10	80
Type SCR-125-A—		
Construction of	10	81
How used	10	81

SIGNAL COMMUNICATION TRAINING MANUALS.

(Corrected to January, 1924.)

No. 20. Basic Signal Communication, Students Manual.
21. Basic Signal Communication, Instructors Guide.
22. Telephone Switchboard Operator, Students Manual.
23. Telephone Switchboard Operator, Instructors Guide.
24. Message Center Specialist, Students Manual.
25. Message Center Specialist, Instructors Guide.
26. Radio Operator, Students Manual.
27. Radio Operator, Instructors Guide.
32. The Pigeoneer, Students Manual.
42. The Lineman, Students Manual.

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UNITED STATES ARMY

TRAINING MANUAL No. 26

RADIO OPERATOR

STUDENTS MANUAL
FOR ALL ARMS

Part II. CODE PRACTICE

Volume 1

PREPARED UNDER THE DIRECTION OF
THE CHIEF SIGNAL OFFICER

1925

WASHINGTON
GOVERNMENT PRINTING OFFICE
1925

Neat and legible printing is of great importance in the duties of an efficient radio operator. As a means of determining progress in lettering the student's copy is compared with a standard printing scale at frequent intervals. This standard scale consists of six printed charts which range from "excellent" (upper left-hand chart in illustration) to "poor" (lower right). The instructor is shown here pointing out to the student the quality of the individual letters as compared with the standard scale.

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CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,

WASHINGTON, *February 2, 1925.*

Manuals for training in the Army are to be prepared and revised from time to time by the branches of the service concerned, and when approved, published by The Adjutant General of the Army in pamphlet form in a series of training manuals.

In accordance with this plan there has been prepared by the Signal Corps a series of pamphlets relating to signal communication specialists.

The pamphlets in this series are titled as follows:

Training Manual No. 20—Basic Signal Communication, Students Manual.

Training Manual No. 21—Basic Signal Communication, Instructors Guide.

Training Manual No. 26—Radio Operator, Students Manual.

Part I, Radio Sets.

Part II, Volume I, Code Practice.

Part II, Volume II, Tactical Radio Procedure.

Training Manual No. 27—Radio Operator, Instructors Guide.

Part I, Radio Sets.

Part II, Volume I, Code Practice.

Part II, Volume II, Tactical Radio Procedure.

This pamphlet is published for the information and guidance of all concerned.

BY ORDER OF THE SECRETARY OF WAR:

J. L. HINES,
Major General,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Major General,
The Adjutant General.

PREFACE

The Radio Operator, Code Practice Instructors Guide, contains an analysis of the methods of giving instruction to Radio Operators in code practice. As much importance is placed on the transmitting ability of an operator as there is on his receiving speed.

The development of instructional methods has progressed considerably since the time the operator was merely required to learn the code and then listen to press until he was able to receive at a required rate of speed. By experience it was found that an operator could more readily and accurately acquire the necessary receiving skill by listening to the characters as they were sent by an expert operator. The student then learned only the sound of the letter. Later it was found that very often an excellent receiving operator was an extremely poor transmitter so that in order to permit the student to see the relation between the components of a properly made letter or numeral, a tape recording machine was used. Thus the student was able by the aid of visual comparison, to note the difference in the way his characters were formed and the way in which characters made by the instructor were formed. Still another method was found to be of service and a decided improvement over anything previously attempted, this was the use of the phonograph or Ediphone. This method eliminates the need for requiring an expert instructor to send for hours at a time while the class has little or no supervision. It permits the instructor to confine his entire attention to supervising the class, and also permits large numbers of students to practice receiving from a record made by an expert operator.

This manual gives the instructor the choice of these three methods of instruction; that is, the instruction without the use of any auxiliary instruments, the use of the undulator or tape recording machine, and the use of the Ediphone. It is evident that for the best instruction a combination of all three of these methods is the most desirable.

The requirements which this Guide must fulfill are:

a. It must analyze the steps in training radio operators in code practice so that officers in time of war can quickly train such men for duty with combat units in the field.

b. It must provide directions for the students to follow these steps, and such directions for the instructors as will permit him to train efficient operators in a minimum time.

c. It must provide tests so that instructors can determine the progress of their students, and when the course is completed to determine their proficiency, so that the term "radio operator" shall come to mean, just as "expert rifleman" means, a soldier who can do certain things in a certain time with a given degree of accuracy.

d. It must provide a method of instruction for the peace-time Army Regular, National Guard, and Reserve, and also for the R. O. T. C. and C. M. T. C., which requires no change of any kind for the training of these specialists in the larger Army which a national emergency may demand.

Notification of errors and suggestions for improvement of this manual should be addressed to the Chief Signal Officer of the Army.

RADIO OPERATOR

STUDENTS MANUAL FOR ALL ARMS

CONTENTS

		Page
U. O. No. 1.	*a.* Lettering with printed capital letters	2
	b. Memorizing by sound only the letter characters D, H, 8, 9, X, Z	7
	c. Receiving of the characters given under *a*	7
	d. Table No. 1, B	25
U. O. No. 2.	*a.* Memorizing by sound only the letter characters 6, O, Y, L, J, 2	7
	b. Receiving of the characters given under *a*	7
	c. Receiving of the characters studied in Unit Operation No. 1	7
	d. Table No. 2, B	25
U. O. No. 3.	*a.* Memorizing by sound only the letter characters 7, Ø, 3, 4, K, 5	7
	b. Receiving of the characters given under *a*	7
	c. Receiving of the characters studied in Unit Operations Nos. 1 and 2	7
U. O. No. 4.	*a.* Memorizing by sound only the letter characters W, E, S, M, A, U	7
	b. Receiving of the characters given under *a*	7
	c. Receiving of the characters given in Unit Operations Nos. 1, 2, and 3	7
U. O. No. 5.	*a.* Memorizing by sound only the letter characters V, R, F, 1, T, I	7
	b. Receiving of the characters given under *a*	7
	c. Receiving of the characters studied in Unit Operations Nos. 1, 2, 3, and 4	7
U. O. No. 6.	*a.* Memorizing by sound only the letter characters B, N, G, Q, C, P	7
	b. Receiving of the characters given under *a*	7
	c. Receiving of the characters studied in Unit Operations Nos. 1, 2, 3, 4, and 5	7
U. O. No. 7.	*a.* Receiving practice on 2-character code groups sent at the rate of 5 to 7 words per minute	8
U. O. No. 8.	*a.* Receiving practice on 3-character code groups sent at the rate of 7 to 9 words per minute	9
	b. Preliminary sending practice	10
U. O. No. 9.	*a.* Receiving practice on 4-character code groups sent at the rate of 9 to 12 words per minute	11
	b. Sending practice on 2-character code groups	11
U. O. No. 10.	*a.* Receiving practice on 5-character code groups at 12 to 15 words per minute	11
	b. Sending practice on 3-character code groups	11
U. O. No. 11.	*a.* Receiving of 5-letter and 6-numeral code groups sent at the rate of 15 to 18 words per minute	11
	b. Receiving practice on press	11
	c. Sending practice on 4-character code groups	11
U. O. No. 12.	*a.* Receiving practice on 5-character code groups sent at the rate of 18 to 20 words per minute	11
	b. Receiving practice on press	11
	c. Sending practice on 5-character code groups	11
I. T. No. 1.	Lettering charts	13
I. T. No. 2.	Code practice equipment	15
I. T. No. 3.	Standard tape scale and its use	21
I. T. No. 4.	Measuring students' progress	23

INDEX OF ILLUSTRATIONS

UNIT OPERATIONS

Figure No.	TITLE	RLP-No.	Page
	Frontispiece	5517	I
1	Printing alphabet showing how letters and numerals should be formed and the sequence in making the various strokes	5597	2
2	Printing scale	5548	3
3	Position of the hand in holding the key	1784, 1785	10
4	Complete Table Wiring and Connections to Ediphone Switchboard	831	15
5	Internal Wiring of the Ediphone	818	17
6	Standard tape scale	5590	21
7	Progress Chart 1	5596	23
8	Progress Chart 2	5595	24

RADIO OPERATOR

STUDENTS MANUAL FOR ALL ARMS

CODE PRACTICE

UNIT OPERATIONS

Equipment.

1. Paper, pencils, and an assigned position at the code practice tables.

Information.

The purpose of Unit Operations Nos. 1–6 is to teach the student the phonetic names of the different letters and numerals, to show how they are printed, and to familiarize him with their sound when sent in the International Morse Code. These three things are taught simultaneously for a group of 6 characters, thus making 6 groups or Unit Operations to be studied in order to teach all 36 characters.

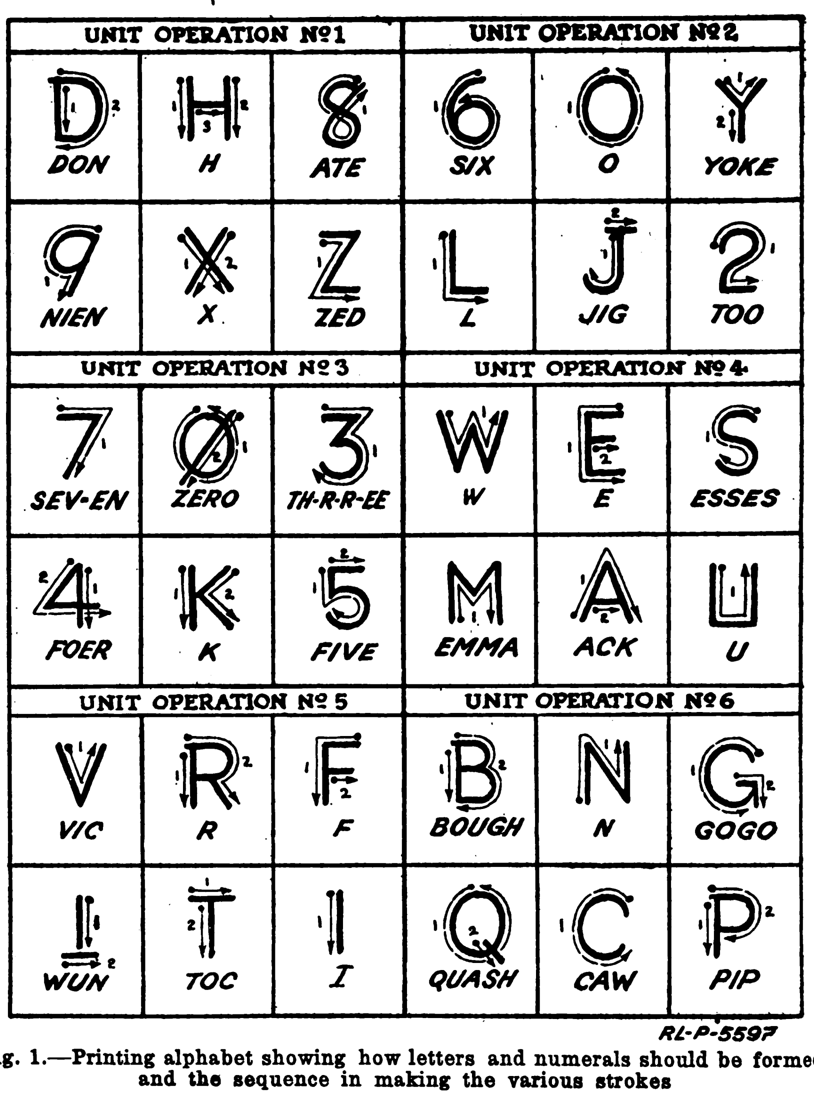
The student is required to print in capital letters all copy that he makes. This is done to insure legibility, and thus prevent errors. The system of printing to be used together with the phonetic name of each character is given in Fig. 1. In this figure the light arrows surrounding the characters indicate the direction of each stroke in forming the character. The heavy dot represents the beginning of the stroke while the point of the arrow shows its end. The numbers on the arrows tell the order in which the strokes are made; number one being made first, then number two. The grouping of the characters in Fig. 1 is the same as the order in which they are studied in the first six Unit Operations.

The Unit Operations and the characters studied in each are as follows:

Unit Operation No.	Characters
1	D, H, 8, 9, X, Z
2	6, O, Y, L, J, 2
3	7, Ø, 3, 4, K, 5
4	W, E, S, M, A, U
5	V, R, F, 1, T, I
6	B, N, G, Q, C, P

Fig. 2 is a photograph of the "Printing Scale." As will be seen, six sample messages are shown, No. 1 being printed practically perfect while No. 6 is, to a large extent, illegible. Nos. 2, 3, 4, and 5 lie between the best and poorest and are arranged in their order of merit. The use of this scale is to furnish a definite check on the quality of the student's printing. This check is obtained in the following manner: The student's copy is placed on the printing scale and compared to the different samples until the one is found which it most nearly resembles. The number of this sample denotes the quality of the student's printing. If the only comparison which can be made is that the student's copy lies between two samples its quality is then denoted by the number of the lower grade sample, plus (for example, 4+). This is explained here in order that the student may at any time grade his own printing if he so desires.

The code practice of the student on each of the first six Unit Operations is divided into two parts. Part one is to teach the sound of the characters being studied while part two is to give practice in the reception and printing of these characters (and any previously studied) when sent at the rate of approximately 25 words per minute.



RL-P-5597

Fig. 1.—Printing alphabet showing how letters and numerals should be formed and the sequence in making the various strokes

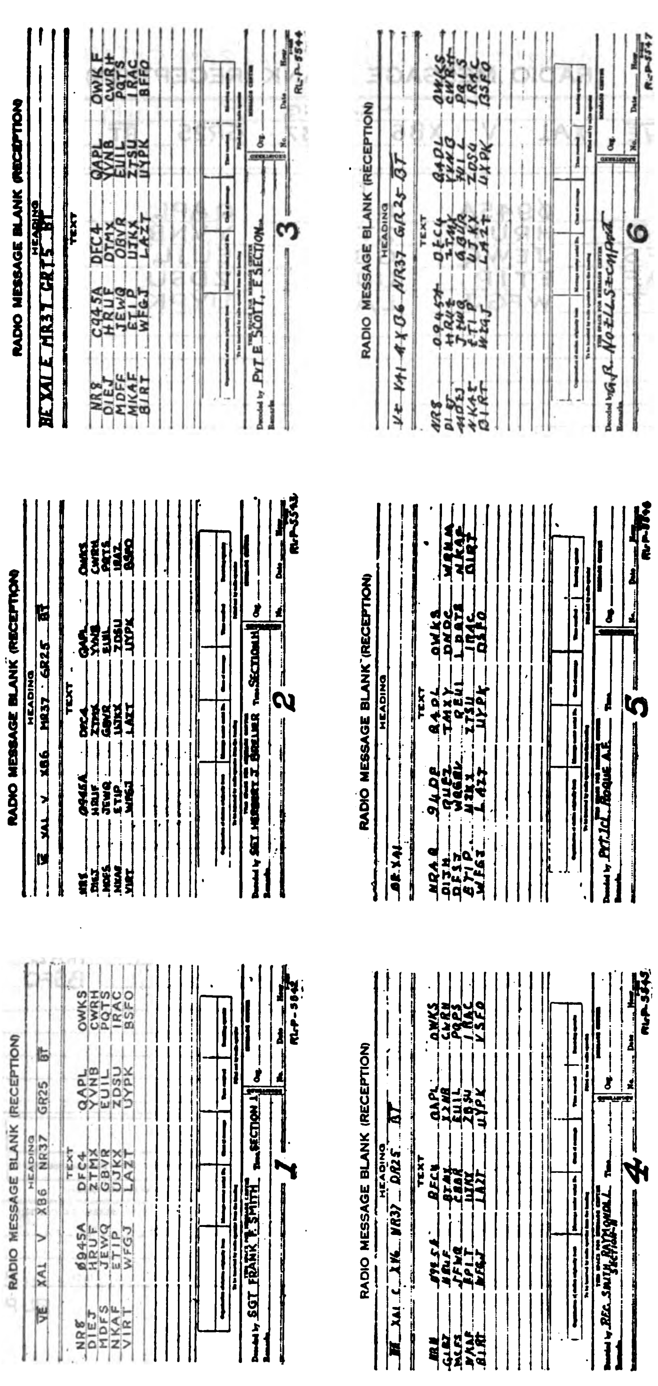


Fig. 2.—Printing scale

RADIO MESSAGE BLANK (RECEPTION)

HEADING

$\overline{VE}$ XA1 V XB6 NR37 GR25 $\overline{BT}$

TEXT

NR8	Ø945A	DFC4	QAPL	OWKS
DIEJ	HRUF	ZTMX	YVNB	CWRH
MDFS	JEWQ	GBVR	EUIL	PQTS
NKAF	ETIP	UJKX	ZDSU	IRAC
VIRT	WFGJ	LAZT	UYPK	BSFO

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER

Decoded by SGT FRANK F. SMITH Time SECTION 1 — REGISTERED — MESSAGE CENTER Org.

Remarks

No. Date Hour

1

RL-P-5542

Lettering chart No. 1

RADIO MESSAGE BLANK (RECEPTION)

HEADING

$\overline{VE}$ XA1 V XB6 MR37 GR25 $\overline{BT}$

TEXT

NR8	Ø945A	DFC4	QAPL	OWKS
DIEJ	HRUF	ZTMX	YVNB	CWRH
MDFS	JEWQ	GBVR	EUIL	PQTS
NKAF	ETIP	UJKX	ZDSU	IRAZ
VIRT	WFGJ	LAZT	UYPK	BSFO

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER

Decoded by SGT HERBERT J. BRELIER Time SECTION H — REGISTERED — MESSAGE CENTER Org.

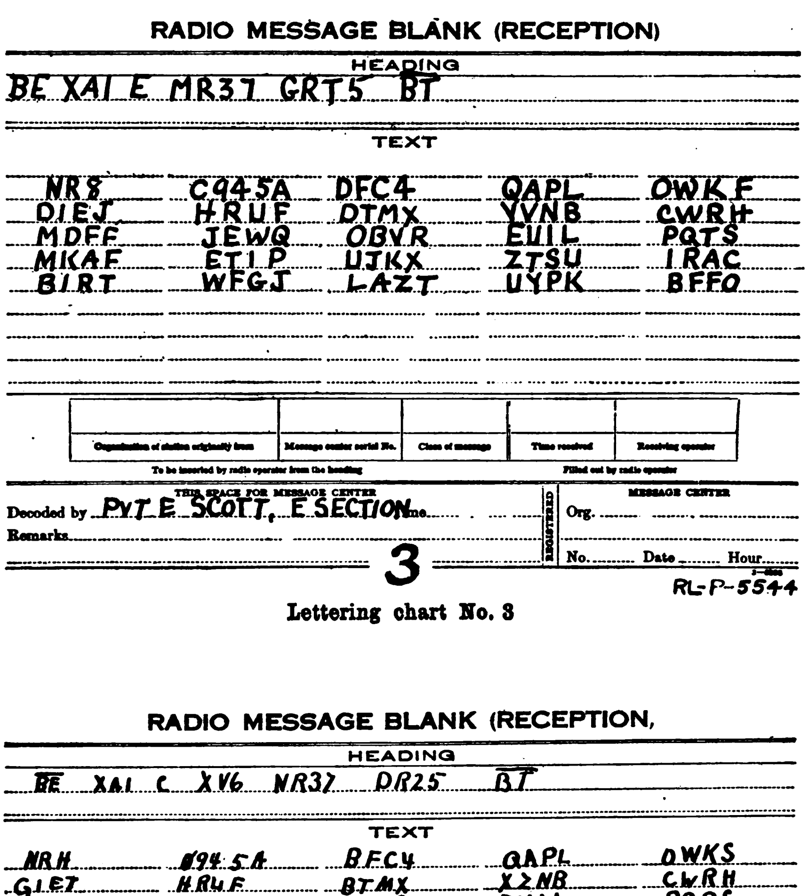
Remarks

No. Date Hour

2

RL-P-5543

Lettering chart No. 2



RADIO MESSAGE BLANK (RECEPTION)

HEADING

BE XAI E MR37 GRT5 BT

TEXT

NR8	C945A	DFC4	QAPL	OWKF
DIEJ	HRUF	DTMX	YVNB	CWRH
MDFF	JEWQ	OBVR	EUIL	PQTS
MKAF	ETIP	UJKX	ZTSU	IRAC
BIRT	WFGJ	LAZT	UYPK	BFFO

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER — MESSAGE CENTER

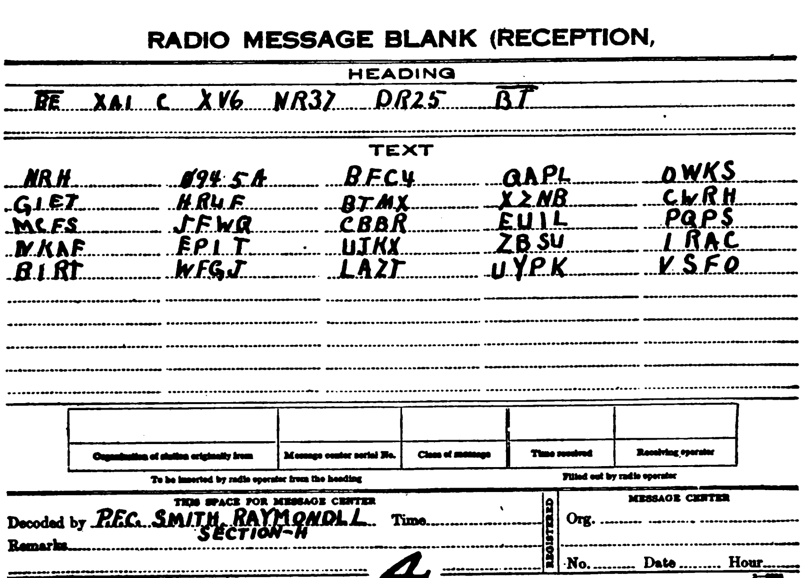
Decoded by PVT E SCOTT, E SECTION Time — REGISTERED — Org.

Remarks — No. Date Hour

3

RL-P-5544

Lettering chart No. 3



RADIO MESSAGE BLANK (RECEPTION,

HEADING

BE XAI C XV6 NR37 DR25 BT

TEXT

NRH	Ø945A	BFC4	QAPL	OWKS
GIET	HRUF	BTMX	XZNB	CWRH
MCFS	JFWQ	CBBR	EUIL	PQPS
NKAF	EPLT	UJKX	ZBSU	IRAC
BIRT	WFGJ	LAZT	UYPK	VSFO

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER — MESSAGE CENTER

Decoded by PFC SMITH, RAYMOND L. SECTION-H Time — REGISTERED — Org.

Remarks — No. Date Hour

4

RL-P-5545

Lettering chart No. 4

107446°—25——2

RADIO MESSAGE BLANK (RECEPTION)

HEADING

BE YAI

TEXT

NRAQ	94DE	Q4DL	OWKS	
DIJH	RUEZ	TMXY	DNDC	WRHM
DFSJ	WQGBV	REUI	LDQTS	NKAF
ETIP	UIKX	ZTSU	IRAC	BIRT
WFGJ	LAZT	UYPK	DSFO	

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER

Decoded by PVT.1CL. ROQUE A.F. Time

Remarks

REGISTERED

MESSAGE CENTER

Org.

No. Date Hour

5

RL-P-5546

Lettering chart No. 5

RADIO MESSAGE BLANK (RECEPTION)

HEADING

VE YAI AXB6 NR37 GR25 BT

TEXT

NR8	09457	DEC4	QADL	OWKS
DIEJ	HRUE	ZTMX	YVNB	CWRH
MDEJ	JEWQ	GBUR	HUIL	PQIS
NKAE	ETIP	UJKX	ZOSU	IRAC
BIRT	WEGJ	LAZT	UXPK	BSFO

Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading — Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER

Decoded by G.R. NOELLS SECMPRT

Remarks

REGISTERED

MESSAGE CENTER

Org.

No. Date Hour

6

R-P-5547

Lettering chart No. 6

Directions.

The following directions apply equally to any one of Unit Operations Nos. 1 to 6 and will be repeated for each operation as it is studied.

1. Pay close attention to the instructor as he explains the method of printing the six characters being studied and, when told to do so, practice printing the characters. Note the phonetic name of each character.

2. When the instructor reads the characters and tells you to print them as they are read, use a sharp pencil and print carefully and accurately on the ruled copy paper, taking care to have your printing evenly spaced on each line.

3. Take your assigned position at the code tables and put on the headset, adjusting it until it is comfortable and the receivers fit closely over the ears. Each character being studied will be sent several times in the International Morse Code. For example: The six characters shown at the top of page 2 constitute Unit Operation No. 1. Each character will be sent six times and then the unit operation will be repeated several times. Listen carefully to the sound of each character as it is made and repeat its name to yourself. When this has continued for some time, the instructor will direct the students to print each character as it is sent. Using the ruled copy paper furnished and a sharp pencil, print each character every time it is certain that the character has been correctly heard.

4. On the completion of par. 3 above, the student should be able to recognize by sound, and print any of the six characters studied. The next step is to be able to recognize and print them (and others which may have been previously studied) when they are sent one after another in fairly rapid succession. In order that the student may do this, the characters will be sent at the rate of 25 per minute. Reception of this transmission should be printed on the ruled copy paper furnished, with the usual care regarding neatness, accuracy, etc. If any character is not recognized at once, do not stop and try to puzzle out which one it is, as to do so will mean the loss of several succeeding ones; leave a space and go ahead. Always place your name and date on all copy you make and turn it in to the instructor at the end of each period.

5. By means of certain tests which will be given, the instructor will determine when a student may progress to the next Unit Operation. Special directions for these tests will be given by the instructor.

RECEIVING PRACTICE IN TWO-CHARACTER CODE GROUPS SENT AT A RATE OF FIVE TO SEVEN WORDS PER MINUTE

Equipment.

Paper, pencils, and assigned positions at the code practice tables.

Information.

On completing Unit Operation No. 6 the student is proficient on receiving all characters when sent at the rate of 25 per minute. The purpose of this Unit Operation is to give the student his first training in the copying of code groups. The simplest possible group will be used; that is, one composed of 2 characters. The student has noted that in all previous Unit Operations each character is sent very fast (about 20 words per minute) and that the slow speed used was obtained by leaving long intervals between characters. In this Unit Operation the same basic idea is carried out in the sending of groups. That is to say, each group is sent quite fast and the slower speed in words per minute obtained by leaving long intervals between groups.

The student will be given practice on groups composed of both letters and numerals but in no case will any one group contain both a letter and a numeral. Numeral groups will be mixed in random order among the letter groups of the transmission.

The transmission on which the students receive practice in this Unit Operation will be at the rate of 5 words per minute at the beginning of the operation. Since a word is taken as 5 characters, 25 characters per minute will be sent. These 25 characters are divided into 2 character groups so that the student will actually receive approximately 12 groups per minute. In copying these groups the student should listen to the entire group, recognize each of the characters composing it, and then, when the transmission of the group has been completed, print the 2 characters recognized during the interval before the next group is sent. As the Unit Operation is studied the speed is increased to 7 words per minute.

In printing his reception in this Unit Operation, the student should be careful to print the same number of groups on each line and to have the groups on a line placed directly under those on the line above.

Directions.

Specific directions for the student will be issued by the instructor. In general, the only directions needed by the student are given by the instructor from time to time.

RECEIVING PRACTICE ON THREE-CHARACTER CODE GROUPS SENT AT THE RATE OF 7 TO 9 WORDS PER MINUTE—PRELIMINARY SENDING PRACTICE

Equipment.

1. Paper, pencils, and assigned positions at the code practice tables.
2. A small brass or iron washer about one-half inch in diameter and one-sixteenth inch thick (a penny will do).

Information.

On completing Unit Operation No. 7 the student is rated as a 7-word receiving operator. This Unit Operation has two purposes. First, to make the student a nine-word receiving operator and second, to start the student's instruction in sending and make him a five-word sending operator.

The telegraph key used in sending is shown in Fig. 3, RL–P–1784 and 1785, which also shows the correct method of holding and operating it. Ability to send will depend to a very great extent on the student acquiring the proper movement of his wrist and hand in operating the key. This movement can be best described in conjunction with Fig. 3, RL–P–1784 and 1785. On this figure several arrows appear. Their explanation is as follows: When the key is closed, the hand executes a forward and downward rocking motion. The wrist moves upward. On opening the key, these two movements are reversed, the hand rocking backward and upward and the wrist moving downward. The importance of operating the key in this manner can not be overemphasized and the student should make every effort to acquire this motion exactly as illustrated. It is important that the back of the hand and wrist be kept horizontal and not tilted.

In order to properly operate the telegraph key, it must be adjusted in a certain manner. Correct adjustment of the key is obtained as follows:

a. Adjust the two trunnion screws which form the pivot of the key lever. See that the lever moves freely up and down and with a very slight amount of side play. In adjusting these screws, be sure that the upper contact of the key, which is mounted on the key lever, is kept directly over the lower contact mounted on the base of the key. When the correct adjustment of the trunnion screws has been obtained, lock them by means of the locking nut on each screw.

b. Unlock the screws on the back end of the key lever and adjust it until the knob of the key moves up and down approximately one-sixteenth of an inch when the key is operating. Lock the screw in this adjustment.

c. Unlock the screw which passes through the key lever just in rear of the key contact and adjust it until the amount of pressure required to close the key is comfortable to the operator using the key. The exact adjustment of this knob will vary with different operators and must be determined by the operator to suit himself.

The student will be required to execute all sending practice given in this Unit Operation with a small washer or penny balanced on the back of his wrist where the wrist joins the hand. The purpose of this is to prevent the hand being turned to either side while the key is being operated. If during the operation of the key the washer falls off, the student should stop sending and replace the washer.

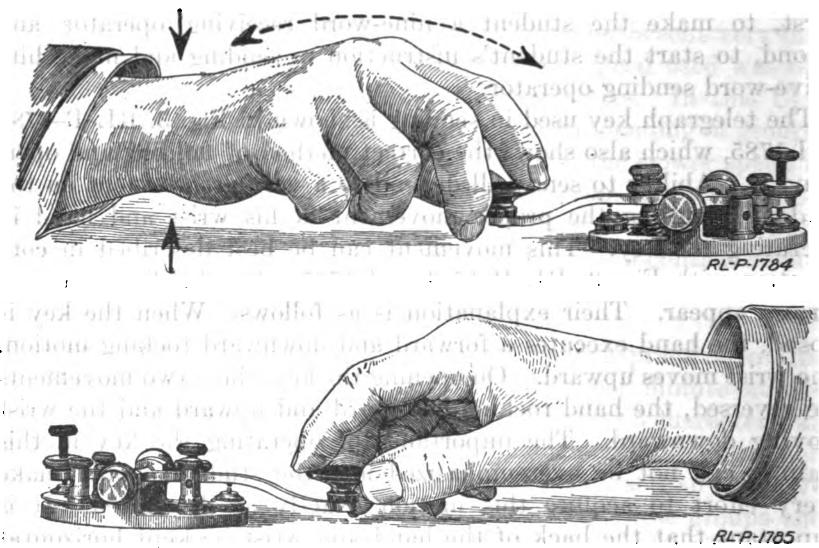


Fig. 3.—Position of the hand in holding the key

All receiving practice on this Unit Operation will consist of three-character groups, some groups being composed of letters and others of numerals. These groups will be sent at the rate of from seven to nine words per minute. Practice on these groups will be given along the same lines as the receiving practice of previous Unit Operations.

Directions.

1. *Receiving practice.*—Any directions needed by the student for the carrying out of the receiving practice required in this Unit Operation will be given by the instructor as needed.

2. *Sending practice.*—Approximately one-third of the total time devoted to the Unit Operation will be used for sending practice. Specific directions for the carrying out of the sending practice will be given by the instructor as needed.

PRACTICE IN TRANSMISSION AND RECEPTION AT 12 AND 15 WORDS PER MINUTE

Equipment.

Paper, pencils, and assigned positions at the code practice tables.

Information.

On completing Unit Operation No. 8 the student is rated as a 9-word receiving operator and a 5-word sending operator. These two Unit Operations have two purposes. Unit Operation No. 9 endeavors to make the student a 12-word receiving operator and a 12-word sending operator. Unit Operation No. 10 endeavors to make the student a 15-word receiving operator and a 15-word sending operator.

Students must observe the exact method of holding and operating the telegraph key as previously instructed in Unit Operation No. 8 for transmitting.

All the student's practice in Unit Operation No. 9 will consist of 4-character groups, some groups being composed of letters and others of numerals. These groups will be sent at the rate of from 9 to 12 words per minute. Practice will be given along the same lines as the receiving practice in previous Unit Operations.

Directions.

1. *Receiving practice.*—Any directions needed by the student for the carrying out of the receiving practice required in Unit Operations Nos. 9 and 10 will be given by the instructor as needed.

2. *Sending practice.*—Approximately one-third of the total time devoted to Unit Operations 9 and 10 will be used for sending practice. Specific directions for the carrying out of the sending practice will be given by the instructor as needed.

PRACTICE IN TRANSMISSION AND RECEPTION AT 18 AND 20 WORDS PER MINUTE

Equipment.

Paper, pencils, and assigned positions at the code practice tables.

Information.

On completing Unit Operation No. 10, the student is rated as a 15-word receiving operator. Unit Operation No. 11 endeavors to make the student an 18-word receiving operator and an 18-word sending operator. Unit Operation No. 12 endeavors to make the student a 20-word receiving operator and a 20-word sending operator.

The same care in sending, the adjustment of the key and lettering, applies to these Unit Operations as in previous ones.

