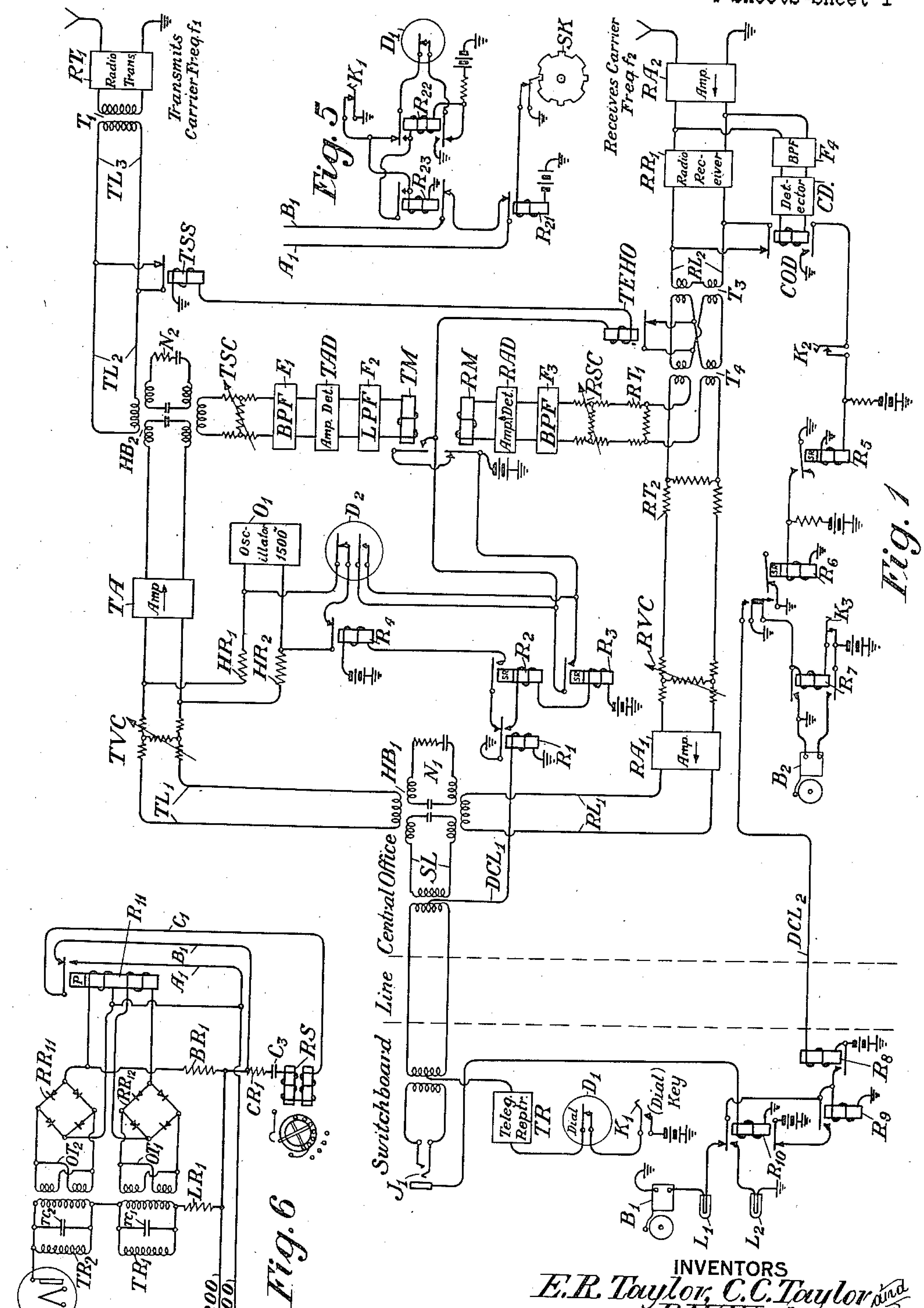
Dec. 22, 1936. E. R. TAYLOR ET AL 2,064,958

SIGNALING SYSTEM FOR RADIOTELEPHONES

Filed May 26, 1934 4 Sheets-Sheet 1



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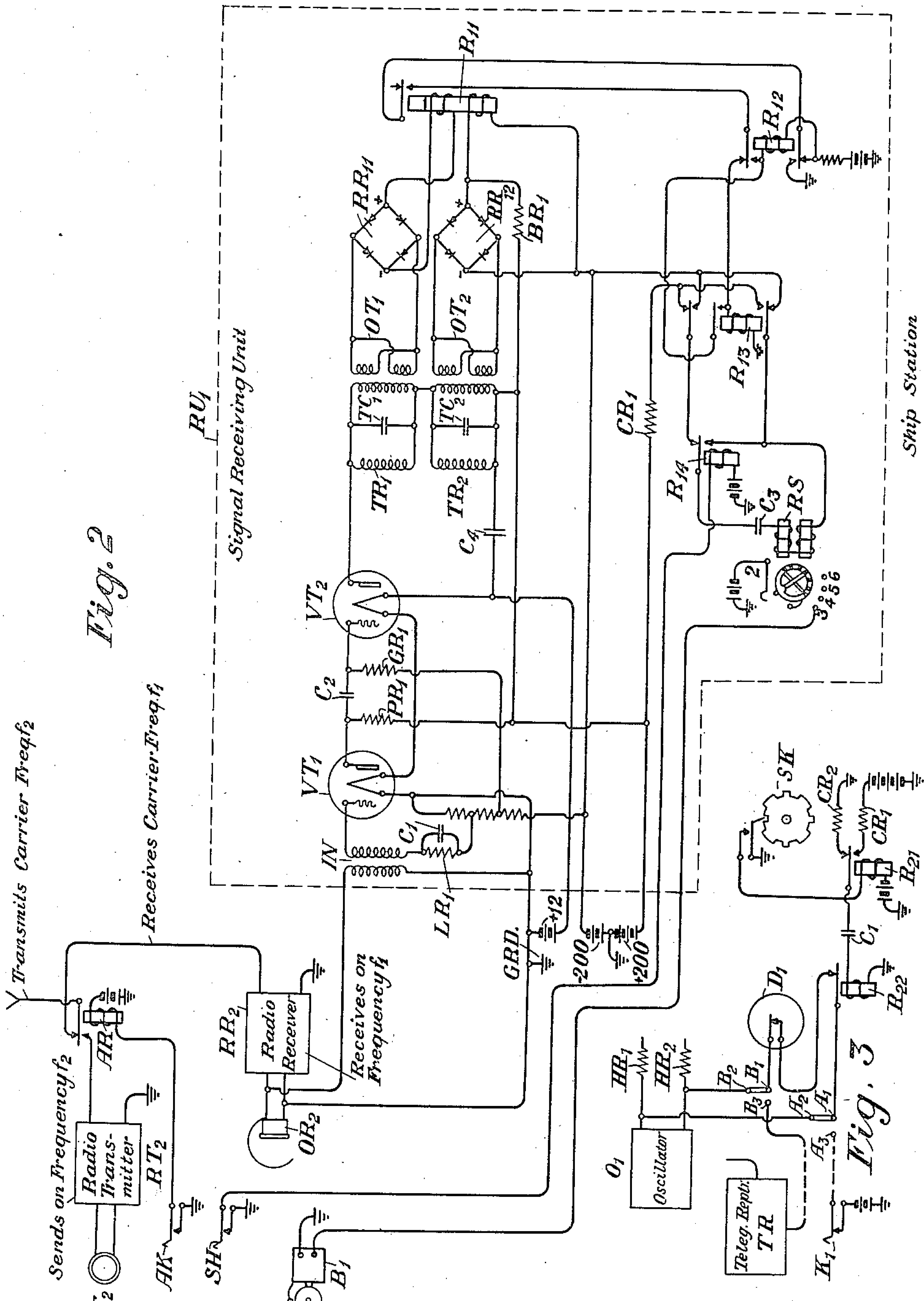

