TECHNICAL REGULATIONS
No. 1215–5

WAR DEPARTMENT,
WASHINGTON, *March 15, 1930.*

SIGNAL CORPS

BATTERY CHARGING SET, TYPE SCR–82

Prepared under direction of the
Chief Signal Officer

SECTION I

GENERAL USES AND DESCRIPTION

1. Where and when used.—The type SCR–82 is a portable charging set for use in the field to charge portable storage batteries, and may also be used to charge the battery of a common battery telephone exchange, or to furnish direct current supply for an emergency lighting system.

2. General description, principal parts.—*a.* The type SCR–82 consists of the following parts:

(1) A Signal Corps, type GE–2, internal-combustion gasoline engine of the single-cylinder, valve-in-head, 4-cycle, upright, air-cooled type.

(2) A Signal Corps, type GN–9, 2-kilowatt direct-current generator, capable of supplying 50 amperes at 25 volts and 5 amperes at 115 volts simultaneously.

(3) A charging control panel, Signal Corps, type BD–4, for the 115-volt supply.

(4) A charging control panel, Signal Corps, type BD–5, for the 25-volt supply.

b. The engine with its fuel tank and muffler is directly connected to the generator which is mounted on one end of the crank case; the complete assembly is then mounted on wooden skids.

c. The charging control panels are separate units. On these panels are mounted the voltmeter, ammeter, charging circuit control switches, and line terminals.

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SECTION II

INSTALLATION FOR SERVICE

3. Charging set as issued.—The charging set as issued consists of three main items: The type BD–4 control panel, the type BD–5 control panel, and the type

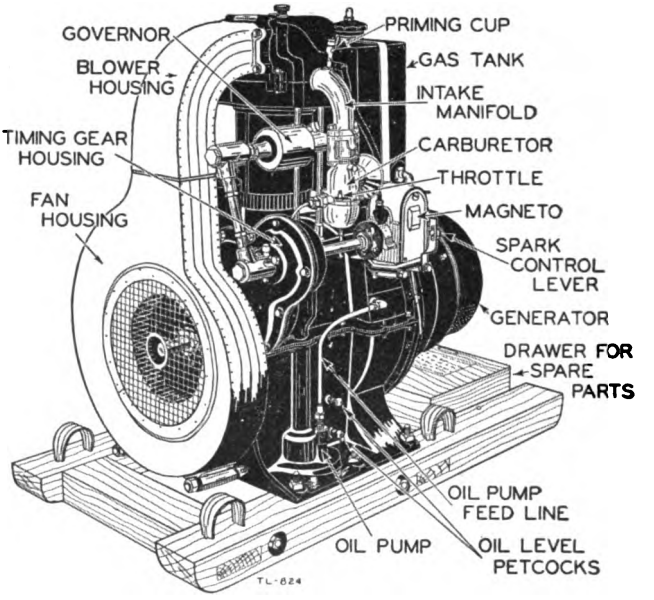

FIGURE 1.—Type GE–2 gasoline engine and type GN–9 generator

GE–2 gasoline engine with the type GN–9 generator mounted together. All spare parts and tools are contained in a drawer mounted under the generator between the skids.

4. Type GE–2 gasoline engine.—Looking at the engine from the cranking position (see fig. 1), its external assembly appears as follows:

a. The wheel to which the starting hand crank is fitted is a fan wheel inclosed in a housing leading to the cylinder head. This wheel and housing form the engine cooling system.

b. The timing gear housing is located on the right-hand side of the crank case just in rear of the engine cooling system. Extending from this housing are two revolving shafts, one of which goes to the magneto and the other to the governor.

c. The carburetor is located just above the shaft leading to the magneto.

d. The oil pump feed line and the oil level gauge cocks are located below the timing gear housing on the right-hand side of the crank case.

e. The crank case oil filling cup is located on the left-hand side of the engine on the top of the crank case between the cooling system and the upright cylinder. (See fig. 2.)

f. The direct-current generator is mounted on the opposite end of the engine and is fastened to the flywheel and flywheel housing. Above the generator is mounted the fuel tank.

g. The top of the housing around the cylinder head is hinged and may be opened to allow adjustment of the valve tappets and affords access to the spark plug.

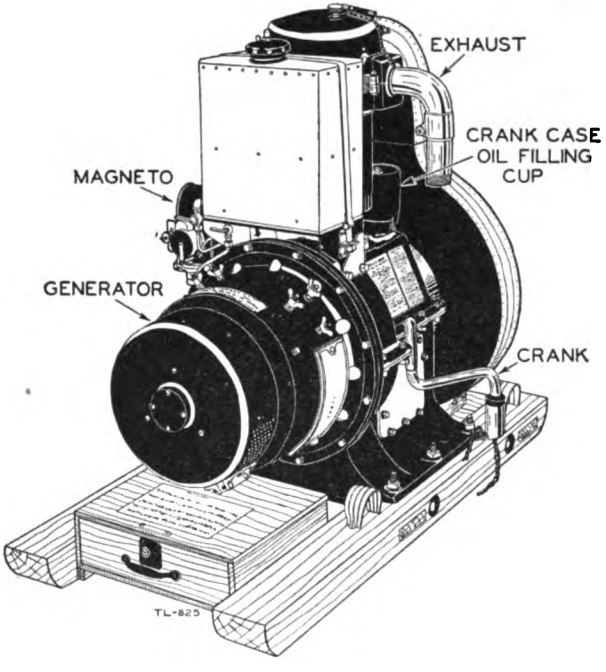

FIGURE 2.—Type GE–2 gasoline engine and type GN–9 generator

h. The engine controls are on the right-hand or carburetor side of the engine and consist of a throttle extending through the side wall of the carburetor, the spark control lever located on the end of the magneto, and the fuel valve located on the bottom of the tank for the control of the fuel line from the tank to the carburetor.

5. Type GN–9 generator.—*a.* A direct-current shunt-wound generator is used on the gasoline charging set, type SCR–82.

b. The generator armature forms an extension to the flywheel of the engine and is bolted to it.

c. The generator field is fastened to the inside of the generator housing, all being bolted to the flywheel housing of the engine.

d. The generator terminals are located on top of the generator housing.

e. The type GN–9 generator used on the type SCR–82 unit has a double-wound armature and two commutators. One armature winding generates an e. m. f. of 25 volts, while the other generates an e. m. f. of 115 volts.

f. The five terminals of the type GN–9 generator are marked as follows:

LOW-VOLTAGE SIDE:
1. 25 VOLTS, ARM+.
2. ARM—, FIELD—(negative).
3. FIELD+.

HIGH-VOLTAGE SIDE:
1. 115 VOLTS, ARM+.
2. ARM—(negative).

g. The variable field rheostat for the type GN–9 generator is mounted on the type BD–5 charging control panel.

6. Type BD–4 charging panel.—*a.* The type BD–4 panel is used on the 115-volt charging main of the type SCR–82 battery charging set as shown in Figure 3. The panel has a face of bakelite-dilecto fastened to a supporting framework of metal.

b. The voltmeter and ammeter, with their respective switches immediately below, are mounted at the top of the panel. The switches have markings on the lugs, "L" for generator, "1" and "2" for charging circuits "one" and "two," and "T" for outside battery test.

c. Two terminals marked LINE + (positive) and LINE — (negative), to which is connected the 115-volt charging main from the generator, will be found on the right-hand side of the face of the panel.

d. Two terminals marked VOLTS—TEST are located on the left-hand side of the panel. Batteries not under charge may be connected thereto in order to test their voltage.

e. Three ammeter shunts, one for the 115-volt charging main from the generator and one for each of the output circuits, are installed on the rear of the panel.

f. Two circuit breakers, one for each of the output circuits, are mounted near the bottom of the panel. Each circuit breaker consists of two electromagnets, one of which is differentially wound, the other being a series single-wound solenoid. The differentially wound electromagnet is used in the underload side of the circuit breaker, and the series single-wound solenoid is used in the overload side. (See fig. 3.)

g. Two load rheostat switches, one for each output circuit, are mounted on the rear of the panel with their operating handles extending through the panels just below the voltmeter and ammeter switches.

h. Four binding posts, two for each output circuit, marked BATT 1 + and —, and BATT 2 + and —, are located at the bottom of the panel and to these terminals are connected the banks of batteries to be charged or the emergency lighting circuits to be operated.

7. Type BD–5 charging panel.—*a.* The type BD–5 panel is used on the 25-volt charging main of the type SCR–82 battery charging set and is similar to the type BD–4 115-volt panel in that nearly the same equipment is provided. (See fig. 4.)

b. The type BD–5 panel has three output circuits so that three banks of batteries can be charged simultaneously.

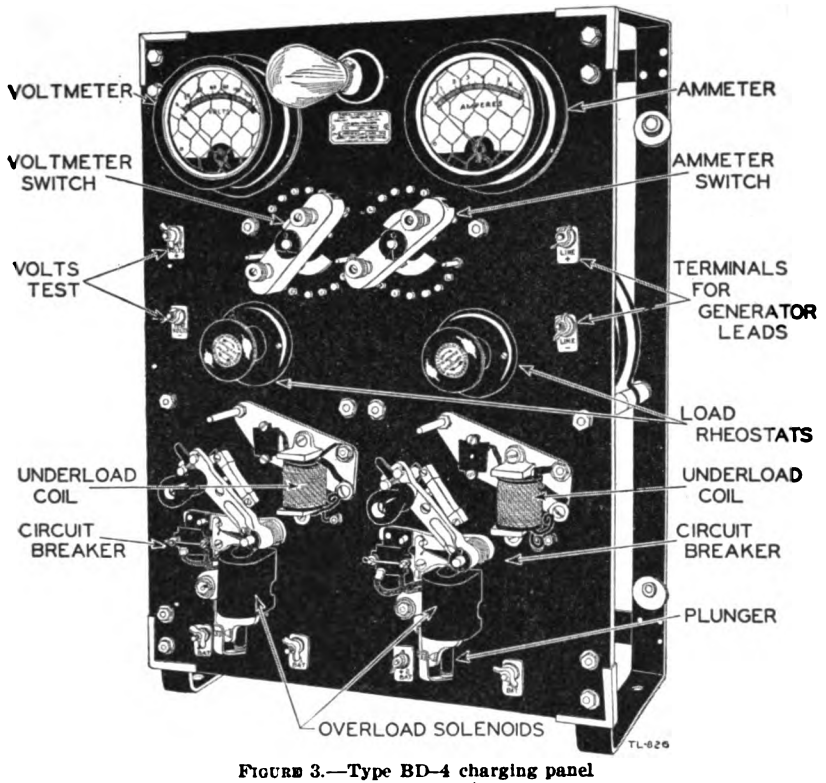

FIGURE 3.—Type BD–4 charging panel

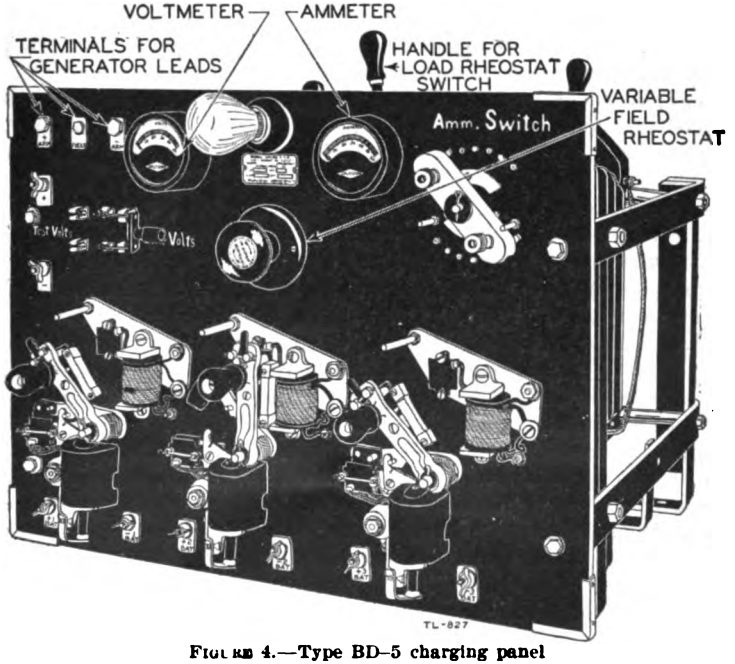

FIGURE 4.—Type BD–5 charging panel

c. There is also an extra rheostat, known as the *variable field rheostat*, which is connected to the field circuit of the generator for the purpose of regulating the generator voltage.

d. Three terminals marked ARM—, FIELD, and ARM+ are provided at the top of the panel for connection of generator leads.

8. Permanent or semipermanent installation.—*a.* When possible, a concrete foundation should be built for the gasoline engine and generator. The foundation should be a solid block of concrete with a top approximately the size and shape of the engine and generator and at least 18 inches thick. Bolts should be placed in the concrete as it is poured. These bolts should be so placed as to fit into the base of the engine and generator, thereby making it possible to bolt these parts to the concrete block.

b. The engine should be so located that the exhaust pipe can be led to the open air. If the engine is placed some distance from the wall the exhaust line should be run up from it and overhead at a sufficient height to prevent persons from coming in contact with the hot pipe. The exhaust pipe should not come in contact with any wooden parts of the building. When necessary to pass it through a wooden wall or partition, a hole 5 or 6 inches in diameter should be cut in the wall and the pipe supported by a metal disk nailed to the wall of the building. If any part of the exhaust line is higher than the exhaust port of the engine, a drip pocket with pet cock should be installed at the lowest point of the exhaust system to drain off the moisture condensed in the exhaust pipe. If several bends are required in the exhaust line, a pipe union should be installed as close as possible to the engine. This allows the removal of the exhaust line from the engine without taking down all the exhaust line piping.

c. Additional muffling of the exhaust may be obtained by running the exhaust through a barrel filled with large, loosely packed stones. The barrel may be partly or completely buried and should stand vertically with the lower end removed to allow water to drain off through the ground.

d. When possible, the charging plant together with the batteries should be installed in a dry, light place, having an average temperature of 70° F. The batteries should be arranged on shelves at a convenient height so that all cells may be easily inspected.

e. The charging control panels should be fastened to a wall near the location of the battery cabinet. The metal frame of the panel is drilled for this purpose.

f. The wires connecting the generator to the charging control panels and those connecting the batteries to the panels should be insulated copper conductors not smaller than No. 12 B. & S. gage. All wiring should be kept away from the floor and away from metal parts. If the wiring is exposed, it should be neatly arranged and should be securely fastened to supporting surfaces by means of porcelain knobs or cleats. The conductors should preferably be run in metal conduit or in B. X. cable.

