May 9, 1939. D. A. HEISNER 2,157,234

RADIO TELEPHONE SYSTEM

Original Filed Oct. 14, 1937 3 Sheets-Sheet 1

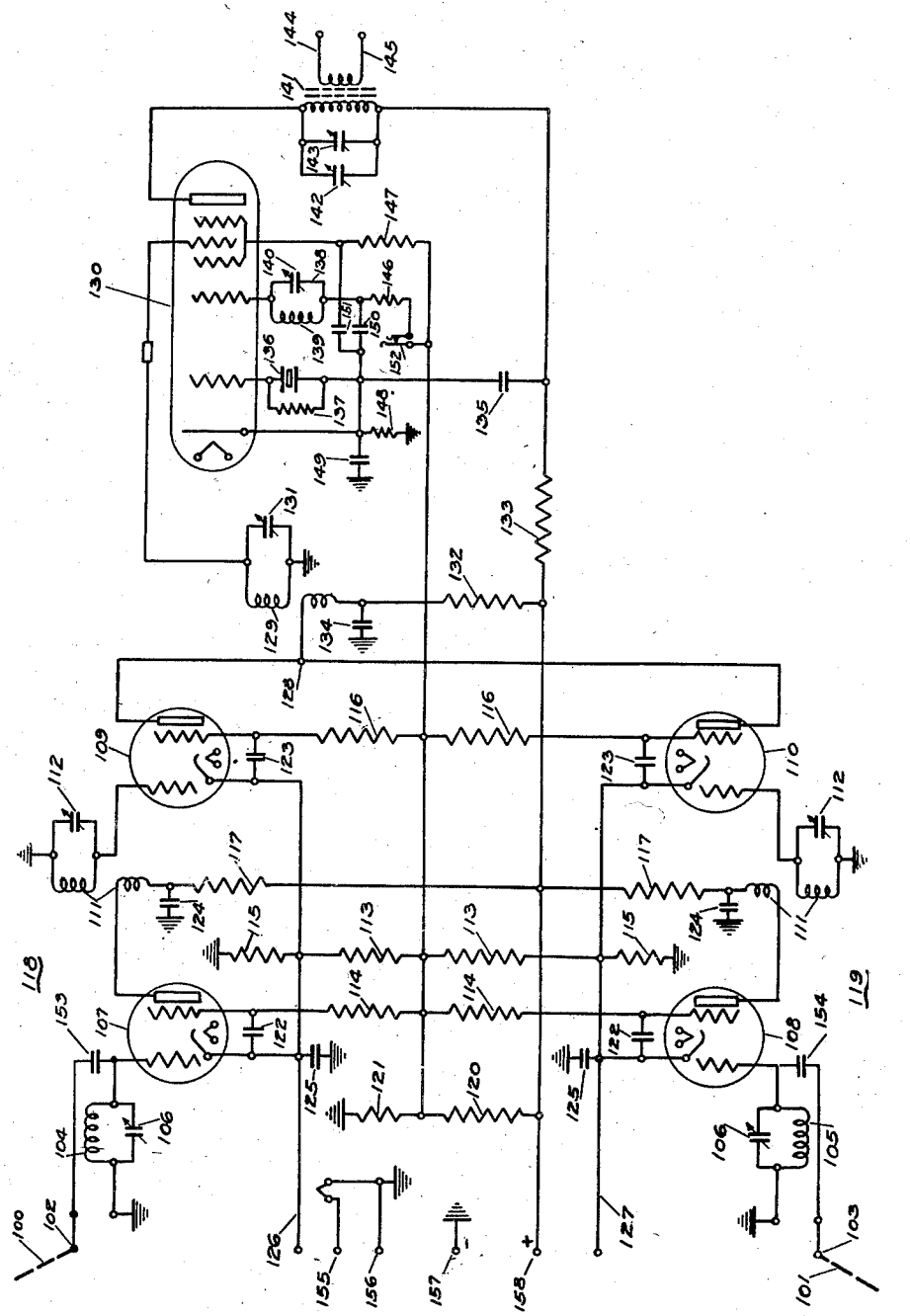


Fig. 1.

