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TWO-WAY T.P.S. SET

Type SCR-76

(Confidential)

Communication
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TWO-WAY T. P. S. SET, TYPE SCR-76

The type SCR-76 set is a transmitting and receiving set for ground telegraph work (T. P. S. or earth induction), and is therefore to be used at stations where two-way communication is necessary. It is practically an assembly of the type SCR-71 T. P. S. buzzer and the type SCR-72 amplifier (with some important changes in design) into a single unit to facilitate the installation and use of the two when both are required at one location. The set comprises an adjustable frequency power buzzer, a telegraph key for sending, and a two-stage vacuum tube low frequency amplifier for receiving. The power required to operate the buzzer and to light the filaments of the vacuum tubes is derived from a 10-volt storage battery.

Principles of Operation

The principle of operation of the SCR-76 set is illustrated in the wiring diagram given herewith, Fig. 1. In general it consists of generating by induction, high potential current of audio frequency, which is caused to flow through the ground between two ground terminals separated by about 500 ft. In flowing through the ground, the lines of current spread out in all directions so that some of them may be intercepted at considerable distances by a suitable receiving device similarly connected to the ground and sensitive enough to respond to the extremely small currents thus received by conduction through the earth. Then by breaking up the pulsating emf. impressed on the ground into dots and dashes, it is possible to read the signals at the receiving station.

In the two-way T. P. S. set, the same ground connections and the same 10-volt storage battery are used for both sending and receiving, this being accomplished by means of a double pole double throw "Transmit-Receive" switch mounted on the panel of the set. With the switch in the "Transmit" position, the local circuit from the storage battery through the sending key and the primary of the power buzzer is completed and the base line wires are connected directly to the secondary or high potential winding. When the sending key is closed, the vibrator interrupter makes and breaks the current through the primary winding at a frequency which is controlled by means of small

weights screwed to the vibrating armature. The following frequencies are possible :

- Large weight out630 cycles per second.
- Large weight in700 cycles per second.
- Two small weights out . . .830 cycles per second.
- One small weight out . . .980 cycles per second.
- One small weight in . . .1150 cycles per second.
- No weights1380 cycles per second.

The pulsating primary current resulting from the action of the buzzer, induces an alternating emf. of high potential in the secondary winding.

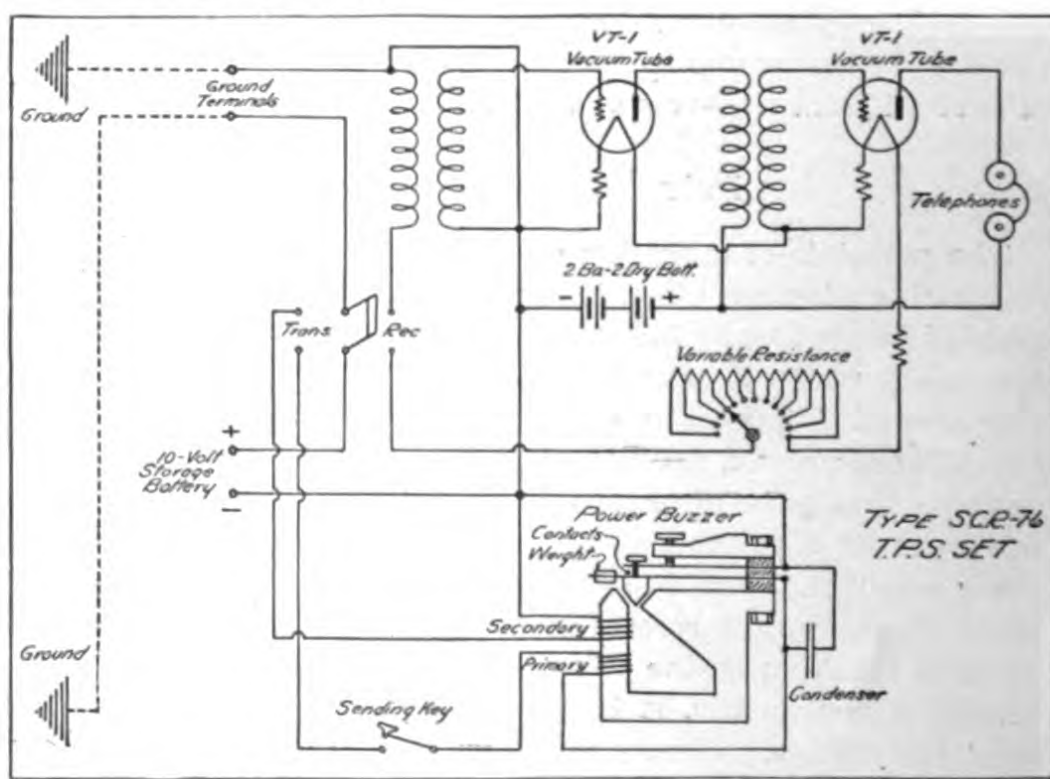


Fig. 1—Schematic Circuit Diagram of Two-Way T.P.S. Set.