9. Temporary installation.—*a.* When a temporary installation is made in the field or where a concrete foundation can not be built, the engine should be set in a trench the width and depth of the skids on which it is mounted. Iron stakes about 2 inches in diameter and 2 feet long should be driven into the ground at the corners and sides of the skids to prevent the engine from creeping.

b. Another method of temporary installation is to bolt the engine to heavy timbers which are then intrenched and staked.

c. The charging control panels may be set on a table, box, or packing chest, but not on the ground.

10. Methods of connecting.—*a.* The line connections between the generator and the charging control panels should be made as shown in Figures 6 and 7.

b. The banks of batteries to be charged or the emergency lighting system to be operated are connected to the terminals marked BATT+ and —, which are located at the bottom of the charging control panels. (See fig. 5.)

11. Tests and inspections for serviceability and precautions to be observed.—The following questions should be satisfactorily answered before putting the apparatus into operation:

a. Is the engine firmly seated?

b. Are all wires properly protected from each other and clear of possibility of contact with personnel or material?

c. Is the exhaust pipe so placed so that it will not endanger personnel or material?

SECTION III

OPERATION

12. Starting and stopping the engine.—The operation of the engine is in general the same as for any other gasoline engine.

a. To start the engine proceed as follows:

(1) Open the upper gauge cock on the crank case.

(2) Fill the crank case with the best grade of medium automobile engine oil until the oil runs out of the upper gauge cock on the crank case.

(3) Close the upper gauge cock on the crank case.

(4) Fill the fuel tank with gasoline.

(5) Open the gasoline fuel line supply valve.

(6) Move the magneto control lever down to the START position.

(7) Move the carburetor air valve throttle lever to the START position.

(8) Crank the engine.

(9) After the engine has fired several times, move the magneto and the carburetor levers to their running positions.

(10) If the engine does not run smoothly adjust the carburetor HIGH SPEED and IDLE adjustment screws.

b. To stop the engine:

(1) Close the gasoline fuel line supply valve.

(2) Move the magneto control lever down as far as it will go, then short circuit the magneto by pressing the cut-out spring on the back of the breaker box until it touches the magneto frame.

13. Starting the charge.—The routine for placing a bank of batteries on charge is as follows:

a. Open all the circuit breakers on the panel.

b. Inspect all batteries in the bank to see that they are properly connected to each other.

c. Connect the positive and negative leads from the bank of batteries to the + and — BATT terminals of the panels.

d. Move the voltmeter switch to the position marked BATT and note the total voltage of the bank of batteries to be charged.

e. Record the voltage reading.

f. Move the voltmeter and ammeter switches to the GEN position.

g. Start the charging set. (See par. 12.)

h. Increase or decrease, by means of the variable field rheostat, the e. m. f. of the generator until a reading is obtained on the voltmeter which is about 10 per cent higher than that of the bank of batteries to be charged. There should be no reading on the ammeter.

i. Move the ammeter switch to the BATT position.

j. Close the circuit breaker and observe the current reading on the ammeter.

k. Increase or decrease the charging current by regulating the load rheostat.

l. Record the rate of charge given the batteries.

14. Control and precautions during charge.—*a.* Check the charging rate once every hour.

b. Check the specific gravity of the battery by reading the pilot cell hydrometer every 2 hours until near the completion of the charge, when it should be read every 15 minutes.

c. Check the oil every 6 hours.

d. Check the gasoline supply every 1½ hours.

e. Always stop the engine when adding oil or gasoline.

f. When the engine is running at full speed, the spark lever should be advanced to such a point that the engine gives its maximum power without the metallic knock which is characteristic of a too advanced spark. With a little practice, it is possible to adjust the advance and retard feature to the best advantage. The engine should never be operated under a full load with a retarded spark, as it will not produce maximum power, will waste fuel, and will quickly overheat.

15. Stopping the charge.—The routine for stopping the charging of batteries is as follows:

a. Record the battery voltage and current readings.

b. Manually operate the plunger (fig. 3), in the electromagnet of the overload side of the circuit breaker, thus opening the charging circuit.

c. Stop the engine. (See par. 12 *b.*)

SECTION IV

REMOVAL FROM SERVICE

16. Dismounting.—All wires connecting the control panels to batteries and the generator should be removed. The engine and generator should be replaced on skids if these were removed when the set was put into service. All parts should be given an external cleaning, and if the set is not to be used for some time all exposed iron surfaces should be painted or oiled and a few teaspoonfuls of oil put in the cylinder.

17. Preparation for transportation in the field.—*a.* When the charging set is transported in the field it should be placed in the bed of a truck on its own skids. Two 10 or 12 foot lengths of 2 by 6 inch timbers should be carried in

the truck for use as skids in removing the set from or replacing it in the truck. When replacing the set the round iron stakes mentioned in paragraph 9 may be used as rollers. Four men are able to dismount the set, but at least six are necessary in mounting it.

b. Care should be taken that all parts are so loaded on the truck that none can strike the top or sides of the truck and thus break any part of the equipment. Special attention should be given to the protection of the carburetor, magneto, radiator, and gasoline tank of the engine and to the instruments on the control panels.

18. Preparation for storage.—All parts of the set should be thoroughly cleaned and all exposed parts that are apt to rust should be painted or coated with a heavy oil. All gasoline should be drained from the tank. Clean engine oil should be left in the base of the engine and a pint of engine oil should be poured into the cylinder.

19. Preparation for shipment.—The same steps should be taken as in preparation for storage, except that in addition a solid crate of at least 1-inch material should be made for each of the charging panels. The faces of the panels should be protected by solid wooden covers. The crate for the gasoline engine and generator should have a framework of 2-inch material. Particular care should be taken to insure the protection of the carburetor, magneto, radiator, and gasoline tank. The engine and generator base should be bolted to the bottom of the crate and the crate marked "THIS SIDE UP" to insure that the set will rest on the base.

SECTION V

OPERATION AND FUNCTION OF PARTS

20. Operation of the charging circuit.—*a.* The complete charging circuit consists of a bank of batteries connected to the + and —BATT terminals of the charging control panel, thence through the circuit wiring and control apparatus of the panels to the generator. (See figs. 5, 6, and 7.)

b. The operation of the charging circuit is as follows:

(1) The e. m. f. produced by the generator connected to the line terminals of the panel marked ARM—, FIELD and ARM+, is controlled by the variable field rheostat (fig. 5), connected across the panel line terminals ARM— and FIELD. This e. m. f. causes a current to flow from the panel line terminal ARM to and through the line ammeter shunt, the battery ammeter shunt, the UL–1 winding of the underload side of the circuit breaker, the right-angle switch of the circuit breaker, the overload side of the circuit breaker, the load rheostat, the +BATT terminal of the panel, thence through the batteries to the —BATT terminal of the panel and to the generator via the panel line terminal ARM—. A small amount of the current also flows through the bridge circuit formed by the UL–2 winding of the underload side of the circuit breaker and the RES–1.

92193°—30——2

(2) If the e. m. f. of the charging circuit is maintained at a value greater than the e. m. f. of the batteries being charged, the current through UL–1 will be greater than that through UL–2 and the right-angle switch will be held closed (fig. 5). Unless the charging rate is checked from time to time—since the e. m. f. of the battery rises on charge—the charging rate

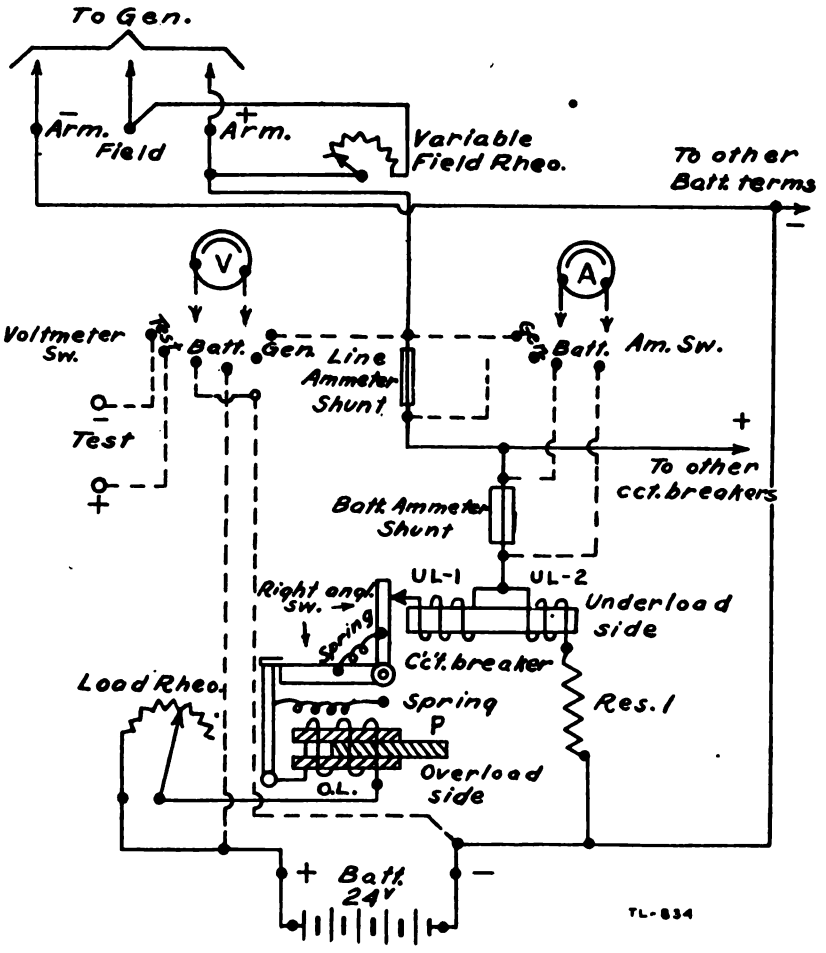

FIGURE 5.—Simplified drawing of the battery-charging circuit used on the types BD–4 and BD–5 charging panels

will decrease, hence the current through UL–1 will decrease; since the e. m. f. of the generator remains almost constant the current through UL–2 will not change and a point will finally be reached where the magnetic strength of UL–1 will nearly equal that of UL–2 and since the windings UL–1 and UL–2 of the underload side of the circuit breaker are in oppo-

sition, their magnetic fields will be nearly neutralized and the right-angle switch will be released, thus opening the charging circuit.

(3) If the current in the charging circuit becomes excessive, sufficient magnetism will be developed in the electromagnet O. L. of the overload side

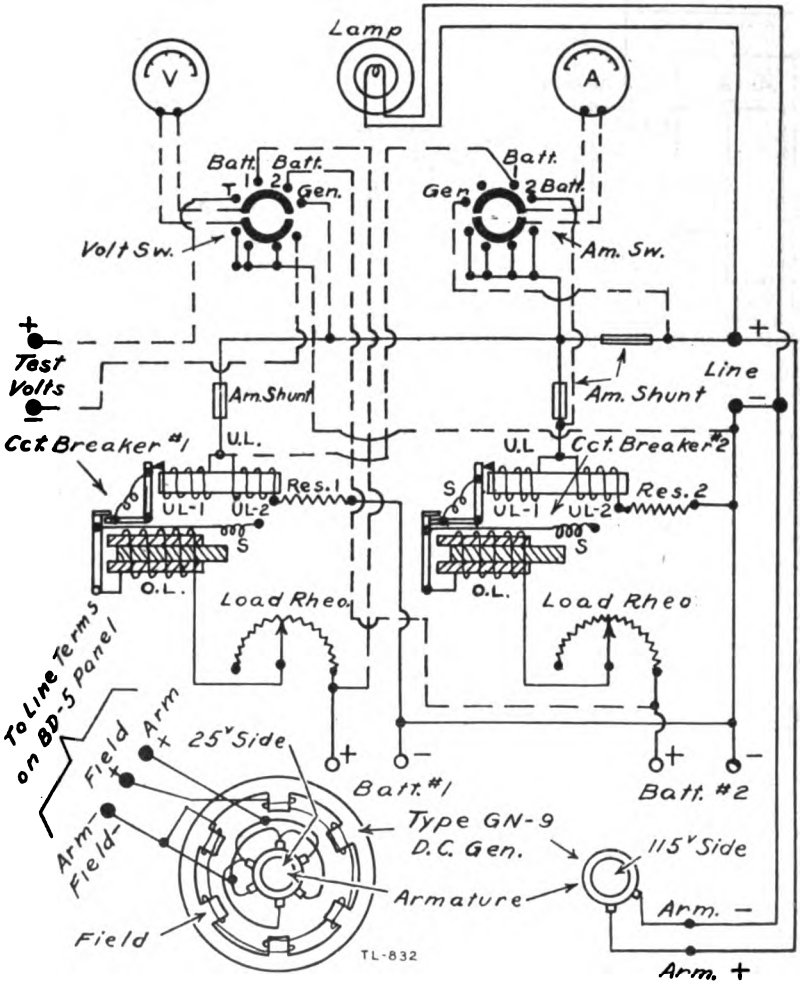

FIGURE 6.—Circuit wiring diagram of the type BD–4 panel and the type GN–9 DC generator

of the circuit breaker to operate the plunger P, which will trip the catch C, thus releasing the right-angle switch and opening the charging circuit.

