



SCR-68 AIRPLANE RADIO TELEPHONE SET

A Sending and Receiving Set Comprising a Fan-Driven Double-Voltage Generator, an SCR-57 Interphone Set, and Other Auxiliary Apparatus—The SCR-59 Airplane Radio Receiving Set Also Described

The SCR-68 radio telephone apparatus combines a transmitting and receiving unit in one set so that the throwing of a single switch makes it possible for an airplane pilot to either talk to or receive messages from another airplane similarly equipped. It is intended primarily for use on airplanes, and particularly planes of the fighting type, although communication may also be had with stations on the ground, if within range. By means of the interphone set which forms part of the complete SCR-68 set, it is also possible for the observer and the pilot of the same airplane to talk with each other during a flight. The radio set is designed for radio telephone communication over a range not in excess of five miles under favorable conditions. When it is used in the vicinity of other radio

stations, either on other airplanes or on the ground, interference may greatly reduce this range. This short range communication is entirely suited to the particular use for which the set was designed.

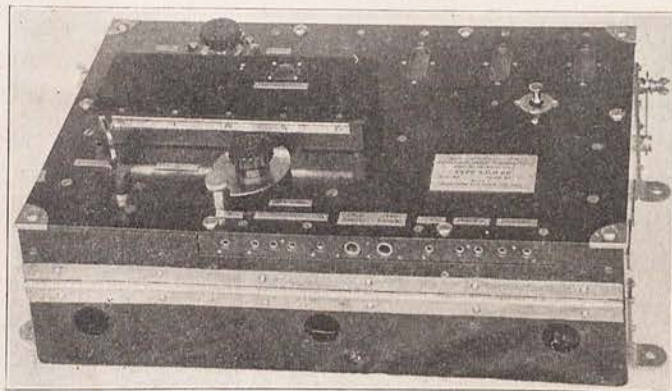


FIG. 1. Operating Panel of SCR-68 Radio Telephone Set.

Elementary Theory of the Radio Telephone

In S. C. R. Pamphlet No. 9, it was shown that the three-electrode vacuum tube might be used to generate undamped oscillations of any desired frequency.

It was also shown that such a tube might be used to absorb power in perfectly controllable amounts, or in other words, to act as a variable resistance shunt on the input energy to the oscillator tube. The operation of the radio telephone is based on these two properties of the three-electrode vacuum tube, and the principles are given herewith.

A three-electrode tube is connected up as an oscillator, that is, with its grid and plate circuits coupled together, and is made to generate undamped oscillations of high frequency. A direct current is supplied to the plate circuit of this oscillator tube by a fan-driven generator, and through the action of the grid and plate circuits upon each other, this current is transformed into a high frequency alternating current which is delivered to the antenna and radiated into space. The power output of the oscillator tube is proportional to

the amount of direct current power supplied to it. The amplitude and frequency of the oscillations generated by the tube are, in themselves, constant.

Across the power supply to the oscillator is connected what is equivalent to a resistance which is varied by the modulations of the voice. This is a vacuum tube connected up as a modulator, that is, so as to absorb power from the d.c. generator, the amount

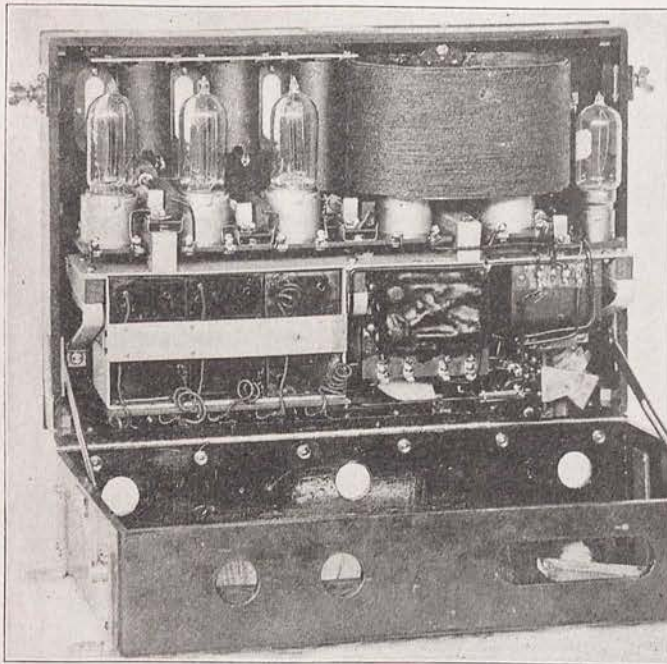


FIG. 2. Mounting of Apparatus in SCR-68 Set Box.

absorbed depending on the resistance of the plate circuit as determined by the voltage of the grid relative to the filament and the plate. The grid voltage is varied by means of the action of a telephone transmitter. The speech frequency wave produced in the telephone transmitter is stepped up by a small transformer and the resulting irregularly varying potential impressed across the space of the tube between the grid and the filament. Under the control of the transmitter and the voice, the tube then allows variable amounts of current to flow from the plate to the filament of the tube in accord with the modulations of the voice. As the d.c. generator supplies only a constant current, this will be divided between the modulator and oscillator tubes which are connected in parallel across the

generator terminals, the current in each tube being proportional to its conductance. The result is that the amount of d.c. power supplied to the oscillator to be transformed into high frequency a.c. power and radiated by the antenna, is varied by the modulator according to the modulations of the voice at the transmitter. The oscillations sent out by the set will be of constant frequency, but of an instantaneous amplitude proportional to the modulations of the voice.