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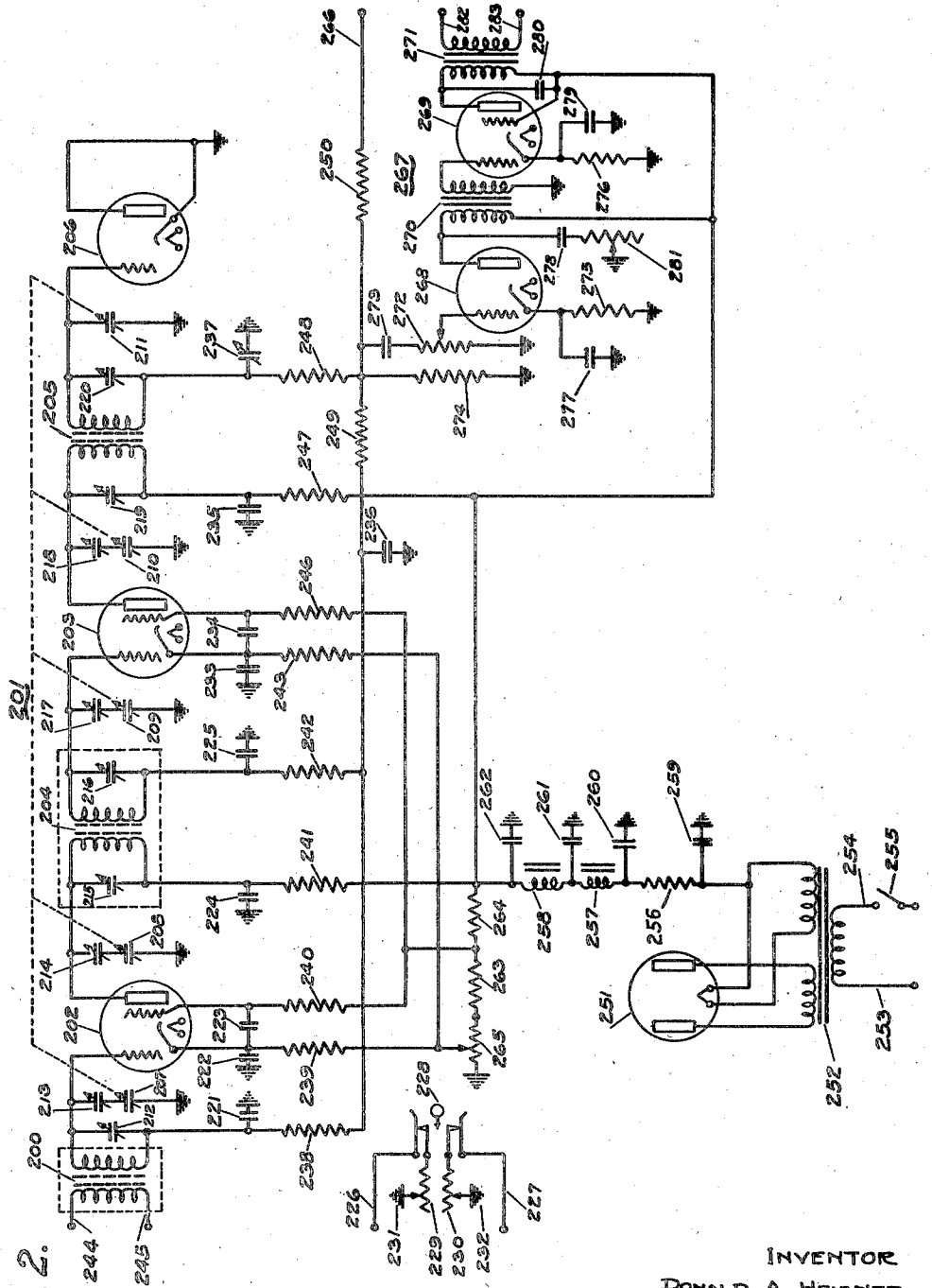


Fig. 2.

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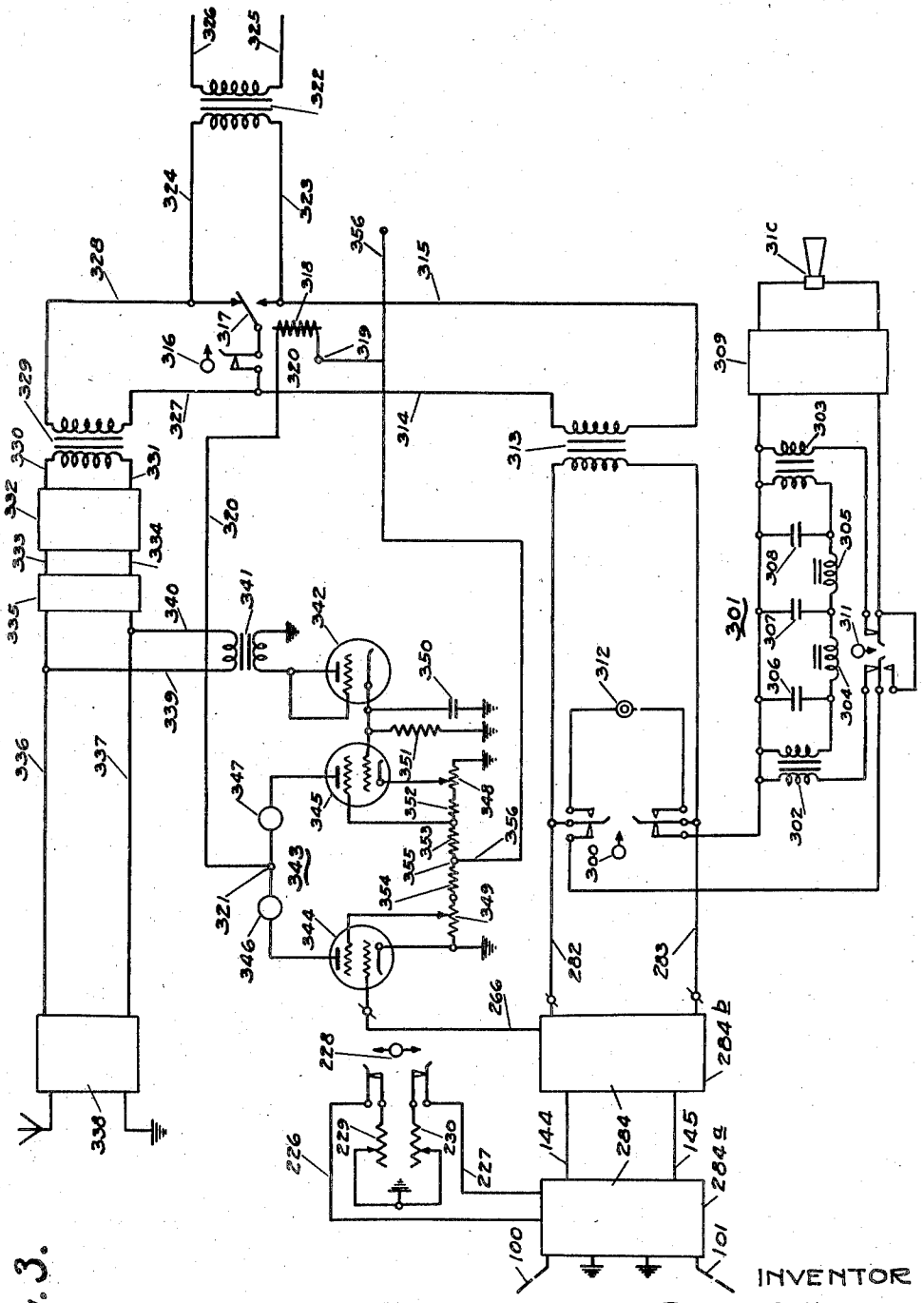


