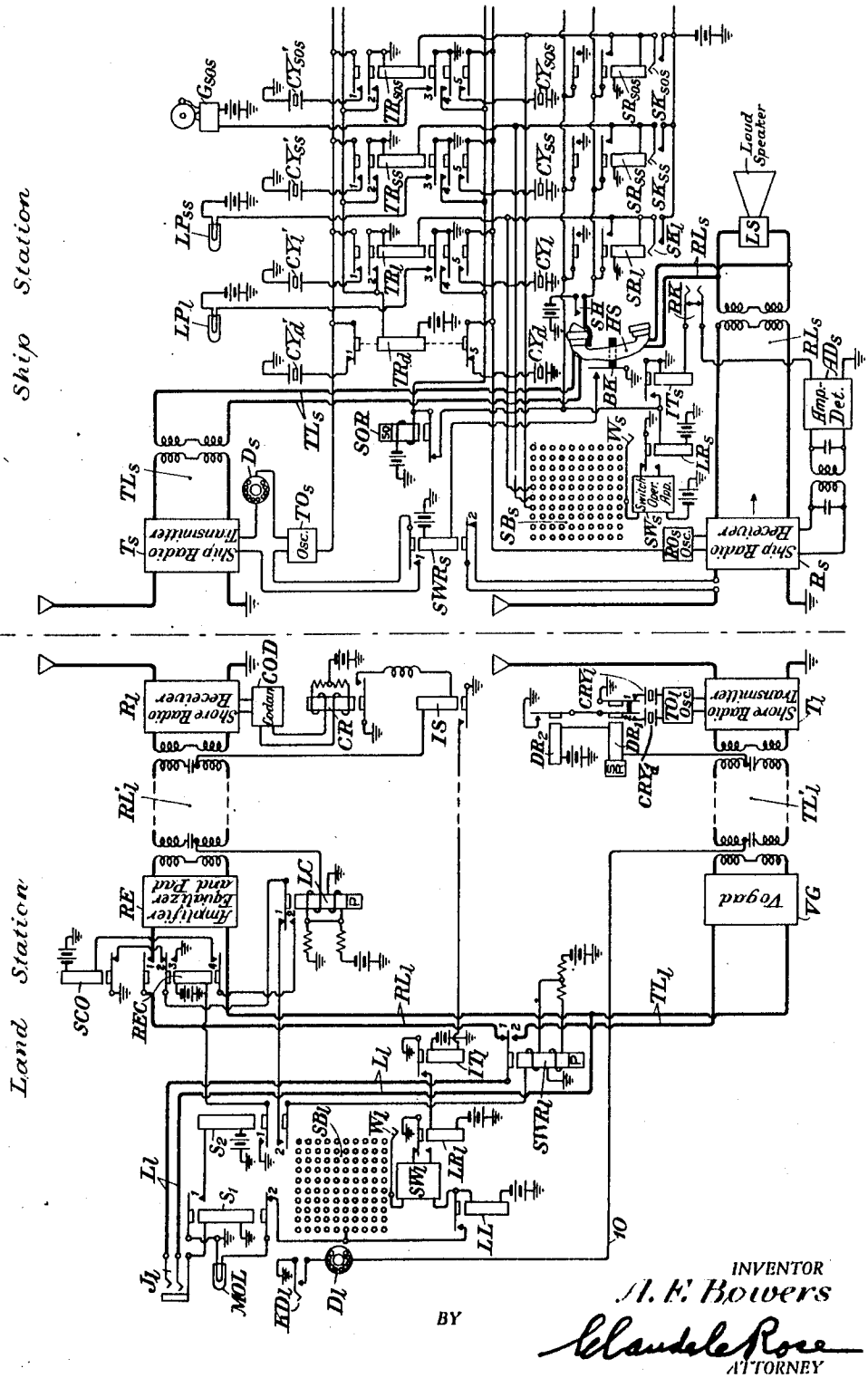
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RADIO TELEPHONE SYSTEM

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RADIO TELEPHONE SYSTEM

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This invention relates to radio systems, and particularly to radio telephone systems adapted for communication between ships and points ashore.

One of the problems in such a system is that of transmitting between stations signals incidental to the establishment of telephone communication between a ship and a shore station, or between two ships.

In my prior U. S. Patent No. 2,265,056, granted to me December 2, 1941, I disclosed a system by means of which signals could be transmitted between a ship and a shore station by utilizing the carrier as a signaling medium This signaling method depended on the fact that when two stations such as a ship station and a shore station were in communication two carriers were used, although not simultaneously. One carrier frequency was used in talking from the shore station transmitter to the ship receiver, and a different carrier frequency was employed for talking from the ship transmitter to the shore receiver. When communicating in one direction the carrier in the opposite direction was cut off, and when both stations were idle neither carrier was transmitted. Therefore an operator at one station could operate a signal at another station by merely transmitting the carrier to such other station, and could operate another signal by cutting off the carrier.

Such a method of signaling is subject to the disadvantage that static or other interference in the carrier range of one of the channels employed might cause false operation of a signal. To overcome this difficulty I disclosed in my patent above referred to an arrangement for operating the signal by interrupting the carrier by code pulses. For example, by interrupting the ship-shore carrier frequency at the ship station by dial pulses, a two digit code could be sent out. This actuated the codan relay (i. e. the anti-noise carrier operated relay) at the shore receiver, and this in turn actuated a step-by-step connector switch to complete the signal circuit. By using different codes the connector switch could perform various functions at the will of the ship operator, such as lighting switchboard lamps and ringing gongs at the shore station. Moreover, the lights and gongs would not respond to miscellaneous interfering signals picked up by the shore station receiver.