At the receiving station, these oscillations when rectified, will have a wave shape or envelope molded to the speech, and they will produce in the telephone receiver a unidirectional pulsating current similar to that in an ordinary wire telephone, exactly reproducing the sound of the voice at the sending station. In the SCR-68 and SCR-59 receiving sets, the oscillations are first rectified by a VT-1 detector tube and then amplified in two stages by two VT-1 tubes connected in cascade.

Component Parts of the SCR-68 Set

The SCR-68 set complete comprises in addition to the radio transmitting and receiving set itself, a fan-driven double-voltage generator with voltage regulator, a filter box, an interphone set, and the antenna system.

GENERATOR.—The fan-driven generator is self excited and has a differential compound field winding and two separate armature windings, one of which supplies a 25-volt direct current for heating the various vacuum tube filaments, and the other a 275-volt direct current for supplying the necessary plate potential in the several tubes. The filaments of the two sending tubes are connected in series across this 25-volt supply, as are also the filaments of the three receiving tubes. This generator is supplied with fans of design differing to take care of various airplane speeds.

A special two-electrode vacuum tube mounted in the stream lining of the generator acts as a regulator to control the output voltage of the generator through wide variations of speed. The filament of this tube is connected in series with the main field winding of the generator and across the 25-volt terminals. The plate of the vacuum tube is connected in the circuit from the positive 275-volt terminal through the differential field winding of the generator. Any rise in the main generator voltage increases the filament temperature. This causes an increase in the plate current through the tube, and therefore, in the current through the differential field winding. As the flux due to this winding opposes that induced by the main winding, the increase in plate current thus tends to keep the generator voltage from rising with increased speed, and vice versa.

THE FILTER BOX.—The filter box is inserted in the output circuits of the generator and is designed to eliminate the commutation noises from the transmitting and receiving circuits. The three leads from the generator are connected to the upper three corresponding term-

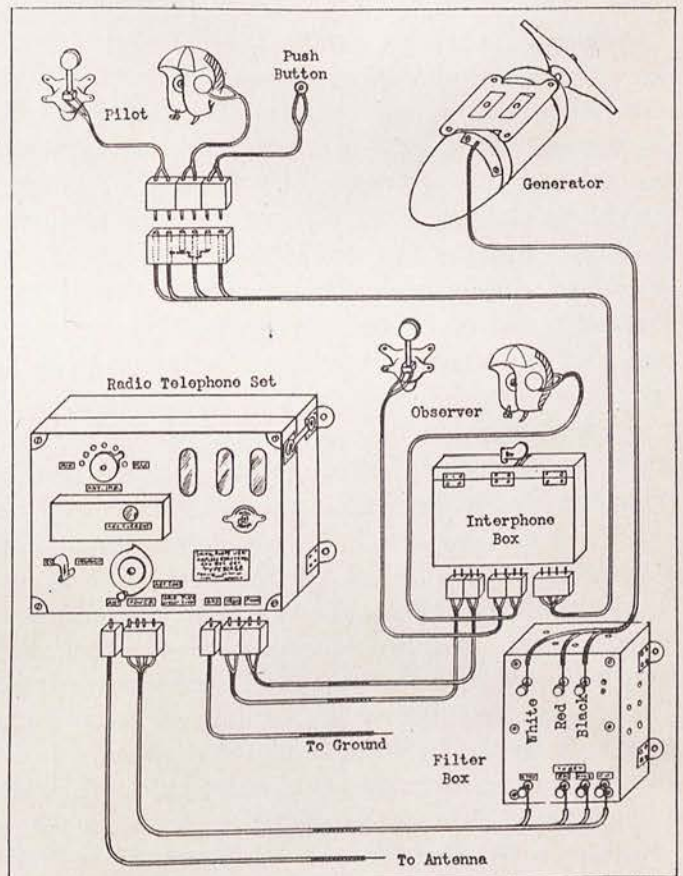


FIG. 3. Cord Connections Between Component Parts of SCR-68.

inals of the filter box and other leads connect the lower terminals of the filter box to the radio apparatus. This filter box contains two condensers, bridged across the high and low voltage generator leads, and a choke coil and resistor which are connected in series with the fourth lead from the box marked "Receiver." The lead extending from this terminal forms the positive connection to the filaments of the receiving vacuum tubes. The resistor contained in the filter box limits the current in the receiving tube filaments to the proper value.

RADIO TELEPHONE SET BOX.—The radio telephone transmitting and receiving circuits are installed together in a wooden case measuring 19 in. x 15 in. x 4 $\frac{3}{4}$ in. and so arranged that the operator may transmit or receive at will by simply throwing over one lever-switch on the top of the set. Inside the case are mounted five three-electrode vacuum tubes and a ballast lamp, two of these tubes being VT-2 power tubes used in the transmitting circuit, and three of them, VT-1 tubes used in the receiving circuit. The ballast lamp is connected in series with the filament circuit of the VT-2 tubes and it functions as an additional regulator. Its characteristics are such that it has a very steep rise in resistance as the current increases, this helping to hold the current in the filament circuit constant as the speed of the generator varies. The ballast lamp has a single hair pin filament and may be seen at the extreme right of the photograph, Fig. 2.