All the student's practice in these Unit Operations will consist of 5 and 6 character groups and 6-numeral groups. These groups will be sent at the rate of from 15 to 18 words per minute in Unit Operation 11 and from 18 to 20 words per minute in Unit Operation No. 12. Practice in receiving these groups will be along the same lines as the receiving practice in previous unit operations.

Directions.

1. *Receiving practice.*—Any directions needed by the student for carrying out the receiving practice required in Unit Operations Nos. 11 and 12 will be given by the instructor as needed.

2. *Sending practice.*—Approximately one-third of the total time devoted to Unit Operations 11 and 12 will be used for sending practice. Specific directions for the carrying out of the sending practice will be given by the instructor as needed.

LETTERING CHARTS

It is of great importance for a radio operator to print characters neatly and legibly. A great number of the messages sent to the message center by a radio operator are in many cases valueless, due to illegible printing. In order to overcome this difficulty, the student is given a thorough course in lettering.

It is evident that if an instructor were to grade the efforts of a student in lettering the mark would be unfair in most cases. This is due to the fact that one instructor would grade a student's paper according to his own ideas of standard printing, while another instructor, who had totally different ideas, might give a considerably lower mark. With this handicap in view a means was devised whereupon the error in the judgment of the instructor is reduced to a minimum.

On page 13 is shown a table containing six lettering charts. If carefully noticed, it will be seen that these charts range from excellent (beginning at the upper left and extending across the top) to poor (at the lower right). These charts were selected from a total number of about 200. The process of selecting the charts was somewhat as follows:

A number of officers and instructors were chosen to select by comparison, out of the 200 charts, 6 which ranged from the best to the poorest. The number of officers and instructors selecting these papers was approximately 25. By averaging their selections the 6 standard charts in the table on page 13 were finally selected as standards. At the bottom of each chart is a number which constitutes its rating compared with the remaining charts.

In order to aid the instructor and to save him the work of producing a new lettering table, large full-page illustrations of each chart in the table shown on page 13 may be found on pages 14 to 16 consecutively. Each of these pages should be cut from the manual and mounted on a heavy bristol board so as to form a complete table similar to the one shown on page 13.

The instructor should collect the papers of the students at the end of at least one of the periods during the daily session. With the standard lettering table in front of him he should take one paper at a time and compare it with the standard.

In these comparisons the best results are obtained in the following manner:

1. Glancing at the student's paper, note the general appearance of the printing as a whole. Look at the standard table and select a chart which has the same general appearance of the student's paper.

107446°—25——3

2. Hold the student's paper beneath the standard chart selected and compare at random a few of the individual characters. If the student's characters are slightly better than those in the standard chart compare the paper with the next higher chart. If the student's characters are not as good as those in the original chart selected, compare the paper with the next lower chart. The student's paper is finally scored according to the score appearing at the bottom of the chart which has been selected as bearing the greatest similarity to the student's paper. This score should be inserted on a daily grade sheet and kept for reference purposes. The instructor should observe very closely the progress of the students in lettering as shown by these daily scores. If there are any students who continually perform poorly in lettering, they should be given individual attention and required to practice outside of the regular hours.

RADIO CODE PRACTICE EQUIPMENT

The code practice equipment described in the following pages, is designed to provide individual keys and headsets for the students, arranged in such a manner that interconnections may be made between the various student positions and between the student positions and the Ediphone, both for receiving and sending practice.

In order to accomplish these interconnections, it is necessary to have a switchboard. A source of tone for operating the headsets is also required.

A type of switchboard and a source of tone well adapted to this work are shown in the upper right hand corner of Fig. 4, which represents the complete circuit arrangement of the Ediphone, the switchboard and the table wiring.

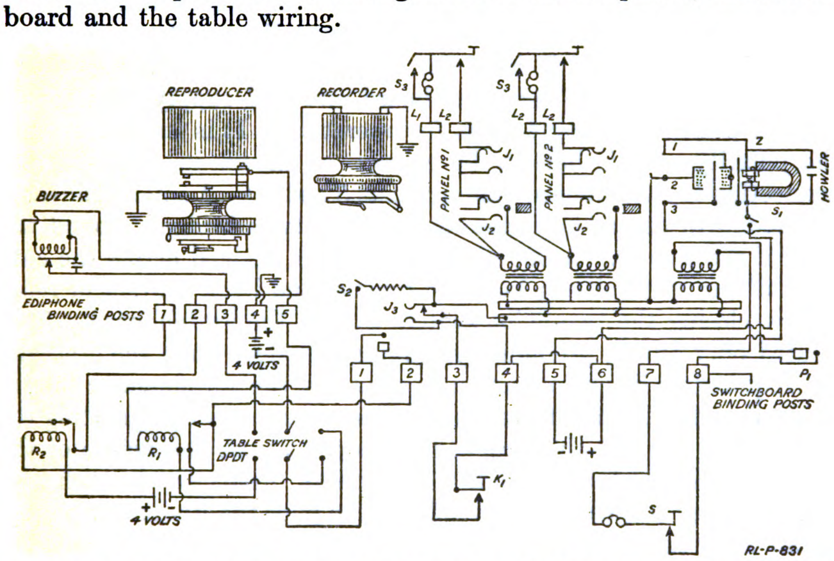


Fig. 4.—Complete table wiring and connections to Ediphone and switchboard

The switchboard is made up of panels from the Signal Corps Monocord Telephone Switchboard. These panels are rewired so as to make a suitable radio code practice switchboard, each panel being a separate unit which may be removed from the switchboard without disturbing the other units. Each unit is provided with a transformer, which is made from the electromagnet of the switchboard drop. The two coils of the magnet are cut apart, one coil being used as a primary and the other as a secondary. Both coils are shielded with a single covering of copper. This arrangement makes a one-to-one iron core transformer, each winding having a resistance of 100 ohms. The primary windings of all the transformers are connected in parallel, care being taken to not reverse the polarities. This is accomplished without wiring or soldering by bringing the tone supply from the howler to two brass bus bars in the switchboard. The primary terminals of each transformer are connected permanently to brass pieces which rest against the bus bars when the units are screwed into the switchboard. Any panel may be removed from the switchboard by removing two screws and without disturbing the wiring. The switchboard may be made with any desired number of units. An extra panel, J_3, is provided for Ediphone operation. An extra transformer is included in the switchboard for connection to the instructor's set. This set consists of a key and a head set connected to a cord and plug which may be inserted in jack J_1 of any unit for purposes of class supervision. The howler, which supplies the tone to all of the paralleled transformer primaries, is identical with the howler used in the Army Buzzerphone, type EE–1. It produces an 800-cycle tone which is ideal for code instruction purposes. The howler is attached to the switchboard and will supply tone for 25 student positions, using 4 volts for operation. It is important that the polarity of this battery be correct, as shown in Fig. 4. (See connection to switchboard binding posts 5 and 6.) A small condenser of one-fourth or one-half microfared capacity is bridged around the coils of the howler. A 300-ohm resistance is bridged across the contacts of the transmitting key, the tongue, and back contact of relay R_1 by closing the two-point switch, S_2, on the switchboard. This is used only during preliminary sending practice, when the students are required to listen to characters made by the Ediphone or the instructor and to imitate the sound of these characters by operating the key. With the 300-ohm resistance bridged across the points of the key, tone is shunted through the students' headsets when the instructor's key is open, which is sufficient to pilot the students' sending. At all other times, the two-point switch is open.

Each student set consists of a key, a telephone head set (70-ohm) and a two-point switch, S_3. The switch is used to place a short circuit around the student's head set when he is making a record This is for the purpose of cutting the resistance of the head set out of the circuit.

Each student position is connected to L_1 and L_2 of a panel in the switchboard, as shown in Fig. 4. From L_2 the circuit passes through jacks J_1 and J_2. From J_2 the circuit is completed by placing the cord plug P in J_2. The circuit then passes from J_2 through the cord and the transformer secondary to L_1.

The howler operates continuously during receiving practice, the tone passing through the primaries of all transformers in parallel and being controlled by the instructor's key or by the tongue and back contact of relay R_1. If it is desired to have the students practice operating in nets, two or more positions can be connected in series by means of the cords attached to each panel. For example, to connect student sets Nos. 1 and 2, place the plug of panel 1 in J_2 of panel 2 and the plug of panel 2 in J_2 of panel 1. To connect student sets 1, 2, and 3, place the plug of panel 1 in J_2 of panel 2, the plug of panel 2 in J_2 of panel 3, and the plug of panel 3 in J_2 of panel 1. In this way, any number of positions may be connected. J_1 is provided for the purpose of supervision by the instructor. By inserting the plug P_1 of his set in J_1 of any panel, he can listen in or operate with his key.

When it is desired to have a student make a record of his sending, the table cord plug is inserted in J_2, the table switch is thrown to the left and key K_1 is closed. The student then closes his switch S_3 and commences to send. During this time the student sends with a dead key, that is, without any tone to pilot his sending. At

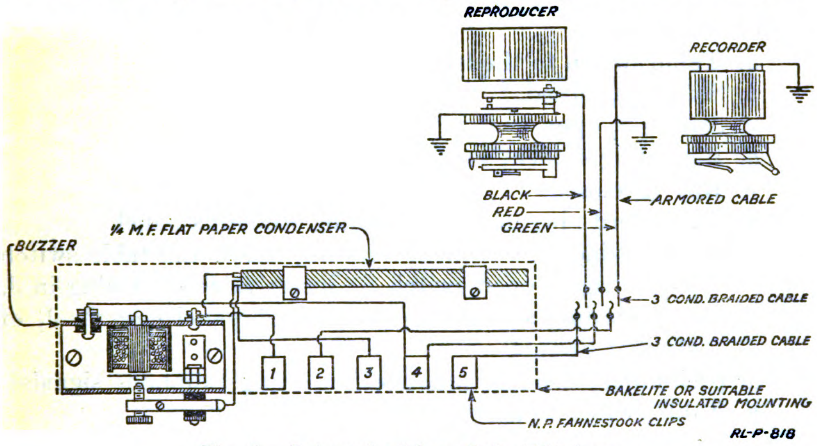


Fig. 5.—Internal wiring of the Ediphone

the same time, the other students can engage in sending or net practice without interference. When through sending, the table switch is thrown to the right, the student's switch S_3 is opened and the record is reproduced for the student to observe or copy.

Figure 4 shows the wiring of the instructor's table and its connection to the Ediphone and to the switchboard. Three 4-volt batteries are required. A storage battery is recommended. The polarities should be as shown in Fig. 4. The relays R_1 and R_2 should have a resistance of 100 or 150 ohms. Relay R_1 is operated by the Ediphone reproducer during receiving practice, the back contact and the tongue of the relay acting as a key in the tone circuit. Relay R_2 is operated by the student's key when making a record. Its tongue and front contact act as a key in the recorder circuit. The table switch is a double-pole, double-throw switch. This is thrown to the right for receiving practice and when the students are practicing sending individually. It is thrown to the left for recording.

SUMMARY OF SWITCHBOARD AND SWITCH CONNECTIONS TO BE OBSERVED

1. For receiving practice and for individual sending practice:
   a. Table switch to the right.
   b. Table cord plug in Jack J_3.
   c. Switch S_1 closed.
   d. Switch S_2 open.
   e. Students' switches S_3 open.
   f. Key K_1 open.
   g. Panel plugs in J_2 of own panels.
2. For supervising students:
   Instructor's plug P_1 in J_1 of any panel.
3. For recording:
   a. Table switch to the left.
   b. Switch S_1 closed.
   c. Switch S_2 open.
   d. Recording student's switch S_3 closed.
   e. Key K_1 closed.
   f. Table cord plug in J_2 of recording student's panel.
   g. To reproduce the student's record, throw the table switch to the right, open switch S_3, insert table cord plug in J_1 of recording student's panel, insert panel cord in J_2 of student's panel.
4. For preliminary sending practice (imitating Ediphone signals):
   a. Table switch to the right.
   b. Table cord plug in jack J_3.
   c. Switch S_1 closed.
   d. Switch S_2 closed.
   e. Switches S_3 open.
   f. Key K_1 open.
   g. Panel plugs in J_2 or own panels.
5. For net practice:
   a. Table switch to the right.
   b. Table cord plug idle.
   c. Key K_1 closed.
   d. Panel plug of panel 1 in J_2 of panel 2.
   e. Panel plug of panel 2 in J_2 of panel 3.
   f. Panel plug of panel 3 in J_2 of panel 1, etc.

NOTE.—Several nets may be operated simultaneously if desired, or nets may be operated while a student is making a record.

OPERATION AND ADJUSTMENT OF THE EDIPHONE

The Signal Corps Special Ediphone consists of an Ediphone dictating machine equipped with a special recorder, a special reproducer, a buzzer, and a condenser.

The recorder and reproducer are mounted on a swivel arm in such a manner that either may be placed in position for operation by pivoting the arm to the right or left.

The buzzer is mounted on the back of the machine, together with the condenser, which is bridged across the buzzer contacts to prevent sparking.

The method of operation of the Ediphone is as follows:

To make a record of the student's sending:

Place a blank wax record on the Ediphone.

Pivot the arm to the right, placing the recorder in contact with the wax record.

Throw the table switch to the left. This places the buzzer in operation.

Place the table cord plug in J_2 of the student's panel.

Have the student close his switch S_3.

Start the Ediphone motor and throw the clutch in to revolve the wax cylinder.

Direct the student to send.

The student's key controls the operation of relay R_2, the local contacts of which are in series with the coils of the recorder and the contacts of the buzzer, so that at each operation of the student's key, a high-frequency current passes through the recorder coils. This throws the recorder diaphragm into vibration and actuates the recorder stylus which places a series of indentations on the wax record that will correspond to the signals made by the student.

To reproduce these signals:

Pivot the arm to the left, placing the reproducer in contact with the wax record at the point where the signals begin.

Throw the table switch to the right.

Place the table cord plug in J_1 and the panel cord plug in J_2 of the student's panel.

Have the student open his switch S_3.

Start the Ediphone as before.

As the reproducer stylus passes over the indentations on the wax record, it throws the reproducer reed into vibration. This vibration corresponds to the frequency of the buzzer with which the signal was made and is high enough to introduce considerable resistance to the flow of current through the contacts on the reed and the inertia bar directly above it. As these contacts are in series with a battery and the coils of relay R_1, the result is a stoppage in the flow of current through relay R_1. The local contacts of relay R_1 are arranged to close, when the armature opens, and as these local contacts are in series with the student's set through the table cord, the tone passing through his secondary transformer circuit will be interrupted in consonance with the signals impressed on the wax record.

For receiving practice, permanent records are used. These are reproduced as directed, for wax records, except that the table cord plug is placed in jack J_3.

For preliminary sending practice the arrangements are the same as for receiving practice, except that switch S_2 is closed.

Closing switch S_2 places a 300-ohm shunt around the local contacts of relay R_1 so that, when these contacts are open, there is still a weak tone passing through the students' head sets.

Preliminary sending practice is conducted as follows:

One of the A records is sent from the Ediphone.

The students listen to the sounds of the characters as they are sent and, between characters, they attempt to imitate them on the key.

The tone which is shunted through the 300-ohm resistance is sufficient to pilot the students' sending and not loud enough to interfere with the sound of the character when made by the Ediphone.

This practice is continued with all of the A and B records, until the students can make the characters properly.

The buzzer has only one adjustment It should be adjusted to give a clear tone by manipulating the contact screw. When adjusted properly, it will not spark at the contacts.

The howler is attached to the switchboard. It is placed in operation by closing switch S_1 and normally furnishes current to all of the transformer primary windings in parallel.

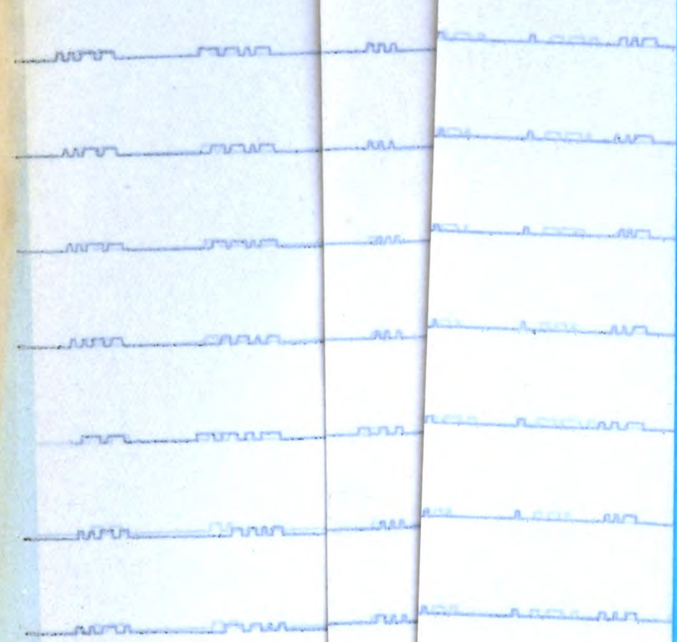
The various grounds shown in Figs. 4 and 5 indicate connections to the frame of the Ediphone. No actual connection to the earth is required.

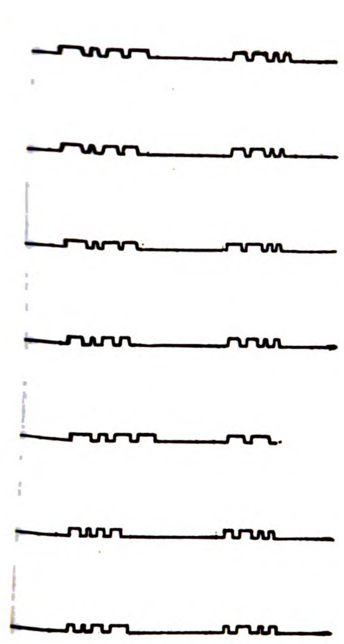
The reproducer requires no adjustment and should not be taken apart.

The recorder consists of a telephone receiver whose diaphragm, when thrown into vibration, actuates a stylus through the medium of an air column. Ordinarily, it needs no adjustment and should not be taken apart or the cover removed unless it fails to operate. In case its adjustment has been altered in this way, it may be readjusted by screwing the receiver in or out until the buzzer signals make a suitable record.

The polarity of the batteries should be as shown in Fig. 4.

Relays R_1 and R_2 are ordinary telegraph relays of 100 or 150 ohms resistance and operate well on from 30 to 50 milliamperes of current.





RL-P-5590

STANDARD TAPE SCALE AND ITS USE

In giving the transmitting tests to the students by means of an undulator it is necessary to use a method for correcting tapes somewhat similar to that used in correcting the lettering tests. Fig. 6 shows a table of standard tape records which were chosen in much the same manner as the lettering charts. A large number of students, instructors, and officers were required to transmit the alphabet with no particular attention paid to speed. Another group of officers and instructors were chosen to select from these tapes a series of 20 which were to be used as standards. An average of these selections made produced a standard table of 7 tape records.

After giving a test according to the directions given in the Instructors Guide of each Unit Operation the instructor is ready to score these tapes. This method of scoring is as follows:

1. Select one of the student's tapes and hold it near the standard tapes shown in Fig. 6. Locate one of the standard tapes which as a whole resembles the student's tape.

2. Glance slowly through the student's tape and notice whether or not the dashes and dots are of uniform length. If they are of uniform length, compare their lengths with the dots and dashes on the standard tape. If the student's tape compares well with the standard tape in this respect, score the paper according to the mark given at the left of the standard tape. If the student's tape does not compare well as far as the individual character is concerned and seems to be poorer than the standard tape in this respect, drop to the next lower standard tape and repeat the process of comparing individual characters. Proceed in this manner until a standard tape is found which compares well with the student's tape in all respects.

MEASURING THE PROGRESS OF STUDENTS IN RECEPTION

In order that the student may see what progress he is making in comparison to other members in the class as well as men in previous classes, the following charts are furnished. Chart 1 shows the progress made by members of a class during a previous school term. The location of the white block indicates at what rate of receiving speed the student began. His progress is marked by the shaded blocks. The white line on the extreme right indicates the 100 per cent speed required of a receiving operator, that of 22 words per minute. Chart 2 shows the progress of a class in receiving speed at the end of the twentieth week of instruction. It will be noted that some of the men started in as low as zero word operators and at the end of the twentieth week were rated as 10-word operators, while others started as 6-word operators, and progressed as high as 22 words per minute. The tests used to measure this progress are found in this manual. Similar charts should be prepared to show the progress of students in transmission.

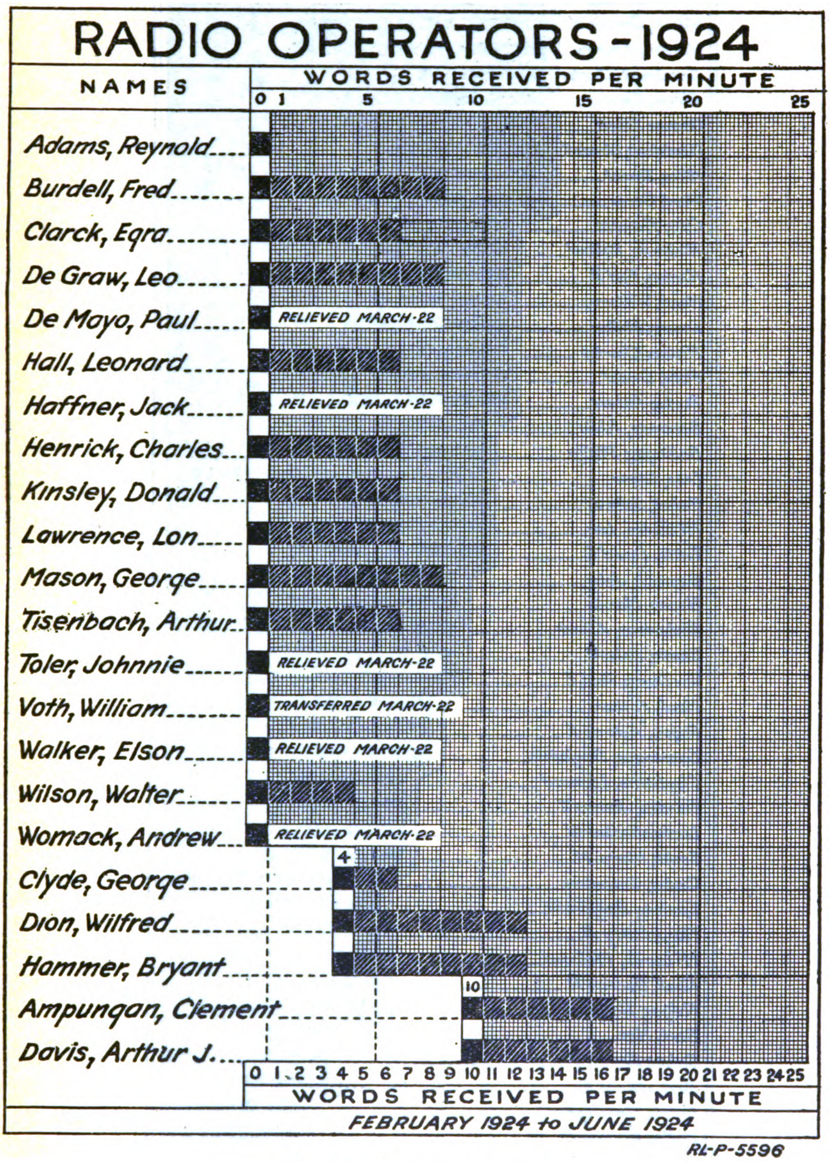


Fig. 7.—Progress chart 1

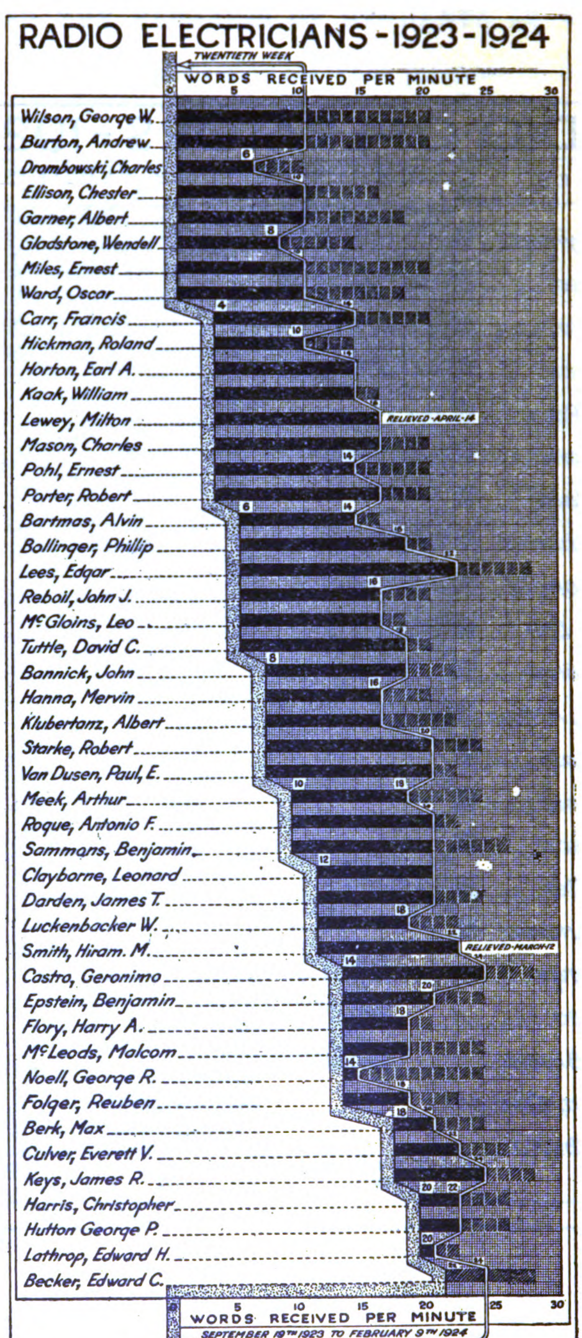


Fig. 8.—Progress chart 2

TABLE NO. 1-B

Record NO. 1-B—150 Characters

D	H	9	X	8	Z	H	D	8	9
Z	X	H	9	X	Z	D	8	H	9
D	8	X	Z	H	9	X	Z	8	D
8	9	Z	D	X	D	Z	8	X	9
D	X	8	9	Z	Z	9	X	D	8
Z	D	X	8	9	D	X	Z	8	9
X	H	D	Z	8	9	D	X	Z	8
D	X	Z	8	9	X	Z	D	9	8
8	9	H	D	Z	D	9	8	X	Z
H	D	X	Z	8	9	Z	X	Z	D
D	X	Z	9	8	Z	X	9	8	X
Z	D	X	H	9	8	D	Z	X	D
9	H	8	9	D	X	9	8	9	X
H	D	Z	9	8	H	8	9	X	D
Z	H	8	D	X	Z	9	H	8	Z

TABLE NO. 2-B

Record NO. 2-B—150 Characters

6	O	Y	L	J	2	Z	D	H	X
9	L	J	8	2	D	L	9	J	L
Z	8	9	O	6	Y	J	L	Y	Z
D	6	8	9	L	X	O	9	8	Y
L	X	6	J	Z	L	Z	9	8	L
2	O	8	9	Y	X	L	D	H	6
2	O	8	D	Z	Y	L	J	O	6
9	2	Y	D	J	X	Y	D	X	6
O	D	H	Z	O	6	J	Y	2	9
L	Y	X	Z	9	8	6	O	9	9
X	Y	X	O	6	8	Z	X	6	O
L	J	2	D	H	J	2	O	L	J
D	8	Z	6	8	J	Y	Z	8	H
D	J	Z	X	Y	D	H	2	Y	2
J	2	2	X	6	L	9	Y	8	J

TABLE NO. 3-B

RECORD NO. 3-B—150 Characters

J	L	Y	O	6	D	H	8	9	X
K	5	2	7	Z	K	J	6	9	8
X	Y	L	3	7	Ø	3	5	O	6
K	L	H	9	8	X	Z	K	J	6
7	3	4	D	K	4	6	J	Y	Z
7	Ø	4	L	J	5	9	Y	3	D
7	3	O	L	D	8	5	9	K	Y
L	5	O	L	D	7	3	4	Ø	2
Z	5	7	2	Y	7	Z	D	5	7
3	O	7	3	4	K	4	7	8	9
6	2	J	Ø	4	6	X	J	2	4
3	Z	9	8	2	Y	3	4	O	H
4	3	D	4	O	2	7	Z	4	7
3	8	X	O	3	7	4	Ø	X	Ø
3	4	X	H	7	K	Y	8	3	Z

TABLE NO. 4-B

RECORD NO. 4-B—150 Characters

W	M	A	4	U	X	3	8	9	5
Z	7	4	O	6	J	U	5	M	E
S	W	A	U	W	3	5	X	E	H
D	8	9	W	E	S	X	7	M	A
4	K	9	Y	W	S	M	3	4	7
J	L	6	U	K	A	O	Y	Ø	3
E	W	A	Ø	9	5	4	7	L	M
4	Z	Ø	E	U	K	S	S	E	7
4	6	O	8	K	7	X	Z	3	4
Y	O	2	8	5	Ø	A	M	W	E
U	M	W	A	Y	J	X	3	7	S
3	Z	L	4	3	7	3	E	W	8
D	W	E	S	4	2	H	2	K	J
6	L	D	2	3	7	S	3	7	E
S	M	D	A	M	A	U	Ø	Z	S

TABLE NO. 5-B

RECORD NO. 5-B—150 Characters

6	Z	S	V	T	U	R	F	I	1
H	A	9	W	D	M	S	4	L	Ø
E	O	8	R	E	K	2	V	6	T
S	3	A	D	Y	X	4	I	7	F
A	3	U	1	E	W	9	M	R	T
1	S	5	A	F	V	T	F	3	M
K	7	R	1	E	U	4	T	J	W
3	V	I	A	R	Y	1	V	R	7
4	W	F	I	3	M	J	E	1	R
V	F	7	W	R	1	R	F	V	I
U	R	U	R	7	Ø	L	F	X	1
M	Z	4	V	2	O	5	8	S	2
H	6	O	Y	1	L	8	I	3	T
J	7	D	Ø	9	X	4	K	5	W
E	S	M	A	U	R	F	V	F	X

TABLE NO. 6-B

RECORD NO. 6-B—150 Characters

C	P	Q	N	G	B	V	4	F	P
W	G	B	C	Q	M	A	7	R	E
1	T	P	R	3	G	S	U	C	I
Q	F	B	E	B	G	F	C	Q	R
1	V	P	N	Q	C	P	R	7	S
U	I	B	T	G	B	V	3	G	P
Q	C	F	R	N	Q	1	Y	Q	C
G	P	R	W	B	N	A	P	R	E
4	B	Q	C	G	I	7	J	2	V
C	P	R	B	Q	1	Ø	K	F	P
C	T	6	B	O	M	U	8	Q	Z
9	D	V	X	M	A	C	5	G	W
S	Y	6	B	3	L	1	N	P	4
T	2	J	7	V	O	Ø	4	X	8
D	I	B	L	H	9	Z	Q	C	P

RECORD NO. 7—180 Characters

TABLE NO. 7-A

5 to 7 words per minute

YB	ST	BL	Ø3	87	CY	HS	FA	YQ	62	71	NU	WC	53	67	18	XV	VJ
IL	RD	84	71	UX	OM	25	68	71	Ø5	ZG	QP	FL	IA	61	Ø8	HX	BJ
RX	UI	EL	OG	FX	14	24	EC	YT	IX	QW	82	Ø3	FK	RI	HV	NA	28
UQ	TE	LC	DS	84	14	95	37	KI	DG	LB	MA	DC	9Ø	16	93	TH	25
HW	Ø2	TD	FA	MG	64	Ø9	KU	DS	EH	AB	39	12	RZ	IQ	VL	KY	94

TABLE NO. 7-B

EM	ZI	3Ø	46	28	SR	23	71	TA	DY	HL	KX	CV	71	54	69	IV	WG
83	76	JO	PF	YG	13	84	QL	HP	AV	MO	21	86	IB	LO	FG	75	43
IB	65	LO	43	FG	27	XW	AC	TM	44	38	75	SU	XR	9Ø	RJ	34	ZM
EF	TS	ZJ	86	WR	NB	KW	57	43	Ø9	IC	UX	21	IB	LO	FG	75	42
41	EJ	UT	NR	57	Ø6	GN	IP	XK	IH	38	Ø4	AX	JR	21	UR	QK	LF
RX	US	EP	QU	25	69	DK	HB	MX	JR	OL	57	MX	JR	OL			

TABLE NO. 7-C

NT	CA	29	31	WX	GF	YV	NA	JT	92	13	58	XB	GU	OR	CH	73	96
WX	GF	DC	UO	BD	92	AK	83	IC	JY	QG	SL	74	OR	CH	BK	LD	65
13	YB	UL	OQ	SR	Ø4	BR	UA	CB	NR	ZY	2Ø	48	71	53	UJ	PD	EN
LZ	IB	EH	TD	FY	7Ø	VN	JW	SN	42	59	CA	13	7Ø	OK	RU	LX	98
35	62	PJ	DF	LA	JP	UF	TI	KG	37	69	NY	HV	SZ	DE	RN	BX	16
RX	JI	EB	WX	91	56	Ø8	RG	LQ	UM	AX	86	35	2Ø				

TABLE NO. 7-D

41	CJ	UT	57	NR	OL	Ø6	29	SC	BP	HK	QV	38	Ø4	XJ	WF	21	65
73	YZ	IG	BZ	ND	64	Ø9	71	QD	CS	HT	71	65	HT	AX	JR	Ø3	87
62	GW	VC	BQ	XU	93	26	MB	71	Ø5	AT	RS	IZ	Ø5	52	RS	IZ	6Ø
IZ	ME	NK	81	94	YV	NA	25	68	14	7Ø	DC	UO	BD	AK	2Ø	18	36
GJ	HE	RF	DW	PN	46	IK	MQ	ZO	TU	15	96	34	YX	LA	JP	UF	TI
HW	RU	Ø3	57	EX	OQ	SJ	BY	21	65	73	Ø8	TD	FA	64			

