Feb. 1, 1938. W. H. TIDD 2,107,168

CARRIER COMMUNICATING SYSTEM

Filed Feb. 12, 1936 2 Sheets-Sheet 1

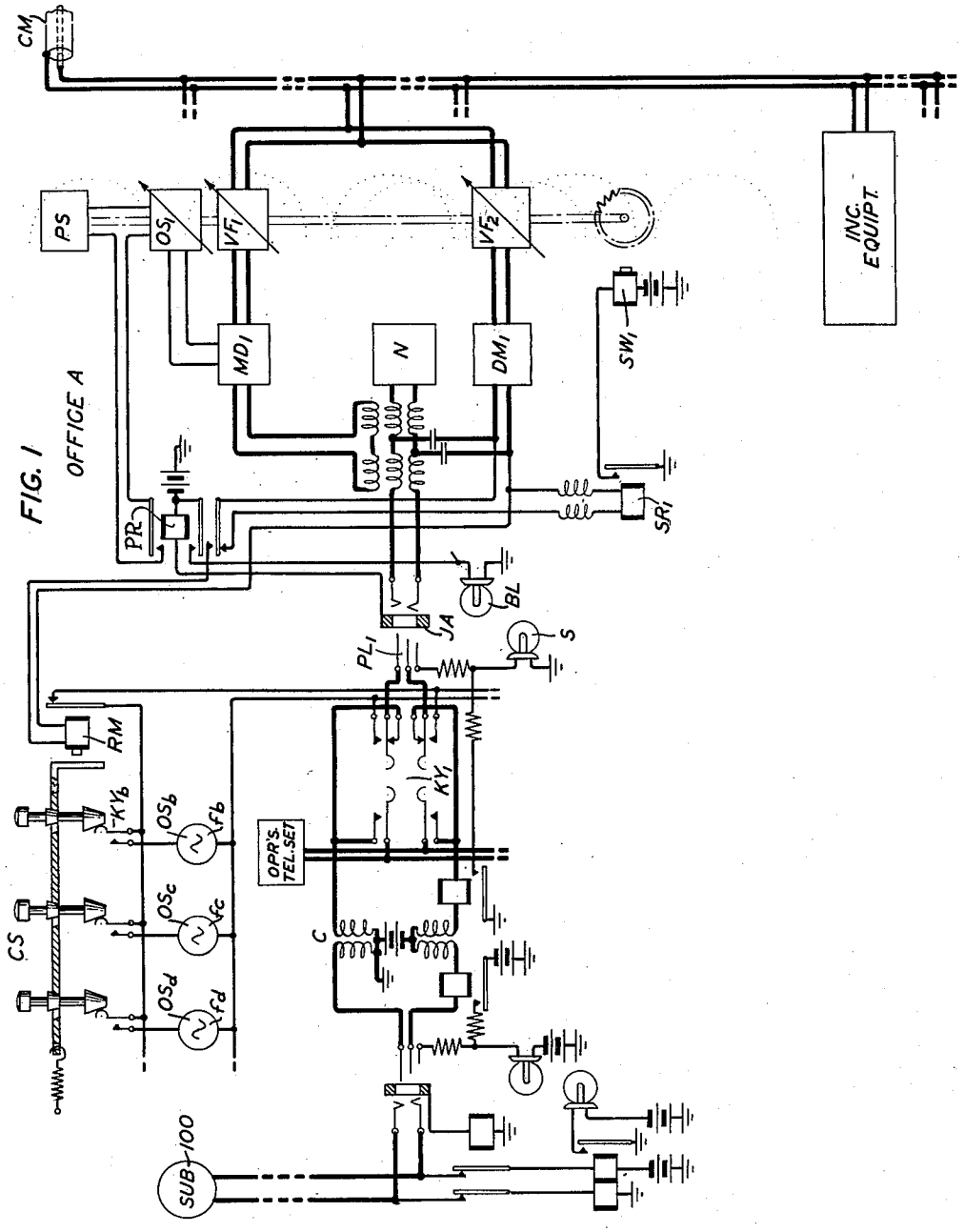

FIG. 1

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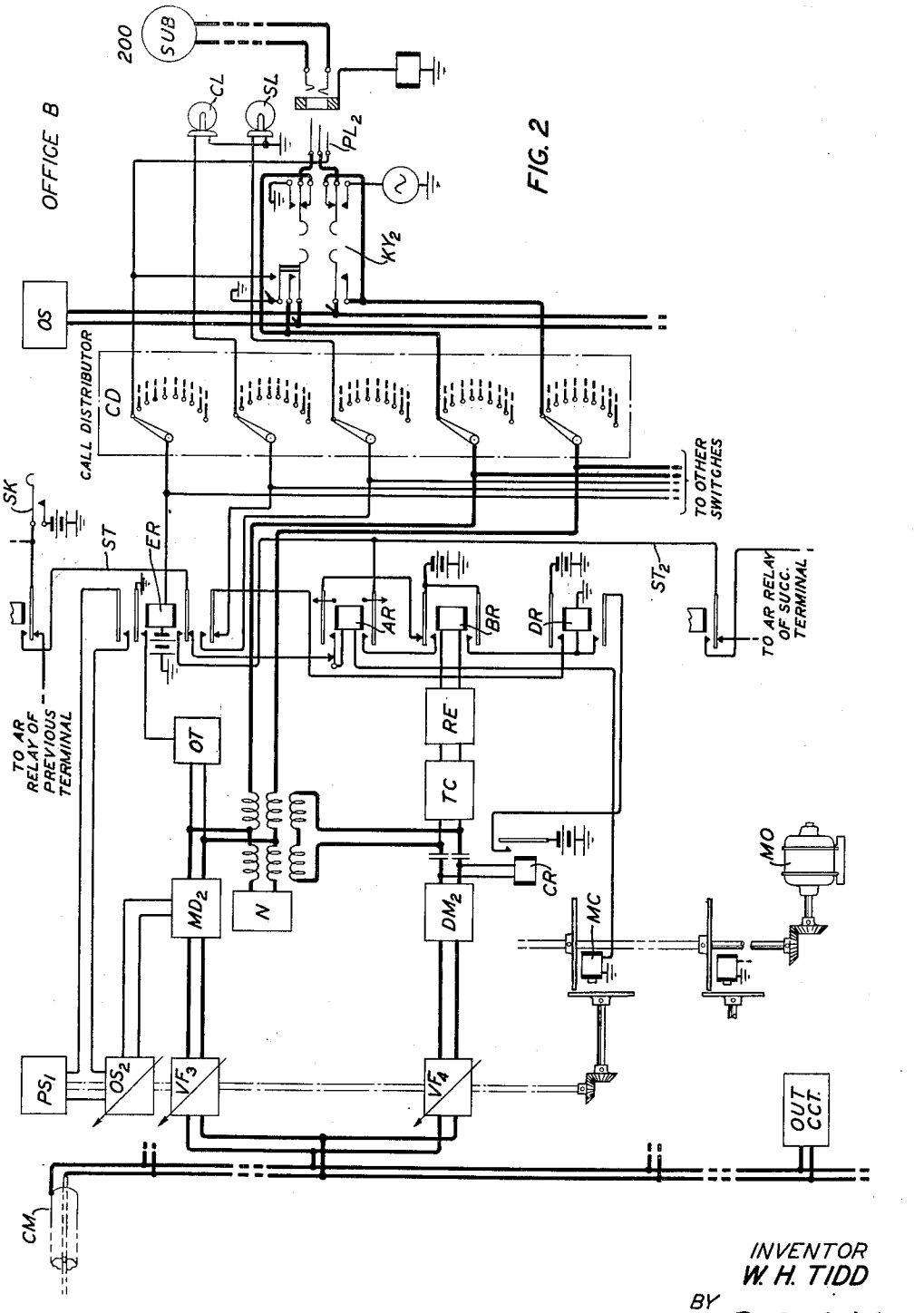

FIG. 2

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UNITED STATES PATENT OFFICE

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CARRIER COMMUNICATING SYSTEM

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11 Claims. (Cl. 179—15)

