

Dec. 22, 1936.

N. MONK

2,064,938

COMMON MEDIUM MULTICHANNEL EXCHANGE SYSTEM

Filed May 26, 1934

2 Sheets-Sheet 1

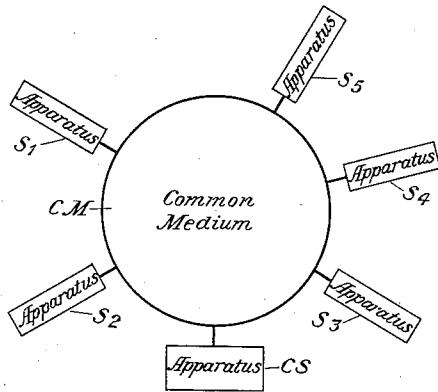


Fig. 1

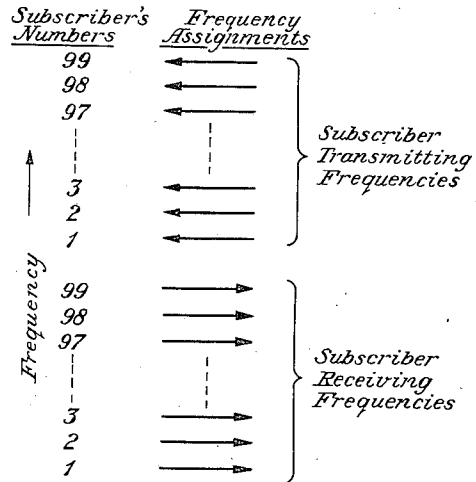


Fig. 3

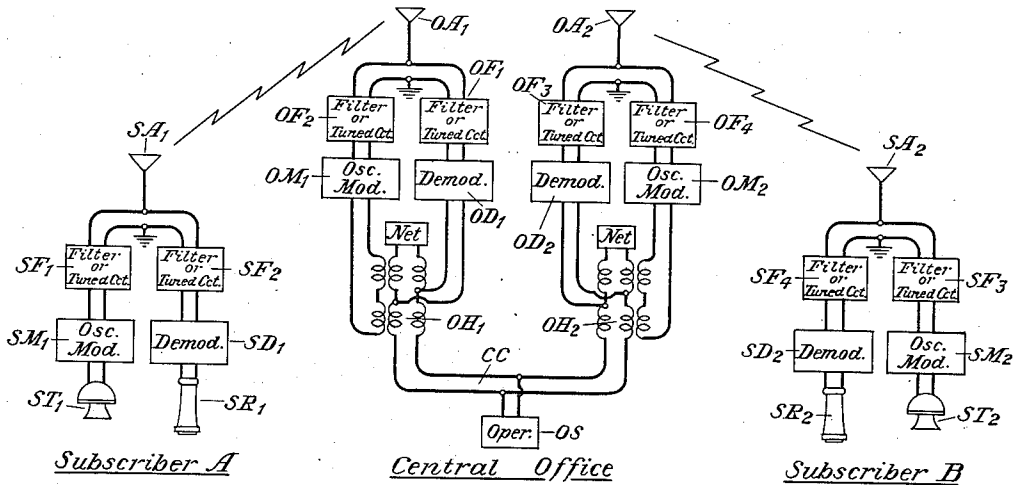


Fig. 2

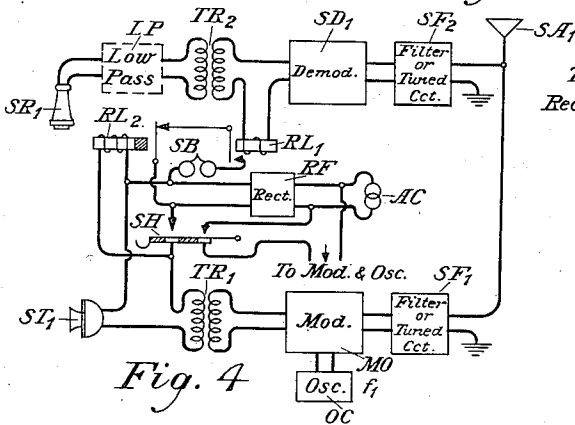


Fig. 4

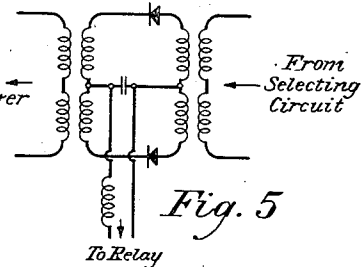


Fig. 5

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2 Sheets-Sheet 2

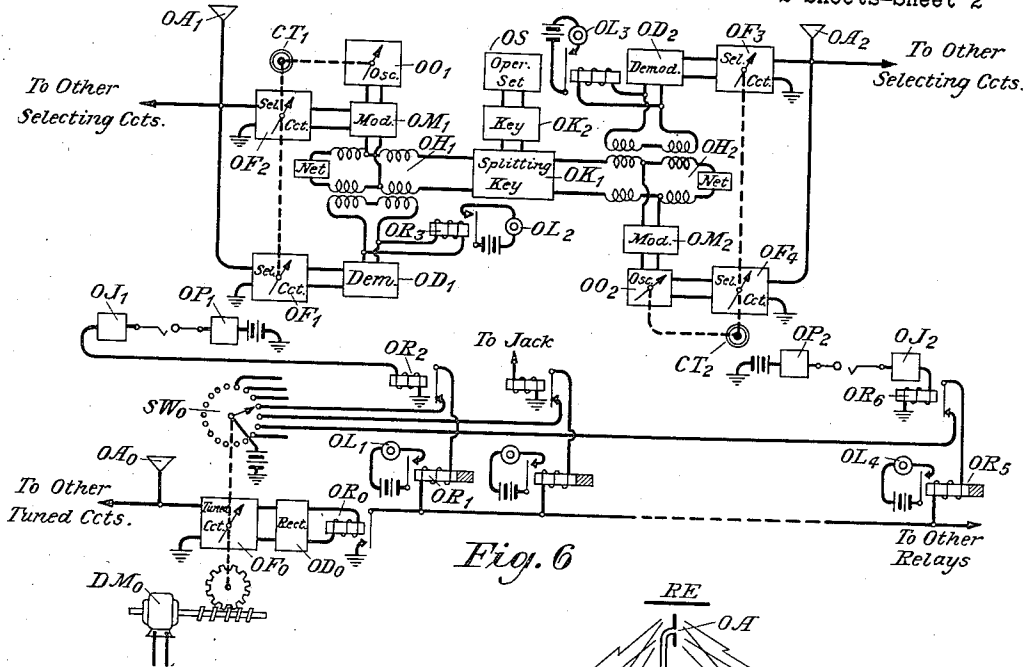


Fig. 6

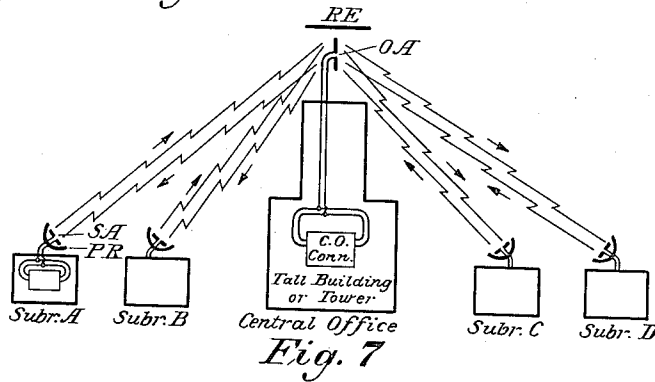


Fig. 7

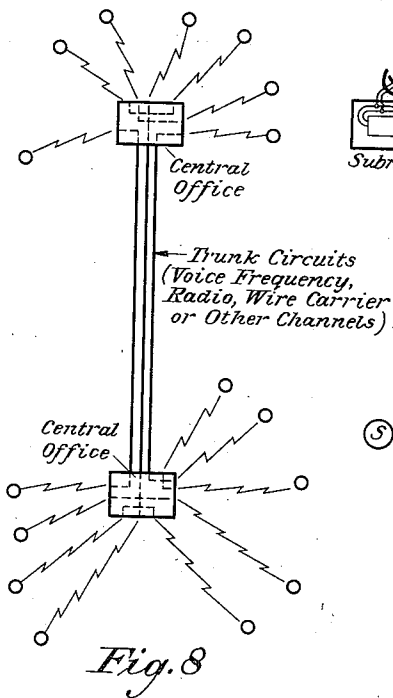


Fig. 8

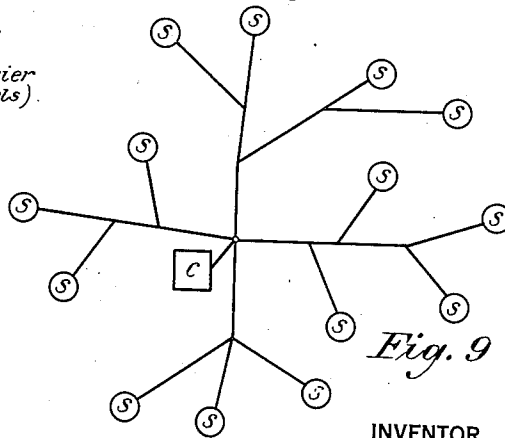


Fig. 9

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2,064,938

COMMON MEDIUM MULTICHANNEL
EXCHANGE SYSTEMNewton Monk, New York, N. Y., assignor to
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Application May 26, 1934, Serial No. 727,799

15 Claims. (Cl. 250—6)

This invention has for its object the provision of an exchange system in which communication between subscribers is carried out over channels of different frequency derived from a common transmission medium. More particularly, the invention is designed to utilize as a substitute for the many subscriber pairs which are employed in the ordinary telephone exchange system the many channels which are obtainable in the high frequency art as it is now unfolding and to provide means whereby these channels may be employed by subscribers for interconnection.