The power buzzer is a double winding, closed magnetic circuit, buzzer interrupter, of practically the same construction as the SCR-71 T.P.S. buzzer. As in the SCR-71 buzzer, a condenser is connected across the vibrator contact points to reduce the spark and improve operation. For every change of frequency, the screw on top of the buzzer should be adjusted to give a good clear note, and then locked in position. The adjustment should be made as tight as possible and still give a clear note, as the current input into the ground will then be a maximum.

For good operation of the buzzer, the vibrator contact points must be clean, and the surfaces even and parallel. After

some 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,

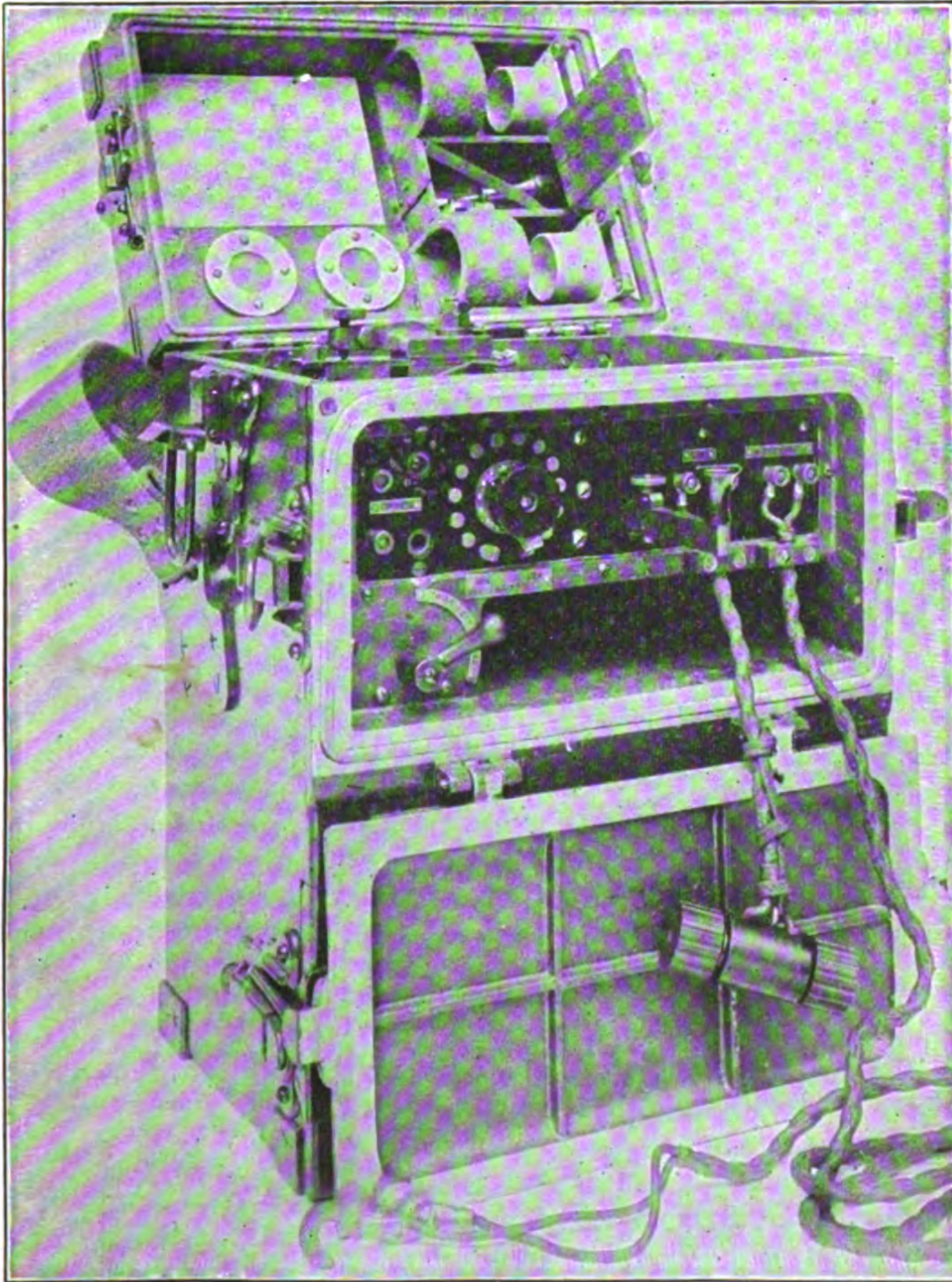


Fig. 2—Buzzer in Top Compartment and the Operating Panel on the Side.

and rub them gently on a piece of 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.

