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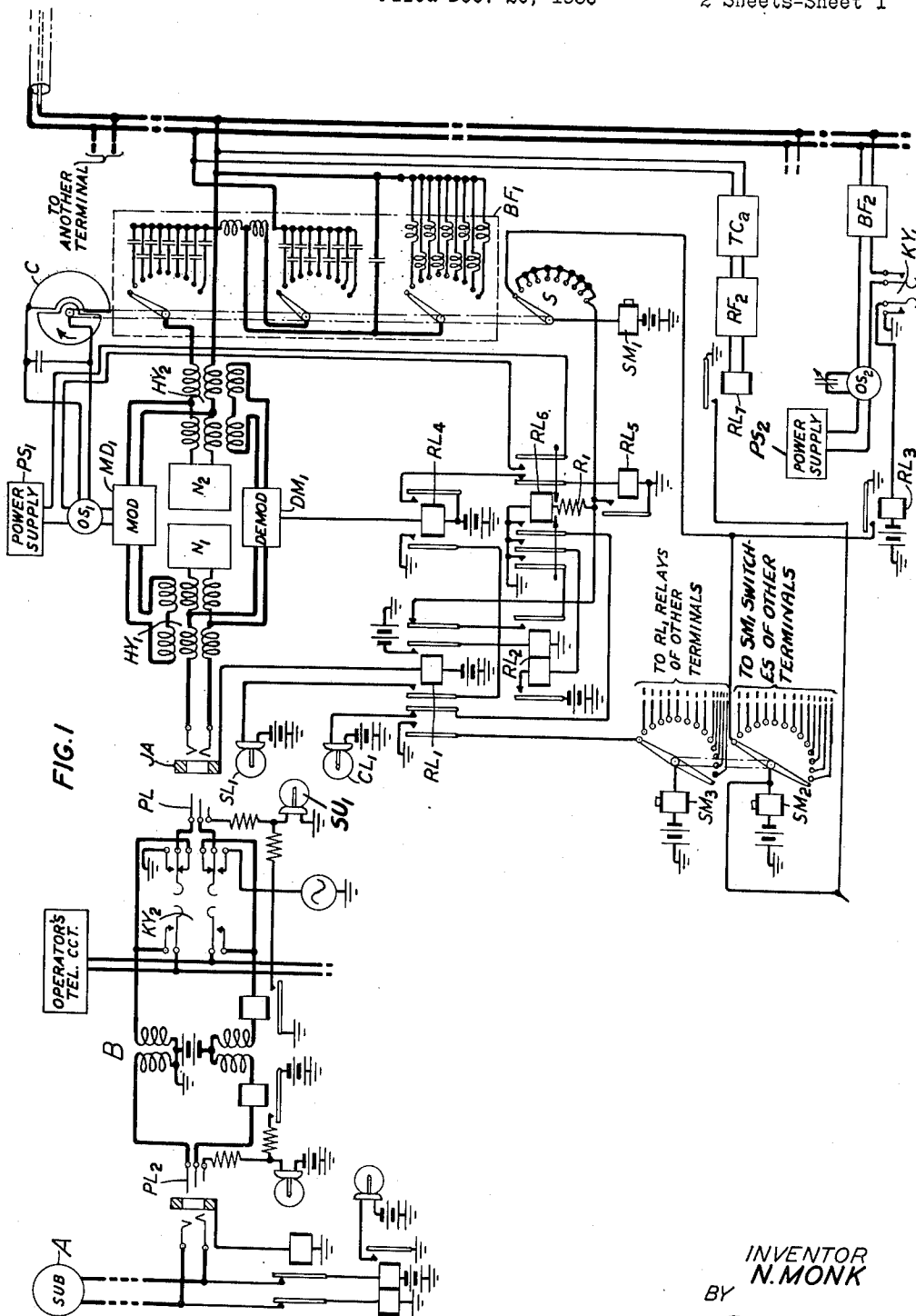
N. MONK

