THE SCR–77–A LOOP SET.

Equipment.

1 set box, type BC–9.
1 equipment box, type BE–48.
1 loop, type LP.
1 battery case, type CS–17.
1 head set, type P–11.
6 tubes, type VT–1 (two good oscillators).
9 batteries, type BA–2.
1 battery, type BB–41.

Information.

The SCR–77–A set (see Fig. 95) provides undamped or continuous wave, two way, telegraph communication over the distances ordinarily separating regiments and battalions. The wave length range of the set, both transmitting and receiving, is from 74 to 76 meters. Within this range of two meters it is possible to work on nine different wave lengths without interference.

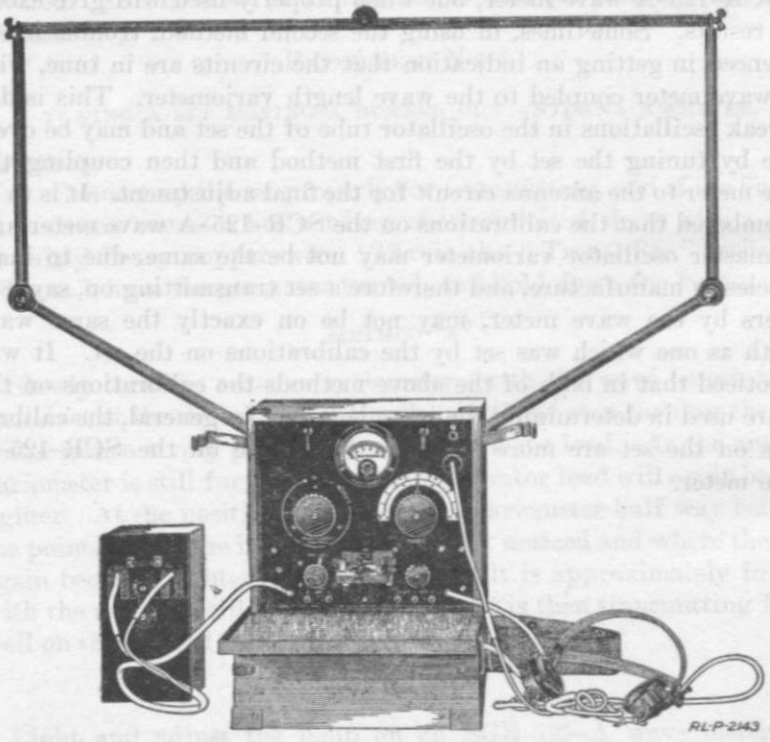

Fig. 95.—The SCR–77–A loop set.

The type of antenna used with the SCR–77–A set is called a *loop antenna.* This consists of a single turn of metallic tubing the ends of which are provided with suitable connection lugs for mounting the loop on the set box and making contact to the circuits in the box. The loop is assembled in three sections which are joined together by bolts and wing nuts. Each section is hinged so that it may be folded for packing.

Directions.

1. Look at the front, top, and rear of the set box. Note carefully how the various controls are marked, how the ammeter is marked, how the key is constructed, and how the sockets for the loop antenna in the rear are constructed.

Questions.

(1) *Into how many positions is the tuner scale divided?*

(2) *How is the filament lighting current connection made?*

(3) *How many pair of telephones can be connected to this set?*

(4) *Why are the luminous paint lines placed on the ammeter scale?*

(5) *Why are these lines placed at the scale markings 4, 5, and 6?*

(6) *Where is the loop connection made to the inside of the set box?*

Directions.

2. Look at the loop antenna of this set. Note the construction and the method of attachment to the set box.

Questions.

(7) *Of how many distinct parts does the loop consist?*

(8) *Why is this type of construction preferred in this case?*

(9) *How is the loop fastened on to the set box proper?*

(10) *Why are wing nuts used on this antenna instead of ordinary hexagonal nuts?*

(11) *Where is the antenna carried during transportation of the set?*

(12) *Why is the antenna given a black finish?*

Information.

In the SCR–77–A the same circuit is used for both transmitting and receiving. (See Fig. 96.) In other words, the oscillator tube which furnishes power for transmitting serves as a detector when

receiving signals. These two functions may operate at the same time. The receiving circuit is provided with two additional tubes which are used as audio-frequency amplifiers. These tubes, combined with audio-frequency transformers amplify the signals from the detector-oscillator. When the set is operating, a special filter circuits from entering the amplifier tubes or the potentiometer circuit, but allows the direct and audio-frequency currents to flow.

