This invention relates generally to radio apparatus and in particular to a portable self-contained combination radio receiver and transmitter unit.

The combination portable radio receiver and transmitter units now generally used are not entirely satisfactory because of their bulk and weight, and the inconveniences encountered in setting them up for operation. In most instances these prior art sets are not self-contained as a package unit and usually include an earphone unit or an antenna unit which are separately attachable to the body of the set by extension wires or the like. As a result these are not capable of operation immediately on reaching a new destination or while enroute to such destination, since some time must be used for assembling the earphone or the antenna units and for making various tuning and control adjustments. Further because of the bulk of the sets they are difficult to handle and generally too heavy to be manually supported while in operation. In fact many of them require special supporting means upon which the various parts of the set are relatively arranged in a manner to facilitate their use. The maneuverability and the flexibility of application of these sets to the various field demands required of sets of this type, such as in an army signal corps, police work and the like, is thus appreciably restricted.

Even after the sets are assembled for operation considerable delay is usually involved in the transmission and reception of signals because of the time lost in changing from transmitting to receiving and vice versa. Also because of their relatively complicated structure, the component parts of the prior art sets are usually completely dismantled for servicing and replacement purposes. Another objection to these sets is that they are open to the atmosphere whereby their use on rainy days is generally impaired or restricted to places having suitable shelters therefor. Further these sets are generally unprotected against rough handling or dropping so that great care must be exercised at all times to prevent permanent injury thereto.

It is an object of this invention, therefore, to provide an improved radio apparatus.

Another object of this invention is to provide an improved combination radio receiver and transmitter unit.

A further object of this invention is to provide a portable self-contained radio receiver and transmitter set which is capable of being operated while held in one hand of the operator and in which the earphone and microphone units are relatively arranged as in a telephone set.

Yet another object of this invention is to provide radio apparatus which is completely waterproof so that it may be entirely submerged without in any way impairing its operation.

A still further object of this invention is to provide a portable radio receiver and transmitter set, which is capable of being supported in one hand and in but one position for either transmitting or receiving, and in which a manually operated switch for changing the set to operate as either a receiver or transmitter is arranged for manipulation by the hand supporting the set.

Another object of this invention is to provide a portable radio receiver and transmitter set in which all of the parts comprising the set are contained within a single housing structure, and of a construction such that they may be easily and individually removed from the housing for replacement or servicing purposes.

Yet another object of this invention is to provide a self-contained portable combination radio receiving and transmitting set which is compact, light in weight, and in which all of the parts are completely protected so that the set is capable of withstanding rough treatment and heavy usage without injury thereto.

A still further object of this invention is to provide a portable radio transmitting and receiving set which can be supported for operation in one hand of the operator and which is immediately operable without requiring any preparatory assembly work or preliminary circuit adjustments.

A further object of this invention is to provide a portable radio receiving and transmitting system which can be efficiently operated by an unskilled operator.

A feature of this invention is found in the provision of a portable self-contained radio receiving and transmitting unit in which all of the component parts thereof are adapted to be completely enclosed and assembled within an elongated housing so that the set can be comfortably grasped in one hand for operating and transporting purposes.

Another feature of this invention is found in the provision of radio equipment capable of being completely enclosed within an elongated housing in which linearly movable contact means for longitudinally extending switch means within the housing is actuated by manual means on the outside of the housing movable substantially in
a direction normal to the linear direction of movement of said contact means.

Yet another feature of this invention is found in the provision of portable radio receiving and transmitting apparatus in which the operating parts are relatively arranged to completely eliminate any long leads for electrically connecting the same. Circuit losses in the apparatus are thus reduced to a minimum.

A still further feature of this invention is found in the provision of a self-contained radio receiving and transmitting system in which the battery energy supplied to the vacuum tubes is automatically decreased when the set is operating as a receiver so as to conserve the battery energy for transmitter operation.

Still another feature of this invention is found in the provision of radio equipment in which an antenna of telescopic or disappearing type is operatively associated with the radio power switch to actuate the same, with the relatively extended positions of the antenna being utilized to indicate the status of the switch of the receiver.

Further objects, features, and advantages of this invention will become apparent from the following description when taken in connection with the accompanying drawings in which:

Fig. 1 shows the complete radio receiver and transmitter unit of this invention supported for operation in but one hand of the operator;

Fig. 2 is a front perspective view of the radio unit of this invention as it appears when not in use;

Fig. 3 is a perspective view of the invention looking at one end thereof, with such end being opened to show the relative arrangement of the chassis unit and battery units, which comprise all of the component operating parts of the invention, in a single housing structure;

Fig. 4 is a plan view of one of the end covers for the housing structure;

Fig. 5 is a transverse sectional view through the housing structure showing the assembly of the battery units therein;

Fig. 6 is a plan view of the chassis unit, the unit being shown in actual size;

Fig. 7 is a side elevational view of a transparent insulating member which forms a part of the switch means for changing the operation of the combination set of this invention from a receiver to a transmitter and vice versa;

Fig. 8 is a plan detail view of the change-over switch means;

Fig. 9 is an elevational view of the chassis unit looking at one side thereof;

Fig. 10 is an elevational view of the chassis unit as seen from the other side thereof;

Fig. 11 is an elevational view of the chassis unit looking at one end thereof along the line 11—11 and showing the means for retaining the receiver and the transmitter crystals in assembly position;

Fig. 12 is a fragmentary sectional view as seen along the line 12—12 in Fig. 10;

Fig. 13 is an elevational end view of the chassis unit as seen along the line 13—13 in Fig. 10;

Fig. 14 is a transverse sectional view taken along the line 14—14 in Fig. 6 showing a portion of the structure for supporting an antenna of telescopic type on the chassis unit;

Fig. 15 is a fragmentary sectional view as seen along the line 15—15 of Fig. 14;

Fig. 16 is a fragmentary sectional view showing the assembly of the antenna with the housing structure, and the means for holding the chassis unit in a fixed position within the housing structure;

Fig. 17 is a fragmentary sectional detailed view showing the assembly of a projecting portion with the lower portion of the telescopic antenna;

Fig. 18 is a front view of an antenna coil utilized in this invention;

Fig. 19 is a transverse sectional view taken approximately along the line 19—19 of Fig. 9;

Fig. 20 is a sectional view taken along the line 20—20 in Fig. 19 showing the assembly of a socket portion for a vacuum tube with a base member of the chassis unit;

Fig. 21 is a fragmentary sectional view taken along the line 21—21 in Fig. 20 showing a combination resistor and condenser unit adapted for cooperative assembly with the tube socket of Fig. 20;

Fig. 22 is a plan view of the combination resistor and condenser unit shown in actual size;

Fig. 23 is an elevational view also in actual size of the unit shown in Fig. 22;

Fig. 24 is a fragmentary sectional view of the combination resistor and condenser unit as seen along the line 24—24 in Fig. 23;

Fig. 25 is an exploded view in perspective of the combination unit;

Fig. 26 is an exploded longitudinal sectional view of the combination unit;

Fig. 27 is a transverse sectional view taken along the line 27—27 of Fig. 26;

Fig. 28 is an elevational end view of the inductance unit of Fig. 26 taken along the line 28—28 in Fig. 26;

Fig. 29 is an elevational view of the inductance unit of Fig. 26 as seen along the line 29—29 in Fig. 26;

Fig. 30 is an elevational view of a base portion for the inductance unit in Fig. 26 as seen along the line 30—30 in Fig. 26;

Fig. 31 is a fragmentary sectional view showing the manually operated means for actuating the change-over switch means;

Fig. 32 is a side view of the complete unit of this invention showing the same ready for operation;

Fig. 33 is a fragmentary sectional view of the earphone means taken along the line 33—33 in Fig. 22;

Fig. 34 is a transverse sectional view taken along the line 34—34 in Fig. 22 showing the microphone unit and its assembly within the housing structure relative to the chassis unit and battery units;

Fig. 35 illustrates diagrammatically a complete circuit for the unit of this invention;

Fig. 36 illustrates diagrammatically a circuit showing the connection of the filaments for the vacuum tubes in the diagram of Fig. 35;

Fig. 37 illustrates diagrammatically the receiving circuit of the invention;

Fig. 38 illustrates diagrammatically the circuit for the tube filaments when the invention is operating as a receiver;

Fig. 39 illustrates diagrammatically the transmitting circuit for this invention and;

Fig. 40 illustrates diagrammatically the circuit for the connection of the filaments of the vacuum tubes when the invention is functioning as a transmitter.

In practicing this invention there is provided a mobile self-contained combination radio receiver and transmitter set which is compact and light in weight so as to be easily carried about or supported in one hand. The set includes a
chassis, battery, microphone and earphone units, each of which is of a preassembled construction and capable of separate assembly in or removal from a common housing. The housing has open ends which are closed by removable cover plates, the housing being divided into a plurality of longitudinally extending compartments for receiving corresponding ones of the chassis and battery units. On removal of the housing cover plates the units are immediately accessible for easy removal from the housing. The housing is of an elongated construction so that it can be readily grasped in one hand, hence the earphone and microphone units being relatively arranged therein so that the set can be held in an operating position by the operator in a manner similar to that of the well-known telephone set.