Fig. 3.

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Patented May 9, 1939 2,157,234

UNITED STATES PATENT OFFICE

2,157,234

RADIO TELEPHONE SYSTEM

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Original application October 14, 1937, Serial No. 168,988. Divided and this application March 21, 1938, Serial No. 197,147

10 Claims. (Cl. 250—6)

This invention relates to radio communication systems, and in particular to radio telephone circuits.

One object of this invention is to provide a system for controlling radio telephone receivers from a remote location, such a system being adapted for operation over ordinary wired lines, such as telephone lines or cables.

Another object is to provide a radio telephone system having a receiving circuit in two portions, one portion of which is located remotely from the other portion and controlled by means of wired communication devices.

Another object is to provide a radio telephone receiving system having directional antennae, and a receiving circuit divided into two parts, one part being located in the vicinity of the antennae and the other part being located remotely, with means for controlling the operation of the first part from the location of the second part, particularly as regards the selection of the desired directional antenna and the amplifying system associated therewith.

Another object is to provide a radio telephone receiving system having a plurality of directional antennae and an amplifier connected to each antenna at one location, connected by wired lines to a second location, where means is provided for controlling the selection and operation of the particular antenna and amplifier, the second location having circuits for completing the reception and transformation of the radio signal into an audible signal.

Another object is to provide a radio telephone receiving system, as described above, wherein means is provided for automatically switching the audible signal to a land telephone line.

Another object is to provide a radio telephone system having a transmitter and a receiver interconnected by a simplified relay switching circuit in which a single relay performs the switching operations from the transmitter to the receiver, and vice versa, this relay being operated in part by received carrier signals and in part by voice currents being transmitted.

Another object is to provide a radio receiving system having a low pass audio filter circuit connected to the loud speaker circuit during stand-by periods, and responsive to the reception of a low frequency audio tone from the transmitting station prior to each call, this being adapted to reduce the annoyance from static crashes during such stand-by periods when the receiving station is adjusted to high sensitivity while awaiting calls.

Another object is to provide a radio signalling system having a transmitter and a receiver interconnected through a switching system operated by a single relay, which in turn, is controlled by a pair of electronic tubes, one tube being responsive to the arrival of received carrier signals for actuating the relay in one direction, as for receiving, and the other tube being responsive to the arrival of transmitted voice currents for operating the relay in the other direction so as to place the transmitter in a transmitting condition.

Another object is to provide a method of controlling the selection of a radio receiver or transmitter by causing the voice currents and carrier wave signal currents to operate switching means for alternately switching in the receiver while switching out the transmitter, and vice versa.

Another object is to provide means for adjusting the radio frequency detector circuit of a diode tuning condenser to a condition permitting ganging of the diode tuning condenser with the amplifier grid and plate tuning condensers, thereby overcoming the difficulty hitherto encountered of ganging these condensers, due to the quite different load on the diode detector circuit than on the amplifier grid and plate circuits.

This application is a division of my application, Serial No. 168,988, filed October 14, 1937.

In the drawings:

Figure 1 is a circuit diagram showing a portion of a radio telephone receiver located in the vicinity of a plurality of directional antennae.

Figure 2 is a circuit diagram of another portion of the radio receiving circuit located remotely from the circuit of Figure 1, and connected thereto by wired lines.