(4) The load rheostat, connected in series with the O. L. winding of the overload side of the circuit breaker and the + BATT terminal, is provided for the purpose of increasing or decreasing the charging current through the battery.

c. The operation of the voltmeter and ammeter circuits may be very easily understood by reference to Figure 6.

21. Operation of the gasoline engine.—As the internal operation of the gasoline engine is identical with that of similar internal-combustion engines

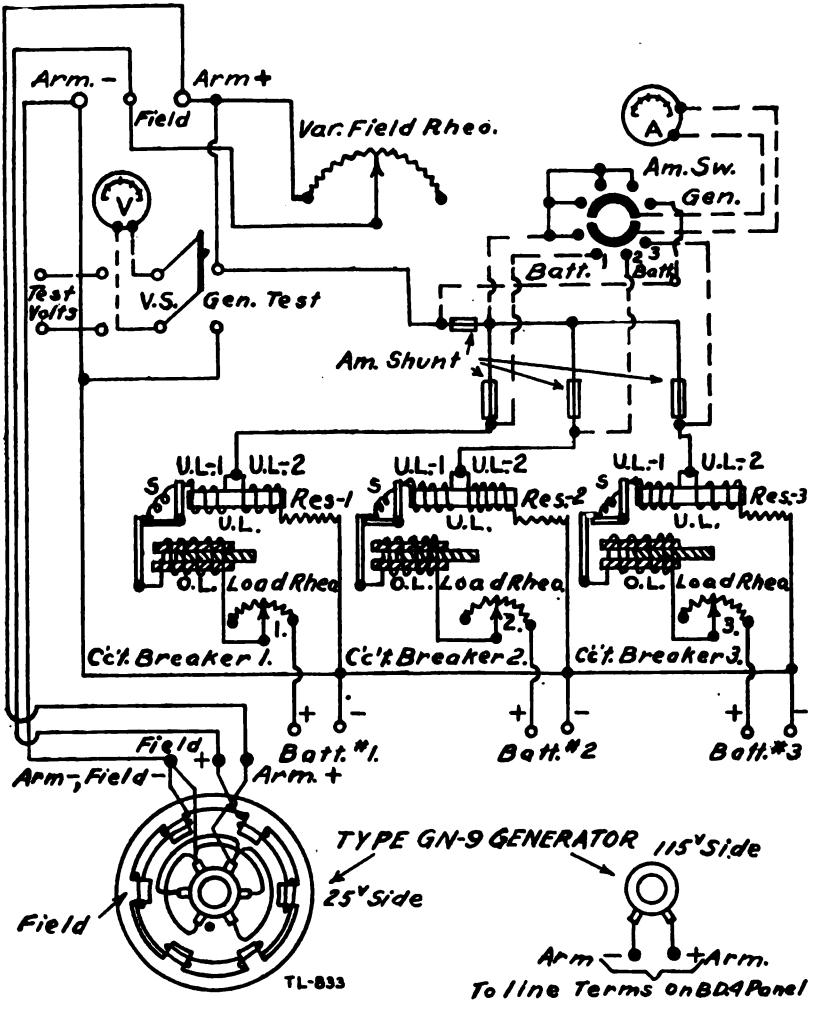

FIGURE 7.—Circuit wiring diagram of the type BD–5 panel and the type GN–9 DC generator

in automobiles or motor boats, an explanation is omitted; however, the ignition and carburetion systems used on the engine will be explained, as they are a source of considerable engine operating trouble.

22. Assembly and operation of ignition system.—*a.* The magneto used on the engine furnishes the high-tension current for ignition purposes. It consists

essentially of a pair of horseshoe magnets, a rotor, a field structure, primary and secondary induction coil windings, an interrupter or breaker, and a condenser.

b. The rotor as shown in Figure 8 consists of two iron wings N′ and S′, separated by a piece of brass B, all solidly mounted together with an extension shaft at each end. The ends of the wings are always very close to the two soft iron plates P and P′, which are themselves in contact with the legs of the permanent magnets. Thus the two iron wings become magnetized by induction as indicated by their lettering. All air gaps in the magnetic circuits are made as small as possible to minimize magnetic leakage.

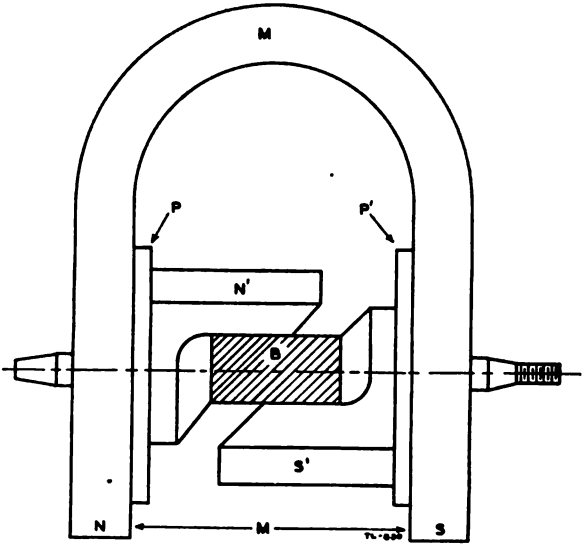

FIGURE 8.—Magneto rotor assembly

c. This assembly thus furnishes a magnet with rotating polar extremities N′ and S′, which are always of the same polarity.

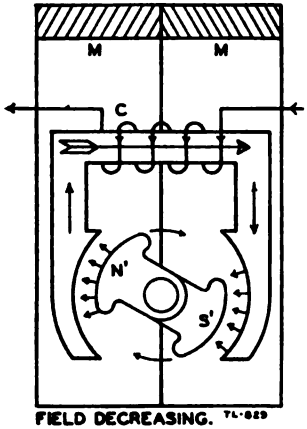

FIGURE 9.—Magneto, showing direction of current flow and revolving N′ and S′ poles

d. When the rotor is revolved, as shown in Figure 9, the wings N′ and S′ direct the magnetism of the permanent magnet M through the coil core C, first in one direction and then in the other. Each change in magnetism induces an e. m. f. of varying intensity in the insulated wire wound around the core C. This winding forms the primary of an induction coil. The maximum value of the e. m. f. thus generated in the primary winding is about 6 volts.

e. An e. m. f. is similarly induced in the secondary coil whenever there is any change of flux through the primary. The maximum value of the e. m. f. in the secondary coil depends upon the rate of change of flux through it, but the maximum value generated is ordinarily not sufficient to cause a spark to jump across the spark plug terminals; hence it is necessary to provide some means of causing a very rapid variation of flux through the secondary coil. This is accomplished as follows: Figure 10 shows a pair of breaker contacts X operated by a cam mounted on one end of the main magneto shaft. The cam is so arranged as to open the breaker contacts when the revolving poles N′ and S′ are vertical (see fig. 9). At that instant the induced e. m. f. and

current in the primary are near their maximum value, since the rate of change of flux producing them is maximum. The self-induced e. m. f. in the primary (when the contacts open) charges the condenser, which also prevents sparking across the contacts. An instant later the flux through the primary, due to the rotating poles N′ and S′, reverses; the induced e. m. f. in the primary decreases; and the condenser, discharging back through the primary coil, causes the reversal of flux to be nearly instantaneous. This rapid reversal of flux through the primary and secondary coils induces a high potential in the secondary of the order of 20,000 volts.

f. The condenser is of the mica type and is usually mounted inside the breaker housing and may be readily removed for inspection or replacement. In some types of magneto the condenser is mounted on top of the induction coil.

g. The secondary winding of the induction coil consists of several thousand turns of fine wire wrapped over the primary. The latter is wound directly on the core itself and consists of but a few hundreds turns of heavier wire. One end of the secondary winding is grounded to the frame of the engine;

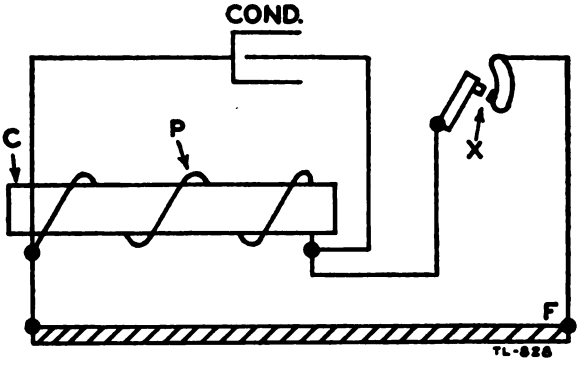

FIGURE 10.—Circuit diagram of the magneto

the other terminates on a brass contact shoe against which a carbon brush continually bears. A high-tension cable carries the current from the carbon brush to the spark plug.

h. In Figure 11 one form of breaker and housing is shown. The contacts should have a maximum separation of 0.02 inch. The magneto screw driver provided with the set has riveted to its handle a small brass gauge of the proper thickness. This gauge should be used in adjusting the contacts and should just pass between them when they are farthest apart.

23. Adjustment and timing of ignition.—*a.* Should any adjustment of the contacts X (see fig. 11) become necessary, first loosen the lock nut A, then turn the platinum pointed contact screw B either in or out until the proper setting has been obtained and tighten up the lock nut A.

b. If a new contact screw is to be inserted, or if the old one is removed for any reason, be sure that the screw threads and threaded seat are cleaned to insure good electrical contact when the parts are assembled.

c. To time the magneto to the engine, turn the engine slowly in the direction it should run until the piston is just at the top of its stroke and ready to come

down on the power stroke. Set the advance and retard lever on the magneto to "full retard." Turn the magneto shaft in the direction it will normally run until the contact points are about to separate. Fasten the magneto drive coupling to the shaft which extends to it from the timing gear housing and which drives the magneto.

24. Assembly and operation of carburetion system.—*a.* The carburetion system on the gasoline engine consists of a carburetor, a governor-controlled intake throttle, and an intake manifold connected to the single cylinder of the engine as shown in Figure 12.

(1) The fuel line conducts the gasoline from the fuel tank to the float chamber of the carburetor, the gasoline flowing by gravity.

(2) The inlet needle mounted on the float regulates the flow of gasoline into the float chamber of the carburetor.

(3) The gasoline is then drawn by suction from the float chamber, through the spray nozzle into the mixing chamber.

(4) The high-speed and idle adjustment screws regulate the flow of gasoline from the float chamber to the mixing chamber.

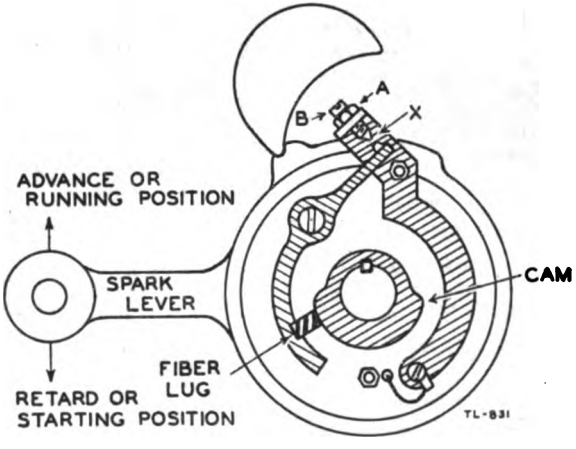

FIGURE 11.—Timer assembly

(5) The mixing chamber converts the gasoline and air into gasoline vapor.

b. The intake stroke of the engine piston causes a suction to take place in the tube formed by the intake manifold, the throttle tube, and the tube of the mixing chamber. This suction raises the gravity air-valve sleeve and draws the gasoline vapor from the mixing chamber, through the gravity air-valve sleeve, past the intake throttle, into the intake manifold, thence to the combustion chamber of the engine, where it is compressed and exploded. The intake throttle regulates the amount of gasoline vapor drawn into the combustion chamber of the engine. The intake throttle is operated by a governor.

c. The throttle governor is of the centrifugal type, driven by a revolving shaft connected to the timing gears. As the engine is accelerated the governor revolves faster causing the weights A′ and A″ to fly out, and the levers at X then operate the sliding shaft T connected to the intake throttle. This movement of the shaft T partially closes the intake throttle and reduces the amount

of gasoline vapor passing to the combustion chamber of the engine. Any decrease in the speed of the engine will cause the weights A′ and A″ to resume their normal position. The levers at X will then move the shaft T, opening the intake throttle and thus allowing a greater volume of gasoline vapor to be drawn into the combustion chamber of the engine.

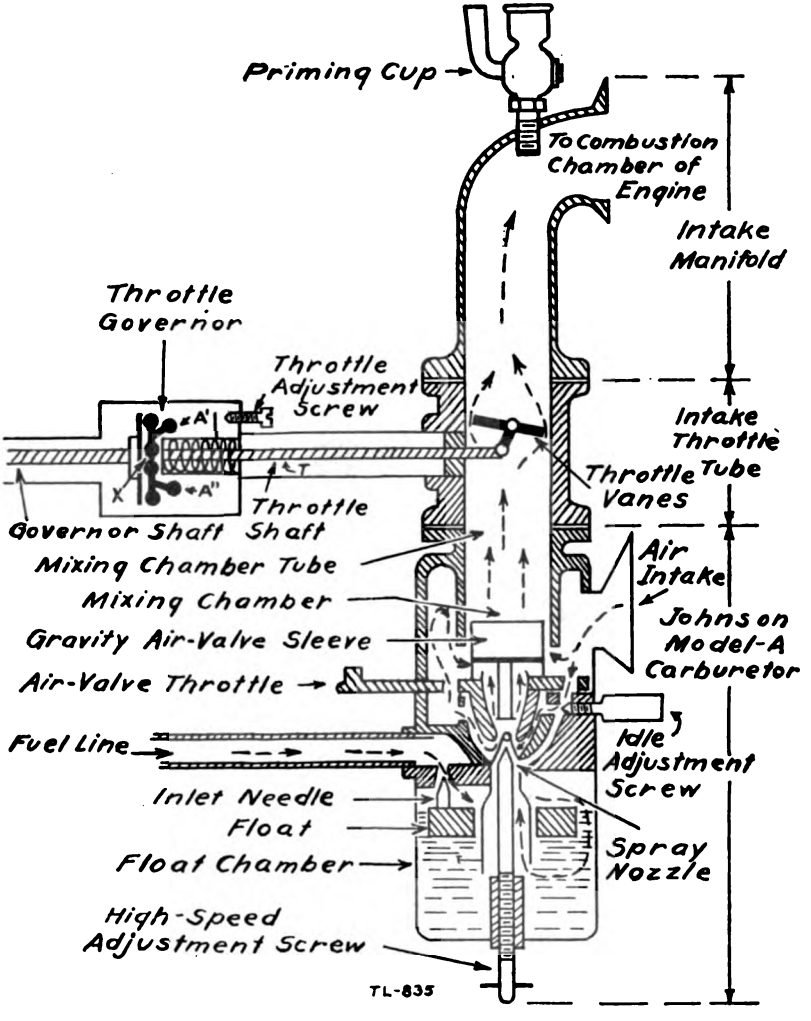

FIGURE 12.—Assembly of the gasoline-engine carburetion system

d. When charging storage batteries with the type SCR–82 charging set, the engine speed must remain constant; this requirement is taken care of by the governor-controlled throttle.