This invention relates to an improved interconnecting and communicating system, and more particularly to a 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 the electrical switching, signaling and communicating apparatus located at separate points of 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 apparatuses 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 connecting medium separate and distinct from the other carriers superposed upon the line or medium over which the carriers are 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 other common medium such as, for instance, a pair of coaxial conductors and are passed through individual arrangements each of which is selective of one carrier frequency to the exclusion of the others, and each of which may have associated with it apparatus that serves to reproduce, from a modulated carrier, the voice, signal or controlling currents with which the carrier was modulated at the distant station. The arrangement which is used to transmit and receive by means of any high frequency wave as distinguished from that which is used to transmit and receive by means of a wave of a different frequency is commonly known as a high frequency or carrier channel, or as a frequency selective channel.

The present invention is directed particularly to a high frequency system in which intercommunication between the various stations of the system is effected through the medium of a number of such non-interfering high frequency channels, each of which may be available to all of the stations. Each of the stations of the system is so organized that not only may it establish connection with any other station of the system by way of any of the high frequency channels, but it may also utilize, simultaneously, all of the channels that are not at the time in use for the interconnection of other stations of the system. Furthermore, the system of the invention is so organized that each station has means for keeping at all times in operative relation with one or more of the channels available for outgoing calls and other means for immediately responding to a channel taken into use at a distant station for a call directed to the incoming station, so that the initiation of a call from a station finds an outlet or inlet for the call at once available; and when one of the channels is taken into use for an outgoing call, another is automatically preselected and placed in operative relation with the means to be used for other and succeeding calls. Further, when the channel bearing an incoming call has been operatively associated with an inlet through which the call is extended to the wanted party, another inlet is immediately placed in a condition to scan the remaining channels for other and succeeding incoming calls.

In order to simplify the system, effect economy in the apparatus required and realize certain advantageous features of operation, the system of the invention is further so organized that a number of channels, each comprising a pair of frequencies, are available to all offices. However, the terminal equipment, that is, the outlet terminals and inlet terminals, instead of having fixed frequency filters, has available variable frequency filters which can select any one of the system channels. The apparatus at each office consists of a plurality of inward terminals and a plurality of outward terminals. These are arranged in such a manner that all outward terminals are automatically set on idle channels and one inward terminal is continuously scanning all the channels seeking a call for that particular office. When a channel bearing such a call is found, responsive equipment causes the call to be routed in any suitable manner to an idle position where it is properly disposed of, while the scanning operations for other incoming calls are, in the meanwhile, advanced to another idle inward terminal.

A clearer conception of 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 outward terminal connected to a common transmission medium such as, for example, a pair of coaxial conductors, together with cord connecting facilities for extending a calling line to the terminal; while

Fig. 2 shows an inward terminal connected on the one side to the same transmission medium as the outward terminal shown in Fig. 1 and, on

the other, to a call distribution cord-ended mechanism which functions in the well-known manner to distribute the incoming calls among a number of inward positions for completion therefrom to the called subscribers. Inasmuch as call distribution terminal facilities are well known to the automatic telephone art, typical apparatus therefor is but schematically indicated in cooperation with the inward terminals, reference being made to such typical patents at Patent 1,861,754 to W. T. Powell issued on June 7, 1932 for a complete description of how such call distribution facilities operate.

The equipment of the outward terminal shown in Fig. 1 includes, among other elements, the usual modulator MD_1, oscillator OS_1 and demodulator DM_1. Two variable frequency filters VF_1 and VF_2 are connected between the modulator MD_1 and demodulator DM_1 and the common medium CM. The tuning of these filters and the tuning of the oscillator OS_1 is controlled simultaneously by a switch SW_1, preferably of the rotary type, having a magnet SW_1 which advances the brushes on the forward stroke or the energization of the magnet to successive tuning points on the corresponding terminal arcs of the switch. That is, a stepping circuit is closed for switch magnet SW_1 causing its operation to advance the switch brushes one step to the apparatus of another carrier channel. If, now, the channel is idle, the apparatus is in readiness for use whereas if the channel is busy, the busy carrier frequency will be demodulated in the demodulator DM_1 and the direct current which results from the demodulation process causes the operation of relay SR_1 which, through the bottom outer back contacts of relay PR, is bridged across the demodulator. Switch SW_1 will then again be actuated to advance its brushes to another channel.