In the telephone exchange systems which have heretofore been provided it has been the practice to group subscribers in central office areas. Each subscriber is connected to his own central office by means of an individual wire circuit or by a party line arranged for non-simultaneous use by a few subscribers. When a subscriber desires to call another subscriber he utilizes his own line to the central office, and upon passing the desired number either to an operator or to an automatic switching mechanism is connected to another line which extends either directly or via another office or offices to the called party. For a system of this kind many thousands of subscriber circuits are necessary in each central office area. These are commonly provided in the form of a network of multiple pair cables extending over the area.

In accordance with the present invention, it is proposed to substitute for such individual wire circuits extending to each subscriber a transmission medium which is common to all subscribers and which will accommodate a range of frequencies sufficiently wide for a large number of telephone channels. Interconnection between subscribers is then carried out over these high frequency channels.

The essence of the invention resides in making available to a large number of subscribers a transmission medium capable of accommodating a wide range of frequencies so that the subscribers may utilize, for the purposes of intercommunication, a plurality of signaling channels derived from the wide band medium. A transmission medium capable of handling the large number of channels required for the exchange system of the invention may be obtained by utilizing either radio transmission in space or high frequency transmission over a conducting or guiding medium.

Considering, first, the use of radio as the medium for transmitting the wide band of frequencies contemplated by the invention, the invention is designed to employ whatever part of the

frequency range may be available. Heretofore, however, the radio frequency spectrum has scarcely afforded sufficient frequency space to yield the channel capacity required for a local telephone exchange system. With the opening up of the field of ultra-short waves this limitation as to channel capacity is removed. Thus, for example, between one and two meters there is a total frequency range of 150 megacycles while the range between 10 and 20 centimeters is 1500 megacycles. The frequency ranges obtainable through the use of still shorter waves are much greater.

With these ultra-high frequencies, however, nature imposed another limitation, i. e., the tendency of the waves to take on quasi-optical characteristics, so that they project only in straight lines and do not bend around corners to any considerable extent. Thus, it becomes necessary that subscribers utilizing such waves have a fairly clear line of sight between their antennas. Some diffraction around obstacles may, of course, be obtained, but, in general, reasonably clear line-of-sight projection without intervening obstacles appears to be called for. This, of course, has the advantage of making it possible to utilize the same ultra-high frequencies in different areas.

The line-of-sight characteristics of the ultra-short waves must be recognized in the design of a telephone exchange system utilizing this technique. In one form of the invention it is proposed to provide in the center of a community a central station with antennas mounted sufficiently high above the surrounding buildings to make possible the necessary directness of transmission between these antennas and practically any point in the territory to be served. One subscriber's station is then placed in connection with another by transmitting first to the central station and thence through central station to the desired other subscriber located in another part of the community. The central station acts as a means for catching the waves from one subscriber at a relatively high point and transmitting them down again to a second subscriber, thus lifting the transmission path above any obstacles lying between the subscribers' antennas.

In order that such a central station may be economical, it is proposed to make it capable of handling simultaneously a wide band of frequencies such as would accommodate hundreds or perhaps thousands of channels. The particular arrangement of the central station will be hereinafter described.

As an alternative to the use of a radio transmission medium, the invention contemplates the employment of a guiding or conducting transmission path suitable for the required band of frequencies. Such a transmission path would be provided in the form of a network, extending to all the subscribers within a given area. Conceivably, such a network might be composed of ordinary wire circuits branched and interconnected so as to make the common circuit available to each subscriber. Thus, the wire network might be somewhat similar to the network employed for distributing light and power currents, except that a simple two-wire network without multi-phase connections, voltage transformation arrangements, etc., would suffice. It would, however, be possible to carry out the invention by employing the light and power network itself and this is contemplated within the scope of the invention.

The preferred form of guiding transmission medium, however, is one which is designed for the transmission of a wide band of frequencies with comparatively low attenuation and preferably also with shielding to minimize the effect of external disturbances. Such a transmission medium may be found in a circuit consisting of two conductors disposed coaxially with respect to one another. In a properly designed coaxial circuit, low attenuation at high frequencies may be attained by the employment of conductors of suitably low high frequency resistance and the use of a substantially gaseous dielectric between the conductors. With this type of circuit the outer conductor serves also as a shield whose protective effect becomes more nearly perfect as the frequency is increased, so that at high frequencies practically complete immunity from external disturbances may be obtained.

The invention contemplates also as an alternative to the coaxial circuit a high frequency transmission medium comprising a circuit consisting of two conductors surrounded by a shield. Here, again, the high frequency attenuation may be minimized by proper design with substantially gaseous insulation and the thickness of shield may be determined so as to minimize interference from external disturbances.

