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GROUND TELEGRAPHY OR T.P.S.

Transmitting Set, Type SCR-71
Receiving Sets, Type SCR-72 and SCR-72-B

(Confidential)

Communication
Radio Pamphlet
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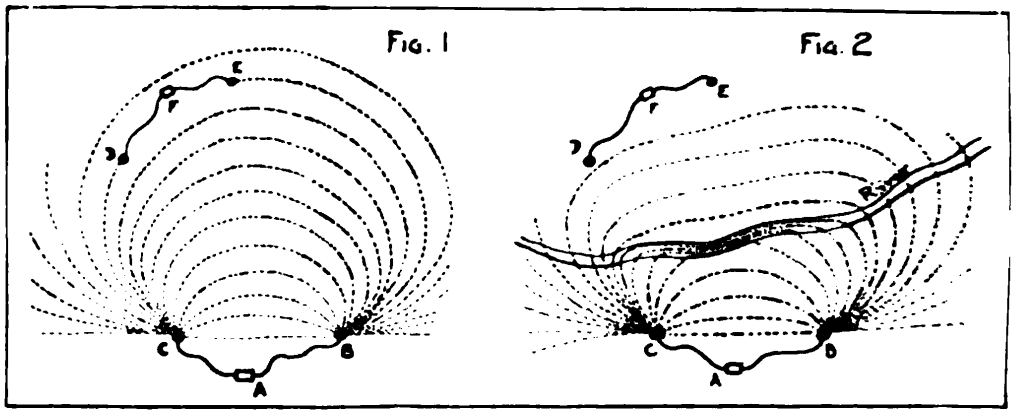
70

Ground Telegraphy or T. P. S.
Description and Use of Transmitting Set, Type SCR-71 and Receiving Sets, Type SCR-72 and Type SCR-72-B

GROUND TELEGRAPHY or T. P. S. (from the French "télégraphie par sol") is a means of communication which requires no wire connection between the sending and receiving stations, but it is different from radio telegraphy, in that it involves the use of pulsating or alternating currents of comparatively low frequency (600 to 1800 cycles per second) instead of oscillations of high frequency, of the order of 100,000 to 2 or 3 million cycles per second. Also, the transfer of electrical energy from the transmitting to the receiving apparatus take place by induction and conduction through the ground, instead of through the air as with radio.

The principles on which the theory of this means of communication are based, are quite simple. They are illustrated in Fig. 1. A generator A (alternator or buzzer) producing an audio frequency, high voltage alternating or pulsating current is connected to the ground by means of two wires, AB and AC, which are grounded at points B and C. These two grounds are 50 yd. to 200 yd. apart. The circuit followed by the current generated at A is then made up by the two wires AB and AC, and by the conducting ground between B and C. Since the ground is a fair conductor of electricity, the electric current will not be concentrated on the straight line BC, but it will follow a great number of paths through the ground, called lines of current flow, and represented schematically in Fig. 1 by the dotted lines. These lines of current flow may, under suitable geological conditions of the ground, spread out as far as 2 or 3 miles away from the sending circuit ABC.

If now at a certain distance from the sending circuit ABC, a metal wire is grounded at two points D and E, the current from A will not flow through the ground between points D and E along the corresponding line of current flow. Instead, will flow through the wire DFE, which is a low resistance path shunting the line of current flow DE in the ground. A suitable instrument F inserted in series with the wire DE, may therefore be employed to utilize this current in



signaling work. The current in the circuit DFE is extremely small due to the rather high resistance of the ground and to the fact that the current generated by A spreads over such a considerable area that the wire DE picks up only a very small portion of the total current flowing through the ground in the various paths between B and C. The instrument F must therefore be very sensitive. It is usually a telephone receiver.

In most cases, the current in the wire DE is even too faint to produce a sound in a telephone receiver directly inserted in series with the wire. This has made it necessary to use amplifying devices, which amplify the currents received.

When the generator A is made to generate pulsating or alternating current of audio frequency, the corresponding current flowing in the circuit DFE will produce a sound in the telephone receiver F, and by opening and closing the sending circuit ABC by means of a telegraph key, it is possible to transmit telegraph signals which will be heard at F.

Natural Conditions Affecting T. P. S. Communication

Since the conductivity of the ground is one of the most important factors affecting the transmission of T.P.S. signals, the distance over which communication is possible with a certain set of transmitting and receiving apparatus will depend greatly on the geological conditions of the surrounding region. Thus, a strata of non-conducting ground below the transmitting circuit BC will prevent the current from passing to any depth into the ground and will force it to spread out horizontally to quite considerable distances. A very dry ground, being of high resistance, will permit only a very weak current to flow, and hence will correspondingly reduce the distance over which communication is possible. A very wet

ground is too good a conductor and permits practically all the current to flow directly between B and C without spreading out to a sufficient extent. The best ground is neither too dry or too wet. The presence of a river or sizable brook between the receiving and sending stations greatly reduces the strength of the current received at the receiving station, and correspondingly decreases the intensity of the signals. This is illustrated in Fig. 2, where a stream is shown to flow between the two stations. Most of the lines of current flow, upon striking the stream, follow it since it is of much better conductivity than the ground. The amount of current available at F is considerably reduced.

T.P.S. Apparatus Used by the Signal Corps

In the following pages, a description will be given of the transmitting and receiving apparatus used by the Signal Corps, and also a discussion of the best relative positions of the stations, their installation, maintenance, etc.

The transmitting apparatus consists of the type SCR-71 T.P.S. transmitting set. The receiving apparatus is the type SCR-72 or SCR-72-B T.P.S. receiving set. At certain stations, two-way communication is required, in which case the above-mentioned apparatus may be used although the work may be facilitated by using a two-way T.P.S. set, type SCR-76, which is a combination in one unit of the transmitting and receiving apparatus. The latter set is fully described in Radio Pamphlet No. 15, and is therefore simply mentioned here. A later model of this set is the type SCR-76-A set, which is described in Radio Pamphlet No. 27.

T. P. S. Transmitting Set, Type SCR-71

The T.P.S. transmitting set, type SCR-71, consists of a power buzzer, used for generating a high-voltage, audio frequency, pulsating current; a storage battery used for energizing the buzzer; and the necessary ground equipment, consisting of ground stakes, field wire, etc. A complete parts list is given at the end of this pamphlet. The method of laying out the station is in many respects similar to that used for laying out a receiving station, and is explained below under a separate heading.