TABLE NO. 7-E

HW	RU	EX	89	IQ	SJ	15	RY	TD	FA	MG	NP	KL	24	WI	RZ	CV	YB
ST	BL	FJ	HY	GO	QA	ZD	Ø3	YW	KM	XR	CU	75	61	EI	MP	CY	HS
73	CM	29	MI	87	XB	VJ	IL	RD	TX	PB	72	93	PS	2Ø	37	95	LT
WQ	SN	AD	91	36	JU	AX	ZE	63	29	57	HJ	SB	CW	PM	DQ	HS	MZ
ZT	MU	DJ	CL	71	65	84	BP	KF	IX	AT	YN	39	12	57	UH	WA	YK
ET	RU	WZ	36	QK	42	34	AB	IV	85	JX	TB	UX	58	5Ø			

RECORD NO. 8—240 Characters

TABLE NO. 8-A

7 to 9 words per minute

QCA	WND	BVM	YEF	298	81Ø	KZB	LXO	TSP	263	754	IHR	JGU	UYB	RGM	Ø24	UYB
RGM	CHA	LFG	TWQ	IFJ	BVO	824	39Ø	976	253	4Ø5	XZS	ENK	PLO	RND	MAB	257
GIZ	YTU	82Ø	385	491	UJC	FWK	285	VQK	HPE	CSR	891	743	JXA	DZW	IOF	925
NVY	128	EFL	SCD	QKG	Ø85	839	RUP	MTH	HKP	WOR	DJV	GMI	ANS	824	39Ø	468
YCQ	TEX	UZB	135	986	ELD	JYQ	NXE	9Ø5	837	GSI	MBL					

TABLE NO. 8-B

924	385	175	FOE	QHJ	SPM	GIW	AUR	173	49Ø	675	NHR	QMS	FOB	PAV	937	483
GBW	AKI	TCN	GZP	SML	BVU	OWE	HJG	FRJ	928	3Ø1	589	317	VUO	WEH	GJF	RJD
JER	XBI	386	KGP	TWV	KSH	UGM	QOY	183	592	YRA	BCL	NJV	285	376	UXD	BCO
NOV	KSO	GHR	UYG	QMV	PJW	TZL	YFC	JNV	238	14Ø	586	718	HCQ	LFS	MYR	UXZ
Ø62	582	174	98Ø	ONG	LYX	RKV	STI	QWF	DCT	ZEH	UIE	PUR	JMP	28Ø	496	587

TABLE NO. 8-C

LFP	JER	GBW	KHX	NOV	415	Ø62	ICU	QYT	SMB	38Ø	421	TSM	WRC	983	684	VYB
LFP	JER	GBW	LHX	NVO	ZDH	AIC	415	769	293	JKH	TXH	NYS	ODQ	71Ø	552	HGE
Ø37	819	494	YFX	ZWM	PGU	IAT	543	679	OHJ	479	DFZ	ONL	BVD	351	786	441
839	674	RWG	OWZ	DGQ	126	INQ	KVN	936	FNC	117	RJT	LCF	814	765	TDF	KSZ
RGD	UCD	QUT	841	967	6Ø1	XUN	DST	GLO	DUT	HGO	982	436	758	LGY	JWX	HUD

TABLE NO. 8-D

TCQ	289	3Ø1	538	CRK	TVJ	CYS	GRH	UDM	FLE	578	293	TRW	WZQ	KAB	IVJ	XPB
829	Ø15	893	XQU	NEK	ZIM	RTS	BYA	HLK	CVQ	GJO	983	582	571	JOP	FGY	QIH
PZV	MOB	KEF	TSZ	JWR	NDK	WIC	UXM	892	357	4Ø6	IBL	OFG	925	391	XWA	ACT
MSU	XRJ	ZMV	925	386	754	HDY	QPE	VPY	OCI	BRI	KIN	HDS	ABE	UBM	TWX	142
ZJD	LKV	357	9Ø7	865	SIF	QUA	NYH	CRO	UGB	89Ø	185	XPW	EZM	YTJ	284	3Ø4

TABLE NO. 8-E

KAD	WEM	TEZ	NVR	XHT	OUD	12Ø	394	857	6Ø1	CDL	LSG	QYJ	CIK	238	475	692
138	UIJ	BWF	TEM	TXZ	QVA	894	375	172	Ø35	ZQV	ANY	HSL	DVI	183	4Ø5	865
OCR	GYH	135	975	OCR	GWH	RSL	UBY	248	3Ø4	861	FTE	ZNV	MJA	KCD	PIX	Ø35
QOB	EPO	983	Ø47	SWV	BAC	SDR	NRQ	825	376	JHZ	CIL	TKM	GUX	892	Ø31	FOE
QJH	SPM	GIV	783	496	OUJ	AUR	BLX	KVT	DYZ	Ø21	385	RNB	CNH	RQM	SFO	374

RECORD NO. 9—300 Characters

TABLE NO. 9-A

9 to 12 words per minute

1591	7Ø19	ARGM	KQVX	NANG	TKYQ	2281	YKHB	PUJP
ITLC	SZQS	EFWV	HOUW	GONH	ORAX	MVGN	9356	44ØØ
HMWP	XKBQ	DSZC	IEDD	EZLL	1355	6789	XUBW	3629
VYAO	FFOO	HVUS	QWAE	TNYR	LPLJ	RXJV	KITL	4771
5395	MAAD	NKEC	PQQU	CWGG	1864	HQRX	IDDO	11Ø9
7Ø12	BTMH	LFGM	JSZY	2154	6745	UTWI	YOEU	FOFB
VLSO	AXEC	NKRY	PVJH	993Ø	Ø683	XRVS	IQLX	AJDM
5832	KACW	QZUH	WGGN	QPXD	DTOA	2642	TIHV	FYMK
SCYV	PLWZ	QIRY						

TABLE NO. 9-B

AOWP	QTVM	2642	17Ø4	NWRY	ULPH	JGZJ	716Ø	9Ø83
447Ø	XICU	JQGC	KEWH	SZFQ	MRNT	5261	TJYU	1387
9936	ECXV	FOCK	WWHY	ZFYA	5189	1Ø63	OGUS	JIIB
LXBQ	XPVH	QNAI	PSDB	2779	GHIC	Ø652	RWVG	4134
9981	DMMQ	IDZV	EUHV	ZJQE	2896	5477	RYTA	JTUX
CFVK	OOKL	426Ø	Ø335	WRYZ	FDAP	5Ø49	GRST	LKBX
XEQF	PUNZ	NNIQ	6478	2782	SHBA	HSCO	1691	WXGA
MGQM	DIVD	Ø886	7997	BOPT	VELJ	JIDV	XZJN	6214
RFUQ	IYFU	LKDH	CBHD	124Ø	9153	SRGA	XGYP	XGYP
876Ø	4974	AMVW	PZOK	EXQC	BSDL	22Ø5	BNNE	TGWP

TABLE NO. 9-C

KBLJ	OJOQ	QZRD	1676	8559	NHXT	BLFH	JMZG	2432
934Ø	YCCY	ZIIA	TEWV	5981	LFAD	AVCM	629Ø	WSRH
DFPZ	VCQO	FBMI	KWSF	3852	4168	IEES	TLFB	Ø773
2141	686Ø	FYAG	JXWK	UPOY	CYAC	WHRG	9Ø23	SRBM
5379	4175	OTNH	ZDZL	YJRX	FHTJ	LSKG	WMEG	Ø351
NUPD	QUFU	VKIB	SILX	UCEW	2Ø77	9452	PBDT	6926
8Ø49	7665	AGIE	WKMS	CYCY	ACAM	RGCI	5796	BMMQ
NHCB	ALKY	WXRO	TZRU	SGBJ	3Ø22	41Ø2	QREH	8315
PDCA	FUIC	IBVE	9Ø94	5527	LJXD	EMBT	6832	OUTX
VVKS	QBZD	11ØØ	TIMC	WAYQ	SJFZ	LHKN	7634	4118

TABLE NO. 9-D

CUGA	DHCD	WAVF	2536	XEON	YZXF	2581	3947	BWXJ
YBUL	SHRW	GXIP	BCKA	2584	9191	XZUS	VNVN	3489
6719	Ø5Ø5	FZST	EFPC	LBCV	9184	IXWD	YGXF	UCQK
BRPF	OHEA	2581	3837	CYDK	UNGJ	MYKS	6411	LZAV
FQCI	4693	WCMX	1313	JMTY	PLEK	983Ø	NYR	VTFZ
JQXL	HRDN	7963	6187	SQVH	ILWB	UKJY	6781	9234
JDSC	8256	811Ø	IAXE	KZJC	LDFG	9128	UYKG	KPUD
SHZJ	7391	AGLX	GEHT	PSDB	AYMO	8431	KJVG	INQU
2435	4657	MKQR	ETPN	ZTYC	8975	UJEF	WNGU	XNHF
24Ø6	DEPL	XDSM	CUMS	DBIG	5154	9832	KSIF	JCAY

TABLE NO. 9-E

ZGQP	FLIA	1347	6892	BJTW	SYMC	3725	DURE	VKIL
3951	BDSA	YTFG	UWWR	2145	Ø583	ZYUL	TIDG	8376
KSWQ	ELDQ	9346	RZVL	MBWQ	KUDS	4612	7153	OMCK
1593	3541	DGRN	LIRY	JNPW	EGZW	4678	CSVK	LBTH
IMHT	4678	5312	HDUG	CQXI	KTDF	HTME	4666	7846
3521	AFTG	NBBD	HTEM	8342	8181	FDKT	SADC	KPIZ
9835	LIQP	EFHM	8321	Ø456	WRTJ	MRKV	WRTP	4581
CJUT	NROL	8537	BPHK	QVXJ	3712	YXIG	7389	Ø9Ø9
1517	QDCS	HTMP	AXJR	9137	LFEY	VNGO	5178	ZDWI
4965	RXUS	EPQY	KDBH	BMUX	5319	9384	XUMB	ATRS

RECORD NO. 10—390 Characters

TABLE NO. 10-A

12 to 15 words per minute

52Ø69	JJMBA	ZEHUI	24718	75483	WFDCP	SVTIQ	LYXRK	EDONG
Ø8762	13594	682Ø1	ITGTB	YRUXZ	34195	6294Ø	VKWAZ	FYCJN
ACYBD	41678	569ØØ	TRYHS	ZCZCD	48489	PKJDE	45178	EHFTU
32456	1Ø1ØØ	71Ø29	62651	ADTRY	JGOJK	85Ø97	34781	NCEFR
45376	49186	13487	PMMSE	AHERT	GDGUE	VAREM	45361	689Ø8
NFJGR	BJRIM	IQXVC	UXYHM	689Ø8	16547	26799	NFTHY	23987
ADOLF	PJERG	689Ø8	91654	72799	LFPVI	JGEHR	GKBWI	95214
Ø3589	17365	75873	GIWKD	KRXQH	ZWLGD	72834	9817Ø	34425
86514	7Ø311	6Ø862	73158	58Ø23	NSVXO			

TABLE NO. 10-B

78234	ONHDU	8951Ø	GCQXW	KJHSD	FGDKT	67342	KIVNG	541Ø1
BXCMK	45783	ASXLR	14536	DSHJK	ERTYH	KISEO	23489	WERQK
LKISD	QAZED	EDCRF	23459	PLMKI	UJNHY	451Ø1	87432	TGBHY
32469	16712	EDCRF	QWERT	ASDFG	ZXCVB	93697	PAMYL	14759
98563	QPALZ	WOEIR	SLDKT	35796	ZMXLS	96281	ECHGI	5341Ø
SRZEP	11ØØ1	BLOAW	789ØØ	72843	XPHTN	QMZQA	4365Ø	GDTBJ
TGBER	689Ø3	ASXNZ	5347Ø	SEKCL	BXSER	UHSOP	27946	YHSXN
67593	RZUIE	23152	LOGFX	71Ø23	VKZYZ	78783	NTQIV	HJASB
68476	6Ø216	63589	RZULE	IXCQN	64187	BUPLA	LYCON	57328
RIBLO	ZXUYN	UCPCH	23645	81Ø98	IQLTD	16743	2311Ø	ENAFU

TABLE NO. 10-C

ORCBU	LCYJY	CYBYQ	83272	42559	YVDQH	QAYOB	WYYPQ	34937
59168	YFAQY	76735	MBYXK	RYCCQ	95Ø17	YCKQY	95Ø17	CQWYZ
18423	XMCRE	PCLYY	27292	CCLYY	OPYYX	6Ø669	IUGXR	113Ø1
JCCDY	47888	78576	CYYYQ	2899Ø	32284	YLPZR	QOZQJ	WZQYL
DQXTF	SDEFT	QTEQD	45678	QFQQG	KQQHL	23458	1Ø178	934ØØ
94112	ZQPSL	8Ø766	QERQX	YCQZC	51Ø73	UQZCL	6451Ø	VZTXF
Ø5321	YIUZM	YMZZO	794Ø7	HZZCF	JZDFF	83534	YMVQG	61755
QBZZQ	27449	TZQLF	SQOOL	1Ø263	49512	REWTG	38Ø3Ø	WERTH
ZBTFB	49512	TFSYS	96127	QJFLY	QDILI	Ø4383	YLLQH	5394Ø
93694	TFSYS	8Ø671	QDILI	61246	SHLLA	QXBLD	26Ø68	ZCLFG

TABLE NO. 10-D

DZQIL	CEPKO	68638	12771	892ØØ	UTZFX	OFGMR	7617Ø	BBNSC
18925	Ø9481	DRCFF	AUTLW	KAIQN	ICKON	CBFHH	2Ø436	98754
BRCFF	AUTLW	KAIQN	69295	21887	ICKON	CBFHH	JNVXA	66518
55673	14ØØ3	YRHAT	QYIWG	98763	QZIWG	GYQXK	55673	ASKCB
14ØØ2	SDCJJ	LTWIM	TQYUA	HENHB	87836	52568	XOGAP	RFXBN
VVOMZ	NKBJS	ASULT	ELEGE	56Ø41	Ø7925	99754	GASHT	23811
TWZNF	MIROP	EGESC	78Ø76	32491	WMPZL	YPFTB	961Ø9	64838
Ø1622	73584	BSLCK	UHJDN	LJTFD	YGVWH	67293	59591	BJAQZ
OHKIX	QEDTJ	349Ø1	Ø7233	SDMSA	RJZVI	HRXKF	8Ø374	4226Ø
AEDRF	MKEIL	DSRTY	34561	64ØØ2	MGSXC	87110	IOSEH	MDHET

TABLE NO. 10-E

61246	QALOI	WSKIE	78166	RFVTK	GHTUI	44433	VBGHT	57916
CLFDS	39852	ASEDR	GHTYU	ØØ744	84586	PXJWI	77452	EJZNS
ZMUFI	FFSAH	42967	91878	ZOFFS	55624	464Ø1	CFFNH	2321Ø
73333	32596	FFSAH	QPDFQ	8566Ø	ZQFLK	LFLDH	94715	OLUES
XHFGD	TUULQ	Ø8854	61327	HSBDU	4658Ø	59936	SPDUP	84043
Ø6171	59576	TUULQ	TSWKU	428Ø8	SSRUU	SEUUC	18799	MIUSJ
59576	MSCSU	954Ø8	71337	SHIUB	63193	HOUDI	AKDYZ	MHVXD
HHNDD	1Ø929	HLDDM	7721Ø	SSTDU	OPODU	Ø8651	VHEAD	53Ø84
SSTDU	NVDHB	82182	HQDUB	VHVOH	45535	QZUHF	96213	HOHXF
8Ø474	24687	ASDFG	HJKLO	39Ø5Ø	POIUY	QWERT	ZXCVB	588Ø8

RECORD NO. 11—480 Characters

TABLE NO. 11-A

15 to 18 words per minute

SQMNE	OCRYL	HITED	WJQFX	GKWZU	PVJBD	AIBLM	AWMZI	IOJGD
BSJHT	MPWCV	IQTNA	YZIUZ	RKDXF	GOLEA	BKDHE	SJDHE	NJUIK
LUKGJ	POINS	QJHZF	MQWRX	YTCEV	DBATR	GXHEP	WDMNE	NHYGF
TRGXA	OISPE	YUHEC	NQXCE	AWMZI	CUTSH	LVOPF	KRPLM	AIBLE
WICLG	KVSDX	NYTFN	UHRGL	PEZAD	QUWGM	KMTHL	KJSTR	DJYXO
DMENH	RPLMA	IBLMB	HESIF	QWCOX	UYGTV	SLDHE	JJUHN	AKIOD
EYJBS	SMVGA	DKLAF	XPWNR	BLFHE	SHDNE	BHAGT	VFDIK	MXBCV
SLDIH	TRGXA	OISPE	YUHFR	KVJLZ	NQBCN	KDWDV	OPFLS	JVJDH
JVBXZ	EOMBP	XTDRL	ICWUN	SHCCQ	YASLF	DXRKV	QUCPM	HNSWO
SHDUJ	ASDFG	HJKLP	OIUYT	REWQA	ZXCVP	NMKJH	VFRED	XSWQA
CKEOH	DLQYI	GSOTQ	AFNML	RVWJX	BPGAN			

TABLE NO. 11-B

DOQJS	WICLG	KVSDX	NYTFN	UHRGL	PEXAS	SHDUW	YBJSH	SJYYH
EIYBF	JPHXT	WURZL	AODXV	KGMCV	QSNVP	SHDYE	SIDUJ	QOAHN
SYLHB	FNGQC	EXMWT	ZIOGJ	JASKD	SHQDN	QCXIF	GBKRA	JSVDD
PZOXC	IVUBY	NTMRE	QMWEN	ALKJU	NHYTA	SIJHN	BGTAD	VFREQ
DQHOE	JDYVM	DYEHS	QRLTB	AYGSE	OOLGY	VKSAW	XSRBY	LPURS
BTTAI	FOJSV	MAJAB	BYLHV	PQKNZ	SPAHW	GVECD	BPNMU	PLSOW
BIDTX	DQEHY	SKNIM	ASHHN	TIXER	XLONQ	VPNMY	QJOLP	UMNPB
CDEVH	FETSS	JIDHS	CJUHA	NHYTG	SODKM	NYAKS	CNHYA	SGCBQ
BIDTZ	DQEHY	SKNIM	ASYHN	TIXER	OQQKL	IVHWE	UNHSW	NHYAD
PYYJT	QGPIB	GBUPV	OVVNG	YEBPV	EBTFI	YTQFA	JCHZA	NHYUJ
RJIPV	BZSNO	EYHZU	FCXMG	WJAIL	WDKXJ	DNICY	LORVS	SDJHF
BGTTE	BAUVD	SLDKF	WCEIR	NHAGS	AOSUD	QHYTG	NHSIA	NGCSA

TABLE NO. 11-C

DQHOE	JKYVM	DYEHS	QRLTB	AYGSE	IATTB	SRUPL	YBRSX	WASLD
OOLGY	QXPYJ	BOWBO	RQGTL	RLKGJ	FZZMY	JEGHB	XATEX	KTTRH
JMGXH	KMDNB	WHAPS	ZNKQP	VHLYB	BAJAM	VSJOF	IUNME	SKDHF
CWJIV	OKUWC	ULPXN	VBOIW	NQVRP	LRKEG	MJDGM	CVCGG	DLISC
GVECD	BPNMU	PLOJQ	YMNPV	QNOLX	KCRUK	PWOKJ	MNSDT	OKISD
SRCXA	TFUED	ASHNT	IXERZ	DRFDA	FZIWN	YOWKL	RERPS	SHDYE
ASBBQ	FYZCE	LWNEB	KJADE	LAWBN	ZJVIH	ARGZH	YFJFU	FKSHW
LTIQX	CHFOR	GIWCR	VTECF	VONUC	UMKYF	NJHDK	ISHDE	LKJUQ
EAXIY	EOODX	SHDUJ	MNAIS	NEHCG	SOIDJ	NHAIK	BQVUK	NHYAL
QWERT	IOPTU	QPHYT	BGFSA	ERGVD	CEKIO	NBEDA	VCTRU	NGFSI
DIGFY	PSYFG	XTOSU	MGSOT	GLTLI	VMKXS	HAGDY	OSNFZ	BSXWI
PMXFS	OJDEZ	IKCTB	GBJMS	QXULQ	PAHSD	VLJDA	UHWAV	RQNYS

TABLE NO. 11-D

ASBBQ	FYZCE	LWNEB	KJADE	IAWBN	SJPWX	LWBKF	USHDE	NHYUJ
EBTFI	JZAOP	YTQFA	PZDKO	MPAVQ	LRKEG	MJDGM	CVDGM	SNDHU
WGBTH	PYAPI	VHQHA	EDZWY	EFXTR	ODKMS	NHUKA	NMJAU	NYDAW
SOLEQ	KPVJB	GJOXR	OQECH	JEGHB	NHUSJ	MUIKA	NGHQY	BTDSA
GVECD	BPNMS	DHFYR	NUOKJ	ASSDF	GHJKL	OMINH	BGTRF	VRDSA
NAHSJ	BHAGS	QIWUE	AYGSE	KSHGG	FDSWE	VCXZA	HGFRT	NBHGT
IUYTR	JHGTR	VCFDE	BGTUJ	NHIKO	VFDSA	CRTEW	XTVEF	CVFRE
OMUNY	BTVRE	CFRED	VCREW	CDEWS	VFRED	CDESA	BGTRF	VFDSW
MJUIK	NHYTG	VRESA	CXZWE	VRYIO	MURFS	VFOIH	NHDSA	BAGST
ASEDF	JHYGF	HJIWS	AHSTG	BGAYS	DHWGE	CNHGA	SBGTX	BGAFS
FLHGQ	WAMIK	BUPZA	SYVRO	LYCTN	DJSND	OEKCH	DLSKD	UZLYF
KDWSL	CVOGI	MXKWD	FPQYN	RJXTJ	EZHBU	YVPWO	LSUDH	OQIAH

TABLE NO. 11-E

DOQJW	LOCLG	GKVSD	XNYTF	NUHRT	LPEZA	QOEHZ	UWVOZ	IQLXP
PNGMA	FDTYB	JXHLP	GANJK	ERFCD	FOZZU	CKWXM	IYIVB	CGYHP
HLPGA	NJKSN	HBTRY	ZXGJS	HLPGA	NJKMS	HBTRY	ZXGJS	BNTOM
IOGJS	VJLZM	ZUBCK	EOELD	VKLDS	WUVHE	ALSOD	ONSHQ	EHSND
OGYHP	MIECU	RXTSR	TRCSA	OISPE	YUHRF	KVSJL	SIAMP	SHDYS
ASKFL	VPHNS	WUCYD	DUVOE	PWSAD	XLOMW	BVPUE	VPOBY	DHSTD
AXEPS	HRUDS	LCHAM	HURDY	RJSHE	BVWHO	DXGHL	JQRQZ	OYAAM
FDKYK	ZXBKB	AYCKQ	RJLHG	XKWLT	AJGWM	DGIUY	BVWOL	GHSKB
BJTTE	TQDCS	SHDUY	PSEXE	UUNHY	PUETS	GRYCD	AWHYD	KHGSR
FIEAW	MTCKJ	XRVDH	ZYOPQ	LUXOW	MXJDU	AWHUY	NOQRE	UYSVL
VKWLT	AJWGM	XCPUZ	HYEON	SZBVP	IJRXJ	DMTCY	LORDY	ORVYS
SZXAP	KIMAW	QHWHF	GOYAL	JBUAT	NZDHG	LOFGT	NTUZD	FZURS

RECORD NO. 12—540 Characters

TABLE NO. 12-A

18 to 20 words per minute

DKOAN	LKJPW	VPQES	UIZXJ	MBCHG	TRYSW	TKVUD	NOXUE	RCMFT	HAIGD
PQGZV	ABEQU	WGMKN	THLXJ	STRBJ	YXOIF	ZCMWO	XPFCM	UJTGY	KLWSG
KQIZR	BAHED	XRKVQ	UCPMH	NSWOF	TLBIE	ADGJY	LYSQT	HDLVL	PMKOC
HEVTX	GRAIB	ZFWER	CTKLP	COHNR	NYIXF	SBVDZ	QWUAJ	NEHST	RYQZG
YQXGJ	SBNIN	NQWKE	OFESY	LHVGN	GQCEX	MWTZI	OGJAK	RVPJG	HYNUJ
DPKHY	KQQEQ	OGIVX	AZZTG	NVRXJ	LABGS	KBARB	JEHAN	PQEII	WUDBN
VWXZQ	FGRFW	QMKWW	EKVEK	SNQRD	UTUGL	IHCTV	ZLPKA	XXMLU	HHGPC
MSNCP	VTSOO	CRWHF	HDOZE	GJFRS	TYTNY	RXLYL	YOBIH	SIIXV	WFEFG
TZASN	KCDBG	VMGVQ	UWJDC	DOYZE	NXLQX	OPYWM	XFSUW	UCQAT	EMTJZ
HYUGL	RUHNI	CJDEO	MTLHG	JGVSJ	BYLTA	ZKNRK	HLPYR	AVMQV	ISKZP
XIFBP	KLCJD	WVQCH	FUMNS	VXDAG	KLIPO	BRXEY	TZCQU		

TABLE NO. 12-B

LEGCN	FUFPS	PKWFF	JXZEL	EJOMN	GGMDG	BTTKL	WXUQC	KHNLY	HNVOH
XYEEO	NSUYE	OOIFF	VDAZI	ZQJXJ	DZNWZ	GLDNR	AVQPP	IIYUA	CJRGV
UGWIP	QHGAG	YCOTT	ACBUR	MWLWR	VADSD	MTIBV	WZXKR	ZKUEH	PFCGM
YJYDJ	GPTMU	QIMHP	OTQPA	IRWLI	TKAAK	RPJQT	XZVVI	KERIS	AFGCX
BVTWB	EDBFT	CCGXF	UZZYT	LGOZY	VMNDK	GSIBV	QQBXM	MNVFQ	XOKCL
BLSQC	YGEOF	SYHZY	SYHZY	OJRIN	HJUHN	RXNGD	WHRXZ	IVEUD	WXCNF
JXIGL	DQNHL	YSDAY	XCXYC	FZJGW	URMXT	COGCB	QABPI	KLCIM	BJASI
RGWJK	PTPUK	FPLKV	OBNQE	EDEFS	AEBSP	LENVE	ASDRE	ASLKE	ZXCVM
NVVQH	EUBRT	VDZFT	MNJER	REPJV	HXAOS	BLKAS	QJYZU	OLNGQ	LUFVM
DCDBG	GQUMY	ASOIJ	SQSYQ	YFWNX	UTECL	REMWH	WMHRB	OGXLD	IMCXN
GATIW	UXIAC	PPWZS	SOLEE	JHRKE	QXQCL	BBKLU	KHPDY	GDURK	YHFGT
OHOMQ	VTZJH	IPSRY	ASVOB	MDDEQ	UBLQG	TATUA	YYRPP	ZMGZC	XOJUE

TABLE NO. 12-C

KLTPD	BJLBP	OOFAT	JQYGE	QRJWM	ZDXKS	RBUOC	UQKYY	NXGAA	HTYCH
BFVRC	LHMGI	JZSBN	MGRMQ	YCONG	CYTHB	ZAZZK	INDLY	ASEDR	ECKFJ
OLAKS	ERCVB	QWEIU	AKSZX	NCFGH	QASOD	ZIXEU	AMSDN	QPOWE	THNFG
PQIFT	THEKS	AZQKT	ASLKE	QOWIE	ALSKE	ZIXER	UFGTE	EGFHT	HQALS
QPWOX	RFVGT	QPWZX	EOBFK	QIZSK	ENFEK	EOQEP	SHDRZ	AGTFH	EGASL
EKSHA	QLZXJ	TKEQO	QWZXM	EYQAL	QNZAD	JASGQ	ZBSKT	QOEVB	AKWIX
OTDWK	UAXVL	KSLJG	QBAUO	ZDIMB	TIDIR	MCLZX	WAQTE	YQTAY	SJGXT
FZUIZ	IHOFC	KNBBQ	NLJPU	XSRKM	QICLF	UXWCV	JGSHN	OPEHO	ZDFFH
NYMUY	KCZMU	LEONG	NIGSL	GREVK	WBQXX	HRRDR	ROGAZ	WYSGT	XWZJS
YLWWV	BXGYF	WOVKY	EMVIZ	SZBBW	PNKHP	QGIJE	GSJUS	IVMIH	ASKQW
KBOJQ	ZRUNH	BLJMY	CZITE	LPAVW	SDFUP	LJOQR	DBQXT	FHZGC	YANWV
ADCMR	HPZQO	BIWFE	TLFYJ	XUKGY	VMSRO	TZDYJ	FHLKW	MNUQC	VXEIU

TABLE NO. 12-D

BZRIB	QAZWS	EDCRF	VTGBY	TGBYH	UJMKI	OLPIY	QPWOE	ASLKD	ASZXN
LWQPO	ZMNDF	ERTHY	QPWOZ	XIRTU	KERTU	ASJHD	ERIOQ	KJQWE	EDRFT
ZFKBN	SXXGR	HQLTO	FUCNL	MLXUS	MTWVC	KSWJB	VOVXP	YCPDH	BDAZK
TGIBQ	AEZHV	JVSDX	WPJIJ	DTEOW	DTECW	SNPRF	EJZKY	QIOEZ	CRGGI
ROKVG	JBQHB	UHBTZ	NNIGD	PGJZQ	OOHMD	IHDSN	FARAS	LTCRH	ZMAPT
QAZWS	EDCRF	TGBYH	UJMIK	OLPIK	QPWOE	ALSKD	ASKDJ	ZXNRY	ASJQU
ALSKD	QPWOE	WEUTE	EFGTY	ZXEIT	QOCIE	SNEHT	JSHRT	AWERZ	ANSDH
TGSEA	QPWOZ	EORIF	ZKXLS	RFASK	ZXEWI	ASKCX	ZXNDH	SASHA	JAQEC
PBAGW	KOYAC	RGBMH	NZLRX	TJSGE	QPDFU	IBLXE	WERTY	DPTEM	SCYAH
CINQG	BKYRO	ZUBJR	HGAIC	VEJDB	TOUVK	OUVKQ	ZTMWY	SFLKN	XQUJY
FXMPO	ZNKLB	GWHRW	TAVSB	DICAQ	JZHNL	SIXGM	KBFUP	PDYCI	EIRBO
YWDXY	DXYLA	IDLQT	GUOBJ	RCWSH	VPNKE	FMZOH	EQRQS	WVNYU	MIZTA

TABLE NO. 12-E

FIEAW	MTCKF	RSFGH	ZPYOW	LUBXO	MSJGD	DJLVA	WHUYM	QRPMX
FVZLE	CRIMF	MTRMG	MSIKZ	RDCEG	WZJOB	AUBQO	CJEFH	HSYGT
DXGHL	XQURD	TGCYA	TBKBX	NKYKD	LAVOM	BKGOH	ROGLB	XUPXA
TTRLA	IDYIL	HZGWR	SAXOR	SNDHE	ALSKD	MYHST	SHWGI	XMDAG
XMDIG	BCLSW	BWKDQ	DHGGR	BWGUX	MEYNG	MSIDY	SHDGB	SNHTG
SALDA	FGHJH	QBWOE	RITUY	ZMXXC	DNBAQ	XSWED	WFRBV	GTYHN
MJUIK	LOPNA	XICUH	NAJSW	BUGRF	AKJUW	SHDRF	RHYSD	NHYTR
BERTG	BHYUJ	MNVUC	AFXUW	WDEFR	TBGYM	MEUDA	CEDSA	DFGHT
MBIOH	WRART	SVBHU	OHJYR	UINNH	DXANF	UCAJE	WXEDH	UEXDN
PBSLN	KKDSD	RNXIN	OGEDG	VDURJ	KSGTV	HBGKQ	BNGNV	MJAIK
AMCEB	LUWKR	WDHUR	XXYBZ	YTPKW	ZYRPM	FAHND	MAIKD	MKALJ
JKOYM	HXMPH	FJCYG	DMJIG	ZKDNQ	PWJHB	SCVAC	TCUCT	MAIKJ
VIQYP	UQAUL	AGZOY	ZYTKA	XRNDU	FUCIQ	FDLEA	XKORK	NAJHQ
ZLNDW	NZRED	CDBFF						

RADIO OPERATOR—CODE PRACTICE

RECORD NO. 13—450 Characters

TABLE NO. 13-A

13 to 18 words per minute

4827Ø3	447351	681285	953764	976Ø14
325Ø43	322667	941258	ØØ9876	221723
586374	765882	63Ø445	2ØØ927	113828
4216Ø3	418Ø76	ØØ9932	394891	385542
9Ø8125	56789Ø	751Ø26	6336Ø5	418Ø78
221726	447356	812896	976Ø14	511689
741397	64142Ø	292956	6Ø4821	Ø77664
331486	Ø43321	625433	618Ø95	943552
191955	14681Ø	Ø24689	558876	139421
998834	641423	896445	Ø28788	251336
418Ø72	334257	1Ø589Ø	123682	311586
29299Ø	625174	334Ø94	385549	435587
4216Ø1	394895	785517	4334Ø6	385549
589932	268776	25115Ø	813991	97Ø568
4Ø7853	327443	12214Ø	4Ø1847	859ØØ1