Automatically tuned filters are, of course, not new. One type is shown in detail in the Patent 2,064,904, granted December 22, 1936, to E. I. Green, and the specific structure of circuit networks at the contacts of rotary arcs for tuning the terminal to each of the different frequencies can be used to serve a similar function in the present invention. For this reason such filters are only schematically indicated in the drawings, reference being made to the above-mentioned patent of E. I. Green for a detailed disclosure and description of their operation.

The equipment of the inward terminal, shown in Fig. 2, includes the oscillator OS_2, modulator MD_2 and the demodulator DM_2. These are connected through variable frequency filters VF_3 and VF_4 to the common medium CM. The frequencies of response of the filters VF_3 and VF_4 and the oscillator frequency can be varied simultaneously by means of the magnet MC which operates in the manner described hereinafter to attract therein one plate of a friction clutch to the periphery of a cooperating plate carried on a drive shaft geared to the shaft of a motor MO. When the two plates are in contact, the shaft which carries the filters VF_3 and VF_4 rotates a number of rotary brushes over corresponding arcs to tune the apparatus to the frequency of an available channel, as in the case of the trunk or terminal shown in Fig. 1.

The inward terminals at each office operate successively, so that as soon as one terminal becomes busy, another starts hunting for incoming calls. Thus only one of the sets of inward terminal equipment is being varied in frequency at any one time.

In order to point out clearly the manner in which the incoming terminals in an office succeed each other in hunting for incoming calls, suppose that the terminal shown in Fig. 2 is to be energized next. Battery will be momentarily applied to conductor ST from a preceding inward terminal, or may be applied to start the system as a whole by depressing the start key SK which also applies battery momentarily to conductor ST. The connection of battery to conductor ST completes a circuit for relay AR which extends from grounded battery on said conductor, bottom inner back contacts of relay ER, continuity contacts of relay AR and winding of relay AR, winding of clutch magnet MC to ground. Relay AR operates and locks over its own upper front contacts to battery on the upper back contacts of relay BR, while magnet MC operates and keeps operated through the locking circuit of relay AR. The magnetic clutch disc is then attracted to the drive plate on the common vertical drive shaft and causes the frequency of response of the filters VF_3 and VF_4 and the frequency of oscillator OS_2 to be varied continuously and cyclically over the frequency range of the system channels.

Due to the variation in the tuning of the filter VF_4, the demodulator DM_2 receives, successively, every frequency which is being transmitted over the medium, and the relay CR will be actuated each time a carrier is received, but this is of no consequence at this time. However, when a carrier is received which is modulated with the particular code frequency assigned to this office, say, frequency f_a, this frequency, upon demodulation, will pass through the filter or tuned circuit TC and be impressed upon the rectifier RE. The rectified current will, in turn, energize relay BR. The operation of this relay, by breaking its upper back contacts, will cause the deenergization of relay AR and that of magnet MC which releases, disconnects the driving plate of the clutch from the driven plate and stopping filters VF_3 and VF_4 and the oscillator OS_2 on terminals which tune the response of said filters to frequency f_a. Inasmuch as relay AR is slow-to-release, then, for a brief interval during which relay AR is in an operated position after it is unlocked, a circuit is completed from grounded battery on the upper front contacts of relay BR, lower contacts of relay AR, conductor ST_2, the lower inner back contacts of relay ER of the next succeeding terminal and thence to the corresponding circuit of relay AR and magnet MC of said terminal. This pulse starts the operation of the succeeding inward terminal which now takes up the call hunting function in the manner already described.

It is obvious that enough inward terminals should be provided to handle the incoming peak traffic from all offices in order that there will always be an idle terminal hunting for incoming calls. Should all the terminals become busy, the start pulse would not be received anywhere and the hunting sequence would stop. In this case it would be necessary to press the start key SK as soon as there was an idle set of equipment available.