Yet another form of transmission medium suitable for carrying out the invention is a dielectric wave guide comprising a cylindrical dielectric material which may or may not be surrounded by a conductor. An advantageous form of such a transmission path is a hollow cylindrical conductor containing air or some other gas as the dielectric. This type of circuit is particularly adapted to transmit waves of very high frequencies, for example, of the order of a few centimeters or less in wave length.

Using any of the above types of transmission media, the interconnection of subscribers at will from the available channels involves a number of new and difficult problems which are solved by the various features of the invention as hereinafter disclosed.

In general, the invention contemplates the assignment to each subscriber of two particular frequencies which might preferably be related to his telephone number. The assignment of frequencies should be such as to facilitate the interconnection of subscribers and one scheme of frequency allocation is suggested in the invention for this purpose.

The foregoing outline having indicated some of the principles of the invention as well as a

few of its major objects, the complete invention with its various details, features and purposes will now be understood from the following description when read in connection with the accompanying drawings, in which Fig. 1 shows a schematic representation of the principal idea of the invention wherein a plurality of stations are connected to a common transmission medium, Fig. 2 shows in schematic form a system for connecting subscribers through a central office using space radio transmission; Fig. 3 shows one possible allocation of frequencies for a multi-channel exchange system; Fig. 4 shows a subscriber station arrangement which may be used in the system of Fig. 2; Fig. 5 shows a modulating device which may be used in various applications of the invention; Fig. 6 shows a central office arrangement which may be used in association with the subscriber station arrangement of Fig. 4; Fig. 7 shows an antenna arrangement for use in a system of the type described; Fig. 8 is a schematic diagram indicating how connections between stations in different areas may be completed through central stations over trunk circuits; and Fig. 9 is a schematic diagram of a guiding or conducting network which is available in common to a central station and a number of individual stations.

Referring to Fig. 1, there is illustrated one of the principal aspects of the invention. In this figure is shown a common medium CM, to which are connected a plurality of stations S₁, S₂, S₃, etc., each of which includes transmitting, receiving and associated apparatus. This apparatus, which will be hereinafter described, is arranged to permit intercommunication between different pairs of stations over the common medium CM employing different frequency bands to permit simultaneous communication between different pairs of stations. Connection between any pair of stations, for example, S₁ and S₃, takes place through the common central station CS.

Fig. 2 shows in schematic form a telephone exchange system in which a number of subscribers may be interconnected through a central office, the connection between each subscriber and the central office being accomplished by radio transmission through space. Each subscriber is provided with transmitting apparatus including an oscillator-modulator and receiving apparatus including a demodulator, together with the necessary selecting circuits. At the central office a plurality of circuits such as the one shown are provided for interconnecting between subscribers. Each connecting circuit includes two separate sets of apparatus, each of which comprises a radio transmitter and receiver, and a connection, to which the operator has access, between the two sets of apparatus.

Transmission from subscriber A to subscriber B is effected by means of the transmitter ST₁, the oscillator-modulator SM₁, the tuned circuit or filter SF₁, the antenna SA₁, the antenna OA₁, the tuned circuit or filter OF₁, the demodulator OD₁, the hybrid coil OH₁, the connecting circuit CC (across which is bridged the operator's set OS), the hybrid coil OH₂, the oscillator-modulator OM₂, the tuned circuit or filter OF₂, the antenna OA₂, the antenna SA₂, the tuned circuit or filter SF₂, the demodulator SD₂ and the receiver SR₂. Transmission in the opposite direction is accomplished in an analogous manner, employing the transmitter ST₂, the oscillator-modulator SM₂, the selecting circuit SF₃, the antenna SA₂, the antenna OA₂, the selecting circuit

OF₃, the demodulator OD₂, the hybrid coil OH₂, the connecting circuit CC, the hybrid coil OH₁, the oscillator-modulator OM₁, the selecting circuit OF₂, the antenna OA₁, the antenna SA₁, the selecting circuit SF₂, the demodulator SD₁ and the receiver SR₁.

It is proposed that different frequencies be employed for the oppositely directed transmissions in Fig. 2 and that the frequencies employed between the calling subscriber and the central office be different from those used between the central office and the called subscriber. Transmission might be on either a double or a single sideband basis with the carrier frequency transmitted.

In order that simultaneous conversations may take place between a number of pairs of subscribers, it is necessary that the frequencies employed in the system of Fig. 2 be properly selected. One way of arranging the frequencies would be to assign to each subscriber a separate pair of frequencies, one for transmitting and one for receiving, and to provide apparatus at the central office for receiving and transmitting the various required frequencies. Thus, subscriber A might be assigned a transmitting frequency f_1 and a receiving frequency f_2 , and subscriber B transmitting and receiving frequencies f_3 and f_4 , respectively. This would mean that in Fig. 2 the modulators SM₁ and SM₂ would operate with carrier frequencies f_1 and f_3 , respectively, and the modulators OM₁ and OM₂ with carrier frequencies f_2 and f_4 , respectively.