2,137,023

CARRIER COMMUNICATING SYSTEM

Filed Dec. 20, 1935

2 Sheets-Sheet 1



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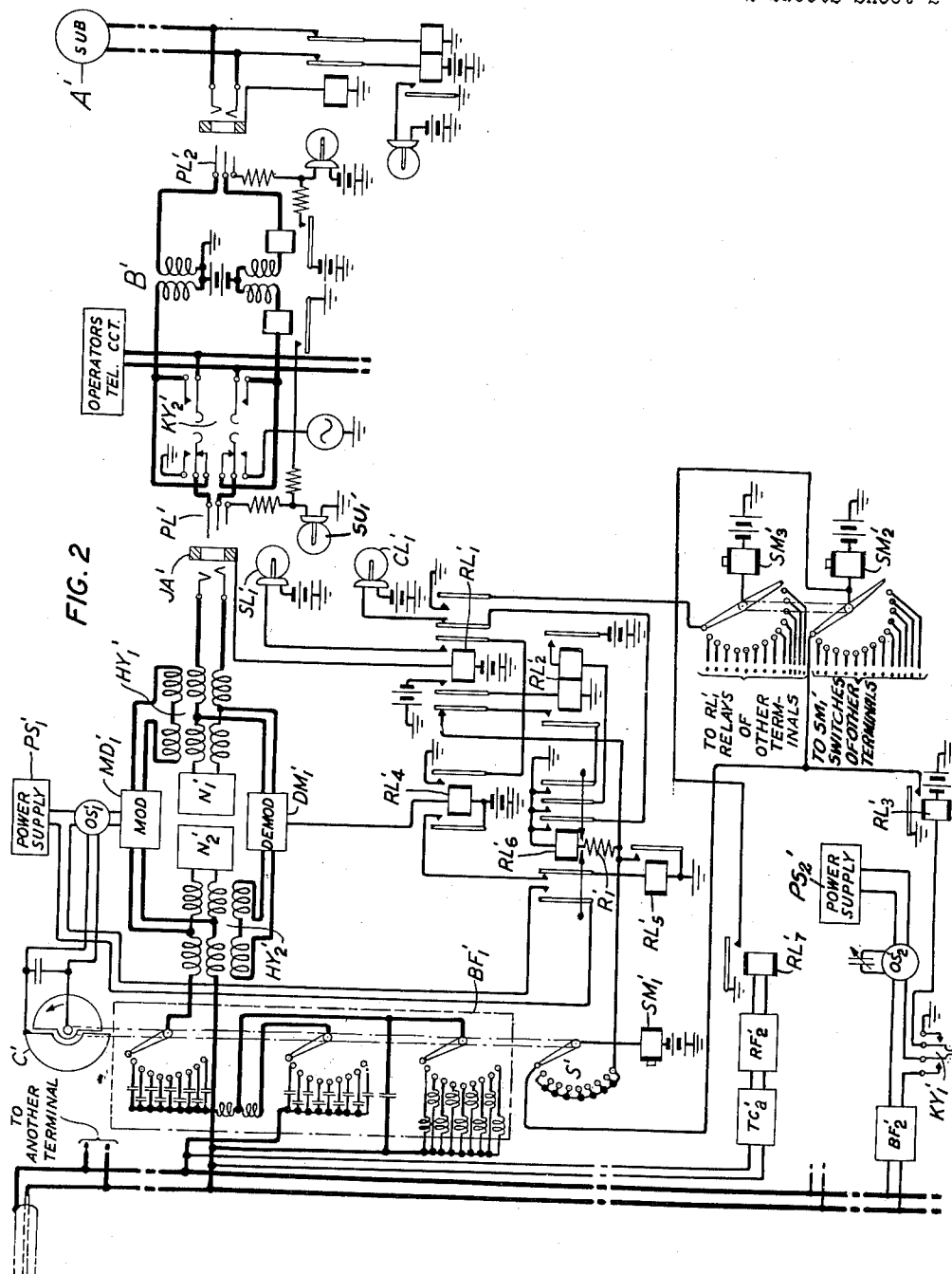
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UNITED STATES PATENT OFFICE