25. Adjustments of carburetion system.—The carburetion system is adjusted as follows:

a. Turn both the idle adjustment screw and high-speed adjustment screw to their seats and by means of the throttle adjustment screw set the throttle approximately to the correct position for open throttle.

b. Open the high-speed adjustment screw one and one-half turns. This will permit the engine to be started. Warm up the engine by running it a few minutes.

c. Place the spark lever in full retard position and open the air-valve throttle until the engine turns at a fairly high rate of speed.

d. Turn the high-speed adjustment screw to the right until the engine speed decreases.

e. Then turn the high-speed adjustment screw to the left until the engine speed increases and then decreases due to too rich a mixture.

f. Again turn the high-speed adjustment screw to the right to a point midway between the extremes indicated in *d* and *e* above. This position should then give a correct mixture for all throttle positions.

g. Adjust the throttle adjustment screw to the desired idling position.

h. If uneven firing occurs, correct it by either turning the idle adjustment screw to enrich the mixture or by screwing it up to give a leaner mixture. The average setting is one-half turn away from the seat. This adjustment is to be made with the spark and throttle levers fully retarded.

i. The float should be set evenly all around, the bottom being ⅞ inch from the float chamber seat.

26. Operation of the generator.—The generator is of the shunt-wound, self-exciting type. The revolving armature cuts the lines of force set up by the field, thereby inducing current in the windings of the armature. When the set is first started there is sufficient residual magnetism in the cores of the field to start the induction of current in the windings of the armature. It is possible that when starting the set the field may be magnetized in the wrong direction, which may be due to throwing the switch on the panel connecting the batteries to the generator while the generator is idle or by the generator being stopped before the switch which disconnects the batteries has been opened. If the field is reversed the set will not generate. This condition can be corrected by reexciting the field in the reverse direction. To do this let current from an external source flow through the field in the same direction to that furnished by the charging current using approximately 4 volts for 30 seconds. The generator, of course, remains stationary while this operation is being performed.

27. Disassembly and assembly of gasoline engine and generator.—When tearing down the gasoline engine and generator for a complete overhaul the following procedure should be followed in the order stated. In case of partial overhaul follow this process only as far as is necessary to expose the parts that need attention.

a. Disassembly:

(1) Remove the blower housing.

(2) Remove the rocker arm housing.

(3) Remove the carburetor, being very careful not to strip the thread.

(4) Remove the gas line and tank.

(5) Remove the cranking pin in the end of the crank shaft as well as the nut and washer, then remove the blower with a gear puller.

(6) Remove the governor assembly intact from the timing gear to the carburetor.

(7) Remove the timing gear housing.
(8) Mark the timing gear with a center punch before removing.
(9) Pull the cam shaft gear with a gear puller.
(10) Remove the spark plug.
(11) Remove the rocker arm.
(12) Check the stroke through the spark plug port.
(13) Remove the cylinder head, remove the valves, grind the valves, and note the type of valve used.
(14) Check the stroke and diameter of the piston; write all these dimensions down for reference.
(15) Check the bore.
(16) Remove the rings, using three shims; check the kind of ring material and sizes of the rings.
(17) Drain the oil by removing the drain plug at the bottom and in front of the crank case.
(18) Remove the plate on the side of the crank case held in place by ten studs.
(19) Remove the connecting rod bearing, taking out the connecting rod and piston intact.
(20) Remove the oil line.
(21) Take out all the studs around the crank case and the generator housing.
(22) Remove the plate nut and the washer on the end of the generator housing.
(23) Remove the one plate holding brushes on the front of the armature.
(24) Remove the generator housing with a gear puller.
(25) Slip the generator housing off, being careful not to scrape or damage the armature.
(26) Remove the oil pump shaft.
(27) Remove the armature and upper part of crank case together; do not remove the cam shaft.
(28) Do not let the armature rest on a concrete floor.
(29) Remove the main bearing.
(30) Note the oiling system.
(31) Remove the oil pump in the bottom of the motor base.
(32) Note the shims.

b. Assembly of motor:

(1) Set up the main bearings one at a time.
(2) Assemble the motor in the reverse order from tearing it down, being careful not to strip the threads on any of the bolts, and more especially the two studs on the carburetor, as they are easily damaged.
(3) After the motor has been assembled continue as explained in paragraph 12 *a*.
(4) Stop the engine as explained in paragraph 12 *b*.
(5) Check the high-voltage side, field, and low-voltage side.
(6) Check these connections with those on the two panels being studied.

c. List of tools required for assembly or disassembly of motor:

One 7/8-inch socket wrench, for removing housing on blower.
One 3/4-inch socket wrench, for main bearings.
One 1/16-inch socket wrench, for wrist pin stud.

One $\frac{1}{8}$-inch adjustable wrench.
One 19868 spark plug wrench.
One 99141 equipment wrench.
One 99142 equipment wrench.
One 99143 equipment wrench.
One 99144 equipment wrench.
One 99139 adjustable pliers.
One 99140 screw driver, 3-inch.
One 99133 crank shaft nut wrench.
One 99135 Dixie magneto wrench and gauge.
One hammer, 2-pound.
One center punch.
One steel punch, 8-inch.
One pliers, 8-inch.
One cold chisel, 6-inch.
One 14-inch monkey wrench.
One 12-inch screw driver.
One 2-inch rule.

SECTION VI

CARE, MAINTENANCE, AND REPAIR

28. Maintenance in service.—*a.* The muffler of the gasoline engine should be removed once a month and thoroughly cleaned with gasoline or kerosene.

b. The push rod and rocker arm should be oiled once during every four hours of running.

c. Before replacing an open circuit breaker, the cause of the trouble should be located and remedied.

d. All nuts on the engine, generator, and power panel should be tightened after every shipment or after every 24 hours of operation.

e. The engine compression should be tested at least once a month.

f. The timer contacts should be cleaned at least once a week if the set is in use.

g. The oil should be drained from the crank case once each month or after 24 hours of operation.

h. Every month or after 24 hours of operation the generator commutator should be cleaned. Never put lubricating oil on the commutator, but clean it with a soft cloth. The commutator when operating properly should be a dark bronze color. If it is of a bright copper color it indicates that the brushes are cutting and that they should be readjusted or replaced.

i. Remove the spark plug after every 50 hours of operation and clean and adjust the points.

29. Lack of compression, causes and repair.—Turn the flywheel over by hand. If the engine has good compression the flywheel will turn over hard during a portion of each alternate revolution. A lack of compression is evidenced by the ease with which the flywheel turns and may be caused by one of the following defects:

a. The spark plug not being screwed in tightly, or a damaged porcelain on the spark plug, which causes it to leak.

b. One of the valves sticking in the head of the engine. In this event the valves should be thoroughly cleaned with kerosene. Test the valves by tapping the rocker arms with a hammer two or three times so that if any particles have lodged on the valve seats they will be jolted down into the cylinder head.

c. A leak between the cylinder head and the cylinder. To detect such a leak, squirt a small amount of lubricating oil into the air mixer. If there is a leak between the cylinder head and the cylinder, smoke will come out through the flywheel when the engine is running. Should this occur the cylinder head should be removed and the necessary repairs or adjustments made.

d. Valves not seating properly. To overcome this, the valves should be cleaned and any carbon on the top of them removed with a screw driver or scraper. The valve seats should be thoroughly cleaned with kerosene and the valves then ground in. To do this, put a small amount of grinding compound on the valve seat and place the valve in position. Insert a screw driver into the slot on the head of the valve. Rotate the screw driver back and forth until the valve and valve seat have become smooth and fit together perfectly. This is the process used in grinding automobile valves.

e. Valves not being properly adjusted. Adjust the length of each push rod by means of the adjusting nut and screw. The push rods should be adjusted so that the distance between the rocker arms and the valve stems is equal to the thickness of an ordinary piece of newspaper when the engine is cold.

f. Leaky or broken piston rings. In case the foregoing tests have been made and it is still found that there is a lack of compression, remove the cylinder head and examine the piston and piston rings.

30. Failure of fuel supply, causes and repair.—If the engine has good compression but fails to operate the next test to be made is that of the fuel or gasoline supply to the cylinder. In order to do this, proceed as follows:

a. Prime the engine by means of the priming can filled with gasoline. If the engine runs only when fuel is supplied in this manner it indicates that the proper amount of fuel is not passing through the nozzle in the mixing valve. Remove the nozzle cleaner plug and insert the probing wire into the nozzle. See if the pump is working. Push handle up and down until fuel flows out of the overflow pipe.

b. If, after working the pump by hand, fuel does not flow back through the overflow pipe, make sure that all connections to the fuel pipe are airtight. The pump should be primed when first placed in operation; this may be done by lifting the plunger until small holes appear; then prime it with enough gasoline to fill up the holes. See that the fuel line cleaner plug is clean and screwed in tight.

c. If the pump does not then work, take out the plunger and examine the check valve at the bottom of the plunger. Take out the two brass screws and clean the small brass ball. The pump should work when these parts are properly replaced, provided none are broken.

31. Ignition failure, causes and repair.—If after the above tests have been made the engine still refuses to operate, the ignition should be tested as follows:

a. See that the small ignition switch is closed.

b. Remove the high-tension lead from the end of the spark plug, and hold it about ⅛ inch from the end of the spark plug; then crank the engine.

c. If a spark jumps from the high-tension lead to the spark plug, it indicates that the ignition is all right up to the spark plug. The plug should then be removed, cleaned, and the points adjusted.

d. If a spark does not jump from the high-tension lead to the plug it indicates that there is something wrong further back in the ignition system, which will necessitate a check of the entire ignition wiring and parts.

32. Method of timing valves and magneto.—*a.* Set the cam shaft in a correct position to operate the valves.

b. Shift the gears of the cam shaft until the intake valve opens on the flywheel mark, with $\frac{1}{32}$-inch clearance between the top of the valve and the adjusting screw.

c. After setting the cam shaft as above, readjust the clearance on the intake and exhaust valves with $\frac{1}{64}$ (0.012) inch clearance between the top of the valve and the adjusting screw.

d. Time the magneto so that when the spark is fully advanced the breaker points just separate when the magneto mark on the flywheel is controlled with the spring on the top of the flywheel housing.

SECTION VII

LIST OF SPARE PARTS AND TOOLS

33. Spare parts and tools.—The following spare parts and tools are issued with the type SCR–82 and are contained in a drawer mounted under the generator and between the skids:

One No. 11169 valve spring.
One No. 99114 valve lifter.
One No. 20422 adjusting screw.
One No. 23786 spark plug.
One No. 19868 spark plug wrench.
One No. 99088 carburetor elbow flange gasket.
One No. 99141 equipment wrench.
One No. 99142 equipment wrench.
One No. 99143 equipment wrench.
One No. 99144 equipment wrench.
One No. 99139 combination pliers.
One No. 99140 screwdriver, 3-inch.
One No. 99133 crank-shaft nut wrench.
One No. 99134 crank-shaft nut wrench handle.
One No. 99145 squirt can for oil.
One No. 99146 squirt can for gasoline.
One No. 99137 governor spring.
One No. 99135 Dixie magneto wrench.
One No. 99136 Dixie No. 2724–A carbon brush with spring.
One No. 99147 rear-bearing cap felt packing.
One Dixie magneto instruction book.

One Johnson carburetor instruction book.
One lock for spare parts container with two keys.

NOTE.—The numbers refer to H. H. Franklin Mfg. Co. drawing numbers, copies of which are on file in the office of the Chief Signal Officer.

[A. G. 062.12 (8–1–29).]

BY ORDER OF THE SECRETARY OF WAR:

C. P. SUMMERALL,
General,
Chief of Staff.

OFFICIAL:
C. H. BRIDGES,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1930

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TECHNICAL REGULATIONS
No. 1215–6

WAR DEPARTMENT,
WASHINGTON, *July 14, 1932.*

SIGNAL CORPS

CHARGING SET, TYPE SCR–169

Prepared under direction of the
Chief Signal Officer

SECTION I

GENERAL USE AND DESCRIPTION

1. **Uses.**—The charging set, type SCR–169, is intended primarily to provide a portable means for charging storage batteries where an internal-combustion engine-driven generator with a direct-current power output of not more than 600 watts at 32 volts is required. The set may be readily transported by truck or wagon and may be used in any location where sufficient space to set it up is available.