The oscillator tube circuit consists of an inductance (the loop), several fixed condensers, and two variable condensers. The plate and grid circuits of the oscillator tube are coupled by the two fixed con-

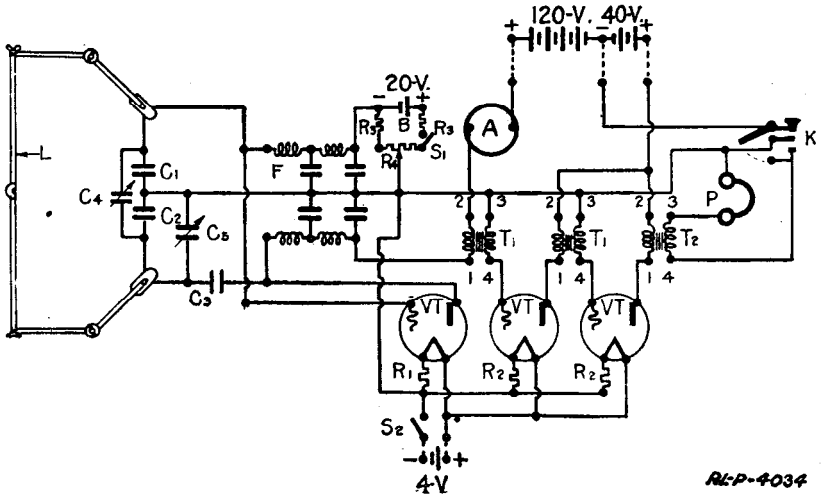

Fig. 96.—Schematic diagram of connections in the SCR-77-A set.

densers connected in series across the loop antenna terminals. A single moveable-plate variable condenser is connected across one of the fixed coupling condensers and enables the oscillator tube circuit to be tuned over a narrow band of wave lengths. A specially constructed two-plate variable condenser is connected directly across the loop terminals. This condenser, called the "screw driver" condenser, is mounted on the inside of the back of the set box with a large slotted head machine screw projecting through the back of the box, so that the condenser may be adjusted or varied without opening the panel of the set. The object of the "screw driver" condenser is to make the calibration of several sets agree at one point on their respective tuner scales.

A 4-volt storage battery supplies the necessary current for lighting the filaments of the 3 VT-1 tubes used in the SCR-77A set. The

necessary plate potential for the detector-oscillator tube is supplied by the 120-volt battery (6 BA–2 batteries in series) carried in the equipment box, type CS–17. The plate potential for the amplifier tubes is supplied by a 40–volt battery (2 BA–2 batteries in series), which is also contained in the equipment box. (See Fig. 97.) In order to operate the set it is also necessary to supply the grid of the detector-oscillator tube with a potential. This voltage is obtained

