Jan. 31, 1928. 1,657,498

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RADIO SIGNALING SYSTEM

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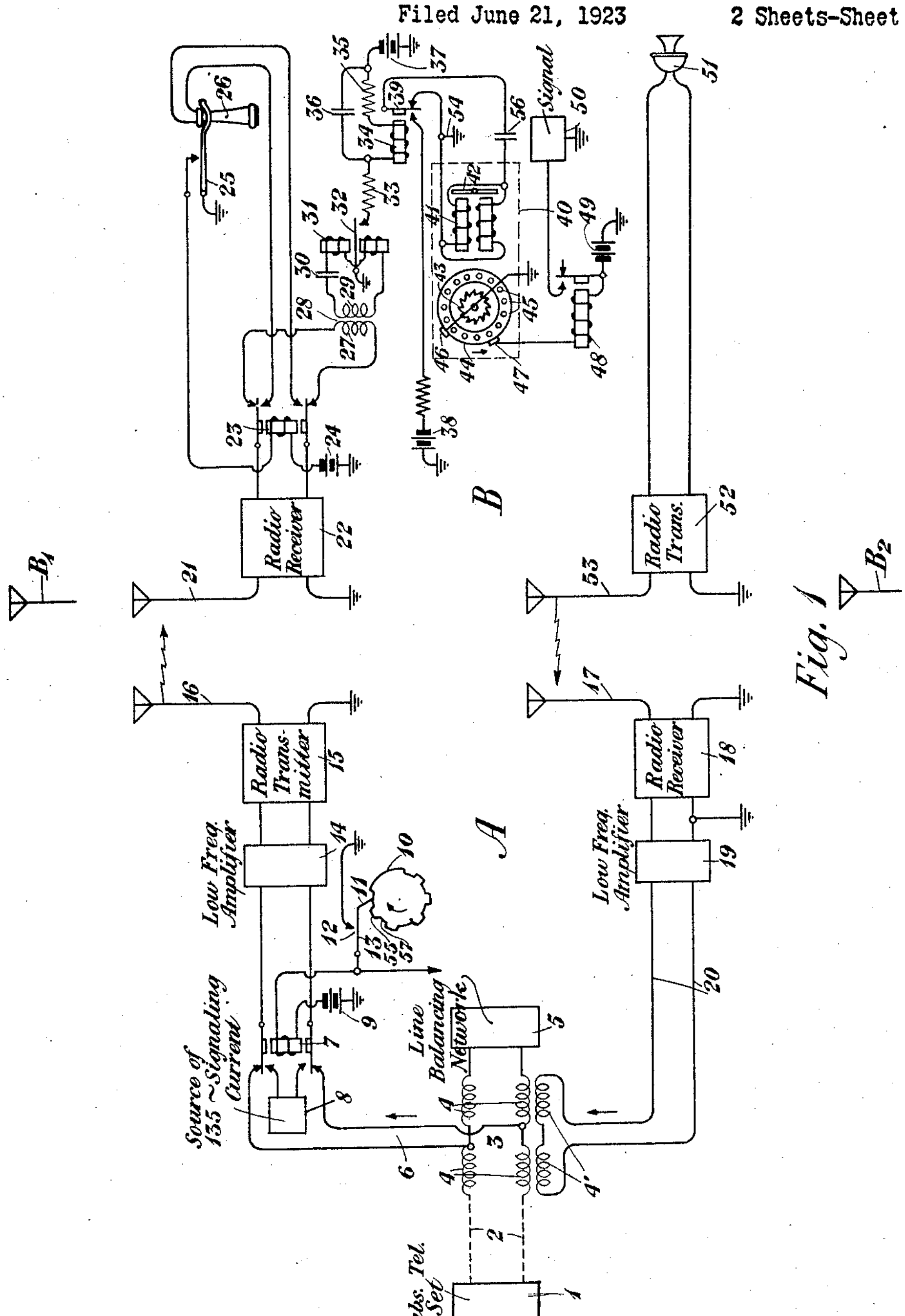