Figure 3 is a circuit diagram of a radio receiver and transmitter interconnected by an automatic switching arrangement, operated by a single relay responsive in part to voice currents and in part to received carrier signals.

General arrangement

In general, the radio telephone system of this invention consists of a transmitter and a receiver, divided into at least two portions, one portion of the receiver being located in the vicinity of the antennae and the other portion being located remotely and connected thereto by wired lines having controlling devices associated therewith. In particular, the receiver preferably has two or more directional antennae,

with an amplifier associated with each antenna, both amplifiers being connected to an oscillator circuit employing a fixed oscillator frequency. The selection of the particular antenna and amplifier is made through wired lines running from the receiver control station.

The receiver shown uses the superheterodyne circuit with a single frequency or a narrow band of frequencies, the intermediate amplifier being capable of being tuned. This tuned amplifier is located at the receiver control station, which is at a considerable distance from the receiving antennae and associated amplifiers. The signals amplified by the intermediate amplifier at the controlling station are, in turn, amplified by an audio amplifier and conducted either to a loud speaker or head 'phones, as desired. A transmitter is located at the receiver control station and selectively connected to a land telephone line by a relay-operated switching arrangement, the relay being operated in one direction by the plate current received from a tube responsive to receiving carrier signals, and operated in the opposite direction by a tube responsive to transmitting voice currents. The former tube operates the relay to place the receiver in connection with the land telephone line, and the latter tube operates the relay to place the transmitter in connection with the land telephone line.

Associated with the loud speaker circuit is a low pass filter system, which permits the passage of a low frequency calling tone from the distant station, but filters out the higher frequency tones resulting from static. In this manner the static annoyance during stand-by periods is greatly reduced, the low pass filter system being arranged to be switched out by the operator when he prepares to receive the message signals from the calling station.

Hitherto, in radio telephone systems, it has been desirable to place the receiving antennae at a distance from the transmitting station in order to avoid interferences from the transmitter. Under such circumstances, it has been usual to provide technical operators at both the receiving and transmitting locations, or alternatively to operate the transmitters by remote control from the receiving location in order to avoid the necessity of having technical operators in constant attendance at the transmitters. Such arrangements, however, are objectionable either on account of the expense of maintaining operators at both stations, or because of the danger of damage to the transmitting equipment where no operators are present and where it is controlled remotely. Accordingly, it is preferable to have the operators at the transmitting location and the receivers operated by remote control. The present invention accomplishes this and enables the selection of a particular directional antenna from the remotely located receiver control station. These directional receiving antennae are provided to improve signalling conditions with mobile stations, such as ships at sea, when communicating with a particular ship in a certain direction.

Hitherto, when the transmitter has been switched into operation and the receiver switched out of operation, a system employing two or more relays has been provided to accomplish this switching service, one relay being operated from the voice signals received by the radio receiver, another operated by the voice signals received over the land telephone line, and a third operated by the carrier wave of the station whose messages are being received. This multiple relay system is exceedingly complicated, and liable to breakdowns, and in the present invention is replaced by a single relay operated in part by carrier signals and in part by voice currents to perform the necessary switching functions.

Hitherto also, in radio telephone stations, atmospheric static conditions have produced annoying noises in the loud speaker or head receivers while the operator has been standing by awaiting calls from distant stations. These static noises could not be avoided because of the fact that the receiver must operate at full sensitivity at such times in order to avoid missing weak signals from distant stations. The constant static noises produce severe nervous strain upon the operators, and are reduced in the present invention by the use of low pass audio filters in the loud speaker circuits during stand-by periods. The mobile stations in calling the land station, first transmit a low frequency audio tone prior to each call, this tone being passed by the filters and operating the loud speaker. The low pass filter system may thus be switched out and the receiver operated in a normal way to receive the message.

Receiver circuit

The receiver circuit shown in Figures 1 and 2 consists, in general, of an antenna located portion shown in Figure 1, and a remotely located portion shown in Figure 2. The receiver employs the superheterodyne principle with the equipment divided in such a manner that the radio frequency amplifiers, oscillator and first detector are located in the vicinity of the antennae, an intermediate frequency of the order of 300 to 400 kilocycles being transmitted over wired lines to the receiver control station of Figure 2, where the intermediate frequency amplifiers, second detector and audio amplifiers are located. The radio frequency amplifiers are tuned to a fixed frequency or a very narrow band of frequencies because only a single frequency or narrow band of frequencies is to be received. Unlike the ordinary superheterodyne receiver, where the intermediate frequency is fixed and the oscillator frequency is tuned to be equal to the received frequency plus or minus the intermediate frequency, the present invention employs a fixed oscillator frequency in order to avoid the necessity of tuning the oscillator by remote control. In the present invention, therefore, the intermediate frequency is not constant but varies within the narrow band of frequencies to be received, hence, the intermediate amplifier is arranged to be tuned.