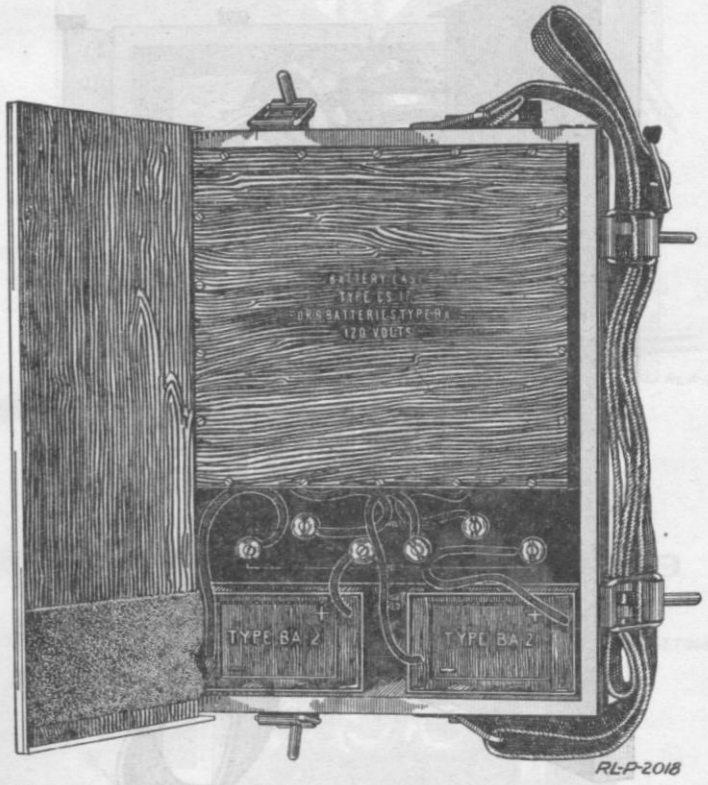

Fig. 97.—Battery compartment of equipment case, type CS–17.

from 1 BA–2 battery which is mounted in a special container on the rear of the panel of the set. As this voltage must be closely regulated or controlled, a variable resistance called a "Potentiometer" or "Controller" is connected across the grid battery. By careful adjustment of this controller the proper potential is supplied to the grid. A switch, used for turning the filament current on and off, also provides a means for opening the controller circuit, so that the grid battery will not have current drawn from it when the set is not

in use. The battery box also contains compartments for 3 spare VT–1 vacuum tubes and a head set. (See Fig. 98.)

In the circuit diagram of the SCR–77–A set (see Fig. 96) it will be noticed that the phones are in series with the secondary winding of a special transformer the primary of which is in the plate circuit of

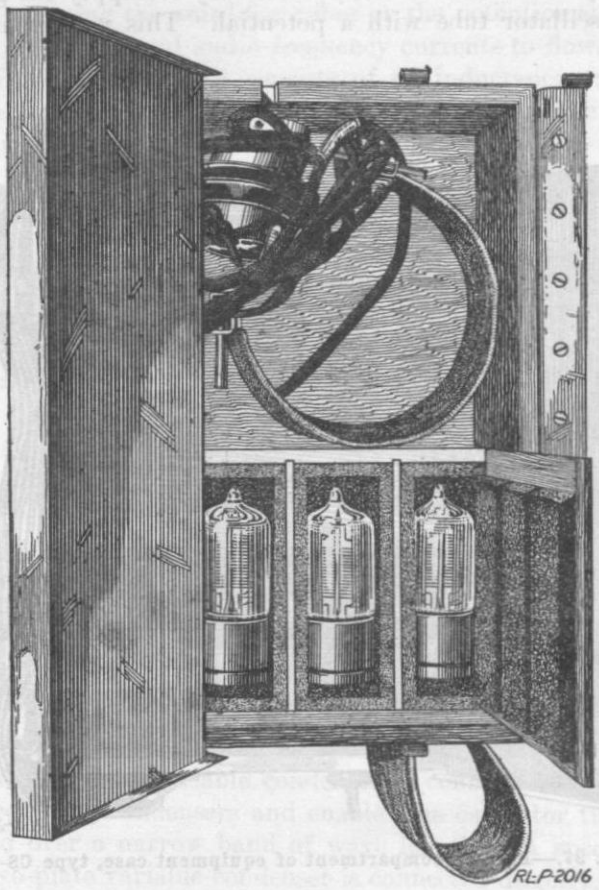

Fig. 98.—Head set and spare vacuum tube compartment of equipment case, type CS–17.

the last amplifier tube. The phones and the secondary of this transformer are across the lower contact and a special middle contact of the telegraph key. The middle contact is also connected to the negative filament terminal. The contact in the key arm is connected to the negative side of the 120-volt and 40-volt "B" batteries. The purpose of this arrangement is to eliminate the loud noise that other-

wise would be produced in the phones whenever the telegraph key is operated.