I will now describe the establishment of a call between subscriber **100**, whose line can be extended by any suitable means, such as cord C for instance, to office A, and subscriber **200** who may be reached through office B and any of the inward terminals thereof ending in plug ended cords

such as PL_2 through the call distribution equipment CD.

In placing an outgoing call, the operator at office A first selects an idle outward terminal as will be indicated by the busy lamp BL being dark. A plug PL_1 of a cord C having its other end plugged into the calling subscriber's line 100 or the extension thereof, is inserted into the jack JA. This connection completes a circuit for relay PR which extends from ground through the cord supervisory lamp S, sleeve of the plug PL_1 and sleeve of the jack JA, winding of relay PR to grounded battery. Relay PR operates and connects the power supply circuit PS to the oscillator OS_1 and to the modulator MD_1 over its upper contacts, whereupon the carrier frequency to which the oscillator OS_1 and the modulator MD_1 happen to be tuned by the setting of the brush arms of VF_1, is transmitted over the common medium. This, of course, makes the channel busy, causing the relay SR_1 in each of the other outward terminals connected to the common medium to operate and close the circuit of the separate stepping switches SW_1 to step the several terminals off the contacts of the busy channel and onto an idle one where the oscillators and modulators are automatically adjusted to the frequency of the idle channel as already described.

At the same time, the operation of relay PR opens the circuit of the stepping relay SR_1 of the terminal taken into use, which circuit normally extends over its lower outer back contacts, to prevent it from operating when the answering carrier is received. Over its lower outer front contacts relay PR further completes the path of the relay RM so that demodulated carrier current, when received as described hereinafter, will operate said relay. Through its lower inner front contacts relay PR completes an obvious circuit for busy lamps such as BL which, upon lighting, indicate to the other positions that the terminal is busy.

The operator now depresses a key such as KY_b in the code sending panel CS designating the called office B, which key remains mechanically depressed. This key permits a frequency f_b, obtained from the oscillator OS_b, to be modulated on the carrier and transmitted to the common medium through the operated contacts of key KY_1 of the cord C. The frequencies f_c, f_d, etc., correspond to the various other offices in the system, there being apparatus at each of these offices to select the particular frequency which identifies the office.

At the incoming office B, the receipt of the incoming carrier modulated by frequency f_b assigned to this office, causes the operation of the relay BR in the incoming terminal which, at the moment, is performing the call hunting function and the operation of this relay causes a transfer of the call hunting function to the next incoming terminal in the series, as already described. Assuming that the incoming terminal shown in the drawings is the terminal which responds to the carrier modulated by frequency f_b and that relay BR has operated in consequence, an obvious circuit is now completed for relay DR which locks over its lower contacts to battery on relay CR which is now operated by virtue of the presence of the carrier upon the medium. The upper contacts of relay DR complete a circuit for the call lamp CL at an idle operator's position extending from grounded battery through the upper contacts of said relay, bottom outer back contacts of relay ER, through the call distribution apparatus CD which is operated in the well-known manner to advance the path of this circuit to an idle operator's position, lamp CL at said position to ground. The call distributor apparatus CD functions in such a manner that the calls received by the various inward terminals are distributed among a number of operator's positions. At each of these positions are a number of circuits from the call distributor, each terminated in a plug such as PL_2 and having associated therewith supervisory and call lamps such as lamps SL and CL.

When a call lamp such as CL is lighted at the associated position, the operator thereat connects her circuit OS by means of KY_2 to the particular cord to which the incoming call has been connected by the call distributor. This key, at the same time, connects ground over an associated circuit through the call distributor to operate relay ER. This relay, over its top outer contacts, connects power supply PS_1 to the oscillator OS_2 and to modulator MD_2 for producing and transmitting the outgoing carrier. Over its top inner contacts it connects the "order tone" circuit OT to the line by means of which a voice frequency is caused to modulate the outgoing carrier. The order tone circuit may be of a well-known type such, for example, as is disclosed in Patent 1,719,494 granted July 2, 1929 to H. W. Ulrich and W. B. Prince, which when started applies two zips of tone current to the circuit with which it is associated and then removes the tone current for the duration of the connection. This modulated carrier is received at the originating office by the demodulator DM_1 which operates magnet RM to mechanically restore key KY_b and cut off the code frequency f_b from the oscillator OS_b.