With the switch closed in the "Receive" position, the base and 10-volt battery are connected to the amplifier. This is a low frequency, two stage amplifier, using two type VT-1 three-electrode vacuum tubes connected for cascade amplification by

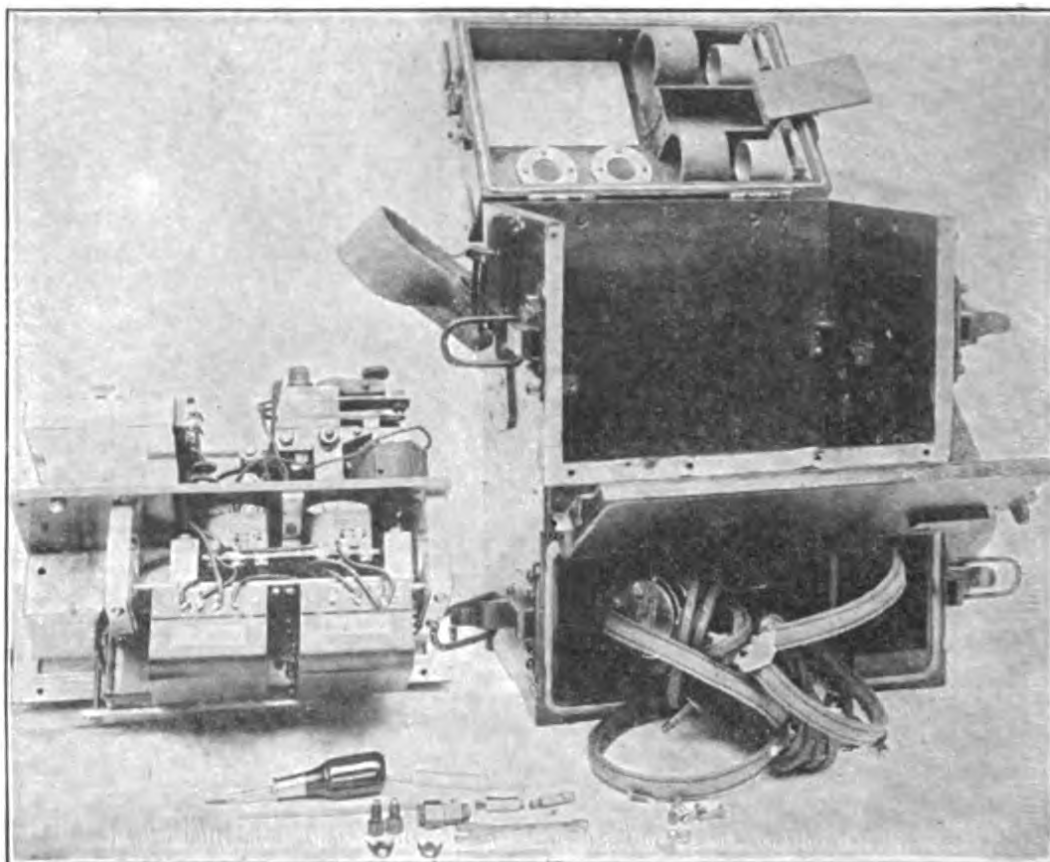


Fig. 3—Radio Apparatus Removed from Set Box.

means of two iron core transformers. Jacks and binding posts for connecting telephone receivers are provided in the plate circuit of the last tube. The filaments of the two tubes are connected in series to the 10-volt storage battery. Three fixed resistances having a total value of 3.9 ohms, and a 6-ohm resistance variable in 12 steps, are in series with the filament circuit. The variable resistance is operated by means of a dial switch on the operating panel of the set, and is cut entirely out of the circuit on the last point to the right, this being the position for maximum amplification. To reduce the degree of amplification, the rheostat is turned to the left to insert resistance in the filament circuit. This decreases the filament temperature and reduces the electron emission in the tubes.

and hence the degree of amplification. A plate potential of about 45 volts is obtained for both tubes by means of two type BA-2 dry batteries connected in series. When the battery voltage has run down to 34 volts, (17 volts each) the batteries should be replaced.

When it is necessary to replace the dry batteries of the amplifier circuit, particular care must be taken to see that they are connected in with the correct polarity. This is essential for the operation of the vacuum tubes. It is also necessary that both vacuum tubes be in good condition, since the amplifier cannot operate on one tube only, with the other one broken, burned out, or out of the circuit. If the amplifier does not work properly, this may be due to a poor telephone connection, or to a wrong connection of either the storage or the dry batteries, or to the failure of one of the tubes.

When the set is not in use, the Transmit-Receive switch should be in the "Off" position as this will avoid any possibility of unnecessarily running down the storage battery.

Mounting of the Set

The set is mounted in a rugged wooden case having the overall dimensions, $15\frac{1}{4}$ in. x $12\frac{7}{8}$ in. x $8\frac{1}{2}$ in. This case is provided with three doors or covers, one at the top and two on the front side, which close against rubber gaskets and are held tightly by strong toggle latches, Fig. 2 and Fig. 3. This construction makes the set fairly waterproof, especially if care is taken to keep the rubber gaskets clean and free from dust or mud before clamping the doors shut.