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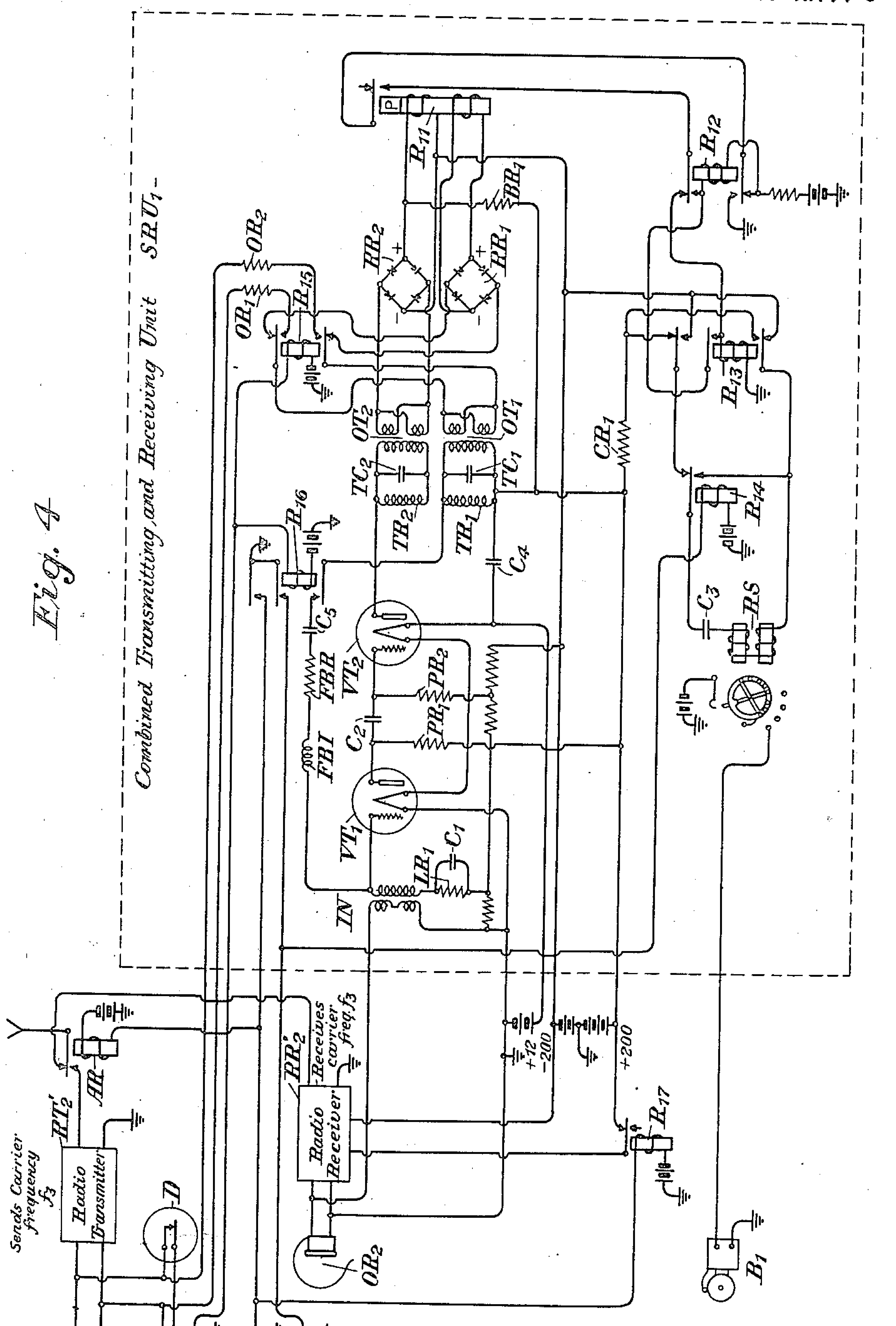