Fig. 1

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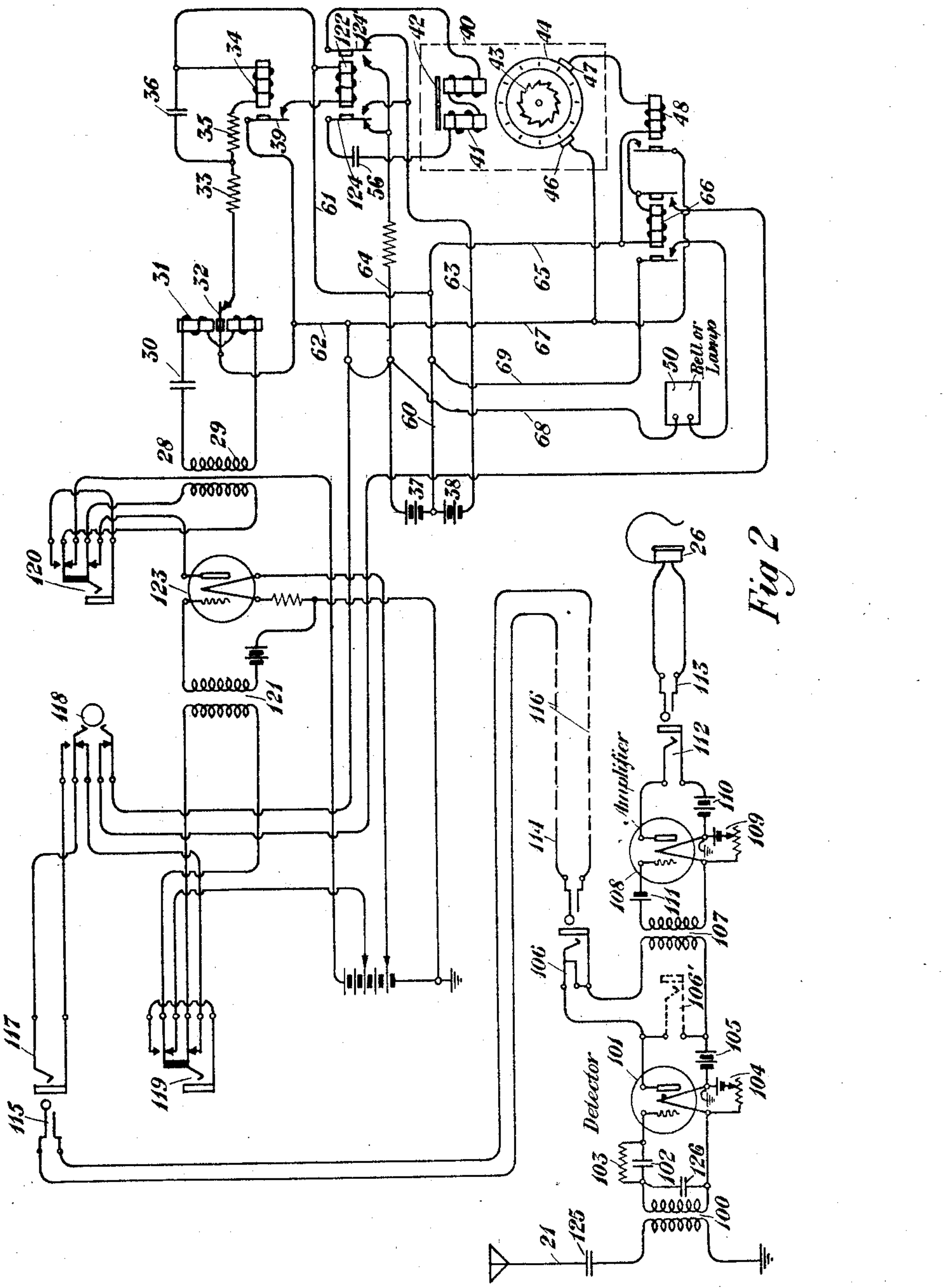

Fig 2

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UNITED STATES PATENT OFFICE.