With such a scheme it might prove desirable in order to facilitate the allocation of frequencies and the interconnecting of subscribers, to have a constant difference between the transmitting and receiving frequencies of each subscriber or, in other words, to make

$$f_1 - f_2 = f_3 - f_4 = D \quad (1)$$

The frequencies f_1 , f_3 , etc., might then be grouped in one part of the frequency spectrum and the frequencies f_2 , f_4 , etc., in another part. A diagram of a frequency allocation of this sort, assuming a total of 99 subscribers, is given in Fig. 3. It will be noted that the order of the frequency assignments corresponds to that of the subscriber numbers. This scheme, while not essential to all embodiments of the invention, is a very desirable feature.

Detailed arrangements of apparatus which might be used at the subscriber's station and at the central office in a scheme of this sort are illustrated in Figs. 4 and 6. While some of the apparatus shown in these figures is more particularly adapted to radio frequencies lying below the ultra-short wave range, it will be understood that such apparatus is shown merely to illustrate the principles of the invention, and is not intended in any way to limit its scope.

The operation of the subscriber's apparatus illustrated in Fig. 4 is as follows: When the subscriber desires to make a call, the receiver SR₁ is removed from the switchhook SH. Through the contacts of the switchhook this closes a circuit which furnishes power supply to operate the oscillator and modulator OC and MO. The operation of the switchhook also provides D. C. supply for the transmitter ST₁, this supply being derived through a rectifier RF which is connected to the A. C. supply. The speech currents produced in the transmitter, after passing through the transformer TR₁, are modulated upon the assigned frequency, here assumed to be

f_1 . The oscillator and modulator may be separate units of any desired types, or a self-oscillating modulator might be used. The carrier and sidebands in the modulator output, after passing through the selecting circuit SF₁, are radiated by the antenna SA₁ to the central office. When communication with the central office is established in a manner hereinafter to be described, the number of the called subscriber is passed orally to the operator and after the proper arrangements are set up at the central office, communication is established with the called subscriber who is provided with apparatus identical with that of Fig. 4 except for the frequency assignments used.

In the case of an incoming call, the carrier frequency f_2 and its associated sidebands are received by the antenna SA₁, selected by the selecting circuit SF₂ and demodulated by the demodulator SD₁. This demodulator may be of the vacuum tube type, in which case it should be kept always in operating condition so that a call may be received. Preferably, however, the demodulator might comprise some passive element or elements, as, for example, copper-oxide units as shown in Fig. 5. Associated with the demodulator is a relay RL₁ which is operated by the rectified current resulting from the incoming carrier frequency and which in turn operates the call bell SB. When the subscriber answers the call, the switchhook SH is operated, which, in addition to completing the contacts previously mentioned, operates the slow-release relay RL₂, which breaks the circuit of the bell SB. The received voice frequency currents, after passing through the transformer TR₂, are applied to the receiver SR₁ and two-way communication is thus established. If desired, a low-pass filter LP (shown dotted in Fig. 4) may be included in the receiver circuit to suppress unwanted high frequency components in the demodulator output. It will be understood that a similar filter may be provided in the arrangements hereinafter described. When the subscriber hangs up, the slow-release feature of RL₂ prevents his bell from ringing before the other party also hangs up.

Fig. 6 illustrates central office apparatus which may be used in conjunction with the subscriber's apparatus shown in Fig. 4. The apparatus is so arranged that a call coming in at any frequency is automatically picked up and brought to the operator, who completes the connection to the called subscriber. Referring to Fig. 6, the antenna OA₀ is designed to receive incoming carrier frequencies within a range corresponding to all of the subscribers assigned to the central office or to a group of subscribers. The received frequencies are delivered to the tuned circuit OF₀ whose frequency of response is being continuously varied by the driving motor DM₀. The same motor also rotates the switch SW₀ which is provided with a number of contacts, one for each subscriber whose incoming frequency may be selected by the selecting circuit OF₀. The switch is arranged so that the contact corresponding to any given subscriber is made at the same moment that the frequency of that subscriber is picked out by the selecting circuit.

The carrier frequency of an incoming call is selected momentarily by OF₀ and is rectified in the rectifier OD₀. The resultant current operates the relay OR₀, which closes a circuit through the winding of the slow release relay OR₁, the back contact of the relay OR₂ and the switch SW₀. The operation of the relay OR₁ lights the sub-

scriber's line lamp OL₁ thereby calling the attention of the operator to the incoming call. Similarly, as the selection and switching are being varied, the line lamps corresponding to other incoming calls will be lighted.

When the operator observes the lamp OL₁ she inserts a plug, for example, OP₁, which is associated with one end of a cord circuit, in the subscriber's jack OJ₁. This action completes a circuit through the relay OR₂, whose operation de-energizes the relay OR₁ and thus extinguishes the lamp OL₁. After insertion of the plug in the jack OJ₁, the operator adjusts manually by means of the control CT₁, the response frequency of the variable selecting circuit OF₁ to the transmitting frequency of the calling subscriber, which at the same time brings the oscillator OO₁ and the selecting circuit OF₂ to the receiving frequency assigned to the calling subscriber. The incoming carrier frequency of the calling subscriber is rectified in the demodulator OD₁ and operates the relay OR₃, thereby lighting the supervisory lamp OL₂ during the time when the calling subscriber's receiver is off the hook.