2. **General description.**—Each charging set, type SCR–169, consists of one power unit, type PE–43, one panel, type BD–61, and one cord, type CD–107. The power unit and the panel are manufactured under the general nomenclature of power unit, type PE–( )–43, and panel, type BD–( )–61, in accordance with so-called "performance specifications" which allow the various manufacturers to furnish equipment of their own design provided certain requirements as to performance are satisfied. The parentheses in the nomenclature are replaced on name plates, etc., by code letters identifying the particular design furnished on any order; for example, "PE–XZ–43." These letters differentiate each design supplied under the specifications from the various other models produced. At the time of printing only the following parts for the type SCR–169 have been procured: Power units, type PE–HA–43, and panels, type BD–LL–61. In the field when not in use the cord, type CD–107, is normally carried in the panel, type BD–61; this allows the set to be carried in two parts.

a. One part is the power unit which consists of a wooden packing crate containing the engine-generator unit and a box for carrying the tools and spare

parts, both of which are attached to a common base which also forms the bottom of the packing crate. While the dimensions of the power units procured on future orders will possibly vary from those of the power unit, type PE–HA–43, its measurements are 17¾ inches wide, 25¼ inches long, and 25⅛ inches high. It weighs 169 pounds and when set up for operation, without the crate, is 21 inches high.

b. The second part is the panel, which consists of a sheet steel cabinet in which is permanently mounted an insulating panel board, with its electrical measuring instruments, rheostats, switches, and terminals. The dimensions of the panels procured in the future also will in all probability vary from those of the panel, type BD–LL–61, which measures 25⅛ inches wide, 25½ inches long, and 17¾ inches deep, and weighs approximately 100 pounds.

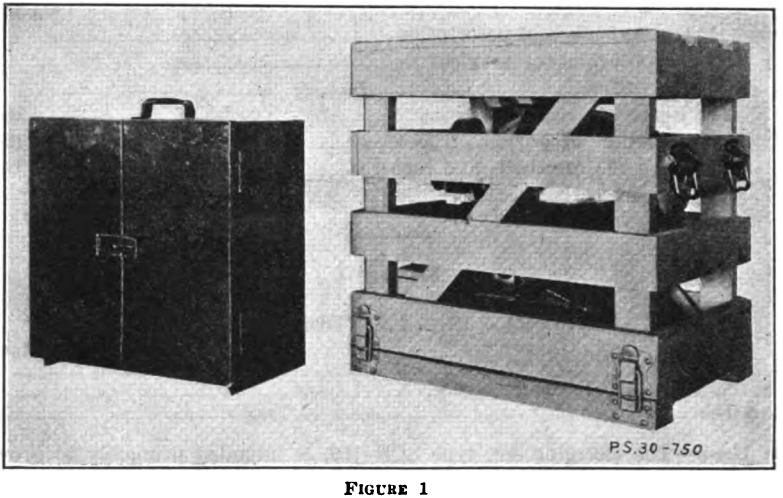


FIGURE 1

3. Illustrations.—*a.* Figure 1 shows the separate parts ready for transportation. Figure 2 shows all parts set up and ready for operation. Figure 3 ① is a sectional view of the power unit, type PE–HA–43, showing construction of the engine and generator. Some of the sets differ slightly from this figure in that a muffler is provided for the exhaust and the filler spout and magneto details are different. Figure 3 ② is a front view of the power unit, type BD HA–43, and shows the details of the voltage regulator. Some of the sets differ slightly from this figure in regard to the magneto, the carburetor adjustment, the outlet, and the fuel pipe flange details. Figure 4 is a front view and Figure 5 is a rear view of the panel, type BD–LL–61. Figure 6 is a schematic diagram of the electrical connections of this panel. Figure 7 shows the engine construction of this power unit and the firing, exhaust, and intake positions of the piston. Figure 8 illustrates the proper method of using the carbon scraper.

b. The numbers which appear in Figure 3 are manufacturer's numbers which should be used in obtaining replacement parts.

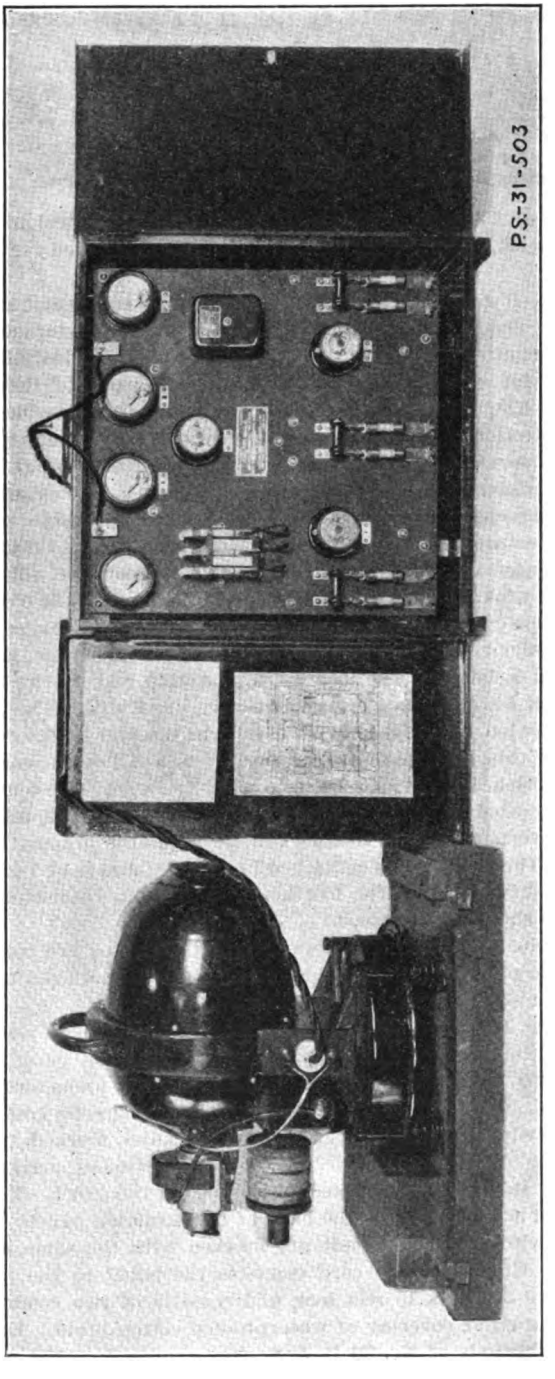


FIGURE 2

SECTION II

INSTALLATION FOR SERVICE

4. General—*a. Transportation.*—Due to the bulk and weight of the parts comprising this set, suitable transportation must be provided for the movement of the set.

b. Personnel.—Two men are required to unload the equipment and to set it up for operation. These men, in addition to being qualified storage battery men, should be especially trained in the care, maintenance, installation, testing, and inspecting for serviceability of the component parts of the set.

c. Location.—The location of the set should be one that provides a reasonable amount of protection against the elements, is centrally situated with respect to the territory served by the set, and is at least 50 feet from any radio set.

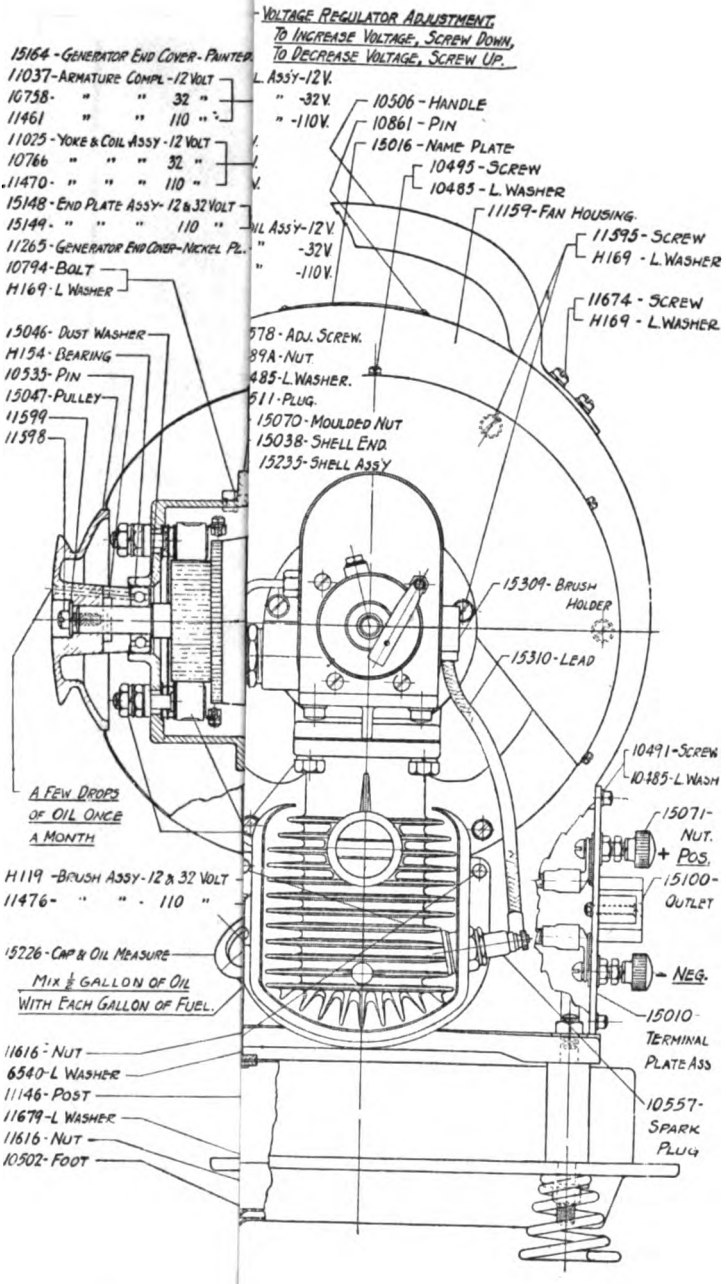
5. Detailed description of the set as issued—*a. Power unit, type PE–HA–43.*—(1) The engine-generator unit is of commercial design, manufacturer's type D, manufactured by the Homelite Corporation, Port Chester, N. Y. It consists of an internal-combustion gasoline engine, generator, voltage regulator, and fuel supply tank, built as a single unit and inclosed in one case.

(2) The single-cylinder 2-cycle engine is inverted, air-cooled, and of the removable cylinder type. The engine develops 1½ horsepower, has a stroke of 2⅛ inches, and a bore of 2⅛ inches. The engine end of the main shaft is mounted on ball bearings and is automatically lubricated. The generator end should be lubricated every 50 hours. A hole in the end of the starting pulley is provided for this purpose. The carburetor is a Tillotson, commercial type MS–52–A. Ignition is provided by means of a Bosch high-tension magneto. The spark plug used is 18 millimeters in diameter with 1½-millimeter pitch thread. No governor is used, as the voltage regulator automatically controls the fuel feed. The fuel tank is contained in the base and is of 1-gallon capacity. This provides sufficient fuel for five hours' operation. Constructional details of the unit are shown in Figure 3.

(3) The 6-pole, shunt-wound generator and the engine are contained in the same case. The generator armature is mounted on the main shaft of the engine. The entire main shaft runs in ball bearings.

b. Panel, type BD–LL–61.—The insulated panel board is made of ½-inch asbestos wood and is permanently fastened to the steel case. A voltmeter, type IF–47, 0–50 volts, d. c. (direct current); three ammeters, type IF–16, 0–10 amperes, d. c., marked "1," "2," and "3"; a magnetic contactor switch; an automatic switch; three rheostat control handles marked "1," "2," and "3"; and three fused, double-pole, single-throw switches marked "BAT 1," "BAT 2," and "BAT 3" are mounted on the face of the panel. Three rheostats of 11 ohms each are mounted on the back of the insulated panel. The ammeter rheostat and switch in each circuit are marked with the same number.

c. Cord, type CD–107.—This cord connects the panel to the power unit as shown in Figure 2. It is 15 feet long and consists of two conductors twisted together with an outer covering of waterproofed cotton braid. Each conductor consists of 104 strands of No. 30 B. & S. gage annealed copper wire, insulated



OF HOMELITE
SHOW FUEL PIPES.