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RADIO SIGNALING SYSTEM.

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This invention relates to signaling systems and particularly to means for selectively signaling one of a plurality of stations constituting a high frequency communication system.

In a high frequency communication system comprising a primary or central station and a plurality of secondary stations, it is desirable that the primary station should be able to call any secondary station without, at the same time signaling all of the other secondary stations.

It is the object of this invention to provide a selective signaling system whereby any secondary station may be called by the primary station. Other objects of this invention will be apparent from the following description when read in connection with the attached drawing of which Figure 1 shows the invention in its simplest form, and Fig. 2 shows a modification of the signal receiving circuit.

In Fig. 1, A represents a primary station, and B represents one of a plurality of secondary stations. These stations taken together might, for example, represent a ship-to-shore system of wireless telephone communication, in which A represents the shore station and B, B_1 and B_2 represent a plurality of ship stations which are arranged to communicate either with the primary station or through the primary station with a telephone subscriber connected therewith.

The rectangle 1 represents either a subscriber's telephone or telegraph set or the switchboard terminal equipment in a local telephone control office. For the purpose of describing this invention, we will assume that 1 represents a subscriber's telephone set which is connected by the line 2 with the primary radio station A, the connection being effected by the hybrid coil 3 comprising a plurality of windings 4 and 4′. Connected with this hybrid coil is a line balancing network 5 designed and adjusted to balance the line circuit 2. Connected with the hybrid coil is the transmitting path 6 of the primary station, the conductors of which are connected with the outer contacts of the relay 7, the inner contacts of which are connected with a source of low frequency signaling current. For the purpose of describing this invention, we have assumed the use of a frequency of 135 cycles, but it is to be understood that the invention is not limited to this particular frequency since other frequencies may be used. The relay 7 is controlled by current from the source of potential 9, the application of which is in turn controlled by a selector key 10. This key may be of any well known type, but is preferably of that type used in train dispatching telephone systems such as is disclosed in the patent to J. C. Field, No. 1,343,256, dated June 15, 1920. The rotation of this key will lift the arm 11, thereby grounding the conductor 13 through its upper contact 12 and similarly opening the said contact whenever the arm again drops back into one of the notches of the selector key. The key shown is designed to transmit a certain code of impulses. Other keys should be provided so designed as to transmit different codes of impulses for signaling other stations. The armatures of the relay 7 are connected with the input side of the low frequency amplifier 14, the output of which is connected with a radio transmitter 15. The output side of this transmitter is in turn connected with the transmitting antenna 16. This radio transmitter may be of any well known type, having a source of high frequency carrier current and means for modulating this carrier current by the 135 cycle signaling current or by the voice currents imposed thereon. This transmitter may also have any number of stages of either audio or radio frequency amplification or both, for effecting the amplification of the currents. The receiving branch of station A, comprises an antenna 17 connected with a radio receiver 18 which may be of any well known type, embodying a detector and possibly one or more stages of radio frequency amplification. The output side of this radio receiver is shown connected with a low frequency amplifier 19. This amplifier could be made part of the receiver 18 itself. The output of the low frequency amplifier 19 is connected with the windings 4′ of the hybrid coil 3.

