

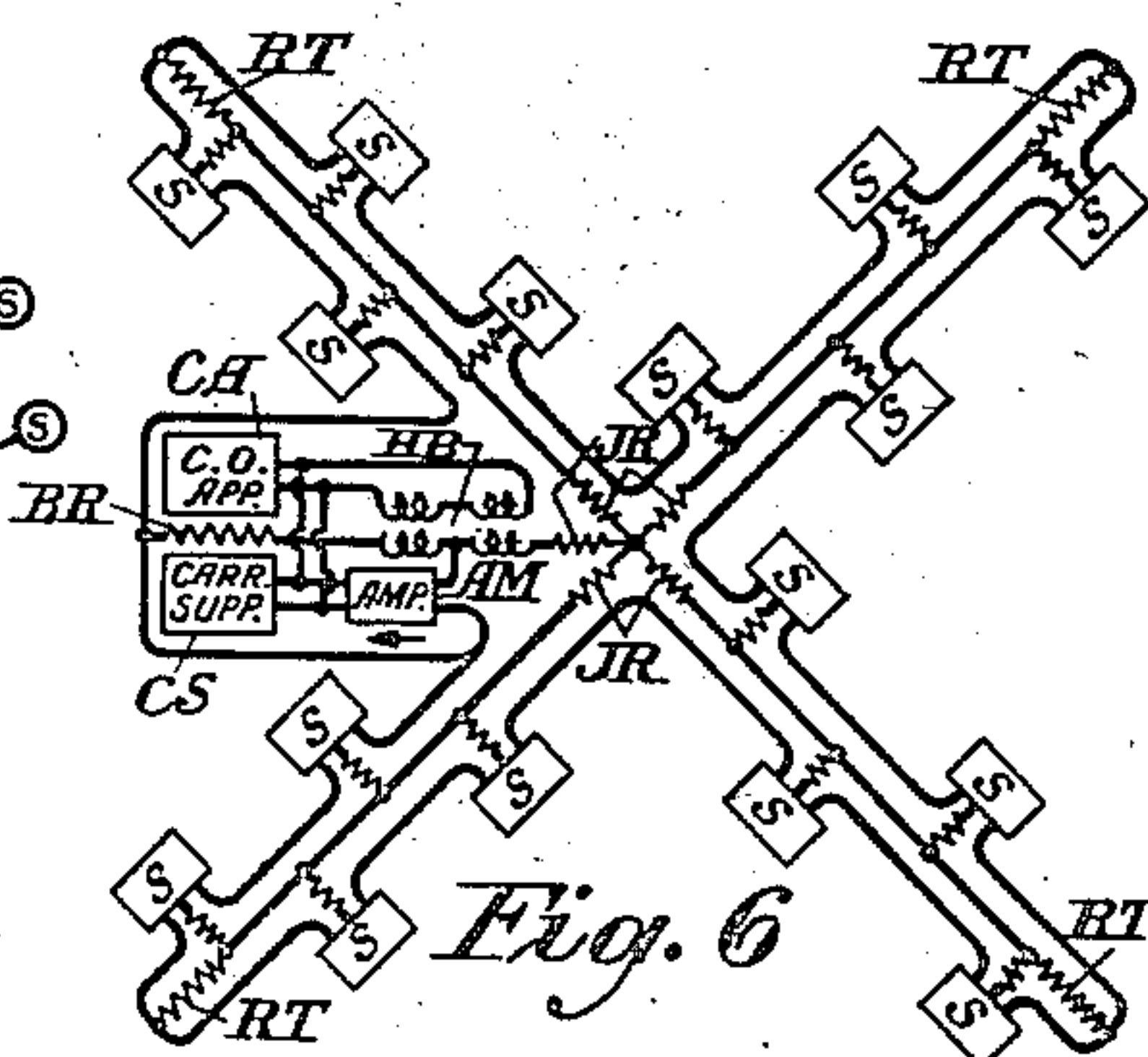