A single switch means is utilized to change the set over from operating as a receiver to a transmitter and vice versa. The switch means is assembled as a part of the chassis unit and is positioned entirely within the housing. A manually operated unit for actuating the change-over switch projects outwardly from one side of the housing and is arranged relative to the earphone and microphone units so as to be positioned below the one hand of the operator used in supporting the set in an operating position. It is necessary merely to press and release the change-over switch with such supporting hand to immediately change the set from a receiver to a transmitter and vice versa. The on and off control or energy supply switch for the combination set is actuated by the movement of the lower section of a disappearing antenna, which is assembled as a part of the chassis unit and has a portion thereof extending through one of the end cover plates for the housing. On pulling out of the lower section of the antenna outwardly from the housing the control switch is turned on, so that the extension of the lower section of the antenna from the housing indicates that energy is being supplied to the set. The set is adjusted to operate at a predetermined frequency so that no tuning or volume adjustments are required in the field. The set is thus immediately operative on extending the lower section of the antenna to supply energy thereto. Because the set is easily supported in one hand to a common operating position for both receiving and transmitting, it is readily apparent that the set can be used at any time regardless of whether the operator has arrived at his destination or is still enroute to such destination. The operating portion for the switch means, the housing cover plates, and the earphone and microphone units are all in a waterproofed assembly relative to the housing so that the complete set can be submerged in water without injury thereto. Since the set is completely enclosed within a common housing structure it is capable of being subjected to considerable rough handling and abrasive treatment without permanent injury thereto.

Referring to the drawings the combination radio receiver and transmitter set of this invention is illustrated in Figs. 2 and 3 as including an elongated housing 40 of substantially square cross section over its entire length and open at the ends 41 and 42 thereof. In order to make the complete set as light as possible in weight it is contemplated that the housing 40 be composed of aluminum or like material. The housing 40 is divided longitudinally by partition members 43 and 44 into compartments 46, 47 and 48 (Figs. 3, 5 and 34) for an “A” battery unit 49, a “B” battery unit 51, and a preassembled chassis unit 52, respectively. The batteries 49 and 51 are the sole source of energy supply for the set. The batteries 49 and 51 have contacts 53 and 54, respectively, at one of their corresponding ends, which are positioned at the open end 41 of the housing 40. The contacts 53 and 54 are thus positioned in proximity to contacts 55 and 57 respectively, carried on an end wall 58 of the chassis unit. The chassis unit 52 is connected through jack connections 59 and 61 to an earphone unit 62 and a microphone unit 63 (Fig. 3), respectively, which will be later fully described.

The wires 48 and 50 connecting the latter two units with the chassis unit 52 at the connections 59 and 61, respectively, are positioned in a space provided by an insulating spacing member 64 extended longitudinally of the “B” battery compartment 41 (Figs. 3 and 5).

The open end 41 of the housing 40 is closed by a door or cover plate 66 pivotally supported by hinge means 67 on the housing 40 and having contact bridges 68 and 69 carried thereon. On closing the cover 66 the contacts 53 and 54 are connected together by the bridge member 66, and the contacts 54 and 56 are connected together by the bridge member 66. Wires for connecting the batteries 49 and 51 with the chassis unit 52 are thus entirely eliminated. The cover 66 is releasably locked in its closed position by a swing bolt 71 pivoted at 72 to the housing 40 and receivable within a slot 73 formed in a projection 74 on the cover 66. With the shank portion of the bolt 71 positioned within the slot 73, tightening of the nut 76 clamps the cover 66 against the open end 41 of the housing.

The battery units 49 and 51 are of unequal lengths, the “B” battery 51 being equal substantially to the length of the housing 40 while the “A” battery 49 is only about half the length of the “B” battery. The partition member 44 does not completely separate the compartments or chambers 46, 47, and 48 from each other but functions primarily as a separating partition between the two battery units. The configuration of the compartments 46, 47 and 48 is such that only one corresponding battery unit will fit within a corresponding compartment. The battery units 49 and 51, therefore, cannot be inserted into a wrong compartment. Each of the battery units is inserted within its corresponding compartment in the housing 40 with the pressure of a corresponding collar spring 49A and 51A, respectively. The springs 49A and 51A are of conical form and similar in construction, the small ends thereof being extended within a corresponding compartment. Since each of the springs 49A and 51A is of a similar construction and similarly assembled with the cover plate 71 for closing the end 42 of the housing 40, only the spring 51A will be referred to in the following description.

The cover plate 77 is of a molded construction and of a substantially dish-shape, the end wall portion thereof being integrally formed with laterally extending projections 78 (Figs. 4 and 5) which are angularly spaced in a circular arrangement for receiving the large end of the springs 51A within the confines thereof. The spring 51A is retained within the confines of the projections 78 by means including a lug 79 integral with the cover plate 77 and having a radially pronged head portion 81. The spring 51A at the large end thereof is formed with an extending portion
of eyelet form for receiving the lug 78 therein. The lug 78 is substantially in the circular arrangement of the projections 76, with the head portion 81 having the prongs thereon bent toward the spring portion 82 to clamp the same against the cover 71. The spring 81A is thus retained against any movement relative to the cover 71. Since the battery 51 is substantially equal in length to the housing 40 the small end of the spring 81A is engaged directly against the inserted end 83 of the battery 51 and in electrical connection therewith to ground the same. However, because of the short length of the battery 48, the spring 48A is connected at the small end thereof with an extension member 64 which projects axially of the spring 48A and into the compartment 48. The inner end 68 of the extension member 64 (Fig. 5) carries a flat disc or plate 87 for bearing against the inner end 88 of the battery 49. A contact 85 on the disc 87 is electrically connected to the battery 49 to ground the same. It is to be understood of course that the extension 84 may be made of any desired length to accommodate any size battery within the compartments 46 and 47. In order to keep track of the date at which the batteries 49 and 51 are changed there is provided an indicating card 50B (Fig. 5) carried in a frame 50C having a transparent cover therein. The card 50B is removable from the frame 50C only when the cover 66 is open to prevent its becoming lost.

The chassis unit 82 is of a preassembled construction and is shown in Figs. 9, 10 and 11 in actual size. The chassis unit 82 includes a frame member 95 of substantially L-shape integrally formed with a base portion 91 and a supporting portion 99. Carried in the supporting portion 99 and in a spaced relation longitudinally thereof are peanut vacuum tubes T1—T5, inclusive. Since each of the vacuum tubes is similarly assembled in the supporting portion 99 only the vacuum tube T1 will be referred to in the following description.

As shown in Fig. 19 the tube T1 is protected outwardly from the supporting portion 99 and transversely across the base portion 91 so as to be substantially within the confines of the dimensions defined by the portions 99 and 91. The socket 92 for the tube T1 is adapted to be received in an opening 93 in the supporting portion 99 and is provided near the socket end 94 thereof with a metal bracket 95 which files flush against the inner side of the supporting portion 99. The end 97 of the socket projects outwardly from the supporting portion 99 and carries a plurality of connections 98 for connecting the tube elements into the radio circuit. The end 97 has mounted thereon an annular or ring-shaped combination resistor and condenser unit 99 which includes all of the resistor and condenser elements required in the circuit of the tube T1.

The combination unit 99 (Figs. 19 and 21—25, inclusive) consists of an annular insulating member 101 of channel shape, the open end 102 thereof being closed by a flat ring-shaped insulating cover 103. The unit 99 is shown in actual size in Figs. 22, 23 and 24 wherein it is seen that the annular member 101 is about one inch in diameter and about three eights of an inch deep. Within the space provided in ring member 101 are resistors R and condensers C, which are electrically connected together in a predetermined circuit arrangement to provide the desired circuit characteristics for the tube T1. Connections 105 for connecting the resistors and condensers to the connections 98 are extended outwardly from the combination unit 99 through the end wall portion 106 thereof. Of course all of the connections from the combination unit are not connected with the tube terminals 98. Some of these connections are connected to other portions of the radio circuit. These connections, therefore, are connected with the lug 165, secured to the body member 101 to facilitate their connections with any other part of the radio circuit.

With the condensers C and resistors R in position within the ring member 101, a suitable impregnating compound such as wax or the like, and indicated at W, is poured into the ring member 101 through the open side 102 thereof, the hardening of the wax retaining the positions of the elements and protecting the same against any short circuiting or exposure to moisture. The fibre ring 163 is then glued or otherwise suitably secured across the open end 102 of the ring member 101 to facilitate the connecting of the combination unit 99 in the tube circuit and to indicate the manner in which the resistor and condenser elements are connected therein, a circuit diagram for the unit, indicated at 165, is applied on the outer periphery of the ring 101.

In the assembly of the tube T1 with the frame member 99 there is utilized a grounding plate 107 which is positioned about the tube socket 92 and between the leg portion 99 of the frame member and the combination unit 99. As a result of the weight considerations in portable radio equipment the use of heavy materials must be eliminated wherever possible. Because of this fact, the frame member 99 which is a relatively large member, is composed of an aluminum material. Aluminum, however, does not readily bond with a solder material so as to provide an efficient electrical connection. To overcome this objection to aluminum relative to its soldering characteristics while benefiting from the light weight thereof, the grounding plate 107 is assembled therewith as will now be described. The plate 107 in one embodiment of the invention is composed of a brass material plated with silver which readily bonds with solder. The bracket member 96 for the socket 92, the supporting portion 99, and the plate member 107 are formed with aligned apertures to provide for their being riveted together.

With the plate 107 riveted with the supporting portion 99, and of a construction providing for its being soldered with other electrical connections of the tube circuit, the tube circuit is efficiently grounded to the frame member 99.