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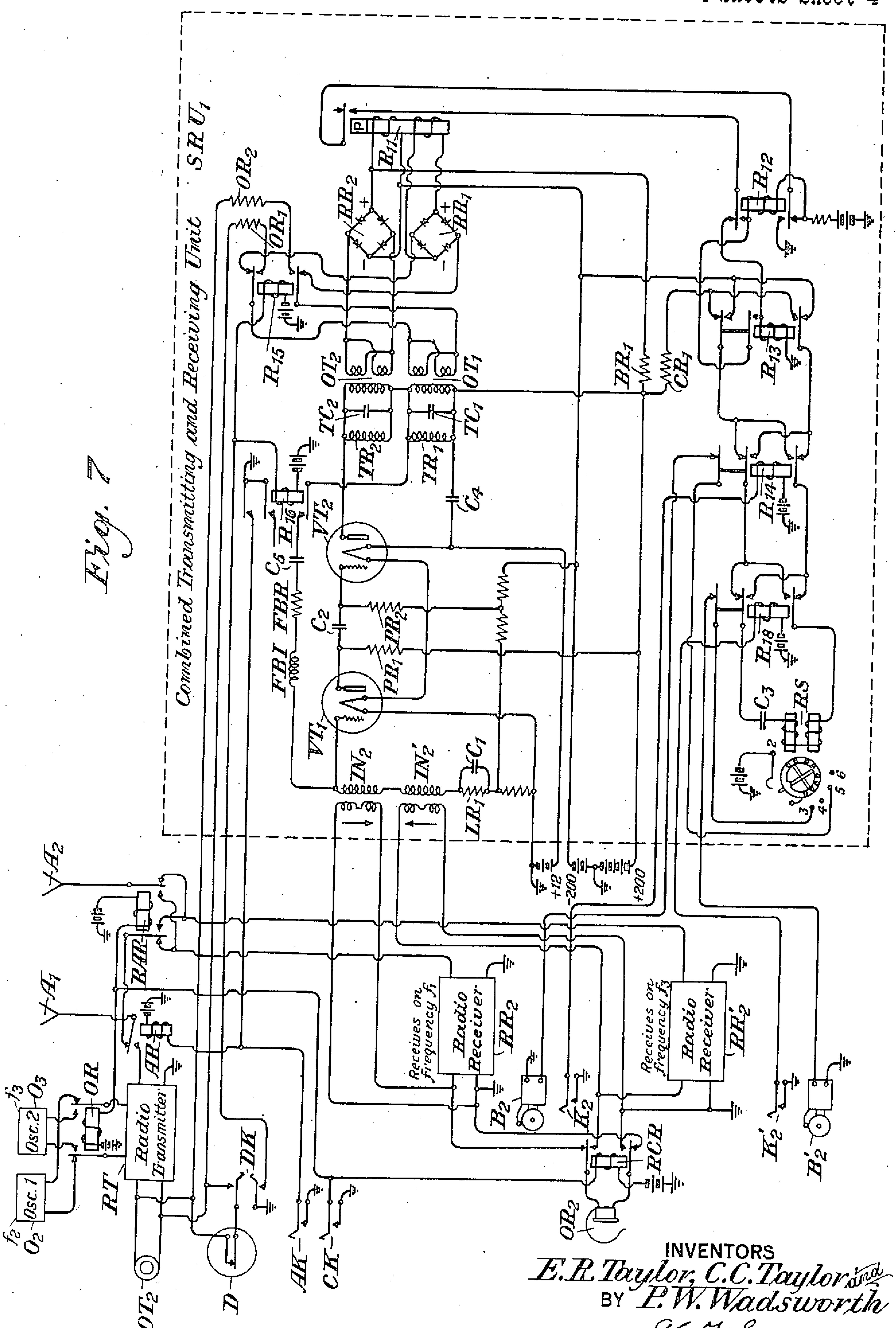
4 Sheets-Sheet 4



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SIGNALING SYSTEM FOR RADIO-TELEPHONES

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4 Claims. (Cl. 250—6)

This invention relates to radiotelephone or land wire transmission systems, to transmission of signaling pulses for alarms, controls or telegraph and to selective signaling means for use on such systems. More particularly it relates to arrangements for selectively calling any one of a number of stations in such systems from a central point, and in certain cases from any other station. Stations may also be called in groups. Likewise the selective apparatus may be used for other control arrangements and the means for transmitting the signal pulses may be utilized for other purposes.

In operating a radiotelephone circuit, such as a harbor radiotelephone system, it is necessary that a central station be able to call any one of the boats, and that the boats be able to call this central station. It may also be desirable for a boat to be able to call other boats. It also is essential that the calling of any boat by a central station be extended to a toll switchboard position permitting a toll operator to handle traffic efficiently over this system. In certain leased wire full or partial period talking circuits set up on land wires similar calling arrangements between the stations by using voice-frequency transmission of the signaling pulses may be required. It is also desirable to call the stations in large groups in cases of emergency or in smaller groups as the more efficient means for broadcasting information. The signaling system of this invention is designed to meet the requirements outlined above.

As is well known, a radio transmitter and radio receiver may be connected by means of a combination of four-wire and two-wire circuits to a two-wire terminal at a switching point where connections may be established by a switching operator between the radio channel and various telephone circuits. It is also well known that terminal amplifiers, voice-operated devices, and other apparatus under the control of a technical operator may be associated with the four-wire circuit in such a manner that echoes and singing, which might be caused by radio or wire line unbalances, are effectively eliminated, and radiation by the radio transmitter of signals received by the radio receiver is prevented.

Likewise on shipboard a four-wire circuit may be made up of a radio transmitter on one branch, a radio receiver on the other, and various controls and necessary auxiliary apparatus.

In accordance with this invention circuit arrangements are provided whereby pulse sending equipment is associated with the four-wire land terminal, control of which is located at the terminal and is also extended to a distant toll switchboard. This pulse sending equipment sends spurts of 1500-cycle tone under control of a dial or selector key, and also controls the terminal in such a manner that static crashes on the receiving branch may not break up the pulsing. At the ship end of the circuit a selective receiving ringer is connected to the output of the radio receiver causing an alarm when the code for that particular ringer is sent in spurts of 1500-cycle tone. Arrangements may also be set up to send pulses from the boat to signal other boats and the land station. Several combinations of these arrangements together with automatic calling-in of the land station under control of the ship's carrier are possible. It will be understood, of course, that the arrangements used at the ship and shore stations may be any of many well-known arrangements and that the invention is not to be limited to a ship-to-shore radiotelephone system.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawings, Figure 1 of which shows the circuit arrangement for one terminal of the radio system embodying the signal sending arrangements; Fig. 2 of which shows a circuit arrangement embodying the signal receiving unit which may be used for one or more radio stations to be communicated with; Figs. 3 and 5 show modified forms of signal transmitters; Fig. 6 shows a modified form of signal receiver; and Figs. 4 and 7 show modified forms of terminal arrangements particularly adapted for use aboard ships.

Referring to Fig. 1, SL designates the two-wire line connecting the control station to the switchboard. The two wire line SL is connected through a hybrid coil, HB_1, to a transmitting path TL_1, and a receiving path RL_1, being balanced by a suitable network N_1. Path TL_1 and the following parts of the transmitting circuit include the transmitting volume control variable attenuator TVC, amplifier TA, hybrid coil HB_2, transmitting path TL_2, transmitting path TL_3, transformer T_1, and radio transmitter RT_1. The receiving path includes receiving amplifier RA_2, radio receiver RR_1, receiving path RL_2, transformers T_3 and T_4, resistance termination RT_2, receiving volume control attenuator RVC, amplifier RA_1 and receiving path RL_1.