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CARRIER COMMUNICATING SYSTEM

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9 Claims. (Cl. 179-15)

This invention relates to an improved communicating system and more particularly to a communicating system of the type in which carrier waves or oscillations, either free or guided, are employed as the medium for conveying energy for effecting the operation and control of electrical signaling controlling and communicating apparatus located at separate points in the system. The invention especially relates to a system in which carrier currents, in the form of high frequency waves guided upon wires, are used as the medium of electrical connection between the electrical devices and apparatus located at different points in the system. These carrier currents are assigned such frequencies that they are non-interfering with one another, so that each carrier serves as a separate and distinct connecting medium superposed upon the line or conductor over which the carrier is transmitted. Each of the carriers is modulated in accordance with the voice currents or other signaling or controlling currents that are to be carried. The carriers thus modulated are transmitted over the toll or long distance line or any other connecting medium such as, for instance, a coaxial cable, and are passed through individual receiving arrangements, each of which is selective of one carrier frequency to the exclusion of the others and each of which serves to reproduce from the modulated carrier the voice or signal currents with which the carrier was modulated at the distant station.

The apparatus which is used to transmit and receive by means of a wave of a different frequency is commonly known as a high frequency channel or a frequency selective channel.

It is the object of this invention to provide a highly efficient communicating system between a number of offices connected by a common medium by providing a number of single high frequency channels common to all the offices, by providing an individual high frequency channel to designate each office and by providing switching equipment at each office so that, upon the initiation of a call from one office to another by the transmission over the common medium of the individual frequency of the called office, the switching equipment at the calling office will be operated to select an idle frequency channel over which the talking and sending connection shall take place, while the switching equipment at the called office will be operated to select the selected frequency channel through which the connection may be completed.

In the type of carrier communicating system to which the present invention particularly relates,

a common transmission medium having a number of stations associated with it is provided with a plurality of single frequencies for both directions of transmission, while at each station in the system there is included a plurality of similar trunks each provided with means to transmit and receive these frequencies. This apparatus includes: a modulator and its associated oscillator, a demodulator, a variable frequency filter and several rotary switches. The variable filter and oscillator are connected mechanically to one of these switches and are controlled by it in the sense that the switch operates to tune the circuit to each one of the system frequencies in rotation. Additional apparatus is also included to start the operation of the rotating switch both when initiating a call and when completing the call. By operating the rotating switches synchronously at any two stations, as will be hereinafter described, a connection is set up. There are also included in each set of apparatus a number of auxiliary relays and lamps for supervising the connection.

In the operation of the system, the operator chooses an idle trunk by plugging the calling cord into the jack of the trunk outlet and then manipulates the calling oscillator to transmit a spurt of calling frequency which is individual to the called office and at which office appropriate responsive apparatus picks it up. In the meanwhile, the mechanical switches are set in motion in cooperation with the variable filter and variable oscillator, the variable filter being automatically adjusted to respond to one of the communicating frequencies and the variable oscillator being variably adjusted to produce it. If this frequency is in use at this time it will be picked up by the filter over the common medium and made to operate a demodulator which, in turn, operates a relay that grounds the hunting terminal upon which the frequency selective switch is standing whereupon the frequency selective switches at the originating and called offices are stepped to the next terminal, the filter and oscillator being tuned, in turn, to the next available frequency. The busy test is now repeated to detect the busy or idle condition of this frequency. If the frequency is found idle, the switches remain where they are; if the frequency is busy, the operations are repeated until an idle frequency is found.