The power buzzer, a circuit diagram and photograph of which are given in Figs. 3 and 4, is practically a copy of the French T.P.S. buzzer. The principle of operation is the

same as that of an induction coil. Two windings, the primary and secondary, are wound on a common laminated iron core The primary winding is energized by a 10-volt storage battery. A telegraph sending key and an interrupter vibrator of special design are in series with this primary circuit. When the sending key is depressed, the primary circuit is closed, and the magnetic field created by the primary coil sets the vibrator interrupter in motion. A pulsating current is thus made to flow in the primary circuit.

The two terminals of the secondary winding of the buzzer are connected to the ground, through the line wires and

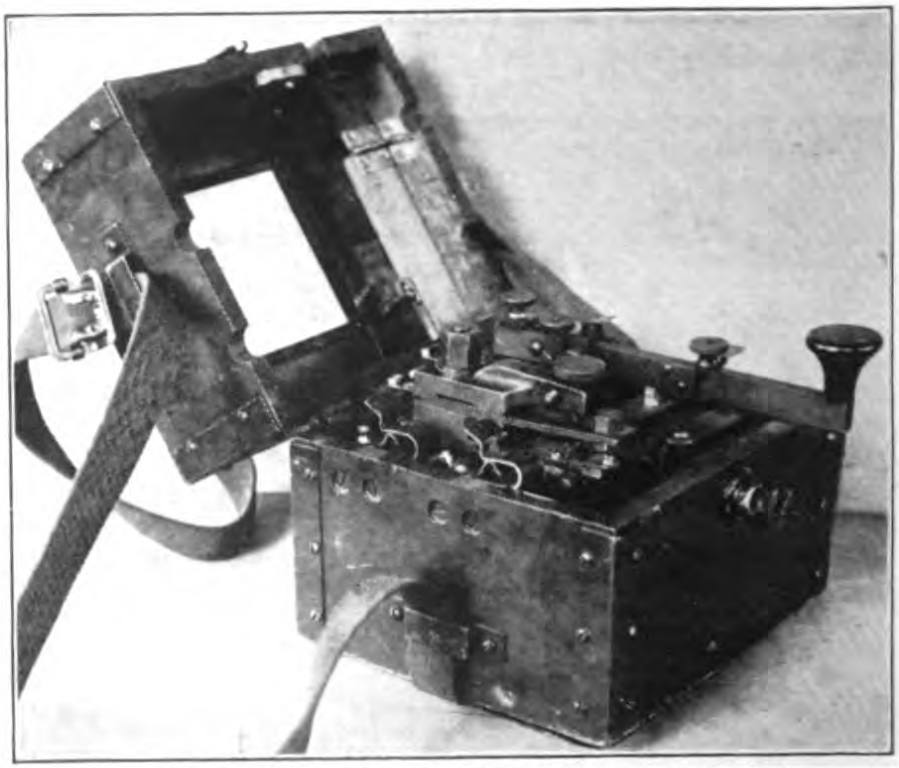


Fig. 3—Set Box, Type BC-16 of the Type SCR-71 Set

ground rods, at two points not less than 50 yd. apart. By this means, the high pulsating emf. induced in the secondary winding by the current in the primary circuit, causes a pulsating current of the same frequency to flow in the secondary (ground) circuit. The current thus flowing into the earth is of about .4 amp. when the ground resistance measured between the grounded ends of the line wires is not over 50 ohms.

The frequency of the pulsating current depends on the adjustment of the vibrator, and can be varied between the approximate limits of 650 and 1700 cycles per second. This

adjustment is obtained by means of a set of small weights which can be fastened singly or in pairs to the vibrator armature by means of a special wrench furnished with the buzzer. The different combinations possible are given below, but the actual frequency obtained may vary quite materially from that given in the table.

Large weight, all the way out.....	650	cycles	per second
Large weight, all the way in.....	750	"	" "
Two small weights, all the way out...	800	"	" "
One small weight, all the way out....1000		"	" "
One small weight, all the way in.....1250		"	" "
No weight 1750		"	" "

The magnetic circuit of the power buzzer is completely metallic, except for a "V" shaped air gap between the iron core of the two windings and an iron armature attached to

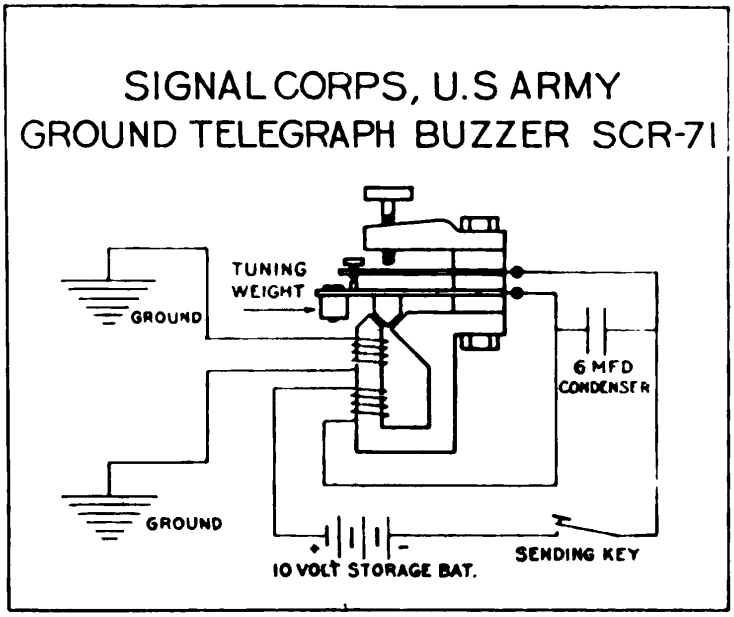


Fig. 4—Schematic Wiring Diagram of the Type SCR-71 Set

the vibrator. The best operation of the buzzer is obtained when the air gap on either side of the projecting "V" is uniform. This adjustment of the air gap is made by loosening the nut and bolt through the yoke of the vibrator and shifting the armature pieces slightly, locking them when in the proper position.