The upper cover gives access to the power buzzer, the tubes in use, and the dry batteries in use. Two spare vacuum tubes, spare parts for the buzzer, the vibrator weights and tools are mounted in the top of the cover. This cover should be open only while adjusting the buzzer or replacing tubes or batteries. It should be kept closed during operation, particularly in rainy weather.

The upper side-cover is of metal and hinges downward. It encloses the operating panel of the set. On this are mounted the telegraph sending key, the filament rheostat, the "Transmit-Receive" switch, two telephone jacks and two emergency telephone binding posts, two binding posts for the line wires, and two binding posts for connecting the 10-volt storage battery.

The telegraph sending key may be folded back against the panel so that it will not protrude beyond the face of the box and thus will allow the cover to close.

Two twisted pair cords are also permanently attached to panel binding posts. One of these is provided with lugs for making connection to an Edison storage battery, and the other is connected to a special double terminal block by means of which connection to the two base line wires is effected. When not in use, these two cords are folded in the pocket provided underneath the operating panel which may be clearly seen in Fig. 2. If a French made storage battery is used instead of an Edison battery, the connection lugs are to be replaced by special terminals provided for the purpose, and normally kept in the top cover box compartment of the set. A rubber curtain is provided with the set to protect the operating panel while using the set in rainy weather.

The bottom compartment of the box, which is normally closed by a wooden cover hinging upward, contains two P-11 telephone head sets and two spare BA-2 dry batteries, Fig. 3.

It may be necessary to take the set apart for repair or inspection. This may be done by opening the top cover and the metal side door and unscrewing the six screws which fasten the panel frame work to the set box. The entire set will then come out of the box as a unit.

Opening a Station

To open a station, the base line, approximately 500 ft. long, is established in accord with the rules laid down below. The set box is then laid horizontally on its back, the bottom door opened, the telephone head receivers removed, and the door carefully clamped shut. This is done in order to keep the set clean and waterproof. The box is then set upright and the metal side door opened. The battery wires are connected to the 10-volt storage battery terminals, due regard being given to the polarity. The two base line wires are connected to the special connector. In order to remove any mechanical strain from the electrical connections on the connector, the line wires are tied together with a piece of cord about 8 in. from their free ends and the cord is tied to the small metal ring at the center of the connector. All these inter-connections between set parts are shown in Fig. 4.

The telephones are plugged in the telephone jack, or connected to the telephone binding posts. By moving the switch to "Re-

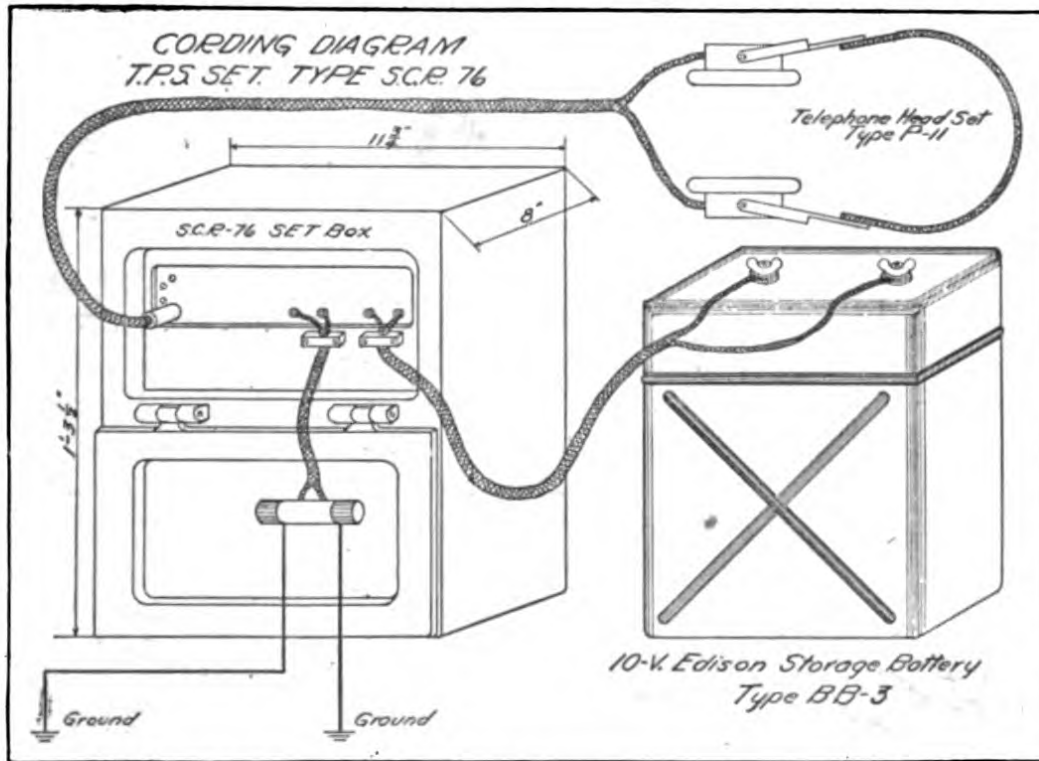


Fig. 4—Cording Diagram of T.P.S. Set, Type SCR-76.