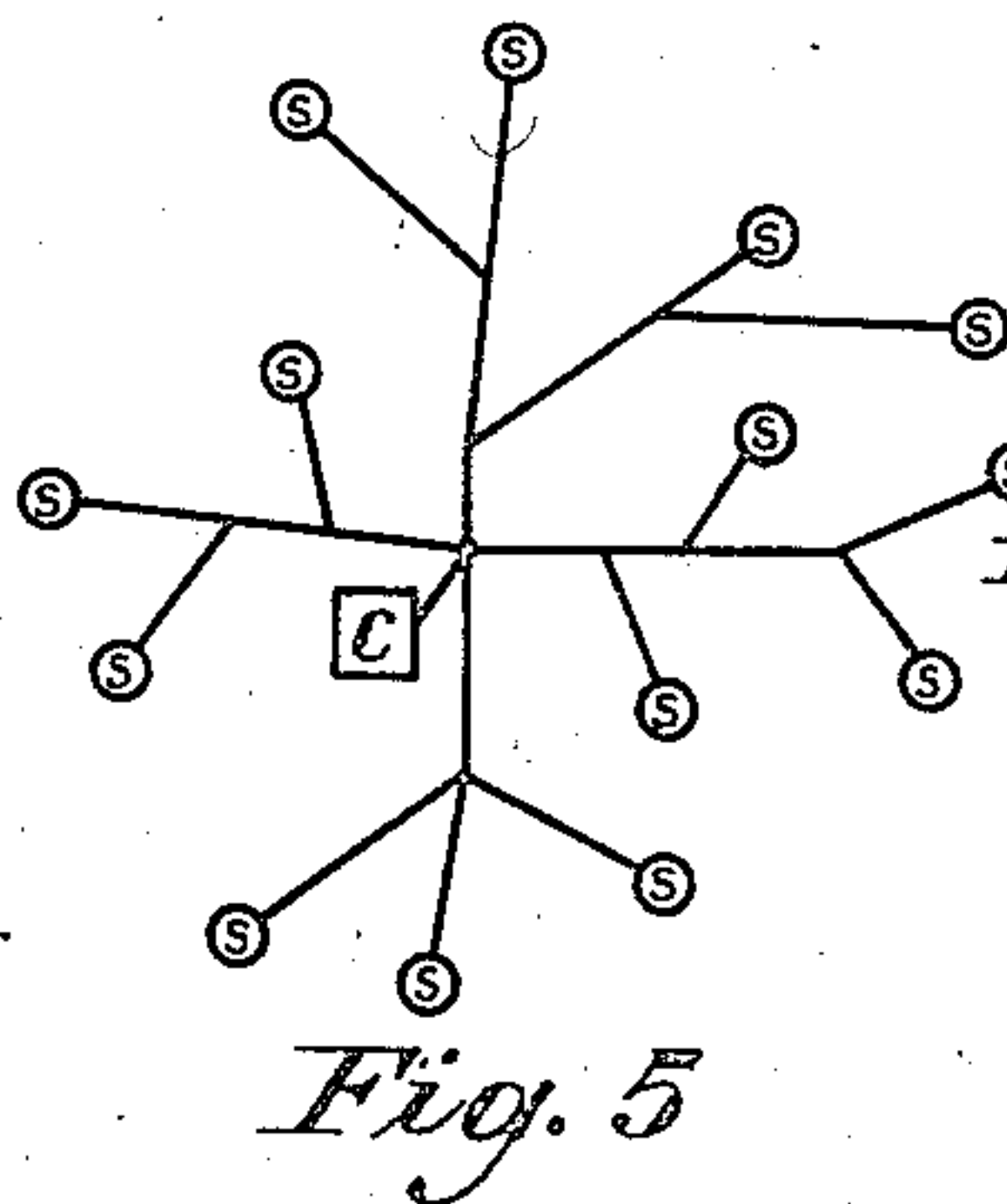