In order that when transmission is taking place over either the transmitting or receiving path the other path will be disabled, echo suppressor devices are associated with each path. The echo suppressor associated with the transmitting path TL_1 comprises an amplifier-detector unit TAD, of a well-known type, with its input connected through variable attenuator TSC and band-pass filter F_1 to hybrid coil HB_2 in conjugate relationship with transmitting path TL_2, the output of amplifier TA being balanced by a suitable network, N_2. The output of the amplifier-detector unit TAD controls through master relay TM the relays TSS and TEHO for performing the blocking or disabling operations whereby transmission is permitted in only one of the paths TL_2 and RL_1 at a time. Normally, transmission path TL_2 is disabled by the back contacts of relay TSS, which short-circuit the conductors, and transmission from transmission path TL_1 to the radio transmitter can not take place. Blocking means comprising transformer arrangements T_3 and T_4 are associated between receiving lines RL_1 and RL_2. These disabling means comprise transformer arrangements which are so connected as to be balanced when the contacts of relay TEHO are opened, thereby preventing transmission through the transformer arrangements. When the contacts of relay TEHO are closed, however, the transformer circuits instead of being balanced are, in effect, connected so as to be parallel-aiding, thereby permitting transmission to take place readily. Normally, relay TEHO (which is controlled by the amplifier-detector TAD) is deenergized so that the receiving path is unblocked to permit transmission to take place from receiving path RL_2 to the two-wire line SL.

The input of an amplifier-detector arrangement RAD is connected through band-pass filter F_3, receiving sensitivity control RSC and resistance termination RT_1 to the secondary windings of transformer T_4, so as to be effectively in series with the resistance termination RT_2 in the receiving path RL_1, and has in its output a relay RM, which when operated opens the control circuit from the amplifier-detector TAD to switching relays TSS and TEHO, thereby maintaining the transmitting path TL_2 blocked and receiving path RL_1 unblocked when signal currents are being received from the radio receiver. Static or other interference is prevented from causing operation of relay RM during idle periods by the action of relay COD which maintains a short circuit on receiving path RL_2 whenever receiving carrier f_2 is not present. As will be explained later in connection with Fig. 2, the distant or boat transmitters are so arranged that carrier frequency f_2 is radiated only when communication from a boat to the shore is desired. The control circuit of relay COD includes the following. The input band-pass filter F_4 which passes substantially only carrier frequency f_2 is connected in multiple with the input of radio receiver RR_1, and the output of filter F_4 is connected to the input of detector CD, the D. C. output of which controls the operation of relay COD. The operation of the apparatus so far described for signal transmission is as follows:

Signal currents incoming over the two-wire circuit SL pass through the hybrid coil HB_1 and through the amplifier TA. Some of the energy enters the amplifier-detector unit TAD and causes relays TM, TSS and TEHO to be energized.

Relay TSS removes the short circuits from transmitting line TL_2 while relay TEHO by opening its contact causes the transformer arrangements T_3 and T_4 to block the receiving path. In the meantime, a part of the energy passes from hybrid coil HB_2 through the transmitting paths TL_2 and TL_3 to radio transmitter RT_1 and is transmitted on carrier frequency f_1. The receiving amplifier-detector RAD associated with the receiving path cannot be actuated to disturb the circuit condition now existing because the receiving path is disabled in the manner already described.

If, in the normal condition of the circuit, carrier frequency f_2 modulated with a signal is received through amplifier RA_2, part of the received energy passes through band-pass filter F_4 to detector CD, causing the operation of relay COD which removes the short circuit from the receiver RR_1 and is demodulated, the resultant mainder of the received energy passes into radio receiver RR_1 and is demodulated, the resultant signals passing through receiving path RL_2 and transformer arrangements T_3 and T_4. Part of the energy passes through receiving amplifier RA_1 and hybrid coil HB_1 to the two-wire line SL. The remaining received energy passes through receiving sensitivity control RSC to the amplifier-detector RAD to cause the operation of relay RM, which opens the circuit controlled by the amplifier-detector unit TAD, thereby preventing energization of relays TSS and TEHO so that the transmitting path is disable and the receiving path remains unblocked while the signal currents are being received.

The apparatus and circuits employed at the ship station may be of several well-known types as, for example, those shown in Fig. 2. This shows an antenna normally connected to radio receiver RR_2, which is arranged to receive carrier frequency f_1, and the radio transmitter RT_2 arranged to transmit carrier frequency f_2. The antenna may be switched from the radio receiver RR_2 to radio transmitter RT_2 by relay AR, which is controlled by key AK. The output of radio receiver RR_2 is connected to operator's receiver OR_2 and the input of radio transmitter RT_2 is connected to operator's transmitter OT_2. Accordingly the operator at the ship station may normally receive signals transmitted on carrier frequency f_1 and may transmit signals on carrier frequency f_2 by operating key AK, which enables radio transmitter RT_2 and disables radio receiver RR_2. Thus carrier frequency f_2 is radiated only when signals are to be transmitted from the boat. The signal receiving unit RU_1 is bridged across the output of the radio receiver along with the operator's receiver OR_2.

The apparatus so far described relates to telephonic or other communication between the two-wire line SL and a distant radio station. The additional equipment and circuits which are associated with the shore terminal in order to afford dial signal transmission and alarm features will now be described.

Referring to Fig. 1 and the operation of the echo and singing suppressing means described above, it will be seen that relay TM must be operated whenever signals are transmitted from the two-wire line SL or from the oscillator O_1 to the radio transmitter RT_1, and that relay COD must be operated whenever signals are transmitted from the radio receiver RR_1 to the two-wire line SL and, hence, one or the other of these two relays TM or COD must be operated whenever communication is attempted in either direction of transmission. When relay TM is operated, relay RM cannot be actuated to disturb the circuit condition. Accordingly, in sending signal spurts from the central station, the signal tone is within the voice range and operates the relay TM. The operate contacts of relay TM are also closed to hold the circuit in the transmitting position. The operation of the circuit is as follows:

The 1500-cycle oscillator O_1 is bridged across the input of amplifier TA through the high resistances HR_1 and HR_2. The oscillator output is normally shorted through the pulsing contacts of dial D_2, and the contacts of relay R_4. When dial D_2 is moved from its normal position, its lower contacts close, shorting the contacts of relay TM and operating relays TSS and TEHO. When dial D_2 is released, its upper contacts are opened once for each unit of the digit dialed. This sends spurts of 1500-cycle tone through amplifier TA and the remainder of the transmitting path in the manner already described. The lower contacts of dial D_2 open when the dial returns to normal.