In addition to the vacuum tubes, the set box contains a large oval shaped antenna inductance coil which is installed in such a way that it encloses the two transmitting tubes. This coil is provided with a number of taps which are connected in their proper relation to the contact points of the dial switches mounted on the main panel and marked "Antenna Inductance," "Wave Length," "Coupling" and "Input." The last three switches are located on the small covered panel which is mounted on top of the main panel and provided with a hinged cover. The antenna coil is used in both the radio transmitting and receiving circuits, and it forms the electromagnetic coupling between the grid and plate circuits of the oscillator tube. But one variable condenser is mounted in the set and this is connected in the receiving circuit in series with the antenna coil. In addition, the set box contains a group of several condensers made up in one unit with several taps, three BA-2 dry batteries, several inductance coils, and the multiple-pole throw-over switch to change from transmitting to receiving. Openings in the box are provided at each vacuum tube so that the operator may observe whether or not the filament of the tube is lighted, without opening the case.

TRANSMITTING CIRCUIT.—The function of the two transmitting tubes located within the antenna inductance is to deliver to the antenna a high frequency radio current, the amplitude of which is modulated by the voice current. It is convenient to consider the transmitter as comprising two circuits, each of which contains one of the transmitter tubes. One of these tubes is connected in the oscillator circuit and produces high frequency current which may be termed the "carrier" current for the voice modulations. The other tube is connected in the modulator circuit and acts to vary the amplitude of the constant frequency current generated by the oscillator circuit as described in an earlier paragraph. The

high frequency carrier oscillations generated by the oscillator tube are set up in the antenna circuit which comprises the trailing antenna wire, the antenna inductance coil L_1 , (Fig. 4), the condenser C_1 , and the metal framework of the airplane serving as a counterpoise. By means of the dial switch marked "Input," the voltage across the condenser C_2 connected immediately between the antenna inductance coil and the grid of the oscillator tube and known as the "input condenser," may be varied so as to impress the proper a.c. voltage on the grid and cause the tube to oscillate.

The inductance of the antenna coil may be varied in order to secure the maximum current in the antenna, by means of the dial switch marked "Coupling." At the same time, the inductance of the antenna circuit may be varied by the dial switch marked "Wave Length," so as to give any wave length within the range of the apparatus. The range of wave lengths is from approximately 215 meters to 450 meters.

The input condenser, C_2 , serves to insulate the grid of the oscillator tube from the positive plate voltage. The inductance coil, L_2 , prevents the radio frequency current from flowing through the 275-volt winding of the generator and forces the high frequency carrier current to follow the path through the condenser C_1 . It also prevents the high frequency carrier current from flowing in

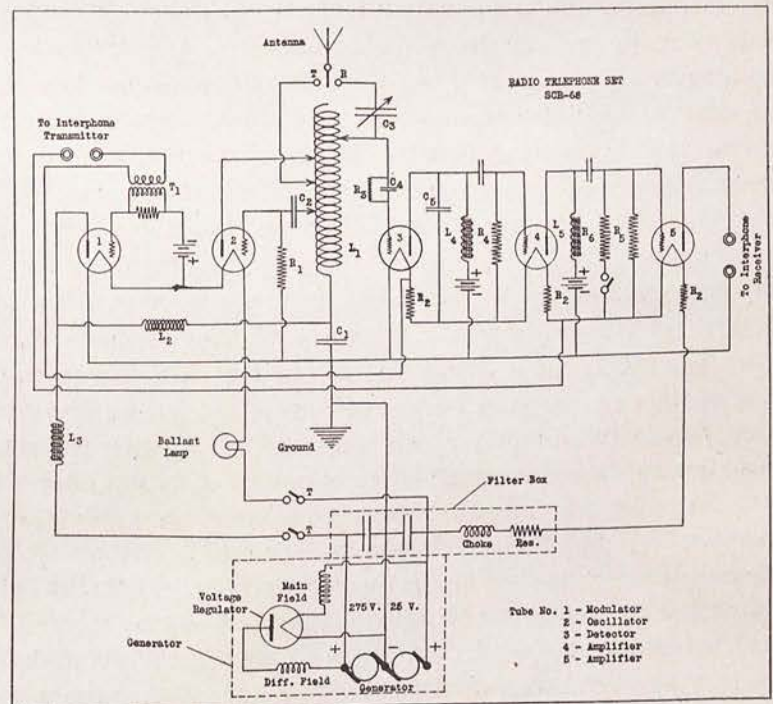


FIG. 4. Schematic Wiring Diagram of SCR-68 Radio Circuits

the modulator circuit. The 10,000-ohm resistance, R_1 , limits the current which may flow from the grid to the filament of the oscillator tube.

The telephone transmitter is supplied with the necessary current, through the voltage drop across the filament of the first amplifier vacuum tube (tube No. 4, Fig. 4) and two of the R_2 resistors in each of the filament circuits of the receiving tubes. The voice current in the observer's telephone transmitter flows through the primary winding of the transformer T_1 . The secondary winding of this transformer is connected in circuit with the grid of the modulator tube. The negative grid voltage necessary for the modulator

tube is supplied by the 15-cell BA-2 dry battery which is connected in series with the secondary winding of the transformer.