In the assembly of the combination unit 99 with the tube socket 92 the soldering of the connections 98 with the connections 99 on the socket 92 holds the combination unit in its assembly position on the socket. To initially retain the combination unit 99 in assembly position it may be cemented or glued to the grounding plate 107. Because of this compact assembly of the combination unit 99 with the tube unit, comprising the tube T1 and socket 92, it is seen that all of the electrical elements connected in the circuit for the tube T1 are confined substantially within the longitudinal and transverse dimensions of the tube unit.

Although the combination unit has been described with reference to a particular application thereof it is readily apparent that it is not limited to this one application, but can be constructed within the scope of this invention for use generally in a radio circuit. Considerable difficulty is usually encountered in the handling
and assembling of the condenser and resistor elements in a radio circuit. By virtue of the compact and insulated assembly of the elements in the unit 99, this unit can be conveniently arranged relative to the circuit in which it is used, and connections made therefrom to other portions of such circuit. Individual handling and assembling of the resistor and condenser elements in the connecting of the radio circuit is thus entirely eliminated, whereby to decrease the time usually required in making the connections and providing for more neat appearing and secure electrical connections.

Radio units are generally subjected to considerable hard use and rough handling so that in many instances the tubes are shaken loose from their supporting sockets. To retain the tube T1 in its position within the socket 92 there is provided means indicated generally as 100, and including a clip member 103 and a spring member 111 (Figs. 8 and 19). The clip member 103 is integrally constructed with a flat portion having an aperture 112 therein and an angular portion comprising a pair of spaced legs 113 and a portion 114 connecting the legs intermediate their ends so that a substantially rectangularly shaped opening 115 is formed between the legs 113. The spring 111 is of flat shape and is formed at one end with a c-shape or arcuate portion 117. The opposite end of the spring 111 is riveted to the base portion 91 of the frame member 85. The arcuate end 117 of the spring 111 is extended through the opening 115 in the clip member 103 in a manner such that the connecting portion 114 of the clip member 103 is locked between the spring end 117 and the base portion 91 while permitting pivotal movement of the clip member 103. On pivotal movement of the clip member 103 the legs 113 thereof function as a cam relative to the base portion 91 so as to raise and lower the spring end 117 relative to the base portion 91. This action of the legs 113 varies the pressure exerted by the spring 111 on the clip member 103 at the connection portion 114. With the clip member 103 positioned, as shown in Fig. 19, the legs 113 are bent outwardly away from the unsupported end 191 of the tube T1. Thus when the flat portion of the clip member 103 is in a substantially vertical direction the spring 111 urges the clip member 103 toward the tube T1. The clip member 103 is provided with a protecting metal can or shield 121 having a projecting annular lip portion 122 in the top thereof for reception in the opening 112 in the clip member 103. By virtue of the tension applied on the clip member 103 by the spring 111 the shield 121 is urged against the supporting portion 89, a rubber cushion 123 arranged between the end of the tube T1 and the top of the shield 121 absorbing any shocks which might be passed to the tube T1 and providing a yieldable connection between the clip member 103 and the tube. The cushion 123 thus retains the tube in a snug position regardless of the tolerance in tube lengths for the same type of tube.

When it is desired to remove the tube T1 from its socket 92 the clip member 103 is moved pivotally away from the tube T1 to its dotted line position indicated in Fig. 19. When the clip member 103 is in this dotted line position the pressure of the spring 111 is applied in a reversed direction relative to the flat portion of the clip member 103 because of the position of the legs 113. The spring thus acts to retain the clip member 103 in its flat or unclamped position. By virtue of this construction of the clip means 106, therefore, the clip member 103 is capable of having a pressure applied thereon in one direction to retain the tube T1 in a supported position, and in an opposite direction to hold it in an open position and away from the tube T1. It is to be understood of course, and as is shown in Fig. 9, that a clip means 103 is provided for each of the tubes T1—T9, inclusive, to retain them on the supporting portion 89.

Also carried on the supporting portion 89 and extending transversely of the base portion 91 is a first IF transformer L4 (Figs. 6 and 9) positioned intermediate the tubes T2 and T3, and a second IF transformer L5 arranged between the tubes T3 and T4. The transformers L4 and L5 are of a similar construction, the windings in each thereof being wound on a powdered iron core and surrounded by a powdered iron sleeve to further increase their inductance. This type of construction gives a high inductance with a very small winding to provide in all an efficient transformer of small size. The primary and secondary windings of the transformers are tuned by small adjustable mica trimmers, indicated at 124 and contained within a metal shield can 126 for each transformer.

Positioned intermediate the tubes T1 and T2 and extending transversely of the base portion 91 is an antenna coil L4 (Figs. 6 and 18) extending through and carried on the supporting portion 89 of the frame member 85 for the chassis unit 92. The antenna coil L1 is of a solenoid type and is wound on a polyurethane body portion 75.

The chassis unit 92 also includes a crystal M1 used when the set is operating as a receiver and a crystal M2 used when the set is operating as a transmitter (Figs. 9 and 6). The crystals M1 and M2 are of a similar construction and are contained in plug-in type holders carried in the supporting portion 89 near the end 127 of the chassis unit 92. It is contemplated that each of the crystal holders be suitably marked to correspond with an associated crystal so as to minimize the possibility of the crystals M1 and M2 being interchanged during the assembly of the chassis unit. The crystals M1 and M2 are extended transversely across the base portion 91 of the frame member 95 so that the free or unconnected ends thereof are positioned away from the supporting portion 89. To retain the crystals M1 and M2 in their supported positions there is provided a clip member 128 (Figs. 9, 11 and 16) integrally formed from a single piece of flat material, and having one end pivotally supported on axis means 129 normal to the plane of the base portion 91 and positioned substantially intermediate the ends of the crystals M1 and M2 and to one side thereof. The unconnected portion 131 of the clip member 128 is of a form corresponding to the shape of the ends of the crystals with the free end of the portion 131 having a catch portion 132 thereon for frictionally engaging the crystals M1 and M2 in a manner clearly shown in Fig. 16. When the crystals M1 and M2 are to be removed the clip member 128 is swingable about its axis 129 outwardly and away from the end 127 of the frame member 95 so that the portion 131 of the clip member is entirely removed away from the ends of the crystals.

An RF choke L3 (Figs. 6 and 10) is carried in an insulating housing 133 connected to a bracket 134 supported on the base portion 89 and arranged in alignment with the crystals M1 and M2 transversely of the base portion 91. The RF
amplifier tank condenser C12 (Figs. 6 and 9) is also carried in the supporting portion 89 and is arranged between the superposed crystals M1 and M2 and the tube T1. Positioned adjacent to the tube T8 and mounted on the base portion 81 of the antenna is an inductance L2 which functions as an audio output reactor for receiving and as a modulation choke for transmitting. The elements L3, L6 and C12 will be further explained in connection with the description of the circuit diagrams in Figs. 35, 37 and 39.

In the operation of the combination radio receiver and transmitter set of this invention, it is contemplated that a group of the sets be used for intercommunication purposes at a particular frequency. In other words, the members of a particular group of operators who are to be in communication with each other, will have their sets tuned to the same frequency so that they can communicate with each other in the field without having to make any adjustments to their sets. In one embodiment of the invention, the combination set is adapted to operate over a frequency range from 2500 to 6000 kc. Twelve antenna coils L1 are to be used to cover this frequency range, each antenna coil being marked to indicate the type of coil and the frequency range over which it is capable of operating. It is, of course, apparent that when a coil L1 in the antenna circuit is changed to provide for the operation of the set at a desired frequency that provision must be made for a corresponding frequency change in the R. F. circuits so that such two circuits may be tuned to resonance at the desired frequency. It is accomplishing a tuning of the R. F. circuit in resonance with the antenna circuit, there is provided an inductance unit indicated as L2 (Figs. 6 and 26 to 30, inclusive) which includes a body portion 174 and a supporting portion 176 secured to the portion 89 of the chassis unit frame member 98 by rivets 171. The coil 181 for the inductance unit L2 is wound about the outer periphery of the body portion 174. The body portion 174 has an internal bore 178 of hexagonal shape for receiving therein for slidably but non-rotatable movement an iron core 179 in the form of a hexagonal nut. The threaded aperture 182 in the nut 179 is threaded insulating screw 183 having a slotted adjusting portion 184 at one end and a peripheral groove 186 formed at the opposite end 187 thereof. The end 187 of the screw 183 is of tapered form and projects outwardly from the body portion 174 for reception in an aperture 188 provided in the supporting portion 176. The supporting portion 176 is comprised of three flat insulating members arranged back to back with the intermediate insulator serving as a spacer for accommodating a loop spring 189 positioned between the outer two of the insulators. Side portions 191 of the spring 189 extend across the opening 188 (Fig. 30) so that on insertion of the tapered end 187 within the aperture 188 the spring portions 191 are initially spread apart and then snapped into engagement with the screw 183 at the recess 187 therein. The engagement of the spring 189 with the screw 183 prevents any axial movement of the screw on rotation thereof for adjusting the core 179 axially of the body portion 174. It is to be noted that the adjustible screw 183 remains in the same relative position with respect to the coil 181 and that the core moves only axially of the screw and entirely within the body portion 174. By virtue of this construction the hexagonal nut 179 is adjustable within the body portion 174 over the entire length of the screw 183, with the length of the screw 183 being defined essentially by the axial length of the body portion 174. A unit of a relatively high variable inductance L2 is provided which is very compact and capable of assembly in a minimum of space. An insulating cap or cover 175 is snap connected with the body portion 174 and has an aperture 186 therein for receiving the screw adjusting portion 184. In the above-mentioned construction, the unit is adapted for operating over a frequency range of from 2500 to 6000 kc., only six inductance units L2 are required to cover this entire frequency range. Along with the changing of the coil L1 and inductance unit L2 for operation at a particular frequency the crystals M1 and M2, of course, must also be changed. The relation of the crystals M1 and M2 for a specified frequency will be taken up hereinafter in connection with the circuit diagrams in Figs. 35, 37 and 39. The operating frequency for the set is indicated on the card 50b (Fig. 3), previously noted.