The vibrator contacts are shunted by a condenser for the purpose of reducing the sparking. Good operation is obtained by means of an adjusting screw, which is mounted on top of the vibrator and is used to vary the stroke of the vibrating armature. This screw is locked in position by a small nut

on the side of the frame holding the adjusting screw, which must be loosened before the adjusting screw can be turned and should be tightened up again after the adjustment has been made. Proper adjustment of the buzzer is made when the adjusting screw is screwed down as tight as is possible and maintain a good clear note of the vibrator. This adjustment must be made every time the weights are changed on the vibrator, or whenever the note of the buzzer is unsatisfactory.

For good operation of the buzzer, the vibrator contacts must be clean, and their surfaces even and parallel. After a time these contact points may become pitted and require cleaning and truing up. It is best not to use the file furnished with the set, but to remove the contacts from the vibrator, and rub them gently on a piece of fine emery cloth laid on a flat surface. Only in exceptional cases, will it be found necessary to use the file or to replace the contact points with the spare ones furnished with the set and kept in the cover of the buzzer box.

Method of Operation

The method of operating the type SCR-71 transmitting set is as follows. By means of the special wrench, place the desired vibrator weight on the buzzer armature in the proper position. Connect the base line wires and storage battery wires to their proper terminals on the type BC-16 set box. Adjust the vibrator by means of the large thumb-screw which is on top of the buzzer frame, first loosening the clamping screw on the frame of the buzzer. The telegraph sending key is then closed and the large buzzer adjusting screw adjusted until a clear steady note is obtained. The adjusting screw is then clamped in place again, and the set is ready to operate by sending code with the key in the usual way.

T. P. S. Receiving Set, Type SCR-72

The T.P.S. receiving set, type SCR-72, is a low frequency amplifier, consisting of a vacuum tube amplifier with the necessary storage batteries and telephone receivers, and a ground equipment similar to that of the SCR-71 transmitting set. A complete parts list is given at the end of this pamphlet.

The amplifier consists of two type VT-1 three-electrode vacuum tubes connected for cascade amplification, and making possible the use of either one or two stages of amplifica-

tion. As shown on the circuit diagrams, Fig. 6, the T.P.S. current to be amplified is made to flow through the primary winding of an iron core input transformer, by connecting the two grounded receiving line wires to the binding posts of the amplifier box marked "T.P.S." The secondary of this input transformer is connected between the filament and the grid of the first vacuum tube. The place circuit of this tube comprises a 22-volt, type BA-2 dry battery connected in series with the primary of an iron core transformer which couples the plate circuit of the first tube to the grid circuit of the second tube. The secondary winding of this coupling transformer is connected between the grid and the filament of the second tube, while a type BA-2 dry battery furnishes the plate current.

The filaments of the two vacuum tubes are connected in parallel across a 4-volt storage battery. In series with each filament is a small resistance which limits the filament current to the proper value. Certain vacuum tubes require a greater filament voltage than others. In these tubes, the positive terminal of the filament is permanently connected to the metal base of the tube, and connection is installed in the amplifier from the metal socket to the positive side of the filament resistance whereby the resistance is thus automatically short-circuited when a tube of this type is inserted.

Telephone jacks are provided in the plate circuit of the last tube, across the plate of the first tube, and across part of the secondary of the input transformer. This gives three different sound intensities for the corresponding jacks, the signals having a maximum strength when the telephones are plugged in the jacks of the last vacuum tube.

This amplifier is not limited in its use to the reception of T.P.S. signals. It may also be used to amplify damped or modulated radio signals after they have been detected (rectified). For this purpose, the entire primary winding of the input transformer is used, the corresponding terminals on the amplifier box being marked "Radio." These terminals are connected to the telephone terminals or plug of the radio receiving set used in the reception of the radio signals it is desired to amplify. This inserts the amplifier in the audio frequency circuit of the radio receiving set. The telephone receivers are then plugged into the particular jack of the amplifier box giving the desired degree of amplification.

When using the amplifier, it is well to insulate the box from the ground, and to protect it from mechanical vibration. This is best done by setting the box on some cushioning substance. The amplifier being all connected up and ready for operation, and with the telephones connected for maximum amplification, a test which will show whether or not the amplifier is in proper working order is to gently tap the first vacuum tube with the finger. A loud ringing noise should be

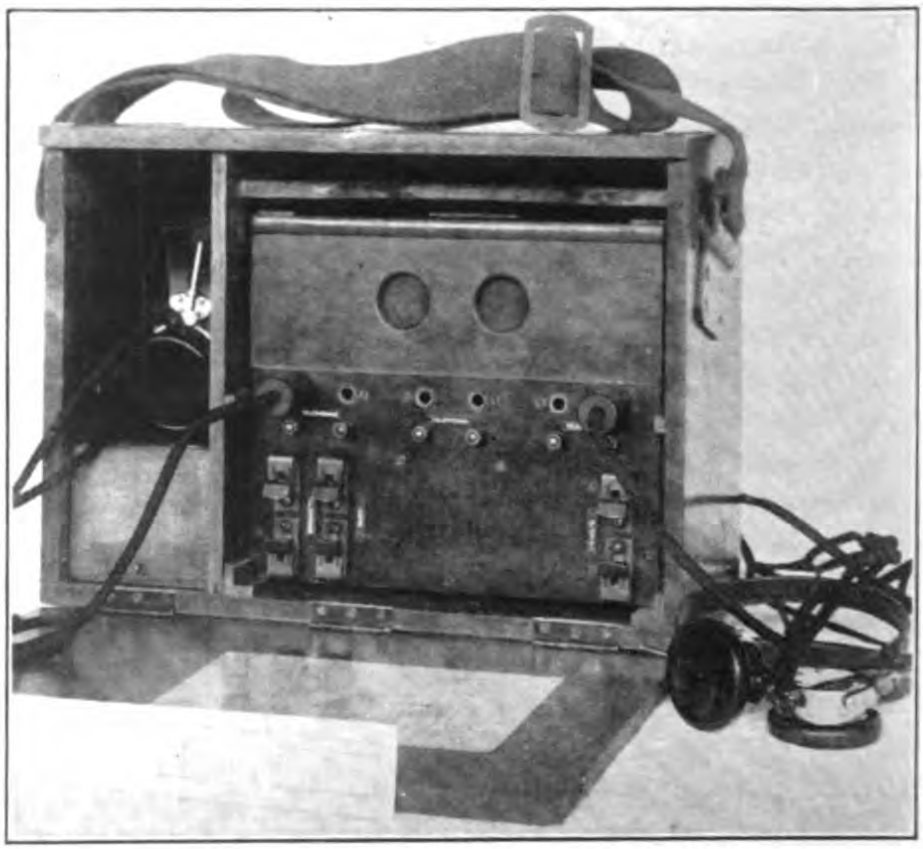


Fig. 5—Set Box, Type BC-17 of the Type SCR-72 Set

heard in the telephone receiver. If the amplifier does not work, the battery connections should be checked up. It is essential that the dry batteries be connected with the proper polarity, as marked on the box and in the circuit diagram.