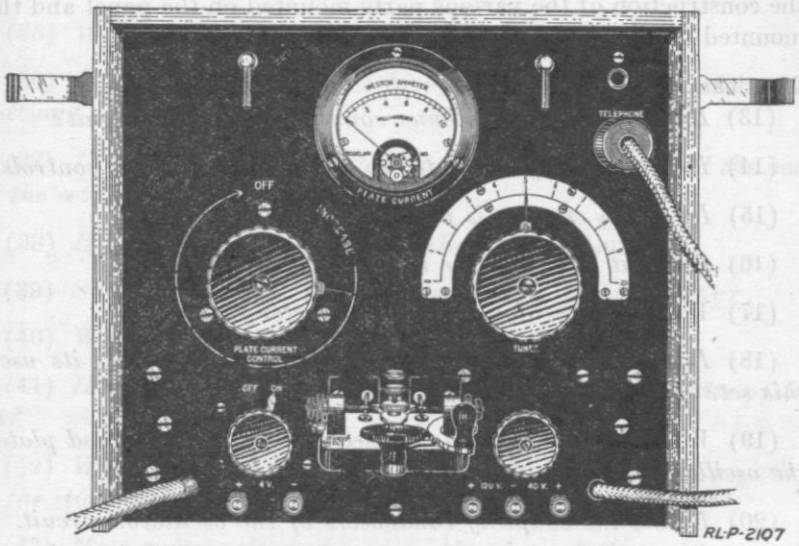

Fig. 99.—Set box, type BC–9 with front cover removed.

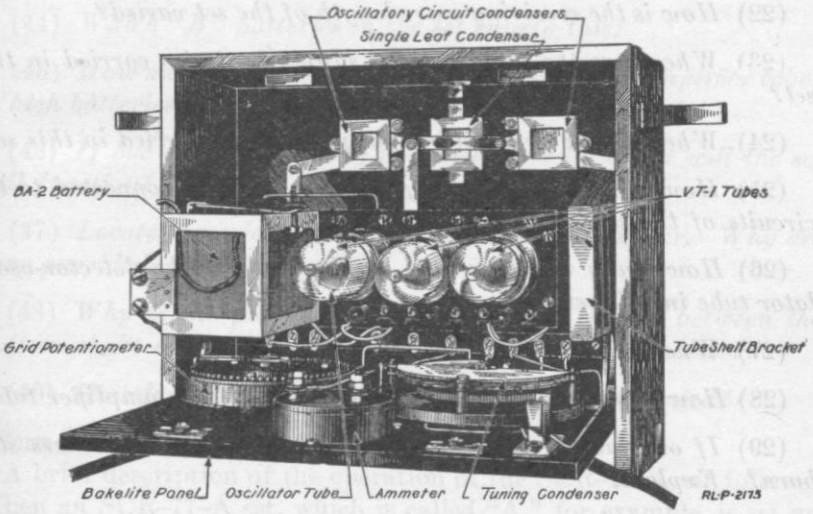

Fig. 100.—Front panel of set box, BC–9, lowered to show interior parts.

Directions.

3. Turn the two catches on the upper edge of the panel and swing the panel forward. (See Figs. 99 and 100.) Reach inside the set box and on the bottom will be found three thumb nuts. Remove these

thumb nuts and lift off the wires connected to the bolts. The panel may now be lifted up and forward and removed from the box. Note the construction of the various parts mounted on the panel and those mounted on the inside of the back of the set box.

Questions.

(13) *How is the loop antenna connected into the circuit?*

(14) *How is the key connected to the circuits which it controls?*

(15) *In which circuits is the key?*

(16) *In what circuit is the milliammeter?*

(17) *What current does the milliammeter read?*

(18) *Locate the "screw driver" condenser. What is its use in this set?*

(19) *What kind of coupling is used between the grid and plate of the oscillator tube?*

(20) *Locate the coupling condensers of the oscillator circuit.*

(21) *How is the transmitting wave length of the set varied?*

(22) *How is the receiving wave length of the set varied?*

(23) *Where are the plate voltage supply batteries carried in this set?*

(24) *Where is the grid voltage supply battery carried in this set?*

(25) *How are the plate voltage supply batteries connected to the circuits of the set?*

(26) *How many volts are used on the plate of the detector-oscillator tube in this set?*

(27) *What batteries supply this voltage?*

(28) *How many volts are used on the plate of each amplifier tube?*

(29) *If one tube is removed from its socket, will the others still burn? Explain.*

(30) *Locate the potentiometer and the fixed resistances in series with it.*

(31) *Why are the fixed resistances used?*

(32) *What kind of coupling is used between the different stages of the amplifier?*

(33) *Locate the audio frequency transformers?*

(34) *Which is the oscillator tube socket?*

(35) *Which are the amplifier tube sockets?*

(36) *Are the amplifier tubes being used when the set is transmitting? Explain.*

(37) *In general, what circuit is mounted on the inside of the back of the set box?*