However, a system of the type above described has a number of limitations, especially where the system is used by vessels passing along a shore line. In such a situation each of several vessels must be able to communicate with any one of several land stations located along the shore. Usually a ship communicates with the nearest land station, but as it moves along shore it becomes necessary to shift its communications to the next land station into whose zone it enters. Moreover each shore station must be assigned two individual frequencies, one for transmitting and the other for receiving, and the frequencies assigned to any given shore station must be different from those of all other shore stations within communication range. Consequently each ship must be equipped with tuning crystals or other selective devices corresponding to the frequencies of the various shore stations with which it may have occasion to communicate. Due to these conditions it is evident that a ship operator, before he can communicate with a shore station, must manipulate certain switches by hand, or perform other manual operations which will tune his transmitter and receiver to the frequencies of a particular shore station.

Since each shore station is assigned individual transmitting and receiving frequencies which differ from station to station, communication cannot be established from shore to ship unless the ship receiver is in tune with a particular shore station's transmitting frequency. Consequently it follows that the operator on a ship proceeding along a coast line must shift his receiving frequency as he leaves the zone of one shore station and enters that of another.

Calls originating on land must be relayed through a shore station to a ship. Indeed any one of several shore stations may have calls routed through it for a particular ship. It will be clear from what has been said above that no such calls can be relayed to the called ship unless transmitted at the frequency to which the ship station's receiver happens to be set at the moment. As ship stations usually keep their receivers tuned to one of the shore frequencies, it is difficult for any other shore station to communicate with such a ship. For the same reason it is difficult for another ship to communicate with a ship whose receiver is so set, without first sending the message to the shore station to which the called ship is tuned, and then relaying the message to the ship through the shore station.

In order to overcome the foregoing difficulties it is herein proposed to make certain improvements in the type of signaling system disclosed in my Patent No. 2,265,056 above referred to, for the purpose of enabling signaling to take place from shore to ship or from ship to ship without being subject to the limitations above discussed. The

improved system is of such character that it is not only useful in ship communication, but is adaptable for use in aviation for communicating between airplanes, or between an airplane and ground. It may also be used for radio control of various kinds of mechanical devices, or for communication between moving vehicles, or between a moving vehicle and a fixed station of any kind.

To accomplish these results it is proposed to establish a single carrier frequency common to all of the stations of a particular classification, such for example as coastal harbor stations. This frequency is to be used by the various ship and shore stations alike for dialing purposes only, and will be hereinafter referred to as the "dialing frequency." By dialing this common frequency various signaling or control functions may be performed.

It is further proposed that all ship stations have their receivers modified to permit selective control of the various crystals or other tuning devices associated with the receiver, in order to tune it to the frequencies used for communication with the various shore stations authorized by the ship's radio license, or for communication with other ships, or with the U. S. Coast Guard. This crystal or tuning control may be exercised either locally by the ship's operator, or from a distant point such as a shore station or another ship. Such tuning when controlled locally may be done by keys, but when controlled from a distance is preferably effected automatically under the control of the operator at the distant station. For this purpose a step-by-step connector switch or other similar switch may be provided at the ship stations to select the proper tuning element. It is also contemplated that crystals or other devices for determining the frequency of the ship's transmitter may be selected and controlled in the same manner as those of the receiver.

For communication from ship to ship a special frequency is allocated, and all of the ships transmit and also receive on this single frequency. When one ship wishes to communicate with another, the operator at the calling ship interrupts the dialing frequency by dialing the code for the special frequency assigned for ship to ship communication, thus causing the called ship and all other ships to have their transmitters and receivers automatically tuned to the ship to ship frequency. The calling operator next actuates a key to shift his own transmitter and receiver to this frequency, and then calls the name of the desired ship by telephone. The called operator answers and conversation proceeds. Operators at other ships may restore their apparatus to the dialing frequency by operating a release key.

The provision of a special common frequency for dialing purposes means that each shore station must be able to send two frequencies—the common dialing frequency and the sending frequency assigned by the station license. A dial is provided at each shore station for sending code signals by the dialing frequency, to automatically tune the transmitter and receiver of the called ship to the receiving and transmitting frequencies of the shore station. Shifting from the dialing frequency to the sending frequency and vice versa at the shore station may be controlled by a key switch actuated by the shoe station operator.

Further details, objects and results of the invention will be clear from the following description when read in connection with the accompanying drawing, in the figure of which a preferred form of signaling system embodying the invention is disclosed.

Referring to the drawing, a typical land or shore station is shown at the left and a ship station appears at the right.

Description of land station apparatus

The land station is similar to that illustrated in my Patent No. 2,265,056, above referred to, but is equipped with means to tune the transmitter to the common dialing frequency when desired and to interrupt or dial said frequency in accordance with a code. As shown the land station differs from that of my patent in that instead of having a common transmitter with several different receivers associated therewith, only one receiver is associated with the transmitter. However, the present system contemplates providing each land transmitter with one or more separate receivers at nearby shore points if desired. Each shore station has an individual transmitting frequency assigned to its transmitter, and a separate frequency individual to the station is assigned to its receiver.