Referring to the drawings in detail, Figure 1 shows the antenna located portion of the receiver circuit as designated by the numerals between 100 and 199. Figure 1 shows a plurality of directional antennae, two being shown, and designated 100 and 101. These antennae are connected at the terminals 102 and 103 through coupling condensers 153 and 154 to the grid circuits of the tubes 107 or 108. Inductances 104 and 105 and variable condensers 106, connected across the inductances 104 and 105, permit the tuning of the grid circuits of the tubes 107 or 108 to the particular frequency which is to be received.

The tubes 107 and 108 are connected, respectively, to tubes 109 and 110 in a circuit constituting a two-stage screen grid radio frequency amplifier for each of the antennae 100 and 101. The grid circuits of the tubes 109 and 110 are inductively coupled by means of the inductances 111 and tuned by means of the variable condens-

ers 112. The usual resistors provided in such a radio frequency amplifying system are designated by the numerals 113 to 117, inclusive, these being duplicated for each of the two radio frequency amplifiers, generally designated 118 and 119, and associated with each directional antenna 100 and 101. Resistors 120 and 121 complete the amplifier circuit. By-pass condensers 122, 123, 124 and 125 are likewise provided.

The gain of these radio frequency amplifiers 118 and 119 is controlled by varying the grid bias voltage from the remotely located receiver control station, this being done by cathode resistances connected across the cathode by-pass condensers 125. The lines 126 and 127 run for this purpose from the cathode by-pass condensers 125 to the remote receiver control station, and connect up with the lines 226 and 227 in Figure 2. The lines 226 and 227 (Figure 2) are connected to a key switch 228, which controls the connection of either of the variable cathode resistors 229 or 230, thereby selecting the particular amplifier 118 or 119 and disabling the associated amplifier. The adjustment of the cathode resistances 229 and 230 controls the gain of the radio frequency amplifiers 118 and 119 from the remotely located receiver control station.

Thus to increase the gain of the upper two-stage amplifier 118 the resistance of the variable cathode resistor 229 between the line 226 and the ground connection 231 is decreased. To disable the upper amplifier 118 the key switch 228 is operated to open the circuit between the variable cathode resistor 229 and the line 226, at the same time closing the line between the variable cathode resistor 230 and the line 227. By variously operating the key switch 228 it is thereby possible to select either or both of the receiving antennae 100 or 101, thereby making directional or diversity reception possible. The variable cathode resistor 230 is similarly connected to the ground at 232. The circuit containing the lines 226 and 227, together with the key switch 228 and resistors 229 and 230, is shown and designated by the same reference numerals in Figure 3.

The outputs of the two radio frequency amplifiers 118 and 119 (Figure 1) are connected together at the terminal 128 and feed into the grid tuning inductance 129 of the first detector or mixer tube 130. A variable condenser 131 is provided for tuning this grid tuning circuit. Resistors 132 and 133 and fixed condensers 134 and 135 are provided in the circuits beyond the inductance 129. The first detector tube 130 also functions as an oscillator under the control of the crystal 136 having the resistor 137 bridged therearound. The oscillations of this crystal 136, in cooperation with the tuning circuit 138 having the inductance 139 and variable condenser 140, serve to convert the radio frequency signal from the amplifiers 118 or 119 into the intermediate frequency of 300 to 400 kilocycles. The output of the first detector or mixer tube 130 is tuned to the intermediate frequency band by means of the inductance 141 and variable condensers 142 and 143.

The transformer 141 has the secondary winding connected to the transmission lines 144 and 145, leading to the receiver control station (Figure 2), the same lines being there designated 244 and 245. The dimensions of the transformer 141, particularly the secondary thereof, are carefully determined to procure the proper impedance matching with the transmission lines 144 and 145, which take the signal to the receiver control station shown in Figure 2. The transmission lines 144 and 145 may consist of paired lines in the ordinary telephone cable, this giving good results up to a length of several miles. Likewise associated with the circuit of the first detector or mixer tube 130 are the resistors 146, 147 and 148 and the fixed condensers 149, 150 and 151, together with the jack switch 152. In the tube 130 the crystal frequency from the crystal 136 is mixed with the radio frequency or signal frequency to produce a beat frequency between 300 kilocycles and 400 kilocycles, which is taken off in the transformer 141 and transmitted to the impedance matching transformer 200 (Figure 2) over the lines 144, 244, 145 and 245. The heater voltage for the various tubes (one filament only being shown for simplicity) is applied between the terminals 155 and 156 and the plate voltage between the terminals 157 and 158. The jack 152 provides means for measuring the oscillator anode current by plugging a meter into the circuit in tuning the oscillator.

The portion of the receiver shown in Figure 2, and termed the "receiver control station", contains the two-stage intermediate frequency amplifier, generally designated 201, and connected into the impedance matching transformer 200. The two-stage amplifier 201 contains the electronic tubes 202 and 203, the coupling transformer 204, the output transformer 205 and the second detector tube 206. The portion of the receiver at the receiver control station is, in effect, a tuned radio frequency receiver using tuned circuits in both the grid and plate circuits. The transformers 200, 204 and 205 have cores of powdered high frequency iron and are tuned to the intermediate frequency corresponding to the signal to be received by means of the ganged variable condensers 207, 208, 209, 210 and 211. Additional variable condensers 212 to 220 and 237 serve to pretune the various circuits so that the ganged variable condensers 207 to 211 will track over the entire scale. Additionally provided are the fixed condensers 221 to 225 and 233 to 236, the resistances 238 to 243 and 246 to 250.