Both the oscillator and modulator circuits are connected in parallel to the 275-volt side of the generator through a high inductance coil, L_3 . The function of this coil is to change the 275-volt energy from a constant voltage supply to a constant current supply. This insures a constant power output by the generator which is then divided in varying proportions between the oscillator and modulator tube circuits by the power absorption action of the modulator tube.

RECEIVING CIRCUIT.—In receiving the main switch is placed in the "receive" position and the receiving circuits then comprise the antenna wire, variable condenser C_3 , antenna coil, condenser C_1 , and the airplane framework. The vacuum tube detector and two amplifier tubes are connected across the antenna coil and condenser C_1 . The handle for adjusting the condenser C_3 , is mounted on the main panel and marked "Antenna Condenser." The plates of this variable condenser may be locked in any position by tightening the knurled head screw attached to the locking device which engages the graduated brass dial on the condenser handle. Taps from the antenna inductance coil are connected to the contact studs of the dial switch located on the main panel and marked "Antenna Inductance." Alternate contact studs of this switch are connected to taps on the antenna inductance coil, and the intermediate contact studs are dead. The tuning circuit then comprises the antenna inductance coil, the fixed condenser C_1 , and the variable condenser C_3 . The antenna circuit is tuned by varying the positions of the antenna inductance and the variable condenser. The plate potential of the detector tube is supplied by one BA-2 battery giving approximately 20 volts, and that of the two amplifier tubes is supplied by two BA-2 batteries in series to give an approximate plate voltage of 40 volts across each amplifier tube.

The detector circuit proper comprises the grid condenser C_4 shunted by the 2-megohm resistor R_3 , the first VT-1 vacuum tube and a BA-2 plate battery. The use of the grid condenser greatly improves the operation of the detector tube. The incoming radio oscillations are impressed on the grid element of the detector tube. These potential fluctuations on the grid correspond to the speech frequency variations in the amplitude of the high frequency carrier current. The resulting speech frequency oscillations in the plate current of the detector tube are amplified in two stages in the second and third VT-1 type tubes.

A condenser, C_5 , is connected between the plate element of the detector tube and the resistor R_2 , in the filament circuit. This condenser serves as a by-pass for the high frequency oscillations superimposed on the plate current. An inductance coil, L_4 , is connected in the plate circuit of the detector tube, and L_5 in the plate circuit of the first amplifier tube, and these allow the continuous plate current supplied by the BA-2 dry batteries to flow, but prevent these batteries and their connections to the plate elements of the tubes from serving as short circuit paths for the currents of radio frequency. These inductance coils are of low resistance and high impedance in order to introduce as little resistance loss in the plate current circuit as possible, but at the same time to effectively obstruct the flow of the high frequency currents.

The current leakage through the resistors R_4 and R_5 , serves to keep the grid potential of the two amplifier tubes at the proper value. The resistor R_6 , shunted across the grid circuit of the second amplifier tube and in parallel with the resistor R_5 , may be cut in or out of the circuit by means of a pull-type switch mounted on the main panel and marked "To Increase Amplification—Push In." When this switch is in its normal position (pulled out) the resistor R_6 , is connected in the circuit, partly short circuiting the grid circuit and decreasing the amount of amplification. Pushing the switch in, then, removes this shunt on the second amplifier tube and increases the amplification.

INTERPHONE SET.—The interphone set for intercommunication between the pilot and the observer of the same airplane comprises an interphone box which is mounted in the observer's cockpit, an extension jack mounted in the pilot's cockpit, a helmet type head set and special transmitter for both pilot and observer, and a push button located in the pilot's cockpit. The interphone box contains two telephone transformers, the BA-3 dry batteries for operating the telephones and the throw-over switch by means of which the observer may connect his transmitter and head set with the radio apparatus or with the interphone set. The connections between the pilot's and observer's telephones are so arranged that when the observer's set is connected to the radio set, the pilot may talk to the observer by simply pressing the push button in his cockpit. The observer, however, cannot talk to the pilot until he throws the switch on the interphone box to the "Interphone" position. When the switch is in this position, the observer's telephone equipment is disconnected from the radio transmitting and receiving circuits and the observer and pilot are placed in direct wire telephonic communication. The telephone condensers and transformers are mounted in the interphone box which is provided with jacks for conveniently making the connections to the head sets, transmitters and radio set.

The transmitters used in this interphone set are so designed that while they are actuated by the sound waves of the voice, they are shielded from or balanced to eliminate the engine and wind noises. The receivers are designed also to exclude the engine and wind noises, principally by virtue of their absolute fit over the ears of the wearer. The telephone equipment of the interphone set otherwise operates in the ordinary manner.

Installation of the SCR-68 Set in an Airplane

The apparatus for this set is mounted principally in the observer's cockpit, as he will make adjustments and operate the radio apparatus. The various component parts are connected together by means of cords, with jacks and plugs connected on all cords. The general scheme of cord connection is shown in Fig. 3, although this does not give an idea of the relative positions of the apparatus in the airplane.