A shore transmitter is shown at T_1 and is normally adjusted to transmit at the assigned transmitting frequency, and for this purpose a crystal CRY_1 is connected to the oscillator TO_1 associated with the transmitter T_1. When it is desired to dial a called ship station to tune its transmitter and receiver to those of the shore station, a key KD_1 may be operated to disconnect crystal CRY_1 and substitute crystal CRY_2.

The radio receiver at the shore station is shown symbolically at R_1 and has associated therewith a codan COD. The codan is a well known device and is therefore represented by a simple rectangle. It receives its name from the fact that it is a carrier operated device unresponsive to noise, the name being derived from the initials of the expression "carrier operated device anti-noise." The codan, in response to received carrier, operates a codan relay CR to accomplish certain results which will appear later.

For communication purposes the transmitter T_1 and the receiver R_1 are connected to a jack J_1 in a manner now to be described. Through this jack connections may be established by a so-called "marine" operator to a person on land who wishes to talk to someone aboard ship. From the jack J_1 a local office connection L_1 extends to a junction point controlled by a switching relay SWR_1. At this point the circuit divides into two branches. One branch TL_1 extends through a vogad VG (symbolically represented) and over a path TL_1' to the transmitter T_1. The other branch RL_1 extends over a path RL_1' to receiver R_1 through an assemblage of apparatus including a voice frequency amplifier, an equalizer and a pad, represented symbolically by rectangle RE. The vogad VG is a well known device for automatically adjusting gain, deriving its name from the initials of the expression "voice operated gain adjusting device."

It will be noted that the relay SWR_1 is located at the point where the local office connection L_1 branches into the paths TL_1 and RL_1 leading to the transmitter T_1 and R_1 respectively, so that its armature determines which of said paths is connected to the local connection L_1. When only the lower winding of relay SWR_1 is energized, as is normally the case, its armature completes the path to the receiver R_1. When the marine operator plugs into the jack J_1 to establish a connection and the land station's receiving carrier is

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transmitted from a ship, no current flows through the upper winding of relay SWR_1 and the connection from local circuit L_1 to the receiver R_1 remains established. When the ship operator cuts off the carrier, the upper winding of relay SWR_1 is energized and said relay switches the local connection L_1 over path TL_1 to the transmitter T_1 and disconnects the path to the receiver R_1. Thus it will be seen that switching from the transmitter to the receiver and vice versa at the shore station is under the control of the talker aboard a ship communicating with the shore station, because the talker switches the carrier on and off as will appear later.

As described in my prior Patent No. 2,265,056, a ship operator may dial a code number representing a desired shore station to call the operator at such station. The dialed pulses operate the codan relay CR, which operates through relays IS, IT_1 and LR_1 to operate a switch of step-by-step or other known types. As illustrated the switch includes a bank of contacts SB_1, a wiper W_1 and switch operating and controlling apparatus symbolically represented by the rectangle SW_1. The equipment represented by the rectangle includes relays similar to those designed D_1, D_1', D_1'', in my prior patent above referred to, as well as the off-normal switch ON, vertical stepping magnet V_1, rotary stepping magnet R_1 and release magnet Y_1, therein shown. As these elements and their mode of functioning are well known, they are not illustrated or described herein, but the reader is referred to my said Patent No. 2,265,056 for further details and the mode of operation. It is sufficient for our present purposes to know that when the code number of the illustrated land station is dialed, the codan relay causes the switching apparatus SW_1 through its wiper W_1 to close the circuit of the marine operator's lamp MOL to apprize the operator that a connection is desired.

Description of ship station apparatus

At each ship station a radio transmitter T_s and a radio receiver R_s are provided. The radio transmitter T_s has associated therewith an oscillator TO_s which determines the carrier frequency sent out by the transmitter. In order that the radio transmitter may send out the receiving carrier frequency of any station in communication with it, a number of crystals such as CY_d', CY_1', CY_{ss}', CY_{sos}', etc. are provided. These crystals may be selectively connected to the oscillator TO_s in a manner hereinafter described, to change its frequency so that any desired carrier may be emitted from the transmitter T_s. The microphone or transmitter element of a handset or other type of telephone set is connected to the radio transmitter T_s over a transmitting path TL_s, and may be used to modulate the carrier sent out from the radio transmitter T_s.

The radio receiver R_s is connected to amplifying and detecting equipment AD_s for receiving dial signals, and over a receiving path RL_s to a loud speaker LS and to the receiver of the handset HS. An oscillator RO_s is associated with the radio receiver R_s and supplies a local beating frequency so related to a received modulated carrier as to detect therefrom the telephonic waves in accordance with which the carrier is modulated at the sending station. In order that speech may be detected from different carriers transmitted from different sending stations, the beating frequency supplied by the oscillator RO_s must be adjustable so as to be properly related to the particular carrier frequency being received. To this end crystals such as CY_d, CY_1, CY_{ss}, CY_{sos}, etc. are arranged to be selectively connected to the oscillator RO_s to determine the beating frequency.

The effective tuning of both the radio receiver and the radio transmitter by means of the sets of crystals above described should be under the control of a shore station when the shore station is calling, but should also be under the control of the operator aboard ship to enable him to call any desired shore station, or any other ship. Hence tuning relays such as TR_d, TR_1, TR_{ss}, and TR_{sos}, etc. are provided to connect individual pairs of crystals over their contacts 1 and 5 to oscillators TO_s and RO_s, respectively. These relays may be selectively operated either by means of a step-by-step switching equipment operable from a distant station and including operating apparatus SW_s, a brush W_s, and a bank of contacts SB_s, or it may be operated by means of selecting keys SK_1, SK_{ss}, SK_{sos}, etc. controlled by the ship operator.