Having ascertained from the calling subscriber the number which is desired, the operator completes the connection by inserting the other cord circuit plug OP₂ in the jack OJ₂ which corresponds to the number of the called party and at the same time adjusts by means of the manual control CT₂ the frequencies of the oscillator OO₂ and the selecting circuits OF₃ and OF₄ to the frequency assignments of the called subscriber. The connection established by the jack OJ₂ energizes the relay OR₄, thereby preventing the line lamp of the called subscriber from lighting when he answers the call. The supervisory lamp OL₃ is lighted when the called subscriber answers, and remains lighted until he hangs up. The conversation then proceeds with the apparatus functioning in a manner similar to that described in connection with Fig. 2. When the conversation is completed the lamps OL₂ and OL₃ are extinguished as the subscribers hang up and the operator takes down the connection. By means of keys such as OK₂ the operator may connect her set to different cord circuits and using the key OK₁ she may split the connection and talk to either subscriber without the other.

As noted, the selecting circuit OF₀ and the switch SW₀ might serve for all the subscribers assigned to the office, or these subscribers might be divided into groups, with one selecting circuit and switch taking care of each group, and all such circuits and switches driven by a common motor.

It is apparent that the arrangement of Fig. 6 permits the employment of a relatively simple arrangement at the subscriber's station, inasmuch as the frequencies used by the subscriber are always the same. The cord circuit arrangement at the central office is somewhat complicated, but the number of cord circuits required will be only a small fraction of the total number of subscribers.

In the various arrangements shown in Fig. 2 to Fig. 6, radio transmission between the subscribers and the central office may be accomplished directly using any suitable type of antenna. However, in order to permit the use of ultra short waves for which substantially line-of-sight projection may be desired, it may be necessary to carry the transmission path above any obstacles lying between the antennas of individual subscribers. For this purpose an ar-

rangement of the type shown in Fig. 7 might be employed.

Referring to Fig. 7, it will be seen that in this case a single central office antenna OA serves for receiving all frequencies from subscribers and transmitting all frequencies to subscribers. This antenna may be mounted on a tall building or tower so that substantially a line-of-sight transmission path is obtained between the central office and each subscriber's antenna within the central office area. The subscriber's antenna should preferably be designed for radiating a beam toward the central office antenna and for receiving radiation from that antenna. Thus the subscriber's antenna might be a balanced doublet SA as shown in Fig. 7, placed near the focus of a parabolic reflecting surface, PR, directed toward the central office antenna OA. The central office antenna, however, is designed for radiating to and receiving from all subscribers. For this purpose there might be employed an antenna capable of radiating in all directions and receiving radiations from all directions throughout the range of frequencies utilized. Such an antenna, for example, might be a balanced doublet OA as shown in Fig. 7. Another possibility would be to employ a central office antenna so designed that it is capable of radiating into and receiving from a conical space which comprehends all subscribers' locations. This might be accomplished by adding the reflector RE above the doublet antenna OA.

It is also contemplated that instead of employing a single central office antenna a multiple antenna arrangement might be used at the central office building, each antenna being designed for handling a part of the total range of frequencies. It would also be possible to employ two antennas for each subscriber instead of one.

Although the arrangements described in connection with Figs. 2, 4 and 6 are designed to provide a radio connection between the subscribers within a given area, it is proposed to interconnect such stations with subscriber stations in other areas by providing in each area a central office, so that a radio connection may be established between a subscriber and his central office, using a frequency or frequencies assigned for that purpose, and the connection completed over suitable interoffice trunks. The method is illustrated schematically in Fig. 8. The central office apparatus to be used in carrying out this method might be patterned after that shown in Fig. 6. The types of trunks which may be used to interconnect the central offices are well known in the art.

In the arrangements thus far described, with the exception of Fig. 1, it has been assumed that free space is employed as the common transmitting medium. It is contemplated, however, that transmission over a high frequency conducting or guiding path may be employed instead of radio transmission. Such a path would take the form of a network extending to all subscribers within a given area and to the central office for that area. A network of this kind is shown schematically in Fig. 9, where each line represents a complete circuit, C designates the central office and S a subscriber's station.

Probably the simplest form of such a network would be one comprised of ordinary two-conductor circuits suitably interconnected and branched so that the common circuit will be available at all desired points. The circuits comprising the net-

work might, for example, consist of pairs of open-wire or cable conductors.

It is contemplated also in accordance with the invention that the wire network employed for distributing light and power currents might be used as the common medium from which to derive high frequency channels for the telephone exchange system. The high frequency channels would be superposed upon the power network by carrier methods which are well known in the art.