Very often, the loudness of the signal is considerably increased when the tubes are interchanged. If some spare tubes are available, the different combinations should be tried until a pair is found giving satisfactory results. Sometimes, singing is observed in the amplifier. This is due to internally generated oscillations taking place in the amplifier circuits, accompanied by rapid interruptions of the plate current. It

seriously interferes with the reception of the signals and may be prevented or stopped by grounding the negative terminal of the storage battery supplying the filament current. A sizzling noise in the telephones may be due to poor connection of the battery leads, or poor contacts in the vacuum tube sockets.

It is important to use storage batteries of a voltage not higher than 4 volts, as the higher voltage would greatly shorten the life of the tubes. Also, if the filaments are burned too bright, the tubes may not amplify properly, as this would shift the position of the characteristic curve of the tubes with reference to the axes. The 22.5-volt dry batteries supplying the plate current may be used satisfactorily until their terminal voltage runs down to about 17.5 volts.

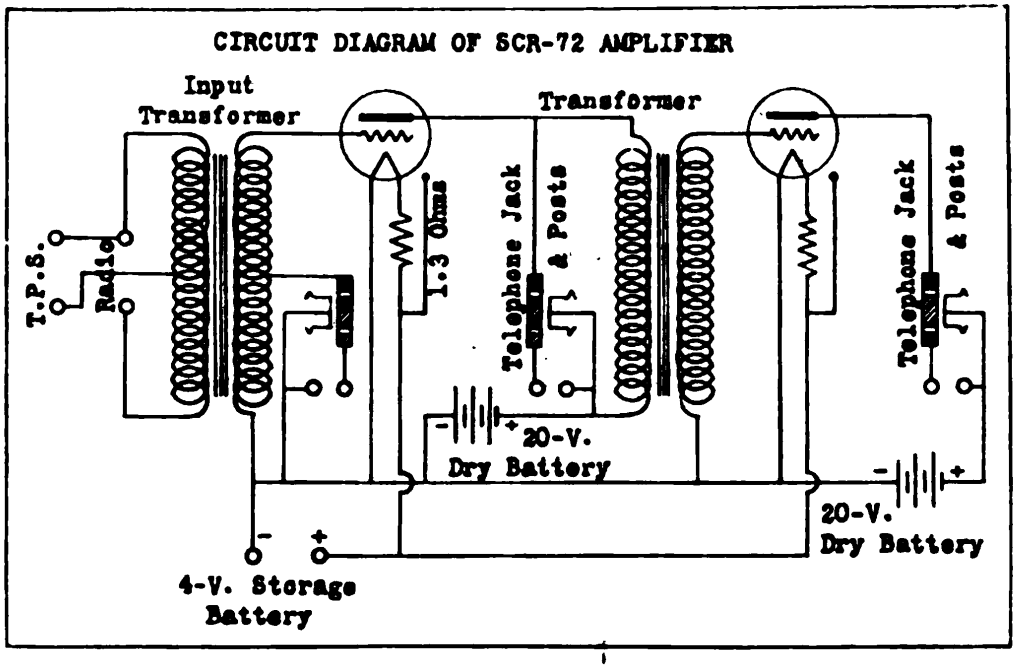


Fig. 6—Schematic Wiring Diagram of the Type SCR-72 Set

The amplifier box may be opened on top for the purpose of changing vacuum tubes and dry batteries. The box should be kept closed at other times and in as dry condition as possible. Two glass windows in the front panel permit one to observe the glow of the filaments of the vacuum tubes, while in operation. While no signals are being received but the set is in operation ready to receive anything that comes in, it is well to look at the tubes frequently to make sure that the filaments are glowing. When the set is not in use the filaments (4-volt) battery should be disconnected from the set. Disconnect at the battery rather than at the set box.

The amplifier box is enclosed in a carrying box, which also contains two telephone head sets, message books and spare dry batteries. This carrying box is provided with a carrying strap and weighs about 27 lb. with the full equipment. Spare vacuum tubes must be carried separately.

With this amplifier, should one tube be burned out and there be none available for replacement, it is still possible to use the first amplification stage if the good tube is placed in the left-hand socket and the telephones plugged into the central jacks. This is not true with the SCR-72-B set.

Method of Operation

The method of operating the type SCR-72 set for receiving T.P.S. signals is as follows. The base line wires are connected to the "T.P.S." binding posts and the 4-volt storage battery to the proper terminals of the type BC-17 set box, due regard being given to polarity. Both vacuum tube filaments should then glow. The telephone receivers are plugged into the telephone jacks corresponding to the degree of amplification desired. The set is now ready for receiving signals.

If signals are not received, it may be because one of the tubes is burned out or because one of the type BA-2 dry batteries is connected with the wrong polarity. Both tubes and dry batteries may be changed by removing the amplifier box from the carrying chest, and opening the cover on top of the box.

T. P. S. Receiving Set, Type SCR-72-A

The type SCR-72-A receiving set, which is electrically the same as the type SCR-72-B set described below, has been entirely superseded by the latter, and is therefore only mentioned here. Only a few models of this set are in existence.

T. P. S. Receiving Set, Type SCR-72-B

The type SCR-72-B receiving set uses an improved type of amplifier which is illustrated by the photographs and circuit diagram given herewith, Figs. 7, 8 and 9. Like the amplifier of the SCR-72 set, it is a two-stage, audio frequency, cascade amplifier, using two type VT-1 vacuum tubes, and working on the same principle as the set described above. The differences from the SCR-72 are the following:

Both tubes work at a plate voltage of 40 volts, supplied by two type BA-2 dry batteries in series. One double telephone

jack is provided in the plate circuit of the last tube only and the degree of amplification is adjusted by a rheostat in the filament circuit which varies the temperature of the filaments and therefore the electron emission and plate current.