CHARGING SET, TYPE SCR-169

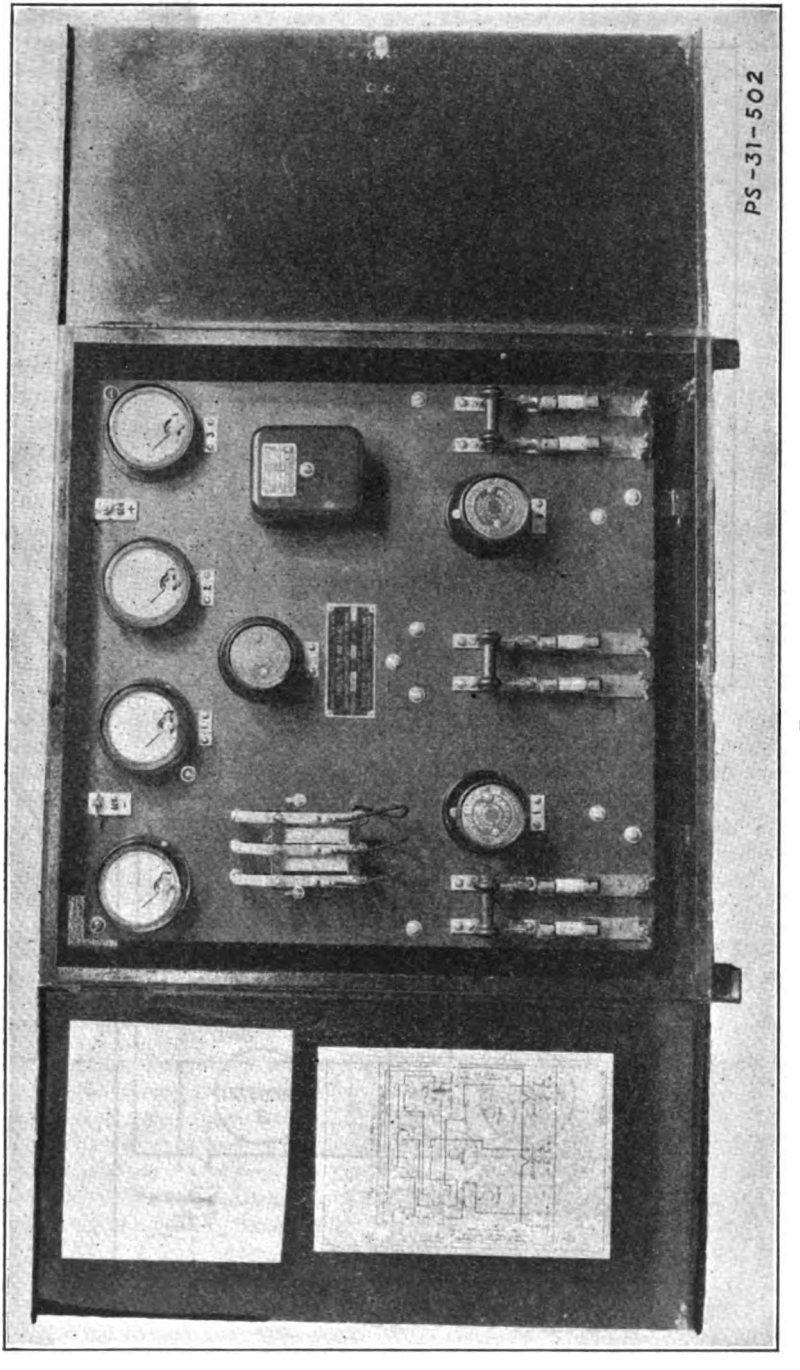


FIGURE 4

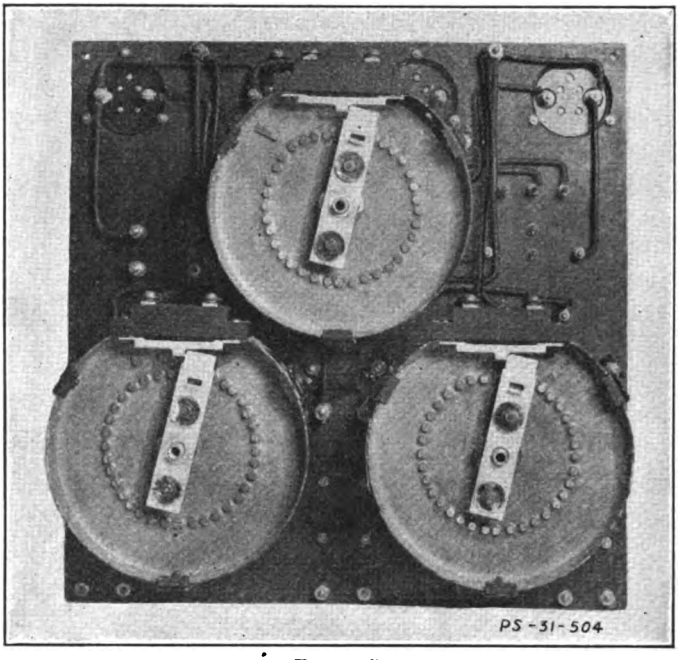


FIGURE 5

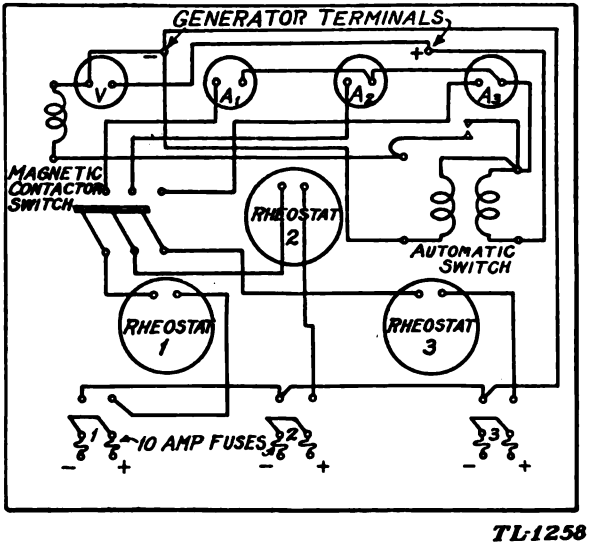


FIGURE 6

with new code rubber and covered with a close cotton braid. One end of the cord is equipped with two hook-type terminals marked + and —, respectively. The other end of the cord is equipped with a 15-ampere polarized plug.

6. Preparing the set for service.—Reference should be made to Figures 1 and 2 in connection with these instructions. Place the power unit in a level position where there is a good circulation of air. Unfasten the four trunk bolts located at the bottom corners of the packing crate and remove the top part of the crate. Place the panel in the desired position. Using the cord, type CD–107, connect the + and — hook-type terminals to the respective binding posts marked "GEN +" and "GEN —" located at the top of the insulated panel board. Insert the plug of the cord in the outlet provided in the power unit case just to the right of the spark plug.

7. Tests and inspections for serviceability and precautions to be observed.—*a.* Before placing the set in operation see that the—

(1) Power unit is level and firmly seated and that the panel is upright and level.

(2) Power unit is to operate in an area with good air circulation to prevent danger to personnel.

(3) Electrical connections are made with proper polarity, and that all wires are protected from each other and are so placed that personnel can not injure themselves by accidental contact.

(4) Fuel tank is filled, and that lubricating oil is mixed with the gasoline as is specified in paragraph 8.

b. Remove any section of pipe or hose that may be attached to the muffler exhaust. If this is not done, the output will be reduced.

c. Do not fill the fuel tank above the bottom of the filler spout.

d. Do not permit fuel to run too low in the tank; fill after 3½ hours of operation to obviate the necessity of readjusting the carburetor.

e. See that the carburetor adjustment is opened one full turn when starting in cold weather.

f. Readjust the carburetor whenever the charging rate is changed.

g. Always run the generator for five minutes before connecting it to the load.

SECTION III

OPERATION

8. Starting and stopping the engine.—The operation of the engine is, in general, the same as that of any gasoline engine.

a. To start the engine, proceed as follows:

(1) Fill the fuel tank with gasoline and oil. Use one-half pint of Texaco Urso extra heavy motor oil or equivalent mixed with each gallon of gasoline. (See par. 15 *a* (1).) Always mix the gasoline and oil before filling the tank.

(2) Pull the choke plunger out. (See fig. 3.)

(3) Insert a few drops of gasoline through the screened opening in the choke body.

(4) Push the choke plunger in.

(5) Wind the starting rope clockwise on the flanged starting pulley and start the engine by sharply pulling on the rope.

(6) Pull the choke plunger out when the motor starts.

(7) Adjust the carburetor adjustment underneath the carburetor until the engine runs smoothly at normal operating temperature under load.

b. To stop the engine, press the button on the front end of the magneto, shown in Figure 3, until the engine stops.

9. Charging the batteries.—After the power unit and panel are connected by the cord, as described in paragraph 7, proceed as follows:

a. Open the switches marked "BAT 1," "BAT 2," and "BAT 3."

b. Inspect all batteries in each bank to see that they are properly connected to each other.

c. Connect the positive and negative leads from each bank of batteries to the respective + and — binding posts on the switch or switches selected. (See fig. 6.)

d. Start the power unit.

e. Turn all rheostat handles completely to the right.

f. Close the battery switches in use.

g. Note the voltmeter and ammeter readings.

h. Increase or decrease the charging current or currents to the proper rate by adjusting the rheostat or rheostats in series with the ammeters in use. Do not charge batteries at a rate exceeding 7½ amperes.

i. Never charge more than six nor less than two batteries, type BB–29, or their equivalent on any one charging circuit.

SECTION IV

REMOVAL FROM SERVICE

10. Repacking for transportation in the field.—To repack the set for transportation after it has been in operation in the field, proceed as follows: Remove the leads from the banks of batteries; remove the connecting cord from the power unit and neatly roll it to fit inside the panel case; close the panel case; place the top of the packing crate over the power unit and fasten it by means of the four trunk bolts.

11. Preparation for storage.—Before placing the charging set in storage, check all parts for serviceability and repair or replace parts if necessary. Cover all metal tools and spare parts with cosmoline and cover all unpainted metal parts of the power unit with a light oil. Drain all gasoline and oil from the power unit. Take care that no oil gets on the electrical wiring. Check with the parts list given in paragraph 17 to see that no parts of the set are missing or are in excess.

SECTION V

FUNCTION OF PARTS

12. Power unit, type PE–HA–43—*a. Speed regulation.*—The automatic electric voltage regulator operates to control the fuel feed so as to maintain an engine speed between 1,500 and 1,600 revolutions per minute.

b. Voltage regulation.—The voltage regulator is designed to maintain the output voltage of the generator between 32 and 40 volts under load. It is adjusted at the factory to maintain 32 volts under full load when the armature is turning between 1,500 and 1,600 revolutions per minute.

13. Panel, type BD–LL–61.—*a.* The function of the panel is to control and indicate the rate of charge to storage batteries; its circuit diagram is shown in Figure 6. Provision is made for charging 1, 2, or 3 banks of batteries separately or simultaneously. An individual rheostat and an ammeter are provided for each of the three charging circuits.

b. A magnetic contactor switch having three separately insulated and independent poles actuated by a single magnet is controlled by the automatic switch.

c. The automatic switch controls the energizing circuit of the magnetic contactor switch in the following manner: The former closes the latter when the generator voltage reaches 40 volts; and opens it when the generator voltage falls below 32 volts, when the generator voltage fails, or when the current is reversed and flows from the batteries into the generator.

SECTION VI

CARE, MAINTENANCE, AND REPAIR

14. Care of the set.—All parts of the set should be carefully handled. When installed, and at regular intervals thereafter, it should be cleaned in order to be kept free from dirt and foreign substances. A daily inspection of all parts of the set should be made as a matter of routine in order to insure its best operating condition. This inspection should include an examination for worn, broken, or corroded connections or parts; dirty panel; grease and oil on engine or generator of the power unit.

15. Maintenance and repair of the power unit, type PE–HA–43.—The inspection outlined in paragraph 7 and the correction of any defects noted are generally all the maintenance required. However, the following notes on the servicing of the power unit should be carefully followed in the maintenance of the unit.

a. Engine.—(1) *Lubrication.*—Only the oils issued for the purpose should be used in lubricating the engine. One-half pint of extra heavy motor oil should be mixed with each gallon of gasoline used as fuel. This provides automatic lubrication to all engine parts. Suitable oil for use is United States Army Specification No. 2–26, class D, grade tractor heavy; viscosity at 210° F., 90 to 100 (Navy grade, aviation summer, Navy symbol 3,100). This is equivalent to Texaco Urso extra heavy.

(2) *Removing carbon.*—To remove carbon from the engine remove the muffler and spark plug. Using the tool provided with the unit, carefully scrape the carbon deposits from the piston head, cylinder head, exhaust port, and spark-plug vent. The scraper should not come in contact with the cylinder wall. The cylinder should not be removed. (See fig. 8.)

(3) *Care of the magneto.*—Examine the contact breaker points at least once every 100 hours of operation, and clean and dress them if necessary. Use No. 00 grade sandpaper for dressing the points. Do not use emery cloth.

(4) *Carburetor adjustment.*—The carburetor is properly attached and adjusted to the engine before leaving the factory. Readjustment is necessary to compensate for climatic changes and for changes in the load. If, when attempting to start the engine for the first time, it does not run perfectly, first check the ignition. If the ignition circuits and adjustments are correct, proceed as follows:

(*a*) *Starting.*—Push the choke plunger in as far as possible after inserting a few drops of gasoline into the choke body. (See fig. 3.) Then turn the carburetor adjustment at the botton of the carburetor in a clockwise direction until it is tight, and then turn it back in a counterclockwise direction one turn. If the engine still fails to start, vary the carburetor adjustment by quarter turns until a point is found where the engine will operate.

(*b*) *Adjustment for operation.*—After the engine has been run under load for a sufficient length of time to have developed normal operating temperature, adjust the carburetor until the engine runs smoothly.

b. Generator.—(1) *Lubrication.*—After every 50 hours of operation place a few drops of medium engine oil in the oil hole in the starting pulley. The generator ball bearings at the engine end of the shaft are automatically lubricated if fuel directions are followed.

(2) *Cleaning.*—Clean the carbon dust from the commutators and brush holders after every 100 hours of operation. Polish the commutator sufficiently often to keep it bright and clean, using telephone switchboard plug polish or a cloth dampened with gasoline. Do not use sandpaper or emery cloth on the commutator.

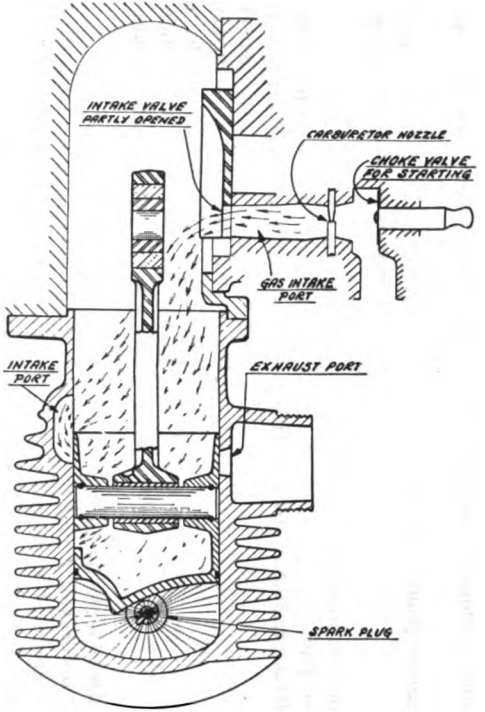
(3) *Brushes.*—Replace immediately any broken or worn-out brushes. Keep an extra set of brushes available at all times. Replace brushes as follows: Remove the generator cover; loosen the nuts between the starting pulley and the housing; turn the bakelite insulating disk and the brush ring and remove the brushes; install new brushes; align the white lines on the housing, the bakelite insulation disk, and the brush ring; tighten the nuts and replace the generator cover. Improper alignment of the white lines will cause excessive arcking and loss of power.

c. Voltage regulator.—The voltage regulator is of commercial design. The adjustment screw is located on top of the regulator. Turning the screw in a clockwise direction increases the voltage. Turning the screw in a counterclockwise direction decreases the voltage. Tighten the lock nut after adjustment.