The tuning relay TR_d has its contacts so arranged that crystals CY_d and CY_d' are normally connected to the oscillators RO_s and TO_s, respectively, to condition the radio receiver R_s and radio transmitter T_s to operate at the dialing frequency. When any of the other tuning relays such as TR_1, TR_{ss}, etc. are operated, they actuate the relay TR_d to disconnect the dialing crystals from the two oscillators. At the same time the operated relay at its contacts 1 and 5 substitutes the crystals controlled thereby for the disconnected dialing crystal. For example, if relay TR_{ss} is operated, it actuates relay TR_d to disconnect the dialing crystals CY_d and CY_d', and over its contacts 5 and 1 relay TR_{ss} connects the crystals CY_{ss} and CY_{ss}' (which are used for ship-to-ship communication) to the oscillators RO_s and TO_s, respectively.

The switching equipment including operating apparatus SW_s, wiper W_s, and bank of contacts SB_s may be in all respects similar to that already discussed in connection with the land station and operates in a similar manner. Normally the radio receiver R_s is set by means of the crystal CY_d to receive at the dialing frequency. Another station desiring to communicate with the ship station illustrated will dial and thereby produce pulsations of the dialing frequency in accordance with the code designating the frequency or pair of frequencies at which communication is to take place. The switch wiper W_s will be operated to make connection with one of the contacts of the bank SB_s and thereby complete a circuit for a selected one of the tuning relays TR_1, TR_{ss}, etc., to switch on the proper crystals.

During communication the switching relay SWR_s at the ship station is used to control the direction of transmission. When the ship operator talks he operates the relay SWR_s by means of a key BK on the handset. The contact 1 of said relay closes the circuit of oscillator TO_s, and its contact 2 opens the circuit of radio receiver R_s, so that transmission takes place from the ship station transmitter to a distant station's receiver. When the operator wishes to listen he opens the contact of key BK and relay SWR_s disables the radio transmitter and closes the circuit of the radio receiver R_s. Transmission now takes place in the reverse direction, i. e., from the distant station to the ship station.

Calling from shore to ship

It will be understood that there may be several ship stations similar to that illustrated, and that

there will be a number of shore installations similar to that shown in the drawing. Any ship can call any other ship, or any shore station, and any shore station can call any ship. Let use consider first a call from a shore station to a ship. All ship station receivers in the standby condition will be tuned to the dialing frequency, because the crystals corresponding to CY_d will be normally connected to oscillators such as RO_s at idle ship stations.

Assuming that the shore station illustrated is calling the ship station shown in the drawing, the marine operator at the shore station inserts a plug in the jack J_1 and closes key KD_1 of the dialing circuit. The sleeve relay S_1 is thus operated and in turn operates relay S_2. In the idle condition of the circuit, before these relays are operated, the polar switching relay SWR_1 is actuated only by its lower or biasing winding, so that its armature rests on its contact 1. In this condition it connects circuit L_1 to the receiving path RL_1 and maintains the transmitting path TL_1 (which leads to the transmitter T_1) disconnected therefrom. The receiving path RL_1 is normally open at contact 1 of relay REC, however.

Relay S_2 by closing its contact 1 energizes relay REC, which, at its contact 1 closes the normally open receiving path RL_1. At the same time a circuit is completed for the upper winding of polar relay SWR_1 over contact 3 of relay REC as follows: From battery, through upper winding of relay SWR_1, over contact 2 of relay S_2, over contact 1 of relay LC, and over contact 3 of relay REC to ground. Relay SWR_1 now operates its armature to its contact 2, thus opening the connection from circuit L_1 to the receiving path RL_1 and establishing the connection to the transmitting path TL_1.

When the marine operator ashore closes key KD_1, a dialing circuit is established from ground over the contacts of said key, through dial D_1, over conductor 10, over upper conductor of path TL_1', and thence through the windings of relays DR_1 and DR_2 to battery. Relay DR_1 by opening contact 1 disconnects crystal CRY_1 (which determines the normal transmitting frequency of the shore station) from oscillator TO_1, and at contact 2 connects crystal CRY_d to said oscillator. Crystal CRY_d is at the same time connected to ground over the front contact of relay DR_2, and thus conditions the transmitter T_1 to transmit at the dialing frequency common to all of the stations.

The crystal CY_d at the ship station is normally connected to the oscillator RO_s of the receiver R_s to condition it to receive at the dialing frequency. Therefore as soon as the dial frequency is received from the land station, the pulses of carrier frequency are applied to the circuit of the amplifier-detector AD_s at the ship station and will cause the operation of relay IT_s. Relay IT_s in turn operates relay LR_s to condition the switching apparatus SW_s to receive pulses.

Since the shore station will (except when dialing) transmit at a fixed frequency determined by crystal CRY_1 and will receive at a different fixed frequency, the receiver and transmitter at the ship station must be conditioned to operate at these frequencies. Assuming that this may be done by selecting the crystals CY_1 and CY_1' at the ship station the marine operator ashore now dials a code number to select said crystals. In the case illustrated this cade number will be 05 and the shore operator now dials this number.

The first dialing operation opens the dialing circuit through relays DR_1 and DR_2 ten times. The relay DR_1 is slow to release and does not fall off between pulses, but relay DR_2 releases its armature each time the dialing circuit is interrupted, thus interrupting the dialing frequency sent out by the transmitter T_1 under control of the dialing crystal CRY_d.