The sending of signals from the central station may be accomplished from a distant toll switchboard as follows:

Dial D_1 and dial key K_1 are connected through a telegraph repeater and line DCL_1 to relay R_1. When key K_1 is operated, relay R_1 operates, in turn actuating the slow-release relays R_2 and R_3. Relay R_3 shorts the contacts of relay TM, operating relays TSS and TEHO. Relay R_2 connects the upper contact of R_1 to the winding of R_4. When dial D_1 is operated, relay R_1 releases once for each unit of the digit dialed. Relays R_2 and R_3, being slow-acting, do not release, however. Therefore, relay R_4 is operated by each release of R_1 and 1500-cycle spurts are sent out as previously explained. When key K_1 is released at the conclusion of the dialing period, a final spurt is sent by the release of R_1 before R_2 has released. This is made use of as will be explained in connection with Fig. 2.

For giving alarms or signals when relay COD is operated, suitable circuits are set up to indicate that a call is desired by some distant station or that a distant station is answering after being dialed. The circuit includes the following:

The lower contacts of relay COD, key K_2, relays R_5, R_6 and R_7, key K_3 and bell or buzzer B_2 for giving an alarm at the central station and, in addition, line DCL_2, relays R_8, R_9 and R_{10}, lamps L_1 and L_2 and bell or buzzer B_1 for giving an alarm or signal at the switchboard. The operation of the circuit is as follows:

The operation of relay COD by carrier frequency f_2 connects ground to key K_2, thereby short-circuiting the winding of relay R_5, which is normally operated as shown if key K_2 is in its normal position, that is, with the contacts closed. Key K_2 is provided so that the alarm arrangements may be disabled when alarm operation is not desired. Relays R_5 and R_6 are made slow-acting in a well-known manner such as short-circuited windings or the addition of a copper slug to the core in order that intermittent short duration operations of relay COD, such as might be caused by static, may not give an alarm. To continue the circuit operation, relay R_5 releases, after a predetermined interval of time has elapsed, and its contacts close short-circuiting in turn, the windings of relay R_6. After a second predetermined interval of time, relay R_6 releases, causing the operation of relay R_7. This, through its lower contacts, completes the circuit to the bell or buzzer B_2, giving an alarm. If key K_3 is in its normal position with its contacts closed, relay R_7 will lock itself operated through its upper contacts and the alarm will continue until K_3 is operated to break the battery circuit.

The remainder of the circuit operation required to operate the alarm and signals at the switchboard is as follows:

Relay R_6, in releasing, places ground on the line DCL_2, causing the operation of relay R_8. Relay R_8 through its contact operates relay R_9, lights lamp L_1 and causes bell or buzzer B_1 to operate. Relay R_9 locks up through the contact of relay R_{10} and the alarm and lamp will remain actuated until the operator at the toll switchboard places a cord in the line jack J_1 when battery flowing through the sleeve circuit will operate relay R_{10}, permitting R_9 to release and removing battery from lamp L_1 and bell B_1.

If the operator has placed a cord in the line jack and has dialed a ship she will receive an indication that the ship has answered by the lighting of lamp L_2. The cord in the line jack has operated relay R_{10}, and when relay COD is operated by the boat answering, relay R_8 will be operated as previously explained, which will send battery through its contact and through the upper lower contact of relay R_{10} to lamp L_2. During the period of a call, it is expected that key K_3 at the central terminal will be operated so that further operation of relay R_7 and bell or buzzer B_2 will not occur as COD is operated. At the conclusion of each call, key K_3 will be restored to normal. This will permit relay R_8 to operate and light lamp L_2 whenever relay COD operates for a length of time sufficient to release relay R_6. Intermittent flashing of L_2 will therefore occur during conversation, but a slow steady flash of L_2 for switchhook supervision may be obtained by the boat station operating and releasing at a slow interval the switch AK in Fig. 2.

Referring to Fig. 2, which represents the ship apparatus for ship-to-shore communication, the carrier frequency f_1 modulated by the 1500-cycle spurts is received by radio receiver RR_2, and when keys SH and AK are not operated the 1500-cycle output of RR_2 enters the signal receiving unit RU_1. This is essentially a two-stage amplifier with a volume limiter action having two tuned output circuits working into rectifying arrangements whose D. C. outputs are made equal and control a pulse dividing relay circuit. This circuit controls a railway selector in such a manner that one step of the selector occurs for a marking and spacing pulse together. The selector consists essentially of a polar relay with a ratchet attachment so arranged that successive operations of the relay at proper speed cause the stepping around of a contact wheel. Stop pins at certain points prevent the contact wheel from returning to its normal position when the regular sequence of stepping is interrupted at these points. Any interruption of the regular sequence of stepping when the contact wheel is at any other point causes it to release. The use of these selectors on railway telephone dispatch systems is well known. The speed of pulsing used in this system is about seven cycles per second.

The signal spurts of 1500 cycles enter the two-stage amplifier through the transformer IN. The permanent grid potential on the first tube is small and the input potential if of sufficient magnitude drives this positive, charging the condenser C_1 and thereby lowering the gain. When the input is removed, the resistance LR_1 discharges condenser C_1 and the gain increases. These units are so chosen that the gain of the amplifier increases somewhat during a spacing pulse while dialing. Also, the gain of the amplifier is lowered in a period of time which is longer than the operate time of relay R_{11}. Dialing spurts tend to lower the gain and thereby decrease the static currents in the relay but the initial spurt of rectified current at the beginning of each marking pulse before the gain is lowered is large and by its action in operating relay R_{11} enables signaling through a higher noise level than would be possible without this action. When no dial spurts are being received the static and voice currents lower the amplifier gain, thereby reducing in magnitude the peaks of rectified current in the balanced branches, helping appreciably to eliminate false operation from any unbalance which may occur in the static or voice currents. This is particularly valuable in the case of voice currents where the characteristics of speech are such that there may be considerable frequency inequality.