At the called office, the spurt of calling frequency operates a circuit tuned thereto which in turn operates a relay that causes the frequency selective switch of an idle trunk to step to the frequency selected at the originating office and,

at the same time, to adjust the variable oscillator and filter of the trunk to produce and respond to this frequency. When the selected frequency is found, a calling lamp of the trunk is lighted and the call is completed thereover in the usual manner.

The scope and purpose of the invention may be obtained from a consideration of the following description taken in connection with the attached drawings in which:

Fig. 1 shows an outlet or terminal in one office connected to a common transmission medium such as, for example, a pair of coaxial conductors; and

Fig. 2 shows a similar outlet or terminal in another office connected to said medium.

Both terminals are identical and each of them may be used either to initiate an outgoing call or to complete an incoming call.

In the system of my invention, the same frequency is employed for both directions of transmission, there being a plurality of such frequencies available for the entire system. At each station in this system there is included a plurality of similar terminals such as the one shown in either Fig. 1 or Fig. 2 and each includes similar equipment; that is, an oscillator and its associated modulator, a demodulator, a variable frequency filter and several rotary switches. The variable filter and oscillator are connected mechanically to one of these switches and are controlled by it. This switch operates to tune the circuit to each one of the system frequencies in rotation. Additional apparatus is also included to start the operation of the rotating switch, both when initiating a call and in completing the call. By operating the rotating switches synchronously at any two stations, as will hereinafter be described, a connection is set up. There are also included in each terminal a number of auxiliary relays and lamps for setting up and supervising the connection.

For clearness of description and for the purpose of more easily identifying corresponding elements in each of the terminals, said elements have been given identical designations in both figures except that the designations of the elements in the terminal shown in Fig. 2 have been primed to distinguish them from the corresponding elements in the terminal shown in Fig. 1.

Each terminal includes a jack JA through which a connection is established from a calling subscriber A, through the medium of a cord such as, for instance, cord B or similar instrumentalities, hybrid coils HY₁ and HY₂, each terminating in appropriate balancing networks N₁ and N₂ respectively, a modulator MD₁, a variable oscillator OS₁ operatively connected with it, and a source of power PS₁ operatively connected to both, a calling variable oscillator OS₂ with its source of power PS₂, key KY₁, a fixed band filter BF₂ capable of passing the various high frequencies produced by the oscillator OS₂, and a variable band filter BF₁ which is synchronously tuned to pass whatever frequency is being produced at any time by the variable oscillator OS₁. The tuning of both the oscillator OS₁ and the band filter BF₁ is controlled through a stepping switch SM₁ in a manner which is completely disclosed and described in the Patent 2,064,904 granted December 22, 1936 to E. I. Green. Two other rotary switches, namely, SM₂ and SM₃ have their arms mechanically connected together so that the operation of one switch, besides causing the movement of its own arm over a cooperating

contact arc, similarly influences the movement of the arm of the companion switch. The switches SM₁, SM₂ and SM₃ are of the type which advance their arms on the energization of their stepping magnets. Each contact in each of the contact arcs of these switches is reserved to one of the available terminals and is used to mark the idle or busy condition of the terminal, as more completely described hereinafter.

The operation of the system will now be described by tracing a connection between subscriber A, whose line can be assumed to have been extended to the cord B in the usual manner and subscriber A' located in the distant office accessible through the terminal shown in Fig. 2, and that this connection is to be made over the common medium extending between the two terminals.