TABLE NO. 13-B

22ØØ56	154389	63789Ø	387654	198723
51634Ø	354679	415133	51689Ø	89Ø454
4169Ø1	364235	914238	283749	Ø53247
5113Ø6	57832Ø	353196	31432Ø	124589
433161	Ø74236	67699Ø	873114	195678
238991	873114	46684Ø	282869	566981
341ØØ5	697652	87645Ø	668893	Ø75634
944562	372654	913224	1Ø8618	9Ø4552
324816	9ØØ236	759125	18Ø471	162894
491355	883Ø95	Ø36958	983547	6Ø1658
18Ø356	61567Ø	5Ø319Ø	594361	Ø36417
447798	179568	8Ø1876	238983	795689
421148	377Ø36	958Ø18	Ø62389	835479
6Ø1652	942117	2Ø8298	941351	594364
Ø62387	6Ø1652	483779	2Ø1365	7258Ø6
311568	483779	Ø16754	966217	574891
861894	237269	2241Ø3	1975Ø1	46Ø391
133246	3147Ø6	491364	334175	983542
942115	Ø36958	765432	1Ø2345	983543
942118	3Ø9683	11ØØ39	413264	795684

TABLE NO. 13-C

2Ø1357	298543	39826Ø	189432	Ø25349
26789Ø	123456	546782	415234	2Ø2633
3Ø2615	315123	625789	718155	198765
313456	343536	149Ø56	146143	1Ø391Ø
2Ø5281	264125	122514	57223Ø	281421
3Ø9517	117143	292856	146198	956437
123449	334924	21122Ø	1Ø5674	45Ø216
171575	415874	37459Ø	213789	197845
211953	91Ø687	264253	Ø38981	Ø868Ø1
752536	411418	615945	386251	25Ø45Ø
473242	517643	934279	681944	131417
21689Ø	314987	Ø92341	36428Ø	2184Ø9
17Ø268	69268Ø	954236	146141	664152
963651	384672	Ø86934	456234	987654
243546	273625	Ø79685	13579Ø	12349Ø
324538	21ØØ54	38542Ø	554431	216439
3388Ø2	39Ø321	513894	216895	246357
21Ø435	514327	11Ø165	398246	165893
415161	158738	Ø35177	855946	176643
367241	394Ø32	165432	854234	Ø56772

TABLE NO. 13-D

9Ø2456	874569	Ø36784	235478	32358Ø
387543	137895	237854	145789	167351
342673	315634	7Ø169Ø	Ø17532	17894Ø
212789	3Ø2Ø61	162465	1Ø3964	152326
393847	4839Ø2	3896Ø1	389465	49Ø264
797Ø16	1Ø3589	219754	876453	Ø38574
134Ø69	263894	432567	139842	389Ø43
2Ø3948	161687	86532Ø	394672	3849Ø5
265349	263279	394725	387548	274358
216789	423678	54Ø234	283946	423864
126738	321567	117854	456732	871Ø73
648912	918756	265743	1Ø1125	246358
2Ø3852	267893	342563	17345Ø	356789
3Ø4562	293564	75689Ø	353657	Ø25789
4Ø2156	284753	246855	53672Ø	21Ø457
253674	654379	215378	217935	62394Ø
314567	394Ø26	3Ø3678	267389	313784
369534	394937	394726	315789	789345
134631	212356	Ø35789	284321	567853
21789Ø	213785	1Ø5789	29Ø361	351Ø6Ø

TABLE NO. 13-E

897643	743928	46859Ø	236419	342568
9Ø7654	234567	Ø37829	425363	743568
394857	2Ø3948	243581	893745	298347
3625Ø1	395746	17824Ø	293641	273Ø54
789234	345267	9Ø2385	Ø98345	2Ø3948
654321	456734	921374	821967	3679Ø9
638165	276435	13762Ø	3Ø8954	Ø1Ø234
654566	237891	785684	1Ø6759	892134
352189	983654	6789Ø1	287345	1Ø2345
294735	342678	123478	293742	Ø24681
273546	Ø87654	213Ø89	252438	2Ø3691
312468	37423Ø	12345Ø	242Ø21	234687
2Ø3694	432168	23863Ø	211Ø53	987654
321145	537293	212Ø36	2Ø4567	382947
313256	218954	21389Ø	Ø12345	314158
31789Ø	5136Ø9	267845	123987	357948
22Ø142	84391Ø	976391	534275	756948
3456Ø7	44819Ø	315678	275685	384752
543278	594837	31Ø389	29Ø453	2Ø789Ø
432123	415678	574839	287643	Ø36792

SIGNAL COMMUNICATION TRAINING MANUALS

Corrected to February, 1925

No.
20. Basic Signal Communication—Students Manual.
21. Basic Signal Communication—Instructors Guide.
22. Telephone Switchboard Operator—Students Manual.
23. Telephone Switchboard Operator—Instructors Guide.
24. Message Center Specialist—Students Manual.
25. Message Center Specialist—Instructors Guide.
26. Radio Operator—Students Manual.
27. Radio Operator—Instructors Guide.
30. Meteorological Observer—Students Manual.
31. Meteorological Observer—Instructors Guide.
32. Pigeoneer—Students Manual.
42. Lineman—Students Manual.
43. Lineman—Instructors Guide.

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UNITED STATES ARMY

TRAINING MANUAL No. 26

RADIO OPERATOR

STUDENTS MANUAL
FOR ALL ARMS

Part II. TACTICAL RADIO PROCEDURE

VOLUME 2

PREPARED UNDER THE DIRECTION OF
THE CHIEF SIGNAL OFFICER

1925

WASHINGTON
GOVERNMENT PRINTING OFFICE
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RL-P-5549

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CERTIFICATE: By direction of the Secretary of War, the matter contained herein is published as administrative information and is required for the proper transaction of the public business.

WAR DEPARTMENT,
WASHINGTON, *February 2, 1925.*

Texts for training in the Army are to be prepared and revised from time to time by the branches of the service concerned, and when approved, published by The Adjutant General of the Army as a series of training manuals.

In accordance with this plan there has been prepared by the Signal Corps a series of pamphlets relating to the training of radio operators.

The pamphlets in this series are titled as follows:

Training Manual No. 20—Basic Signal Communication, Students Manual.

Training Manual No. 21—Basic Signal Communication, Instructors Guide.

Training Manual No. 26—Radio Operator, Students Manual.
- Part I—Radio Sets.
- Part II, Vol. I—Code Practice.
- Part II, Vol. II—Tactical Radio Procedure.

Training Manual No. 27—Radio Operator, Instructors Guide.
- Part I—Radio Sets.
- Part II, Vol. I—Code Practice.
- Part II, Vol. II—Tactical Radio Procedure.

A complete list of training manuals for Signal Communication Specialists may be found on the last page of this document.

This pamphlet is published for the information and guidance of all concerned.

BY ORDER OF THE SECRETARY OF WAR:

J. L. HINES,
Major General,
Chief of Staff.

OFFICIAL:
ROBERT C. DAVIS,
Major General,
The Adjutant General.

PREFACE

1. *a*. Part II, volume 2, Training Manual No. 27, The Radio Operator, is a training course in Tactical Radio Procedure.

b. The Students Manual consists primarily of the procedure which an operator with radio stations of tactical units is required to know in order to be proficient. This material has been analyzed and arranged in teaching units called "Unit Operations." The Unit Operations have been so arranged that the instruction is progressive.

2. The established Signal Corps Training Policy has been followed in this manual.

a. All the principles and rules necessary to govern the operation of tactical radio nets, together with the necessary explanatory matter to show the cause, effect, or operation of these rules, have been arranged in as logical order as possible in the Information Topics.

b. The material in the Information Topics has been analyzed into teaching units, called Unit Operations. For instance, the basic procedure signs and radio operating signals necessary for the most elementary transmission are taken up in Unit Operation No. 1.

c. Each Unit Operation contains all the information necessary for the work contained therein. A series of steps or hurdles is provided within each of these teaching units. There is also given the information and directions for the practice necessary in learning to jump each hurdle. The actual instruction in this teaching unit may require 15 minutes, or two 1-hour periods or more, but all the steps or hurdles are closely related within each Unit Operation. This teaching unit is called a Unit Operation in Signal Corps Training Manuals primarily to emphasize the Signal Corps and Army policy of teaching men by the applicatory method, by having them *do* things. Hence, the sum of the things to be done by the student is called a Unit Operation.

d. Additional procedure signs and operating signals are taught as their need is developed.

e. The Instructors Guide consists primarily of suggestions for handling classes, suggestions for giving applicatory problems, and instruction, progress and proficiency tests.

3. It should be noted that this method is quite different from that of requiring each individual instructor to take the material contained in Information Topics and arrange his own course of instruction from it.

4. Suggestions for the improvement of this manual should be addressed to The Chief Signal Officer.

RADIO OPERATOR

STUDENTS MANUAL FOR ALL ARMS

CONTENTS

	Page
U. O. No. 1. The call up and answer	1
U. O. No. 2. Errors and repetitions	7
U. O. No. 3. Use of radio message blanks for transmission and reception	11
U. O. No. 4. Operation of a controlled net and the use of traffic sheets	17
U. O. No. 5. Establishing a net and reporting out of a net	22
U. O. No. 6. Operation of a directed net	24
U. O. No. 7. Operation of a free net	27
U. O. No. 8. Changing the N. C. S. and designating the N. C. 2	29
U. O. No. 9. Transmission of long messages and transmission to a silent station	32
U. O. No. 10. Transmitting messages between stations in different nets of the same type	35
U. O. No. 11. Relaying messages, case I	37
U. O. No. 12. Relaying messages, case II	41
I. T. No. 1. General rules	43
Index	87

INDEX OF ILLUSTRATIONS

Figure No.	Title	R. O. No.	Page
	Frontispiece	RL-P-5549	I
1	A typical message as received by the radio operator from the message center	1	12
2	The message blank shown in Fig. 1 after it has been properly prepared for transmission by the operator	2	13
3	After the radio message blank (transmission) has been completed as shown above, it is kept at the radio station	3	14
4	Showing the four main parts of the message blanks (reception)	4	15
5	A message blank (reception) ready to go to the message center	6	16
6	Traffic sheet for controlled nets		18
7	Traffic sheet shown in Fig. 6, as it would appear after all the traffic has been cleared		19
8	Two different nets of the same type	16	35
9	Relayed message with the heading of the blank filled out by the transmitting operator at the station of origin	7	38
10	The message shown in Fig. 9, with the new heading prepared by the relay station operator	8	38
11	Two different nets with stations at the same headquarters	9	42

RADIO OPERATOR

TACTICAL RADIO PROCEDURE

STUDENTS MANUAL FOR ALL ARMS

UNIT OPERATIONS

THE CALL UP AND ANSWER

Information.

Radio communication, like telephone communication, involves the calling up of the desired party and his answer before any messages or information may be transmitted. In telephone communication each subscriber is designated by a number, while in radio communication each station is designated by a "call sign." This call sign will consist of several letters or a combination of letters and numbers. Since there may be a number of radio stations on the same wave length, when calling a station it is necessary to state the call sign of the station calling, in order that the called station may know to whom his reply should be directed. An attention signal is used to notify all stations who may hear it, that a call is about to be sent. A signal meaning "from" separates the call sign of the station being called from the call sign of the station calling. Call signs transmitted in a call are sent twice so that if they are not read the first time it may be done the second. The following is an example of the proper transmission of a call:

Attention signal	Call sign of station called		"From"	Call sign of station calling	
$\overline{\text{VE}}$	XA2	XA2	V	XB3	XB3

One and two-character signals, to which arbitrary meanings are assigned are called procedure signs. $\overline{\text{VE}}$ and V are one-character procedure signs. (See Par. 43, I. T. No. 1.)

However, to simply call a station without telling what is wanted is a waste of time, consequently the rule has been made that whenever a station is called for the first time an operating signal will be sent which will say what is wanted of the called station. An operating signal is a three-character signal to which a meaning has been assigned. (See Par. 43, I. T. No. 1.) For the same reason that the call sign of a station is sent twice, operating signals which are used in the original calling of a station are sent twice. It is important that the station called shall know when the transmitting station is through sending. To tell the receiving station this, an "ending sign" is sent at the end of every transmission. The combination of the call, the operating signal, and the ending sign is termed a "call up." The "space sign" II, is used to separate the different parts of the call up as shown in the following example:

$\overline{\text{VE}}$ XA2 XA2 V XB3 XB3 II ZTF ZTF II $\overline{\text{AR}}$

The operating signal ZTF means "I have a message for you." The procedure sign $\overline{\text{AR}}$ (and ending sign) means this is the end of this transmission.

The answer to a call up will consist of a call, a procedure sign which tells what the operator wishes to do, and an ending sign. In the answer to a call up the call signs of each station are sent twice but the procedure sign indicating the action desired is sent only once. This is because the two stations are now in communication and there is little likelihood that the first sending of the procedure sign will not be read. The following is a possible answer to the call up given above:

$\overline{\text{VE}}$ XB3 XB3 V XA2 XA2 II K

The procedure sign K is an ending sign meaning "go ahead."

The operator at XB3 on receiving the above answer to his call up would then proceed to transmit the message which he had for station XA2. Station XA2, when he had copied the message sent to him would acknowledge its receipt by sending:

$\overline{\text{VE}}$ XB3 XB3 V XA2 XA2 II R

The procedure sign R is an ending sign meaning "received."

Directions.

1. Groups of five or six students will take their assigned positions in the code room. These positions will be connected together so as to form a table net. That is, the operator at each position will be able to hear the sending of all of the others and in turn be able to send to all. The instructor will furnish each student with a list showing the position to which each student is assigned, his call sign, and the organization which he represents. This list will be somewhat as follows:

Operator	Unit	Call sign
Smith, G. W.	1st Bn 1st Inf.	XA1
Jones, A. F.	2d Bn 1st Inf.	XB2
Johnson, J. O.	3d Bn 1st Inf.	XC1
Brown, M. O.	1st Bn 1st F. A.	XD2
Instructor	1st Inf.	XF2

Log sheets, the use of which has been previously explained to the student, will also be provided. Each student should at all times have several sharp pencils.

2. After all of the students operating in the net have taken their assigned positions and are ready to commence, the instructor will call one of them as follows:

$\overline{\text{VE}}$ XB2 XB2 V XF2 XF2 II ZTF ZTF II $\overline{\text{AR}}$

The student should reply:

$\overline{\text{VE}}$ XF2 XF2 V XB2 XB2 II K

The instructor will then transmit to the student a message of eight or ten code groups. On completion of the message the student will acknowledge for it by sending:

$\overline{\text{VE}}$ XF2 XF2 V XB2 XB2 II R

All students in the net will copy all transmissions in the net whether they are addressed to them or not.

Questions.

1. *Of what does a call consist?*

2. *Of what does a call up consist?*

3. *Why are the call signs of the station sent twice in a call or call up?*

4. *Why is the three-character procedure sign sent twice in a call up?*

5. *Of what does the answer to a call up consist?*

6. *In an answer to a call up, is the procedure sign which tells the calling operator the wishes of the operator called sent only once?*

7. *Why is an ending sign used?*

8. *What transmissions does each operator in the net ccpy?*

9. *Between what parts of a call up is the space sign used?*

Information.

Radio stations of an army in the field are organized into what are called "nets," each net including a definite list of stations. The purpose of organizing the radio stations into nets is to control them so that they will operate most efficiently. The operation of the net is controlled by one of the stations of the net which is known as the

"Net Command Station" (N. C. S.). This station is generally the one at the headquarters of the highest tactical unit which the net serves. Instructions or commands issued by the N. C. S. of a net are binding on all other stations in the net and must be strictly followed. The other stations in the net are called "Secondary Stations."

The N. C. S. often wishes to know what messages the secondary stations have on file. The procedure sign ZLV when used as a call sign means that the transmission which follows is addressed to all stations in the net and that they will all stop transmitting and copy. The N. C. S. therefore transmits:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZAQ ZAQ II $\overline{\text{AR}}$

ZAQ means "Have you anything to transmit?"

The secondary stations of the net answer the above transmission of the N. C. S. in the "Order of Operation." The order of operation is the order in which the stations are listed on the card giving the call signs unless some other order has been designated. A secondary station might answer the above transmission of the N. C. S. in one of the three following ways:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZBJ II $\overline{\text{AR}}$

ZBJ means "Have nothing to transmit to any station in the net."

Or:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZTF II $\overline{\text{AR}}$

ZTF means "Have messages for you."

Or:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZAR XD2 II $\overline{\text{AR}}$

ZAR followed by XD2 means "Have messages for XD2."

When the reply of the first secondary station has been acknowledged by the N. C. S., the second secondary station on the order of operation will report his messages on file and so on until all of the stations have reported. If a secondary station fails to answer when its turn comes, the next station in the order of operation will wait one minute and then go ahead.

Sometimes, when a station receives a call up it is impossible or undesirable to take a message at that moment, so that it becomes necessary to tell the calling station to "wait." This is done as follows:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II Q

The procedure sign "Q" means "wait." A station sending "wait" should comply with the request of the N. C. S. as soon as possible.

For example, if station XA1 calls XF2 and says, "ZTF," and XF2 answers by saying, "Q," then the next call up of XA1 by XF2 might be as follows:

VE XA1 XA1 V XF2 XF2 II K

This means "go ahead and send the message you have for me."

The operating signal ZLX means "close station" and if it is desired to send it to all stations the "net call" must be given. This would be done as follows:

VE ZLV ZLV V XF2 XF2 II ZLX ZLX II AR

ZLV is the net call and means "all stations stop transmitting and copy."

Stations would acknowledge receipt of the above in the order of operation.

Directions.

3. The same call signs, position assignments, etc., that were issued under Direction No. 1, will be used. In addition, the instructor will issue to each student one code message of eight to ten groups. All messages will be addressed to the N. C. S. The instructor will call one of the secondary stations as follows:

VE XD2 XD2 V XF2 XF2 II ZAQ ZAQ II AR

The secondary station will reply as follows:

VE XF2 XF2 V XD2 XD2 II ZTF II AR

The N. C. S. will call several other secondary stations in the same way, acknowledging the report of each by sending the signal "Q."

4. The N. C. S. will then call one of the secondary stations that has previously given a report of its messages directing the station to "go ahead." After this station has transmitted its message and the N. C. S. has acknowledged it, the N. C. S. will transmit the the following to one of the other secondary stations and say:

VE XA1 XA1 V XF2 XF2 II ZTF ZTF II AR

The secondary station should reply:

VE XF2 XF2 V XA1 XA1 II K

and the N. C. S. should then send the message, which the secondary station will acknowledge.

5. After all of the secondary stations have communicated with the N. C. S. in one of the ways given in Direction No. 5 the N. C. S. will transmit as follows:

VE ZLV ZLV V XF2 XF2 II ZAQ ZAQ II AR

Secondary stations should answer the above transmission in the order of operation giving a report of the messages they have on file. The N. C. S. will then proceed to grant permission to the secondary stations to transmit their messages. This will continue until all of the messages reported have been handled.

Questions.

10. What is a "net"?

11. Why are radio stations organized into nets?

12. What is the "N. C. S"?

13. What station of the net is generally the N. C. S.?

14. How is the operating signal ZLV used? How is it answered?

15. What is meant by the "order of operation"?

ERRORS AND REPETITIONS

Information.

The student has probably noted in Unit Operation No. 1 that an operator often wishes to correct his own errors in sending or to ask the other operator about some part of the transmission which he has had trouble in receiving. Nearly all tactical messages sent by radio are in code; consequently the text of the message is no check on its accuracy, as is the case when messages are sent in plain language. It is therefore very important that errors do not occur, or that when they do occur they may be easily and quickly corrected.

Errors in sending are generally known to a good operator the instant he makes them; therefore he can correct them instantly. The procedure sign "E" sent 10 times in rapid succession means erase. It is the same as saying: "I have just made an error in transmission. Erase the last word or group that you received and I will start over again with the last word or group that was sent correctly." An example of the use of "E" follows:

VE XF2 XF2 V XD2 XD2 II ZAQ
ZAY EEEEEEEEEE ZAQ ZAQ II AR

which means "ZAY is wrong. The groups after II should be ZAQ ZAQ II AR."

If a receiving operator is at any time doubtful of his reception of any part of a transmission he should ask for a repetition of that part. The procedure sign IMI means "repeat" or "I am about to repeat." If the receiving operator desires that the entire transmission be repeated he should send as follows:

VE XD2 XD2 V XF2 XF2 II IMI II AR

meaning "repeat your last transmission." Note that the procedure sign IMI is in this case sent only once. This due to the fact that the transmission is not an original call up. The answer to the above transmission would be the repetition asked for.

In most cases, however, it is unusual to have more than one or two words or a small part of a message repeated. It then becomes necessary to designate in some manner the words or groups which it is desired to have repeated. One method of doing so will be taken up here. The procedure sign WA means "words or groups after" and is used in the following manner: Suppose that the receiving operator has missed all of the message after a certain group. In order to obtain a repetition of the groups missed he would transmit:

VE XF2 XF2 V XD2 XD2 II IMI WA CFHK II AR

where CFHK was the last group that he had received correctly. The answer to the above transmission would be:

VE XD2 XD2 V XF2 XF2 II CFHK TURD SCXI OUMW II AR

the last three groups being those missed.

The case also occurs where several groups are missed but they are not at the end of the message; consequently it would be a waste of time to have the transmitting operator repeat all of the message after the last group which was missed. The procedure sign $\overline{\mathrm{XE}}$ is written thus: / (oblique stroke). It is used to mean "to." Thus the group 8/15 is transmitted 8 XE 15, where 8/15 means code groups 8 to 15, both inclusive. Suppose that the receiving operator misses several groups in the middle of the message and desires to have them repeated. He would transmit as follows:

$\overline{\mathrm{VE}}$ XF2 XF2 V XD2 XD2 II $\overline{\mathrm{IMI}}$ WA FDCJ $\overline{\mathrm{XE}}$ UTYS II $\overline{\mathrm{AR}}$

meaning "Repeat the groups after FDCJ to the group UTYS."

Directions.

1. Each student will be issued a list showing the position assignments in the code room, the call signs, etc. All copying will be done on the standard log sheet form and all students will copy all transmissions occurring in the net, except their own which will be indicated with sufficient detail to tell what they were. The instructor will be the N. C. S. of the net. The time for starting the operation of the net will be designated by the instructor.

2. The instructor will file with each student several messages addressed to different stations in the net. Students will not transmit any message without first being told to do so by the N. C. S. The instructor will start the operation of the net by transmitting as follows:

$\overline{\mathrm{VE}}$ ZLV ZLV V XF2 XF2 II ZAQ ZAQ II $\overline{\mathrm{AR}}$

Secondary stations of the net should answer the above transmission of the N. C. S. in the order of operation by giving a report of the traffic they have on file. (See Direction 4, U. O. No. 1.) The N. C. S. will direct one of the secondary stations to send a message and following this, the N. C. S. will send a message. The N. C. S. will continue to alternate in this manner. All operators will be required to use the proper procedure in correcting their own transmitting errors and in asking for repetitions.

Questions.

1. How many times is the procedure sign "E" sent when correcting an error?

2. If an operator missed the last four or five groups of a message how would he obtain their repetition?

3. If four or five groups in the middle of a message were missed how would their repetition be obtained?

4. Why is absolute accuracy necessary in tactical messages sent by radio?

5. How is the repetition of an entire message obtained?

Information.

After communication between two radio stations has been established by a call up and its answer, the actual message is trasmitted. However, in sending the message it is necessary to send more than the message itself. This additional information is contained in what is known as the "heading" of the message. In order to clearly separate the heading from the message itself the procedure sign "BT" is used. Thus, the transmission of a message might appear as follows:

$\overline{\text{VE}}$ XD2 XD2 V XF2 XF2 $\overline{\text{BT}}$ XDEA IUHR DEIN GRQK FRZO II $\overline{\text{AR}}$

The code groups following $\overline{\text{BT}}$ constituted the message itself, that is, the "text" of the message. The heading as given above is not complete, however.

Unless the receiving operator knows how many code groups should be in the text of the message it is entirely possible for him to miss some of them and still think that he has received the entire message. In order to prevent an error like this the number of code groups composing the text of the message is given in the heading of the message:

$\overline{\text{VE}}$ XD2 XD2 V XF2 XF2 II GR 5 $\overline{\text{BT}}$
HYTF GRWK FDMH IUCH WQIM II $\overline{\text{AB}}$

The receiving operator should count the number of groups received between $\overline{\text{BT}}$ and the ending sign and should only acknowledge for the message if his count agrees with the number given in the heading. If it does not agree the receiving operator should call the transmitting operator as follows:

$\overline{\text{VE}}$ XF2 XF2 V XD2 XD2 II $\overline{\text{IMI}}$ ZCN II $\overline{\text{AR}}$

ZCN means "How many groups were in the message you just transmitted to me?" If the number given by the transmitting station in reply to the above still does not check with the number of groups actually received the receiving operator should ask for a repetition of the entire message.

In order to identify its messages a message center gives each one a serial number known as the "message center serial number." This number must be transmitted as a part of the heading of the message to which it is given in order that if necessary at some later time the receiving operator may refer to the message by that number. An example of the heading of a message containing both the check (GR....) and the message center serial number (NR....) follows:

$\overline{\text{VE}}$ XD2 XD2 V XF2 XF2 II NR $\underline{1}$ II GR 5 $\overline{\text{BT}}$ .... II $\overline{\text{AR}}$

NR $\underline{1}$ GR 5 means that the message is number one and has five groups in its text.

The groups in the text of a message are numbered consecutively from the beginning to the end for the purpose of referring to any of them. This numbering is made use of in asking for repetitions.

For example, suppose that the receiving operator has missed the second, fifth, and eighth groups of a message and wants them repeated. He transmits:

$\overline{\text{VE}}$ XF2 XF2 V XD2 XD2 II $\overline{\text{IMI}}$ GR 2 II GR 5 II GR 8 II $\overline{\text{AR}}$
meaning "Repeat groups 2, 5, and 8."

The transmitting operator would reply to the above as follows:

$\overline{\text{VE}}$ XD2 XD2 V XF2 XF2 II GR 2 DFUO II
GR 5 UTEK II GR8 EWOH II $\overline{\text{AR}}$

giving groups 2, 5, and 8. Or, if the receiving operator had missed several consecutive groups, he might transmit:

$\overline{\text{VE}}$ XD2 XD2 V XF2 XF2 II $\overline{\text{IMI}}$ GR 6 $\overline{\text{XE}}$ GR 9 II $\overline{\text{AR}}$
meaning "Repeat groups 6 to 9." This is an alternative to using "WA."

Directions.

3. With the same call sign, position assignments, etc., as given under Direction No. 1 the instructor will file with each station of the net several messages of 10 to 12 groups, each which will have written on its face the message center serial number assigned to it. When all stations are ready to start operating, the instructor, acting as N. C. S., will call one of the secondary stations and ask if he has anything to transmit. The secondary station should reply by saying that he has a message for either the N. C. S. or one of the other secondary stations. The N. C. S. will tell him to "go ahead."

4. The N. C. S. will continue to call different secondary stations and tell them to transmit a message until all of the traffic filed has been dispatched.

Questions.

6. *What is the heading of a message?*

7. *Of what does the heading of a message consist?*

8. *What is the text of a message?*

9. *How is the heading separated from the text of a message?*

10. *Why are the number of groups in the text of a message given in the heading?*

11. *How should a receiving operator check a message before acknowledging it?*

12. *How would a receiving operator who had missed the check of a message as given in its heading obtain a repetition of the check?*

13. *If the number of groups actually received in a message is not the same as that given by the check what should be done?*

14. *What number is transmitted in the heading of a message? Why?*

THE USE OF RADIO MESSAGE BLANKS FOR TRANSMISSION AND RECEPTION

Information.

The originator of a message writes it on the Field Message Blank and sends it to the message center for transmission. The message center employs the most suitable means available for the transmission of messages so entrusted to it. When the message center desires to have a message transmitted by radio, they encode it, writing the code groups in the space marked "Text" on the radio message blank (transmission).

In order that the radio operator, who may have several such encoded messages to transmit, may know which ones are the most important, the message center places on the radio blank (transmission) the class of the message. For this purpose the message center inserts one of the following procedure signs; P, $\overline{\text{OD}}$, and D, following the words "Class of message --------" in the space provided for message centers. A "P" or Priority Message is one which must be sent at once and which takes precedence over any other class of message. An "$\overline{\text{OD}}$" or Rush Message ranks next to priority messages. "D" or ordinary messages are the least urgent of any. Messages of the same class are sent in so far as possible in the order in which they were filed. However, this order is not allowed to delay traffic. Operators will attempt to send all P, then all $\overline{\text{OD}}$ then all D messages. If the message can not be sent, notify the message center and send the $\overline{\text{OD}}$ and D messages,

The message center sends the encoded message to the radio station. The radio operator inserts the proper procedure sign in the heading of the message. The following is an example of a heading as it is actually transmitted:

$\overline{\text{VE}}$ XF2 XF2 V XD2 XD2 II NR 3 II $\overline{\text{OD}}$
II GR8 $\overline{\text{BT}}$ -------- II $\overline{\text{AR}}$

$\overline{\text{OD}}$ means that the message is a "rush" message.

From a study of this blank it will be seen that it is divided into four main parts. That part between the first two sets of parallel lines is for the use of the message center and will be filled out by them. The second part, the heading, is arranged for the convenience of the radio operator. The third part contains nothing but the text of the message and is filled in by the message center. The fourth part is filled in by the radio operator when the message has been sent or when it is decided that it can not be sent.

Fig. 1 shows a typical message as received by the radio operator from the message center. Note that $\overline{\text{VE}}$, the space sign II, and $\overline{\text{AR}}$ which appear in the transmission above do not appear on the blank.

The radio operator in preparing this message for transmission does the following things:

a. Looks up the call sign of the organization to which the message is to be sent (in this case, the 2d Inf.) and inserts it in the space above the words "Station called" in the second part of the blank.

b. Inserts his own call sign in the space above the words "Station calling."

c. Inserts in the space over the words "Message center serial number" in the second part of the blank the message center serial

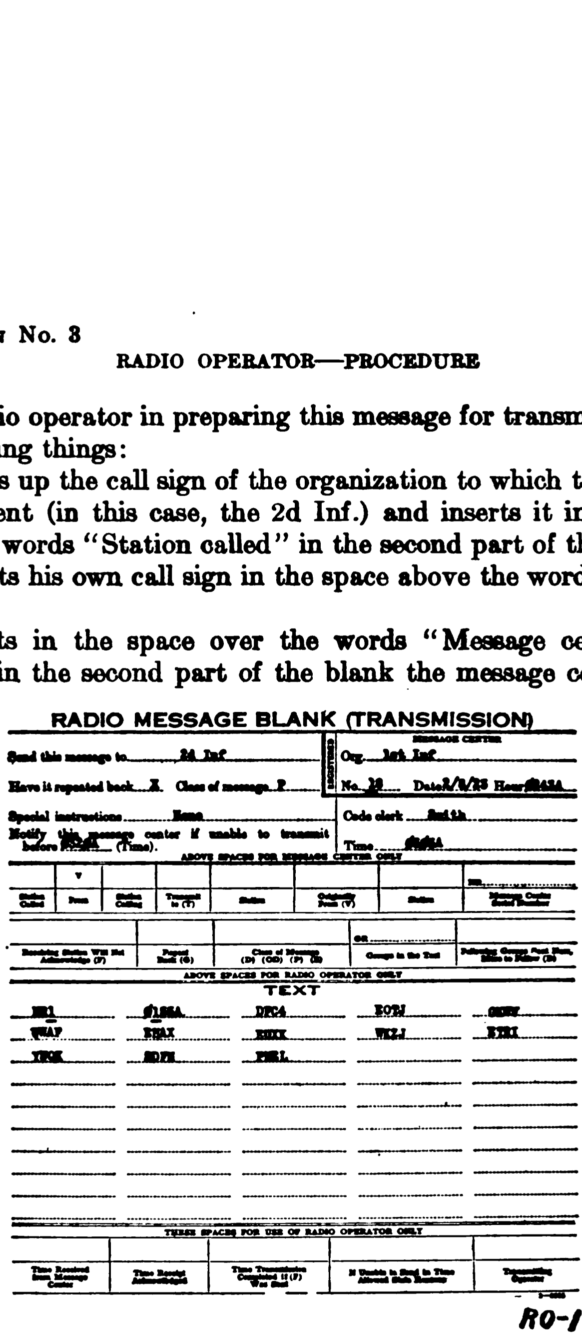


Fig. 1.—A typical message as received by the radio operator from the message center

number which he obtains from the space in the upper right-hand corner of the first part of the blank.

d. Inserts the procedure sign "G" in the space above the words "Repeat back" (G) in the heading, if the blank space following the words, "Have it repeated back," in the first part of the message blank is checked.