Unlike the type SCR-72 amplifier, the type SCR-72-B set will not operate at all unless both vacuum tubes are in operative condition. This is due to the fact that only one telephone jack is provided and this is inserted in the plate circuit of the last tube.

When the type SCR-72-B set is not in use, the filament battery should be disconnected. This is done by turning the

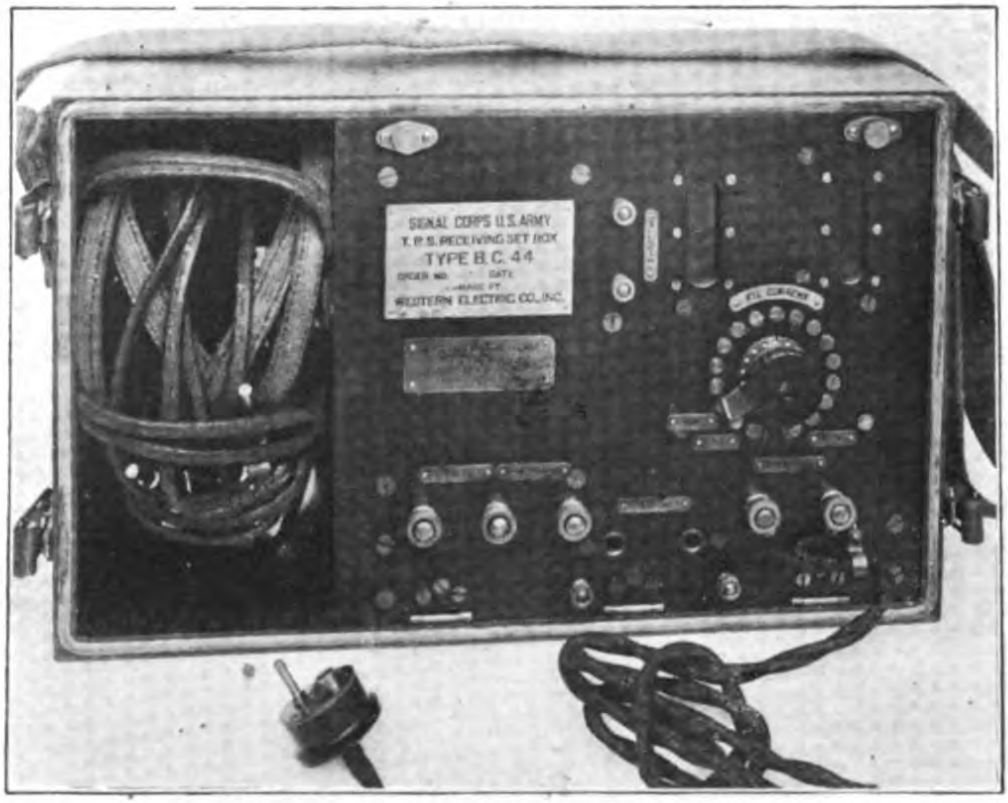


Fig. 7—Set Box, Type BC-44 of the Type SCR-72-B Set

"Filament Current" switch to the "Off" position (extreme left), and it is not necessary to disconnect the battery leads.

As for the SCR-72 amplifier, singing may be stopped by grounding the negative side of the storage battery. Should type BA-2 batteries be not available at any time, any other 40-volt d. c. supply may be readily used in place of them by connecting to the binding posts marked "B-Battery." Care should be taken never to short circuit these posts as this would short circuit the plate batteries.

The amplifier box is a great improvement over the SCR-72 amplifier box, no carrying chest being required. The box is

waterproof, the cover closing on rubber gaskets. Two telephone head sets are carried in a compartment of the amplifier box. The operating panel is hinged at one side, and may be lifted after unscrewing the two thumbscrews in the upper corners of the panel. This is done when it is desired to change vacuum tubes or dry batteries. The spare tubes and dry batteries are supported in holders at the bottom of