The secondary station B which is typical of all secondary stations of the system, comprises a receiving antenna 21 connected with a radio receiver 22, which may be of any well known type, comprising a suitable detecting device and one or more stages of radio or audio frequency amplification, or both. The output side of such receiver is connected with the armatures of the relay 23. This relay is controlled by current from the source of potential 24 which in turn is controlled by the receiver switch-hook 25. The inner contact of relay 23 are connected with the subscriber's telephone receiver 26 shown as supported by the switch-hook which, of course, is its normal position when the subscriber is not talking. The outer contacts of relay 23 are connected with the primary winding 27 of the transformer 28 which is especially designed to transmit a low frequency current, for example, of the order of 135 cycles. The secondary winding 29 of this transformer is connected in a circuit which includes a condenser 30 and the windings of a highly sensitive and selective relay 31. A preferred type of relay is that disclosed in the copending applications of E. O. Thompson, Serial Nos. 525,727 and 525,728, filed December 29, 1921, and an application of Thompson, Grimes and Fisher, Serial No. 525,729, also filed on the same date. By proper adjustment of the constants of this circuit, it can be made resonant to 135 cycles. The armature 32 of this relay which is grounded is designed to vibrate freely at the resonant frequency. The contact point of the relay is connected through the resistance 33 to a circuit consisting of two parallel branches, one of which includes the winding of the relay 34, and a resistance 35, and the other a condenser 36. These parallel branches are connected with a source of potential 37. Since the armature 32 makes and breaks this contact at the rate of 135 times per second, the circuit containing the elements 34, 35 and 36 is so designed that during the time in which the armature 32 is off its contact, the condenser 36 will discharge through this closed circuit and will tend to maintain the armature 39 of the relay 34 in this closed position. The left-hand contact of relay 34 is connected with a grounded source of potential 38. The right-hand contact is connected with a selectively operated circuit controlling device 40, (shown within the dotted lines) this connection being grounded at the point 54. The armature 39 is also connected with the other terminal of this device, the said connection including a condenser 56. This selectively operated circuit controlling device 40 is preferably of the type shown in the patent to J. C. Field, No. 1,343,256, dated June 15, 1920. For the sake of simplicity, it is shown in the drawing in a schematic matter. A full disclosure of its construction and method of operation is to be found in the said patent to Field. The principal elements of this selector are the windings 41 which control an armature 42 which is designed to rotate an annular element 44 which carries a grounded contact 46. This contact is intended to engage the contact 47 whenever the element 44 has been moved through the proper distance which will be effected by the proper actuation of the ratchet 43 by means of the armature 42. Associated with the element 44 are a plurality of holes, such as 45, which are adapted to have pins inserted therein. The positioning of the pins, usually three in number, controls the responsiveness of a particular selector to a particular code of impulses. The operation of this selector will be referred to herein in only a general way inasmuch as a full detailed description is to be found in the said patent to Field. The contact 47 is connected with the windings of relay 48 with which also is connected the grounded source of potential 49. This source is also connected with the armature of the said relay in such manner that when the relay is operated current will flow therefrom through the signal device 50. The transmitting path of station B comprises in its simplest form, a transmitter 51 connected with a radio transmitter 52 which may be of any well known type, comprising a suitable source of high frequency currents, a modulating device and preferably one or more stages of radio or audio frequency amplification, or both. This radio transmitter is connected with the transmitting antenna 53. The sections of antennæ marked B_1 and B_2 are intended to represent symbolically other secondary stations of the system, having similar equipment to station B.

The method of operating the system is as follows. If the operator at station A desires to call the subscriber at station B in order to establish communication with such subscriber, he will actuate the proper selector key to send out the required code of impulses for operating the selector equipment at station B. If this selector key is 10 it will be rotated at uniform speed so as to open and close contact 12 a definite number of times, the said impulses being grouped in a manner which will be more fully described later. Upon the closing of contact 12, relay 7 will operate and connect the source 8 of 135 cycle current with the radio transmitter 15, through the low frequency amplifier 14. This signaling current will modulate the high frequency carrier current set up by the radio transmitter and radiated by the antenna 16. The high frequency current will continue to be modulate by 135 cycles during the time in which the arm 11 is traveling over the tooth 55 of the selector key, which is rotating in the direction of the arrow. This high frequency modulated wave will be impressed upon the antenna 21 and passing into the radio receiver 22 will be demodulated therein. The receiver is designed to detect the 135 cycle component. Since the receiver 26 is at this time upon the receiver hook, relay 23 is deenergized and consequently the armatures of relay 23 are touching their outer contacts. Accordingly the 135 cycle current will pass into the circuit containing the primary winding 27, the secondary of which is connected to relay 31. Since this current is of the right frequency, it will cause the armature of relay 31 to vibrate at the rate of 135 times per second. As soon as the armature 32 touches this contact, current will flow from the source 37 charging condenser 36 and also sending current through the winding of relay 34 to ground, causing the relay to operate. The flow of current through the winding of relay 34 will energize said relay and attract its armature 39, thereby bringing it into contact with its left-hand contact point which is connected with the source of potential 38. As has been pointed out, the armature 32 makes and breaks this contact at the rate of 135 times per second. Whenever it breaks this contact, condenser 36 discharges through the closed circuit containing also the winding of relay 34 and resistance 35 and the direction of flow of current from the condenser through the said winding will be such as to maintain the armature 39 upon its left-hand contact during the interval of time in which the armature 32 is off its contact. It will be seen therefore that as long as the impulse is being transmitted from station A, the armature of relay 31 will vibrate at the rate of 135 times per second, but the armature of relay 34 will be moved to its left-hand contact as soon as the said impulse is received at station B, and will remain upon that contact point as long as the impulse continues to be received, regardless of the movement of the armature 32 in response to the frequency of the said impulse.