(38) *How should the contacts of the key be adjusted?*

(39) *Should the joints of the loop be kept tight? Why?*

(40) *Where are the "B" batteries carried in this set?*

(41) *How are the "B" batteries connected to the circuits of the set?*

(42) *Which binding posts are positive and which are negative, as the student looks from the front of the set?*

(43) *How many volts are used on the plate of the oscillator tube in this set?*

(44) *Which "B" batteries in the set supply this?*

(45) *How many volts are used on the plate of each amplifier tube? Which batteries supply this?*

(46) *If one amplifier tube is removed from its socket will the set still function? Explain.*

(47) *Locate the grid resistances and the potentiometer. Why are they provided in this set?*

(48) *Why is the piece of varnished cambric placed between the bottom choke coil and the aluminum of the battery container?*

(49) *How is the receiving wave length of this set varied?*

Information.

A brief description of the operation of the SCR–77–A set follows: When an SCR–77–A set, which is called "A," for example, is set up and properly connected and the key is closed, the set will transmit and receive at the same time. In other words, the oscillator tube is generating impulses which leave the the loop antenna in the form of continuous waves, while at the same time, the tube is acting as a detector of incoming waves. If another SCR–77–A set, "B," is erected

and put in operation at a suitable distance from set A and its key closed, it will send out continuous waves and detect incoming signals at the same time.

If set B is now tuned to almost the same wave length as set A, a musical or whistling note, called a "beat" note, will be heard in the telephone receivers of both sets. The action taking place in set B is as follows: The impulses generated by the oscillator tube of set B are combined with the impulses received from set A. This combination of impulses is detected by the oscillator tube of set B and causes a musical beat note to be heard in the telephone receivers of the set. The action in set A takes place in the same way. The impulses generated by the oscillator tube of set A are combined with the impulses received from set B and a beat note is heard in the receivers of set A due to the detector action of the oscillator tube in this set. When the two sets are operating as described above a beat note will be heard in the telephone receivers of both sets at the same time. If the key of either set is opened the beat note in the telephone receivers of both sets will cease.

If communication is to be established between the two sets, the levers on the sides of the keys of both sets are first closed. The tuner knob of one set is adjusted to any given setting on the dial and is left in that position. The tuner knob of the other set is adjusted until a strong beat note is heard. This beat note should be heard in the telephone receivers of both sets except under certain conditions which will be described later. If the operator of set A desires to send a message, he opens his key lever and proceeds to transmit. When he has finished, he closes the key lever and is ready for receiving. The operator at set B opens his key lever as soon as the operator at set A has finished and proceeds to answer. In this way it may be seen that in order to transmit the key lever must be open and to receive, it must be closed.

This method of operation of the SCR–77–A set makes possible the "break-in" system. Either operator, when two sets are in communication, may interrupt or "break-in" on the sending of the other. For instance, if the operator of set A is sending a message and the operator of set B misses a word, the operator of set B immediately opens his key lever and after waiting a few seconds advises the operator at set A of that fact. As the operator of set A can not hear his own transmitted signals when the key switch of set B is opened, he will thus know that the operator of set B is breaking in, and will accordingly close the key switch of set A and stand by for signals from set B. In the same way the operator of set A can break-in when set B is transmitting.

In order to obtain maximum efficiency in the operation of the SCR–77–A set it is necessary to use a VT–1 tube in the oscillator socket which has been especially selected for this purpose. Since this tube must fulfill two functions, i. e., as an oscillator and as a detector, two sets of conditions will be given for selecting the tube. These two sets of conditions are opposed to each other so that the best that can be done is to compromise between the two in the final selection.

The best oscillator tube, that is, the one which will transmit the best, is the tube which, when placed in the oscillator socket and with the set in operation can be made (by adjusting the controller) to draw the greatest plate current and at the same time to show the greatest drop in plate current when the loop is touched with the bare hand. If one tube can be made to draw 8 milliamperes and drops to 6 milliamperes when the loop is touched, it is a better oscillator than a second tube which will draw 6 milliamperes and drops to 4 milliamperes when the loop is touched. However, if the second tube drew 6 milliamperes and dropped to 3 milliamperes when the loop was touched it would probably be a better transmitter tube than the first tube.