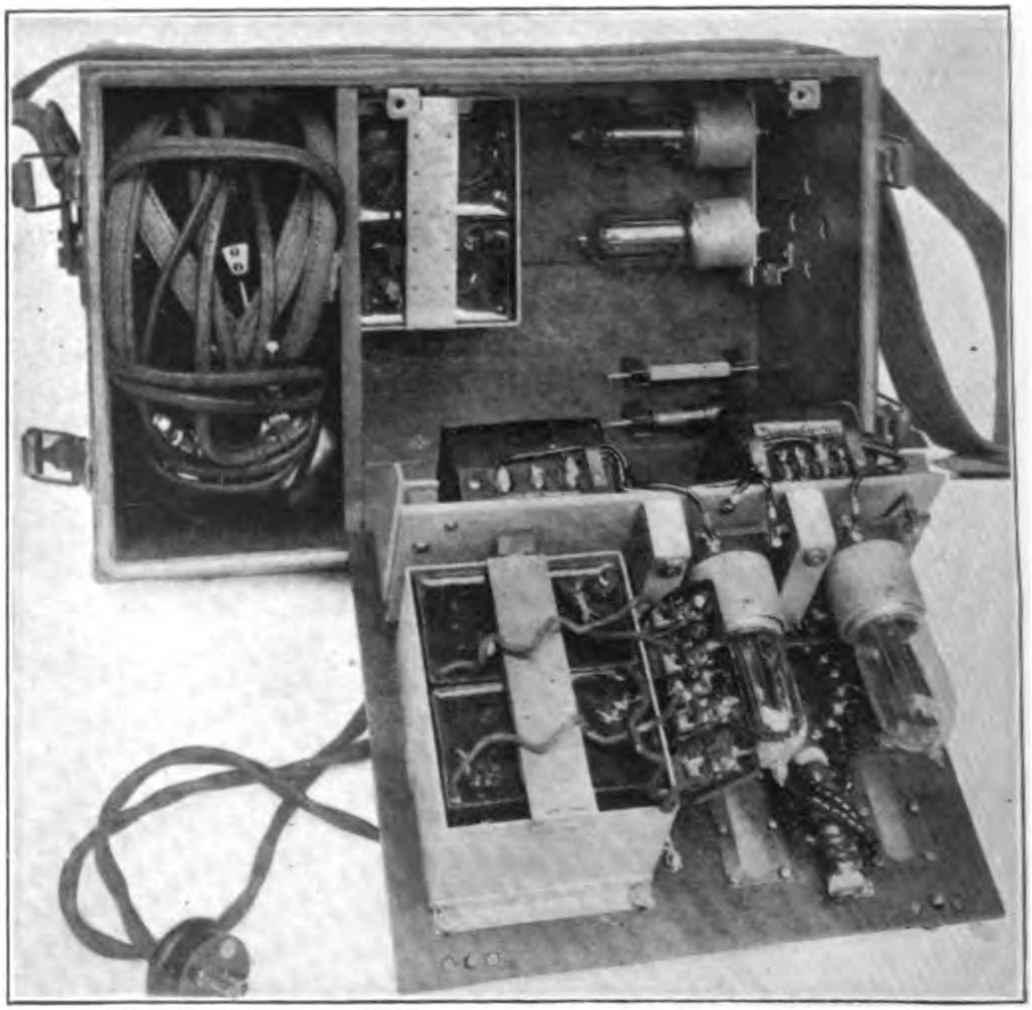


Fig. 8—Mounting of Apparatus and Spare Tubes and Batteries in the Type BC-44 Set Box

the box as seen in Fig. 7. Care should be taken that the leads on the spare dry batteries do not come in contact with each other either directly or by touching the metal holder.

Method of Operation

The proper method of operating the type SCR-72-B set for receiving T.P.S. signals is as follows. The base line wires are connected to the "Ground Telegraph" binding posts, the battery plug is plugged in the 4-volt storage battery, the tele-

phone receivers are connected to the telephone jack or telephone binding posts, and the "Filament Current" dial switch is turned toward the right until the vacuum tube filaments are observed to glow with a dull red color. If signals are received very faintly, this switch should be turned somewhat more toward the right. This should be avoided if possible, however, as the brighter the filaments are burned, the shorter

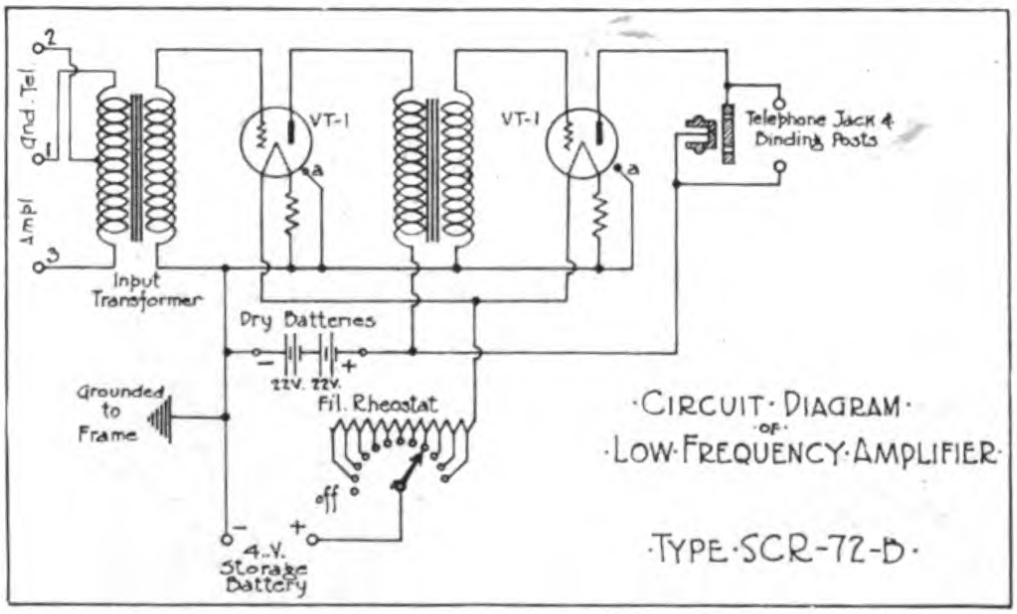


Fig. 9—Schematic Wiring Diagram of the Type SCR-72-B Set

the life of the vacuum tubes. Failure to receive signals may be due to a vacuum tube burned out, or to one of the dry batteries connected with the wrong polarity.

Laying out Stations and Establishing Grounds

In using ground telegraph sending and receiving sets, special attention should be directed to the position of the ground rods of the sending and receiving stations relative to each other. The power buzzer is connected to the two sets of ground rods placed not less than 50 yd. apart. A straight line joining these earth connections is called the "sending base line." The receiving instrument or amplifier is similarly connected to ground rods, and the line connecting them is called the "receiving base line." These two base lines must be laid out in such a manner that a straight line joining the centers of the bases will make equal angles with each of them, the angles considered being on the same side of that line. The best position is that whereby the bases are exactly parallel and opposite each other. This condition is shown in Fig. 10, top drawing.