ceive" and setting the filament rheostat to the desired value (generally to "Maximum"), the set is ready for receiving signals. If it is desired to send a message, the switch is thrown to "Transmit", the telegraph key straightened out and the buzzer adjusted to give a clear note of the desired frequency. This is done, after opening the top cover, by placing the proper weight on the vibrator armature and adjusting the set screw of the buzzer. The cover is then closed and the set is ready for operation.

How to Lay Out the Base Lines

When laying out the base lines of various stations communicating with each other, it is very important to follow the general rule of arranging them so that the imaginary straight line joining the centers of the base lines of the stations will make equal angles with the two base lines, the angles considered being taken on the same side of that imaginary line and between the base lines. The best position is that in which the two base lines are parallel to each other and the line joining their centers makes right angles with them. This arrangement is indicated in the first drawing of Fig. 5. The other two drawings show the application of the above rule by two different methods to the case of one station communicating with two others.

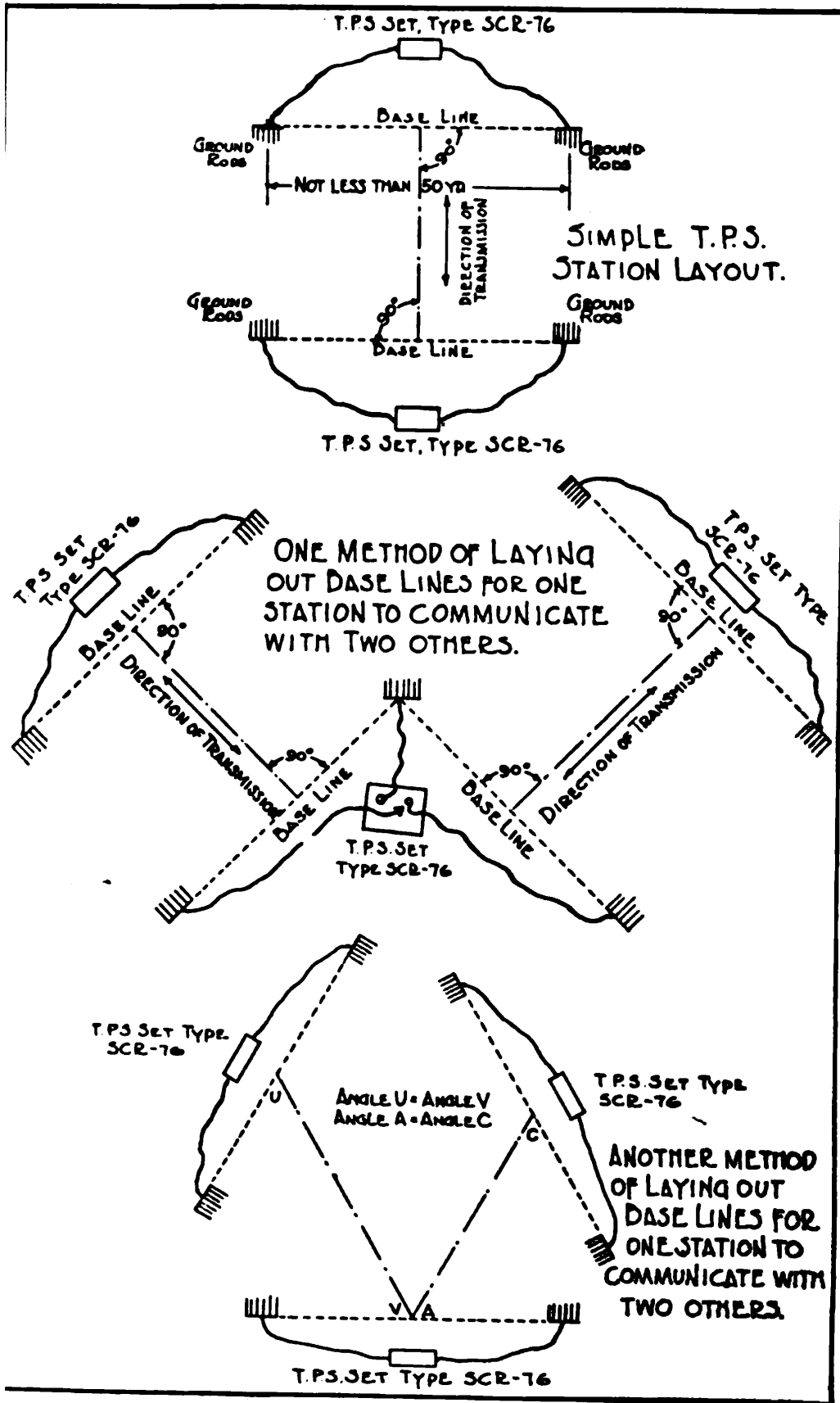


Fig. 5—Methods of Laying Out Simple T.P.S. Station, and One Station to Communicate with Two Others. Original from NEW YORK PUBLIC LIBRARY