In the operation of the set as either a transmitter or a receiver there is utilized an antenna 136 of telescopic or disappearing type which is assembled as a part of the chassis unit 52 (Figs. 6, 9, 10, 12 and 16). The lower section 137 of the antenna 136 is slidably supported in a channel or U-shaped insulating member 138 extending longitudinally of the chassis unit 52. The end 139 of the channel member is supported in the end member 58 of the chassis unit (Figs. 6 and 13). The opposite end 141 of the channel member 136 is supported on the antenna coil L1 by conductor means indicated generally as 142 and which will be later fully explained. The lower end of the antenna section 137 (Figs. 6 and 17) is provided with an insulating projection 144 having a leg portion 146 inserted within the antenna section 136 and retained therein as by rolling, or clamping at 147. The leg portion 146 seals the end of the antenna section 137 to prevent any moisture within the section 137 from passing outwardly therefrom. The projection 144 is arranged within the open side of the channel member 136 and is slidable therein.

As shown in Fig. 6, the chassis unit is provided with a power switch 148 of toggle type having an actuating arm 149 of substantially L-shape projecting outwardly from the supporting portion 98. The cross arm portion 151 of the actuating arm 149 is of a substantially arcuate shape and provided with laterally projecting extensions 152 and 153 at each end thereof. The projection 144 on the antenna section 137 is arranged intermediate the projections 152 and 153 so as to be selectively engageable with one of said projections on linear movement of the antenna section 137 in reversed directions. In the present invention the toggle switch 148 controls the supply of energy to the chassis unit 52 and hence to the set. When the antenna section 137 is in its position shown in Fig. 6 the actuating arm 149 is in a position for cutting off the supply of energy to the chassis unit 52, thereby rendering the set inoperative. On movement upwardly of the antenna section 137, as viewed in Figs. 6 and 10, the extension 144 engages the projection 153 and moves the actuating arm 149 upwardly to a position providing for the supply of energy to the chassis unit. On continued movement upwardly of the antenna section 137 the extension 144 is moved out of engagement with the projection 153 to permit the antenna section 137 be-
ing slidably moved outwardly from the channel member 138. On upward movement of the actuating arm, however, the projection 182 is moved into the path of movement of the extension 144, so that on a reversed movement of the antenna section 137 downwardly to its contracted position within the channel member 138 the extension 144 engages the projection 182 to return the actuating arm 148 to its position indicated in Fig. 6. It is seen, therefore, that the position of the antenna section 137 relative to the insulating member 138 indicates the control positions of the actuating arm 148. Since the extension of the antenna section 137 projects the same outwardly from the housing 40, as will be later explained, a visible indication of the position of the actuating arm 148 is given by the position of the antenna section 137 relative to the housing 40. In actual practice the "click" of the toggle switch to an operated position is audible to the operator of the set so as to further aid him in determining the control positions of the toggle switch 148.

The conductor means 142, previously mentioned, for supporting the upper end 141 of the channel member 138 on the chassis unit 62 includes a metal ring 156 (Fig. 10) and a metal bracket member 157. The bracket member 157 is provided in one piece which is bent double and formed with a circular portion 158 at one end and flat portions 159 and 161 at the opposite end thereof adapted for back to back engagement (Fig. 14). The arcuate portion 158 is extended about the antenna section 137 and is formed at one end 160 with wiper portions 162 (Figs. 10 and 15) which are maintained in pressing engagement against the antenna section 137 by a spring member 163 extending about the antenna. The conductor means 142 includes also a contact member 164 (Figs. 14 and 15) positioned between the portions 159 and 161 of the member 157 and having a plurality of spring fingers 166 extended into an opening 167, formed in the arcuate portion 158 of the member 157, and in pressed engagement against the antenna section 137. The portions 159 and 161 of the member 157 and the contact member 164 are secured together by a rivet 168 supported in a base portion 169 which serves as a socket for the antenna coil L1 previously noted. The socket 169 is supported in the portion 89 of the frame member 95, an insulating portion 171 being arranged intermediate the conductor means 142 and the socket 169 to properly position the conductor means 142 relative to the antenna 136.

The conductor member 167 is formed at the end 172 thereof (Fig. 10) with projections 173 adapted to be positioned within the ring member 156. The ring member 156 thus functioning to lock the member 167 with the channel member 138. By virtue of this construction the antenna section 137 is positively connected electrically with the antenna coil L1 without the use of any wires. Short circuiting and replacement troubles inherent with movable wires connected to telescopic type antennas are thus completely eliminated. The extension of the antenna section 137 from the channel member 138 is defined by the engagement of the extension portion 144 with the metal ring 156 of the conductor means 142.

A single control switch 192 assembled as a part of the chassis 82 is used to completely change over the operation of the combination set from its function as a receiver to a transceiver and vice versa. The switch 192 (Figs. 6 and 7) and 8) extends longitudinally of the chassis unit 82 and to one side thereof across the tubes T1--T6, inclusive. The switch 192 includes a stationary insulating member 193 of flat form and a movable insulating member 194 also of flat form and arranged for linear movement relative to the stationary member 193. Extending in linear alignment and arranged in a spaced relation longitudinally of the stationary member 193, are contacts 196 having engaging fingers 197 and 198 (Fig. 31). As illustrated for the switch contact 196c in Fig. 8, the stationary member 193 is formed with an aperture 199 for receiving therein the finger portion 197 of the switch contact 196a. The finger portion 197 is thus retained substantially in the plane of the stationary member 193. It is to be understood, of course, that the above construction for the contact 196a is similar for all of the contacts 196.

The movable member 194 carries contacts 201 of substantially L-shaped having a leg portion 202 extending through a corresponding slot 203 formed in the stationary member 193. The end portion 204 (Fig. 31) of the leg portion 202 is anchored in the movable member 194 so as to be retained in a fixed position thereon. A second leg portion 205 substantially normal to the leg portion 202 is projected laterally away from a corresponding slot 206 for positioning between the fingers 197 and 198 of corresponding contacts 196. By virtue of the finger 197 being substantially in the plane of the stationary member 193, the leg portion 206 are slidably supported for movement on the member 193 and through the finger portions 197 and 198 whereby to slidely support the movable member 194 on the stationary member 193. It is seen, therefore, that on linear movement of the movable member 194 relative to the stationary member 193 the contacts 201 are moved relative to corresponding contacts 196 to control the energization of the circuits associated with the contacts 196. Contacts on the stationary member 193 not engaged by any contacts 201 on the slideable member 194 are indicated at 200. These contacts 200 are merely the lugs for other circuit connections.

The operation of the switch 192 is manually controlled by a manually operated unit 205 operatively supported on the housing 40 and to the outside thereof (Fig. 31). The switch 192 includes toggle or extensible means 208 comprising a pair of members 209 and 211 of substantially arcuate shape which are pivotally connected together at their adjacent ends by axis means 212. The end 213 of the toggle member 211 is pivotally connected by axis means 214 with a bracket member 216 secured to the housing 40 by a screw or the like 217 so that the end 213 is in a fixed position relative to the housing 40. The end 216 of the toggle member 209 is pivotally connected by axis means 218 with a linearly movable member 221 which is slidely supported on the housing 40. The linear movement of the slideable member 221 is in the same direction as the linear movement of the movable member 194 of the switch 192, the member 221 having guiding rim portions 223 thereon for receiving a guiding member 224 secured by a screw 225 to the housing 40. On pressing the toggle means 208 toward the right, as viewed in Fig. 31, the pivotal connection 212 between the toggle members 209 and 211 is moved in an arcuate path which is substantially normal to the direction of linear movement of the slideable member 221 and hence to the direction of linear movement of the switch member 184.
movement of the toggle means 208 linearly moves the end 218 of the toggle member 208 in turn move the slidable member 221 in a linear direction. The position of the parts of the manually operated unit 207 when the toggle means is in a depressed condition is shown in dotted lines in Fig. 31. The movement of the pivotal connection 212 is limited by a cushioned bumper 227 carried on the housing 40 and secured thereto by the screw 217.

The slidable member 221 has an extension 228 thereon which extends through an opening 230 formed in the housing 40. This extension 228 is in slotted engagement with a projection 229 secured to the movable switch member 194 and extending laterally therefrom through a slot 231 formed in the stationary switch member 193. On movement of the pivotal connection 212 to the right, as viewed in Fig. 31, the extension 228 on the slidable member 221 is moved downwardly in turn engage the projection 229 for movement therewith to their positions shown in dotted lines in Fig. 31. This downward movement of the projection 229 in turn linearly moves the movable member 194 in one position relative to the stationary member 193 and hence the contacts 201 relative to the contacts 186 to control the radio circuits.