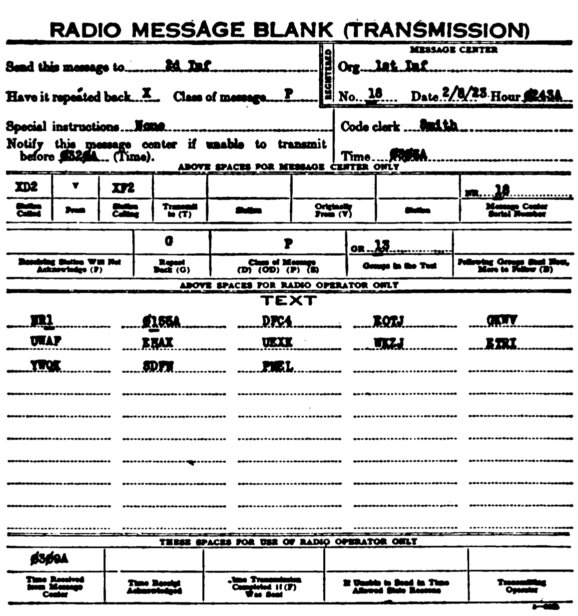
e. Inserts in the space above the words "Class of message" in the second part of the blank, the procedure sign showing the class of the message which is given after the words "Class of message" in the first part of the blank.

f. Counts the number of groups composing the text of the message and insert this number in the space above the words "Groups in the text" in the second part of the blank.

The blank shown in Fig. 1 is shown in Fig. 2, after it has been properly prepared for transmission by the operator.

XD2 is the call sign of the Second Infantry and XF2 is that of the First Infantry. When the messenger from a message center delivers a message to a radio station, the radio operator initials the delivery list presented and immediately enters the "time received from the message center" on the radio message blank (transmission).

After the operator has transmitted the message and received an acknowledgment for it he will complete the blank as shown in Fig. 3.


RADIO MESSAGE BLANK (TRANSMISSION)

MESSAGE CENTER

Send this message to 2d Inf | Org. 1st Inf

Have it repeated back X Class of message P | No. 18 Date 2/8/23 Hour Ø243A

Special instructions None | Code clerk Smith

Notify this message center if unable to transmit before Ø32ØA (Time). | Time Ø3ØØA

ABOVE SPACES FOR MESSAGE CENTER ONLY

XD2	V	XF2					NR 18
Station Called	From	Station Calling	Transmit to (T)	Station	Originally From (V)	Station	Message Center Serial Number

	G	P	GR 13	
Receiving Station Will Not Acknowledge (F)	Repeat Back (G)	Class of Message (D) (OD) (P) (R)	Groups in the Text	Following Groups Send Now, More to Follow (B)

ABOVE SPACES FOR RADIO OPERATOR ONLY

TEXT

NR1	Ø155A	DFC4	KOTJ	GKWV
UWAP	EHAX	UEXX	WKZJ	ETRI
YWOK	SDFN	PMEL		

THESE SPACES FOR USE OF RADIO OPERATOR ONLY

Ø3ØØA				
Time Received from Message Center	Time Receipt Acknowledged	Time Transmission Completed if (F) Was Sent	If Unable to Send in Time Allowed State Reasons	Transmitting Operator

RO-2

Fig. 2.—The message blank shown in Fig. 1 after it has been properly prepared for transmission by the operator

The procedure sign "G" means "the receiving operator will repeat back this message." It is sent in the heading of the message as follows:

V̄Ē XD2 XD2 V XF2 XF2 II NR
18 II G II P II GR 13 B̄T̄--------

After the radio message blank (transmission) has been completed as shown in Fig. 3 it is kept at the radio station. All such blanks are sent to the message center at least once in every 24 hours.

Directions.

1. Students will be grouped into nets as in the previous Unit Operations and will be issued lists showing call signs, position assignments, organizations, etc. The instructor will issue to each student five or six prepared messages addressed to the different organizations in the net.

2. When directed by the instructor the student will:

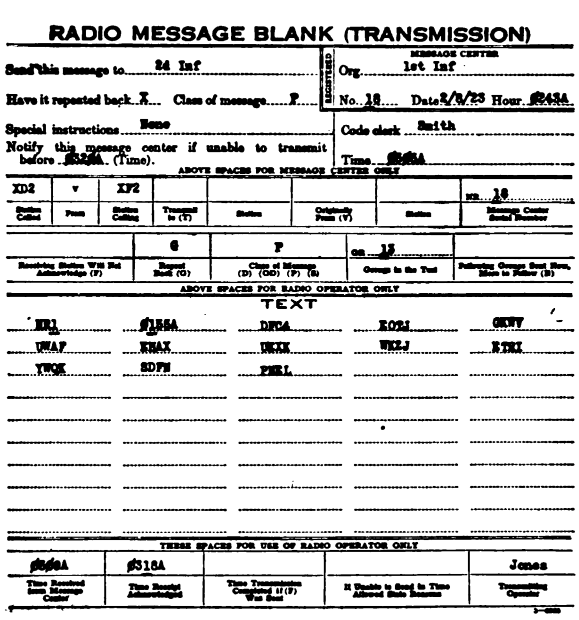
a. Fill out the second part of the message blank.

b. Fill out the fourth part of the blank, making the time at which the receipt was acknowledged 10 minutes later than the code clerk's time.

Questions.

1. Who assigns a "Class" to a message?

2. What are the three procedure signs introducing the class of a message and what class does each indicate?



RADIO MESSAGE BLANK (TRANSMISSION)

Send this message to 24 Inf
Have it repeated back X Class of message P
Special instructions None
Notify this message center if unable to transmit before ..... (Time).

MESSAGE CENTER
Org. 1st Inf
No. 18 Date 2/9/23 Hour .....
Code clerk Smith
Time .....

ABOVE SPACES FOR MESSAGE CENTER ONLY

XD2	v	XF2					NR 18
Station Called	From	Station Calling	Transmit to (T)	Station	Originally From (V)	Station	Message Center Serial Number

	G	P	GR 15	
Receiving Station Will Not Acknowledge (F)	Repeat Back (G)	Class of Message (D) (OD) (P) (S)	Groups in the Text	Following Groups Sent Here, More to Follow (B)

ABOVE SPACES FOR RADIO OPERATOR ONLY

TEXT

NR1	Ø155A	DFCA	KOZJ	GKWV
UWAP	KHAX	UKXX	WKZJ	ETKI
YWQK	SDFN	PHKL		

THESE SPACES FOR USE OF RADIO OPERATOR ONLY

ØØØØA	Ø318A			Jones
Time Received from Message Center	Time Receipt Acknowledged	Time Transmission Completed if (F) Was Sent	If Unable to Send in Time Allowed State Reasons	Transmitting Operator

RO-3

Fig. 3.—After the radio message blank (transmission) has been completed as shown above it is kept at the radio station

3. What blank form is a message originally written on?

4. What is the purpose of the second part of the radio message blank (transmission)?

5. How does the operator obtain the number of groups in a message?

6. What does the procedure sign "G" mean?

7. If the space after the words "Have it repeated back" in the first part of the blank is checked, what does the operator do?

8. What is done with the message blank after the message has been sent and acknowledged?

Information.

The radio operator in receiving a message copies it on the Radio Message Blank (Reception). This blank is furnished for the convenience of the operator and the message center who must decode the message. It is essential that the message center be able to read without error the copy the operator has written. Therefore it is required that all copying on this blank be done in printed capital letters. Fig. 4 shows the radio message blank (reception).

It will be seen from Fig. 4 that the blank is composed of four main parts. The first part is the portion at the top of the blank where the operator copies the heading of the message. The second part is the center portion of the blank where the text of the message is copied. The third part includes the spaces under the text of the message which are filled out by the operator, while the fourth part includes those spaces at the bottom of the blank which are used by the message center.

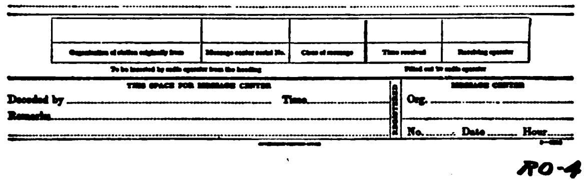


Fig. 4.—Showing the four main parts of the message blanks (reception)

The heading of the message is separated from the text by the procedure sign $\overline{BT}$. The receiving operator copies on the first part of the blank all of the message which comes before the sign $\overline{BT}$. In copying the heading he puts down only once those procedure signs and call signs which are sent twice and does not copy the space sign "II." Fig. 4 also shows how the receiving operator would fill out the first part of the blank for the message shown on the transmission blank in Fig. 2.

A carbon copy is always made of all received messages and kept at the radio station. The original copy is sent to the message center. It will be noted that the blanks are so bound that every other one is perforated and can be removed from the book. This is the one on which the original copy of the message should be made.

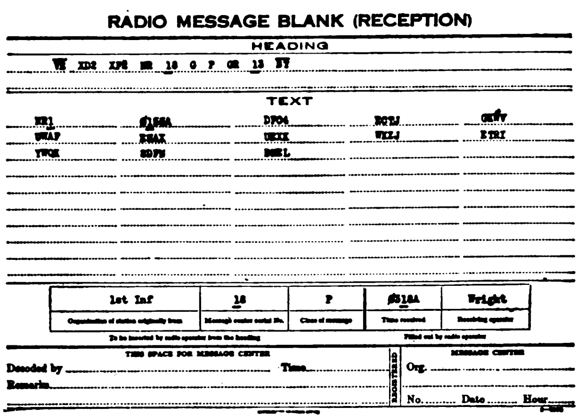
The text is printed in the second part of the blank, placing one code group on each section of the dotted line, thus making five groups to the line.

The first three blank spaces in the third part of the message blank are filled in from the information given in the heading of the message. The receiving operator notes the time that he transmits R and enters this time in the space marked "Time received." The receiving operator signs his name in the fifth space. Fig. 5 shows a blank ready to go to the message center.

Directions.

3. With the same net organization, call signs, positions, etc., as given in Direction No. 1 and with each student having the messages he has prepared under Direction 2, the instructor as the N. C. S. will start the operation of the net.

4. Received messages will be copied on the Radio Message Blank (reception) and the blank completely filled in except for those portions intended for the message center.



RO-5

Fig. 5.—A message blank (reception) ready to go to the message center

5. At the completion of this unit operation all copies of both transmitted and received messages will be turned in to the instructor for correction.

Questions.

9. What is copied on the first part of the reception blank?

10. On the second part?

11. Why is capital letter printing employed?

12. How many code groups are printed per line?

13. The time inserted in the blank space over "Time received" should correspond to what time on the transmission blank?

14. Who fills out the fourth part of the reception blank?

15. How many copies of the received message are made?

16. Which copy is sent to the message center?

OPERATION OF A CONTROLLED NET AND THE USE OF TRAFFIC SHEETS

Information.

The main purpose in organizing the radio stations of the Army into nets is to insure control over the several stations forming a net and to so supervise their operation that the greatest possible use is made of the stations. If operators are left entirely on their own initiative, traffic will often become jammed and delayed due to no fault of the individual operator but simply because no one operator has control of the situtaion. It is for the above reasons that the command of a net is given to the N. C. S. and that his decisions are made absolute.

Nets may be operated "Free," "Directed," or "Controlled." In this Unit Operation the controlled net will be studied. The general rule which governs a controlled net is observed, so that no station in the net may transmit any signal without permission from the N. C. S. There are certain exceptions to this rule which will be taken up later.

It follows naturally, that since the secondary station can not transmit without being called by the N. C. S., the N. C. S. should know what messages are on file at each of the secondary stations in the net. When the N. C. S. desires to operate a controlled net he transmits:

VE ZLV ZLV V XF2 XF2 II ZZC ZZC II AR

The above transmission is considered not only a statement that the net will be controlled but also a command to report the messages on file. Secondary stations in the net acknowledge the above transmission in the order of operation as follows:

VE XF2 XF2 V XA1 XA1 II ZAR II TWO P
XFQ II ONE OD XB2 II THREE D XC1
II AR

The N. C. S. will acknowledge the above transmission as follows:

VE XA1 XA1 V XF2 XF2 II R

As the reports of messages on file are received by the N. C. S. they are entered on the traffic sheet. Traffic sheets are kept by all stations in the net so that if the N. C. S. should leave the net and another station have to act as N. C. S. it would not be necessary to call for another report of traffic until all the messages previously reported have been cleared. The traffic sheet kept by the secondary stations will be exactly the same as that kept by the N. C. S. except that messages on file at the N. C. S. will not be shown. The following directions will be used in the filling out and keeping of traffic sheets:

TRAFFIC SHEETS

Fig. 6 shows the form for a traffic sheet used in the dispatch of traffic in a controlled net.

In this example the number of lines placed opposite the call signs in the columns headed P, $\overline{\text{OD}}$, and D indicates the number of messages of that particular class from one station to another. Thus station XA1 has one $\overline{\text{OD}}$ and three D messages for station XD1 which were reported at 8.02 a. m.

The manner in which the N. C. S. will dispatch his traffic will be influenced by many factors. Suppose all stations in the net are working on the same wave length; then only one message at a time may be transmitted. If, however, each station has a separate wave length, then there may be transmitted at the same time one message for each pair of stations in the net provided the messages reported are evenly distributed.

NET					DATE		
FROM	TO	Class of message			Time		Remarks
		P	$\overline{\text{OD}}$	D	Reported	Permission granted	
XA1	XB1	1			8:Ø2 A		
XA1	XD1		1	111	8:Ø2 A		
XB1	XA1		11		8:Ø4 A		
XB1	XC1	1		1	8:Ø4 A		
XB1	XD1		1		8:Ø4 A		
XC1	XA1		1		8:Ø7 A		
XD1	XC1	1		1	8:1Ø A		
XD1	XB1			1	8:1Ø A		

Chief Operator.

Fig. 6.—Traffic sheet for controlled nets

The following general rules will always be followed in dispatching messages:

a. All P messages tabulated on the traffic sheet will be cleared before any $\overline{\text{OD}}$ or D messages are sent.

b. All $\overline{\text{OD}}$ messages tabulated on the traffic sheet will be cleared after all P messages have been transmitted.

c. D messages will be cleared when all other messages have been sent.

d. Messages of the same class will be cleared in the order in which the stations at which they originated appear in the order of operation.

e. Priority messages reported by secondary stations between the general reports of traffic on hand, will be cleared in the same manner as those reported at the regular time.

f. When a message must be relayed by one of the stations of the net the N. C. S. will grant permission to the station originating it to transmit the message to a relay station which the N. C. S. will designate. When the N. C. S. operator hears the relay station acknowledge receipt to the secondary station of origin, he will enter the message on his traffic sheet as having been reported by the relay station. The message will then be cleared from the relay station in the usual order.

g. Messages which for any reason can not be sent will be so noted in the column headed "Remarks" on the traffic sheet.

Traffic Sheet for Controlled Nets

NET					DATE		
FROM	TO	Class of message			Time		Remarks
		P	$\overline{\text{OD}}$	D	Reported	Permission granted	
XA1	XB1	I			8:02 A	8:12 A	
XA1	XD1		I	III	8:02 A	8:23 A 8:47 A 8:51 A 8:58 A	
XB1	XA1		II		8:04 A	8:27 A 8:31 A	
XB1	XC1	I		I	8:04 A	8:15 A 9:03 A	
XB1	XD1		I		8:04 A	8:35 A	
XC1	XA1		I		8:07 A	8:40 A	
XD1	XC1	I		I	8:10 A	8:20 A 9:10 A	
XD1	XB1			I	8:10 A	9:16 A	

Chief Operator

Fig. 7.—Traffic sheet shown in Fig. 6, as it would appear after all the traffic has been cleared

In the column headed "Permission granted" the time permission was granted will be noted and at the same time the vertical marks in one of the columns headed P, $\overline{\text{OD}}$, or D (indicating the message for which permission has been granted) will be canceled by drawing an oblique line through it. Where a station has more than one message for another, the time that permission is granted for each message will be entered successively in the column headed "Permission granted" and on the line indicating traffic between those two stations.

Fig. 7 shows the traffic sheet of Fig. 6 as it would appear with all traffic cleared.

Questions.

1. *In what three different ways may a net be operated?*

2. *What is the general rule for a controlled net?*

3. *When secondary stations are told by their N. C. S. that the net is controlled what do they do?*

4. *How does the N. C. S. acknowledge the report of traffic by a secondary station?*

5. *What form is used to tabulate the reports of traffic?*

6. *How can it be told from a traffic sheet whether or not a message has been sent?*

7. *In what order are the messages shown on a traffic sheet cleared?*

8. *What stations in the net keep traffic sheets?*

9. *Are the messages on file at the N. C. S. shown on any other traffic sheet than his own?*

Information.

When the N. C. S. first directs that the net be operated as a controlled net, messages on file are reported as explained previously. After this traffic has been cleared it is necessary for the N. C. S. to call for another report of traffic. This is done as follows:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZFD ZFD II $\overline{\text{AR}}$

Secondary stations will reply in the order of operation as shown previously. If a secondary station had no traffic on file his reply would be:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZBJ II $\overline{\text{AR}}$

The N. C. S. will acknowledge each of the above replies.

After traffic has been reported and tabulated on traffic sheets the N. C. S. will direct the transmission of messages reported as follows:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II
ZZH ZZH II ONE P XF2 II K

Permission is thus granted to XA1 to transmit one priority message to XF2 or:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II ZZH XF2 II ZZH XF2 II K

Permission is granted to XA1 to transmit all messages he has addressed to XF2. This form will rarely be used, as the priority of messages will in general prevent a station clearing all of its messages to another station before some other station is allowed to transmit. Note that the above transmissions end with "K," so that no acknowledgement of them is necessary.

As mentioned in the beginning of this operation, there are certain times when a secondary station operating in a controlled net may call the N. C. S. without permission. They are as follows:

a. To transmit the net call (ZLV) for any purpose for which it may be used except to send a message to all stations.

b. To report out of the net.

c. To report priority messages which have been filed since the last report of traffic on file was called for by the N. C. S.

It must be remembered that the purpose of having a controlled net is to secure the greatest possible control over the stations forming the net and that any unauthorized transmissions will defeat this purpose.

Questions.

1. How does the N. C. S. request secondary stations to report the traffic they have on file?

2. How does the N. C. S. grant permission to transmit a message?

3. Does permission granted to transmit a message cover all transmissions concerning that message?

4. Is permission ever granted to a station to transmit all of its messages regardless of their class?

5. How is the fact that permission has been granted noted on the traffic sheet?

Directions.

1. Obtain from the instructor the following:
   a. Call sign card.
   b. Special instructions for this operation.
   c. Messages to be transmitted.
   d. Traffic sheet, Log sheets, Radio Message blanks (reception).
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

ESTABLISHING A NET AND REPORTING OUT OF THE NET

Information.

A field radio station is established at the headquarters of a unit to serve that unit. These stations therefore conform their operations and changes of location to the movements of the unit to which they are attached. For instance an Infantry Brigade Net is composed of a station at Brigade headquarters and one station of each regiment in that Brigade. In active operations it will often occur that one or more of these headquarters must usually move with it. Due to the above conditions the operator of a station which has just moved does not know what other stations in his net are set up and operating. How does he find out?

Suppose that a radio station has just been established and is ready for operation. The operator will listen in on his net wave length to determine if any of the other stations of his net are working. He will transmit as follows:

$\overline{\text{VE}}$ ZLV ZLV V XA1 XA1 II ZZA ZZA II $\overline{\text{AR}}$

If an answer to the above transmission is received, it will indicate that one or more stations of the net are already established and that the answering station is the regular or acting N. C. S. The answer to the above transmission should contain procedure signs indicating the type of net and the stations in the net, transmitted as follows:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II ZMQ XC2 XB3 II $\overline{\text{AR}}$

Such an answer indicates that station XF2 is in command of the net, which is controlled, and that stations XC2 and XB3 are also in the net. If no stations other than the N. C. S. were in the net the procedure sign ZMQ would have been followed by the word "None" instead of station call signs.

If no answer is received by station XA1 when it transmits the net call and reports into the net it will indicate that XA1 is the first station to be established. XA1 should then act as the temporary N. C. S. until the entrance of the designated net command station into the net. This means that XA1 will answer the reports of other secondary stations into the net as outlined above.

When a net command station sets up and desires to enter the net he will transmit:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZZA ZZA II $\overline{\text{AR}}$

The acting N. C. S., noting that it is the N. C. S. entering the net, will include in its answer procedure signs, giving the type of net then in operation and the stations in the net, as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZZC II XB3 XC2 II $\overline{\text{AR}}$

The N. C. S., after having received the answer to his net call, is then at liberty to take command of the net or to permit it to continue to operate under the acting N. C. S. Note that if the N. C. S. enters a controlled net, takes command and has traffic reported, the report of traffic may have also been given a few minutes before to the acting N. C. S. This causes unnecessary delay and should be avoided. In controlled nets the N. C. S. usually waits to take command until a report of traffic is required.

If the N. C. S., on transmitting his net call, receives no reply he will know that it is the first station of the net to be established and will answer stations which he later hears reporting into the net.

Questions.

1. How many stations are required to form a net?

2. Why is the net call used in reporting into a net?

3. In the absence of the regularly designated N. C. S., what station is in command of a net which has just been established?

4. If on reporting into a net the station is informed that the net is "controlled," what information should its reply contain?

5. How does a station know that it is the first to be established in a net?

6. How often should the first station established call the other stations of the net before they reply or enter the net?

Information.

For various reasons it often becomes necessary for a station to report out of the net in which it is operating. This is done as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZZB ZZB II ONE hour II $\overline{\text{AR}}$

or:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II

where XF2 is the N. C. S. of the net.

Directions.

The instructor will issue to each student a call sign card which will contain, in addition to the usual information, specific directions covering the application of the information given in this Unit Operation to actual operation of the code room tables. These directions must be carefully read by the student and exactly followed on the tables.

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OPERATION OF A DIRECTED NET

Information.

The student has learned from his operation of a controlled net that the control exercised by the N. C. S. is absolute and that secondary stations can do practically nothing without permission from the N. C. S. It is often desirable to operate the net without such strict control and yet maintain discipline and the ability to direct the operation of all secondary stations. This is accomplished by using a "directed" net. The general rule governing the operation of a directed net is that no secondary station may transmit a message without first obtaining permission from the N. C. S. Note that the secondary station may call the N. C. S. at any time and ask for permission to send a message. No report of messages on file is made by the secondary stations.

The directed net will be more often used than any other type of net operation and should therefore be clearly understood. With average operators it will be found that more messages can be handled in a given length of time and with less confusion than in any other type of operation.

Suppose that a net is being operated "controlled" and that the N. C. S. wishes to change to a directed net. He would transmit as follows:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZZD ZZD II AR

Secondary stations in the net would acknowledge the above in the order of operation as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II R

Suppose that station XA1 has a priority message for station XB3 and wishes permission to transmit it. He would transmit as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II
ZAR ZAR II One P XB3 II $\overline{\text{AR}}$

XF2 (the N. C. S.) would answer in one of two ways:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II K

meaning "go ahead and transmit the message"; or:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 II Q

meaning "wait."

If a station had more than one message for another station and wished permission to transmit all of them he would transmit as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 XA1 II ZAR
ZAR II One P TWO $\overline{\text{OD}}$ XB3 II $\overline{\text{AR}}$

The N. C. S. would answer the above in one of the two ways given above or as follows:

$\overline{\text{VE}}$ XA1 XA1 V XF2 XF2 Π ZZH One P II $\overline{\text{VA}}$

meaning "transmit the one priority message only." Note that the above example ends in the procedure sign $\overline{\text{VA}}$, meaning that no acknowledgment is desired. If an acknowledgment was desired, the transmission would have ended in $\overline{\text{AR}}$. The sign $\overline{\text{VA}}$ may be used as an ending sign for any transmission to which no reply is desired.

In order that there may exist an interval during which a station having some very urgent reason for transmitting may do so, the following general rule has been made:

No station will transmit for a period of one-half minute after the end of a previous transmission which requires no answer or acknowledgment, except for the following purposes:

(1) To transmit the net call.
(2) To report a priority message when the net is controlled.
(3) To report out of the net.

The observance of this rule requiring the one-half minute silent interval is very important and must be strictly enforced. Without such an interval stations having very important calls to make are often unable to do so. The interval will most probably be used to the greatest extent by the N. C. S. of the net. In the operation of a directed net the rule is specially important in preventing the confusion which exists when several stations call the N. C. S. at the same time.

Questions.

1. *Why is the "directed" form of net operation employed?*

2. *Is the directed net frequently used?*

3. *What is the general rule regarding the operation of a directed net?*

4. *What information is given when permission is asked to transmit a message?*

5. *In how many different ways may the N. C. S. reply to a request for permission to transmit a message?*

6. *How does the N. C. S. grant permission to transmit only one message when permission has been asked for several?*

7. *What is the general rule regarding the one-half minute silent interval?*

8. *For what purposes may a station transmit during the one-half minute silent interval?*

9. *Why is the silent interval required?*

Directions.

1. Obtain from the instructor the following:
    - *a.* Call sign card.
    - *b.* Special instructions for this operation.
    - *c.* Messages to be transmitted.
    - *d.* Log sheets, and Radio Message blanks, reception.
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

OPERATION OF A FREE NET

Information.

One other type of net operation is used in addition to the two which the student has already studied. It is the "free" net. In operating directed and controlled nets the supervision exercised by the N. C. S. is quite complete and strict. The secondary stations are therefore at all times under very good control. However, where the traffic load is light and the operators in the net are all well trained and experienced it is sometimes desired to allow them more freedom. This is done in the operation of a free net. The general rule for the operation of a free net is that any secondary station may call any other station at any time without permission from the N. C. S. This allows direct communication between stations without the intervention of the N. C. S. and in many cases shortens the time required to handle traffic. When a net is operated free, it does not mean that an N. C. S. no longer exists. The N. C. S. may change the type of net operation.

When operating a free net, particular care must be given to the observance of the rule requiring a one-half minute interval after all transmissions which do not require an answer or acknowledgment. Unless this rule is strictly followed confusion is almost sure to follow. In general, a free net will be the exceptional and not the normal way of working.

The type of net to be operated is decided by the N. C. S., who bases his decision on his knowledge of the ability of the operators in the net, the traffic load, the operating conditions under which the stations must work, etc. The N. C. S. is at liberty to change the type of net at any time. Suppose that a free net is being operated and it is desired to change to a directed net:

$\overline{\text{VE}}$ ZLV ZLV V XF2 II ZZD ZZD II $\overline{\text{AR}}$

is what would be transmitted by the N. C. S. The student has probably noted by this time that net calls which are to be acknowledged are always answered by the stations of the net in the order of operation.

Changing to the controlled net would be done as follows:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZZC ZZC II $\overline{\text{AR}}$

and the answer of each secondary station to the above would contain a report of the traffic he had on file.

Questions.

1. Give the general rule governing the operation of a free net.

2. Under what conditions would a free net be operated?

3. Must a secondary station follow any instructions issued by the N. C. S. when the net is being operated free?

4. Is there more or less chance of confusion when the net is being operated free than when operated in some other way?

5. What are the advantages of a free net?

6. How is the type of net changed and by whom?

Directions.

1. Obtain from the instructor the following:
   a. Call sign card.
   b. Special instructions for this operation.
   c. Messages to be transmitted.
   d. Traffic sheets, log sheets, and radio message blanks, reception.
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

CHANGING THE N. C. S. AND DESIGNATING AN N. C. 2

Information.

Although the station at the highest tactical unit in a net, is normally the N. C. S. of the net it is sometimes desirable to have another station take command of the net. The reasons for doing this are as follows:

a. The N. C. S. may not have power enough to reach all stations in the net while some other station has the power to reach all of them.

b. The N. C. S. may have to leave the net for a considerable length of time.

c. The signal officer may desire to give secondary stations practice in commanding the net.

d. The unit commander may be temporarily at the headquarters of a subordinate unit and desire to direct combat operations by radio from that station.

The method of changing the N. C. S. divides itself into three cases as far as the operator is concerned. They are as follows:

Case I.—Where the N. C. S. orders a secondary station to take command of the net. In this case the N. C. S. would transmit as follows:

$\overline{\text{VE}}$ ZLV ZLV V XA1 XA1 II XF2
ZFF ZXE II XF2 ZFF ZXE II $\overline{\text{AR}}$

The secondary station thus ordered to take command of the net would acknowledge as follows:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II ZZG II $\overline{\text{AR}}$

All other stations in the net acknowledge by transmitting R to station XF2 in the order of operation. If all stations were working well XF2 could have ended his transmission with $\overline{\text{VA}}$ instead of $\overline{\text{AR}}$ and no acknowledgment would have been given by any other station, thus saving time.

Case II.—A secondary station is ordered to take command of the net by the commanding officer of the headquarters which the regular N. C. S. serves. In this case the commanding officer is at the headquarters of the secondary station.

a. If the commanding officer who ordered the secondary station to take command of the net has a P message to be sent at once, the secondary station (XF2) will obtain silence in the net, if it does not exist, by sending:

$\overline{\text{VE}}$ ZLV ZLV V XF2 XF2 II $\overline{\text{VA}}$

during the next one-half minute silent interval and then listening to see that all stations in the net have stopped transmitting. When the net is silent it will send:

$\overline{VE}$ ZLV ZLV V XF2 XF2 II
ZZG ZMB II ZZG ZMB II $\overline{VA}$

This tells all stations in the net that XF2 has taken command by authority of the brigade commander and that they are not to reply. He then transmits his P message.

b. As soon as the emergency passes, or as soon as possible, he again sends the net call and announces that the net is controlled, directing them to report their traffic, or that the net is directed or free, so that other stations may clear their traffic.

c. Before the superior commander leaves that headquarters, or when it is apparent that the emergency is entirely over, the operator of the chief of section will ascertain whether command of the net is to be returned to the N. C. 1 or not.

Case III.—When the N. C. S. can not be found in the net. The procedure to be followed in this case will be explained in the following paragraphs on designating an N. C. 2.

Designating an N. C. 2:

When any net is in operation it will often happen that the N. C. S. must leave the net for an indefinite period of time. This would leave the net without a commanding station unless one of the secondary stations took command. In order to prevent any confusion when this occurs the secondary station which is to take command of the net when the N. C. S. can not be found is designated by the N. C. S. immediately after the net is established. This secondary station is known as the N. C. 2, and would be designated by the following transmission:

$\overline{VE}$ ZLV ZLV V XA1 XA1 II ZBD XF2 II ZBD XF2 II $\overline{AR}$

Stations acknowledge receipt in the order of operation. If the stations were all working well, the above transmission could have ended with $\overline{VA}$ instead of $\overline{AR}$.

When the N. C. S. disappears from the net for over half an hour and can not be found, and an inspection of the log sheet shows that the N. C. S. has not reported leaving the net, N. C. 2 will take command of the net. However, if the net is being operated, either directed or controlled, and the absence of the N. C. S. is delaying the dispatch of traffic, the N. C. 2 will at once take command as follows:

$\overline{VE}$ ZLV ZLV V XF2 XF2 II ZZG ZFF II ZZG ZFF II $\overline{VA}$

and proceed with the dispatch of traffic.

Questions.

1. *What station of a net is ordinarily the N. C. S. of the net?*

2. *Give four reasons for changing the N. C. S. of a net.*

3. *From the operator's viewpoint what are three cases which require changing the N. C. S.?*

4. *Explain the procedure used for Class I of question 3.*

5. *Explain the procedure used in Case II of question 3.*

6. *Explain the procedure used in Case III of question 3.*

7. *What is an N. C. 2?*

8. *By whom and when is the N. C. 2 designated?*

9. *Under what conditions does the N. C. 2 take command of the net?*

Directions.

1. Obtain from the instructor the following:
   - *a.* Call sign card.
   - *b.* Special instructions for this operation.
   - *c.* Messages to be transmitted.
   - *d.* Traffic sheets, log sheets and radio message blanks, reception.
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

TRANSMISSION OF LONG MESSAGES AND TRANSMISSION TO A SILENT STATION

Information.

With radio sets having no "break-in" or "duplex" features it is impossible to stop a station from transmitting in the middle of a message. Thus if a long message is being sent and at the beginning of the message the receiving operator misses several groups it will be impossible for him to obtain a repetition of those groups until the end of the message. For this reason long messages are transmitted in parts, and an acknowledgment of each part is obtained before the next is sent.

B—The procedure sign "B" is used in the heading, if the message is a long one, to indicate that transmission will be in groups. When used in this case, it is followed by figures to indicate the number of groups in each part of the transmission. When used at the end of a transmission, it means "More of this same message to follow."

B—The letter "B" followed by a number is used as the procedure sign to signify "Following number of groups sent now. More to follow." The number after the letter indicates the number of groups sent. The total number of groups in the message must also be indicated when "B" is sent as a part of the heading.

When used by itself "B" indicates that there is "More to follow" of this message.

Example.

TS1 has a long message of 32 groups for RS1 and decides to send only the first 10 in the first transmission, TS1, after calling up RS1 and receiving the "go ahead" sign, would proceed as follows:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II NR6 II D II
GR32 II $\overline{\text{BT}}$ 1 $\overline{\text{XE}}$ 1Ø BT NR4 II 1ØØ1A II
DFC1 II XNO POY RTZ MNZ RSO PNT
ZKS II B

Station RS1 would acknowledge by transmitting:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R 1 $\overline{\text{XE}}$ 1Ø II K

Upon receiving the above, TS1 after deciding to send 10 more groups would transmit:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II B 11 XE 2Ø $\overline{\text{BT}}$
FLX TRO MOP XFK RSN POS RPT NKO
ROL TSZ II B

Station RS1 would then acknowledge as follows:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R 1Ø XE 2Ø II K

Station TS1 after getting the above receipt would send the remaining groups as follows:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II B 21 XE 32
$\overline{\text{BT}}$ XTN MZO XPX TRN MIS HIM POR
TNW CDF FPN TRX II $\overline{\text{AR}}$

Section RS1, receiving the groups from 21 to 32, inclusive, would not acknowledge the entire message, it not being necessary to acknowledge the groups from 21 to 32.

Station RS1 would transmit:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R NR6 II $\overline{\text{AR}}$

Questions.