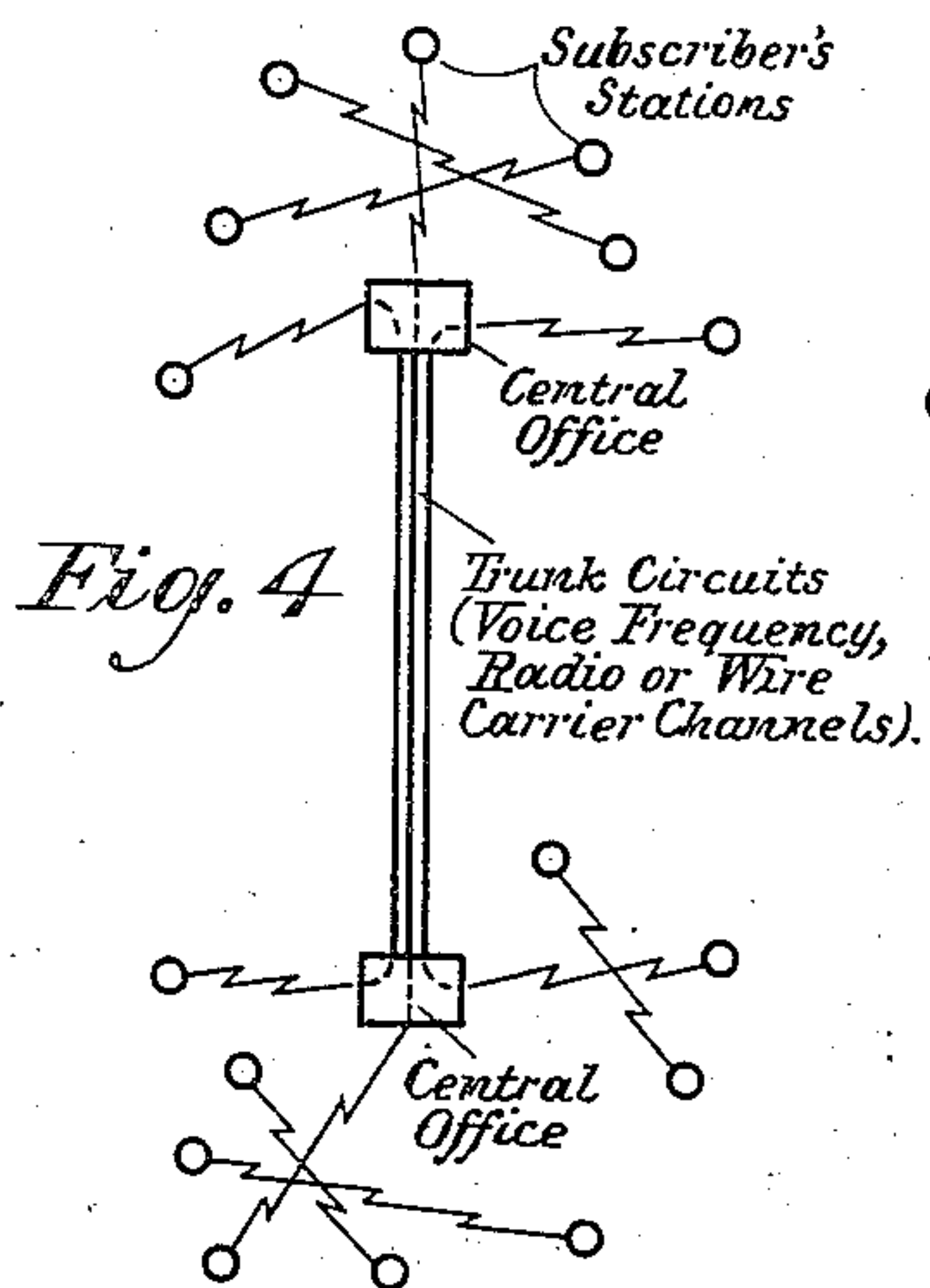
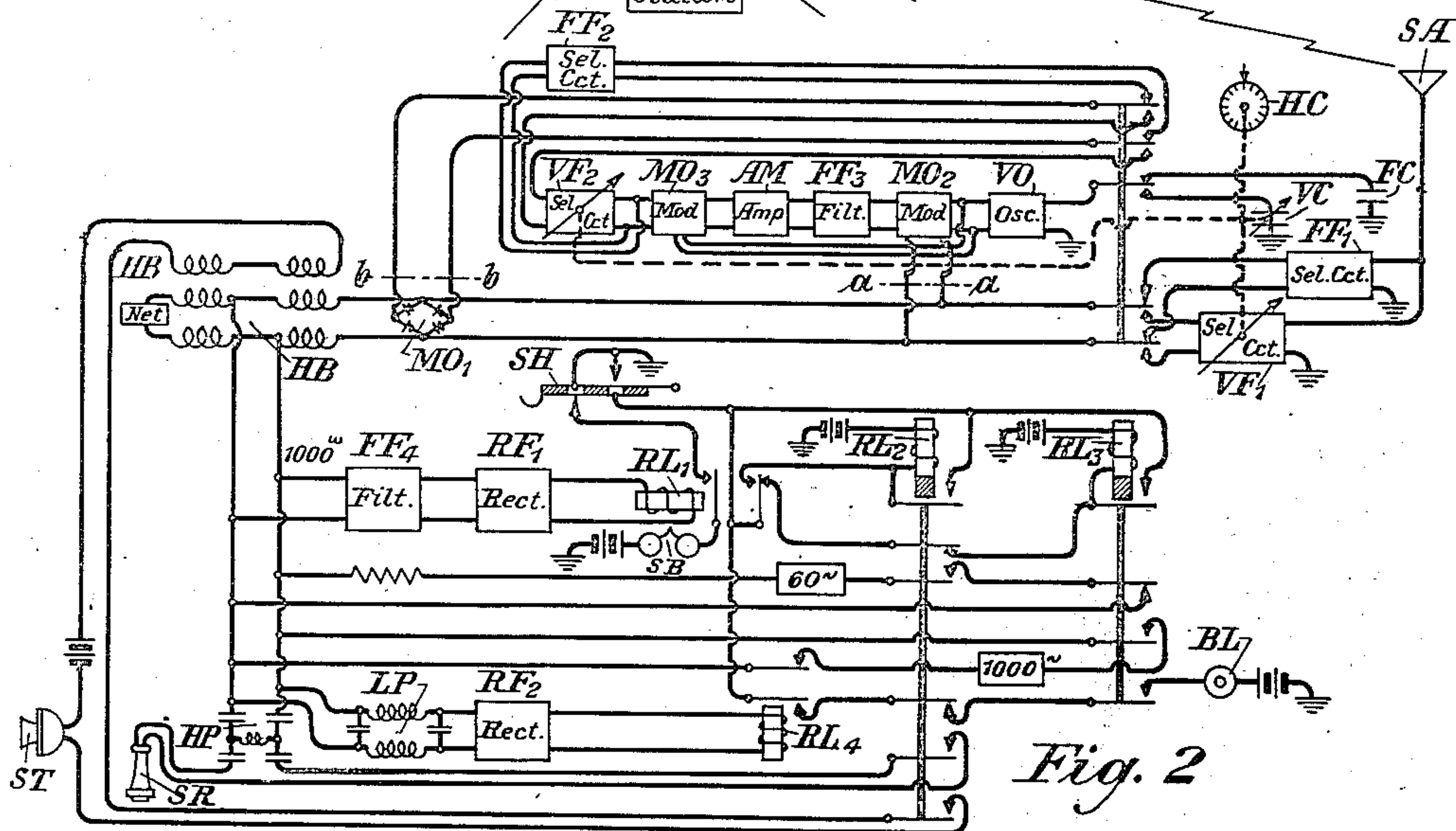