When the armature 39 touched its left-hand contact, current flowed from the souce 38 through the said contact and armature 39 through the condenser 56 and the windings 41 to ground at 54, energizing the said windings and also charging the said condenser. The armature 42 would be actuated so as to move the element 44 in the direction represented by the arrow and through a distance represented by the angle between two adjacent pinholes 45. When the arm 11 of the selector key 12 has passed over the tooth 55 and dropped in the slot 57 at the end of this tooth, the contact 12 will be opened, releasing relay 7 and discontinuing the transmission of the impulse of 135 cycle current. Accordingly, the relay 31 will cease to operate and relay 34 will be deenergized allowing its armature 39 to drop back. This will open the circuit from the source 38 and the condenser 56 will then discharge and current will flow through the windings 41 to ground at 54. Although the impulse transmitted therethrough will be in opposite direction to that produced by current from the source 38, the mechanism associated with the armature 42 is so arranged that the effect of this impulse is to move the rotating member 44 in the direction of the arrow, namely, the same direction in which the impulse from the source 38 moved the said member. This is fully set forth in the said patent to Field. By applying the correct number of impulses the movable contact 46 will be brought into such position as to touch the fixed contact 47, thereby grounding the relay 48 and causing it to operate. Upon this operation current will flow from the source 49 over its armature and inner contact to the signal device 50 which may be any form of visual or audible signal, such as in lamp or bell or similar device.

Since all the secondary stations of the communication system will receive the modulated high frequency wave and since their responsive relays, such as 31, are designed to respond to the same frequency, namely 135 cycles, it will be apparent that all of the stations of the system would be signaled unless some means were interposed to effect such selection. In our system this selection is effected by sending out the proper code of impulses and by utilizing at each secondary station selectively operated circuit controlling means substantially as shown in said patent to Field.

The arrangement shown in Fig. 2 is a modification of that shown in Fig. 1. The antenna 21 may be connected in any well known manner such as by the transformer 100 with a radio receiving circuit here shown as comprising a detector 101 and an audio frequency amplifier 108. The antenna circuit is tuned by condenser 125 to the frequency of the carrier of the transmitting station; the secondary of transformer 100 is tuned by condenser 126. The input circuit of the detector contains the grid condenser 102 and the grid leak 103. Connected with the filament is a source of potential 104 and means for varying the current. Connected with the plate circuit of the detector is a source of potential 105. This circuit is connected with the amplifier circuit by the transformer 107. The plate circuit also contains a jack 106 which is adapted to receive the plug 114. This jack is so arranged that the plate circuit will be effectively connected with the amplifier circuit when the plug 114 is not inserted in the said jack; and alternative arrangement of the jack is shown by the dotted lines designated 106′ representing a bridged connection of the jack. The amplifier circuit contains sources of potential 109, 110 and 111, and also a jack

112 which is adapted to receive the plug 113 whereby the receiver 26 may be connected with the output side of the amplifier.