The best detector tube, that is, the one which will receive the best, is the tube which, when placed in the oscillator tube socket and with all connections properly arranged, can be made (by adjusting the controller) to draw the least plate current and still show a slight drop when the loop is touched. Thus a certain tube may draw only one milliampere. The meter needle indicates a slight decrease in reading when the loop is touched and returns to the one milliampere reading when the hand is removed from the loop. Another tube can not be made to draw less than 2 milliamperes. The meter needle indicates a slight decrease in reading when the loop is touched and returns to the 2 milliampere reading when the hand is removed from the loop. The first tube is the better detector of the two and since it is a poorer oscillator than the second tube it will cause less interference on any tuner setting when listening in on the transmission of another station.

The tube, therefore, finally selected for the oscillator should be one which will best fulfill both the oscillator and detector conditions with different settings of the controller.

Due to the fact that the plate current is supplied by BA-2 batteries and that these batteries will not supply over 6 milliamperes without greatly shortening their life, it is best to use in transmitting not more than the above value of plate current. Occasionally,

when a distant station can not be reached with signals loud enough scale slowly, and if there is another SCR–77–A set transmitting only, to 8 or 9 milliamperes, provided that the tube used is a better oscillator at that value of plate current.

To place the set in operation, insert and connect the necessary batteries in the equipment box. (See Fig. 95.) Place the set box on top of the equipment box and clamp the two together; and connect, with the proper polarity, a 4-volt storage battery to the battery leads from the set. Open the panel and insert a selected oscillator tube in the oscillator tube socket, insert two amplifier tubes in the amplifier tube sockets. Close the panel. Insert the plug of the plate-battery connecting cord in the jack provided in the equipment box and plug in a headset. With the key lever closed, turn the filament switch to the "On" position and adjust the controller until the tube is oscillating strongly as shown by touching the loop and noting the meter deflection. Turn the tuner over its scale slowly, and if there is another SCR-77A set transmitting within range, a beat note will be heard in the headset.

EXPERIMENT No. 1.

THE SELECTION OF OSCILLATOR TUBES FOR THE SCR–77–A.

Information.

Oscillator tubes for the SCR–77–A must be selected before the set is sent into the field for operation. At the most, only one out of every ten or fifteen tubes tested will prove satisfactory for use in the oscillator tube socket of this set. Every SCR–77–A set going into the field should have with it at least two and, if possible, three or four selected oscillator tubes.

The selection of the oscillator tubes should be based on the information given on this subject earlier in this Unit Operation, and should be carried out in the following manner:

Directions.

4. To connect up the set ready for operation proceed as follows:

a. Open up the rear compartment of the equipment box, type BE–48, and insert a battery case, type CS–17, which shows a reading of at least 110 volts when tested with a voltmeter. Connect the positive and negative leads to the two binding posts marked "+ 120" and "— 120" volts, with the proper polarity. Place two BA–2 batteries in the small compartment and connect their leads with the correct polarity to the four binding posts marked "40 volts." Close the compartment.

b. Place the set box on top of the equipment box in the correct position and clamp the two together.

c. Remove the loop from its carrying bag, straighten out the three pieces to their correct shape, and clamp their hinged joints tightly. Place the two sides of the loop in their respective sockets on the back of the set box and put the top bar in place, at the same time tightening up the wing nuts which hold it. Go over the entire loop and see that all joints are tight.

d. Open up the front cover of the set box sufficiently to pull out the plate battery connecting cord and plug and lay it to the right of the set. Open up the front compartment of the equipment box, remove the tubes and head sets which are to be used in operating the set, and plug in the plate battery connecting plug into the jack provided. Lay the cord in the little notch on the right side of the compartment and close the compartment.

e. Let down the front cover of the set box all the way and open the panel. (See Fig. 100.) Place a BA–2 battery in the compartment attached to the panel and connect the leads from this battery to the two binding posts on the side of the compartment with the polarity as marked. Place two VT–1 tubes in the two amplifier tube sockets.

f. Connect the red terminal of the storage battery cord which extends from the panel to the positive terminal of a 4-volt storage battery and the black terminal of the cord to the negative terminal of the battery.

g. See that the filament current switch is in the "On" position.

h. The set is now ready to operate with the exception of placing a selected oscillator tube in the oscillator tube socket, closing the panel, and plugging in a head set.