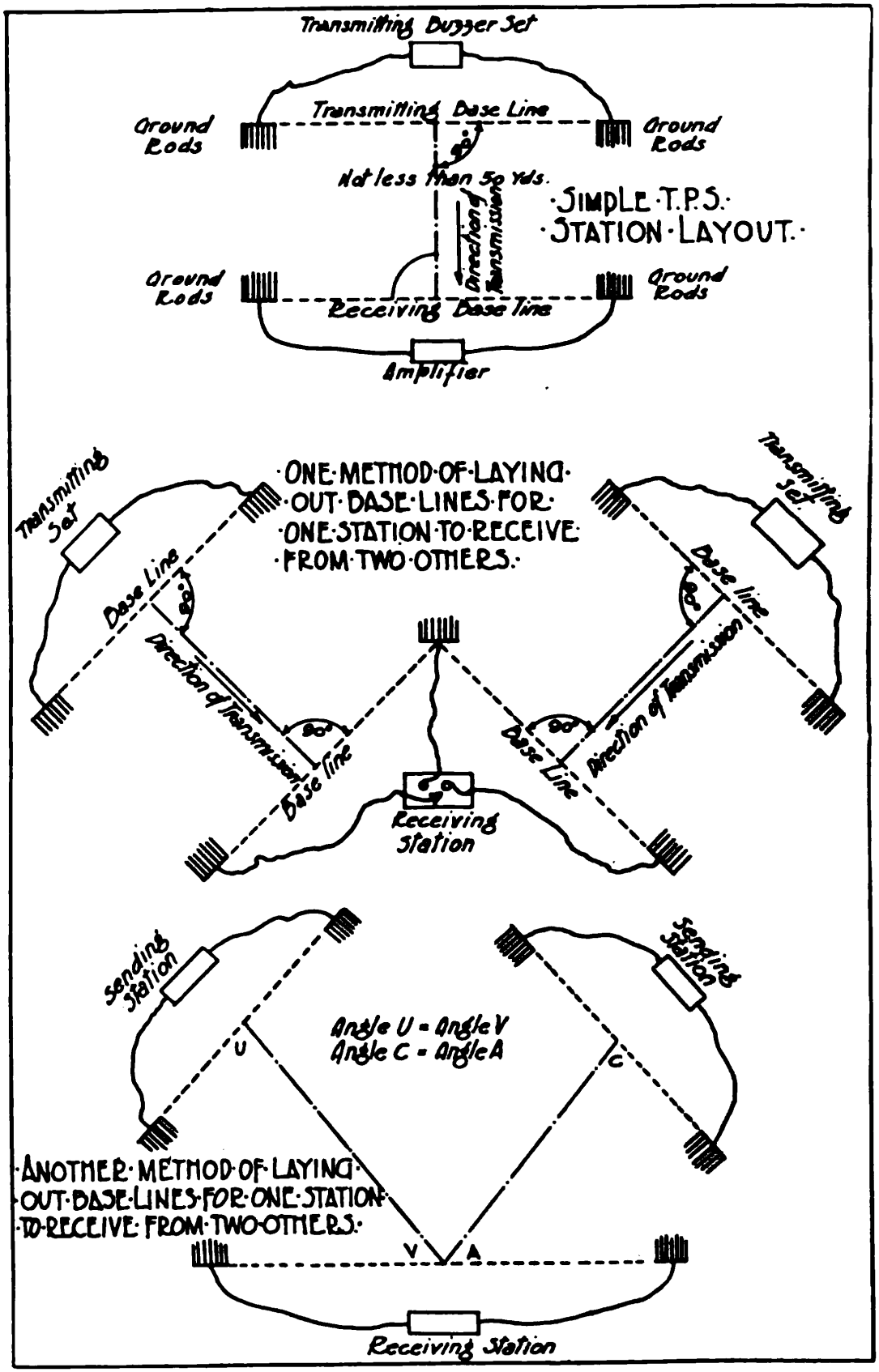


Fig. 10—Methods of Laying Out Simple T. P. S. Station, and One Station to Communicate with Two Others

When two power buzzers communicate with the same receiving station from different directions, it is desirable that separate bases for the reception of signals from each sending station should be provided, as shown in Fig. 10, middle drawing. If it is impossible to provide two bases, the single receiving base should be aligned with respect to the two sending stations, as shown in Fig. 10, bottom drawing, so that a straight line joining the centers of the bases will make equal angles with the two bases joined. This follows the general law first stated, as applied to each combination of receiving and sending stations. The correct relative positions of receiving and sending base lines may be established by the use of a compass which should always be utilized to insure proper orientation. Usually the angle between the base line and the line connecting the centers of the receiving and sending bases must be greater than 60 deg. to enable communication. Special attention should be paid to securing a good earth connection at the ends of both the sending and receiving base lines.

Due to the nature of this system of communication, it is very easy for the enemy to pick up messages sent, and all communications should therefore be in code.

In place of the ground rods furnished with the set, or in addition to them, various metallic bodies, like cartridge cases, etc., may be buried in the ground and connected to the wire. This provides a lower ground resistance and increases the range of the signals. In cases of very weak signals at the receiving station, or if very great range is desired, the sending buzzer may be operated on 20 volts without injury to the apparatus. This should however be avoided.

The wires used to connect the t. p. s. apparatus (sending or receiving) to the two ground plates should always have a perfectly good insulation. They may then be laid on the ground, or even be buried, which is quite frequent practice at the sending stations which are generally in or near the first line trenches. In no case should bare wire or lead covered cable be used for making up the sending station, as signals could not be sent out to any distance. The weakness of the bare wire is obvious. With lead covered cable, the metal sheath will short circuit the current leaving the ground plates of the sending station, instead of letting it spread out through the ground to the receiving station. At the receiving station the wires are seldom buried underground, as there is

less danger of having them cut by shell fire, the receiving station being generally at some distance from the front line. It should be noted that lead covered wire is not objectionable at the receiving station. However, when a station is used for two-way communication, ordinary insulated wire should be used. Other wire than that supplied with the equipment should be used only in case of emergency.

Parts Lists

In ordering this set or parts of this set specification must be made by names and type numbers as listed below, exactly. The designations printed in **bold face type** *only*, will be used in requisitioning sets or parts, making property returns, etc.

In ordering *complete* sets, it is not necessary to itemize the parts; simply specify, "2 Sets, T.P.S. Transmitting, Type SCR-71." If *all* parts listed under a group heading are desired, it is not necessary to itemize the parts; simply specify, for example, "1 Equipment, Type RT-2."

The sets are not complete unless they include all items listed under their respective headings.

SET, T.P.S. TRANSMITTING, TYPE SCR-71

EQUIPMENT, (A) TYPE PE-13* or (B) TYPE PE-11; Power

(A)* 2 Batteries, Type BB-3; Edison storage; 10 volts, 30 amp-hr.; includes electrolyte in separate container; 1 in use, 1 spare, or

(B) 3 Batteries, Type BB-23; lead storage; 10 volts, 20 amp-hr.; electrolyte is not included; concentrated acid for electrolyte supplied separately in carboys; 1 in use, 2 spares.

EQUIPMENT, TYPE RT-2; Transmitting

1 Set Box, Type BC-16; t. p. s. transmitting; 7⅛ in. x 6½ in. x 6⅛ in.

1 Strap, Type ST-4; carrying, for BC-16.

1 Weight, Type WT-2; large, for vibrator in BC-16.

2 Weights, Type WT-3; small, for vibrator in BC-16.

2 Contacts, Type CN-1; upper; spares for use in BC-16.

2 Contacts, Type CN-2; lower; spares for use in BC-16.

1 Wrench, Type TL-6; for changing vibrator weights in BC-16.

1 Gauge, Type TL-7; air gap; for BC-16.

1 File, Type TL-5; contact; for BC-16.

1 Lead, Type CD-22; battery; two-conductor.

EQUIPMENT, TYPE GD-3; Ground

12 **Stakes, Type GP-4;** ground; 18⅜ in. x ⅝ in.; weight 5 lb. 14 oz.