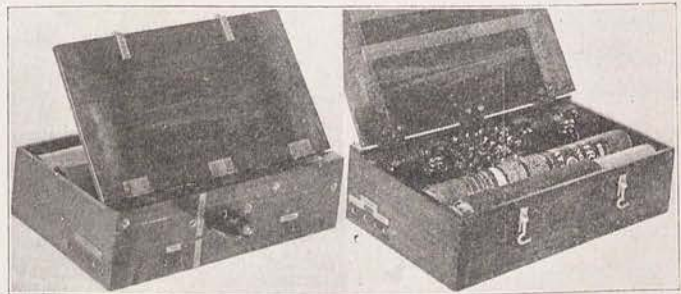


FIG. 5. Interphone Box Showing Apparatus Mounting

The double-voltage generator is secured to a steel bracket by means of which it is fastened either to the side or bottom of the fuselage or to the wing of the airplane. The three current-carrying leads from the generator are run into the fuselage by the shortest feasible route. The filter box may be mounted on the dashboard or on the floor of the fuselage or any other available place in the observer's cockpit. It does not need to be readily accessible since all electrical connections to it are permanent and it comprises no apparatus that requires frequent renewal or inspection. The radio telephone set box is preferably installed on the dashboard of the observer's cockpit where the various adjustments and switches will be readily accessible to the observer. The projecting lugs from the back corners of the case should preferably be mounted upon rubber cushions to minimize the mechanical vibrations which may be transmitted to the box and may cause a breakage of the vacuum tubes.

The SCR-57 interphone box is mounted in such a position that the observer may readily manipulate the "interphone-radio" switch mounted on the side of the box, and where there will be space for inserting the cord plug connection on the side opposite the switch. The observer's and pilot's telephone equipment are worn in the usual manner. The leather helmet must be adjusted to the head carefully, in order to keep out the noises of the engine and wind. The transmitters are supported in front of the operators by means of straps around their necks in such a manner that the mouthpieces are held at about $\frac{1}{2}$ -in. or less from the mouths of the speakers. The pilot's push button switch is mounted at some point to be at all times within easy reach of the pilot.

The fairlead, by means of which the radio set is connected to the trailing antenna, is mounted on the bottom of the fuselage and a cord plug-in connection extended up to the radio set box. Another cord from the radio box makes electrical connection to a ground including all metallic parts of the airplane—the engine, stay wires, pontoon wires, metallized wings, etc.—forming the counterpoise of the radio system.

Adjustment of the Set

In general, all adjustments of the SCR-68 transmitting and receiving set may be made from the operating panel. The principal adjustments consist of three dial switches. These three principal adjustments control the wave length, the grid current and the plate current in the oscillator and modulator tubes. The set may be tuned while the airplane is in flight, or it may be tuned on the ground by using a separate power source and connecting a phantom antenna of the proper capacitance and inductance. Jacks are provided on the side of the box for connecting a milliammeter into the grid or plate circuit and a wavemeter may be placed on or near the case for measuring the wave length. As constructed, the set allows the changing of the inductance in definite steps by means of the wave length switch. Any fine adjustment of wave lengths between that given in these steps must be secured by altering slightly the length of the trailing antenna.

All switches turn to the right in adjusting towards the longer waves. When working on the shorter waves, it may be necessary to couple more closely by turning the coupling switch farther than the wave length switch (these switches usually have the same relative setting), but care should be taken not to turn it too far. The modulator switch is so constructed that closing the cover closes the switch. None of these switches should be touched with the hand while the power is on, as the potential between them and the frame of the machine may be several hundred volts.

The apparatus required for tuning the SCR-68 set in readiness for operation, when this is done from the ground, includes the following:

- 1 voltmeter, reading from 0 to 500 volts.
- 1 milliammeter, reading from 0 to 150 milliamp.
- 1 wavemeter, reading from 200 to 700 meters.
- 1 phantom antenna.

The phantom antenna consists of a resistance, a condenser, and a hot wire ammeter connected in series. The ammeter scale should read from 0 to .5 amp. The resistance should be variable from 0 to 40 ohms in steps of not greater than 1 ohm. The condenser should have a variable capacitance of from 100 to 500 micro-mfd. and withstand 1500 volts potential. It should be variable in about 10 micro-mfd. steps.

The apparatus used for adjusting the set while the airplane is in flight, is the same as that for tuning on the ground, except for the phantom antenna. In adjusting for wave length, reel out 300-ft. (more or less, according to the wave length desired) of antenna wire with the lead weight attached to the trailing end. The wavemeter is placed on or near the set, if used, but it is usually not carried up, the wave length being estimated and adjusted by the length of antenna wire unreeled.

The generator voltage varies from a maximum of 310 volts to a minimum of 240 volts. The set should be adjusted with the generator delivering 275 volts in order that it may be tuned for average conditions. This voltage is determined by connecting the voltmeter across the leads extending from the filter box. The voltage on the low tension side of the generator should be 25 volts.

Specific Steps in Method of Operation

1. When tuning on the ground, connect the phantom antenna between the fairlead and the nearest stay wire, using the minimum length of connecting lead.
2. Set the phantom antenna at some value of effective capacitance and inductance which will be equal to the corresponding constants of the actual antenna, when using the wave length and length of antenna wire agreed upon.
3. Put on the head set and transmitter so that the hands will be free to make adjustments.
4. Place the transmit-receive switch in the "Receive" position. The switch should always be in the "Receive" position except when sending or when noting readings while making adjustments.