For supplying plate voltage the rectifier circuit containing the plate supply rectifier tube 251 is provided together with the transformer 252 connected to the power lines 253 and 254 by way of the line switch 255. The resistor 256 and chokes 257 and 258, together with the fixed condensers 259 to 262, inclusive, complete the rectifier circuit. To the resistors 263 and 264 are connected the potentiometer 265, the adjustment of which serves to adjust the sensitivity of the receiver. This potentiometer 265 is located in the amplifier cathode circuit, as is seen from Figure 2. The second detector tube 206 is connected as a rectifier, and supplies negative voltage for the automatic volume control of the amplifier by means of the bias voltage passing through the resistor 249 to the tubes 202 and 203. This bias voltage also passes through the resistor 250 to the line 266 for connection to the voice terminal equipment shown in Figure 3.

The second detector tube 206 also supplies audio voltage to the audio frequency amplifier, generally designated 267, and having the audio amplifier tubes 268 and 269, together with the audio transformers 270 and 271. The audio voltage from the second detector tube 206 is fed to the potentiometer 272, the arm of which is connected to the grid of the first audio tube 268. The potentiometer 272 serves as the audio vol-

ume control, and has associated therewith the fixed condenser 273. Additional resistors 274, 275 and 276, together with fixed condensers 277, 278, 279 and 280 and a potentiometer 281 complete the audio amplifier circuit. The output of this two-stage audio amplifier 267 is taken off at the lines 282 and 283.

Voice terminal circuit

In Figure 3 the circuit shown in Figure 2, consisting of the receiver control station, is shown by the same reference numerals. The entire amplifying and detecting system, however, and including the radio frequency amplifier 201, audio frequency amplifier 267 and rectifier circuit, is indicated diagrammatically and designated the "receiver" 284. This numeral 284 refers to all of the equipment shown in Figure 2 excepting the circuit 226 to 232, controlled by the key switch 228 for selecting and controlling the receiver circuit shown in Figure 1. The latter may be mounted upon or near the masts of the antennae and requires no constant attendance of an operator.

The output of the receiver 284 from the lines 282 and 283 (Figure 3) is connected through the normally closed contacts of the key switch 300 to the low pass filter circuit, generally designated 301, and consisting of the transformers 302 and 303, the inductances 304 and 305 and the fixed condensers 306, 307 and 308 and an amplifier 309, which in turn, is connected to a loud speaker 310. The key switch 311 is provided for cutting the low pass filter circuit 301 out of the circuit of the loud speaker 310.

The low pass filter circuit 301 eliminates most of the static noise, but passes the low frequency tone transmitted from the ship prior to each call. When the operator hears this tone from the loud speaker 310 he may operate the key switch 311 to cut the filter circuit 301 out of the circuit of the loud speaker 310, or else he may operate the key 300 to disconnect the filter circuit 301 and loud speaker 310, together with its amplifier 301, and simultaneously to connect the output lines 282 and 283 of the receiver 284 to the telephone head 'phones 312.

Beyond the key switch 300 the receiver output lines 282 and 283 are connected into the primary of a transformer 313, the secondary of which is connected to the lines 314 and 315, respectively. The line 314 runs to the key switch 316 by which the relay 317 may be cut into or out of operation. The relay 317 is provided with a relay-operating coil 318, connected at the terminal 319 to a suitable source of positive current, and on its other side connected to the line 320 leading to the terminal 321. The line 315 from the transformer 313 is connected beyond the relay 317 to the repeat coil or transformer 322 by way of the line 323. From the opposite terminal of this winding of the repeat coil 322 the line 324 runs to the opposite terminal of the relay 317. The other winding of the repeat coil 322 is connected to the land or wired telephone lines 325 and 326, leading to the land telephone system with which it may be desired to connect the radio telephone system for direct communication between a ship station and a land telephone subscriber.

Beyond the key switch 316 and relay 317 the lines 327 and 328 run to one winding of the transformer 329, the opposite winding of which is connected by the lines 330 and 331 to the transmitting amplifier 332. The output lines 333 and 334 of the latter run to the attenuation device 335, from which the lines 336 and 337 run to the radio transmitter 338. The details of the radio transmitting system are immaterial to the present invention. The lines 336 and 337 are connected by the lines 339 and 340 to one winding of a transformer 341, the other winding of which is connected into the plate and grid circuit of a vacuum tube 342, forming a part of the switching circuit, generally designated 343. Besides the tube 342 the switching circuit 343 contains electronic tubes 344 and 345, having their plates connected through the milliammeters 346 and 347 to the terminal 321 of the line 320 leading to the operating coil 318 of the relay 317. In this manner plate current from either of the tubes 344 or 345 will energize the relay coil 318 and operate the relay 317.