1. *Why is a long message transmitted in groups?*

2. *What is the shortest message that would be sent in groups?*

3. *How many groups should be sent at a time?*

4. *If a set is being operated "duplex" or "break-in" would it be necessary to send a long message in groups?*

5. *After all parts of the message have been sent how does the receiving operator acknowledge for the entire message?*

Information.

TRANSMISSION TO A SILENT STATION

If all the radio stations in a division, for instance, were changed in one night at the same time, no matter how secret the movement of troops, the new operators on new sets would at once give away to the enemy the fact that a relief was taking place. In order to prevent this, stations are sometimes ordered not to transmit. Such a station is known as a *silent* station and is announced in orders to all message centers and radio stations concerned.

The letter "F" is used as a procedure sign in the prefix of a message to indicate, when a message is sent to a "silent" station, that "Message following is not to be answered or acknowledged."

This method is also used where it is desired to transmit an important message to a station, the character of the message being such that for additional secrecy it is necessary that the enemy not know the location of the station to whom it is addressed. This is termed "blind" transmission.

The use of this method requires that stations know through other means that the silent stations are working.

It affords a method of handling messages in plain English in emergencies when transmission in clear is ordered.

When "F" is used in the prefix, the message will always be sent through twice.

When "F" is used in the prefix, stations are not in any case to ask by radio for repetitions or corrections.

Silent stations receiving a message addressed to them, acknowledge receipt by some other means than radio.

The $\overline{\text{VA}}$ sign is always used to indicate the end of a message or series of messages with "F" in the prefix.

Suppose, for example, that station XA1 has a message to be sent by the "F" method to station XF2. XA1 would transmit as follows:

$\overline{\text{VE}}$ XF2 XF2 V XA1 II NR6 II F II
$\overline{\text{OD}}$ II GR4 II $\overline{\text{BT}}$ NR8 II Ø348P II
DFC1 II XNZ II $\overline{\text{IMI}}$ II NR6 II F II $\overline{\text{OD}}$
II GR4 II BT NR8 II Ø348P II DFC1 II
XNZ II $\overline{\text{VA}}$

Questions.

6. *What is a silent station?*

7. *How are silent stations designated?*

8. *What is the meaning of the procedure sign "F"?*

9. *For what other case in addition to transmitting to a silent station is the "F" method used?*

10. *What ending sign is used for a message sent by the "F" method?*

11. *How many times is the message sent?*

Directions.

1. Obtain from the instructor the following:
   a. Call-sign card.
   b. Special instructions for this operation.
   c. Messages to be transmitted.
   d. Traffic sheets, log sheets, and radio message blanks (reception).
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

TRANSMITTING MESSAGES BETWEEN STATIONS IN DIFFERENT NETS OF THE SAME TYPE

Information.

Traffic between different nets is called internet traffic. The net command stations of the nets concerned will have control over intercommunication between their respective nets. In all cases except P messages permission will be obtained from the originating station's N. C. S. before entering another net. After permission is granted by the N. C. S. to enter another net, the calling station will change to the wave length of the other net, ascertain that he will not disturb that net, and call the N. C. S. of that net, requesting permission to transmit his message. When permission is granted, he will call the station for which he has a message. When finished, he will report back into his own net.

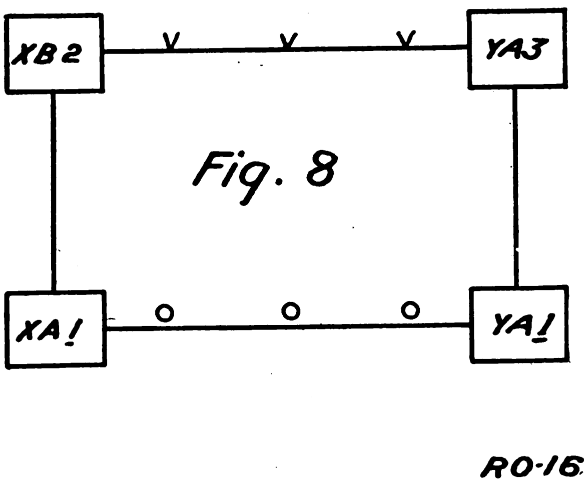


Fig. 8.—Two different nets of the same type

For example, station XB2 has a message for station YA3 which is in an adjacent net. (See Fig. 8.)

XA1 is the N. C. S. of XB2 and YA1 the N. C. S. of YA3. Station XB2 calls up his N. C. S. and asks permission to engage in internet traffic as follows:

$\overline{\text{VE}}$ XA1 V XB2 XB2 II ZMA ZMA II $\overline{\text{AR}}$

XA1 would answer as follows, if he desired to grant the permission:

$\overline{\text{VE}}$ XB2 XB2 V XA1 XA1 II ZLU II K

XB2 would then change his wave length to that of the net to which YA3 belongs and listen in to ascertain that he would not interfere. When the net was silent, he would transmit as follows:

$\overline{\text{VE}}$ YA1 YA1 V XB2 XB2 II ZMA ZMA II $\overline{\text{AR}}$

YA1 would answer:

$\overline{VE}$ XB2 XB2 V YA1 YA1 II ZLU II K

or, if the traffic is heavy. YA1 may require further regarding the class and to what station XB2 has a message.

XB2 then calls YA3 in the usual manner and transmits his message. YA1, who has followed the transmission, since it is on his wave length, knows when XB2 is through; but XA1 on another wave length does not know when XB2 is through; hence XB2 reports to his own N. C. S. (XA1) when he returns to his own net, and after having ascertained that he will not disturb traffic; thus:

$\overline{VE}$ XA1 XA1 V XB2 XB2 II ZZA ZZA II $\overline{AR}$

This procedure for internet traffic will be followed no matter what the type of operation in either net.

Questions.

1. *What constitutes internet traffic?*

2. *Why is it required that a station obtain permission before leaving his net to engage in internet traffic?*

3. *Why is it required that a station report back into his own net on the completion of internet traffic?*

4. *How would the handling of a P message in internet traffic differ from that of $\overline{OD}$ and D messages?*

5. *Would the net command stations of two similar adjacent nets ordinarily handle message traffic?*

Directions.

1. Obtain from the instructor the following:
   - *a.* Call sign card.
   - *b.* Special instructions for this operation.
   - *c.* Messages to be transmitted.
   - *d.* Traffic sheets, log sheets, and radio message blanks (reception).
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

RELAYING MESSAGES, CASE I

Information.

It often happens that a message given to a radio station for transmission can not be sent by that station direct to its destination owing to the distance separating the two stations or due to the fact that the station to which it is addressed is equipped with a different type of set and is working on a different wave length.

Case I of relaying messages deals with the first condition outlined above, that is, the two stations are so far apart that the station of origin can not reach the station to which the message is addressed.

Two conditions may be met under Case I which are as follows:

a. Where the station of origin and the station to which the message is addressed are in the same net. Under this condition the N. C. S. of the net will specify the station or stations which are to relay the message.

b. Where the station of origin and the station to which the message is addressed are in different nets of the same type of radio set. Under this condition the N. C. S. of the nets concerned will where possible make arrangements for the stations which are to do the relaying.

Under either of the above two conditions the procedure used in handling the messages is the same. The transmitting operator at the station of origin will:

a. Insert "T" in the proper space in the preamble of his message.

> NOTE.—The heading of a message consists of (1) the commencing sign; (2) the call; (3) the preamble and (4) the prefix. The preamble only occurs when a message required routing, that is, when it is relayed so that this is the first time that the student has used this part of the heading.

b. Insert the call letters of the station of final destination.

c. Insert "G" in the prefix of the message.

It will be noted here that it is required that all relayed messages be repeated back no matter whether the message center has required it or not. Fig. 9 shows the heading as filled out by the transmitting operator at the station of origin.

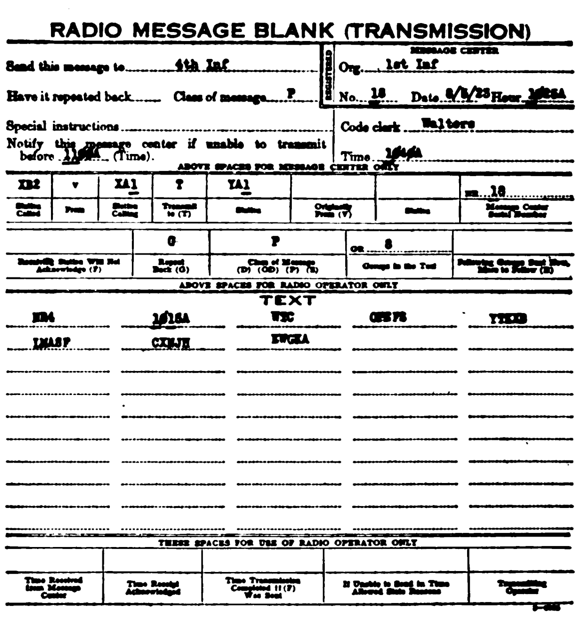
The operator at the relay station marks on the original copy of the message which he has received for relay "Message received for relay," and sends it to his message center. His message center is responsible:

a. That this "message for relay" is decoded.

b. That if there are undecodeable groups, repeats are asked for.

c. That corrections received are forwarded to the station of final destination.

d. That if of sufficient importance, the message is also sent by some other means.


RADIO MESSAGE BLANK (TRANSMISSION)

Send this message to 4th Inf
Have it repeated back Class of message P
Special instructions
Notify this message center if unable to transmit before (Time).

MESSAGE CENTER
Org. 1st Inf
No. 18
Code clerk Walters

ABOVE SPACES FOR MESSAGE CENTER ONLY

XB2	V	XA1	T	YA1			18
Station Called	From	Station Calling	Transmit to (T)	Station	Originally From (V)	Station	Message Center Serial Number

	G	P	GR 8	
Receiving Station Will Not Acknowledge (F)	Repeat Back (G)	Class of Message (D) (OD) (P) (R)	Groups in the Text	Following Groups Sent Here, More to Follow (H)

ABOVE SPACES FOR RADIO OPERATOR ONLY

TEXT

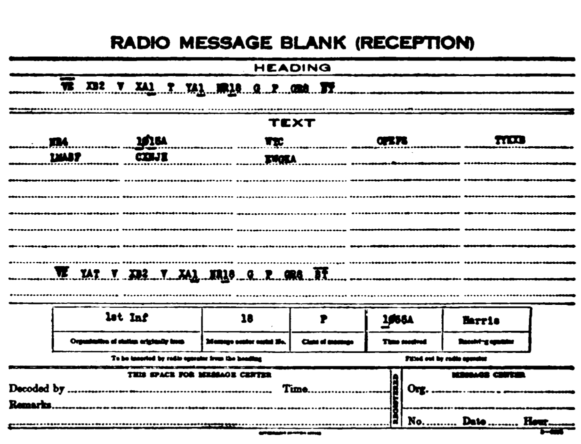
				YTKXB

THESE SPACES FOR USE OF RADIO OPERATOR ONLY

Time Received from Message Center	Time Receipt Acknowledged	Time Transmission Completed II (F) Was Sent	If Unable to Send in Time Allowed State Reasons	Transmitting Operator

RO-7

Fig. 9.—Relayed message with the heading of the blank filled out by the transmitting operator at the station of origin


RADIO MESSAGE BLANK (RECEPTION)

HEADING

XB2 V XA1 T YA1 NR18 G P GR8

TEXT

YAT V XB2 V XA1 NR18 G P GR8

1st Inf	18	P		Harris
Organization of station originally from	Message center serial No.	Class of message	Time received	Receiving operator

To be inserted by radio operator from the heading / Filled out by radio operator

THIS SPACE FOR MESSAGE CENTER
Decoded by Time
Remarks

MESSAGE CENTER
Org.
No. Date Hour

RO-8

Fig. 10.—The message shown in Fig. 9, with the new heading prepared by the relay station operator

The operator at the relay station writes a new heading at the bottom of the carbon copy of the message. In the heading he inserts the call sign of the station called, "V," his own call sign, "V" (originally from), followed by the call sign of the station of origin, and copies the balance of the prefix just as he received it. He then transmits the message. Fig. 10 shows the heading written at the bottom of the message.

Where more than one relay station is required and the correct radio route of the message is known to the station of origin the procedure sign "M" is used in the preamble of the message, meaning "Relay via" (Relay by way of). When "M" is used, the procedure sign "T" must also be used in the preamble. Suppose, for example, that XA1 has a message for BA2 which is to be relayed through YB2 and MK4 in that order. The heading would be sent as follows:

VE YB2 V XA1 XA1 II M II MK4 II T II
BA2 II NR3 II G II P II GR 16 BT

NOTE.—Since this method of relaying a message will seldom be required in tactical nets, no space is designated for it in the Radio Message Blank (Transmission). All operators should, however, note carefully its position ahead of "T."

Questions.

1. *Explain how messages are relayed when two stations are too far apart to reach each other.*
   a. *When both stations are in the same net.*
   b. *When in different nets of the same type of set.*

2. *What kinds of messages have a preamble?*

3. *Of what does the heading of a message consist?*

4. *What procedure sign is the operator required to insert in the heading of all messages which are to be relayed?*

5. *What does the operator at the relay station do with each of the two copies of the message which he makes?*

6. *What is required of the message center at the relay station?*

7. *Explain the procedure used when more than one relay station is required.*

8. *Where in the heading of a message is the procedure sign "M" inserted?*

Directions.

1. Obtain from the instructor the following:
    a. Call sign card.
    b. Special instructions for this operation.
    c. Messages to be transmitted.
    d. Traffic sheets, log sheets, and radio message blanks (reception).
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

RELAYING MESSAGES, CASE II

Information.

As stated in the previous unit operation, Case II of relayed messages occur when the station of origin and the station of destination are working in different nets having different types of sets. Thus at the relay station it will be required to transfer the message by messenger from the receiving station to the other station at that headquarters which is working in another net and which will send the message on to its destination. Two conditions will occur under Case II which are as follows:

a. Where the call sign of the station of final destination is known.

b. Where the call sign of the station of final destination is unknown.

If the call sign of the station of final destination is known the message will be handled as an ordinary relayed message between stations in the same type of net. The receiving operator on receiving "T" in the preamble of the message will know that it is to be relayed and will ascertain from his list of call signs the station and net in which that station is working. He will then send a carbon copy of the message by messenger to the proper radio station at his headquarters marked "Message received for relay." The original copy will be sent to the message center with the notation "Message received for relay. Copy sent to .... radio station," giving the name of the station.

The relay message center is responsible that the message is decoded. If it is undecodeable the necessary repeats are obtained and the message at the relay radio station is corrected. The message center will also ascertain from the text of the decoded message whether any additional means of transmission is required.

The operator at the relay transmitting station will make out a new heading on the bottom of the carbon copy as shown in the previous unit operation and transmit the message.

As an example in Fig. 11 XA$\underline{1}$ has a message for YA3 which must be relayed through XB4 and YB3 which are stations in different nets at the same headquarters.

XA$\underline{1}$ transmits the following heading:

$\overline{\text{VE}}$ XB4 XB4 V XA$\underline{1}$ XA$\underline{1}$ II T YA3 II
NR7 II G II $\overline{\text{OD}}$ II GR8 $\overline{\text{BT}}$

XB4 sends the message by messenger to YB3. YB3 places the following heading on the message and transmits it to YA3:

$\overline{\text{VE}}$ YA3 YA3 V YB3 II V XA$\underline{1}$ II
NR7 II G II $\overline{\text{OD}}$ GR8 II $\overline{\text{BT}}$

This shows the operator and message center at the station of destination from what station the message originally came.

Under the second condition of Case II where the call sign of the station of final destination is not known, the originating message center will encode the address in the text of the message immediately after the group indicating the type of code used. This procedure will require the message to be repeated back. For such a message the receiving and transmitting radio operators at the relay station will not know it is to be relayed, and the receiving message center when decoding, will immediately understand that the message is to be relayed and take the necessary steps to have it done.

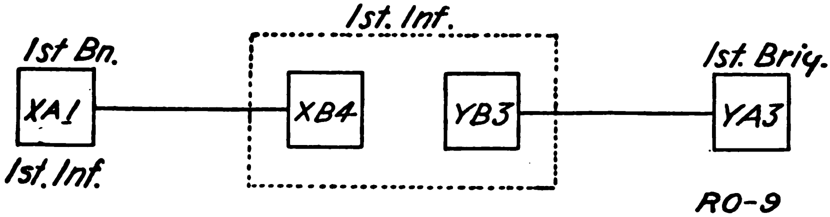


Fig. 11.—Two different nets with stations at the same headquarters

Questions.

1. *Explain how messages are relayed where the two stations are in two nets of different types of radio sets.*
   a. When the call sign of the station of destination is known.
   b. When it is unknown.

2. *What does the receiving operator at the relay station do with the two copies of the message which he makes?*

3. *For what is the message center at the relay station responsible?*

4. *When the call sign of the station of destination is unknown, how do the radio operators at a headquarters know that the message they are handling is a relayed message?*

Directions.

1. Obtain from the instructor the following:
   a. Call sign card.
   b. Special instructions for this operation.
   c. Messages to be transmitted.
   d. Traffic sheets, log sheets, and radio message blanks, reception.
2. Read carefully the special instructions for this operation.
3. Consult the bulletin board in the code room and obtain your position assignment.
4. Be in your proper position in the code room at the time instruction is to start.

GENERAL RULES

1. In general the term "*Procedure*" denotes the manner in which messages are actually transmitted or received via radio, visual, buzzerphone, or other similar means of signal communication.

2. Tactical Radio Procedure is used in the transmission of messages:
   - *a.* In time of war between the various mobile army radio stations, and
   - *b.* In time of peace for training the operators of such stations for war.

3. The procedure instructions must be *accurately* and *strictly* observed.

4. The requirements of tactical radio procedure are:
   - *a.* To provide for the transmission of coded messages—
     - (1) Between two stations with the same type of set operating on the same wave length in units of the same arm.
     - (2) Between two stations operating the same or different types of sets, on different wave lengths in units of the same arm.
     - (3) Between stations in different arms with the same or different type of sets and wave lengths.
     - (4) Between airplane and ground stations when either one or two way radio communication is practicable.
   - *b.* To provide brief standardized means by which operators can obtain a check on the accuracy of their reception and thus restore lost or erroneous code groups.
   - *c.* To provide the minimum number of procedure signs for handling such traffic.
   - *d.* To provide standard message forms always in front of the transmitting and receiving operators for the purpose of rapid training of operators and to insure uniformity and accuracy in message transmission.
   - *e.* To provide for joint team work between message centers and radio stations—
     - (1) That messages are not delayed without its being known at the message center.
     - (2) That coded messages relayed by radio are correct before they leave the relay transmitting stations.
     - (3) That the message center knows what radio stations its station can reach at any time, and the condition of traffic at its station.
     - (4) To provide for the transmission of heavy traffic loads when other means are inoperative.

f. To provide for a command station clothed with authority and methods for controlling traffic under all conditions.

g. As the tactical situation changes and the unit commander moves, to permit the control of traffic from any headquarters where he may arrive. (See Pars. 66 and 67.)

h. As the tactical situation changes and stations move forward and leave or enter nets, to provide for brief signals which inform stations in that net of what is taking place and the authority therefor.

i. To provide means by which Net Command Stations can shorten the methods of handling traffic as operators in the net become more experienced and obtain better results from their sets.

RADIO NETS

5. Many different radio sets are supplied to the tactical units of an army. In order for them to work without interference with one another there are several different types of nets. Sets of like character, serving headquarters which have to communicate with each other are organized into nets. Each net is usually assigned one or more wave lengths on which to operate.

6. The organization and operation of these nets is tactical in character and must conform to the tactical situation. Nets may serve tactical units in reserve, or those which are in support. In either case they may not be allowed to transmit but they can always receive. When allowed to transmit, their traffic will ordinarily consist of tactical messages but it may also consist of messages relating to administration and supply. In training areas they will transmit messages relating to administration and supply when not being trained to handle tactical messages or when their units are not engaging in maneuvers. When units enter the front line their nets advance and retire with their units. There are times when there must be absolute control of the air in every net and those messages which are of vital importance to the front line units must be given the right of way. These changes produced by the varying tactical situation require net discipline, control, and direction, so that any given net can serve promptly the will of the tactical commander who is responsible for its actions. In order that commanding officers may be able to reach any unit which is equipped with radio, as well as to control the net as the tactical situation may demand, a Net Command Station is assigned for each net.

7. The regulations in this Information Topic provide the means for the control of radio stations in their respective nets by Net Command Stations under any tactical situation, under the direction of the

signal communications officer, who executes the instructions of the commanding officer of the unit which the net serves.

8. The different nets take their names from the command units to which they pertain as, Corps Net or Division Net; or according to the character of the service rendered as the Division Air Service Net, or the Railroad Artillery Net; or according to the type of set used as the SCR–130 net.

9. In each net the station belonging to the highest command unit is called the NET COMMAND STATION of N. C. S. Under orders from proper authority however, the N. C. S. may be a station in the net other than that belonging to the highest command unit. All other stations in the net are called SECONDARY STATIONS and are under the control of the N. C. S.

10. The N. C. S. will always designate a secondary station in each net as NET COMMAND STATION No. 2 (N. C. 2), as soon as the net is established. The N. C. 2 will assume command of the net under orders from proper authority or in event the N. C. S. becomes silent, in which case he will immediately designate a secondary station as an N. C. 3 to take command in case N. C. 2 becomes silent. (See Par. 66.)

11. The Net Command Station is charged with the clearing of traffic within the net as expeditiously as possible and with maintaining order within the net. As far as traffic is concerned the Net Command Station bears the same relation to stations in its net as the commanding officer of a platoon does to his sections and squads on the firing line. Any questions concerning traffic within the net are referred to the N. C. S. for decision. The decisions of the N. C. S. are final and its orders will be strictly obeyed.

12. Secondary stations will inform the N. C. S. when they leave or enter the net. (See Pars. 55 and 64.)

13. Radio communication in tactical units is not an auxiliary or emergency means of communication but is equally important as telephone communication.

14. Radio nets strive for accuracy and rapidity of transmission. They must be prepared to assume the entire message traffic load of a headquarters at any time. In order that they can be prepared to do this, message centers will see to it that their radio stations receive a fair proportion of traffic daily in order that when all of the traffic must be handled by radio the stations are capable of doing it. If the radio service sends no messages when telephones are working, when the telephones fail the radio service can not be expected to do the work.

15. There must be close cooperation between a radio station and its message center in order that messages may be handled as expedi-

tiously as possible. The chief of station will furnish the message center with a list of the stations in his net. The operator on duty will keep the message center informed at all times of stations entering or leaving the net. If a station reports that it is to be out of the net for a certain length of time, the information will be sent at once to the message center so that any messages to be sent to that station may be dispatched by some means, other than radio, during that period. A telephone line will connect the radio station and the message center for the above purposes wherever possible.

16. The radio service is but one of the several means of communication used for transmission of messages between tactical headquarters, and radio operators will use such of the other available means as are necessary for the conduct of their work. When radio stations have messages for a station known to be in the net, which does not answer when called, the section chief will ascertain by the telephone or any other available means, whether the station can receive or not, and when it expects to be in the net. Chief of sections by use of the telephone to determine troubles or delay can frequently insure radio communication later when the telephone lines go out.

17. Chiefs of section and all radio operators will notify the message center if they cannot get the messages through by radio. The message center may say "keep on trying," but reports should still be made on such cases.

18. Communications officers will prescribe that the chief of the radio section of the second command will report to the message center in writing or verbally, at such times during each 24 hours as may be required, those messages transmitted and those remaining unsent, in order that all messages may be sent by some means.

19. *Message blanks.*—There are two message blanks which a radio operator must use: (1) Radio Message Blank (Transmission) and (2) Radio Message Blank (Reception).

Radio Transmission Blank (Transmission): The blank used for messages to be transmitted is a combined message center and radio station blank, and has the advantage that all data referring to a particular message are included on one sheet. These forms are kept by the message center and after the spaces pertaining to the message center are filled out, the text of the message is printed in capital letters or written on the typewriter in capitals in the proper place with five code groups to the line. The form is then sent to the radio station for transmission.

20. Every operator will read through the text of each message he receives to ascertain that the individual letters of each code group are clear and unmistakable. If there is any doubt about any of the letters he will call the message center and verify such letters. Message center chiefs are responsible that messages go to the radio station with every letter clearly made.

In order to distinguish between the letter "O" and the numeral "zero" the figure for "zero" will be written by all signal communication personnel with a diagonal bar through it, thus Ø.

To distinguish between the letter I and the number "one" the numeral one will be written with a bar under it, thus $\underline{1}$.

The following letters carelessly made by either the message center code clerk or the receiving operators may render messages undecodable and subject important messages to delay:

X–V, E–F, C–G, U–V, P–D, Q–O, Y–V.

The radio operator will then fill in the time received, the blank spaces for the call, preamble, and prefix, obtaining his data from what has been written on the blank at the message center and from his list of call signs. Procedure signs in the heading are explained in Section VIII. When transmission is completed, the operator fills in "Time receipt acknowledged" and his initials in the proper spaces. Delay in transmitting a message at the radio station should arise only from the amount of traffic being handled. Message centers keep track of the average delay time, except for priority messages, and usually insert that time in the space marked "Notify this message center if unable to transmit before ...." If, from the state of traffic, operators can tell that the time will be exceeded, or when that time has elapsed, they must notify the message center, which has authority to change the class of the message or the means by which it is sent.

21. Radio Message Blank (Reception): This form is also a combined radio station and message center blank. It is kept by the radio operator and all received messages are copied there with a *carbon duplicate*, using *printed capital letters*. The original copy will be sent at once to the message center. The duplicate will be filed with the log sheet for three days and will then be destroyed by burning. In the event message centers can not make out certain code groups, they will call the radio station and ask for those particular groups. The operator reads them from the duplicate copy, which is in his own handwriting. This duplicate is also used in relaying messages. (See Par. 69.) Receiving operators will write only five-code groups per line, as this facilitates the checking of the number of groups received.

Log Sheets

22. *a.* Log sheets will be kept by the recording operator. If there are two operators on duty at a station, one is called the key operator and the other the recording operator. The key operator is responsible for the station during his tour of duty. If only one operator is on duty he will keep the log sheet, entering for messages not addressed to his station the full message, and for those transmitted from or addressed to his station the heading only.

b. The form for a log sheet below will be used to copy all reception which is not entered directly on message blanks. The form for actual use should be about 8½ by 13 inches, printed on the face as shown and on the back without the heading, thus giving more space in which to copy. The following rules will govern the use of log sheets:

(1) All copying will be made either with a fairly hard pencil or on the typewriter.

(2) The printed letters used in copying with a pencil will not be over three-sixteenths of an inch in height.

(3) Both sides of the log sheet will be used.

(4) Entries on the log sheet must be such that at a later time there may be obtained from it a continuous record of what took place.

(5) Log sheets must be legible.

(6) The heading of the log sheet must be properly filled out.

(7) Time will be entered in the column provided for that purpose, accurate to the nearest minute.

(8) Remarks will be made in the traffic column whenever needed to make the meaning of the log sheet clear.

(9) All pages of a log pertaining to the tour of duty of the operator who signs it or to the period during which the station was in operation will be securely fastened together in their proper order.

STATION LOG

Sheet No. ....Net............Date............................19....

Station Call............Station Opened.............Closed...............

....
Senior Operator Junior Operator
....

Time	To	Fm.	Traffic

23. Everything heard in the net except transmitted messages will be entered on the log sheet (see Par. 22) and in case only one operator is on duty a received message for that station will be copied on the Radio Message Blank (Reception), notation being made on the log sheet of the heading of the message and the time. If there is a recording operator on duty, he will copy received messages for his station on his log sheet just as he does anything else heard in the net, leaving the transmitting operator to copy received messages for his station directly on the Radio Message Blank (Reception). This offers at once an immediate check on the received messages by an independent operator.

24. Accurate log sheets are essential for combat units. Either station may go out before the key operator has a chance to ask for a repeat. Stations in rear copying messages for which they hear no receipt given will send them to their own message center, which forwards them to the message center of the addressed stations by any available means. The operator will write on such messages "No receipt heard. Forward to............" The use of log sheets

permits a chief of section or communications officer to check up errors and it also serves to train new operators.

25. Log sheets will be kept by the chief of section for a period of three days and then will be destroyed by burning.

26. Careful notations of time will be made in the proper place on the log sheets and if any explanatory remarks are necessary for a clear understanding of the log they will be entered and plainly marked.

27. Communications officers or radio officers inspect log sheets of all stations visited to ascertain:

a. That call ups contained procedure signals. (See Par. 44.)
b. That procedure signs were used correctly.
c. That unnecessary transmissions did not occur.
d. That called stations did not delay answering call ups.
e. That stations have sent messages for which no receipt was heard to the message center.
f. That no transmissions have been sent in plain text.
g. The delay time on messages at the radio station.

They inspect retained carbon copies of messages to ascertain that the message is copied in printed capital letters, that the message center data is properly filled in, and that the transmitting station has used the heading properly. They inspect transmission blanks to ascertain that headings of transmitted messages have been correctly filled in; that the time of receipt is entered. They question the delay on such messages. The log sheet should answer questions of delay. Only by inspections can signal officers insure improvement and eliminate the delays due to faulty operation and poor writing.

MESSAGES

28. Messages transmitted by Army radio operators are designated as either Tactical or Nontactical.

Tactical messages are those transmitted during combat or maneuvers which concern the fighting of the units.

Nontactical messages are those which relate to administration, supply, or the signal service.

Messages are classified by message centers as Ordinary, Rush, or Priority to show which shall be transmitted first.

29. Nontactical messages in some cases may be of utmost importance, and permit no delay in transmission.

30. Ordinary messages, classified "D" and so entered on the blank, are transmitted by the radio service as far as possible in the order in which they are received, but when the traffic is heavy operators transmit them in such order as will clear their traffic in the shortest possible time. (See Par. 80.)

31. A Rush message, classified "OD" and so entered on the blank, is one of such importance that it is given preference over all ordinary messages on file and waiting to be sent. In combat, tactical messages giving orders for immediate movement of troops, requesting such authority, reporting events which will cause such orders, or requesting or directing fire of any kind are Rush messages. (See Par. 91.)

32. A Priority message, classified "P" and so entered on the blank, is one of such importance that it takes precedence over Rush messages, and is sent immediately upon receipt, even if the operator has to interrupt the transmission of an ordinary or rush message. In combat, requests for barrage fire, directing barrage fire, airplane messages to ground stations, and messages where delay means loss of life are classed as Priority messages. (See Par. 92.)

33. *a.* A Signal Service message, classified "S" and so entered on the blank, is one relating to the signal service which can not be transmitted by direct telephone connection between the interested parties. Such messages are originated by an officer or N. C. O. in the signal service.

b. When originated by other than radio sections of signal communication units, signal service messages will be sent to the message center. They will be sent by radio if possible. They will be encoded by message center personnel in the code most suitable to their contents. They will be classified as D, OD, or P by the message center, depending on their contents.

c. (1) When originated by signal officers or radio personnel, signal service messages will be encoded in the radio service code by the chief of the radio section. He will give them to his operator for transmission in the usual manner. He will send the duplicates of both the plain text and code copies of such messages to the message center for file.

(2) The chief of the radio section is responsible for deciding the necessity for a message of the above type originating at his station.

(3) If the contents of the message do not permit encoding in the radio service code they will be sent to the message center as in *b* above.

d. Messages encoded in the Radio Service Code received at a radio station will be decoded sufficiently at that station to determine to whom they are addressed. If addressed to other than the radio station, the decoding will be stopped and the received copy sent in the usual manner to the message center. If addressed to the radio station the decoding will be completed, the decoded copy delivered to the addressee, and the original received copy then sent to the message center, marked "Decoded and copy furnished addressee."

34. All messages will be treated as strictly confidential by all personnel. All messages other than those encoded in the Radio Service Code (R. A. D.), received at a staion and addressed to that station, will be delivered to the message center *immediately*.

35. A radio station will transmit only such messages as are furnished or approved by its message center (except signal service messages). Such messages bear this remark "Send this message to the ...." The operator must know the call sign
(Organization)
of the designated unit and call it by its own call sign. The words in plain text (such as 27th Infantry, 1st Brigade, 8th Division) designating the organization, are not transmitted, as this would at once indicate to an enemy the organization opposing him. If there is a further address it is contained in the text of the message which has been encoded and the operator need not know or care anything about that. He must know only to what headquarters the message goes.

36. Normally all messages to be transmitted by tactical nets are sent in code. The encoding and decoding will be done by the message center except as noted in Par. 33. Messages are sent in plain text only under orders from the commanding officer of the headquarters which the station serves, when the tactical situation is such that the information in the message so transmitted can not be of use to the enemy.

37. A message will consist of the following (see Par. 40):

a. The heading, which comprises—
- (1) The call.
- (2) The preamble.
- (3) The prefix.

b. The text, which comprises—
- (1) Sender's number.
- (2) Sender's time or time of origin.
- (3) Type of code or cipher used.
- (4) Address.
- (5) The message itself.
- (6) The signature.

38. *Heading.*—*a.* The *Call* consists of the commencing sign, the call sign or signs of the called station or stations, the procedure sign "from," and the call sign of the calling station. The *Call* should not be confused with the *call up*. (See Pars. 44 and 45.)

b. The *Preamble* consists of procedure signs and call signs indicating the routing of the message. (See Pars. 70–72, 76, 77, 88, 95.)

c. The *Prefix* includes the message center serial number, procedure signs indicating the type of the message, any instructions regarding the message itself, and the "check" or number of groups or words in the text.

d. The *heading* is separated from the text by the procedure sign "BT" (break or double dash).