5. Connect the voltmeter to the generator high voltage terminals and adjust the supply so that the voltmeter will read approximately 275 volts. Connection of the voltmeter can be made readily at the filter box.

6. Place the "Wave Length" switch in a position estimated to give the desired wave length. Until considerable experience has been acquired, it is advisable to begin with a long wave length and work down to the desired value after an oscillating condition has been set up.

7. Adjust the "Coupling" switch to a position corresponding to that of the wave length switch. To do so, count backward the same number of contacts from the position of maximum coupling and of maximum wave length (extreme right).

8. Place the "Input" switch at the maximum position (extreme left).

9. Open the modulator switch.

10. Plug the milliammeter in the "Plate Current" jack.

11. Throw the main switch to "Transmit," momentarily, and observe the plate current. If this is not excessive, (a tube can stand 60 milliamp. for a very short period) switch to "Transmit" again and note if there is current in the antenna, as indicated on the small "Antenna Current" lamp in the covered panel (installed on only a few sets) or as indicated from step No. 13.

12. Measure the wave length by means of the wavemeter and increase or decrease it as desired, at the same time altering the coupling to maintain the corresponding positions of wave length and coupling dials. Finally adjust the coupling to give a plate current of approximately 40 milliamp., with 275 volts input from the generator.

13. Plug the ammeter in the "Grid Current" jack.

14. Observe the grid current. This should be from 2 to 5 milliamp. If less than 2 milliamp., the oscillator is not delivering its full power output; if more than 5 milliamp., decrease by moving the input switch away from the maximum.

15. Close the modulator switch. The plate current should now be from 70 to 80 milliamp. at 275 volts generator input.

16. Talk. The operator should hear himself fairly loud with one stage of amplification. This is the indication of whether or not the tube is oscillating, which will be most used. If the tube is not oscillating, shift the coupling switch a point or two to the right or left.

17. Go over the adjustments again to make sure that the proper conditions obtain, as each adjustment affects somewhat the ones made previously.

ADJUSTING THE RECEIVING SET.—

1. Turn the transmit-receive switch on the radio set box to the "Receive" position.

2. Tune the receiving circuit to the incoming waves by means of the variable inductance and condenser dial switches marked "Antenna Inductance" and "Antenna Condenser," respectively, in the antenna circuit. The minimum wave length is obtained when the antenna inductance switch is turned to the left to the point marked "Minimum."

3. The antenna inductance dial switch has seven contact points, of which the second, fourth and sixth are dead contacts. On final adjustment of the antenna inductance, add something to the setting, so that the condenser dial position will be at about the middle of the scale. The slight adjustments necessary in the air, then, can be taken care of by adjusting the condenser only.

ADJUSTING THE INTERPHONE SET.—

1. With the switch on the side of the interphone box thrown to the position marked "Radio," the observer's head set and transmitter are connected to the SCR-68 set box for radio receiving and radio transmitting. However, while the switch is in this position, the pilot may talk to the observer by closing the push button switch in his cockpit, but the observer cannot talk to the pilot.

2. When the interphone switch is thrown to the position marked "Interphone," the observer's head set and transmitter are entirely cut off from the radio set and the pilot and observer may communicate with each other.

General Instructions

When observing the grid current, as indicated in step No. 14 above, it should be borne in mind that best operation is obtained when the grid current in the oscillator tube reads 3 or 4 milliamp. at 275 volts input from the generator. Too large a grid current is not only hard on the tube, but it represents a loss of power in the grid resistance that may exceed in value the increased output of the tube, the net result being an actual decrease in antenna power.

The plate current, as noted in step No. 15, should be from 70 to 80 milliamp. If it is over 80 milliamp., either the tube in the modulator circuit is a poor modulator, or the voltage of the negative battery is below normal. Many tubes that are poor modulators behave very well as oscillators, and vice versa, and interchanging these tubes will often remedy the difficulty. Interchanging the VT-1 receiving tubes may likewise improve reception.

When the set is tuned with the airplane in flight and using the trailing antenna, the only indication of oscillations is the presence of a grid current, or the observer hearing his own voice. It is possible with very abnormal switch positions to obtain a grid current with an oscillating circuit which does not include the antenna, but with a little experience this condition should be readily avoided.

When the wavemeter is not in use, be sure that it is set far out of tune. Never adjust the plate current while the wavemeter is present and in tune, for the reaction on the oscillator will give false plate current readings that do not represent the conditions obtaining when the wavemeter is removed.

The following rule will give the approximate length of antenna to use to secure the desired wave lengths:

For 400 meters, reel out 300 ft. of wire. Add or subtract one foot per meter for other wave lengths.

The SCR-68 set is not designed to operate on wave lengths, expressed in meters, numerically less than the length of antenna wire, expressed in feet. At 400 meters wave length, 300 ft. of wire with a Curtiss JN airplane will have about 9 ohms resistance and 320 micro-mfd. capacitance.

Possible Trouble and Suggestions as to Cause

1. Noise in the receiver may be due to—

- a. Poor or worn out dry batteries used in the receiving tube plate circuits.
- b. Poor paper leak resistors.
- c. Loose connections in the plate, filament or grid circuits of the tubes.
- d. Poor contacts between the tube and the spring contacts in the tube socket.
- e. Broken down grid leak condenser.
- f. Noisy detector vacuum tube.
- g. Excessive sparking at the commutators of the generator or bad adjustment of brushes.