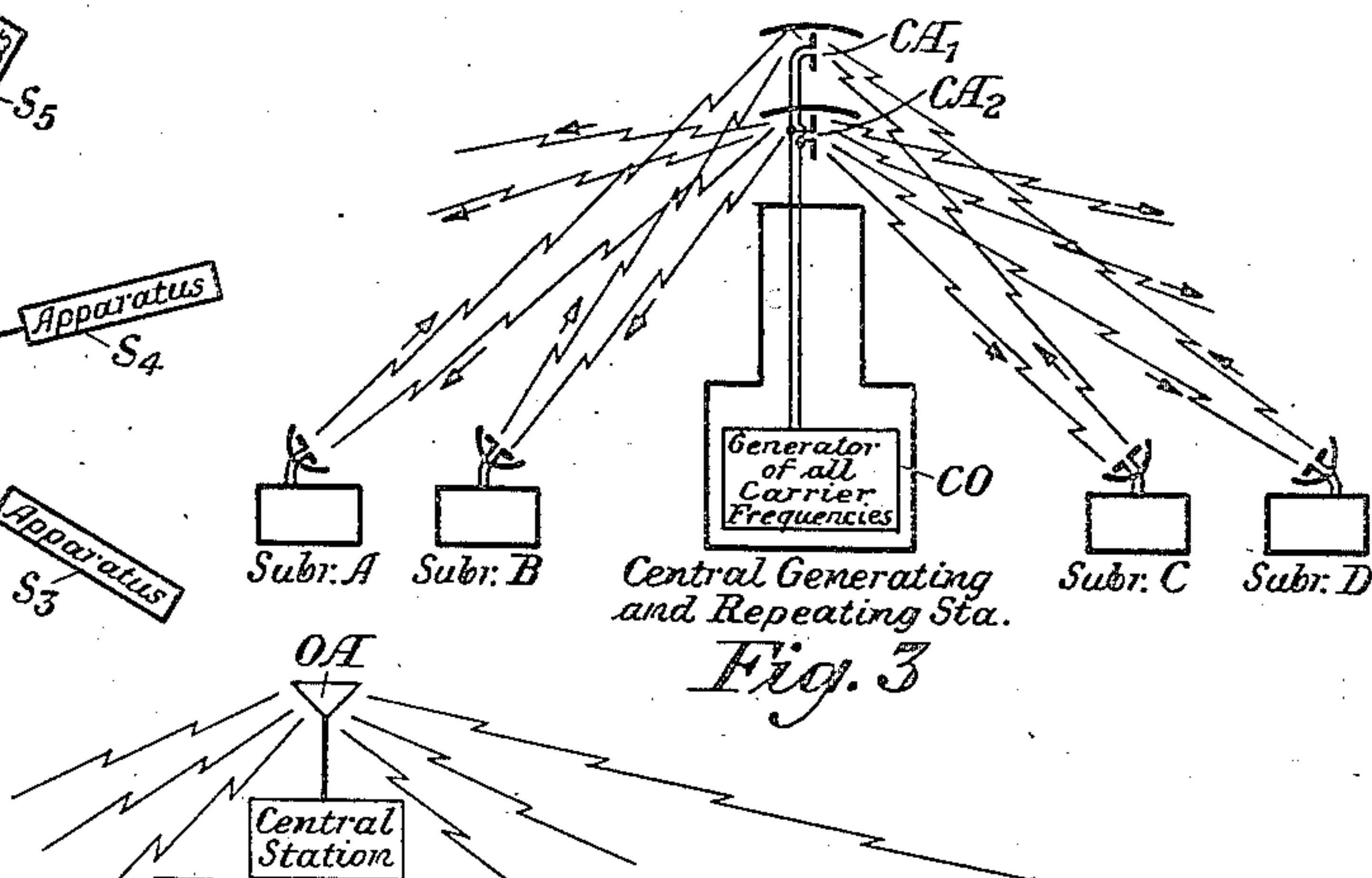