The tube 345 is hereinafter called the "voice tube" and is normally biased to cut off i. e. zero plate current by means of the potentiometer 348 in its cathode circuit. The tube 344, on the other hand, hereinafter called the "carrier tube", is normally biased by means of the potentiometer 349 in its screen grid circuit so as to pull a predetermined amount of current, for example, two milliamperes. This current holds the relay 317 in an operated condition (Figure 3), shunting out the radio receiver output circuit and leaving the land telephone lines 323 and 324 connected to the radio transmitter input lines 336 and 337. The switching circuit 343 is completed by the fixed condenser 350 and the resistors 351 to 354, inclusive. Between the resistors 353 and 354, the terminal 355 is connected to the line 356 leading to a source of positive "B" voltage, such as 300 volts, this connection being similar to that of the terminal 319 of the relay-operating coil 318, and completing the relay-operating coil circuit.

The control grid of the carrier tube 344 is connected to the automatic volume control voltage of the radio receiver 284 through the line 266, previously mentioned. The tubes in the receiver which have this automatic volume control voltage applied to their grids are of the variable-mu type and require a high bias voltage for plate current cut-off. The tube 344, which may be of the type known commercially as the type 6C6, is an abrupt cut-off tube. Accordingly, when a normal signal is received from the radio receiver 284 enough bias voltage will be generated to completely block the carrier tube 344. Since the carrier tube plate current normally holds the relay 317 operated to connect the land telephone lines 323 and 324 with the radio transmitter 338, every time a signal is received by the radio receiver 284 the "voice-controlled carrier" will set up enough bias voltage to block the carrier tube 344, which in turn, allows the relay 317 to move against its back or upper contact. The carrier is transmitted by the remote station only when talking, the transmitter being put into operation by voice signals.

When the relay drops the output of the receiver 284 is automatically connected directly to the land telephone lines 323 and 324, and the radio transmitter input is automatically shunted out. When the radio telephone party at the distant station stops talking, the carrier disappears, the automatic volume control voltage over the line 266 drops, and the carrier tube 344 draws current. This current energizes the relay coil 318 to operate the relay 317, and the land telephone party is again connected to the radio transmitter 338. When the land telephone party begins to

talk a small portion of the audio input to the radio transmitter **338** is fed through the lines **339** and **340** to the transformer **341**, thence to the tube **342**, which rectifies this voltage and places the rectified voltage on the grid of the voice tube **345**.

This rectified voltage from the tube **342** operates to make the grid of the voice tube **345** less negative, or in the case of strong signals, actually positive with respect to the cathode of the voice tube **345**. This change in the grid voltage on the grid of the voice tube **345** causes plate current to flow from the plate thereof, which supplements the current through the relay coil **318** from the carrier tube **344**, thereby causing the armature **317** to maintain its contact with the front or lower contact member, even though static crashes might occur while the land telephone party is talking. The attenuator **335** serves for adjusting the speech volume fed into the radio transmitter.

Operation

Much of the operation of the radio system of this invention has been described in connection with the respective circuits. When the operator at the receiver control station, in Figure 2, desires to communicate with a particular ship in a known direction, he selects either or both of the directional receiving antennae **100** or **101** by manipulating the key switch **228**, in the manner previously described. This automatically connects the radio frequency amplifier **118** or **119** with the cathode variable resistors **229** or **230**, by which the gain of each amplifier may be adjusted from the receiver control station.

When a ship calls, it first sends out a low audio tone, which is received over one of the antennae **100** or **101**, amplified through the selected radio frequency amplifier **118** or **119**, and mixed in the first detector tube **130** with the crystal frequency from the crystal **136** to produce a beat frequency between 300 and 400 kilocycles. This passes through the impedance matching transformer **141** and over the lines **144**, **145**, **244** and **245**, through the impedance matching transformer **200** to the intermediate frequency amplifier **201**, which has been adjusted by means of the ganged condensers **207** to **211** to receive the ship's frequency.

The signal continues through the audio frequency amplifier **267** and over the output lines **282** and **283**, through the key switch **300** and low pass filter system **301** to the amplifier **309** and loud speaker **310**, where it sounds the low tone. This warns the operator of the presence of the signal and he then manipulates the key **311** to cut out the low pass filter circuit **301** from the loud speaker **310** so as to hear the message signals directly over the loud speaker **310**, or else he manipulates the key switch **300** to transfer the message signals to his head 'phones **312**. The ship then transmits the message signals upon the selected frequency, and these message signals operate the switching system **343**, in the manner previously described, to actuate the relay **317** in such a manner as to connect the land telephone lines **325** and **326** to the radio receiver **284** (Figure 3). The relay **318**, however, may be placed in or out of operation by manipulating the key switch **316**. The land party then listens to the message.