As all of the ship stations are normally set to receive at the dialing frequency, all idle stations will respond alike to the dialing operation. Therefore it will be understood that the description of the operation at the illustrated ship station will apply equally to the other ship stations. Each time the dialing carrier is interrupted the alternating current relay IT_s is released and in turn releases relay LR_s. Each time relay LR_s releases the switching apparatus SW_s elevates the brush W_s a step so that at the tenth pulse the wiper is on a level with the tenth row of contacts. The shore operator now dials the digit five, which steps the wiper horizontally to the fifth contact. After the dialing operation is completed the shore operator opens dial key KD_1, releasing relay DR_1 and DR_2, to again connect crystal CRY_1 to the oscillator TO_1, so that the transmitter is now conditioned to transmit at its normal working frequency.

When the wiper W_s comes to rest on the fifth contact of the top row of the bank SB_s, a circuit is closed from battery, over said wiper and contact, and through the winding of tuning relay TR_1 to ground. Relay TR_1 at its contact 2 energizes relay TR_d which disconnects dialing frequency crystals CY_d and CY_d' from the oscillators RO_s and TO_s, respectively. Relay TR_1 at its contacts 5 and 1 connects crystals CY_1 and CY_1' to said oscillator, thus conditioning receiver R_s and transmitter T_s to receive and transmit at the respective transmitting and receiving frequencies assigned to the shore station illustrated. The ship station is now conditioned to communicate with the calling land station.

For the instant that is required for the relay TR_d to pull up its armature after the relay TR_1 operates, both crystals CY_d and CY_1 are connected to the oscillator RO_s. This conditions the receiver R_s to receive momentarily at a frequency other than that emitted by the transmitter T_1 at the land station. This would result in a momentary interruption of the carrier supplied to the relay IT_s and thus might cause the relay LR_s to release the switch SW_s. To prevent this, relay TR_1 connects ground over its contact 4 to briefly lock up the circuit of relay LR_s during the time required by slow operating relay SOR to open said locking circuit. At its contact 3 relay TR_1 closes a circuit for the lamp LP_1 to apprize the ship's operator that a call has come in on the ship-shore channel. Similar lamps are lighted at all other idle ship stations.

Upon seeing the lamps light each ship operator removes his handset HS from the switch-hook SH and, if he wants to talk, momentarily operates selecting key SK_1. Key SK_1 operates selecting relay SR_1 which in turn locks up tuning relay TR_1 from battery, over switch-hook SH, and over lower contact of relay SR_1. Relay SR_1 closes its upper contact to lock up relay LR_s of the switch SW_s so long as the receiver is off the switch-hook. This prevents any possibility of the switch SW_s being restored to normal and the receiver returned to the dialing frequency each time the ship's transmitter is turned on. If it were not for this feature, each time the transmitter TS is conditioned to transmit the con-

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current disabling of receiver R_s by relay SWR_s it would cut off the received carrier, thus releasing relay IT_s and the switch SW_s. All of the ship sets are now conditioned to communicate with the calling land station and the ship operators use their handsets to listen for the land operator to call the name of the ship with which communication is desired.

The land station operator, after restoring the dialing circuit, talks over the connection L_1. As no ship is sending out the land station's carrier, the upper winding of relay SWR_1 is energized and the armature of said relay is on contact 2, thereby connecting circuit L_1 over transmitting path TL_1 to the transmitter T_1. The land operator, talking over this path, calls out the name of the wanted ship station in the usual manner. The operators at unwanted ship stations, upon hearing this, hang up their handsets, thereby releasing selecting relay SR_1 and unlocking tuning relay TR_1 and relay LR_s at such ships. Said operators then momentarily open their keys RK to release the relays corresponding to IT_s long enough to cause the switches SW_s at unwanted stations to be released and restored to normal. This releases tuning relays corresponding to TR_1 at unwanted ships, and again conditions their sets for transmission and reception at the dialing frequency. If any ship stations are unattended they will be restored to dialing frequency when the shore station goes off the air, as this interrupts the carrier received at such ship stations and releases their relays corresponding to IT_s and LR_s.

The operator at the called ship station can talk to the shore station by operating the button key BK on the handset HS. This energizes relay SWR_s to disable receiver R_s and close the circuit of oscillator TO_s, so that transmitter T_s can send out its carrier. Said carrier when received by receiver R_1 at the shore station causes the codan relay CR to close a circuit from the grounded contact of relay CR, through the winding of relay IS, over lower conductor of path RL_1', and through upper winding of polar relay LC to battery. Relay LC opens contact 1 thereby de-energizing the upper winding of relay SWR_1. Relay SWR_1 shifts its armature from its contact 2 to contact 1, thus connecting circuit L_1 to the receiver R_1 so long as the carrier is sent out from the ship station.

The ship station operator replies to the shore operator and then releases the button BK. This cuts off the transmitting carrier, whereupon relay SWR_1 at the shore station shifts the connection from circuit L_1 back to the transmitter T_1. The shore operator is now able to talk again to the ship operator. Thus it becomes evident that the shore station is shifted between talking and receiving condition by the ship operator manipulating the key BK associated with the handset HS. At the end of the conversation the ship operator, by hanging up his handset HS and momentarily opening release key RK, restores his set to normal as already described in connection with unwanted stations, and conditions the ship set to transmit and receive at dialing frequency by the release of tuning relay TR_d.