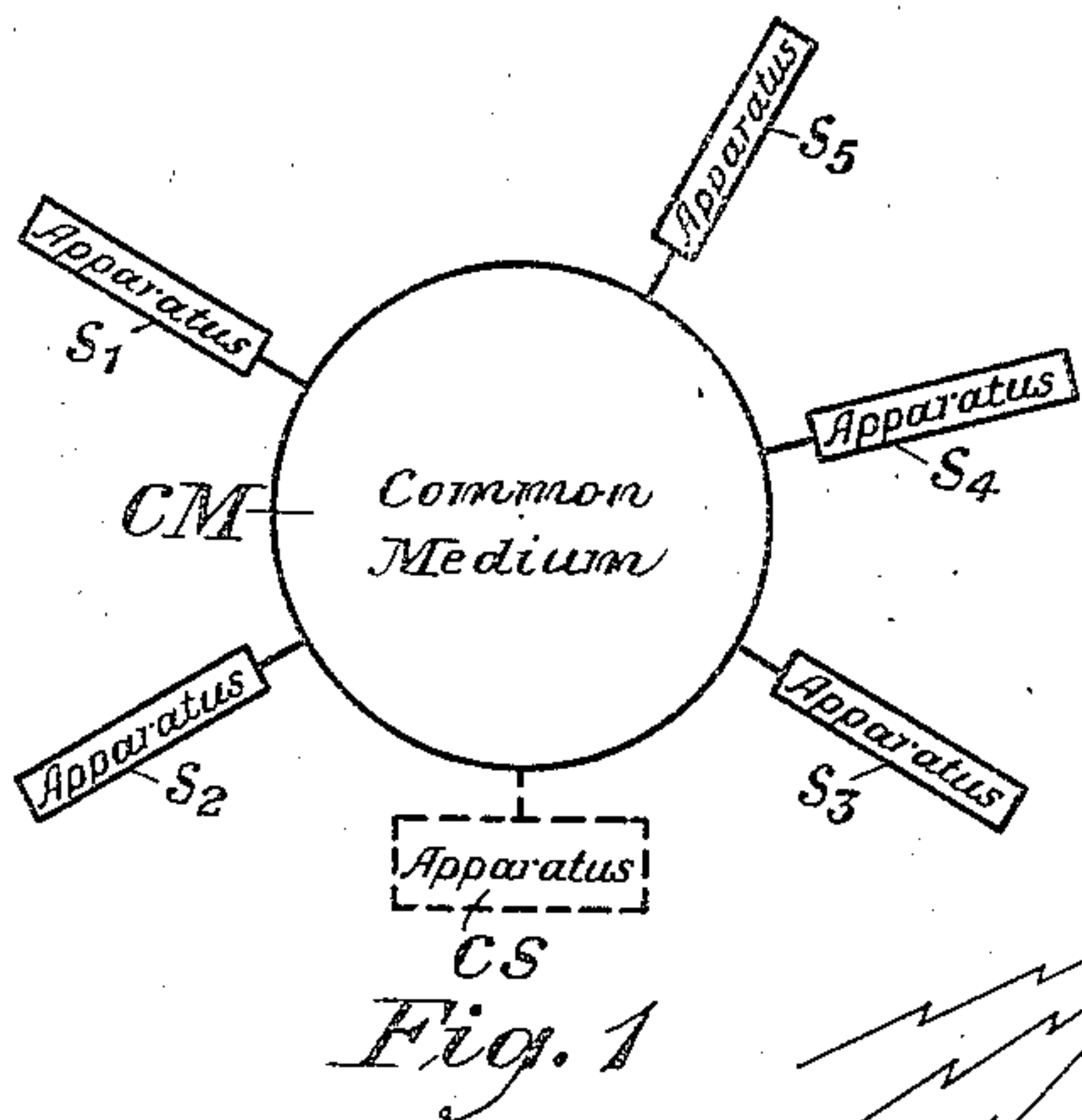
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2,064,906