The plug 114 is connected with the cord 116 with which is also connected another plug 115, which may be inserted in the jack 117. As an alternative to be used with jack 106′, it may be inserted in jack 119 or 120. The circuit with which the jacks 117, 119 and 120 are connected may be designated the signal receiving circuit. This circuit contains an amplifying tube 123 having associated therewith an input transformer 121 and an output transformer 28. The other elements of this arrangement which are the same as in Fig. 1, have been given the same designating numbers. The arrangement of Fig. 2 differs principally from Fig. 1 in having an additional relay 122 controlled by relay 34 so as to reverse the polarity of the potential applied to the controlling circuit of the selector 40 containing the condenser 56 and the windings of the magnet 41 whenever relay 34 operates or releases.

The operation of this system is as follows. Let it be assumed that station A is sending out a high frequency carrier wave modulated by an impulse of 135 cycle ringing current. This wave will be received by the antenna 21 and impressed by the transformer 100 on the detector 101 whereby the low frequency component will be detached. Furthermore, let it be assumed that the plug 114 has been inserted in jack 106 and plug 115 in jack 117. Accordingly, the low frequency signaling current will pass from the output circuit of detector 101 over the conductors of the cord 116; thence, from the conductors connected with the jack 117 and through the contacts of key 118 and jack 119 (both being in their normal unoperated positions) to the input transformer 121. This low frequency current will be amplified by the amplifier 123 and the resultant amplified current will be impressed upon the circuit of the relay 31 which is tuned to 135 cycles. The armature 32 of this relay will vibrate at the rate of 135 times per second so long as the impulse continues to be received by the antenna 21. As soon as the armature 32 touches its contact, current will flow from battery 37, over conductors 60 and 61, thence, through the winding 34 and condenser 36 in parallel, thence through the contact of the armature 32 and conductor 62, to the opposite pole of battery 37. This will energize relay 34 and cause its armature 39 to touch its contact. Due to the action of condenser 36 previously described this armature will continue to maintain a closed contact so long as the impulse continues to cause the armature 32 to vibrate. Upon the closing of the contact of armature 39, current will also flow from battery 37 over conductors 60 and 61 through the winding of relay 122 and contact of relay 34 to the opposite pole of battery 37, energizing relay 122. The armatures 124 and 124′ of the said relay would be attached to their inner contacts. Current will accordingly flow from battery 38 over conductor 63, armature 124, thence through condenser 56 the winding of the magnet 41, the armature 124′ and conductor 64, to the opposite pole of battery 37. It will be seen that these batteries are connected in series aiding manner. The winding 41 will be energized and the armature 42 actuated. The rotating element 44 of the selector 40 will be stepped around a predetermined distance by the operation of the armature 42 in the manner fully described in the patent to Field. Upon the completion of the impulse, the armature 32 will stop vibrating, thereby releasing relays 34 and 122. When the armatures 124 and 124′ drop back, an impulse of opposite polarity will be transmitted through the winding 41 which will assist the impulse stored up in the condenser 56. As has been pointed out, the selector 40 is arranged so that the rotating member 44 will be stepped around through the same distance and in the same direction as effected by the first impulse although the direction of flow of current in the circuit of the windings 41 is different in the two cases. When the rotating element 44 has been moved sufficiently as to cause the movable contact 46 to touch the fixed contact 47, a circuit will be established from battery 37, conductors 60 and 65, winding of relay 48, contacts 47 and 46, and conductor 67, to the opposite pole of battery 37, thereby energizing relay 48. Upon the energization of relay 48, relay 66 will be energized and current will flow from battery 37 over conductors 60 and 69, left-hand contact of relay 66 to signal 50, thence over conductor 68 to the opposite pole of 37 thereby operating the said signal. Relay 66 will be locked up over its right-hand contact, the locking connection including the key 118.

Upon the receipt of this signal, the subscriber will operate key 118. This effectively disconnects the signal receiving circuit from the radio receiver of which detector 101 forms a part. By the closing of the upper contact of key 118, the plate circuit of the detector 101 is effectively connected through the transformer 107 to the speech frequency amplifier 108. Since the plug 113 will normally be inserted in jack 112, the receiver 26 will thereupon be effectively connected with the antenna 21 and accordingly the speech signals received by antenna 21 will be heard by the subscriber at the receiver 26. The operation of the key 118 also serves to open the locking circuit of relay 66, thereby stopping the ringing of the bell.