On release of the toggle means 208 the toggle member 211 is initially moved by a spring member 232 out of a binding position with the toggle member 208. The continued movement of the toggle means 208 to its unoperated position is accomplished by a tension spring 233 (Fig. 8) connected at one end to the stationary member 193 and at its opposite end to the movable member 194, the spring being partially positioned within a slot 234 formed in the stationary member 193. This action of the spring member 233 linearly moves the member 194 in an opposite direction relative to the member 193, with the engagement of the projection 229 with the extension 228 on the slidable member 221 returning the toggle means 208 to an idle position. When the manually operated unit 207 is in the position indicated in full lines in Fig. 31, the set is connected for operation as a receiver. With the toggle unit 207 in the position indicated in dotted lines in Fig. 31 the set is operated as a transmitter. It is seen therefore, that changing the operation of the set, the transmitter to a receiver is automatically accomplished simply by releasing the operating unit 207 and that the set will operate as a receiver so long as the unit 207 is retained in a depressed position. The change from receiving to transmitting and vice versa is accomplished in a minimum of time and without any delay for making adjustments between the receiving and transmitting operations.

The flat arrangement of the change-over switch means 192 longitudinally of the chassis unit 52 and across one side of the tubes 21-72, inclusive, provides for the contacts 198 and 201 corresponding to an associated tube being substantially adjacent such tube without projecting any appreciable distance laterally from the chassis unit 52. By virtue of a tube and its associated contacts being adjacent each other only very short leads or connections are required for connecting the contacts of the switch 192 into the tube circuits so as to substantially reduce the circuit losses resulting from long connections. A transparent insulating member 239 (Fig. 7) is arranged in a superposed relation with the switch unit 192 and is secured at each end thereof to the radio chassis 52. The transparent insulating member 239 is adapted to have applied thereon suitable markings, indicated as 241 (Fig. 6), to facilitate the assembly and checking of the tube circuits.

From a consideration of Figs. 6, 9 and 11 it is seen that the chassis unit 52 is completely constructed as a pre-assembled unit which is of a substantially rectangular cross section over the entire length thereof, All of the resistor and condenser elements for the various tube and circuit arrangements, the tubes, the antenna 136, the changer unit 192 are arranged so as to be confined within a space defined substantially by the transverse and longitudinal dimensions of a tube and associated socket portion. The chassis unit, including the change-over switch 192 and the antenna 136, is thus adapted to be removed from or inserted within the housing 40 as a complete and compact package.

In connection with the insertion of the chassis unit 52 within the housing compartment 48 it is seen from Fig. 31 that the projection 223 on the change-over switch 192 is received in the extension 228 on the slidable member 221. The extension 228 and projection 229, therefore, do not in any way interfere with the assembly of the chassis unit 52 within the housing 40 and are completely operatively connected concurrently with the positioning of the chassis unit within the housing.

With reference to Figs. 6 and 16 it is seen that the upper end 242 of the antenna 136 extends longitudinally beyond the end 127 of the chassis unit frame member 95. In the assembly of the chassis unit 52 within its corresponding compartment 48 in the housing 40 the end 127 thereof is initially inserted within the compartment 48 and the antenna end 242 extended through an opening 243 provided in the housing cover 77. The opening 243 has a threaded annular rim or wall portion 244, the antenna 136 being spaced from the cover 77 and the flange 244 by an insulating member 246 having one end 241 inserted within the flange 244 and about the antenna. The opposite end 248 of the insulating member 246 carries a rubber grommet 249 which is fitted about the antenna 136 to prevent moisture from passing along the antenna into the housing 40. As illustrated in Fig. 2 the threaded annular flange 244 about the antenna 136 is adapted to receive in threaded engagement thereon a cap member 251 for covering the antenna end 242 when the set is not in use. When the antenna 136 is being used the cap 251 is threadedly engaged with a threaded holding flange 252, the position of the cap in connection with the flange 252 being shown in Figs. 1 and 32. When the set is not in use, therefore, the passage of any moisture about the antenna 136 or injury to the antenna is positively eliminated by the protector cap 251. The cap 261 may be attached to the cover 77 by a chain or the like 263 to prevent the loss thereof. Referring to Fig. 1 it is seen that the set is capable of use while the operator is in motion. Securing of the cap 261 with the holder 262 prevents any rattling of the cap when the set is not used.
partment 48 is in a substantially flush fit with the housing end 41. The plate 58 is somewhat larger than the cross sectional area of the compartment 48 so that the peripheral portion thereof indicated as 254 engages the partition member 43 when the chassis unit 52 is positioned within the compartment 48. With the chassis unit in the compartment 48 a threaded aperture 255 (Fig. 16) is provided in a boss portion 256 on the frame member 95 at the end 127 thereof and is in coaxial alignment with the aperture 251 in the housing cover 77. On tightening of a screw 258, which is extended through the aperture 251 for threaded engagement in the threaded aperture 256, the side plate 58 of the chassis unit 52 is drawn against the end of the partition member 43 and the cover 77 is firmly secured to the chassis unit 52 and clamped in closing engagement with the housing 40 at the end 42 thereof. The single screw 258, therefore, in conjunction with the operating action of the partition member 43 relative to the partition member 43 functions to securely lock the cover 77 in a closed position while acting also to retain the chassis unit 52 in a fixed position within the housing 40. The cover 77 is integrally formed with an apertured ear portion 266 for connection with a strap 297 by axis means 267 (Figs. 16 and 32), to be later noted.

Moisture is prevented from entering the housing 40 from without the cover 77 by a gasket 251 positioned within a peripheral groove 253 integrally formed in the cover 77 (Fig. 16). Thus when the cover 77 is positioned over the housing end 42 the gasket 253 engages such housing end to seal the same. The cover 66 for the housing end 41 is adapted for sealing engagement with the housing 40 by means of a gasket 268 received in a marginal groove 269 integrally formed in the cover 66 (Fig. 5). On tightening of the locking means 71 the gasket 268 is clamped against the housing end 41 in an obvious manner.

The passage of any moisture into the housing 40 from about the manually operated unit 201 for the change-over switch 192 is prevented by a rubber hood 271 having a central portion preformed to a shape corresponding to the shape of the toggle means 291 when the same is in a rest position and a flat rim portion 272 for fitting against the housing 40 (Figs. 3 and 31). The rim portion 272 is clamped against the housing 40 by a clamping plate 273 having an aperture 274 therein for receiving the toggle means 291 and the central preformed portion of the gasket 211, the plate 273 being secured to the housing 40 by screws or the like 276.

The earphone unit 62, previously mentioned, is received within a housing projection 60 which is of ring shape and peripherally threaded at its open free end 275 (Figs. 32 and 33). The unit 62 is essentially a dynamic speaker used for receiving purposes, and includes an annular body portion 274 receivable within the projection 60 and a diaphragm 276 attached to an annular metal rim portion 277 extending peripherally beyond the periphery of the annular body portion 274. The diaphragm 276 is coated with a suitable water repellent material so as to make the same impervious to moisture. A rubber gasket 278 is positioned intermediate the free end 273 of the projection 60 and the rim portion 271. A perforated insulating cap 279 is threadably engaged with the end 273 for closing the open side of the projection. When the cap 279 is threaded on the end 272 the inner surface there of engages the rim portion 271 to clamp the rub-

ber gasket 278 in sealing engagement with the rim 277 and the end 271 of the projection 60. By virtue of this sealed engagements and the water resistant character of the diaphragm 276 moisture is prevented from entering the housing portion 60 while the moisture contacting the diaphragm 276, through the perforated cap 279, is incapable of injuring the same.

The microphone unit 81 (Figs. 32 and 34) is receivable within the annular housing portion or projection 85 and includes an annular body portion 281 and a microphone diaphragm 282. A protector diaphragm 283 is composed of a waterproof material, which does not interfere with the passage of sound waves to the microphone diaphragm 282, and is arranged in a superposed relation with respect to the microphone diaphragm 282 but spaced therefrom by a spacer ring 284. In one commercial embodiment of the invention the protector diaphragm 288 is composed of a rubberized cloth having a thickness of approximately 0.007", with the spacer ring 284 being 0.025" thick. The spaced assembly of the diaphragm 282 and 283 is retained by a rubber gasket 286 of annular shape having an inwardly extending lip portion 287 at one end extended partially about the protector diaphragm 283 and a lip portion 288 at the opposite end thereof for fitting a shoulder 289 provided on the body portion 281. The microphone diaphragm 282 is thus completely enclosed by the gasket 286 and the protector diaphragm 283. The gasket portion 287 is of a greater diameter than the diameter of the open end 289 of the housing portion 285 so that when the unit 81 is positioned within the portion 85 the gasket portion 287 fits over the end 289. A perforated cap 291 of insulating material is threadably engageable with the end 289 of the housing portion 85 and when screwed thereon clamps the gasket 286 against the housing end 289 to completely seal the microphone unit 81. A metallic ring 292 may be positioned intermediate the cap member 291 and the gasket 286 to prevent any twisting action of the gasket by the cap member when the cap member is being tightened.