If one station is to communicate with a number of different stations, best results are obtained by providing at that one station a number of base lines, laid out radially around the station in positions at right angles, respectively, to the lines joining that base line to each of the other station base lines. A selector switch then enables the connection of the central station to any desired base line.

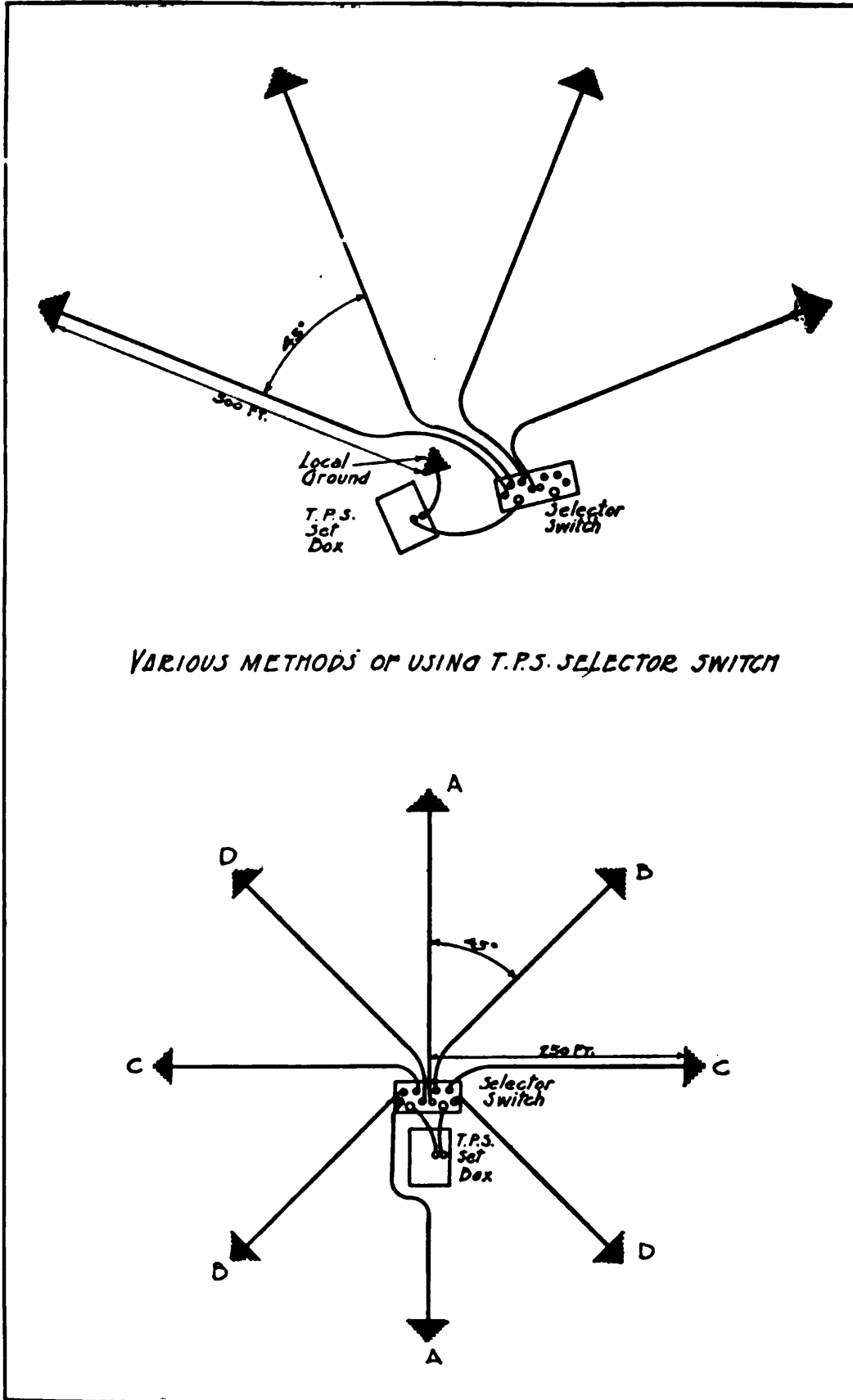
The installation of such a central station may be made in a number of different ways. Two methods are illustrated in Fig. 6. By the method shown in the upper drawing, any one of the four outer ground terminals may be used with the local ground to make four different base lines, these covering closely almost any direction. By the method shown in the lower drawing, the two switches will usually be placed to make A and A, or B and B, etc., the ends of the base line in use. However the terminals D and B on opposite switches might be used as the pair of ground terminals if they were laid out the proper distance apart. This gives an idea of the various combinations possible.