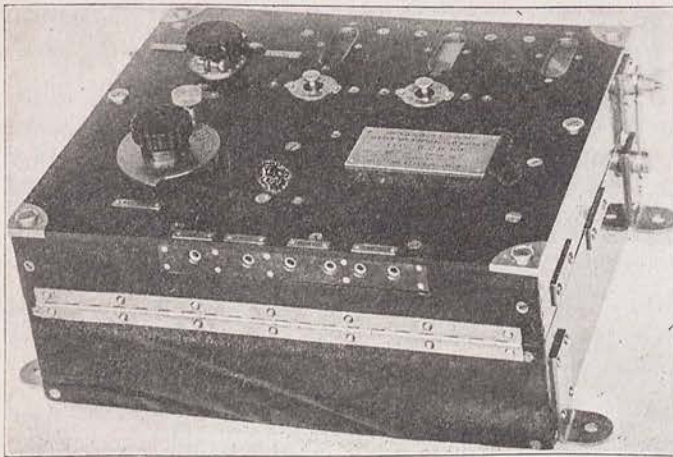


FIG. 6. Operating Panel of SCR-59 Receiving Set Box

2. Blocking of the receiver may be due to—

- a. An open in the grid circuit.
- b. An open or high resistance grid leak.

3. Poor or weak signals may be due to failure of any of the component parts.

4. Failure of the receiving tubes to light and excessive current through the transmitter tubes may be due to a ground on either transmitter lead.

5. Heating of the oscillator tube may be due to—

- a. Too high a plate voltage.
- b. Improper adjustment of

the "Coupling" and "Input" dial switches for the wave length used.

- c. Poor tube.

6. Failure to oscillate may be due to—

- a. Too small a filament current in the oscillator tube (poor tube).
- b. Improper adjustment of the circuit.
- c. An open in the antenna circuit.
- d. Leaky antenna insulators.
- e. Grounded antenna.

7. Failure to modulate may be due to—
 - a. An open in the modulator tube plate circuit. (The milliammeter should indicate an increase of 30 to 40 milliamp. in the value of the plate current upon closing the modulator knife switch; if no increase is noted, the circuit is open. A larger increase than this is a probable indication of a defective dry battery in the modulator grid circuit).
 - b. Lack of voice current upon the grid of the modulator tube.
8. Lack of voice current on the grid of the modulator may be due to—
 - a. Faulty transmitter (loose connections, broken cord, etc.)
 - b. Lack of the necessary voltage drop across the filament of the vacuum tube included in the transmitter circuit, which may be the result of no current flow in the receiving tube filaments, any one of the receiving tubes being broken, poor tube connections, open in the filament circuit wiring, etc.
 - c. Short or open circuit in the speech transformer or connections to the grid circuit.
9. Failure of the detector or amplifier tube to function may be due to—
 - a. A faulty tube.
 - b. Run down plate battery.
 - c. Short circuit of the filament current brought about by a breakdown of the condenser across the 25-volt leads in the filter box. (The normal filament current should give a cherry red glow.)
 - d. Too much filament current, caused by a short circuit of the resistor unit in the filter box.

SCR-59 Radio Telephone Receiving Set

The SCR-59 radio telephone receiving set is practically identical to the receiving portion of the SCR-68 two-way telephone set. It is designed to be used in conjunction with the SCR-68 set, and will be mounted on a certain number of the planes of a squadron or flight. The filament current for the detector tube and the two amplifier tubes is supplied by a 4-volt, 22.5-amp-hr. storage battery, type BB-4. The plate potential is supplied by two BA-2 batteries mounted in the set box. The set is tuned by means of various taps on an inductance coil and a variable condenser which may be readily seen in the accompanying illustration. The two dial

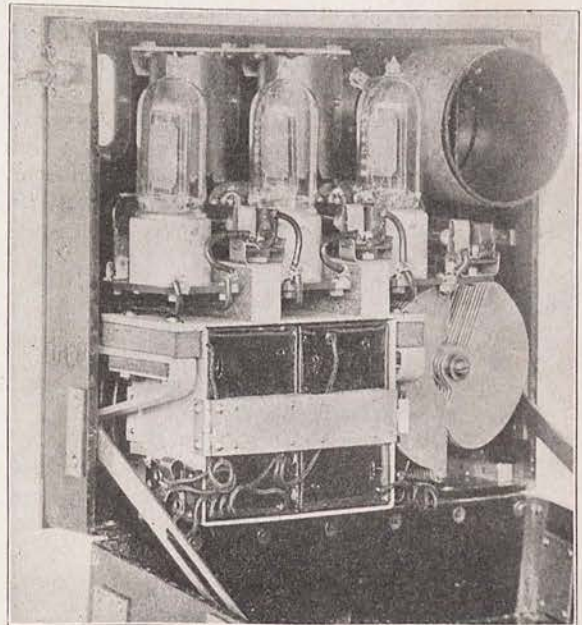


FIG. 7. Mounting of Apparatus in SCR-59 Set Box

handles controlling the amount of inductance and capacitance in the oscillating circuit are mounted on the main panel of the set. There are also two of the pull-type switches, one of which cuts in or out a resistance shunting the second stage of amplification, similar to the scheme in the SCR-68 set, while the other cuts in or out the filament current supply. The antenna and counterpoise connections, and the storage battery and telephones are plugged into the set the same as are the equivalent circuits in the SCR-68 set.