From a consideration of Figs. 1, 2 and 3, it is seen that the housing portions 60 and 85 from a common side of the housing 40 while the manually operated unit 201 projects from a next adjacent side of the housing 40. The housing portions 60 and 85 are inclined toward each other and are relatively spaced to provide for their use in the manner of a telephone set as indicated in Fig. 1. In other words with the housing 40 supported in one hand of the operator the microphone unit 62 is positioned near the operator's mouth while the earphone unit 62 is positioned near one of his ears. In the above described embodiment of the invention previously mentioned, the housing 40 is about a foot long and approximately three inches square with the weight of the entire unit being only about five pounds. The housing 40 is thus capable of being easily grasped in one hand of the operator and by virtue of the light weight of the complete set can be readily and simply supported in an operating position which is common for both receiving and transmitting. The operating unit 201 for the change-over switch 192 is arranged relative to the housing portions 60 and 85 so as to be positioned below the hand of the operator which is used in holding the set in its operating position, as shown in Fig. 1. By merely opening and closing the hand, therefore, the unit 201 is operated to control the change-
over switch 192. It is seen, therefore, that the supporting of the set in an operating position, and the manipulation of the operating unit 201 to change from receiving to transmitting and vice versa is accomplished entirely by one hand of the operator, so that the other hand of the operator is left free for tuning notations or performing other miscellaneous duties. An adjustable strap 257 connected at opposite ends thereof to the axis means 67 and 267 at the ends 41 and 42, respectively, of the housing 40 may be utilized to facilitate the holding of the set by the operator. When the set is not in use the strap 257 can be loosened sufficiently to serve as a sling for carrying the set on the operator's back.

The operation of the set is best understood in connection with the circuit diagrams in Figs. 35-40, inclusive. The complete circuit for the set is shown in Fig. 35, with the circuit portion utilized for receiving being shown in Fig. 37 and the circuit portion utilized for transmitting in Fig. 39. For the purpose of simplicity and clarity of description the change-over switch 192 will be considered as comprised of 14 sections A to M, and the control section K, inclusive, and the parts of the control circuit will be described relative to their functions as controlled by these switch sections.

It is to be understood of course that corresponding parts in all of the figures will be designated by like numerals of reference.

Referring to Fig. 35 the change-over switch 192 is shown in full lines in a position providing for the operation of the set as a receiver. For this condition of operation, therefore, reference will be made to both Figs. 35 and 37, the latter figure showing only the receiving circuit.

In a receiving condition, the set acts as a five tube superheterodyne receiver consisting of one RF amplifier stage including the tube T1, one oscillator mixer stage including the tube T2, one IF amplifier stage including tube T3, one diode detector and first audio-amplifier stage including tube T4, and one audio output stage including the tube T5.

With the change-over switch 192 in a position for receiving, the switch section A connects the crystal M1 across the grid 300 and the screen grid 301 of the tube T2. The connection of the crystal M1 in this manner provides the necessary coupling for oscillation.

Section B connects a voltage divider V illustrated as comprised of three resistors across a resistor R4 to be later noted. This voltage divider V provides the grid bias voltage for the tubes T1, T2 and T3, the grids for these tubes being held at 302, 300, 302', respectively.

The switch section C connects the control grid 302 of the tube T1 into the AVC circuit of the diode detector tube T4.

Switch section D connects the antenna 136 to the tuning condenser C7. The section E connects the plate 304 of the tube T1 to the coupling condenser C10 of the signal grid 300 of tube T2.

The switch section F connects the oscillator feedback condenser C6 to ground. Section G puts the voltage dropping resistor R10 in series with the plate 304 of tube T1. Section K connects the base of tube T2 to the plate 304 of the coupling grid 307 of the tube T3. The section H also connects the voltage dropping resistor R11 in series with the plate 308 of tube T5.

The section J of the change-over switch 192 is not shown in the receiver circuit of Fig. 37 since it functions to ground the microphone unit 68 when the set is utilized for receiving. The switch section K connects the terminal A of the filament 309 of the tube T3 to the "A" battery 49 and disconnects one section of the two-section filaments 311 and 312 in the tubes T1 and T5, respectively, from the "A" battery in a manner which will be later explained. The switch sections L and M are connected together electrically through contact 201 on the movable switch member 194 of the change-over switch 192. When contact 201 is in its receiving position shown in Fig. 37 and in full lines in Fig. 35, the dropping resistor R16 is connected in series with the screen grid 301 of the tube T5. These switch sections L and M also place the dropping resistor R17 in series with the screen grids 314 and 301 of tubes T1 and T2, respectively, and connect the "B" battery 51 to the plate 302 of tube T1.

The sections N and O are electrically connected together through a second contact 201' of the change-over switch 192. The contacts 201' are substantially L-shaped, as shown in Fig. 8, for contact with two terminals 195 on the long portion of a single terminal 195 on the short portion thereof. These sections N and O are placed in the earphone unit 62 across the audio choke L6 and the plate 308 of tube T5. The sections N and O also place the dropping resistor R19 in series with the earphone unit 62 to reduce the intensity of the signal in the earphone unit.

When the set is to be operated as a receiver the antenna 136 is series tuned by the mica trimmer C7. The signal voltage developed across C1 is amplified by the tube T1 and applied to the grid 300 of the tube T2. In the mixer oscillator tube T2, the incoming signal is mixed with the oscillator signal generated in the tube and produces a beat frequency plate current of 455 kc. The oscillator uses a crystal M1 in a crystal circuit, previously noted, and functions at 455 kc above the carrier or incoming signal frequency.

For a particular frequency at which the set is to be operated the receiver crystal M1, therefore, is 455 kc. higher in frequency than the transmitter crystal M2.

The beat frequency or IF signal produced in the mixer tube T2 is amplified by the tube T4 and is applied to the grid 300 of the tube T3. Due to the detection process the modulated IF signal is demodulated and an audio voltage is impressed across the resistor R20 which is the grid resistor of the pentode section, or grid 311, of the tube T4. The signal is then applied to the grid 305 of the tube T5, the power amplifier, where it is further amplified and then applied to the earphone unit 62.

The inductance or antenna coil L4 functions as a loading coil which aids in resonating the antenna 136. The grid resistor R2 of tube T1, provides a DC path for the bias voltage applied to the grid 302 of tube T1. The condenser C8 is an RF bypass for the circuit from the screen grid 314 of tube T1 an functions to reduce regeneration. The condenser C2 bypasses the RF current from the screen grid 314 of tube T1. Bypassing of this RF current by the condenser C2 is rendered more effective by the resistor R18 which increases the impedance of the path from the plate 302 of tube T1 to the condenser C8. This component is commonly called a decoupling filter. The resistor R18 also reduces the current flow in the screen grid 314 of the tube T1.

The permeability tuned inductance L2 provides the RF plate load for the tube T1 and is resonated by a capacity made up of the distributed capacity of the coil, the output capacity of
The tube T1, the input capacity of the tube T2, and the capacity of the circuit wiring for such tubes.

A coupling filter for the circuit of the plate 304 of the tube T1 consists of the condenser C3 and resistor R10. The resistor R10 also serves to lower the D.C. plate voltage on the tube T1 which reduces its plate current and gives a more economical operation of the “B” battery. In other words the resistor R10 functions to decrease the current flow from the battery 51 through the plate 304 of tube T1 when the set is not in use.

The condenser C10 in the circuit of the grid 300 for the tube T2 functions as a coupling condenser for the passage of an R.F. current to the grid 300, but prevents any D.C. plate voltage from tube T1 reaching the grid 300, the resistor for grid 300 being R4. Resistors R3 and R4 provide the bias voltage for the grid 300 of the oscillator and mixer tube T2 as well as the bias voltage for the audio output tube T5. A D.C. voltage suitable for biasing purposes is produced across the resistors R3 and R4 because of the grid current which exists as a result of driving the oscillator grid 300 positive. The voltage divider V previously mentioned, provides the proper values of grid bias for the tubes T1, T2 and T8 when necessary to reduce regeneration.

A filter for the automatic volume control (A.V.C.) applied to the grids 302, 306, and 308 of the tubes T1, T2, and T3, respectively, is comprised of condensers C13 and C14 and resistor R8. The A.V.C. voltage is obtained from the detector load resistance made up of the resistors R12 and R14. The filter removes the audio component of the detector voltage from the D.C. component which is used for the A.V.C. function.

The condensers C5 and C22 function as bypass condensers to prevent a voltage of the oscillator frequency getting into the control grids 302 and 303 of the tubes T1 and T8, respectively, through the bias systems. The condenser C4 is a neutralizing condenser. It reduces the voltage of the oscillator frequency on the signal grid 300 of tube T2, due to coupling within the tube, by feeding back a voltage of the oscillator frequency out of phase with the internal coupled voltage.

A choke L4 serves as a shunt feed arrangement for the screen grid 308 of tube T2 and further provides a low resistance path to the D.C. screen current and a high impedance path to the R.F. screen current. The condenser C11 and resistor R17 make up a decoupling filter for the screen circuit of tube T2.

The first I.F. transformer L4, is illustrated as composed of two coils 319 and 321, wound on iron cores and surrounded by an iron sleeve 322 to provide for the use of small coils of high inductance. The coils 319 and 321 are tuned by the trimmers C10 and C18, respectively. The resistor R8 which is contained within the iron shield 322 functions to broaden the response of the transformer.

Condensers C17 and resistor R12 make up a decoupling filter for the screen grid 307 of the tube T3. A decoupling filter for the plate circuit of tube T3 is comprised of condenser C18 and the resistor R15.