5. The student will be supplied with 20 VT–1 tubes out of which the tubes suitable for use in the SCR–77–A set must be selected. Each tube has a number written on a small piece of paper pasted on the glass of the tube. Refer to the tubes by their number in stating the qualifications of each tube in this experiment.

6. Insert one of the tubes in the oscillator tube socket of the set, close the panel and see that the key lever is closed. Vary the controller and determine if the tube will oscillate at any value of plate current within the range of the set. If it does oscillate (as shown by the decrease in plate current when the loop is touched) determine the points at which it is the best oscillator and the best detecor. Re-

peat the above for each of the 20 tubes given you and fill out a table similar to the one shown below.

Tube No.	For best oscillations.		For best detection.	
	Plate current.	Deflection.	Plate current.	Deflection.

NOTE.—If a tube can not be made to oscillate with any adjustment, write down its number and put an x in each of the columns opposite that number.

Questions.

Study carefully the table which has been filled out and answer the following questions:

(50) *State by number, in the order of your choice, the three tubes which are the best oscillators.*

(51) *State by number, in the order of your choice, the four tubes which are the best detectors.*

(52) *State by number, in the order of your choice, the three tubes which best fulfill both qualifications as a detector and an oscillator.*

(53) *State your reasons for choosing the tubes selected in response to question 52.*

(54) *If all of the stations which are to be communicated with are very close to each other, which tube would you use? State the number of the tube.*

(55) *Which tube would you use in order to cover the extreme range of an SCR–77–A set? State the number of the tube.*

(56) *Suppose that the plate current milliammeter shows no reading, but that otherwise the set is working, could you tell by listening in the headset whether or not a tube was oscillating? If so, how?*

(57) *Out of the 100 VT–1 tubes, how many would you expect to be suitable for use in the SCR–77–A set as oscillators?*

EXPERIMENT No. 2.

CHOOSING A "MASTER" SET AND CALIBRATING ALL SETS.

Information.

With the SCR–77–A set the different wave lengths are referred to as "tuner settings." Due to the fact that these tuner settings are very close together and that the set always works on a tuner setting which is not assigned to any other set within range, it is of extreme importance that the tuner settings of all sets within range check together. Whenever intercommunicating radio sets are working on different wave lengths it becomes very important that the different wave length settings on all of the sets be exactly alike, so that when one of the sets tunes to the wave length of another it is really on the wave length desired.

As mentioned before, the SCR–77–A set covers a wave length range of 2 meters, but due to slight and unavoidable differences which arise in manufacture, some sets will cover a slightly greater and some a smaller wave length range. Therefore it is necessary when selecting a set as the "master set," with which all other sets are to be oscillated, to choose the one which covers the smallest or shortest wave length range. This is necessary, for the reason that, if some of the sets to be checked cover a smaller range than the master set, it would be impossible to check them on all of the calibrations of the scale of the master set. After the master set has once been chosen the same set should be kept as the master set as long as it operates or does not become damaged in any way which affects its calibration.

Directions.

7. *To choose the "master set."*—1. Set up any one set as a temporary master set and place it in operation. Turn the adjustment screw of the screw driver condenser in a clockwise direction as far as it will go and then give the screw exactly four complete turns in a counterclockwise direction. With the screw in this position the screw driver condenser is adjusted at one-half its total capacity, which is the correct adjustment for the master set.

8. Set up one of the sets to be tested about 200 yards from the master set and place it in operation. Turn the tuner knob of the master set to tuner setting No. 5. Slowly turn the tuner knob of the set being calibrated until the beat note is heard. If the beat note is

heard on a setting below the No. 5 setting, the adjustment screw of the screw driver condenser of the set under test must be turned in a counterclockwise direction. If the beat note occurs above the No. 5 setting, the adjustment screw of the screw driver condenser must be turned in a clockwise direction. The adjustment screw of the screw driver condenser must be turned in the directions stated until a " zero " beat note is obtained with the tuner knob set on exactly the No. 5 setting. The explanation of the term " zero beat note " is as follows:

9. When one set is being tuned to another the beat note is at first heard in the form of a very high pitched whistle as the tuner dial is slowly turned. If the operator continues turning the dial in the same direction, the whistle will become lower and lower in pitch until a point is reached where no sound is heard at all in the receivers. When the beat note disappears at this point, it is at zero value and is known, therefore, as the " zero beat note." If the dial is turned beyond this point, the whistle or beat note will again be heard, first as a very low whistle, and then gradually going higher in pitch until it is inaudible.