**Parts List of SCR-68 Airplane Radio Telephone Set, Including Renewal Parts for
One Month's Service**

POWER EQUIPMENT, TYPE PE-1

- 2 Air Fans, Type FA-3 (1 in use, 1 spare)
- 1 Wind-driven Generator, type GN-1 or GN-2
- 5 Regulator Tubes, type TB-1 (1 in use, 4 spares)
- 1 Extension Cord, type CD-19 (generator to filter)
- 1 Filter, type FL-1

RADIO EQUIPMENT, TYPE RE-1

- 1 Airplane Radio Telephone Set Box, type BC-11
- 8 Vacuum Tubes, type VT-2 (2 in use, 6 spares)
- 8 Vacuum Tubes, type VT-1 (3 in use, 5 spares)
- 3 Ballast Lamps, type LM-1 (1 in use, 2 spares)
- 12 Dry Batteries, type BA-2 (3 in use, 9 spares)
- 1 Extension Cord, type CD-10 (BC-11 to ground)
- 1 Extension Cord, type CD-11 (BC-11 to fairlead)
- 1 Extension Cord, type CD-17 (BC-11 to filter)
- 1 Extension Cord, type CD-9 (BC-10 to BC-11, telephone receiver terminals)
- 1 Extension Cord, type CD-18 (BC-10 to BC-11, telephone transmitter terminals)
- 1 Airplane Interphone Set Box, type BC-10
- 2 Airplane Telephone Head Sets, type HS-1
- 2 Airplane telephone transmitters, type T-1
- 1 Extension Cord, type CD-6 (BC-10 to pilot's jack)
- 1 Extension Cord, type CD-7 (pilot's extension jack to push button switch)
- 20 Dry Batteries, type BA-3 (2 in use, 18 spares)

ANTENNA EQUIPMENT, TYPE A-21

- 1 Antenna Reel, type RL-2
- 2 Antenna Reel Drums, type DR-2
- 3000 ft. Antenna Wire, 16-strand, No. 30 B. & S gage soft copper, braided. Probable maximum length of antenna, 300 ft.
- 10 Antenna Weights, type WT-1 (1 in use, 9 spares)
- 2 Fairleads, type F-1 (type F-2 when type F-1 is not available) (1 in use, 1 spare)
- 20 ft. Braided Twine. (Breaking strength 70 to 80 lb.; treated with insulating compound; approximately 2 ft. in use)

**Parts List of SCR-59 Airplane Radio Receiving Set, Including Renewal Parts for
One Month's Service**

POWER EQUIPMENT, TYPE PE-14

- 2 Storage Batteries, type BB-4 (18-amp-hr., 4-volt, 3-cell Edison, with electrolyte in powdered form in separate containers)

RECEIVING EQUIPMENT, TYPE RC-2

- 1 Airplane Radio Receiving Set Box, type BC-12
- 1 Extension Cord, type CD-10 (BC-12 to ground)
- 1 Extension Cord, type CD-11 (BC-12 to fairlead)
- 1 Extension Cord, type CD-12 (BC-12 to battery)
- 8 Vacuum Tubes, type VT-1 (3 in use, 5 spares)
- 8 Dry Batteries, type BA-2 (2 in use, 6 spares)
- 1 Extension Cord, type CD-9 (BC-10 to BC-12, telephone receiver terminals)
- 1 Airplane Interphone Set Box, type BC-10
- 2 Airplane Telephone Head Sets, type HS-1
- 2 Airplane Telephone Transmitters, type T-1
- 1 Extension Cord, type CD-6 (BC-10 to pilot's jack)
- 1 Extension Cord, type CD-7 (pilot's extension jack to push button switch)
- 20 Dry Batteries, type BA-3 (2 in use, 18 spares)

ANTENNA EQUIPMENT, TYPE A-21

- 1 Antenna Reel, type RL-2
 - 2 Antenna Reel Drums, type DR-2
 - 3000 ft. Antenna Wire, 16-strand, No. 30 B. & S gage soft copper, braided. Probable maximum length of antenna, 300 ft.
 - 10 Antenna Weights, type WT-1 (1 in use, 9 spares)
 - 2 Fairleads, type F-1 (type F-2 when type F-1 is not available) (1 in use, 1 spare)
 - 20 ft. Braided Twine. (Breaking strength 70 to 80 lb.; treated with insulating compound; approximately 2 ft. in use)
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WAR DEPARTMENT,
OFFICE OF THE CHIEF SIGNAL OFFICER.

MEMORANDUM for Inclusion in S.C.R. Pamphlet No. 20.

Paste this warning between pages 14 and 15 of S.C.R. Pamphlet No. 20.

FIXED BLADE AIR FANS MUST NOT BE USED ON PLANES CAPABLE OF
TRAVELING AT HIGHER SPEEDS THAN THAT FOR WHICH THE FANS ARE DESIGNED.
DISREGARD OF THIS PRECAUTION IS LIKELY TO RESULT IN THE BREAKING OF THE
FAN WITH CONSEQUENT SERIOUS INJURY TO PILOT OR PLANE.