A second I.F. transformer L5 is comprised of primary and secondary coils 323 and 324, respectively, wound on corresponding iron cores and surrounded by an iron sleeve 325, a trimmer condenser C19 being used to tune the secondary winding.

The resistor R14 is the detector load across which the audio voltage is obtained. Resistor R12 in conjunction with condensers C20 and C21 make up a filter to remove the I.F. component from the audio component of the detector voltage. The condenser C22 couples the detector to grid 311 of tube T4 and prevents the D.C. component of the detector voltage from biasing this grid 311. The grid resistor R20 of the tube T4 has a resistance of 10 million ohms so that the small amount of grid current which exists in the tube T4 and flows through this resistor, provides additional bias for this tube on large signal inputs. The condenser C25 is an I.F. bypass to eliminate any I.F. current which exists in the circuit of the plate 321 of tube T4 from getting into the audio plate load resistor R22 for the tube T5. The condenser C26 and resistor R24 make up a decoupling filter for the screen grid 324 of the tube T4. Resistor R22 is the plate load for the tube T4, and C27 is the coupling condenser.

Resistor R28 is the grid resistor of tube T5. The condenser C29 and resistors R24 and R16 serve as a decoupling filter for the screen grid 313 of the tube T5. The resistor R16 also reduces current flow to the plate 315 on the D.C. path for the plate current in the tube T5 which is provided by the audio choke L5 which also offers a high impedance path to the audio plate current. A decoupling filter for the plate 308 of the audio amplifying tube T5 is provided by the condenser C30 and resistor R14. The resistor R14 also serves as a dropping resistor to lower the voltage in the plate 308. A condenser C24 prevents the D.C. plate voltage from reaching the earphone unit 62.

The circuit for the filaments 311, 312, 309, 302 and 313 for the tubes T1—I-To, inclusive, when the set is operating as a receiver is shown in Figs. 36 and 38. The filament terminals indicated as x and y, and the “A” battery terminal Xa in Figs. 36 and 38 correspond to the like terminal reference characters in Figs. 35 and 37. As previously mentioned the filaments 311 and 312 for tubes T1 and T4, respectively, are of two-section type, the filament 311 including sections 313 and 314, and the filament 312 including sections 314 and 317. With the switch section K in a position for a receiving operation of the set the single section filaments 311, 308, and 332, and only the filament sections 333 and 308 of filaments 311 and 312, respectively, are connected to terminal Xa for receiving energy from the “A” battery 48, the circuit for the filament sections 334 and 337 being open at the switch K. By virtue of this arrangement of the filament circuit the drain on the “A” battery 48 is reduced for receiving operation when current requirements for efficient signal reception are less than the current requirements for efficient signal transmission. The energy of the “A” battery is thus conserved during receiving so as to be available for the increased requirements in transmitting.

Referring to Fig. 35 the positions of the switch sections A—H, and J—O, both inclusive, are shown in dotted lines in the positions they occupy when the set is operated as a transmitter. Each section will be described with respect to its control of the transmitter portion of the circuit in Fig. 35, the transmitter circuit being shown in Fig. 39.

When the combination set is operating as a transmitter only four tubes are used, the I.F. amplifier tube T3 being eliminated. The tube
T1 for transmitting acts as an R.F. power amplifier tube, the tube T2 as an oscillator, tube T4 as a microphone amplifier, and tube T3 as a modulator.

Section A connects the transmitting crystal M2 with the screen grid S1 of the oscillator tube T2 in a crystal circuit arrangement.

The section B of the change-over switch 192 disconnects the voltage divider V which, when the set was being operated as a receiver, provided the grid bias voltage for the tubes T1 and T2 and T4. Switch C connects the control grid G2 of tube T1 to the grid leak resistor R4. The section D connects the antenna 138 to the plate 304 of the R.F. amplifier tube T1, while the switch section E connects the plate 304 to the R.F. amplifier tank condenser C12.

The section F connects the condenser C8 to the oscillator grid G2' of the tube T2, and section G short out the resistor R16 from the plate 304 of the tube T1. Section H disconnects the "B" battery S1 from the plate 304 and screen grid S1 of the tube T2 and also shorts out the resistor R11 from the circuit of the plate 304 of the tube T5.

The switch section J connects the microphone unit 83 to the grid 317 of the first audio amplifier tube T4.

Section K operates to disconnect the filament 305 of the tube T3 from the "A" battery, and to connect the second sections 334 and 331 of the filaments 311 and 312 of tubes T1 and T5, respectively, with the "A" battery as will be later described in connection with Fig. 40.

The electrically connected sections L and M shunt the resistor R16 out of the circuit of the screen grid S1 of tube T5, and the resistor R17 out of the screen grid circuits of tubes T1 and T2. The connected switch sections N and O connect the screen and plate circuits of the R.F. amplifier tube T1 to the plate 305 of the modulator tube T5.

When the set is operating as a transmitter the R.F. carrier is generated in the oscillator section of the tube T2. The crystal M2 used for transmitting operates at a frequency which is 550 kc. lower than the frequency of the crystal M1 used when the set is operating as a receiver, as was previously noted. The generated R.F. signal is applied to the grid 302 of the tube T1 where it is amplified and fed into the antenna 135. The antenna is coupled to the amplifier tank or tuned circuit by an impedance matching network of the P.I. type in which the capacity between the antenna rod and housing makes up one shunt branch.

The microphone output is amplified by the pentode section 317 of tube T4 and then applied to the grid 303 of tube T5 where it is further amplified. The output of tube T5 is then fed into the plate circuit of tube T1 of the R.F. amplifier. It is to be noted that since the screen grid 314 of tube T1 is tied to the lower end of coil L2 that the modulating voltage is introduced into the screen grid circuit as well as the plate circuit. This arrangement improves the percentage and quality of modulation. The earphone unit 62 is also connected across the audio output so that the operator can hear what he is saying. This arrangement is referred to as a side tone.

When the tube T2 is operating in the transmitter circuit only the oscillator section thereof is utilized. The resistors R3 and R4 make up the grid leak which provides the bias voltage for the oscillator grid 302'. The D.C. voltage developed across R4 is used also for the grid bias for the modulator tube T5.

The R.F. choke L3 provides a shunt feed arrangement for the screen grid 301 of the oscillator tube T2, with the condenser C15 determining the amount of feed back to the grid. A circuit bypass for the screen grid 301 of tube T2 is provided by a condenser C11. Condenser C8 functions as a coupling condenser and provides a path for the R.F. current to the grid 303 of the R.F. power amplifier T1, but prevents the D.C. screen grid voltage from being applied to the grid 302. The resistor R6 is a grid leak and provides the bias voltage for the grid 302. An R.F. by pass for the screen grid 314 of tube T1 is provided by the condenser C12.

The coil L2 serves as an R.F. amplifier tank coil and C12 as an R.F. amplifier tank condenser. The condenser C12 also acts as one branch of the P.I. network connecting the antenna 135 to the amplifier tank. The capacity between the antenna rod and the housing acts as the other shunt branch of the P.I. network. The antenna coil L1 is the series branch of the P.I. network and serves as an antenna loading inductance.

Condenser C3 is the R.F. bypass for the plate circuit of tube T1. In order to provide ready access to the plate current measurement necessary for tuning up the antenna stage properly there is provided a current jack 341 in the plate circuit of the tube T1.

The grid resistor R20 for the tube T4, also acts as a load resistor for the microphone unit 83. A decoupling filter for the screen grid 328 of tube T4 consists of the resistor R21 and condenser C16. Resistor R21 also serves to obtain the proper operating voltage on the screen grid with the resistor R22 furnishing the plate load. Condenser C27 functions as a coupling condenser, and R23 as the grid resistor of the tube T8.

The decoupling filter for the screen grid 313 of tube T5 is comprised of the condenser C28 and resistor R24. Condenser C28 produces a low impedance path around the modulator choke L5 for the current of the carrier frequency. This is necessary since the R.F. amplifier tank and modulator choke are connected in series. A low resistance path to the D.C. plate current of the modulator tube T5 and R.F. amplifier tube T1 is accomplished by the modulator choke L5 which offers a high impedance load to the audio frequency plate current of the modulator.

Over loading of the monitoring earphones is prevented by the resistor R16, since the audio output for modulating the R.F. amplifier is quite high. A condenser C29 removes the D.C. plate voltage of the tube T3 from the earphones, while condensers C31 and C34 are "B" battery bypasses.

It is to be noted that the condensers C4, C13, C14, C23 and C25, and resistors R1, R5, R11, and the resistors of the voltage divider V are without use when the set is operated as a transmitter; their functions when the set is operated as a receiver having been previously explained.

The circuit arrangement of the filaments 311, 312, 312, and 312 for the tubes T1—T5, inclusive, for transmitter operation is shown in Fig. 40. The filament 309 of the I.F. amplifier tube T3 is open at the switch K and is not utilized for transmitting. However, the remaining filaments, including both sections of each of the filaments 311 and 312 are in series connection with the "A" battery so that tubes T1, T2,
T4 and T5 are operated at maximum output for transmitter operation.