Further, upon receipt of the order tone from the wanted office B, the subscriber's number is passed to said office and the connection is completed so far as the outward terminal is concerned.

At office B, the operation of relay ER as already described, further causes the transfer of the start pulse circuit to the next incoming terminal for the duration of the call by the fact that the conductor ST is now transferred over its bottom inner front contacts to conductor ST_2 which extends to the bottom inner back contacts of relay ER of the succeeding terminal and thence to the winding of relay AR of that terminal. At its outer lower back contacts, relay ER further extinguishes the call lamp CL and transfers the lighting circuit to the supervisory lamp SL.

The operator now completes the call by inserting the plug PL_2 into the jack of the subscriber's line 200. When this is accomplished and key KY_2 is released, relay ER is held operated by means of ground on the sleeve contact of the subscriber's line jack. The operator can now proceed with the completion of another call.

When the connection is completed and a signal to that effect is given in the well-known manner to the originating operator, she removes her plug PL_1 from jack JA, whereupon relay PR releases, the oscillator OS_1 and modulator MD_1 are removed from the line and the carrier is removed from the medium. This causes the deenergization of relay CR at the incoming terminal which, in turn, unlocks relay DR causing it to release, whereupon the circuit of the supervisory lamp SL is opened and this lamp is extinguished,

thereby informing the inward operator that the call is completed. Plug PL_2 is then removed from the subscriber's jack. This operation causes the release of relay ER and leaves the apparatus idle and ready to start hunting for an incoming call upon receipt of a start pulse over conductor ST.

What is claimed is:

1. In a high frequency communicating system, a calling station and a called station, a plurality of high frequency carrier channels common to said stations, means at said calling station for maintaining an idle one of said carrier channels preselected for use on a subsequent outgoing call, and means at said called station for identifying the channel preselected.

2. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common transmission medium, of an outgoing terminal connected to said medium comprising a variable frequency oscillator to produce each of said carrier frequencies, a pair of variable frequency filters to pass each of said carrier frequencies, a modulator for varying the outgoing carrier, a demodulator capable of responding to each of said carrier frequencies, a relay bridged across said demodulator when said terminal is not in use and operative by demodulated carrier currents, and means responsive to said relay for tuning said oscillator to produce and tuning said filters to pass a carrier frequency different from the carrier frequency that caused said relay to operate.

3. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common transmission medium of an incoming terminal connected to said medium comprising a variable frequency oscillator to produce each of said carrier frequencies, a pair of variable frequency filters to pass each of said carrier frequencies, a modulator for varying the outgoing carrier, a demodulator capable of responding to each of said carrier frequencies, means responsive to an operation in said terminal for tuning said oscillator and said filters in succession to each of the carrier frequencies, a tuned circuit connected in series with said demodulator and responsive to a specific modulation of any carrier frequency, and means responsive to said specific modulated current for causing the tuning of said oscillator and said filters to remain at the tuning point of the carrier frequency specifically modulated.

4. In a carrier communication system provided with a number of different high frequency carrier channels, an office comprising a plurality of outward terminals each provided with a carrier frequency current source, a plurality of inward terminals, means in each of said outward terminals for automatically varying the frequency of said carrier frequency source to the frequencies of different carrier channels to preselect an idle carrier channel for use on a subsequent outgoing call, and means for setting one of said inward terminals to continuously scan all of said carrier channels for an incoming call for said office over one of said channels.

5. In a carrier communicating system provided with a number of different high frequency carrier channels, an office comprising a plurality of outward terminals each provided with a carrier frequency current source, a plurality of inward terminals, means in each of said outward terminals for automatically varying the frequency of said carrier frequency source to the frequencies of different carrier channels to preselect an idle carrier channel for use on a subsequent outgoing call, means for setting one of said inward terminals to continuously scan all of said carrier channels for an incoming call to said office over one of said channels, a plurality of operators' positions, call distribution facilitates interconnecting said inward terminals with said operators' positions, and means in said call distribution facilities responsive to an inward terminal responding to a carrier channel appropriated for an incoming call for routing said terminal to an idle operator's position.