Another form of transmission medium, and one which is peculiarly advantageous in that it is capable of transmitting a wide band of frequencies with comparatively low attenuation and which may be so shielded as to be practically immune to external disturbances, may be found in a network of circuits consisting of two conductors disposed coaxially with respect to one another. A circuit of this type has been disclosed in the patents to L. Espenschied and H. A. Affel, No. 1,835,031, December 8, 1931, H. A. Affel and E. I. Green, No. 1,781,092, November 11, 1930, etc.

As an alternative to the coaxial circuit, the high frequency transmission medium might comprise a network of circuits, each consisting of two parallel conductors surrounded by a shield. Circuits of this type are disclosed in the patents to Green, Curtis and Mead, No. 2,034,032, Green and Curtis, No. 2,034,033 and Green and Liebe, No. 2,034,034, all granted March 17, 1936.

The invention contemplates also utilizing as the high frequency transmission medium a dielectric wave guide comprising a cylindrical dielectric material which may or may not be surrounded by a conductor. Such dielectric guides are disclosed in the patent applications of G. C. Southworth, Serial No. 661,154, filed March 16, 1933 and Serial No. 701,711, filed December 9, 1933.

It is contemplated in accordance with the invention that the subscriber set and central office arrangements which have been described may be employed with any of the above types of transmission paths. For this purpose, it is necessary merely to substitute the transmission network for the radio path, replacing the connection of the apparatus to the radio antenna by a connection suitable to the type of medium employed.

It will be obvious from the preceding discussion 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. A system for the exchange of intelligence over a common medium, said system comprising a plurality of more than two individual subscribers' stations and a common central station through which any two individual subscribers' stations may be connected, said individual subscribers' stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station for identifying any of a plurality of said individual subscribers' stations whenever said stations are calling.

2. A system for the exchange of intelligence over a common medium, said system comprising a plurality of more than two individual subscribers' stations and a common central station through which any two individual subscribers' stations may be connected, said individual

stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station to indicate and identify each of a plurality of calling subscribers' stations upon receipt of unmodulated carrier frequencies from said calling stations.

3. A system for the exchange of intelligence over a common medium, said system comprising a plurality of individual subscribers' stations and a common central station through which any individual subscribers' stations may be connected, said individual subscribers' stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station for identifying any of a plurality of calling subscribers' stations upon receipt of unmodulated carrier frequencies from said calling stations, said means including an adjustable selective receiving circuit, and means for varying the frequency of response of said circuit continuously and systematically.

4. A system for the exchange of intelligence over a common medium, said system comprising a plurality of individual subscribers' stations and a common central station, said individual subscribers' stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, means at the central station including a receiving circuit, means to vary the frequency of response of said circuit continuously and systematically, and means controlled by said receiving circuit to indicate and identify a calling subscriber's station upon receipt of unmodulated carrier frequencies from said calling station, said last mentioned means being unresponsive to said unmodulated carrier frequencies after said indication has been acted upon by establishing a carrier current connection to said subscriber's station, said last mentioned means being also arranged to remain unresponsive so long as said calling station may be interconnected with any other station.

5. A system for the exchange of intelligence over a common medium, said system comprising a plurality of more than two individual subscribers' stations and a common central station through which any two individual subscribers' stations may be connected, said individual subscribers' stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station for interconnecting in pairs said individual subscribers' stations including a plurality of sets of transmitting and receiving equipment for two-way carrier transmission to and from subscribers' stations, each set being adjustable to the frequencies of any subscriber's station which is to be connected to any other subscriber's station, each set being connected together at voice frequencies, and means associated with each receiving equipment for supervising the connections.

6. A system for the exchange of intelligence over a common medium, said system comprising a plurality of individual subscribers' stations and a common central station, said individual subscribers' stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, means at the central station whereby a plurality of calling subscribers' stations may signal an operator, said means including a continuously varying frequency selecting and receiving circuit, said cir-

cuit controlling means arranged to operate a plurality of relays, at least one corresponding to each subscriber's station, upon receipt of unmodulated carrier frequency from said calling stations, said relays being arranged to close circuits individual to the subscribers' stations to indicate and identify the calling subscribers' stations.

7. A system for the exchange of intelligence over a common medium, said system comprising a plurality of individual stations and a central station, said individual stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station for indicating a calling station including a continuously and systematically varying frequency selecting circuit for selecting in rotation the transmitting frequencies of said individual stations, a rectifier, a plurality of relays including at least one for each of said individual stations, indicating circuits and apparatus associated therewith, and a switch comprising a plurality of fixed contacts one for each individual station, said contacts being continuously swept over by a moving contact in such a manner that a connection is established between the moving contact and each fixed contact when the variable frequency selecting circuit is tuned to the transmitting frequency of the station associated with that contact.