From a consideration of the above description and drawings, therefore, it is seen that the invention provides a combination radio receiver and transmitter set which is of a very compact construction, light in weight, and which is completely self-contained as to the antenna, source of energy supply, and all of the necessary operating component parts. In the commercial embodiment hereinafter referred to efficient communication is attained over distances of approximately one to five miles depending upon the ground resistance. All of the parts of the set are pre-assembled into a minimum number of complete units to provide for the individual assembly and removal of these units relative to the housing therefor as separate packages. These various preassembled units may be kept in stock and because of their being readily interchangeable in the housing, new units may be substituted in the complete set for those units requiring service work or adjustments thereon. The set is thus adaptable for substantially continuous service. All of the parts included in the set are clearly indicated as to type, and means are provided for the assembly of these parts in only one position to assure their proper relative assembly. No tuning or adjustments are required for the sets while in service, and only a single switch is utilized for changing the set from transmitting to receiving and vice versa. Because of this simplicity in construction, assembly, and operation of the set, it may be readily operated efficiently by an unskilled operator. It is to be noted also that the combination is immediately operative on turning on of the energy supply switch so that communications may be carried on while the operator is en route to a destination or after he has arrived at such destination.

Although the invention has been described with specific reference to a particular embodiment thereof, it is to be understood that it is not to be so limited, since changes in the parts and in their relative arrangement can be made therein which are within the intended scope of the invention as defined by the appended claims.

I claim:

1. A self-contained combination radio receiver and transmitter set adapted to be held in one hand by the operator thereof, and in but one position for both receiving and transmitting including a housing member, microphone and earphone means relatively arranged on said housing so as to be simultaneously in position near the mouth and an ear, respectively, of the operator when the set is in said one position, means for supplying all of the energy to said set, combination transmitter and receiver circuit means, with said energy supply means and circuit means being carried within said housing member, an antenna operatively connected with said circuit means and extending outwardly from said housing member, and switch means for changing the operation of said set as a receiver or transmitter having an actuating portion projecting from said housing and positioned thereon so as to be manipulated by the hand of the operator supporting said set.

2. A self-contained radio receiver and transmitter set adapted to be held in one hand by the operator therefor and in but one position for both receiving and transmitting including an elongated housing member, a preassembled chassis unit, battery units electrically connected with said chassis unit, said chassis and battery units being completely enclosed within said housing, microphone means projecting from one side of said housing, earphone means projecti

3. A self-contained radio receiver and transmitter set adapted to be supported and entirely operated by one hand of the operator and including an elongated housing member having a pair of projecting portions on one side thereof, microphone means in one said projecting portions, earphone means in the other said projecting portions, said two projecting portions being relatively arranged so that when the set is in said hand supported position listening and speaking can be carried on interchangeably by the operator without changing said position, with said housing being open at one end, said preassembled chassis unit including extensible antenna means, battery units for supplying the energy to said chassis unit, means dividing said housing longitudinally into compartments corresponding to said battery units and preassembled chassis and said preassembled chassis unit, with said battery and chassis units being receivable in a corresponding compartment through the open end of said housing, and said antenna being extended from the opposite end of said housing, cover means for closing said open housing end, switch means for switching from transmitting to receiving and vice versa having a manually operated portion extending through another side of said housing, said operating portion being positioned relative to said two projecting portions so as to be positioned under the hand of the operator for manipulation when the set is in said hand supported position.

4. A self-contained combination radio receiver and transmitter set adapted to be held in one hand by the operator therefor including a housing, combination receiver and transmitter circuit means, energy supply means for said circuit means, with said latter two means being within said housing, a hand-hold portion on said housing, an antenna supported on said housing and extending outwardly therefrom, switch means at said hand-hold portion adapted to be operated by the hand holding the set for changing the operation thereof as a receiver or transmitter, and receiving and talking means on the housing rigid with reference thereto and adapted to be used by the operator when the set is held adjacent the mouth and ear of the operator.

5. A combination radio receiver and transmitter set self-contained within a housing member adapted to be held in one hand of the operator for the set, circuit means and means for supplying all of the energy to said circuit means located within said housing, talking and receiving portions adapted for positioning adjacent the mouth and ear, respectively, of the operator when the set is held for operation, and an antenna for both transmitting and receiving operatively connected with said circuit means and adjustable in and out of said housing.
6. In a self-contained radio receiver and transmitter set adapted to be submerged in water, a housing having a pair of open ends, means dividing said housing longitudinally into a plurality of compartments, a preassembled chassis unit including an antenna, a plurality of spaced circuits, and a continuously spaced circuit, a microphone operatively connected to said chassis unit, a plurality of spaced contacts on said chassis unit, a plurality of spaced contacts on said chassis unit, a plurality of spaced contacts on said housing, said antennas being positioned longitudinally within said housing and extended outwardly therefrom through an opening in one of said covers, means for selectively changing the operation of said apparatus as a receiver or a transmitter having a manually operated portion projecting from one side of said housing, waterproof means extended about said switch means and in sealed engagement with said housing, said housing having a pair of spaced projecting portions on another side thereof, with each projection being open at the end thereof, a microphone means in one of said housing portions, earphone means in the second of said housing portions, water repellent diaphragm means extended across the open end of each of said housing portions, and means retaining each of said diaphragm means in said housing, and operatively connected to said microphone and receiver, a complete radio transmitting and receiving apparatus located within the casing and operatively connected to said microphone and receiver, and an antenna for said apparatus extending from and supported by said casing.

10. A portable radio telephone receiving and sending unit comprising a casing, a microphone and a receiver supported by said casing and spaced and angularly positioned to be placed in simultaneous juxtaposition to the mouth and ear respectively of the operator, said casing having a handle portion by which the casing may be supported by one hand of the operator with said microphone and receiver in said juxtaposed position, a complete radio transmitting and receiving apparatus located within the casing and operatively connected to said microphone and receiver, and an antenna for said apparatus extending from and supported by said casing.

11. A portable radio telephone receiving and sending unit comprising a casing, a microphone and a receiver supported by said casing and spaced and angularly positioned to be placed in simultaneous juxtaposition to the mouth and ear respectively of the operator, said casing having a handle portion by which the casing may be supported by one hand of the operator with said microphone and receiver in said juxtaposed position, a complete radio transmitting and receiving apparatus located within the casing and operatively connected to said microphone and receiver, and an antenna for said apparatus extending from and supported by said casing.

12. A self-contained portable radio telephone receiving and sending unit including a casing consisting of a pair of housings connected by a handle adapted to be grasped by a hand of the operator to support the entire casing thereby, a microphone in one of said housings and a receiver in the other, said microphone and receiver being so spaced and positioned that they may be located simultaneously in juxtaposition to the mouth and ear respectively of the operator when the operator supports the casing by said handle, and a complete radio transmitting and receiving apparatus located within said casing and operatively connected with said microphone and receiver.

13. A portable radio telephone receiving and sending unit including a casing consisting of a pair of housings connected by a handle adapted to be grasped by a hand of the operator to support the entire casing thereby, a microphone in one of said housings and a receiver in the other, said microphone and receiver being so spaced and positioned that they may be located simultaneously in juxtaposition to the mouth and ear respectively of the operator when the operator supports the casing by said handle, and a device for selectively causing said apparatus to operate to transmit or receive signals, and an antenna for said apparatus supported by said casing.

14. A portable radio telephone sending and receiving unit including a casing consisting of a pair of housings connected by a handle adapted to be grasped by a hand of the operator to support the entire casing thereby, a microphone in one of said housings and a receiver in the other, said microphone and receiver being so spaced that they may be located simultaneously in juxtaposition to the mouth and ear respectively of the operator when the operator supports the casing by said handle, and a complete radio transmitting and receiving apparatus located within the casing and operatively connected to said microphone and receiver.
supports the casing by said tubular handle, and radio sending and receiving apparatus located in said casing, said radio apparatus including a battery located in said tubular handle.

15. A self-contained portable radio apparatus comprising, a housing member adapted to be held in one hand of the operator of the set, a combined radio receiver and transmitter circuit means in said housing member, said housing member including provisions therewithin for receiving all requisite power supply means for said circuit means, and a microphone and speaker, said housing member having projecting portions enclosing said microphone and speaker and disposed and proportioned for positioning adjacent the mouth and ear, respectively, of the operator when the set is held in an operating position.

16. A self-contained portable radio apparatus comprising, a housing member adapted to be held in one hand of the operator of the set, a combined radio receiver and transmitter circuit means in said housing member, said housing member including provisions therewithin for receiving all requisite power supply means for said circuit means, and a microphone and speaker, said housing member having projecting portions enclosing said microphone and speaker and disposed and proportioned for positioning adjacent the mouth and ear, respectively, of the operator when the set is held in an operating position.

17. A self-contained portable radio apparatus comprising, a housing member adapted to be held in one hand of the operator of the set, a combined radio receiver and transmitter circuit means in said housing member, said housing member including provisions therewithin for receiving all requisite power supply means for said circuit means, and a microphone and speaker, said housing member having projecting portions enclosing said microphone and speaker and disposed and proportioned for positioning adjacent the mouth and ear, respectively, of the operator when the set is held in an operating position.

18. A self-contained portable radio set comprising a housing having an extendable antenna for use in combination with radio circuits therein including energy supply means therefor, said antenna having at least one rigid extendable conductive member, means within the housing for mounting said member to permit movement thereof to either one of two positions, switch means positioned in cooperative relation to said one conductive member at one of said positions, cooperating means between said one member and said switch means to operate the latter responsive to movement of said one conductive member whereby the switch means is in closed circuit position when the antenna is fully extended and such position of the switch means is visually indicated by the extended antenna.

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