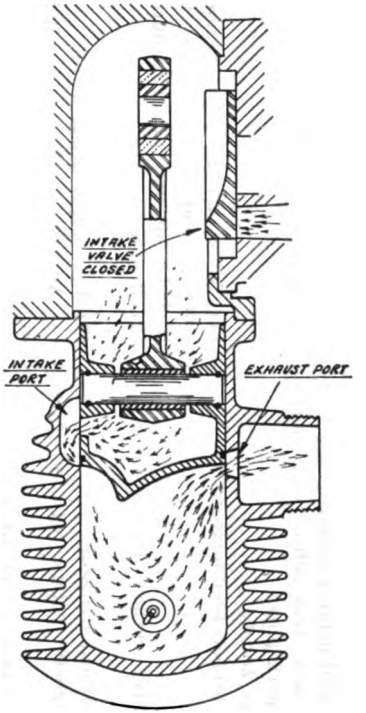
16. Troubles and their remedies.—Following are listed the most common troubles that may develop in the power unit, type PE–HA–43, and their remedies:

a. Motor will not start.

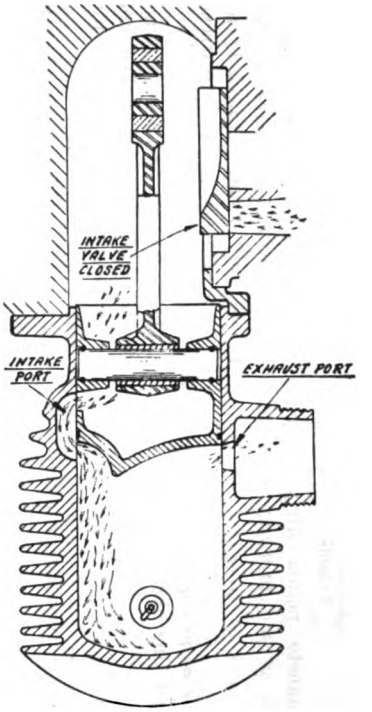
Trouble	Remedy
(1) Fuel supply exhausted.	(1) Fill fuel tank with proper fuel mixture.
(2) Fuel line to carburetor clogged.	(2) Clean out fuel line.
(3) Cylinder flooded by too much priming.	(3) Pull choke plunger out, turn motor over a few times, and let stand a few minutes before starting.
(4) Carburetor not properly adjusted.	(4) Adjust the carburetor.



P.S. 31-169 FIRING POSITION SHOWING FLOW OF GAS FROM INTAKE VALVE



EXHAUST POSITION SHOWING FLOW OF GAS THROUGH EXHAUST PORT



INTAKE POSITION SHOWING FLOW OF GAS THROUGH INTAKE PORT

TL-1027

FIGURE 7

Trouble	Remedy
(5) Magneto points dirty, pitted, worn out, or not properly adjusted.	(5) Clean points, replace or adjust points to 0.012-inch clearance with the points fully opened. Check by means of gage attached to magneto wrench.
b. Motor stops continually after starting.	
(1) Fuel line clogged.	(1) Clean out fuel line by blowing in fuel tank; if blowing does not remove obstruction, remove fuel line at carburetor and clean.
(2) Voltage regulator stuck.	(2) Tap outside of case lightly or remove plunger and clean.
c. Motor stops suddenly.	
(1) Fuel supply exhausted or fuel line clogged.	(1) Fill tank or blow out fuel line.
(2) Loose, broken, or fouled spark plug.	(2) Tighten, clean, or replace plug.
(3) Fouled magneto points.	(3) Clean or replace points.
(4) Broken lead wire from magneto to spark plug.	(4) Replace lead wire.
d. Motor knocks.	
(1) Improper fuel mixture.	(1) Allow motor to reach normal operating temperature under load, pull choke out, and adjust carburetor.
(2) Heavy carbon deposit in cylinder.	(2) Remove carbon.
(3) Overheated motor.	(3) Use proper grade of oil.
(4) Magneto points set too far apart.	(4) Adjust points to 0.012-inch clearance as indicated in *a* (5) above.
e. Motor shows lack of power.	
(1) Overheated motor due to carbon.	(1) Remove carbon.
(2) Faulty carburetor adjustment.	(2) Adjust carburetor for smooth operation.
(3) Magneto points too close.	(3) Adjust contact points to 0.012-inch clearance as indicated in *a* (5) above.
(4) Poor compression.	(4) Replace piston ring.
(5) Poor fuel.	(5) Replace with suitable fuel.
(6) Voltage regulator inoperative.	(6) Check leads that connect regulator to the output of the generator. If the regulator becomes unserviceable, remove it and its leads, plug the hole in the top of the carburetor with a cork, and continue to use the set.
(7) Muffler clogged by carbon.	(7) Clean muffler.
f. Motor overheats.	
(1) Poor grade of oil used.	(1) Use only specified oil.
(2) Insufficient oil.	(2) Add oil to fuel supply.
(3) Excess of oil.	(3) Reduce oil.

Trouble	Remedy
(4) Excessive carbon deposit.	(4) Remove carbon.
(5) Magneto points not properly adjusted.	(5) Adjust points to 0.012-inch clearance as indicated in *a* (5) above.
(6) Carburetor not properly adjusted.	(6) Allow motor to reach normal operating temperature, open choke, and adjust carburetor.
g. Motor misfires.	
(1) Carburetor out of adjustment.	(1) Adjust carburetor.
(2) Magneto points not properly adjusted.	(2) Adjust points to 0.012-inch clearance as indicated in *a* (5) above.
(3) Dirty or damaged spark plug.	(3) Clean or replace spark plug.

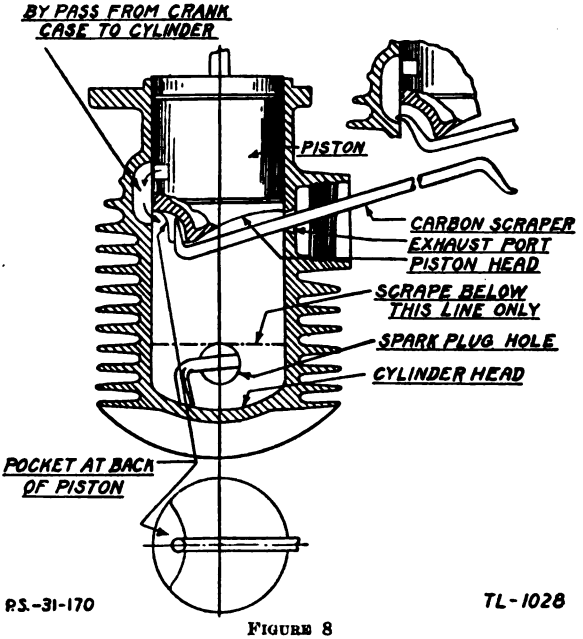


FIGURE 8

h. Motor hard to start.	
(1) Carburetor not properly adjusted.	(1) Adjust carburetor.
(2) Too much priming.	(2) Pull choke out, turn motor over, and allow to stand a few minutes before trying to start motor.
(3) Spark plug dirty or improperly set.	(3) Clean and set points at 0.025-inch gap. Check by means of gage attached to magneto wrench.
(4) Magneto points pitted, dirty, or improperly set.	(4) Clean and adjust points to 0.012-inch clearance as indicated in *a* (5) above.

i. Generator gives no voltage.

Trouble	Remedy
(1) Open windings.	(1) Do not attempt to make repairs in the using organization.
(2) Broken brush leads or poor brush contact.	(2) Examine, repair, or replace broken connections, or replace brushes as indicated in paragraph 15 *b* (3).
j. Generator voltage too high.	
Engine speed too fast.	Turn adjusting screw on top of the voltage regulator in a counterclockwise direction until the proper voltage is obtained under load.
k. Generator voltage too low.	
(1) Engine speed too slow.	(1) Turn adjusting screw on top of voltage regulator in a clockwise direction until proper voltage is obtained under load.
(2) Poor brush contact.	(2) Replace brushes as indicated in paragraph 15 *b* (3).

SECTION VII

LIST OF PARTS

17. List of parts.—*a.* A complete list of parts of the charging set, type SCR–169, is given below pending its inclusion in the Signal Corps Supply Catalogue.

1 cord, type CD–107.
1 panel, type BD–61 (BD–LL–61 is supplied at present).
1 power unit, type PE–43 (PE–HA–43 is supplied at present).

b. The following accessories are supplied with each set and are packed in a wooden box mounted on the wooden base of the power unit:

4 brushes, spare.
2 contacts, magneto.
3 gaskets.
1 pamphlet, manufacturer's instruction.
1 parts list, manufacturer's.
2 plugs, spark, spare.
1 rope, starting.
1 scraper, carbon.
1 wrench, end, 1-inch and 1⅛-inch openings.
1 wrench, end, ½-inch and $\frac{7}{16}$-inch openings.
1 wrench, end, $\frac{9}{16}$-inch and ⅜-inch openings.
1 wrench, magneto, with gages.
1 wrench, socket, $\frac{11}{16}$-inch.

c. The following are not issued with the set but are desirable accessories:
1 can, 1-gallon, with flexible spout.
1 cup, measuring, ½-pint.
2 oilers, small, for priming and oiling.
[A. G. 062.12 (3–2–32).]

BY ORDER OF THE SECRETARY OF WAR:

DOUGLAS MACARTHUR,
General,
Chief of Staff.

OFFICIAL:
C. H. BRIDGES,
Major General,
The Adjutant General.

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TECHNICAL REGULATIONS
No. 1215–10

WAR DEPARTMENT,
WASHINGTON, *March 26, 1930.*

SIGNAL CORPS

CODE PRACTICE EQUIPMENT, TYPE EE–81

Prepared under direction of the
Chief Signal Officer

SECTION I

GENERAL USES AND DESCRIPTION

1. Use.—Code practice equipment, type EE–81, is designed for use in training radiotelegraph operators. It can be used in troop, post, or service schools or where an installation of permanent or semipermanent nature is necessary.

2. Capacity.—Switchboard, type BD–57, which forms part of the equipment provides for connections to 20 student positions. By means of this switchboard the instructor is able to plug in on any student's circuit and listen to the practice. The tone used in making the telegraph characters is obtained from a motor alternator, type GN–33, which is also part of the code practice equipment.

3. Weight, size, and external description.—*a.* The switchboard weighs 25 pounds, is 24 inches wide, 9¾ inches high, and 8$\frac{17}{32}$ inches deep over all. On the upper part of the front is a bakelite panel having a horizontal row of 20 supervisory jacks. Directly under this row is a row of 20 student jacks. At the left end of the panel is a battery switch which is used to close the 12-volt battery supply circuit to the motor alternator, type GN–33. An extra jack marked "AUXILIARY" is provided so that the red-cord circuit may be connected in series with the master-key circuit.

b. Below the bakelite panel is a wooden door which holds the cords in their compartment during transport.

c. At the right-hand end of the switchboard is a large round hole through which the various connecting wires are brought in. A large wooden door is provided at the back of the switchboard which, when removed, permits access

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to the terminal strip for the purpose of making connections. This door also provides access to the internal wiring connecting the jacks, individual transformers, motor alternator generator, type GN–33, and other parts of the set.

d. The type J–35 key comprises a closed-circuit type legless telegraph key mounted on a 4¾ by 3 inch bakelite base. Two extra binding posts are provided at the upper edge of the base thus permitting the connection of the head set, type HS–16, in series with the key. This type head set is the same as the type HS–4 except that the plug, type PL–21, is removed.

Figure 1 shows a front view of the switchboard.

Figure 2 shows a front view of the switchboard with the wooden door removed and the cords in position.

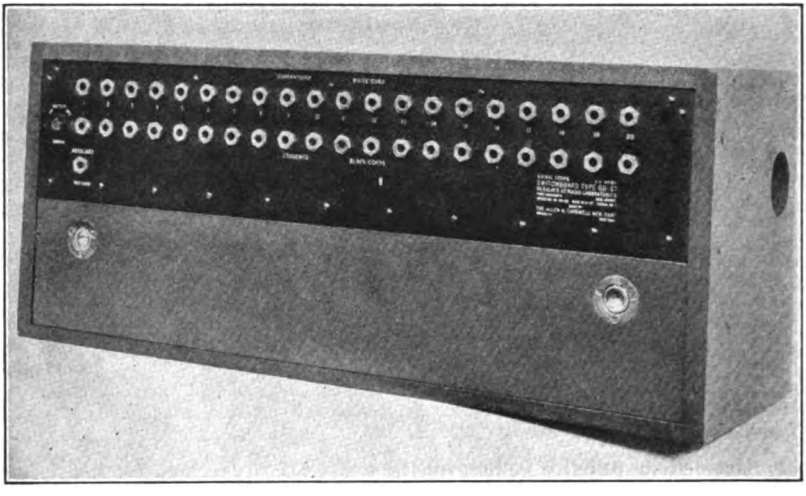

FIGURE 1.—Front view of switchboard, type BD–57

Figure 3 shows a rear view of the internal wiring and parts with the type GN–33 motor alternator mounted on the right.

Code practice equipment, type EE–81, complete and ready for issue, consists of the following parts:

1 switchboard, type BD–57.
22 keys, type J–38; 20 for students, 1 for instructor, and 1 for master key.
21 head sets, type HS–16 (type HS–4 without plug).
6 batteries, type BB–29, 4-volt lead; 3 in use, 3 spare.
500 feet of wire, type W–33, 2-conductor, No. 19 B. & S. telephone house wire.
200 staples, Blake No. 3, insulated.