6. In a carrier communicating system provided with a number of different high frequency carrier channels, an office comprising a plurality of outward terminals each provided with a carrier frequency current source, a plurality of outward terminals, means in each outward terminal for automatically varying the frequency of said carrier frequency source to frequencies of different carrier channels to preselect an idle carrier channel for use on a subsequent outgoing call, means for setting one of said inward terminals to continuously scan all of said carrier channels for an incoming call for said office over one of said channels, and means responsive to an inward terminal connecting with a channel carrying an incoming call for advancing the scanning function to another inward terminal.

7. In a carrier communicating system provided with a number of different high frequency carrier channels, an office comprising a plurality of outward terminals each provided with a carrier frequency current source, means for automatically varying the frequency of the carrier frequency source of each outward terminal to a frequency not in use on any carrier channel, and means responsive to the appropriation of an idle carrier channel by one of said outward terminals for changing the frequency of the carrier current sources of all other terminals to a frequency not in use on any of said channels.

8. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common transmission medium of means for modulating any one of said carrier frequencies with any one of a plurality of calling frequencies, an incoming terminal connected to said medium comprising a filter variable to pass each of said carrier frequencies, a demodulator responsive to each of said carrier frequencies, a filter bridged across said demodulator and tuned to be responsive to a particular one of said calling frequencies, a relay responsive to the passage of said calling frequency through said tuned filter, means for continuously varying said variable filter to scan all of said carrier channels, and means effective upon the operation of said relay for arresting the variation of said variable filter in a position to maintain said terminal tuned to the carrier frequency so modulated.

9. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common transmission medium of means for modulating any one of said carrier frequencies with any one of a plurality of calling frequencies, an incoming terminal connected to said medium comprising a filter variable to pass each of said carrier frequencies, a demodulator responsive to each of said carrier frequencies, a filter bridged across said demodulator and tuned to be re-

sponsive to a particular one of said calling frequencies, a relay responsive to the passage of said calling frequency through said tuned filter, means for continuously varying said variable filter to scan all of said carrier channels, means effective upon the operation of said relay for arresting the variation of said variable filter in a position to maintain said terminal tuned to the carrier frequency so modulated, and a signal controlled by said relay for indicating an incoming call.

10. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common medium of means for temporarily modulating any one of said carrier frequencies with any one of a plurality of calling frequencies, an incoming terminal connected to said medium comprising a filter variable to pass each of said carrier frequencies, a demodulator responsive to each of said carrier frequencies, a relay bridged across said demodulator and responsive upon the demodulation of any one of said carrier frequencies, a filter bridged across said demodulator and tuned to be responsive to a particular one of said calling frequencies, a second relay responsive to the passage of said calling frequency through said tuned filter, means for continuously varying said variable filter to scan all of said carrier channels, means effective upon the operation of said second relay for arresting the variation of said variable filter in a position to maintain said terminal tuned to the carrier frequency so modulated, a signal controlled by said second relay for indicating an incoming call, and means controlled by said first relay for maintaining said signal operated following the withdrawal of said calling frequency.

11. In a carrier communicating system provided with a number of carrier frequency communicating channels, the combination with a common medium of means for modulating any one of said carrier frequencies with any one of a plurality of calling frequencies, a plurality of incoming terminals connected to said medium each comprising a filter variable to pass each of said carrier frequencies, a demodulator responsive to each of said carrier frequencies, a filter bridged across said demodulator and tuned to be responsive to a particular one of said calling frequencies, a relay responsive to the passage of said calling frequency through said tuned filter, means operative when said incoming terminal is idle for continuously varying said variable filter to scan all of said carrier channels, means effective upon the operation of said relay for arresting the variation of said variable filter in a position to maintain said terminal tuned to the carrier frequency so modulated, and means responsive to said last means for starting the variation of the variable filter of the next idle incoming terminal.

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