10. When the set under test has been adjusted to a zero beat note on tuner setting No. 5, turn the tuner knob of the master set to the No. 1 setting and vary the tuner knob of the set under test until a zero beat note is again obtained. Note whether the zero beat note is obtained above or below the No. 1 setting on the scale of the set under test.

11. Repeat Direction 10 with the tuner of the master set on setting No. 9.

Questions.

(58) *If in Direction 10 and 11 the zero beat note settings were below setting No. 1 and above setting No. 9, has the set under test a smaller wave-length range than the set selected for the temporary master set or greater?*

(59) *If the zero beat note settings were above setting No. 1 and below setting No. 9, has the set under test a smaller or greater wave length than the temporary master set?*

(60) *If both zero beat note settings of the set under test were either above or below Nos. 1 and 9, has the set under test a smaller or greater wave-length range than the temporary master set?*

Directions.

12. If settings are obtained as outlined under either Question 59 or Question 60 above, place the set tested to one side. Proceed to test another set, following the instructions as given in Directions 7, 8, and 9.

13. If settings are obtained as outlined under Question 58 above, take the set tested and substitute it in place of the temporary master set. Adjust the new temporary master set as explained in Direction 7, and continue the testing of sets.

14. If, while testing the remaining sets, another set is found which has a shorter wave-length range than the sets which have already been tested, substitute this set as before in place of the temporary master set. This process should be repeated until a set is found which has the shortest wave-length range of all the sets tested. The set having the shortest wave-length range should be chosen as the permanent master set.

15. *To calibrate all sets.*—Set up the master set and place it in operation. Adjust the screw-driver condenser of the master set as explained in Direction 1 above.

16. About 200 yards away set up and place in operation one of the sets to be calibrated. No sets other than the two already mentioned should be in operation.

17. Adjust the tuner knobs of both the master set and the set to be calibrated to setting No. 5 and vary the screw-driver condenser of the set to be calibrated until a zero beat note is obtained.

18. Adjust the tuner knob of the master set to setting No. 1 and turn the tuner knob of the set under calibration until a zero beat note is obtained. When adjusting the tuner knob of the set under calibration, the zero beat note may not occur exactly on the No. 1 setting. If this happens, mark the exact position of the tuner pointer where the beat note does occur by drawing a single pencil mark on the scale of the tuner extending from the black line in the center of the scale to the inner edge of the scale. Opposite the outer end of this mark place the figure "1."

19. Repeat Direction 18 above, with the tuner of the master set adjusted successively set on tuner settings Nos. 2, 3, 4, 6, 7, 8, and 9. The result should show that the set being calibrated checks with the master set setting on No. 5 and either checks or has a pencil calibration which does check with all other settings on the master set.

NOTE.—SCR-77-A sets are never calibrated on settings Nos. 0 and 10, due to the fact that at these positions of the tuner the amount of change obtained by turning the tuner is very little and quite erratic.

20. Repeat directions 15 to 19 above for all sets which have to be calibrated, taking one set at a time and completing its calibration before going to the next.

Questions.

(61) *Why is it necessary to select a set as the master set?*

(62) *What should be the qualifications of the set to be used as the master set?*

(63) *If the movable plate of the master set tuner condenser should become bent, would a new master set have to be selected?*

(64) *Does the position of the controller affect the tuner settings of a set?*

(65) *In selecting a master set, why are the sets first made to agree on the No. 5 setting?*

(66) *As the screw-driver condenser adjustment is turned clockwise does the capacity of the condenser increase or decrease?*

(67) *In checking calibrations by means of the screw-driver condenser, why is it necessary to turn the screw-driver condenser adjustment in a clockwise direction if the position of the tuner pointer of the set being calibrated is too high?*

(68) *Why can only one set be calibrated at a time?*

(69) *If only a few of the tuner settings were to be used, would it be necessary to calibrate all of them?*

(70) *Why are the sets separated by several hundred yards while calibration is going on?*