8. A system for the exchange of intelligence over a common medium, said system comprising a plurality of individual stations and a central station, said individual stations employing different fixed frequencies for transmission and other and different fixed frequencies for reception, and means at the central station for indicating to the operator a calling station including a selecting circuit, the frequency of response of which is being continuously and systematically varied by a motor, a switch having fixed contacts one for each station and a rotating contact also connected to said motor and so arranged that a circuit will be established between the moving contact and the fixed contact associated with any one station at the moment when the variable selecting circuit is tuned to the transmitting carrier frequency of said station, a rectifier and relay connected to said variable frequency circuit, a set of relays one for each individual station, a second set of relays also one for each individual station, the windings of each of said second set of relays being separately connected to one of a plurality of jacks, one for each station, and so arranged that when a carrier frequency is received from a calling station a signal identifying the calling station is given and means whereby when a plug is inserted in the jack corresponding to said calling station a circuit will be established through said switch to remove said signal and hold it inoperative until said plug is removed from said jack.

9. A system for the exchange of intelligence comprising a plurality of individual stations, a central station, and a common transmission medium, each of said individual stations employing different fixed carrier frequencies for transmitting and other and different fixed carrier frequencies for receiving, means at the central station for determining automatically the number of a calling station, means for adjusting manually variable frequency transmitting and receiving apparatus associated with the common medium to the frequencies of the calling station, means for ascertaining from the calling subscriber the number of the called station, means

for adjusting manually a second set of variable frequency transmitting and receiving apparatus, also associated with the common medium, to the frequencies of the called station and means for interconnecting the two sets of transmitting and receiving apparatus to establish a connection between the calling and called stations.

10. A telephone system comprising a plurality of individual stations, a central office, and a common transmission medium, each of said stations employing different fixed carrier frequencies for transmitting and other and different fixed carrier frequencies for receiving, means at the central office for determining automatically the number of a calling station, means for adjusting manually variable frequency transmitting and receiving apparatus associated with the common medium to the frequencies of the calling station, means for ascertaining from the calling subscriber the number of the called stations, means for adjusting manually a second set of variable frequency transmitting and receiving apparatus, also associated with the common medium, to the frequencies of the called station and means for interconnecting the two sets of transmitting and receiving apparatus to establish a connection between the calling and called stations.

11. A telephone system comprising a plurality of individual stations, a central office, and a common transmission medium, each of said stations employing different fixed carrier frequencies for transmitting and other and different fixed carrier frequencies for receiving, means at the central office for determining automatically the number of a calling station, means for adjusting manually variable frequency transmitting and receiving apparatus associated with the common medium to the frequencies of the calling station, means for ascertaining from the calling subscriber the number of the called station, means for adjusting manually a second set of variable frequency transmitting and receiving apparatus, also associated with the common medium, to the frequencies of the called station and means for interconnecting the two sets of transmitting and receiving apparatus to establish a connection between the calling and called stations and means for monitoring said connection.

12. In a telephone system comprising a plurality of individual stations greater than two, a central office having a tunable element for identification, a common transmission medium, each of said individual stations employing different fixed carrier frequencies for transmitting and other and different fixed frequencies for receiving, and translating apparatus at said central station adjustable to the transmitting and receiving frequencies of any calling station and capable of translating such frequencies to the corresponding frequencies of any called station for two-way communication, the method for indicating and identifying at the central office any of a plurality of calling stations which consists in continuously cyclically adjusting said tunable element to periodically and successively tune it to the transmitting carrier frequency of each of said stations, indicating the receipt of any of said carrier frequencies, identifying the stations transmitting said received frequencies, and adjusting said translating apparatus to the transmitting and receiving frequencies of the calling station identified, without interrupting the continuity of the adjustment of said tunable element.

13. In a telephone system comprising a plurality of at least three individual subscribers' sta-

tions, a common central office and a common transmission medium, each of said subscribers' stations employing different fixed carrier frequencies for transmitting and other and different fixed carrier frequencies for receiving, means 5 at the central office for determining automatically at the central office the frequencies of any one of a number of subscribers' stations, means at the central office for establishing communication 10 with the calling subscriber's station, means at the central office for establishing carrier frequency communication with the called subscriber's station, means for interconnecting the calling and called subscribers' stations at the 15 central office at a common frequency, and means for effecting simultaneously a plurality of such interconnections.

14. Means for indicating transmission from and identifying any of a plurality of carrier fre-

quency transmitting stations, said means including a variable frequency selecting and receiving circuit, means for continuously varying said circuit, a plurality of relays controlled by said circuit, at least one corresponding to each transmitting station, and means responsive to the receipt 5 of unmodulated carrier frequency from said transmitting stations for operating the corresponding relays, said relays being arranged to close circuits individual to the transmitting stations to indicate transmission from and identify 10 the transmitting stations.

15. Means for the reception of signals on each of a plurality of frequencies during successive intervals, a plurality of relay devices operated 15 by said means, one relay corresponding to each of said frequencies and operable during the receipt of a respective frequency.

NEWTON MONK.