The output of the first stage tube VT_1 is impedance-coupled to tube VT_2 by resistance PR_1, condenser C_2 and resistance GR_1. Tube VT_2 is transformer-coupled to two Rectox circuits RR_{11} and RR_{12} by means of two output transformers OT_1 and OT_2. Transformer OT_1 is tuned to 1500 cycles by means of retard coil TR_1 and condenser TC_1 while output transformer OT_2 is tuned to 500 cycles by retard coil TR_2 and condenser TC_2. The rectified output currents are opposing when applied to relay R_{11}, the current from OT_1 being in the direction to cause relay R_{11} to operate while current from OT_2 is in the direction to aid the permanent biasing current supplied through resistance BR_1 and hold relay R_{11} in the non-operated position. Noise and voice currents, therefore, tend to balance out and produce no operation of relay R_{11}, although actual voice currents have such unbalanced frequency characteristics that occasional operation of relay R_{11} may occur particularly at the start of an exclamation before any gain regulation of the amplifier occurs. The sensitivity of the amplifier is such that relay R_{11} may be successfully operated for an input range from about 25 db. above 1 milliwatt to about 20 db. below 1 milliwatt.

Relay R_{11} is operated by a marking signal (spurt of 1500-cycle current) for each dial pulse. The biasing current returns it to the non-operated position for spacing pulses. With relays R_{12} and R_{13} in the position shown in Fig. 2 when relay R_{11} operates, relay R_{13} operates reversing the polarity across the condenser C_3 and the selector winding and operating the polar relay in the selector RS while the condenser is charging. When R_{11} releases, R_{12} operates and R_{13} remains operated. When R_{11} again operates, R_{13} releases and reverses polarity on the selector RS while R_{12} remains operated. When R_{11} next releases, R_{12} releases and R_{13} remains non-operated. Thus relay R_{13} reverses polarity on and operates the polar relay in selector RS for each operation of relay R_{11} or for each unit of the digit dialed. The polar relay operates while the condenser C_3 charges but releases when the charge completes. The condenser C_3 and resistance unit CR_1 are such that the polar relay does not release during the dialing of a digit (at the speed of pulsing used in the system) but does release between digits permitting all contact wheels in the selectors not resting on stop pins to return to normal. When any contact wheel has been stepped up and rests on the final stop pin, battery flows from terminal 2 through the contact wheel to terminal 3, 4, 5 or 6 and the bell or buzzer B_1. Terminal 2 is the arm which holds the stop pin and prevents the wheel from returning to normal. The bell rings then only when the contact wheel comes to rest on the final stop pin. The bell will ring until a final dialing spurt is sent or until the switch SH is operated. As mentioned above when dialing from the toll switchboard, this final spurt is sent when the dial key is returned to normal by the operator. The key SH is normally open but is closed when the handset is lifted from the switchhook. This key operates relay R_{14} which discharges the condenser C_3 through the selector windings, causing it to operate once and return to its normal position. No operations of selector RS may occur while relay R_{14} is operated.

Returning to Fig. 1, the dial D_1 being an ordinary telephone dial, signals by sending a marking and spacing impulse for each digit unit and is not capable of sending signals corresponding to digits of more than ten units. The railway selector of Fig. 2 is so arranged that where any particular station is to be called the selector responds to impulse in groups corresponding to a plurality of digits, as for example 3—7—7 or 4—6—7. As each digit does not exceed ten pulses these digits may be sent by successive operations of the dial D_1. Where, however, it is desired to select a group of stations, the dial D_1 cannot ordinarily be used due to the limitations of the selector RS which is so arranged that for group selection a continuous train of pulses must be received which is equal in number to the sum of the pulses of the code digits of any individual station. In a system having a considerable number of stations this will involve sending a continuous group of pulses greater than ten and hence the dial D_1 is not adapted for group calling. A common arrangement of the selector is to make it responsive to group calls involving continuous trains of say 17, 19 or 21 pulses. Thus one group of stations might be set to respond to a train of 17 pulses, another group to a train of 19 pulses, etc. The groups of stations might include in part the same stations, or one group might be a sub-group of the other.

The transmission of these large trains of impulses makes it necessary to supplement the dial D_1 by one or more railway selector key sending units of the type shown at SK in Fig. 3, one such unit being provided for each group to be called. Each selector key unit involves a code disc having a number of teeth suitably arranged to operate pulsing contacts. The dial may then be used for calling any one of a small number of stations and the selector key unit may be used to call a group. For a large system it will be preferable to omit the dial and use a master railway selector key of known type both for calling individual stations and for calling groups. The master railway selector key is so arranged that by setting certain combinations of keys the proper series of pulses for calling any individual station or any group may be sent.

If either the selector key unit or master railway selector key is provided, since the dial D_1 sends a marking and a spacing pulse for each unit of the digit dialed, whereas the selector key unit and the master railway selector key each send only one pulse (either marking or spacing) for each unit of the digit, it will be necessary to provide the selector keys with pulse multiplying relays such as R_{21} and R_{22} of Fig. 3. These put out a marking pulse followed by a spacing pulse for each pulse sent by the selector key whether the selector key pulse be marking or spacing.

The operation of this circuit is as follows: When key SK turns so that its contacts close relay R_{21} operates. Battery flows through resistance CR_1, and the lower contacts of R_{21} to charge condenser C_1. Relay R_{22} operates on this charge current, condenser C_1 and resistance CR_1 being so chosen that the time during which R_{22} remains operated is ½ that during which the contacts of SK remain closed. When the contacts of SK open R_{21} releases and C_1 discharges through resistance CR_2 and the windings of R_{22} causing R_{22} to operate for the same period of time that it operated when C_1 was charging through CR_1. Therefore, relay R_{22} operates and releases putting out a marking and a spacing pulse of equal length each time the contacts of SK close or open. The contacts of R_{22} are shown in series with a dial D_1 shorting the output of an oscillator when A_1 connects to A_2 and B_1 to B_2. Spurts of tone will be sent from the oscillator as R_{22} operates or the dial opens its contacts. If remote control of the oscillator is desired as shown on Fig. 1 the contacts of the dial D_1 and relay R_{22} may be placed in series between key K_1 and telegraph repeater TR as shown in Fig. 3 by connecting A_1 to A_3 and B_1 to B_3 in which case the telegraph circuit will be controlled directly instead of the oscillator output. This control may then be applied to a distant oscillator in the manner shown on Fig. 1 and explained previously. It should be noted that the combination of dialing equipment and oscillator may be used with central control equipment as shown on Fig. 1, or may be multipled with operator's transmitter OT_2 as in Fig. 4 and used to modulate radio transmitter RT_2 or may be associated with any signal transmission system which will transmit the frequency output of oscillator O_1.