The first method is preferable, it being easier to install and operate. There are only five grounds to establish, and one half of the selector switch only is used. In the second method, both sides of the switch are used and there are eight grounds to establish.

When a station having a single base line is to communicate with a central station having the choice of a number of base lines, the single station will establish its base perpendicularly to the line joining the two stations. The central station then selects the one of its bases which is nearest perpendicular to the line joining the two stations.

The best method for laying out the base lines is to use a compass, by means of which the direction of the bases of the various stations can be determined accurately. A number of types of compasses are in use, which makes it impossible to give definite rules as to their use in this connection.

Another important consideration is the method of grounding the far ends of the base line wires. Twelve ground rods are furnished with the set. At least four rods should be driven into the ground in a straight line at each end of the base, and at a distance apart of not less than 2 ft. They should be driven at least 1 ft. into the ground. It is well to moisten the ground around the rods after they have been driven in.



VARIOUS METHODS OF USING T.P.S. SELECTOR SWITCH

Fig. 6—Methods of Laying Out Central T.P.S. Stations.

For more complete details on the theory of ground telegraphy, and the methods of laying out ground stations, see Radio

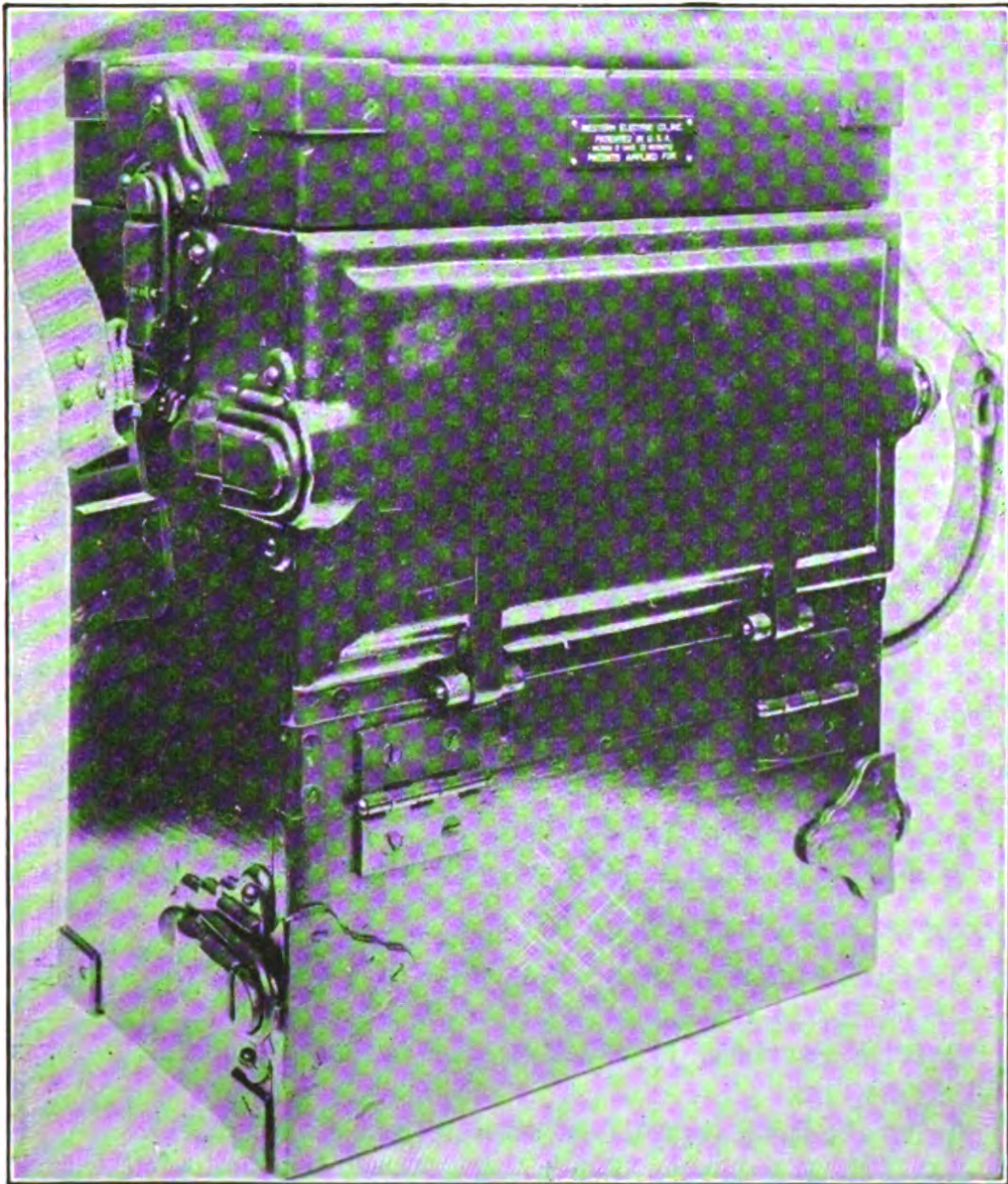


Fig. 7—Type SCR-76 Set Box Closed Up and Waterproof.