The operator at the originating office first takes into use an idle one of the available terminals whose idle condition is indicated by the fact that no plug PL of a cord such as cord B is in a terminal jack JA or, if multiple jacks are employed, busy lamps may be provided which are lighted by means of a signaling circuit controlled through the ground on the sleeve of the cord plug PL inserted into the jack. The operator next inserts the plug PL into the jack JA. This connection places ground through the calling supervisory cord lamp SU₁ on the sleeve of the jack and an obvious circuit is thereby completed for relay RL₁ which operates to perform a number of functions. First, it closes a partial path through its left inner contacts for supervisory lamp SL₁ thereby permitting this lamp to be controlled through the left contacts of relay RL₁; second, at its left middle contacts, it breaks the connection through the call lamp CL₁, thus preventing this lamp from lighting when relay RL₁ operates as described hereinafter; third, it completes a circuit which extends from grounded battery through its right inner contacts, right winding of relay RL₂ to ground; fourth, through its right outer contacts, it breaks the path from the arcs of the strapped terminals of rotary switch SM₁ to the winding of the rotary magnet SM₁ of said switch; and fifth, it connects ground through its left outer contacts to the contact of the arc of switch SM₃ which is reserved for the terminal shown in Fig. 1 and marks said terminal as busy. Inasmuch as the arm of switch SM₃ is mechanically connected to that of switch SM₂, then, if the arm of switch SM₃ is on the terminal to which the contact of relay RL₁ is connected, the above ground completes a circuit to battery through the winding of switch magnet SM₃ causing the arm of said switch as well as that of switch SM₂, to advance to the next contact on the respective arcs which are reserved to another terminal. If this terminal is busy, ground will be connected to the contact on the arc accessible to the arm of switch SM₃, said ground being extended thereto by relay RL₁ of said terminal, or on the arc accessible to the arm of switch SM₂ from the contacts of relay RL₁ as described hereinafter. In either event, the operation of magnet SM₃ or SM₂ will continue for each succeeding set of contacts on either one of which ground is present until a set of contacts is reached having no ground thereon; that is, until a free outlet or terminal is reached, at which time the switch arms will rest on said contacts.

The operator now manually or by other appropriate means, adjusts the frequency of the calling oscillator OS₂ to a particular frequency

which, for calling purposes, is assigned to the desired office. The operator next momentarily depresses key KY_1 which permits a spurt of that particular frequency to pass through the filter BF_1 which likewise passes all the calling frequencies for the entire system, over the common medium to said desired office. Key KY_1 also closes an obvious circuit for relay RL_6 which is momentarily energized, first to connect ground to the contact on the arc of switch SM_2 for the purpose of driving said switch off the contact if the arm thereof is standing on said contact, which would be the case if the key KY_1 were operated prior to plugging into the jack JA of the idle terminal taken into use; secondly, to close a circuit which extends from ground through its contacts, through the normal contact on the arc S of switch SM_1 , winding of the switch magnet SM_1 to battery. This circuit causes magnet SM_1 to operate and adjust, mechanically, the filter BF_1 to, say, the frequency f_1 and adjusts the oscillator OS_1 to this same frequency since the rotor of condenser C by which said oscillator is adjusted, is carried on the same shaft of switch SM_1 as the moving elements for tuning the filter BF_1 . If, now, this frequency f_1 is in use over the common medium and hence is being transmitted back and forth thereover, it will be applied from an oscillator such as OS_1 tuned to generate the frequency f_1 to the hybrid coil HY_2 and thence to the demodulator DM_1 and relay RL_4 which is connected to the plate circuit (not shown) of the demodulator DM_1 , will be operated which, in turn, closes a circuit for relay RL_6 extending from negative battery through the right contacts of relay RL_4 , right inner contacts of relay RL_6 , winding of relay RL_6 to ground. Relay RL_6 operates and connects ground to one side of relay RL_5 and to the strapped contacts of arc S of switch SM_1 whereupon the operating circuit of magnet SM_1 is completed which, on operating, causes the arms of said switch to be advanced to the next terminal, thereby tuning the oscillator OS_1 and the filter BF_1 to the next frequency, say f_2 . If this frequency is also in use at the time, it will be present on the common medium and will cause the response of demodulator DM_1 which, in turn, causes the operation of relay RL_4 followed by that of relay RL_6 , followed by that of magnet SM_1 and by the stepping of the switch arms to the next set of terminals to which are connected the electrical elements for tuning the filter BF_1 and the oscillator OS_1 to the next frequency, say f_3 of the total number of communicating frequencies available to the system. The above operations will continue until an available frequency is found, relay RL_6 remaining short-circuited so long as relay RL_5 remains operated in order not to disturb the operating path of the switch SM_1 . Furthermore, relay RL_6 (and likewise relay RL_5) has a slow-to-operate characteristic which will prevent its false operation in advance of the operation of relays RL_4 and RL_5 at the time the arm of switch SM_1 steps on the strapped terminals of arc S , at which time, should the switch then be connected to a busy channel, relay RL_4 operates and closes the circuit of relay RL_5 , in which event, relay RL_6 being slow to operate, the operation of relay RL_5 is assured and relay RL_6 is prevented from operating by the connection of ground to both sides of its winding. Assuming, however, that frequency f_2 is not in use, then, when the arms of switch SM_1 reach the second set of terminals, relays RL_4 and RL_5 will not operate, no current