When the party on the ship ceases talking, the relay **317** automatically operates in response to the action of the switching system **343**, connecting the land telephone party to the radio transmitter **338**. When the land telephone party begins to talk the audio input current, which passes through the transformer **341** to the tube **342** of the switching circuit **343**, causes plate current to flow in the voice-operated tube **345**, which supplements the current through the relay coil **318** from the carrier tube **344**, thereby holding the relay **317** against its front or lower contact, irrespective of the fact that static crashes may occur while the land party is talking. When the land party ceases talking and a radio signal is again received by the radio receiver **284**, the switching system **343** and relay **317** again operate to connect the radio receiver **284** to the land telephone lines **325** and **326**, in the manner previously described.

Thus, the carrier tube normally holds the relay **317** in position to connect the radio transmitter **338** to the land telephone lines **325** or **326**. The voice currents produced in the land lines **325** and **326** are rectified by the tube **342**, and applied to the voice tube **345** in such a manner as to hold the relay **317** in the transmitting position so long as the voice currents from the land telephone party continue to arrive over the lines **325** and **326**.

When a carrier wave arrives in the radio receiver **284**, however, a negative voltage is generated thereby, which is conveyed to the carrier tube **344** in such a manner as to cut off its plate current and the relay **317** is released to make contact with its upper terminal. When neither the carrier tube **344** nor the voice tube **345** pulls current through the relay coil **318**, the radio signal received may pass through the relay **317** to the land lines **325** and **326**.

The term "diversity reception" is used herein as commonly used to denote receiving the same radio signal on several antennae as high frequency waves do not fade at the same efficiency on antennae relatively close to each other. The variable condenser **237** permits the adjustment of the radio frequency detector circuit to a condition where ganging it with the amplifier grid and plate tuning condensers is made possible. On diode detectors the load is quite different from the load on the amplifier grid and plate circuits, and hitherto this has made it quite difficult to gang the diode tuning condenser with the amplifier grid and plate tuning condensers. In place of the relay **317** switching by means of tubes, copper oxide rectifiers or other analogous devices might alternatively be employed. It will also be understood that the signal announcing means responsive to low audio frequency signals only may include loud speakers mechanically tuned to respond to low frequencies only, or mechanical low pass filters and other devices, excluding high audible frequencies and passing only low audible frequencies.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, switching means for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, means responsive solely to carrier signals for operating said switching means to connect said wired telephone circuit with said

radio receiver, and voice-responsive means for operating said switching means to connect said wired telephone circuit with said radio transmitter.

2. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, switching means for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, an electronic tube circuit responsive solely to carrier signals for operating said switching means to connect said wired telephone circuit with said radio receiver, and a voice-responsive electronic tube circuit for operating said switching means to connect said wired telephone circuit with said radio transmitter.

3. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, carrier-signal-responsive means for operating said relay to connect said wired telephone circuit with said radio receiver, and voice-responsive means for operating said relay to connect said wired telephone circuit with said radio transmitter.

4. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, a relay constituted of a single actuating coil and armature for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, a carrier-signal-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio receiver, and a voice-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio transmitter.

5. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, means including a radio-signal-responsive electronic tube having abrupt cut-off characteristics for operating said relay to connect said wired telephone circuit with said radio receiver, and a voice-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio transmitter.

6. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, a radio-signal-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio receiver, and means including a voice-responsive electronic tube biased to draw a predetermined current for operating said relay to connect said wired telephone circuit with said radio transmitter.

7. In a radio station, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, a radio-signal-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio receiver, and a voice-responsive electronic tube circuit for operating said relay to connect said wired telephone circuit with said radio transmitter, said voice-responsive electronic tube circuit including an electronic tube biased to draw a predetermined current and a rectifier tube adapted to rectify voice currents and supply the rectified voltage to said voice-responsive tube to cause plate current to flow therefrom through said relay, whereby to maintain the position of said relay irrespective of the currents of static crashes during the transmission of voice signals from said wired telephone circuit to said transmitter.

8. In combination, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, means for maintaining the operating coil of said relay in an energized condition whereby the wired telephone circuit is normally connected to said radio transmitter, and means responsive to currents of carrier frequency for disabling said maintaining means whereby the operating coil of said relay is deenergized to make a connection between the wired telephone circuit and the radio receiver.

9. In combination, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio receiver and transmitter respectively, means for maintaining the operating coil of said relay in an energized condition whereby the wired telephone circuit is normally connected to said radio transmitter, means including a voice-operated device for supplementing the current through said maintaining means, and means responsive to currents of carrier frequency for disabling said maintaining means whereby the operating coil of said relay is deenergized to make a connection between the wired telephone circuit and the radio receiver.

10. In combination, a radio receiver, a radio transmitter, a wired telephone circuit, a relay for selectively connecting said wired telephone circuit to said radio transmitter respectively, means for maintaining the operating coil of said relay in an energized condition whereby the wired telephone circuit is normally connected to said transmitter, and means responsive to currents in a carrier frequency circuit for disabling said maintaining means whereby the operating coil of said relay is deenergized to make a connection between the wired telephone circuit and the radio receiver, and means for preventing a false operation of said disabling means brought about by static crashes in the carrier frequency circuit, said false-operation-preventing means comprising a voice-operated relay which serves to supplement the current in said maintaining means during the time the wired telephone circuit is connected to the radio transmitter.

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