COMMON MEDIUM MULTICHANNEL EXCHANGE SYSTEM

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COMMON MEDIUM MULTICHANNEL
EXCHANGE SYSTEM

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18 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 selected by subscribers at will and employed 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 fre-

quencies 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 still greater.

With these ultra-high frequencies, however, nature imposes 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 repeating 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 repeating station and having the repeating station repeat the transmission to the desired other subscriber located in another part of the community. The central repeating 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 repeating 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 repeating 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 comprise 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, as will be hereinafter explained, 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 cylindric form 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 wavelength.

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.

It is contemplated in the present invention that subscribers will be connected together directly by means of the common medium, without necessitating the interposition of a central office. Direct connection between subscribers is effected by a process of tuning or selection. This method takes advantage of the fact that the transmission

medium is common to all of the subscribers, with all of the channels accessible to each subscriber at will. The switching function is placed in the hands of the individual subscribers by eliminating the central office in so far as connections within the given area are concerned. Connection to subscribers in other areas is carried out through the respective central offices which are joined by trunk channels or circuits suitable for the purpose.

The invention contemplates the assignment to each subscriber of a particular frequency which might preferably be related to his telephone number. The assignment of frequencies should be such as to facilitate the interconnection of subscribers.

One of the features of the invention is that communication between two subscribers is accomplished using a single carrier frequency. Another feature of the invention is that the carrier frequencies required at the subscribers' stations are supplied from a central point. This obviates the necessity of generating carrier frequencies at any subscriber's station, and makes possible better frequency stability and the two-way use of a single carrier frequency without interference.

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 drawing, in which Figure 1 shows a schematic representation of the principal idea of the invention wherein a large number of stations are connected to a common transmission medium; Fig. 2 shows an embodiment of the invention in which communication is established between subscribers using the same frequency band for both directions of transmission; Fig. 3 shows an antenna arrangement which may be used with subscriber stations of the type shown in Fig. 2; Fig. 4 is a schematic diagram indicating how connections may be established directly between subscribers in the same area, while connections between subscribers in different areas are completed through central offices over trunk circuits; Fig. 5 is a schematic diagram of a guiding or conducting network which is available in common to a central station and a number of subscribers; Fig. 6 shows a coaxial conductor network for use with the arrangement of Fig. 2, in which amplification is provided at the central station.

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 is 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.

When, as in the present invention, the same frequency is employed for both directions of transmission, there might be some difficulty in obtaining sufficiently close synchronism between the frequencies generated by the two subscribers. Accordingly, it may be desirable in this case for both subscribers to obtain the carrier frequency from a common source. It is proposed that this common source be a central station from which

there are radiated continuously the frequencies required by the various subscribers. Each subscriber will then select from the frequencies received by his antenna the particular one which he desires to use both for modulation and demodulation. Since the received energy may be small, it may be found desirable to amplify the carrier before applying it to the modulator. An arrangement of this kind is illustrated in Fig. 2, which is a diagrammatic representation of one possible arrangement of subscriber equipment, wherein the same carrier frequency is used for both directions of transmission. In accordance with this arrangement it is proposed that a single carrier frequency be assigned to each subscriber for use on incoming calls and that in placing an outgoing call the subscriber will select the frequency assigned to the called party.

Referring to Fig. 2, the carrier frequency to be used by the subscriber is selected either by the fixed selecting circuit FF_1 or by the variable selecting circuit VF_1 and led via an auxiliary path to the modulator MO_2 . This modulator is supplied with a local carrier frequency by the oscillator VO . The value of the locally supplied frequency is so determined that the beat frequency produced between it and the incoming carrier corresponds with the pass frequency of the sharp selecting filter FF_3 . In the output of this filter the beat frequency is amplified by the amplifier AM and applied to the modulator MO_3 which is supplied also with the frequency from the oscillator VO . Accordingly, there is obtained in the output of the modulator MO_3 an amplified carrier of precisely the same frequency as that received. This frequency is selected by selecting circuit FF_2 or VF_2 , as the case may be, the unwanted products of modulation being rejected, and the carrier is then applied to the two-way modulator MO_1 . This modulator, being of the balanced type, does not permit the carrier to pass back to the input of the modulator MO_2 , so that singing is prevented.

The operation of the arrangement of Fig. 2 in receiving an incoming call will first be described. In this case, the output of the fixed selecting circuit FF_1 (which is tuned to the frequency assigned to the subscriber) is connected to the two-way modulator MO_1 which serves to modulate both the outgoing signals and the incoming signals. The output of the selecting circuit FF_1 is applied also to the modulator MO_2 . The frequency of the oscillator VO is at this time determined by the fixed condenser FC and is of such value as to combine with the carrier selected by FF_1 to produce the beat frequency which passes FF_3 . The amplified intermediate frequency is remodulated to obtain the original carrier, FF_2 being adjusted to the same frequency as FF_1 . The amplified carrier is delivered to MO_1 which is associated with the hybrid coil HB to which the transmitter ST and the receiver SR are conjugately connected, the latter through the high-pass filter HP .