will flow through the winding of the stepping magnet SM_1 and the switch will remain set upon the set of contacts designating the frequency f_1 . Relay RL_6 will now operate in series with the winding of magnet SM_1 in a circuit to be later described.

In the meanwhile, and at the time that the operator depresses key KY_1 to transmit a spurt of calling frequency to the required office which, it may be assumed, is that represented by the terminal shown in Fig. 2, the carrier current at this frequency is transmitted over the common medium and effects the tuned circuit or filter TC'_a at the wanted office, which filter or circuit is tuned only to the frequency individual to the wanted office and transmitted from the originating office. A rectifier RF'_2 is associated with the tuned circuit TC'_a and the received spurt of current operates through the rectifier to close momentarily the contacts of relay RL'_7 . This relay timed to operate simultaneously with relay RL_6 at the originating office.

The operation of relay RL'_7 momentarily connects ground to the winding of the magnet of switch SM'_2 and through the switch arm controlled thereby to the normal contact of the arc S' of switch SM'_1 of the terminal taken into use whereupon a circuit is completed through the winding of magnet SM'_1 and another circuit is completed through the winding of magnet SM'_2 . Switch SM'_1 now operates to find an idle frequency in the same manner as switch SM_1 at the originating office and since relay RL'_7 operates simultaneously with relay RL_6 at the calling office, switches SM_1 and SM'_1 will step in synchronism and bring their switch arms to rest on corresponding terminals allocated to the same available frequency.

The ground connected to the winding of switch magnet SM'_2 by the contacts of relay RL'_7 causes said magnet to step the arms of both switches SM'_2 and SM'_3 to the next set of contacts. Now if this next set of contacts is associated with a busy terminal, which fact is determined by the connection of a cord plug PL' into jack JA' and the consequent operation of relay RL'_1 , a circuit will be completed extending from ground on right outer contacts of relay RL'_1 , corresponding terminal on the arc of switch SM'_3 and its arm, winding of magnet SM'_3 to battery. The arms of both switches will now be advanced to the next set of contacts and continue to step over successive contacts until the arm of switch SM'_3 engages an ungrounded terminal of its arc corresponding to an idle terminal. The switches SM'_2 and SM'_3 thus always maintain an idle terminal preselected. It is obvious that, if desired, a single switch with two sets stationary contacts and two mechanically associated arms could be employed instead of the separate switches SM'_2 and SM'_3 .

Returning, now, to the operations taking place in the calling office, after the switch SM_1 has been stepped to the terminal representing an idle frequency, a circuit is completed for relay RL_6 extending from ground through the winding of relay RL_6 , resistance R_1 , terminal in the arc S of switch SM_1 upon which its associated arm is brought to rest, winding of magnet SM_1 to battery and ground. The quantity of current flowing in this circuit is such that relay RL_6 will operate but magnet SM_1 will not. Relay RL_6 , upon operating, connects ground to its left group of contacts. The ground connected to its left inner contacts extends to the left middle con-

tacts of relay RL₁. Since, however, said relay is operated at this time, lamp CL₁ will not light. The ground through the left outer contacts of relay RL₂ extends through right contacts of relay RL₂, which is operated, to an open circuit on the right outer contacts of relay RL₁, while the ground through left middle contacts of relay RL₂ serves to lock up relay RL₂ through its left winding and contacts to battery.