39. *Text.*—*a.* The *sender's number* is the serial number given by the writer to identify his message. This is not encoded and is counted as one group in the "check." Examples: NR 1 NR 18. The sender's number is separate from the sender's time by the space sign II.

b. The sender's time indicates the time the message was written and is sent in plain English as a group of four figures followed by "A" to represent a. m. or "P" to represent p. m.; thus: Ø645A; 1215P; Ø31ØP; 1215A. The space sign II is used to separate sender's number from sender's time.

c. The type of code if used, is an abbreviation in plain text indicating the code or cipher in which the message is encoded. The space sign II is used to separate type of code used from the first code group.

Examples:

War Department Telegraph Code would be WTC.
Division Field Code No. 1 would be DFC1.
Radio Service Code No. 2 would be RAD2.
Meteorological Code would be METRO.
Cipher Device would be CD.

40. *Example of message.*—Station AB2 has just received from his message center a message already encoded to be sent to radio station CD2 and to be repeated back. The text of the message is "NR1 1ØØ3A DFC4 MONZ PACO HIKO PYNE." The message requires no routing; hence the preamble is missing.

Having prepared his heading in the spaces provided on the Radio Message Blank (Transmission), station AB2 would first "call up" station CD2. (See Pars. 44 and 45.) After station CD2 has answered and sent "K" ("go ahead") station AB2 would send as follows:

Section	Part	Signal		Meaning
Reading	Commencing Sign	$\overline{\text{VE}}$		
	Call	CD2	CD2	Call sign of receiving station
		V		from
		AB2	AB2	Call sign of sending station
		II		Space sign
	Preamble		(Sent here if message requires routing)	
	Prefix	NR1		Message center serial number
		II		Space sign
		G		Repeat this message back
		II		Space sign
		$\overline{\text{OD}}$		Rush message
		II		Space sign
		GR7		Number of groups in text is 7
		$\overline{\text{BT}}$		Break between heading and text
Text		NR6		Sender's serial number is 6
		II		Space sign
		1ØØ3A		Sender's time was 10:03 AM
		II		Space sign
		DFC4		Text is encoded in Division Field Code No. 4
		MONZ		Message
		PACO		"
		HIKO		"
		PYNE		"
		II		Space sign
	End	$\overline{\text{AR}}$		Ending sign

RADIO PROCEDURE SIGNS AND OPERATING SIGNALS

41. In handling traffic by tactical procedure the International Morse or General Service Code will be used.

42. *Punctuation marks and other signs.*—Wherever a bar is placed over two or more letters the combination *is sent* as one signal without a space between the letters; for example:

$\overline{\text{AR}}$ (the ending sign) would be sent . — . — . and not . — . — .

43. Army Procedure Signs consist of single and two-character signs.

SINGLE-CHARACTER SIGNS

Sign	Equipment	Meaning	Paragraph
$\overline{AA}$	·—·—	Unknown station	47
$\overline{AR}$	·—·—·	Ending sign (written) $\overline{AR}$.	48
B	—···	More to follow	49, 50
$\overline{BT}$	—···—	Double dash or break signal (written) +.	51
C	—·—·	You are correct	52
D	—··	Ordinary message	3, 53
E (10 times)		Erase	54
F		Not to be acknowledged	55
G	——·	Repeat back	43, 45, 56, 61
$\overline{IMI}$	··——··	"Repeat" or "I am about to repeat".	58
K	—·—	Go ahead	59
M	——	Relay the following via	60
N	—·	Nothing received	61
$\overline{OD}$	————··	Rush message	4, 64
P	·——·	Priority or emergency message	5, 65
Q	——·—	Wait	66
R	·—·	Received	67
T	—	Transmit following to	43, 45, 61, 68
V	···—	From	69
$\overline{VA}$	···—·—	Finish (no reply desired)	39, 41, Ex. 2; 55 (*h*); 70
$\overline{VE}$	···—·	Commencing	13, 18, 71
W	·——	I am being interfered with by other radio work.	48, 73
X	—··—	I am being interfered with by static.	19, 74
$\overline{XE}$	—··—·	Oblique stroke (/)	50
Y	—·——	Acknowledge	76
COMMA		When a comma appears the word "COMMA" should be spelled out.	

TWO-CHARACTER PROCEDURE SIGNS

Sign	Equipment	Meaning	Paragraph
GR	—— — • — • •	Groups or words	57
II	• • • •	Space signs, used to separate the component parts of the heading, to separate procedure signs, to separate code groups when necessary.	77
NR	— • • — •	Number	63
WA	• — — • —	Words or groups after	73

RADIO OPERATING SIGNALS

ENCODING SECTION

Sign	Meaning	Paragraph
	CODE FOR COMMUNICATIONS OFFICERS AND UNIT COMMANDERS	
ZLL	Battalion Communications Officer	
ZRY	Regimental Communications Officer	
ZXE	Brigade Communications Officer	51
ZLZ	Division Radio Officer	
ZIO	Division Signal Officer	
ZXY	Battalion Commander	
ZMR	Regimental Commander	
ZMB	Brigade Commander	41
ZUU	Division Commander	
	(NOTE.—For use of the above with ZZG and ZER, see par. 41.)	
	MESSAGES	
ZAR	Have the following to transmit, or (Have messages for ____________)	29, 30, 32, 48
ZBJ	Have nothing to transmit to any station in the net	
ZAQ	Have you anything to transmit?	
ZZH	Transmit your message to ____________.	
ZFD	What class and to whom are your messages	31, 32
ZFG	May I transmit message to ____________?	
ZTF	Have message(s) for you	18, 60
	NETS	
ZLV	Net Call Sign all stations stop transmitting and copy	32, 36, 39, 41
ZZC	Net is controlled	32
ZLP	Is net controlled?	
ZZD	Net is directed	36
ZYO	Is net directed?	
ZZF	Net is free	28
ZRN	Is net free?	
ZFF	Net Command Station (N. C. S.)	
ZDF	Secondary station	
ZER	Take command of the net until I come in	
ZKL	Will you take command of the net?	
ZES	Take command of the net until ______ o'clock	
ZZG	I take over command of net (by authority of _________)	41
ZBD	Act as N. C. 2	
ZVL	Go to the net wave length	

RADIO OPERATING SIGNALS—Continued

ENCODING SECTION—Continued

Sign	Meaning	Paragraph
	NETS—continued	
ZZA	Station reports into the net ready to function	28, 38
ZMQ	The following stations are now in the net	28
ZZB	Station ceases operation temporarily for ------ hours	37
ZIJ	Have you heard ------------ in the net?	------------
ZBC	------------ is (are) not in the net	------------
ZLU	Permission granted to engage in internet traffic	38
ZMA	Request permission to engage in internet traffic	38
	TRANSMISSION	
ZPB	Affirmative, Yes	------------
ZPA	Negative, No, Not	------------
ZLX	Close your station	------------
ZRH	Shall I close station?	------------
ZBV	Reception very bad. Send each group ------ times	77(*h*)
ZBQ	Send slower	19
ZBP	Send faster	------------
ZKH	Increase your wave length ------ meters	------------
ZGH	Decrease your wave length ------ meters	------------
ZWN	Shall I stop sending?	------------
ZYU	Stop sending	32
ZMP	What is my signal strength?	60
ZJF	Your signals are strength (------)	60
	NOTE.—The above procedure signs are those required for ordinary net operation and should be memorized. For additional operating signals see Radio Service Code No. 2 or subsequent codes.	

DECODING SECTION

ZAQ	Have you anything to transmit?	------------
ZAR	Have the following to transmit, or (Have messages for------------).	------------
ZBC	------------is (are) not in the net	------------
ZBD	Act as N. C. 2	------------
ZBJ	Have nothing to transmit to any station in the net	------------
ZBP	Send faster	------------
ZBQ	Send slower	------------
ZBV	Reception very bad; send each group------times	------------
ZDF	Secondary station	------------
ZER	Take command of the net until I come in	------------
ZES	Take command of the net until------o'clock	------------
ZFD	What class and to whom are your messages?	------------
ZFF	Net Command Station (N. C. S.)	------------
ZFG	May I transmit message to	------------
ZGH	Decrease your wave length------meters	------------
ZIJ	Have you heard------in the net?	------------
ZIO	Division Signal Officer	------------
ZJF	Your signals are strength	------------
ZKH	Increase your wave length------meters	------------
ZKL	Will you take command of the net?	------------
ZLL	Battalion Communications Officer	------------
ZLM	Go to your station wave length	------------
ZLP	Is net controlled?	------------

RADIO OPERATING SIGNALS—Continued

DECODING SECTION—Continued

Sign	Meaning	Paragraph
ZLU	Permission granted to engage in internet traffic	
ZLV	Net call sign; all stations stop transmitting and copy	
ZLX	Close your station	
ZLZ	Division Radio Officer	
ZMA	Request permission to engage in internet traffic	
ZMB	Brigade Commander	
ZMP	What is my signal strength?	
ZMQ	The following stations are now in the net	
ZMR	Regimental Commander	
ZPA	Negative, No, not	
ZPB	Affirmative, Yes	
ZRH	Shall I close station?	
ZRN	Is net free?	
ZRY	Regimental Communications Officer	
ZTF	Have message(s) for you	
ZUE	Change net wave length to ______ meters	
ZUU	Division Commander	
ZVL	Go to the net wave length	
ZWN	Shall I stop sending?	
ZXE	Brigade Communications Officer	
ZXY	Battalion Commander	
ZYO	Is net directed?	
ZYU	Stop sending	
ZZA	Station reports in net ready to function	
ZZB	Station ceases operation temporarily for ______ hours	
ZZC	Net is controlled	
ZZD	Net is directed	
ZZF	Net is free	
ZZG	I take over command of the net by authority of	
ZZH	Transmit your message to	

CALLING UP—ANSWERING

44. *a.* The "call" consists of the commencing sign, call sign, or signs of the called station or stations, the procedure sign V, and the call sign of the calling station. The call forms part of the heading of a message. (See Par. 38.) The call also is part of a "call up."

b. The "call up" consists of the "call" followed by some procedure sign, which in itself is a message to the called station, together with the ending sign.

c. No station will call up any other station without also transmitting some procedure sign explaining the reason for the call up. If a station can hear its call sign, it also can hear the procedure sign following the call.

d. Frequently the procedure sign in the call up is ZTF or ZAR, which in directed or controlled nets is followed by the designation of the message waiting for the called station, or waiting to be sent. In the following examples TS1 will be used as the call sign of the transmitting or calling station.

RS1, RS2, RS3, etc., will indicate the call sign of the receiving or called stations.

Each station is furnished by the Signal Officer with its own call sign as well as those of all other stations in the net, the net wave length, and call signs and wave lengths of such stations in adjacent nets as may be necessary.

e. In order that there may exist an interval during which a station having some urgent reason for desiring to transmit may do so, the following general rule will govern: "No station will transmit for a period of one-half minute after the end of a previous transmission which requires no answer or acknowledgment, except in the following cases:

(1) To transmit the net call.
(2) To report a priority message.
(3) To report out of the net."

45. *Method of calling up.*—A station wishing to "call up" another station will send the "commencing sign" once, followed by the call sign of the station called, transmitted twice, the sign "from" transmitted once, its own call sign transmitted twice, and some procedure sign or signs explaining the reason for the call up repeated twice, followed by the "ending sign."

Example

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II ZTF ZTF II $\overline{\text{AR}}$

Where two or more procedure signs, call signs, or words are used in an original "call up" after the "call" the following rule will govern their repetition:

a. If a procedure sign requiring an additional sign or signal to complete its meaning is used, they will be sent as follows:

Example

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II ZFG RS2 II ZFG RS2 II $\overline{\text{AR}}$

b. If the information given in the call up is rather lengthy, it will be sent as follows:

Example

$\overline{\text{VE}}$ NC1 NC1 V TS1 TS1 II ZAR
ZAR II ONE P TWO D RS1 II $\overline{\text{AR}}$

In order to avoid undue interference with other stations in the net, the following rules will govern calling up a station known to have been in the net:

(1) If the receiving stations fail to answer the first call up, it will be repeated once.

(2) If the receiving stations fail to answer this second call up, the chief of section will ascertain by telephone whether the called station can hear the call up and whether he is replying. If the called station can not be reached by telephone, the nearest radio station will be requested to determine by radio or telephone if the station called is working. If the station called is in the net and working but can not be reached by the station calling, the messages will be relayed through a station which can reach the called station. If it is impossible to ascertain by radio or telephone whether or not the station called is in the net, the calling station's message center will be notified, and it will either authorize this message to be transmitted "blind" or state that some other means of transmission will be depended upon, or will direct the radio station to continue calling.

(3) If the transmission "blind" is authorized, the station transmits the message twice (see Par. 82), omitting F, and changing $\overline{\text{VA}}$ to $\overline{\text{AR}}$. This method carries no assurance that the message had been received, but if the receiving station can receive but not transmit it will receive the message before it can be transmitted by any other means. Message centers directing this method of transmission immediately transmit it by some other means.

(4) If the message center directs that calling be continued, the radio station will not call more often than once in five minutes, and will keep all its other traffic clear.

46. *Method of answering a call up.*—A station hearing its own call sign being transmitted by another station will answer by transmitting the commencing sign once, the call sign of the calling station twice, followed by the sign "from" and its own call sign transmitted twice. This will be followed by "go ahead" sign or any other instructions made necessary by the procedure sign in the original call up.

Examples

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II Q

or

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II ZBQ II Z II K

PROCEDURE IN TACTICAL NETS

47. There are two types of nets as follows:

a. The ordinary net, in which all sets work on the same wave length and in which only two stations can communicate at the same time.

b. The SCR–77–A Net which is one composed of that set or sets of similar operating characteristics. All stations within the net do not work on the same wave length, but the net has assigned to it a band of wave lengths or tuner settings and within that band each station has its individual wave length or tuner setting. In this type of net the number of stations which may work at one time is equal to the total number of stations in the net divided by two.

48. Either of the above types of nets may be operated with regard to the handling of traffic in one of three ways: As a Free Net, a Directed Net, or a Controlled Net.

49. A Free Net is one in which the secondary stations intercommunicate without obtaining permission or instructions from the N. C. S.

50. A Directed Net is one in which a secondary station must first call up and obtain permission from the N. C. S. before transmitting any message or signal to any other station in the net. Permission granted by the N. C. S. to a secondary station to transmit messages covers all transmissions concerning such message until the receiving station or stations finally acknowledge for same. In the absence of orders to the contrary a Directed Net will always be used.

51. A Controlled Net is one in which a secondary station will not transmit any signal whatever, without first being called by the N. C. S. and directed to do so except:

(1) To report a PRIORITY message,
(2) To report out of the net, or
(3) To transmit the net call for the following purposes: To report into the net; to change the N. C. S.

(See Pars. 55 and 68.) A controlled net is used only in instances where the tactical situation demands its use or in cases of confusion or disorder in the net. Controlled nets operate under an "order of operation."

52. The order of operation in a controlled net is specified by the signal officer when the call sign cards are prepared, in that all stations answer the net call in the order in which the call signs appear on their call sign card. The communications officer preparing these cards is responsible that the call signs appear on all cards for the same net in the same order. This arrangement makes the order of operation automatic.

53. In some nets under certain conditions there are stations which engage more often in inter-net traffic than others and in such nets it may be desirable to change the order of operation from that automatically provided. In such cases the N. C. S. will issue an order approved by its signal officer, to be included in the special radio instructions of Signal Operation Instructions, designating the order in which stations answer a net call. Stations receiving such an order will number the left margin of their call sign cards to corre-

spond with this order, placing the words "Order of operation" above the column of figures.

54. Net calls will be used for the following purposes:

a. To change the type of net operation.
b. To change the N. C. S.
c. For a message addressed to all stations.
d. To establish a net.
e. To designate an N. C. 2.

55. *To establish a net.*—In the examples in this section the N. C. S. will be designated as NC$\underline{1}$ in order to distinguish it readily, although in actual practice it will have some other call sign.

The radio station at the senior command post in the net is the N. C. S. unless otherwise ordered.

Secondary stations, as soon as they are set up and established will enter the net as shown in the following example:

Example

Station TS$\underline{1}$ (a secondary station) has moved forward into a combat area with its headquarters and is set up and ready to function. It listens on its wave length and hears nothing. TS$\underline{1}$ calls as follows:

$\overline{\text{VE}}$ ZLV ZLV V TS$\underline{1}$ TS$\underline{1}$ II ZZA ZZA II $\overline{\text{AR}}$

a. If an answer to this transmission is received, it will indicate that one or more stations of the net are already established, and that the answering station is either the regular or an acting N. C. S. The answer to the above transmission should contain procedure signs indicating the type of net and the stations then in the net, transmitted as follows:

$\overline{\text{VE}}$ TS$\underline{1}$ TS$\underline{1}$ V RS2 RS2 II ZZF II ZMQ RS3 II $\overline{\text{VA}}$

Such an answer as the above would indicate that station RS2 had assumed command of the net in the absence of station NC$\underline{1}$; that the net was free; and that station RS3 was also in the net.

If RS2 had desired an acknowledgment he would have ended the transmission by $\overline{\text{AR}}$ instead of $\overline{\text{VA}}$.

b. If station TS$\underline{1}$ receives no answer to its transmission reporting into the net it will know that it is the first station to be established in the net and will therefore act as a temporary N. C. S. until the entrance of NC$\underline{1}$ into the net.

c. NC$\underline{1}$ will enter the net as follows:

$\overline{\text{VE}}$ ZLV ZLV V NC$\underline{1}$ NC$\underline{1}$ II ZZG ZZG II $\overline{\text{AR}}$

If the net is already established each station in the net will answer the N. C. S. by transmitting:

$\overline{\text{VE}}$ NC$\underline{1}$ NC$\underline{1}$ V TS$\underline{1}$ TS$\underline{1}$ II R

except the acting N. C. S. who will include in his answer, procedure signs indicating the type of net and the stations in the net.

Example

VE NC1 NC1 V RS2 RS2 II ZZC II ZMQ RS3 TSZ II AR
These answers would be made in the order of operation given on the call sign cards.

The N. C. S. after having received the answers to his net call on entering the net is then at liberty to continue the operation of the net as any type of net he may desire. However, his decision must be announced to the secondary stations:

VE ZLV ZLV V NC1 NC1 II ZZD ZZD II VA

If the N. C. S. on transmitting his net call on entering the net receives no reply, he will know that he is the first station of the net to be established and will answer stations which he later hears reporting into the net as shown previously.

The first station to establish in a net will call the other stations of the net regularly at least every half hour, until they reply or report into the net, unless from its log sheet or orders it is known that such stations will not enter for a certain time.

Nets will always be originally established as directed nets. After stations have reported into the net and traffic has started, the type of net operation may be changed as ordered or desired. (See Par. 63.) Traffic will never be held up waiting for stations to report into the net. Stations already in the net clear traffic as promptly as possible, while new stations report into the net between message transmissions.

A secondary station upon reporting in a net and being informed what stations are in the net and that the net is *controlled*, will acknowledge by giving a report of the traffic it has on file.

56. *Free net—Method of procedure.*—A net having been established (see Par. 55) when traffic conditions are very light in a net, may be operated free.

Example

Station TS1 has a message for Station TS2. Station TS1 calls up as follows:

VE TS2 TS2 V TS1 TS1 II ZAR D II ZAR D II AR

Station TS2 replies as follows:

VE TS1 TS1 V TS2 TS2 II K

Station TS1 then transmits its message. (See par. 40.) Upon receipt of message, station TS2 acknowledges in the prescribed manner (see par. 94), which ends the transmission.

57. *Directed net—Method of procedure.*—The net having been established by two or more stations reporting in, a station having messages for a station other than the N. C. S. must always call the N. C. S. and request permission to transmit.

Such permission granted by the N. C. S. covers all transmissions concerning that particular message until the receiving station finally acknowledges for the same.

The secondary station's call up of the N. C. S. requesting permission to transmit will indicate the station he wishes to transmit to, how many messages he has for that station, and their class.

Example

TS1 has one Rush ($\overline{\text{OD}}$) and two ordinary messages (D) for RS1 and wishes to obtain permission from the N. C. S. to transmit them; TS1 will call up as follows:

$\overline{\text{VE}}$ NC1 NC1 V TS1 TS1 II ZAR
ZAR II ONE $\overline{\text{OD}}$ TWO D RS1 II $\overline{\text{AR}}$

58. *Method of granting or not granting permission to transmit.*—The N. C. S. will answer in one of three ways:

$\overline{\text{VE}}$ TS1 TS1 V NC1 NC1 II K

meaning "Go ahead and transmit all of the messages you have just reported to RS1"; or

$\overline{\text{VE}}$ TS1 TS1 V NC1 NC1 II ZZH ONE $\overline{\text{OD}}$ II $\overline{\text{VA}}$

meaning "Transmit only the one $\overline{\text{OD}}$ message to RS1"; or

$\overline{\text{VE}}$ TS1 TS1 V NC1 NC1 II Q

meaning "Wait; you can not send your message to RS1 now."

Each station in the net must keep a traffic sheet.

59. *Controlled net—method of procedure.*—When disorder or confusion arises in a free or in a directed net, the N. C. S. should change to a controlled net. A controlled net should be used only in an emergency and then only so long as is necessary to return the net to normal conditions. With partially trained operators who "jam" the air in trying to get right of way, it will be found that a controlled net in the end clears traffic more rapidly than other types of net operation.

If several stations are trying "to get the air" at once and no traffic is going through in a free or directed net, then NC1 should change to a controlled net.

During one of the one-half minute silent intervals he will send:

$\overline{\text{VE}}$ ZLV ZLV V NC1 II ZZC ZZC II ZFD ZFD II $\overline{\text{AR}}$

Secondary stations in the net upon receipt of above acknowledge to the N. C. S., according to the order of operation (see Pars. 52 and 53), as follows:

$\overline{\text{VE}}$ NC1 NC1 V RS1 RS1 II ZAR II one P
RS3 II one $\overline{\text{OD}}$ RS4 II $\overline{\text{AR}}$

The N. C. S. replies as follows:

VE RS1 RS1 V NC1 NC1 II R

All stations in the net as they receive these reports of traffic tabulate them on their traffic sheet in the manner given below. Secondary stations will not receive a report of the traffic the N. C. S. has on file. Secondary stations will check off the messages on their traffic sheet as they are transmitted. When the N. C. S. goes out of the net the N. C. 2 or any other secondary station can assume command of the net without requiring a report of traffic until that already reported is cleared.

a. Example No. 1 shows the form for a traffic sheet used in the dispatch of traffic in a controlled net.

b. In this example the number of lines placed opposite the call signs in the columns headed P, OD, and D indicate the number of messages of that particular class from one station to another. Thus, station XA1 has one OD and three D messages for station XD1 which were reported at 8.02 a. m.

TRAFFIC SHEET FOR CONTROLLED NETS

Net					Date		
From	To	Class of message			Time		Remarks
		P	OD	D	Reported	Permission granted	
XA1	XB1	1			8:02 A		
XA1	XD1		1	111	8:02 A		
XB1	XA1		11		8:04 A		
XB1	XC1	1		1	8:04 A		
XB1	XD1		1		8:04 A		
XC1	XA1		1		8:07 A		
XD1	XC1	1		1	8:10 A		
XD1	XB1			1	8:10 A		

EXAMPLE NO. 1

Chief operator

c. The manner in which the N. C. S. will dispatch his traffic will be influenced by many factors. Suppose all stations in the net are working on the same wave length; then only one message at a time may be transmitted. If, however, each station has a separate wave length, then there may be transmitted at the same time one message for each pair of stations provided the traffic reported is evenly distributed.

The following general rules will always be followed in dispatching traffic:

(1) All P messages tabulated on the traffic sheet will be cleared before any $\overline{OD}$ or D messages are sent.

(2) All $\overline{OD}$ messages tabulated on the traffic sheet will be cleared after all P messages have been transmitted.

(3) D messages will be cleared when all other messages have been sent.

(4) Messages of the same class will be cleared in the order in which the stations at which they originate appear in the order of operation.

(5) Priority messages reported by secondary stations between the general reports by all stations of traffic on hand will be cleared in the same manner as those reported at the regular time.

(6) When a message must be relayed by one of the stations of the net, the N. C. S. will grant permission to the secondary station of origin to transmit the message to the relay station which the N. C. S. will designate. The N. C. S. will enter the message on his traffic sheet as having been reported by the relay station when he hears the relay station acknowledge receipt to the secondary station of origin. The message will then be cleared from the relay station in the usual order.

(7) Messages which for any reason can not be sent will be so noted in the column headed "Remarks" on the traffic sheet.

In the column headed "Permission granted" the time permission was granted will be noted and at the same time the vertical mark in one of the columns headed P, $\overline{OD}$ or D indicating the message for which permission has been granted will be canceled by an oblique line through it. Where a station has more than one message for another the time that permission is granted for each message will be entered successively in the column headed "Permission granted" and on the line indicating traffic between these two stations.

Example No. 2 shows the traffic sheet of Example No. 1 as it would appear with all traffic cleared.

TRAFFIC SHEET FOR CONTROLLED NETS

Net					Date		
From	To	Class of message			Time		Remarks
		P	OD	D	Reported	Permission granted	
XA1	XB1	I			8:Ø2 A	8:12 A	
XA1	XD1		I	III	8:Ø2 A	8:23 A 8:47 A 8:51 A 8:58 A	
XB1	XA1		II		8:Ø4 A	8:27 A 8:31 A	
XB1	XC1			I	8:Ø4 A	8:15 A 9:Ø3 A	
XB1	XD1		I		8:Ø4 A	8:35 A	
XC1	XA1		I		8:Ø7 A	8:4Ø A	
XD1	XC1			I	8:1Ø A	8:2Ø A 9:1Ø A	
XD1	XB1			I	8:1Ø A	9:16 A	

EXAMPLE NO. 2

Chief operator

After having received all reports and having tabulated all traffic the N. C. S. will study his traffic sheet and grant permission to stations for the transmission of messages. If any station in his net fails to report, the N. C. S. will call that station individually, and announce that the net is controlled, and obtain a report of its traffic.

The N. C. S. directs transmission of the messages reported as follows:

VE RS1 RS1 V NC1 NC1 II ZZH RS3 II K

This authorizes RS1 to transmit all the messages he reported above.

If there were P messages reported from other stations, NC1 would have sent

VE RS1 RS1 V NC1 NC1 II ZZH P RS3 II K

This permits RS1 to transmit only his P message.

When all traffic covered by the original call is completed or when traffic has been transmitted for so long a period that other important messages may have been filed, the N. C. S. will again call for a report as follows:

$\overline{\text{VE}}$ ZLV ZLV V NC1 II ZFD ZFD II K

The secondary stations reply in the order of operation as before. The net remains controlled until orders are issued changing its method of operation; hence ZZC does not have to be repeated in this transmission.

60. *SCR–77–A net—Method of procedure.*—Procedure in this net differs from other procedure in that groups of two stations within a net may communicate at the same time without interference. In a net which operates on a single wave length only one station is able to transmit at a time. Breaking of the transmitting station in SCR–77–A nets may be done in the same manner as on an ordinary telegraph line. Net calls can not be used with this set. In all other cases the same rules and methods that are prescribed elsewhere in this procedure apply to the SCR–77–A net in the use of procedure signs.

61. *Calibration of the SCR–77–A set.*—On entering a net a secondary station will place his set on the "Stand by" position and gradually go over the tuner settings (wave length band) of his net, listening to the traffic of the net. After locating the N. C. S. he will call it the first time it is silent and report into the net in the usual manner. After reporting to the N. C. S. the secondary station will return to "Stand by" and adjust his screw-driver condenser so that he actually gets the N. C. S. on the tuner setting which has been assigned to it.

Use of the SCR–77–A break-in feature.—With this set a receiving operator may break the transmitting operator at any time by simply opening his key, or on some of these sets by making a series of dots. This is made use of as follows:

Station RS1 is receiving from TS1 and due to some cause misses a letter or a group of the message. RS1 opens his key and waits a moment. TS1 notes the disappearance of his transmitted signals in his head set and closes his key. RS1 then transmits:

$\overline{\text{VE}}$ TS1 V RS1 RS1 II $\overline{\text{IMI}}$ WA XOM II K

meaning the group XOM was the last group received. (See Pars. 85 and 101.)

62. *No net call for SCR–77–A set.*—No net call can be used with the SCR–77–A set. This arises from the fact that if three or more stations are on the same tuner setting, interference is so great that none of the sets can hear anything. This is the reason why sets

desiring to call another station go on "Stand by" when they listen to ascertain whether a station they desire to call is working or not.

If it is desired to reach all stations in the net, the operator should work with each one separately and permit the others to go ahead with their traffic until it is desired to call them.

63. *Changing from one type of net operation to another.*—If from any cause the N. C. S. desires to change from one type of net operation to another, he will do so by transmitting the net call followed by the conventional signal (or procedure sign) indicating the type of net operation that it is desired to use. Upon the receipt of this, the secondary stations will acknowledge in the "order of operation" appearing on their call sign cards. (See Pars. 42 and 53.) In the event one or more secondary stations fail to acknowledge, the N. C. S. will transmit to them individually the change in the type of net.

Example

Station TS1 (the N. C. S.) desires to change from a controlled to a directed net. He calls the net as follows:

$\overline{\text{VE}}$ ZLV ZLV V TS1 TS1 II ZZD ZZD II $\overline{\text{AR}}$

Upon receipt of this the secondary stations acknowledge in the prescribed manner. Had he sent $\overline{\text{VA}}$, they would not have acknowledged.

64. *To report out of a net.*—A station knowing that it will be silent for a definite length of time, due to moving forward or other cause, will always report this fact to the N. C. S. promptly, giving the approximate duration of time the station will be out of the net. (See Par. 15 and ZZB in Par. 43.)

Example

Station TS1 is working in a net and about to move forward. TS1 desires to inform his N. C. S. that he will be out of the net about one hour. TS1 calls up NC1 in the usual way, as follows:

$\overline{\text{VE}}$ NC1 NC1 V TS1 TS1 II ZZB ZZB II one hour II $\overline{\text{AR}}$

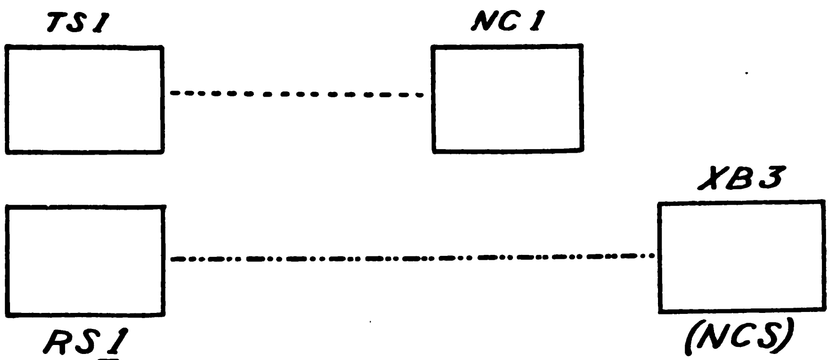
65. *Transmissions between stations in different nets of the same type.*—Transmissions between stations of different nets of the same type of set are governed by the following rules:

a. Net command stations of adjacent nets of the same type will control intercommunication between their respective nets.

b. In all cases permission will be obtained from the originating station's N. C. S. to enter the adjacent net; the calling station will change to the wave length of the adjacent net, ascertain that he will not disturb that net, and call the N. C. S. of the net, requesting permission to transmit his message. When permission is granted, he will call the station for which he has a message. When finished, he will report back into his own net.

Example

TS1 has a message for RS1 in another net.



RO-17

Transmitting station TS1 calls up his net control station (NC1) and asks permission to engage in internet traffic:

VE NC1 NC1 V TS1 II ZMA ZMA II AR

NC1 answers:

VE TS1 TS1 V NC1 NC1 II ZLU II AR

TS1 then changes his wave length to that of the other net and ascertains that he will not interfere. He then calls XB3 the N. C. S. of the adjacent net as follows:

VE XB3 XB3 V TS1 TS1 II ZMA ZMA II AR

XB3 answers:

VE TS1 TS1 V XB3 XB3 II ZLU II K

Or if traffic is heavy XB3 may inquire further. (See par. 58.) TS1 then calls RS1 and transmits his message in the ordinary manner. XB3, who has followed the transmission, knows when TS1 is through, but NC1 on another wave length does not know he is through; hence TS1 reports to his own N. C. S. when he returns to his own net after ascertaining that he will not disturb traffic; thus:

VE NC1 NC1 V TS1 TS1 II ZZA ZZA II AR

This procedure for internet traffic will be followed no matter what the type of operation in either net.

66. *Designating an N. C. 2.*—As soon as a net is established the NC$\underline{1}$ will designate an N. C. 2. This N. C. 2 so designated should, if possible, be centrally located in the net and known to have a good set and competent operators.

Examples

NC$\underline{1}$ designates RS$\underline{1}$ as N. C. 2 thus:

$\overline{\text{VE}}$ ZLV ZLV V NC$\underline{1}$ NC$\underline{1}$ II ZBD RS$\underline{1}$ II ZBD RS$\underline{1}$ II $\overline{\text{AR}}$

Stations acknowledge receipt in the order of operation. If the stations are working well, NC$\underline{1}$ can use $\overline{\text{VA}}$ and no acknowledgment will be made.

When the N. C. S. disappears from the net for over half an hour and can not be found, and an inspection of the log sheet shows that the N. C. S. has not reported leaving the net, the N. C. 2 will take command of the net. However, if the net is being operated as a directed or controlled net and the absence of the N. C. S. is delaying the transmission of traffic, the N. C. 2 will at once take command. (See par. 59 for use of traffic sheets in case the net is controlled.)