While only one relay TR_1 and its associated shore station crystals CY_1 and CY_1' have been shown, it will be evident that other selecting relays similar to TR_1, each having associated crystals, will be provided to tune the ship receiver and transmitter for communication with other shore stations. If another shore station wishes to call, the operator thereat will dial the number designating its assigned carrier frequencies. Thereupon the switch SW_s at the ship station will be operated to establish a circuit for the proper relay similar to TR_1 at such station, and the ship station will be conditioned by the selection of proper crystals to communicate with the calling land station.

Calling from ship to shore

If the ship operator at the illustrated ship station desires to call a land station, he removes the handset HS from the switch-hook SH, and then momentarily depresses a selecting key such as SK_1 which corresponds to the desired land station. Only the key SK_1 for calling the illustrated shore station is shown, but it will be understood that other keys will be provided to select other shore stations. Assuming the land station illustrated is to be called, selecting key SK_1 is operated. This energizes selecting relay SR_1 which in turn completes a circuit from battery, over the switch-hook SH, and through the winding of tuning relay TR_1 to ground. Relay TR_1 operates relay TR_d, thus disconnecting crystals CY_d and CY_d' and substituting crystals CY_1 and CY_1', so that receiver R_s and transmitter T_s are respectively tuned to the transmitting and receiving carrier frequencies of the shore station. The shore station, it will be understood, has its transmitter T_1 and receiver R_1 normally tuned to these frequencies.

The ship operator now presses the button switch BK on his handset HS to actuate relay SWR_s, thus disabling receiver R_s and conditioning transmitter T_s to send out the carrier frequency determined by crystal CY_1'. Having done this the operator manipulates the dial D_s to dial the code call for the desired land station, thus interrupting the ship's carrier in accordance with the pulses of the code. Let us assume that the call number assigned to the land station illustrated is 50. Before dialing starts, relay SWR_s, under the control of the ship operator, causes the ship transmitter to send out the carrier at which the land station normally receives, thus operating codan relay CR.

Codan relay CR closes the circuit previously described for relays IS and LC. The operation of the latter relay is without effect, as both circuits controlled by its armature are open at other points. Relay IS, however, actuates relay IT_1 which in turn operates relay LR_1 to prepare the switching apparatus SW_1 for the stepping operation. When digit 5 is dialed the relay LR_1 is interrupted 5 times and the wiper W_1 is stepped to the level of the fifth row of contacts in the bank SB_1. Upon dialing the digit 0 the wiper is moved horizontally ten steps and comes to rest on the last contact in the fifth row.

The switch now completes a circuit from battery, through relay LL, over wiper W_1 and the last contact of the fifth row, over back contact 2 of the sleeve relay S_1, and through lamp MOL to ground. Relay LL locks the lamp circuit independently of the wiper W_1 and the lamp notifies the operator that a call has come in. The ship operator at the end of the dialing operation releases key BK, thus disabling the transmitter T_s and again conditioning the receiver R_s to receive at the transmitting frequency of the shore station. Disabling the transmitter T_s cuts off the carrier, releasing the codan relay CR and the chain of relays IS, IT_1 and LR_1 to restore the switch SW_1 to normal.

The marine operator at the land station, observing the signal, plugs into the jack J_1 and op-

erates sleeve relay S_1 which at its contact 2 opens the lamp circuit and releases locking relay LL. At its contact 1 relay S_1 operates relay S_2 which in turn operates relay REC. Relay REC at its contact 1 closes the receiving path RL_1 and at its contact 2 closes the circuit previously traced through the upper winding of switching relay SWR_1. Relay SWR_1 operates its contact 2 to disable the receiving path RL_1 and closes its contact 2 to connect circuit L_1 over the transmitting path TL_1 to the transmitter T_1. The operator now talks to the ship operator over the carrier determined by the crystal CRY_1 associated with transmitter T_1 and conversation proceeds. The ship operator can now manipulate the button key BK of his handset, thus shifting at both stations from east bound carrier to west bound carrier, and vice versa, in the manner already described.

At the end of the call the shore operator removes the plug from jack J_1 to restore the land station apparatus to normal. The ship operator returns the handset to switchhook SH, thereby unlocking selecting relay SR_1. This releases tuning relay TR_1 which in turn releases relay TR_d. The transmitter T_s and receiver R_s are thus again conditioned to operate at the common dialing frequency.

Calling from ship to ship

All ship-to-ship calls are made on a single common carrier frequency which is assigned for that purpose and is used for both transmitting and receiving. This enables any ship to talk to all other ships simultaneously if desired. When the call is only for a particular ship, the calling ship operator so signifies by calling the name of the ship, and the operators at other ships can then hang up their receivers and let the conversation proceed exclusively between the two ships concerned.

Assume that a ship-to-ship frequency requires that at each ship a crystal CY_{ss}' to be connected to the oscillator of the transmitter T_s and a similar crystal CY_{ss} to be connected to the oscillator of the receiver R_s. The calling ship operator removes the handset HS from the switch-hook SH and operates the button key BK to turn on the transmitter T_s and disable receiver R_s. The transmitter is set to operate on the dialing frequency determined by crystal CY_d' as relay TR_d is not operated. The operator now dials the code number assigned for ship-to-ship transmission, which we will assume to be 06.