By inserting the plug 114 in jack 106′,

and the plug 115 in the jack 119, the detector 101 will be connected with the input side of the amplifier 123, whereas, if the plug 115 is inserted in jack 120, the detector will be connected directly with the resonant circuit of relay 31, thereby cutting out the amplifier 123.

While a selective signaling system has been shown in Figs. 1 and 2, as described heretofore, the arrangements there shown may be readily made non-selective by a simple modification of the apparatus at the central and the secondary stations. Thus, for example, in Fig. 1 the selector key 10 may be replaced by any simple type of key whereby the circuit of relay 7 might be opened and closed. At the secondary station B the selector 40 may be disconnected from the right-hand contact and armature 39 of the relay 34. This armature may then be directly connected with any slow acting relay, the winding of which should be grounded. The armature of such relay may be arranged to control a signal, such as 50. In such system whenever the key at the central station A is closed, relay 7 will be operated, and a carrier current modulated by 135 cycle signaling current will be transmitted from the antenna 16. This current will be demodulated by the radio receiver 22, and the 135 cycle component will operate the relay 31, which will in turn control relay 34 in the manner fully described heretofore. This relay, when energized, will connect the source of potential 38 with the slow acting relay mentioned above, which in turn will control the signal 50.

Furthermore, it is desired to point out that although the system of Figs. 1 and 2 has been described as a one-way signaling system, viz., from station A to B, B_1 and B_2, it is to be understood that it is not so limited but may be readily adapted for two-way signaling. Thus, by inserting in the transmitting branches of the various secondary stations the selective transmitting apparatus, such as is shown in the transmitting branch of station A, code signaling impulses may be sent out from the various secondary stations. By inserting in the receiving branch of station A a low frequency signaling circuit, such as is shown in the receiving path of station B and having a plurality of selectors connected therewith, the code impulses transmitted from the secondary stations will be received, thereby not only enabling the secondary stations to signal the operator at the central station, but also to indicate the number of the calling station.

While mention has been made of a plurality of selector keys at station A for calling particular secondary stations, it is desired to point out that a master key such as is disclosed in the patent to Field, cited heretofore, may be used, whereby if desired, all of the secondary stations may be called simultaneously.

It is also desired to point out in connection with Fig. 2 that the amplifier 123 may be omitted if the energy output of the detector tube is sufficient to operate the relay 31.

While this invention has been disclosed as embodied in a particular form and arrangement of parts, it is to be understood that it is not so limited, but is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a radio communication system for the transfer of messages and calling signals, consisting of a series of impulses grouped in accordance with a predetermined code, the combination with a radio receiver of a speech receiving circuit having a telephone receiver and a hook switch connected therewith, a signal receiving circuit having a mechanically tuned relay in an electrically tuned circuit responsive to the low frequency component, a slow acting relay controlled by the said tuned relay adapted to be energized and deenergized at the beginning and ending of the operation of the tuned relay, a code selective switching means responsive to the said slow acting relay and an indicating device connected therewith. and switching means controlled by the said hook switch to connect the said radio receiver with either the said speech receiving circuit or the said signal receiving circuit.

2. In a radio communication system for the transfer of messages and calling signals consisting of a series of impulses grouped in accordance with a predetermined code, the combination with a radio receiver of a speech receiving circuit, a signal receiving circuit having a mechanically tuned relay in an electrically tuned circuit responsive to the low frequency component of the signaling waves, a slow acting relay controlled by the said tuned relay adapted to be energized and de-energized at the beginning and ending of the operation of the tuned relay, a code selective switching means responsive to the said slow acting relay, an indicating device connected with the said selective switching means, and means to connect the said radio receiver with either the speech receiving circuit or the said signal receiving circuit.

In testimony whereof, we have signed our names to this specification this 20th day of June 1923.

CHARLES S. DEMAREST.
MILTON L. ALMQUIST.