Relay RL₂ also performs two other functions. Over its right outer contacts it connects power supply PS₁ to the oscillator OS₁ which is now mechanically adjusted to produce a current of frequency f_2 and, through its right inner contacts it opens the path of relay RL₂ thereby preventing the operation of this relay until the completion of the call.

At the incoming office, when the switch SM'₁ comes to rest the contact on the arc S' which corresponds to the selected frequency f_2 , relay RL'₂ operates in the manner described for an identical operation at the outgoing office and completes a circuit for lamp CL'₁ extending from grounded battery through the lamp CL'₁, right middle contacts of relay RL'₁, right inner contacts of relay RL'₂ to ground. Lamp CL'₁ lights to inform the operator that a call is awaiting on the terminal designated by the lighted lamp. The operator then inserts the plug PL' of an available cord B' into the jack JA' of the designated terminal and, by operating KY'₂ connects her telephone set to the talking circuit. After ascertaining the number of the wanted subscriber she inserts the plug PL'₂ of a cord circuit into the jack of the called subscriber A'. In addition to completing the talking connection, plug PL' causes a circuit to be completed extending from ground on the sleeve of the plug through the called supervisory lamp SU'₁ of the cord, winding of relay RL'₁ to battery. The operation of relay RL'₁ causes lamp CL'₁ to be extinguished and further connects ground through its right outer contacts to the contact on the arc of switch SM₃ reserved for the terminal taken into use to mark said terminal as busy.

A path is now completed for lamp SL'₁ extending from grounded battery through said lamp, right inner contacts of relay RL₁ right contacts of relay RL'₄ to ground. The demodulator DM'₁ responds to the incoming carrier so that, so long as the connection is maintained, relay RL'₄ is operated and lamp SL'₁ will be lighted to signify that the two subscribers are conversing.

When the call is completed and the calling operator is apprised of the fact through the usual signaling equipment associated with the cord circuit, she removes the plug PL from the jack JA, thus deenergizing relay RL₁. A circuit is now completed extending from ground through the left outer contacts of relay RL₂, right contacts of relay RL₂, right outer contacts of relay RL₁, the arc S of switch SM₁, winding of magnet SM₁ to battery. The arms of switch SM₁ will now be stepped around to their normal position at which point the stepping circuit is broken and the switch will come to rest. This also serves to bring the filter BF₁ and the oscillator OS₁ to their normal position. The switch SM₁, upon returning to its normal position, also breaks the circuit through the winding of relay RL₂ which, in turn, unlocks the relay RL₂. The terminal at the outgoing office is now in readiness for use in setting up a new call.

When the relay RL₂ releases at the calling

office and the power supply PS₁ of the oscillator OS₁ is opened at the right outer contacts of this relay, frequency f_2 is removed from the line whereupon the demodulator DM'₁ at the called office causes the release of relay RL'₄ and the opening of the circuit of lamp SL'₁. This lamp, when extinguished, signals the operator at the incoming office that the call is terminated, whereupon she removes the plug PL' from the jack and the apparatus at the incoming office restores to normal in the manner already described for the calling office.

What is claimed is:

1. In a high frequency communicating system having a plurality of stations associated with a common transmission medium, the combination with a plurality of trunks at each station of means for transmitting and receiving a number of high frequencies, each of said high frequencies designating a particular station, means in each trunk for transmitting and receiving a number of other high frequencies used for communicating purposes, means responsive to the transmission of a high frequency designating a called station from one of said stations when calling for selecting an idle communicating frequency and associating it with a trunk taken into use thereat for establishing an outgoing connection to said called station, means at said called station responsive to the reception of said high frequency for selecting an idle trunk and operatively associating it with the same communicating frequency which was selected at the calling station.