Example

$\overline{\text{VE}}$ ZLV ZLV V NC2 NC2 II ZZG ZFF II ZZG ZFF II $\overline{\text{AR}}$

If all the other stations are known to be working $\overline{\text{VA}}$ could be used.

67. *Reasons for changing N. C. S.*—It may be necessary at any time to change the N. C. S. for the following reasons:

a. The N. C. S. may have to leave the net for a considerable period.

b. The communication officer may desire to give other secondary stations practice in commanding the net.

c. The N. C. S. may not have power enough to reach all stations in the net while some other station has the power to reach all of them.

d. The N. C. S. may have poor operators or an insufficient number of operators on account of casualties.

e. The unit commander may be temporarily at the headquarters of a subordinate unit and desire to direct combat operations by radio from that station.

68. *Method of changing the N. C. S.*—There are three cases so far as operators are concerned:

Case I—Where the N. C. S. orders a secondary station to take command of the net.

Case II—Where a secondary station is ordered to take command of the net without the N. C. S. having been previously told.

Case III—When the N. C. S. can not be found in the net. (See par. 39.)

Examples

Case I.—NC1 orders secondary station RS1 to take command of the net by transmitting:

(1) The net call.
(2) His own call sign.
(3) Call sign of station which is to take command.
(4) Code group for "Take command of the net."
(5) Code group for the authority, as follows:

$\overline{VE}$ ZLV ZLV II NC1 NC1 II RS1
ZFF ZXE II RS1 ZFF ZXE II $\overline{AR}$

RS1 acknowledges by transmitting:

(1) The net call.
(2) His own call.
(3) Code group for "I take over command of the net by authority of."
(4) The authority.

$\overline{VE}$ ZLV ZLV V RS1 RS1 II ZZG ZXE II $\overline{AR}$

Stations other than the former NC1 acknowledges transmission by transmitting R to RS1 according to the order of operation.

If all stations are known to be working well, RS1 could have ended his transmission with $\overline{VA}$.

Case II.—RS2 is ordered to take command of the net by the brigade commander who has arrived at the headquarters of RS2.

a. If the brigade commander has a P message to be sent at once, RS2 will obtain silence in the net, if it does not exist, by sending $\overline{VE}$ ZLV ZLV II RS2 RS2 II $\overline{VA}$ several times during the next one-half minute silent interval, until the net is silent. (See par. 66.)

When the net is silent he will send:

$\overline{VE}$ ZLV ZLV II ZZG ZMB II ZZG ZMB II $\overline{VA}$

This tells all stations in the net that he has taken command of the net, by authority of the brigade commander, and that they are not to reply. He then transmits his P messages.

b. As soon as the emergency passes, or as soon as possible, he again sends the net call and announces that the net is controlled, directing them to report their traffic, or that the net is directed or free, so that other stations may clear their traffic.

c. Before the brigade commander leaves that headquarters, or when it is apparent that the emergency is entirely over, the operator or the chief of section will ascertain whether command of the net is to be returned to the NC1 or not.

RELAYING MESSAGES

69. There are two distinct cases in which radio messages are relayed in tactical units:

Case 1.—Relaying messages between two stations in the same net, or between stations in different nets of the same type where the relaying, transmitting, and receiving stations are one and the same station:

a. Where these stations are in the same net and so located that the distance is too great for one station to reach the other station, the N. C. S. will specify the station or stations which are to relay messages to those inaccessible to other stations in the net.

b. For transmission of messages between stations in different nets of the same type, where relay is required, either in the net of origin or in the net of destination, the arrangements for stations which are to do the relay work will be made by the N. C. S. of the nets concerned, subject to approval of their radio officers. (See Par. 88, where more than one relay point is required.)

70. *Instructions for relaying messages in Case 1.*

(1) The transmitting operator at the station of origin will:

a. Insert "T" in the proper space in the preamble of his message. (See Par. 69.)

b. Insert the call letters of the station of final destination.

c. Insert "G" in the prefix of the message.

(2) The receiving and transmitting operator at the relay station will:

a. "Repeat back" the message.

b. Send the original copy to the message center, marked "Message received for relay."

c. Write a new heading at the bottom of the carbon copy, inserting call sign of station called, "V," his own call sign, "V" (original from), followed by the call sign of the station of origin, and copy the balance of the prefix just as he received it.

d. Transmit the message.

(3) The message center at the relay point is responsible:

a. That this "message for relay" is decoded.

b. That if there are undecodable groups, repeats are asked for.

c. That corrections received are forwarded to the station of final destination.

d. That, if of sufficient importance, the message is also sent by some other means.

71. *Case 2.* Where the message is addressed to a station in a net having a different type of set than the sets in the net of origin, and requires that the message be transferred by messenger from a radio station in one net to another radio station of the same headquarters, which uses a different type of set in another net, there will be two cases:

a. Where the call sign of the station of final destination is known.

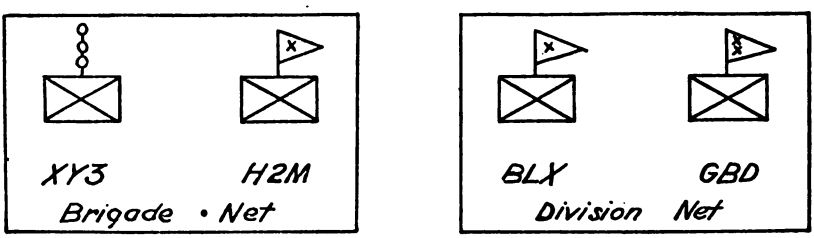
b. Where it is unknown.

72. *Instructions for relaying messages in Case 2.*

(A) If the call sign of the station of final destination is known:

a. The radio operator will insert "T" in his preamble, and in the following space the call letters of the station of destination, and "G" in the prefix.

b. The receiving operator copying the "T," followed by a call sign, will know that this is a relayed message, and will ascertain from his call sign card the name of the station and the net it is in and send the carbon by messenger to the proper radio station at his headquarters marked "Message received for relay."



RO-22

c. The original copy will be sent to the message center with the notation "Message received for relay. Copy sent to .... radio station," giving the name of the station.

d. The relay message center is responsible that the message is decoded; and that if undecodable that the necessary repeats are obtained, and the message at the relay radio station corrected. It will also ascertain from the text of the decoded message whether any additional means of transmission is required.

e. The operator at the relay transmitting station will make out a new heading on the bottom of the blank and enter in the preamble "V" (originally from) followed by the call sign of the station of origin taken from the heading, followed by the prefix copied from the original heading.

f. Transmit the message with the new heading.

XY3 has a message for GBD which must be relayed through H2M and BLX, the two latter being stations in different nets at the same headquarters.

Heading of XY3:

$\overline{VE}$ H2M H2M V XY3 II T GBD II
Call Preamble

NR7 II G II $\overline{OD}$ II GR II
Prefix

H2M sends the message to BLX by messenger.

Heading of BLX:

$\overline{VE}$ GBD V BLX II V XY3 II
Call Preamble

NR7 II G II $\overline{OD}$ II GR II
Prefix

This shows the operator and message center at station of destination from what station the message originally came.

73. (B) If the call letters of station of destination are unknown, the originating message center will encode the address in the text of the message immediately after the group indicating the type of code used. It will require the message to be repeated back. For such a message the transmitting and receiving radio operator will not know it is to be relayed, and the receiving message center, when decoding, will immediately understand that the message is to be relayed and take the necessary steps to have it done.

ILLUSTRATIONS OF THE USE OF PROCEDURE SIGNS

74. $\overline{AA}$.—The "unknown station" sign is used when a station hears its call sign being made, but can not make out the call of the calling station:

Example

RS1 hears its call sign being made but is unable to determine the origin.

RS1 will then transmit:

$\overline{VE}$ $\overline{AA}$ $\overline{AA}$ V RS1 RS1 II K

75. $\overline{AR}$. The "Final or Ending" sign is used after every transmission which does not end with one of the procedure signs "B," "C," "R," "Q," or "$\overline{VA}$." When so used, it means "This is the end of this particular message or transmission." It may be used thus:

Example

TS1 calls up RS1, stating he has a message for him and finishing with the "ending sign" $\overline{AR}$, thus:

$\overline{VE}$ RS1 RS1 V TS1 TS1 II ZAR ZAR II one $\overline{OD}$ II $\overline{AR}$

76. B.—The procedure sign "B" is used in the heading, if the message is a long one, to indicate that transmission will be in groups. When used in this case, it is followed by figures to indicate the number of groups in each part of the transmission. When used at the end of a transmission it means "More of this same message to follow."

77. B.—The letter "B" followed by a number is used as the procedure sign to signify "Following number of groups sent now. More to follow." The number after the letter indicates the number of groups sent. The total number of groups in the message must also be indicated when "B" is sent as a part of the heading.

When used by itself "B" indicates "More to follow."

TS1 has a long message of 32 groups for RS1 and decides to send only the first 10 in the first transmission. TS1, after calling up RS1 and receiving the "go ahead" sign, would proceed as follows:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II NR6 II D II
GR32 II B1 $\overline{\text{XE}}$ 1Ø NR4 II 1ØØ1A II DFC1
II XNO POY RTZ MNZ RSO PNT ZKS II B

Station RS1 would acknowledge as follows:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R1 $\overline{\text{XE}}$ 1Ø

Upon receiving the above, TS1, after deciding to send 10 more groups, would transmit:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II B 11 $\overline{\text{XE}}$ 2Ø $\overline{\text{BT}}$ FLX
TRO MOP XFK RSN POS RPT NKO ROL TSZ II B

Station TS1 after getting the above receipt would send the remaining groups as follows:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II B 21 $\overline{\text{XE}}$ 32 $\overline{\text{BT}}$ XTN
MZO XPX TRN MIS HIM POR TNW XRB CDF
FPN TRX II$\overline{\text{AR}}$

Station RS1, receiving the groups from 21 to 32, inclusive, would now acknowledge the entire message, it not being necessary to acknowledge the groups from 21 to 32.

Station RS1 would transmit:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R NR6 II $\overline{\text{AR}}$

78. $\overline{\text{BT}}$.—The "Break" sign is used to separate the text from the heading in all encoded or plain language messages.

Example

The heading of an encoded message is:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II NR2 II $\overline{\text{OD}}$ II GR4

The text is:

NR6 1140P WTC MZOXI II AR

The heading and text, separated by the break sign, would be sent and separated as follows:

VE RS1 RS1 V TS1 TS1 II NR2 II OD II GR4
BT NR6 II 1140P II WTC II MZOXI II AR

79. C.—The letter "C" used by itself signifies "You are correct" and refers to the last transmission only. It can also be used as an ending sign. (See Par. 83.)

Example

Station TS1 having sent a message NR–23 to RS1, prefixed with the letter "G" (Repeat back) and RS1 having repeated back correctly, TS1 then transmits:

VE TS1 TS1 V RS1 RS1 II NR23 II C

RS1 having received a message not preceded by "G" from TS1, but being doubtful about the second group, which was MNOXP, would transmit:

VE TS1 TS1 V RS1 RS1 II INT GR2 II MNOXP II AR

If MNOXP is correct, TS1 would reply:

VE RS1 RS1 V TS1 TS1 II C

Station RS1 would then acknowledge the communication.

80. D.—The letter "D" is used by itself in the heading only and indicates the class of message. It signifies "The following message is an ordinary message."

"D" messages are those of the class composing routing reports, or which permit of a delay equal to the average delay time at that station. Such messages are filed for transmission by the operator in order of their receipt.

An operator who cannot get the station of the first "D" message on his file, will get any station he can for which he has messages, and will transmit all that he has for that station irrespective of their order in his file.

81. E. (10 times).—The letter "E" sent 10 times in rapid succession is used to erase a word or group incorrectly transmitted. Should a station in the course of transmitting a message make a mistake in a word, group, or letter, the "Erase" sign must be made immediately; then the last word or group made correctly will be repeated and the message continued.

The "Repeat" sign (IMI), the "Interrogation" sign (INT), or the "Break" sign (BT) will not be used to indicate mistakes. The "Erase" sign will be used exclusively for this purpose.

Example

Station TS1 while transmitting a message the body of which is "NR1 Ø946A DFC1 FOR NTA XDN" makes a mistake on the group "FOR." To correct this TS1 transmits as follows:

NR1 II Ø946A II DFC1 II FMEEEEEEEEEE
DFC1 II FOR NTA XDN II $\overline{AR}$

82. The letter "F" is used as a procedure sign in the prefix to indicate, when a message is sent to a "silent" station, that "Message following is not to be answered or acknowledged."

a. A *silent* station is one which receives but does not transmit. Silent stations are announced in orders to all message centers and radio stations concerned. Silent stations may be used for the purpose of deceiving the enemy. When units are relieved the radio stations of some of the relieving units may be silent for 24 or 48 hours. If all the radio stations in a division, for instance, were changed in one night at the same time, no matter how secret the movement of troops, the new operators on new sets would at once give away to the enemy the fact that a relief was taking place. The prefix of messages addressed to silent stations will always include the conventional sign "F" which adds a double check to insure that no transmission takes place.

b. This method is also used where it is desired to transmit an important message to a station, the character of the message being such that for additional secrecy it is necessary that the enemy not know the location of the station to whom it is addressed.

c. The use of this method requires that stations know through other means that the silent stations are working.

d. It affords a method of handling messages in clear, in emergencies when transmission in clear is ordered.

e. When "F" is used in the prefix, the message will always be sent through twice.

f. When "F" is used in the prefix, stations are not in any case to ask by radio for repetitions or corrections.

g. Silent stations receiving a message addressed to them acknowledge receipt by some other means than radio.

h. The $\overline{VA}$ sign is always used to indicate the end of a message or series of messages with "F" in the prefix.

Example

Station TS1 has a message for RS1. Due to the fact that RS1 has secretly moved forward into a combat area and as a "silent station" is not to answer, TS1 would transmit:

VE RS1 RS1 V TS1 TS1 II NR6 II F II OD
II GR4 BT NR8 II Ø348P II DFC1 II XNZ II
IMI II NR6 II F II OD II GR4 BT NR8 II
Ø348P II FC1 II XNZ II VA

83. G.—The procedure sign "G" used in the prefix of a message, or in connection with a code group, means "Repeat back."

The procedure sign "G" is placed by the *transmitting operator* in the prefix of the heading of a message, *when so directed by the message center*, to insure, for the information of the message center, that important messages are correctly received at the receiving station.

It is also used by the transmitting operator to correct groups incorrectly repeated back, as shown below. Operators will always inform message centers when receiving operators have correctly repeated back messages as ordered by the message center. The sign "G" will be inserted by all operators in the prefix of those messages which they know are to be relayed. (See Pars. 70 and 72.)

When repeating back or correcting repetitions, the text or groups concerned are sent once only, notwithstanding the fact that the original message may have been sent twice.

Example

TS1 has a "priority" message for RS1 which is so important that the message center had directed that it be repeated back. The text of this message is "NR1 II Ø6Ø3A II DFC1 II YBZ XKO MOK ZRM." TS1 requests RS1 to repeat this message back by inserting the procedure sign "G" in the proper place in the prefix:

TS1 having prepared his heading transmits:

VE RS1 RS1 V TS1 TS1 II NR1Ø II G II P II GR7
BT NR1 II Ø6Ø3A II FC1 II YBZ SKO MOK ZRM
II AR

a. RS1 repeated the message back correctly. TS1 replies:

VE RS1 RS1 V TS1 TS1 II NR1Ø II C.

This completes that transmission.

b. RS1 failed to receive the group YBZ correctly, but repeated this as YDZ. TS1 wishes to correct this mistake, and to have RS1 repeat the group. He accordingly transmits as follows:

VE RS1 RS1 V TS1 TS1 II G II GR4 YBZ II AR

RS1 then answers as follows:

VE TS1 TS1 V RS1 RS1 II GR4 YBZ II AR

To this TS1 replies as in (*a*).

84. GR.—When used in the heading, the procedure sign GR followed by a number indicates the number of code groups or words in the text of the message.

Upon receipt of a message for transmission, the radio operator will fill out his heading as follows: When he reaches GR, he will count the separate code groups or words in the text and insert this number after GR.

The sender's number counts as one code group.

The sender's time, if shown, counts as one code group.

The type of code, if shown, counts as one code group.

The message center arranges these groups and the following groups of a message, each on a separate code group space on the Radio Message Blank (Transmission).

85. $\overline{\text{IMI}}$.—*a*. The "Repeat" sign is used during, or immediately following, the transmission of a message by the *receiving operator*, to request a repetition of that part which was not received.

b. When a message is made twice through, the "Repeat" sign is inserted between the first and second transmission. In this case the "Repeat" sign is immediately preceded by, and followed by, the "Space" sign II.

Example

Station TS$\underline{1}$ received a message from station RS2 but has missed the third group. He transmits as follows:

$\overline{\text{VE}}$ RS2 RS2 V TS$\underline{1}$ TS$\underline{1}$ II $\overline{\text{IMI}}$ GR3 II $\overline{\text{AR}}$

NOTE.—For use of $\overline{\text{IMI}}$ with Procedure Sign "F," see example, Par. 82. For method in obtaining a repeat of several code groups see WA and $\overline{\text{XE}}$.

86. $\overline{\text{INT}}$.—The Interrogation sign ($\overline{\text{INT}}$) is used in requesting verification of a portion of a message of which the reception is doubtful. In this connection it means "Have I correctly received the portion of the message which I am repeating back?" It questions the receiving station's own reception of a small portion of a message.

It is also used in the same manner as the ordinary question mark, that is, as a mark of punctuation at the end of a sentence.

Example

Station RS2 is doubtful about his reception of 4 groups of a 10-group message received from Station TS$\underline{1}$. He transmits as follows:

$\overline{\text{VE}}$ TS$\underline{1}$ TS$\underline{1}$ V RS2 RS2 II $\overline{\text{INT}}$ (doubtful groups) II $\overline{\text{AR}}$

If station RS2 has repeated the groups correctly, station TS$\underline{1}$ transmits as follows:

$\overline{\text{VE}}$ RS2 RS2 V TS$\underline{1}$ TS$\underline{1}$ II C

Station RS2, upon the receipt of "C," will then acknowledge the message in the prescribed manner.

In the event that station RS2 did not receive the four groups correctly, station TS1 will repeat the groups.

87. K.—*a*. The letter "K" as a procedure sign means "Go ahead with your message or communication."

"K" is used by net command stations as a command to direct operators at secondary stations to proceed with transmission as indicated by the procedure sign or signs which precede K. (See Par. 50.)

It is used by all operators to indicate to another operator that he should proceed with the transmission which has just been reported. (See Par. 56.)

The letter "K" is not used in the heading.

The sign "K" followed by a number, in an answer, signifies "Go ahead ; your signals are of the strength indicated by the number." (See "Scale of Signal Strength" below.)

SCALE TO BE USED TO EXPRESS THE STRENGTH OF SIGNALS

1. Very faint.	3. Fair.	5. Very strong.
2. Just readable.	4. Strong.	

88. M.—The sign "M," meaning "Relay via" ("Relay by way of"), is used in the preamble if a message has to be passed through more than one relaying station and the correct radio route is known to the transmitting station.

When "M" is used, the sign "Transmit to" (T) must also be used in the preamble. (See Pars. 70 and 72.)

Example

Station TS1 has a message for RS1 which is to be relayed through TS2 and TS3 in that order. The heading would be sent as follows:

VE TS2 TS2 V TS1 TS1 II M II TS3 II T
II RS1 II NR2 II G II OD II GR6 BT

NOTE.—Since this method of relaying a message will seldom be required in tactical nets, no space is shown in the Radio Message Blank (Transmission) for it. All operators should, however, note carefully its position ahead of "T."
(For further instructions see Pars. 70 and 72.)

89. N.—*a*. The sign "N" used by itself signifies "Nothing received." When a station does not immediately answer a message which requires an answer, or does not proceed with a message after "K" has been sent in answer to a call up, the sign "N" may be used.

b. The sign "N" followed by a serial number means "Message number ---- has not been received."

Example

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II N II NR8 $\overline{\text{AR}}$

90. NR.—The procedure sign "NR" indicates "Serial number ....." It is followed immediately (without space sign) by the number. It is written NR.

When used in the heading, the number is that of the message center.

When used in the text, it is the number which the originator used to identify it and although a part of the text is not encoded. When used in the text NR with the number following as one-code group.

Both of these numbers are important as a means of identification.

Example

A message which was numbered 3 by its writer was renumbered 16 by the message center. The prefix of this might appear:

NR16 II G II P II GR6 $\overline{\text{BT}}$ NR3 II 1ØØ6A II FC1 II etc.

In requesting repetitions or in referring to a meassage the message center serial number (the NR in the heading) is the number that is used to identify the message and not the originator's number.

Example

RS1 wishes to acknowledge receipt of the above message. He would refer to this message by its message center number and not by the originator's number, thus:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II R II NR16 II $\overline{\text{AR}}$

91. $\overline{\text{OD}}$.—The sign "$\overline{\text{OD}}$" is used in the prefix to indicate "The following is a *Rush* message." This classification of the message will be made by the message center and not by the operator. $\overline{\text{OD}}$ messages are usually tactical in character and are sent ahead of all D messages. When used by itself $\overline{\text{OD}}$ means "Rush message."

The operator of station TS1 has just received a message from his message center a message for station RS1 having "Rush message" written in the proper space by the message center. After calling up RS1 and receiving the "go ahead" sign "K," TS1 transmits:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II NR6 II $\overline{\text{OD}}$ II GR6 $\overline{\text{BT}}$ etc.

92. P.—*The use of "P" by message centers.*—The sign "P" is placed opposite the heading "Class of message" by the message center to indicate "The following is a Priority message."

In case two "P" messages are filed at the same time, the one from the superior headquarters has the right of way. If there are P messages from stations of equal rank, the N. C. S. decides which shall be transmitted first. It is used by message centers only for tactical messages which admit of no delay.

The determination of the degree of importance to warrant the sign "P" is made by the message center only, under orders from the commanding officer of the unit, with the knowledge that such a message stops all traffic in the net until it is transmitted.

93. *Q*.—This sign used by itself means "Wait."

Example

a. TS1 calls RS1, but RS1 is busy and wishes TS1 to wait.

VE TS1 TS1 V RS1 RS1 II Q

b. TS1 is transmitting a message to RS1 and something happens to his equipment. RS1 signals:

———————————XNO POX ZOH INZ II Q

94. *R*.—The procedure sign "R" means "Message received." The procedure sign "R" is used:

a. By operators to indicate that they have received the last transmission.

b. By operators in connection with "NR" to acknowledge the receipt of a message. Operators will not transmit R to indicate the receipt of a message unless certain of the accuracy of the reception, nor will it be transmitted unless the "Check" agrees with the number of groups "GR–" indicated in the prefix.

Example 1

NC1 having transmitted the controlled net call, has received from TS1 the following:

VE NC1 NC1 V TS1 TS1 II ZAR II ONE OD TS3 II AR

Replies as follows:

VE TS1 TS1 V NC1 NC1 II R

Example 2

TS1 has received message number 9 from station RS8. TS1 acknowledges as follows:

VE RS8 RS8 V TS1 TS1 II R II NR9 II AR

95. T.—The sign "T," used in the preamble, signifies "Transmit following to............." The sign "T," when used in the preamble, directs that the message be sent to the station whose call letter immediately follows T.

(See M, Par. 61, for examples of use of T; also Pars. 70 and 72.)

96. V.—The procedure sign "V" is used between call signs and signifies "From." (See Par. 45.) When "V" is used in the preamble, it means "Originally from." (See Par. 72.)

97. $\overline{VA}$.—The procedure sign $\overline{VA}$ means "Finish" ("No reply needed"). It is always used to indicate the end of a message with "F" in the prefix. (See Par. 82–*h*.) It is also used by operators in shortening procedure in directed or controlled nets. (See Pars. 55, 63, 66, 68.)

98. $\overline{VE}$.—The "Commencing" sign $\overline{VE}$ is used as a preliminary sign before every transmission. (See Pars. 40 and 45.)

99. W.—The sign "W" is used by itself to indicate "Am being interfered with by another station." A call sign following the sign "W" and separated therefrom by the space sign denotes that the interference is being caused by the station indicated.

Example

Station RS1 is prevented from receiving a message from TS1 and asks for a repeat, thus:

$\overline{VE}$ TS1 TS1 V RS1 RS1 II $\overline{IMI}$ II W $\overline{AR}$

100. WA.—The procedure sign "WA" (. — — . —) means "Words or groups after." It is used only in conjunction with $\overline{IMI}$ or $\overline{INT}$ and is followed by the word or code group before the one referred to.

Example

RS1 has missed the group after RSNTX in a coded message. RS1 transmits as follows:

$\overline{VE}$ TS1 TS1 V RS1 RS1 II $\overline{IMI}$ II WA RSNTX II $\overline{AR}$

101. X.—The sign "X" by itself signifies "Am being interfered with by static."

Example

$\overline{VE}$ RS1 RS1 V TS1 TS1 II X II $\overline{AR}$

102. $\overline{XE}$.—The procedure sign "$\overline{XE}$" (written as an oblique stroke "/") is used to separate two numbers or code groups representing a series, such as 20/31, which would be read as "twenty to thirty-one."

It may be used with WA in requesting the repetition of certain code groups.

Example

$\overline{VE}$ TS1 TS1 V RS1 RS1 II $\overline{IMI}$ II WA RSNTX $\overline{XE}$ GAHOT II $\overline{AR}$

NOTE.—See Par. 77 for another use of $\overline{XE}$.

103. Y.—The sign "Y" used by itself indicates "Acknowledge last communication." When followed by a number, the sign "Y" indicates "Acknowledge message number ----."

Example

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II Y II $\overline{\text{AR}}$

or

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II Y II NR6 II $\overline{\text{AR}}$

104. II.—The space sign II is used:

a. Between all parts of the preamble and prefix. (See Pars. 40 and 72.)

b. To separate sender's number from sender's time in the text. (See Par. 40.)

c. To separate sender's time from the code group in the text. (See Par. 40.)

d. To separate the code used from the first code group in the text. (See Par. 40.)

e. To separate the call from any following procedure signs in the call up. (See Par. 40.)

f. To separate procedure signs in a call up, where two or more appear together. (See Par. 45.)

g. To separate each code group in the text where reception is difficult.

h. Between every two different code groups where code groups are repeated twice because of difficulty in reception.

GENERAL RULES

a. Where reception is difficult, due to interference or static, operators should not hesitate to request, or Net Command Stations to direct, the use of II between code groups of the text, or that the code groups of the text be repeated twice. This method will invariably save time under conditions of difficult reception.

b. II is used in call ups to separate code groups repeated twice.

Example

TS1 has transmitted to RS1 but RS1 could not get many of the code groups in the text because of interference.

RS1 sends:

$\overline{\text{VE}}$ TS1 TS1 V RS1 RS1 II ZBV 2 WA $\overline{\text{BT}}$ II ZBV 2 WA $\overline{\text{BT}}$ K

He has requested that all code groups in the text be repeated twice.

TS1 replies:

$\overline{\text{VE}}$ RS1 RS1 V TS1 TS1 II $\overline{\text{BT}}$ $\overline{\text{BT}}$ II NR6
NR6 II Ø2Ø8A Ø2Ø8A II DFC1 DFC1 II ZBO
ZBO HBC HBC II DRF DRF II $\overline{\text{AR}}$

INDEX

ALL NUMBERS REFER TO PAGES

(See paragraph 43 of Information Topic No. 1 for Index of Procedure Signs)

SUBJECT	Unit Operation	Information Topics
A		
Address	--------	51
Airplanes	--------	45
Answering a "call up"	2	58
B		
"Breaking" another station	--------	68
C		
Calibration of SCR–77	--------	68
Call	1	52, 61
Call sign	1	52
Called station	--------	--------
In the net	1	79
Call up	1	58
Answering a call up	8	58
Method of calling up	1	59
Number of times authorized	--------	59
Receiving station failing to answer call up	--------	59
Carelessly made letters	--------	47
Checking legibility	--------	47
Chiefs of section	--------	46
Code	--------	53
General service	--------	54
Used in tactical procedure	--------	52, 54
Code groups	--------	47
Number per line	--------	47
Code clerk	--------	--------
Type of letter used	--------	46, 47
Commanding officer(s)	--------	45
Communications officer(s)	--------	46
Controlled net	17	61, 67
D		
Delay	--------	47
Determining whether a called station is in the net	--------	59
Directed net	24	--------
Directions		
For relaying messages	--------	73
E		
Ending sign	2	--------
Erase	7	77
Errors		
Transmitted	7	--------
Received	9	--------
Method of indicating	7	--------
Total	10	--------
Establishing the net	22	62

SUBJECT	Unit Operation	Information Topics
F		
Free net	27	61, 63
G		
Go ahead	2	81
H		
Heading	9, 37	52
I		
Importance of radio	--------	45
Inspections	--------	50
Internet traffic	--------	61, 69
Procedure in	35	69
K		
Key operator	--------	48
L		
Log sheets	3	48, 50
How and when destroyed	--------	48
Inspected by whom	--------	50
Inspected for what	--------	50
Kept how long	--------	50
Prepared by whom	--------	48
M		
Message blanks	--------	46
Reception	11	47
Transmission	11	--------
Message center(s):		
Number	--------	82
Responsibility for relayed messages	37	73
Chiefs	--------	47
Serial number	--------	82
Messages	--------	50, 53
Confidential	--------	52
For stations in the net	--------	46
Messages:		
How prepared and handled	--------	46
Legibility of	--------	47
Number of words in, how determined	9	80
Ordinary	--------	50
Priority	--------	51
Relaying	37	73
Rush	11	50
Transmission of	--------	46
Transmitted by radio	--------	52
Method of:		
Answering	2	60
Calling up	1	58
Establishing a net	22	62
Transmitting long messages	32	--------
N		
N. C. S	--------	45
Nets:		
Changing operation of	27	69
Changing order of operation in	--------	61
Controlled	17	64
Definitions of	--------	61

SUBJECT	Unit Operation	Information Topics
Nets—Continued		
Directed	24	61
Establishment of	22	62
Free	27	61
Net call	2	62
Order of operation	2	61
SCR–77A		68
Transmission between, of the same type	35	69
Types of	17	60
Net command stations		43, 45
Changing the N. C. S	29	71
N. C. 2	30	71
Net number		61
Net procedure		60
Number of words in a message	7	80
Numeral one		47
Zero		47
O		
Operator:		
Key		47
Receiving		47
Recording		47
Transmitting		46
Order of operation:		
How determined		61
Changing the		61
P		
Permission to transmit	19	64
Plain text (how authorized)		52
Preamble	37	52
Prefix	37	52
Printed capital letters		47, 50
Priority	11	50, 51
Procedure signs		54
Use illustrated		75, 85
Procedure, tactical radio		
Requirements of	1	
R		
Radio communication:		
Importance of		45
Operators		83
Receiving station:		
Failure to answer call up		19
Receipt for a message	5	
Recording operator		48
Relaying messages	37	73, 74
Relay message center		74
Repetitions	7, 8	
Report into a net	17	45, 62
Report out of a net	18	45, 69
Reports required		46
Requirements of tactical radio procedure		44
Responsibility for radio stations receiving traffic		45
Responsibility for messages buried in radio stations		46
Requesting permission to transmit a message	17	63
Requesting permission to engage in internet traffic	32	69
Rules governing call up		58

SUBJECT	Unit Operation	Information Topics
S		
Secondary station	--------	45, 62
Sender's number	--------	53
Sender's time	--------	53
SCR-77A, net	--------	68
Silent station	32	78
Space sign	--------	54
T		
Telephone	--------	45
Text: Include what	--------	52, 53, 80
Traffic	--------	45
Traffic sheets for controlled nets	--------	65
Transmission blind	33	60
Transmitting messages	--------	53
Between stations in the same net	35	61
Between stations in different nets	35	69, 73
Transmit to	35	--------
Type of code	--------	53
U		
Unsent messages	--------	46
Use of telephone	--------	46
W		
Wait	4	83

TRAINING MANUALS

(Corrected to January, 1925)

Manuals prepared by the Signal Corps, relating to signal communication specialists are titled as follows:

	Training Manual
Basic Signal Communication:	
*Students Manual	No. 20
*Instructors Guide	No. 21
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*Students Manual	No. 22
*Instructors Guide	No. 23
Message Center Specialist:	
*Students Manual	No. 24
*Instructors Guide	No. 25
Radio Operator:	
*Students Manual	No. 26
*Part I—Sets.	
*Part II, Vol. I—Code Practice.	
*Part II, Vol. II—Tactical Radio Procedure.	
*Instructors Guide	No. 27
*Part I—Sets.	
*Part II, Vol. I—Code Practice.	
*Part II, Vol. II—Tactical Radio Procedure.	
Telegraph Operator:	
*Students Manual	No. 28
*Instructors Guide	No. 29
Meteorological Observer:	
*Students Manual	No. 30
*Instructors Guide	No. 31
Pigeoneer:	
*Students Manual	No. 32
Instructors Guide	No. 33
Basic Electrician:	
Students Manual	No. 34
Instructors Guide	No. 35
Radio Electrician:	
Students Manual	No. 36
Instructors Guide	No. 37
Telephone Electrician:	
Students Manual	No. 38
Instructors Guide	No. 39
Telegraph Electrician:	
Students Manual	No. 40
Instructors Guide	No. 41
Lineman, Field:	
*Students Manual	No. 42
*Instructors Guide	No. 43
Lineman, Signal Corps:	
Students Manual	No. 44
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