1 **Reel, Type RL-6;** breast; 9 in. x 11 in. x 4½ in.

2 **Drums, Type DR-3;** 8 in. x 8½ in.; for type RL-6 reel.

1 **Bag, Type BG-3;** carrying; for ground stakes.

1000 ft. **Wire, Type W-4;** No. 16 B. & S. gauge, modified, N. E. C. lamp cord; two 500-ft. lengths, each wound on type DR-3 drum; net weight, 20 lb.

60 ft. **Wire, Type W-5;** 16 strands, No. 30 B. & S. gauge, soft copper, braided; in two 30-ft. lengths, each wound in a 3-in. coil.

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* Not to be shipped overseas.

SET, T.P.S. RECEIVING, TYPE SCR-72

EQUIPMENT, TYPE PE-12; Power

2 **Batteries, Type BB-2;** Edison storage; 4 volts, 90 amp-hr.; with powdered electrolyte in separate container.

EQUIPMENT, TYPE RC-3; Receiving

1 **Set Box, Type BC-17;** t. p. s. receiving.

1 **Case, Type CS-2;** carrying; for T.P.S. receiving set.

2 **Head Sets, Type P-11;** telephone.

1 **Lead, Type CD-22;** battery; two-conductor.

4 **Batteries, Type BA-2;** dry; 2 in use, 2 spares.

4 **Tubes, Type VT-1;** vacuum; 2 in use, 2 spares.

EQUIPMENT, TYPE GD-3; Ground

12 **Stakes, Type GP-4;** ground; 18⅜x⅝ in., weight, 5 lb. 14 oz.

1 **Reel, Type RL-6;** breast; 9x11x4½ in.

2 **Drums, Type DR-3;** 8x8½ in.; for type RL-6 reel.

1 **Bag, Type BG-3;** carrying; for ground stakes.

1000 ft. **Wire, Type W-4;** modified No. 16 B. & S. gauge, N. E. C. lamp cord; two 500-ft. lengths each wound on type DR-3 drum; net weight 20 lb.

60 ft. **Wire, Type W-5;** 16 strands, No. 30 B. & S. gauge, soft copper, braided; in two 30-ft. lengths, each wound in 3-in. coil.

SET, T.P.S. RECEIVING, TYPE SCR-72-B

EQUIPMENT, TYPE PE-10; Power

3 **Batteries, Type BB-14;** storage; lead; 4 volts; 100-amp-hr. at 10-amp. discharge rate; acid for electrolyte supplied separately in carboys; 1 in use, 2 spare.

EQUIPMENT, TYPE RC-3-B; Receiving.

1 **Amplifier, Type BC-44;** low frequency; 14⅝ in. x 9⅛ in. x 7¾ in.; weight 15 lb. 5 oz.

2 **Cords, Type CD-40;** extension; 6 ft., 2-conductor, No. 16 B. & S. gauge lamp cord, type W-8, with battery plug on one end and spade clips on other end; amplifier to battery; 1 in use, 1 spare.

1 **Cord, Type CD-56;** extension; 4 ft. long, 2-conductor, wire type W-15; with telephone plug type PL-5 on one end and spade clips on other end; for connecting amplifier to a radio receiving set box for amplifying radio signals.

2 **Head Sets, Type P-11;** telephone.

4 **Batteries, Type BA-2;** dry; 2 in use, 2 spare.

4 **Tubes, Type VT-1;** vacuum; 2 in use, 2 spare.

1 **Bag, Type BG-13;** carrying; 10 in. x 7¼ in. x 3 in.

1 **Compass, Type I-1;** "Cebynite" or equivalent; luminous dial.

¼ lb. **Tape, Friction;** ¾-in.

1 **Pliers, Type TL-19;** universal, 6-in., similar to Fairbanks' combination pliers No. 70.

1 **Voltmeter, Type 1-10;** d.c.; 0 to 10 and 0 to 50 volts; with lead.

1 **Screwdriver, Type TL-2;** 4 in. long; Stanley No. 21 or equivalent.

1 **Emery Cloth, Sheet;** No. 4-0; about 11 in. x 8 in.

1 **Pamphlet, Instruction.**

EQUIPMENT, TYPE GD-3-A; Ground

1 **Bag, Type BG-8;** carrying, for ground stakes; 21 in. x 4¼ in.

12 **Stakes, Type GP-6;** ground; 18 in. long, ½ in. diameter with wing nut binding post near top.

1 **Reel, Type RL-6;** breast; 9 in. x 11 in. x 4½ in.

2 **Drums, Type DR-3;** for breast reel; 8 in. x 8½ in.

1000 ft. **Wire, Type W-4;** No. 16 B. & S. gauge, modified N. E. C. lamp cord; two 500-ft. lengths, each wound on drum type DR-3; net weight, 20 lb.

60 ft. **Wire, Type W-5;** 16 strands, No. 30 B. & S. gauge, soft copper, braided; in two 30-ft. lengths, each wound in 3-in. coils.

1 **Hammer, Type HM-1.**

Carrying Units

All of the parts of the type SCR-72-B set may be grouped in nine carrying units, as follows:

1 to 3.—3 Batteries, Type BB-14.

4.—1 Amplifier, Type BC-44; containing:
- 1 Cord, Type CD-40.
- 1 Cord, Type CD-56.
- 2 Head Sets, Type P-11.
- 4 Batteries, Type BA-2.
- 4 Tubes, Type VT-1.

5.—1 Bag, Type BG-13, containing:
- 1 Cord, Type CD-40.
- 1 Compass, Type I-1.
- 1 Tape, Friction, Rolls.
- 1 Pliers, Type TL-19.
- 1 Voltmeter, Type I-10; with leads.
- 1 Screwdriver, Type TL-2.
- 1 Emery Cloth, Sheet.
- 1 Pamphlet, Field.
- 2 Wire, Type W-5; coils.

6.—1 Bag, Type BG-8, containing:
- 12 Stakes, Type GP-6.

7.—1 Reel, Type RL-6.

8 and 9.—2 Drums, Type DR-3, on each of which is wound 500 ft. of lamp cord, Type W-4.