2. In a high frequency communicating system, the combination with a first station having a plurality of trunks and associated high frequency apparatus in each trunk adapted to transmit and receive a number of high frequencies, of means at said station for originating an outgoing call, a distant station, a plurality of trunks and associated high frequency apparatus in each of said trunks at said distant station adapted to transmit and receive the same number of high frequencies as the trunks at said first station, and apparatus individual to each trunk in said first station for selecting the same idle frequency over which the call is to be established, and apparatus common to said trunks in said second station responsive to the origination of an outgoing call at said first station for selecting an idle trunk and operatively associating it with said selected frequency.

3. In a high frequency communicating system having a plurality of stations, means at each station for transmitting and receiving a number of high frequencies each designating a particular station, and a plurality of trunks at each station, the combination in each trunk of means for transmitting and receiving a number of high frequencies used for establishing communication between the different stations, a selecting mechanism adapted to select an idle one of said communicating frequencies when said trunk is used for originating an outgoing call, and means under the control of the high frequency designating a station in which the trunk is located for operating said selecting mechanism to select the same communicating frequency as at an outgoing station when said trunk is used for completing an incoming call.

4. In a high frequency communicating system having a plurality of stations, the combination of a plurality of trunks at each station with means in each trunk for transmitting and receiving a

number of high frequencies available at each station for communication purposes, means in each trunk when taken into use for originating a call for selecting one of said available frequencies, means at each station when called for selecting for use one or another of the associated trunks and means responsive to the selection of a trunk at said called station for selecting the high frequency utilized by the trunk at the originating station and associating it with the selected trunk.

5. In a high frequency communicating system, the combination with a station having a plurality of trunks and communicating apparatus adapted for connection with any of said trunks, of apparatus in each trunk for transmitting and receiving a plurality of high frequencies to be used for communication purposes, means responsive to the connection of said communicating apparatus with a trunk for testing for and selecting an idle communicating frequency over which a connection is to be extended to and from said trunk, means responsive to the selection of said high frequency for adjusting said apparatus to transmit and receive the selected communicating frequency and means responsive to the use of said frequency for supervising a connection.

6. In a high frequency communicating system, the combination with a station having a plurality of trunks and associated apparatus in each trunk for transmitting and receiving a plurality of communicating frequencies, of selecting means common to said trunks adapted to select a particular one of said trunks, selecting means in each trunk adapted to select a free communication frequency and means for rendering said selected trunk responsive for the transmission and reception of said selected high frequency.

7. In a high frequency communicating system, the combination with a plurality of stations each having a plurality of trunks each equipped with a variable oscillator and a variable filter respectively capable of producing and responding to

any one of a number of high frequencies available for use at each of said stations, of a switching mechanism in each of said trunks mechanically connected to said oscillator and to said filter, and means responsive to the taking into use of any one of said trunks for a operating said switching mechanism to select a frequency not at the time being produced and received at any of the stations, and to adjust said oscillator to produce said frequency and said filter to respond to said same frequency.

8. In a high frequency communicating system having a plurality of stations connected to a common medium and a plurality of high frequencies available at each station, the combination with a plurality of trunks in which each is provided with apparatus capable of adjustment to transmit and receive each of said high frequencies, of a mechanism in each trunk to select an idle frequency when said trunk is used at its associated station to originate a connection and to adjust said apparatus to transmit and receive the selected frequency, and of another mechanism responsive to a calling signal from another station to select an idle trunk for operative association with said selected frequency for completing the connection.

9. In a high frequency communication system having a plurality of stations associated with a common transmission medium, the combination with a plurality of trunks at each of said stations of means in each trunk for transmitting and receiving a plurality of high frequencies for communication purposes, means for selecting an idle trunk at a calling and at a called one of said stations, and means at each of said calling and called stations responsive to the selection of a trunk thereat for selecting the same idle communication frequency and associating it with the selected trunk of that station.

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