Pamphlet No. 10. For details of the listening-in service and the means of coping with interference, see Radio Pamphlet No. 18.

Comparison of SCR-76 with SCR-71 and SCR-72 Combination

The advantages of the SCR-76 set over the former practice of utilizing the SCR-71 buzzer and SCR-72 amplifier are given as follows:

1. The set is more convenient to set up, as there is no switch to connect, thereby avoiding the numerous short interconnecting wires. Generally, all connections are easier to make.

2. The radio apparatus is easier to transport, as it is contained in a single box which is not an excessive load for one man. The total weight of the two sets SCR-71 and SCR-72 is somewhat greater than that of the SCR-76 box.

3. A great advantage is that there is only one storage battery required for the set, the 4-volt filament battery of the former set being entirely eliminated.

4. Space for spare vacuum tubes and dry batteries is provided within the set, while they had to be carried in separate boxes with the old set.

The following disadvantages may be pointed out :

1. If the set is used at stations where one-way communication only is required, the SCR-76 set provides superfluous material and equipment.

2. The amplifier of the SCR-76 set cannot be used for radio frequency amplification purposes. If it is desired to use it in connection with radio signals, it must be connected in the audio frequency circuits of the receiving set.

Parts List of the Two-Way T.P.S. Set, Type SCR-76

POWER EQUIPMENT, TYPE PE-13.

2 Storage Batteries, type BB-3. (1 in use, 1 spare).

GROUND EQUIPMENT, TYPE GD-3.

12 Ground Rods, type GP-4; size 22½ in. x ⅝ in.; weight 5 lb. 14 oz.

2 Wire Carriers, type DR-3; for breast reel; size 9 in. x 9½ in.

1 Breast Reel, type RL-6; size 10 in. x 12 in. x 2 in.

1,000 ft. Wire, type W-4, in two 500-ft. lengths, each wound on wire carrier, type DR-3; net weight 20 lb.; modified B & S No. 16 gage.

1 Carrying Bag, type BG-3 for wire, ground stakes, etc.

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

T. P. S. EQUIPMENT, TYPE RE-3.

1 T.P.S. Set Box, type BC-21; size 15½ in. x 11¾ in. x 8 in.; weight 32 lb.

1 Large Weight for vibrator, type WT-2.

- 2 Small Weights for vibrator, type WT-3.
- 2 Spare Upper Contacts for vibrator, type CN-1.
- 2 Spare Lower Contacts for vibrator, type CN-2.
- 1 Wrench for changing vibrator weights, type TL-6.
- 1 Air Gap Gauge for vibrator, type TL-7.
- 1 Contact File for vibrator, type TL-5.
- 2 Telephone Head Sets, type P-11; total weight 2 lb. 4 oz.
- 4 Dry Batteries, type BA-2 (2 in use, 2 spare); weight 3 lb. 8 oz.
- 4 Vacuum Tubes, type VT-1 (2 in use, 2 spare).
- 1 Selector switch, type SW-16.
- 1 Compass, type I-1.
- 1 Roll Friction Tape, $\frac{3}{4}$ -in., Spec. 5C9-B.
- 1 Pair Pliers, type TL-19; Universal.
- 1 Voltmeter, type I-2; with leads; 8 to 24 volts, d.c.
- 1 Screwdriver, type TI-2.
- 1 Sheet Emery Cloth, 11 in. x 8 in.
- 1 Carrying Bag, type BG-13; size $9\frac{1}{2}$ in. x $7\frac{1}{2}$ in. x 1 in.

CARRYING UNITS.

All of the above parts are included in five carrying units, as follows:

1. Set Box, type BC-21, $15\frac{1}{2}$ in. x $11\frac{3}{4}$ in. x 8 in.; weight 39 lb., including telephone head sets, dry batteries, vacuum tubes, etc.
2. Carrying Bag, containing 12 ground rods, 2 spools of wire and 2 coils of wire.
3. Storage Battery, type BB-3, 10 volts; 11 in. x $10\frac{1}{2}$ in. x 7 in.; weight 45 lb.
4. Carrying Bag, containing compass, voltmeter, tape, screwdriver, pliers, emery cloth, selector switch, also breast reel if desired.
5. Breast Reel, type RL-6, 10 in. x 12 in. x 2 in., when not included in unit 4 above.