The circuits shown in Figs. 1 and 2 are arranged for ship-to-shore communication and hence the shore station sends on frequency f_1 and receives on frequency f_2 while each ship circuit as shown in Fig. 2 sends on frequency f_2 and receives on frequency f_1. For communication between ships it is desirable that a different frequency be used as otherwise the supervisory signals B_1 and B_2 of Fig. 1 would be operated at the shore station every time a call between ships took place. Hence the ship stations should be arranged to transmit and receive on some third frequency f_3 for intership communication as shown in Fig. 4 in which a separate set of transmitting and receiving equipment is provided for communication between ships.

If we now consider Fig. 4 we see a ship station arranged for two-way selective signaling and using the receiving unit amplifier as an oscillator when the dialing key DK is thrown to permit dialing from this station. The operation of the unit as a signal receiving device is as previously outlined for Fig. 2. When it is desired to send pulses from this station key DK is operated. This puts the contacts of dial D across the input of radio transmitter RT'_2 the input being shorted except when these contacts open once for each unit of the digit dialed. Key DK also operates relays R_{15} and R_{16}, R_{16} in turn operating R_{14}, R_{17} and AR. R_{16} connects the tuned output transformer OT_1 primary winding through its lower contacts and condenser C_5, resistance FBR and inductance FBI to the input transformer providing a feedback circuit which may be adjusted by well-known means to give proper phase relations and amount of energy fed back so that a two-stage oscillater is set up. The frequency of oscillation will be that of the tuning of OT_1, 1500 cycles in this case. The amount of energy fed back is such that condenser C_1 is charged and volume limiting action is set up. The oscillator will, therefore, maintain a constant output level because of the volume limiting action of its amplifier.

Relay R_{15} connects the output of the oscillator through output resistances OR_1 and OR_2 to the input of the radio transmitter RT'_2. As dial D is operated spurts of 1500-cycle tone enter the radio transmitter. Relay R_{16} when operated puts ground on the leads from switches A.K. and S.H. This operates relay AR switching the antenna to the transmitter RT_2, relay R_{17} removing the plate supply from the receiver RR_2 and R_{14} disabling the selector RS operating circuit. The circuit is thus set up to transmit the dial pulses. When dialing is completed key DK is returned to normal and the circuit is under control of switches A.K. and S.H. for normal service. It is obvious that the combined transmitting and receiving unit SRU_1 may be used with any transmission system either two-wire or four-wire by proper application and, therefore, that its use is not to be confined to the example here given.

We have described Figs. 1, 2, 3 and 4 showing a system of signaling using spurts of 1500-cycle tone. The successful operation of this system through heavy static is somewhat dependent upon having tone on only for the dial spurts the amplifier constants being adjusted for maximum efficiency when using spurts. However, the system may be set up to have steady tone on when dialing is in progress and to interrupt that tone by the dial. Such a system under most static conditions will work as effectively as the spurt system. This system will be referred to as the interrupted tone system and this invention should not be confined to the spurt system, but should be understood to include the interrupted tone system.

Likewise we may set up this signaling system so that each unit of the digit or code is sent by either a marking or a spacing pulse. Such a system is partly spurt and partly interrupted tone since the pause between digits in the code may be either a marking or spacing pulse depending on the preceding digit being odd or even. Fig. 5 shows the dialing arrangements for such a system. The selector key SK operates relay R_{21} opening the lead A_1 B_1. A_1 B_1 will connect to an oscillator or D. C. control circuit as explained for Fig. 3. When key SK is in its normal position R_{21} is released. It is controlled by SK to send either a marking or spacing pulse for each unit of the code. Dial D_1 normally sends a marking and spacing pulse for each unit of the digit so that pulse dividing relays R_{22} and R_{23} are associated with it here. These put out a marking pulse or a spacing pulse for each code unit comprising a marking and a spacing pulse from D_1 as explained in connection with the pulse dividing relays R_{12} and R_{13} in Fig. 2. Key K_1 when closed as shown always assures that relay R_{23} is non-operated and lead $A_1 B_1$ closed. Opening K_1 permits the dialing from D_1.

With this system of pulsing the pulse dividing relays R_{12} and R_{13} are no longer required in the signal receiving unit. The selector RS is then controlled directly by relay R_{11} as shown in Fig. 6. When R_{11} operates condenser C_3 is charged from +200 through CR_1, the windings of RS and the lower contacts of R_{11} operating RS. When R_{11} releases C_3 discharges through CR_1, the upper contacts of R_{11} and the windings of RS operating RS in the opposite direction.

One additional example of the use of a selective signaling unit is illustrated in Fig. 7, in which the features of Figs. 2 and 4 are combined. In this figure a radio transmitter RT is provided on board ship, and by switching to either of two oscillators O_2 and O_3, generating frequencies f_2 and f_3, the transmitter may be used to transmit either to the shore station or to another ship. Two radio receivers are provided on board the ship, the receiver RR_2 being used to receive from the shore station and the receiver RR'_2 being used to receive from another ship. For signaling between ship and shore the frequency f_1 is used from shore to ship and the frequency f_2 is used from ship to shore, but in communicating between two ships the same frequency f_3 may be used in both directions.

Two antennae A_1 and A_2 are provided. The antenna A_1 is used for both sending and receiving under the control of the key AK, the antenna being connected normally for receiving but being connected to the radio transmitter RT when the key AK is actuated. By means of the key CK the antenna A_1 may be connected to either the radio receiver RR_2 when communicating with the shore station or to the receiver RR'_2 when communicating with another vessel. In the stand-by position, antenna A_1 is connected to the receiver RR_2 to receive signals from the shore station and the antenna A_2 is connected to the receiver RR'_2 to receive signals from another vessel. When, however, the key CK is operated in order to establish connection with another vessel, the antenna A_1 is connected to the receiver RR'_2 and the antenna A_2 is shifted to the receiver RR_2 in order to receive a code signal from the shore station if one should be received while the vessel is communicating with another vessel. The two receivers RR_2 and RR'_2 are connected to two input transformers in series, the transformer IN_2 being bridged to the output of the receiver RR_2 and the transformer IN'_2 being bridged to the output of the receiver RR'_2. These two transformers are so poled with respect to the input of the amplifying arrangements VT_1 and VT_2 that a static crash reaching the outputs of the two receivers will balance out if the crash is of equal volume in the two input transformers. As the outputs become unequal the balancing-out effect becomes less but the effect of the static crash will nevertheless be of smaller magnitude than if only one receiver were connected to the amplifier.