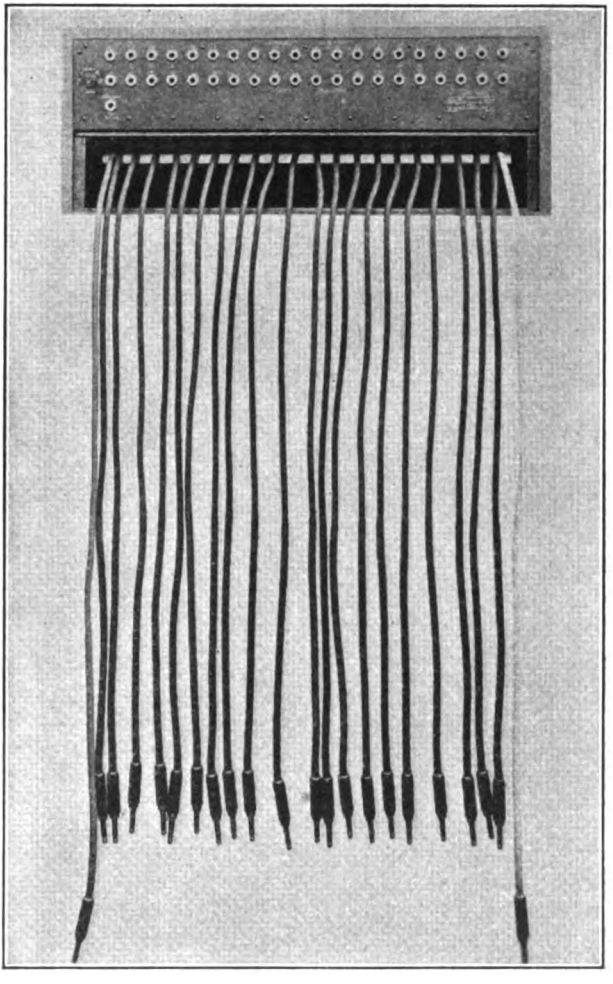

FIGURE 2.—Front view of switchboard with cords exposed

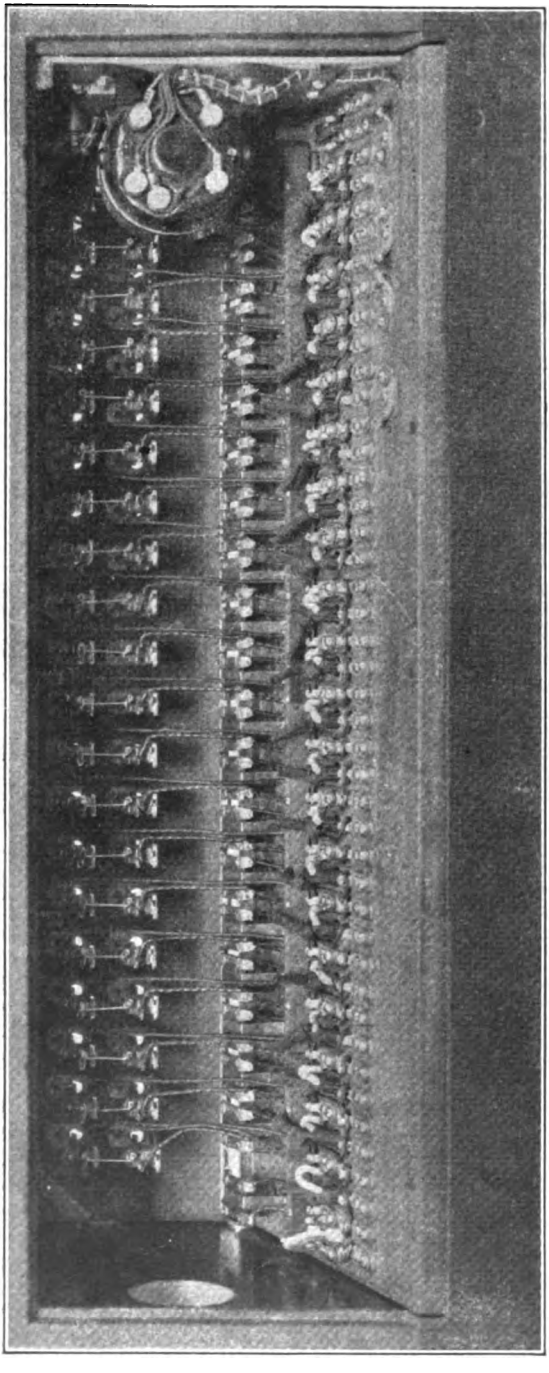

FIGURE 3.—Rear view of switchboard showing internal connections

SECTION II

INSTALLATION FOR SERVICE

4. Mounting the switchboard.—The switchboard, type BD–57, should be mounted on a firm table or bench so that the rear of the switchboard is easily accessible for making line connections, changing cords, and repair of parts. The table or bench should be of sufficient height to permit the cords to hang free and not rest on the floor. The switchboard should be placed in such a way that all the external wiring can be brought in conveniently through the round hole at its end.

5. Connecting the storage batteries.—The 12-volt storage battery (three 4-volt batteries in series) should be connected to the switchboard terminals which are marked for polarity. If the battery is at a considerable distance from the switchboard the leads should be sufficiently heavy to permit a voltage drop not exceeding 0.5 volt. The type GN–33 motor alternator normally takes 0.6 ampere. Wire, type W–33, No. 19 telephone house wire, is suitable for the battery leads in situations where the battery is located not more than 500 feet from the switchboard.

6. Wiring to positions.—A 2-conductor lead should be run from each pair of switchboard line terminals to each key, type J–38, equipped with a head set, located at each of the 20 student positions. Wire, type W–33, telephone house wire, is furnished for this purpose. The group of wires may be cabled or run through rings as the wires running to the switchboard increase in number. Individual wires may be supported by the Blake No. 3 insulated staples. All external wiring should be placed where it will be least disturbed by students entering or leaving their positions.

7. Connecting the head set and key.—*a.* The type J–38 master key and the instructor's supervising key, type J–38, with head set connected, should be installed alongside the switchboard so that the supervisor can plug into any of the student's circuits without moving from his position. This key as used by the instructor and each student has the 2-conductor line connected between the two binding posts marked "Line," one at the right-hand corner of the bakelite base and one on the brass key base. The type J–38 key that is used as the master key is connected to the two binding posts on the brass key base as no head set, type HS–16, is used with the master key. The type HS–16 head set is connected to the two binding posts marked "Tel," one at the left-hand corner of the bakelite base and one on the brass key base.

b. When the connections to the terminal board back of the switchboard have been completed, the wooden door should be replaced.

SECTION III

OPERATION

8. Description of operation.—*a.* After all student positions have been provided with keys, type J–38, and head sets, type HS–16, and the switchboard has been set up ready for operation, the instructor should direct the students to take their assigned positions and direct each to close his key side-lever switch.

b. The instructor then takes his position at the switchboard, straightens out the cords so that a black cord is under each student's jack.

c. He should then turn the switchboard battery switch to the "ON" position, noting that the type GN–33 motor alternator starts running.

d. The instructor then opens the master key side-lever switch, after which he is ready to transmit to all student positions.

9. Individual transmission and reception by students.—For individual code practice by students, the instructor plugs in the black cord in a student's jack directly above the cord. This enables a student to hear the tone in his head set. The student may then open his key switch and he is ready to transmit. The instructor then closes his key side-lever switch, plugs the white cord into any supervisory jack, thus connecting him to a certain student's position. The instructor can then listen-in on this student's transmission. In case the instructor desires to give directions, he opens his key switch and transmits a break-in signal which can be heard by the student. The student then ceases his transmission, closes his key switch, and is ready to receive the message from the instructor.

10. Net operation.—If two or more students are assigned practice in net operation the instructor connects the black cord of one student to the next student's jack, and so on for as many positions as are desired. The last student's black cord is returned to the jack of the first student in the net. This joins all the students' positions in the net in series. One student at a time then opens his key side-lever switch and transmits his message in accordance with net procedure. The instructor may listen-in at any time by closing his key side-lever switch and plugging the white cord into the desired supervisory jack.

11. Connecting an automatic sender and termination of operation.—*a.* To connect an Ediphone, Omnigraph, or other automatic sender to the switchboard, fasten the leads of the automatic sender to the pair of terminals located on the extreme right-hand side of the terminal strip. These terminals are connected inside of the switch board to the red cord, which, when plugged into the jack marked "AUXILIARY," opens the transformer primary circuit. This pair of terminals may also be used to introduce actual radio signals from a receiving set into the distributing system of the switchboard.

b. Upon completion of the practice period the instructor should turn the switchboard battery switch to the "OFF" position which ceases the operation of the type GN–33 motor alternator.

SECTION IV

DESCRIPTION OF CIRCUITS AND FUNCTION OF PARTS

12. The 12-volt supply circuit.—The circuit diagram is shown in Figure 4. The 12-volt battery supply circuit connects through the battery switch to the direct-current motor armature of the type GN–33 motor alternator. The field

circuit is also supplied from the battery and is completed through a fixed resistance of 60 ohms (Western Electric Co., No. 1–D). This resistance adjusts the speed of the motor alternator so that the alternator generates an alternating voltage having a frequency of about 675 cycles.

13. The alternating-current circuit.—The alternating-current circuit of the type GN–33 motor alternator connects to the primaries of the 21 transformers, type C–69, all the primaries being connected in series. In series with this tone supply circuit are the normally closed auxiliary jack and the externally connected master key, the latter being the type J–38 with connections made to the two binding posts on the brass base of the key. The side-lever switch of this key must be kept closed when the key is not in use in order to complete the tone circuit. The volume of the tone may be adjusted as desired by the potentiometer.

14. Individual students' circuits.—Each individual student's circuit consists of the secondary of a type C–69 transformer connected by means of a black cord (there are 21 C–69 transformers provided, one for each of the 20 student circuits and one for the instructor's circuit), in series with the corresponding supervisory and student jacks, and the 2-conductor line leading to the student's type J–38 key and his type HS–16 head set. When a single-conductor black cord is inserted in the student's jack directly over it, the student will hear a steady tone with his key down, or tone telegraph characters when he is operating. This operation of his key does not affect the signal heard by other students who may also be operating. By interchanging black cords, two or more student circuits can be connected in series, so that any key controls the combined circuits, and the operators can thereby exchange messages as in a radio net. When thus connected, the transformer secondary voltages add, hence the strength of the signal heard in net practice is the same as in individual practice.

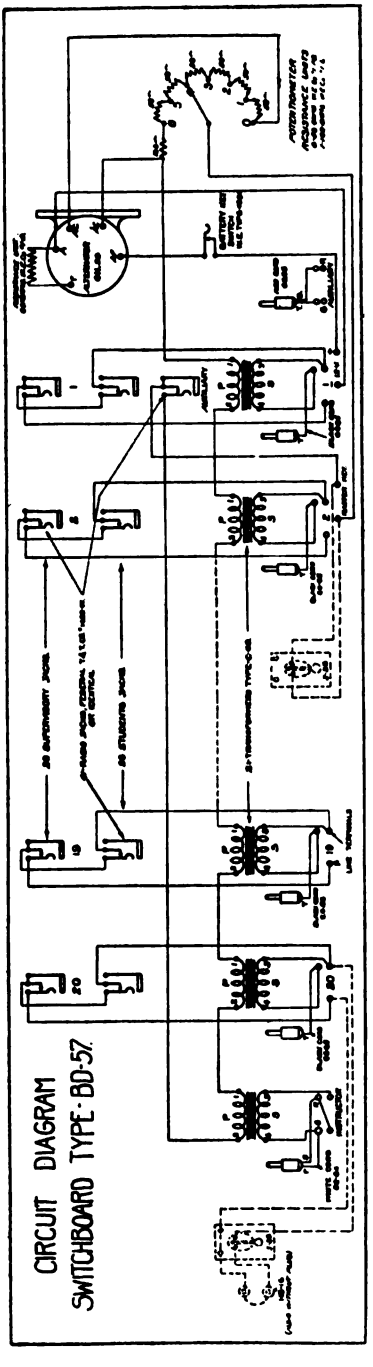

FIGURE 4.—Circuit diagram of switchboard, type BD–57.

15. Supervisor's circuit.—The supervisor's circuit consists of the secondary of a type C–69 transformer connected in series with the 2-conductor white cord and the 2-conductor line leading to the supervisor's type J–38 key and type HS–16 head set mounted on the table alongside the switchboard. The supervisor hears no tone until his white-cord circuit is completed by plugging into one of the 20 supervisory jacks. He is then connected in series with that student's circuit of which the jack is a part. As the supervisor's circuit includes a type C–69 transformer secondary, the strength of the signal heard by the student is unaffected, and the student is unaware of the supervision. The instructor can transmit to the student by opening the side-lever switch of his key.

SECTION V

CARE, MAINTENANCE, AND REPAIR

16. The switchboard.—The apparatus of the switchboard, type BD–57, is of fairly rugged construction and should give satisfactory service over a long period of time if proper care is exercised in handling it. There are no adjustments necessary. A periodic inspection of the internal connections will be found advisable in order to insure satisfactory operation. The transformers may need replacing from time to time; this work should be done only by an experienced repairman. Cords and plugs may become worn through improper handling. For example, in establishing and taking down connections the instructor should take hold of the plug shells instead of the cords. This prevents pulling the cord loose from the plug and insures longer life of the cord. The external surface of the switchboard, type BD–57, should be cleaned daily with a soft dry cloth. The plugs should be kept free from tarnish by cleaning with an approved plug polish. The internal wiring should be cleaned as often as required with a small hand bellows, vacuum cleaner, or fan.

17. The type GN–33 motor alternator.—Ordinarily the type GN–33 motor alternator should give no trouble. In case it does not start consistently after it has been in service for some time, the machine should be removed from the cabinet, taken apart, and the commutator cleaned. All carbon dust should be removed from the inside of the machine. If the brushes are worn down, new ones should be inserted. The ball bearings should be repacked with vaseline.

18. Keys.—The key contacts and switches should be cleaned as often as required with carbon tetrachloride applied with a clean cloth or small brush.

19. Storage batteries.—The storage batteries should be kept clean and free of corrosion and the terminals greased. For care and maintenance of storage batteries see TR 1160–5.

[A. G. 062.12 (11–25–29).]

BY ORDER OF THE SECRETARY OF WAR:

C. P. SUMMERALL,
General,
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OFFICIAL:
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