Upon dialing the digit 0 the dialing frequency sent out by the transmitter T_s is interrupted ten times. This is followed by dialing the digit 6 which produces six such interruptions. Having dialed the code number to operate switches similar to SW_s at all other ship stations in a manner about to be described, the ship operator momentarily operates selecting key SK_{ss}. This operates selecting relay SR_{ss} and locks it up over the switch-hook SH. Relay SR_{ss} operates tuning relay TR_{ss} to connect crystals CY_{ss} and CY_{ss}' to the receiver R_s and transmitter T_s respectively. Relay TR_{ss} at its contact 2 operates relay TR_d to disconnect the dialing crystals CY_d and CY_d'. The transmitter and receiver at the calling station are now tuned to transmit and receive at the ship-to-ship frequency. Holding his button key BK operated the calling operator calls out the name of the desired ship by voice in the usual manner. Each time he talks the operator's local receiver is disabled by the action of the button key BK and the switching relay SWR_s, thus preventing side tone in the ear of the operator.

At all other ship stations the interruption of the dialing frequency by dialing the ship-to-ship code number 06 causes identical operations. The relays corresponding to IT_s are released for each interruption and the wiper W_s is moved to the sixth contact of the tenth level to complete an obvious circuit for the tuning relay TR_{ss}. This relay at its contacts 1 and 5 connect crystals CY_{ss}' and CY_{ss} to the transmitter T_s and receiver R_s respectively. At its contact 2 it operates relay TR_d to disconnect crystals CY_d' and CY_d. At its contact 3 it lights a lamp LP_{ss} and at its contact 4 it momentarily locks up relay LR_s to prevent possible release of the switch during the interval both crystals CY_d and CY_{ss} are connected to the oscillator RO_s associated with the receiver R_s.

The transmitters and receivers at all ships are now tuned to the ship-to-ship frequency and are in condition to send and receive voice calls. The lighting of the lamps corresponding to LP_{ss} at all ships apprize all ship operators that a call is waiting on the ship-to-ship channel. Each operator now removes his handset HS from the switch-hook and listens to hear the name of the ship being called. All operators other than the called operator, upon hearing the name of the called ship, hang up their handsets to restore the locked up relays and momentarily release their keys corresponding to key RK to release the step-by-step switches. All uncalled ship stations are now normal.

The operator at the called ship station, upon hearing the name of his ship announced, momentarily depresses key SK_{ss} and locks up relay SR_{ss} over the switch-hook SH. Relay SR_{ss} at its lower contact locks up relay TR_{ss} selected by the switch SW_s, and at its upper contact locks up relay LR_s to prevent the receiver corresponding to R_s being returned to dialing frequency when the called ship's transmitter is turned on and the receiver disabled so that the carrier operated relay IT_s is released. Both the calling and called ships have their transmitters and receivers tuned to the ship-to-ship frequency, and conversation may proceed. Each talker operates the button key BK while talking, thus disabling the local receiver and preventing side-talk. At the end of the conversation the operators hang up and momentarily open their keys RK, thus restoring all apparatus to normal.

Distress calls

Distress calls are made in the same manner as other ship-to-ship calls. The calling ship operator dials a special SOS code call which we will assume is 07. At all other ship stations the interruption of the dialing frequency in accordance with the code call steps the switches corresponding to SW_s to the seventh contact of the tenth row at each station. This operates the selecting relay TR_{sos} at each station, thus ringing the SOS gongs G_{sos} on each ship over contact 3 of the selected relay.

Each operator, upon hearing the gong, removes his handset from the switch-hook. If he desires to take part in the conversation, he may, by operating his key corresponding to SK_{sos}, lock up the selected relay TR_{sos} with results similar to those described in connection with ordinary ship-to-ship calls. The calling operator will, of course, after dialing, operate his key SK_{sos} to operate and lock up relay TR_{sos} and shift the tuning of his transmitter and receiver from the dialing frequency to the ship-to-ship frequency. All oper-

ators who have not hung up now have their receivers and transmitters tuned to the ship-to-ship frequency, and conversation may proceed in the usual manner.

Calling from a ship to Coast Guard stations

A call from a ship to the Coast Guard is made in substantially the same manner as a ship-to-ship call. For a Coast Guard call a common frequency is used by all stations, just as in ship-to-ship transmission, except that the frequency is different from that used for communication between ships. For calling the Coast Guard another key similar to SK_{ss} is used to operate a selecting relay similar to SR_{ss} and a tuning relay similar to TR_{ss}. Said key and relays are not shown as their connection and functioning is obvious from what is illustrated and described with respect to ship-to-ship communication.

Other uses

It will be obvious from the foregoing that the system herein described may be used for communication between airplanes and ground stations, and for use in communicating between planes.

Similarly the system might be used for communication between vehicles of all kinds, such as trains, automobiles, trucks, etc., and between such vehicles and fixed stations.

While this invention has been disclosed in certain specific arrangements which are deemed desirable, it will be obvious that the general principles herein set forth may be embodied in many other organizations, widely different from those illustrated, without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, and means at each fixed station to automatically adjust the frequency determining means at a mobile station to enable it to communicate over the channel assigned to said fixed station.

2. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, switching means at each mobile station to selectively adjust said frequency determining means, and means at each fixed station to selectively control the switching means at a mobile station to selectively adjust the frequency determining means thereat to enable it to communicate over the channel assigned to said fixed station.

3. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to dial said dialing frequency in accordance with a code, and means at each mobile station responsive to dialed codes to adjust the frequency determining means at said station to enable it to communicate over the channel assigned to a particular fixed station.

4. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to dial said dialing frequency in accordance with a code, and switching means at each mobile station operating in response to a code sent out from a fixed station to selectively adjust said frequency determining means at said station to enable it to communicate over the channel assigned to said particular fixed station.

5. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to dial said dialing frequency in accordance with a code, switching means at each mobile station operating in response to a code sent out from a fixed station to selectively adjust said frequency determining means at said station to enable it to communicate over the channel assigned to a particular fixed station, and means at each mobile station whereby the operator thereat, upon learning that the call is intended for another station, may restore the mobile station to the common dialing frequency.

6. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto and having its transmitter normally adjusted to transmit at the transmitting frequency of the channel, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to adjust its transmitter to the common dialing frequency, means at each fixed station to dial said dialing frequency in accordance with a code, and means at each mobile station responsive to dialed codes to adjust the frequency determining means at said station to enable it to communicate over the channel assigned to a particular fixed station.

7. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto and having its transmitter normally adjusted to transmit at the transmitting frequency of the

channel, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and each having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to adjust its transmitter to the common dialing frequency, means at each fixed station to dial said dialing frequency in accordance with a code, and switching means at each mobile station operating in response to a code sent out from a fixed station to selectively adjust said frequency determining means at said station to enable it to communicate over the channel assigned to a particular fixed station.

8. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto and having its transmitter normally adjusted to transmit at the transmitting frequency of the channel, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and each having frequency determining means thereat, a dialing frequency common to all of the stations, means at each fixed station to adjust its transmitter to the common dialing frequency, means at each fixed station to dial said dialing frequency in accordance with a code, switching means at each mobile station operating in response to a code sent out from a fixed station to selectively adjust said frequency determining means at said station to enable it to communicate over the channel assigned to a particular fixed station, and means at each mobile station whereby the operator thereat, upon learning that the call is intended for another station, may restore the mobile station to the common dialing frequency.

9. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations each arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a plurality of frequency determining elements thereat, one for each fixed station two-way high frequency communication channel, and means at each mobile station for selecting, under the control of the mobile station operator, the frequency determining element thereat corresponding to the channel assigned to a fixed station with which it is desired to communicate.

10. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a common two-way high frequency communication channel for intercommunication between mobile stations, each mobile station having a plurality of frequency determining elements thereat, one for each fixed station two-way high frequency communication channel and one for said common two-way high frequency channel, and means at each mobile station for selecting, under the control of the mobile station operator, the frequency determining element thereat corresponding to a fixed station channel when it is desired to communicate with a fixed station, or the frequency determining element corresponding to said common high frequency channel when it is desired to communicate with another mobile station.

11. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a common two-way high frequency communication channel for intercommunication between mobile stations, each mobile station having frequency determining means thereat whereby it may communicate with any desired fixed station over the assigned high frequency channel thereof or with another mobile station over said common two-way high frequency channel, and means at each mobile station to automatically adjust the frequency determining means at another mobile station to enable it to communicate over said common two-way channel.

12. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a common two-way high frequency communication channel for intercommunication between mobile stations, each mobile station having frequency determining means thereat whereby it may communicate with any desired fixed station over the assigned high frequency channel thereof or with another mobile station over said common two-way high frequency channel, code operated means at each fixed station to operate a signal thereat in response to a code individual to that station, code operated means at each mobile station responsive to a particular code to adjust the frequency determining means thereat to said common two-way high frequency communication channel, and means at each mobile station to send codes to selectively operate signals at said fixed station or to adjust the frequency determining means at another mobile station to said common two-way high frequency communication channel.

13. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a common two-way high frequency communication channel assigned thereto for intercommunication between mobile stations, each mobile station having frequency determining means thereat whereby it may communicate with any desired fixed station over the assigned high frequency channel thereof or with another mobile station over said common two-way high frequency communication channel, a dialing frequency common to all of the stations, code operated means at each fixed station to operate a signal thereat in response to a code individual to

that station, code operated means at each mobile station responsive to a particular code to adjust the frequency determining means thereat to said common two-way high frequency communication channel, and means at each mobile station to dial codes to selectively operate signals at said fixed stations, said last mentioned means also operating to modify said dialing frequency in accordance with a code to adjust the frequency determining means at another mobile station to said common two-way high frequency communication channel.

14. In a signaling system, a plurality of fixed stations each having a different fixed frequency two-way communication channel assigned thereto, each fixed station being arranged for two-way communication over the assigned channel only, a plurality of mobile stations arranged for two-way communication over any of a plurality of two-way channels having different frequencies and having a common two-way high frequency communication channel assigned thereto for intercommunication between mobile stations, each mobile station having frequency determining means thereat whereby it may communicate with any desired fixed station over the assigned high frequency channel thereof or with another mobile station at said common two-way high frequency communication channel, a dialing frequency common to all of the stations, code operated means at each fixed station to operate a signal thereat in response to a code individual to that station, code operated means at each mobile station responsive to a particular code to adjust the frequency determining means thereat to said common two-way high frequency communication channel, means at each mobile station to dial codes to selectively operate signals at said fixed stations, said last mentioned means also operating to modify said dialing frequency in accordance with a frequency determining code, and means at each mobile station responsive to said dialing frequency when modified by a particular code at another mobile station to adjust the frequency determining means at said first mentioned fixed station to said common two-way high frequency communication channel.

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