The operation, in so far as it may not be understood from the previous description of Figs. 2 and 4, is as follows:

With the circuit in the condition shown, the apparatus is arranged to receive from the shore station, the antenna A_1 being connected over the back contact of relay AR and the back contact of relay RAR to radio receiver RR_2 to the output of which is connected the operator's receiver OR_2. If a code signal corresponding to the ship station is received from the shore station the interrupted tone will be transmitted from the output of the receiver RR_2 through the transformer IN_2 to the input of the amplifier of the receiving unit SRU_1. The amplifier rectifying arrangements of the combined transmitting and receiving unit SRU_1 operate as described in connection with Fig. 4 to set the receiving selector RS which will connect the point **2** of the selector to point **5** of the selector, completing a circuit for the bell B_2 over the upper contact of the relay R_{14}. Upon hearing the bell the operator may actuate the key K_2, thereby energizing relay R_{14} which opens the bell circuit and reverses the connection to the polar relay of the receiving selector RS to restore the selector to normal, as previously described. The ship operator may then by throwing the key AK talk to the shore station since the radio transmitter is normally supplied with carrier frequency from the oscillator O_2. Whenever the key AK is restored the antenna A_1 will be disconnected from the output of the transmitter RT and will be connected to the input of the receiver RR_2 so that the ship operator may listen to the shore station.

Should the operator of the ship station desire to call another vessel, the operator will throw the key CK, thereby energizing relay RCR, RAR, and OR. Relay OR connects the oscillator O_3 to the radio transmitter RT and enables transmission at the frequency f_3. The relay RAR at its left-hand front contact connects the antenna A_1 to the radio receiver RR'_2, which receives on the frequency f_3 used in communicating between ships. At its right-hand front contact the relay RAR connects antenna A_2 to the receiver RR_2, thereby acting as a stand-by connection to enable the shore station to send a code signal to the ship during intership communication.

The operator then throws the key DK, actuating the relay R_{16}, to set up an oscillating circuit through the amplifier VT_1—VT_2 to produce the signaling tone. The relay R_{15} is actuated at the same time to connect the output transformer OT_1 to the radio transmitter RT. By actuating the dial D the tone may be interrupted to send the code combination to call another ship through the radio transmitter RT. At the end of the dialing operation the key DK is restored, thereby returning the amplifying arrangement to its normal amplifying condition and again connecting the transformer OT_1 to the rectifying arrangement RR_{11}.

Having called the other ship, the operator may now, by throwing the key AK, connect the antenna A_1 to the radio transmitter RT and transmit to the other ship at the frequency f_3. Upon restoring the key AK to normal, the antenna A_1 will be connected over the upper contact of the relay AR and the left-hand front contact of the relay RAR to the radio receiver RR'_2 in order to enable the operator to receive from the distant station. In this connection it should be noted that the relay RCR, which was actuated when the key CK was thrown, connects the operator's receiver OR_2 to the output of the radio receiver RR'_2.

When the key CK is restored to normal the relays OR, RAR and RCR are de-energized and the antennae A_1 and A_2 are connected to the radio receivers RR_2 and RR'_2, respectively, so that code signals may be received from either the shore or another ship. If another ship should send in a code signal, such code signal would be received at the frequency f_3 over the antenna A_2 and be transmitted to the radio receiver RR'_2 whose output is connected through the transformer IN'_2 to the combined transmitting and receiving unit SRU'. Preferably the code combination transmitted from another ship will be different from that transmitted from the store station in calling the same ship station. The combined transmitting and receiving unit operates as previously described to actuate the selector RS which may connect the points 2 and 3, thereby completing a circuit for the bell B'_2 over the upper contact of relay R_{18}. Upon hearing the bell B'_2 the ship operator will actuate the key K'_{22} thereby energizing the relay R_{18} and reversing the connection through the polar relay of the selector RS, which will be restored to normal. The ship operator will now throw the key CK to enable communication with the calling ship by sending over the radio transmitter at the frequency f_3 and by receiving over the antenna A_1 and the radio receiver RR'_2 at the same frequency. While this communication is going on, the code signal received from the shore station would come in over the antenna A_2 and be received by the receiver RR_2. In such case the combined transmitting and receiving unit which is not used during voice transmission would receive the code signal through the transformer IN_2 and the selector RS would be actuated as before to ring the bell B_2.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signal transmission system, a master station, a plurality of associated stations, means at said master station to transmit calling code signals individual to each associated station, means at individual associated stations to transmit calling code signals to other associated stations, said calling codes transmitted by said master station and said associated stations being converted into audible tone wave groups, separate receivers at each associated station for picking up signals from the master station and signals from other associated stations, a wave converter at each associated station to convert received tone waves to code signals, said receivers being connected to said wave converter in opposing relation, and signal responsive means associated with said converter.

2. In a signal transmission system, two signal receiving circuits adapted respectively to receive independent signals on corresponding different frequencies, an amplifier common to both circuits, said amplifier having a different gain when signaling current is present than it has in the absence of signaling current, and a common indicator associated with said circuits, said circuits being connected with opposite effect to said indicator whereby they will give a null response for static.

3. In a signal transmission system, a master station comprising a radio transmitter and a radio receiver, a plurality of associated stations each comprising two antennas, two radio receivers and a radio transmitter, one receiver being normally connected and adapted to receive signals through one antenna from the master station, the other receiver being normally connected and adapted to receive signals through the other antenna from other associated stations, and means under the control of an operator at an associated station to change these connections for signaling between such associated station and the master station or another associated station and for talking with either such station.

4. In a signal transmission system, two receiving circuits adapted respectively to receive waves of different frequencies from different parts of the spectrum of voice and static frequencies, an amplifier common to both circuits, said amplifier having a different gain when signaling current is present than it has in the absence of signaling current, a common indicator associated with said circuits, said circuits being connected with opposite effect to said indicator, and means for sending signals on one of said frequencies to be received by the appropriate receiving circuit of the said two receiving circuits.

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