As will be explained later, the equipment of the calling subscriber will at this time have modulated the carrier frequency with a ringing frequency of 1000 cycles. This ringing frequency, being demodulated by MO_1 , passes through the 1000-cycle filter FF_4 and after rectification in the rectifier RF_1 , serves to energize the relay RL_1 . This relay closes the circuit of the bell SB which is connected through the break contact of the switchhook SH .

The subscriber answers the call by taking his

receiver off the hook, which breaks the circuit of the bell. The make contact of the switchhook also completes a circuit through the winding of the slow-release relay RL_2 and a make contact of RL_1 . Thus RL_2 is operated, whereupon it forms for itself a locking circuit through one of its make contacts and the make contact of the switchhook, so that RL_2 remains operated until the switchhook contact is broken. The operation of RL_2 serves to disable the relay RL_3 so that the connections to the fixed selecting circuits FF_1 and FF_2 and the condenser FC remain unchanged. The operation of RL_2 also serves to connect 60-cycle current through a back contact of RL_3 to the hybrid coil, whence it passes to the modulator MO_1 . At the other subscriber's station this 60-cycle current is demodulated and used to cut off the 1000-cycle ringing current in a manner to be explained below. The frequency of 60 cycles is continuously applied to the modulator throughout the connection, and serves as a "busy indicator" in the manner hereinafter explained. RL_2 acts also to complete the circuit of the transmitter ST and the receiver SR . Thus, the equipment is in readiness for the conversation to proceed. At the conclusion of the conversation the subscriber hangs up, whereupon his equipment restores to normal.

The operation of the arrangement of Fig. 2 when the subscriber places an outgoing call will now be explained. First, the subscriber, by means of the control HC , adjusts the frequencies of the variable selecting circuits VF_1 and VF_2 to the frequency of the called party. At the same time the frequency of the oscillator VO is adjusted (by means of the variable condenser VC) so that the beat between this frequency and the frequency of the called party passes the fixed filter FF_3 . Thus the equipment is in readiness to amplify the carrier frequency of the called subscriber, although the circuit connections at this time are still established with the fixed selecting circuits FF_1 and FF_3 and the condenser FC which are employed for receiving the incoming call.

The subscriber now takes his receiver off the hook. Since there is no incoming call, the received carrier is not modulated by the 1000 cycles and the relay RL_1 is deenergized. Accordingly, a circuit is completed through slow-release relay RL_3 , which is connected through a back contact of RL_2 , a back contact of RL_1 , and the make contact of the switchhook. Thus RL_3 is operated, whereupon it forms for itself a locking circuit through one of its make contacts and the make contact of the switchhook. The operation of RL_3 establishes the connections to the variable selecting circuits VF_1 and VF_2 and the variable condenser VC .

If at this time the frequency of the called party is in use, this frequency will be modulated by 60 cycles, as has been explained above. In this case the 60-cycle current, after being demodulated by MO_1 , will pass through the low-pass filter LP and, upon being rectified in RF_2 , will energize the relay RL_4 . This will serve to light the busy lamp BL which is connected through a make contact of RL_3 , a break contact of RL_2 , the make contact of RL_4 , and the make contact of the switchhook. The subscriber may then hang up or wait until the called subscriber's frequency becomes idle.

If, at the time RL_3 operates, the called subscriber's frequency is not busy, the operation of RL_3 serves to apply to the hybrid coil HB the ringing frequency of 1000 cycles, the connection being carried through a back contact of RL_4 .

The 1000-cycle frequency passes through the filter FF_4 and after rectification energizes the relay RL_1 , which, in turn, completes the circuit of RL_2 . In the modulator MO_1 the ringing frequency is modulated to produce side frequencies of the called party's carrier. At the called station these side frequencies are demodulated and the resultant 1000-cycle current applies a frequency of 60 cycles to the modulator of the called subscriber. The modulated frequencies corresponding to 60 cycles which are sent out from the called station are demodulated by MO_1 and serve to energize the relay RL_4 which cuts out the 1000-cycle ringing current. Since the operation of RL_2 has completed the circuits of the transmitter ST and the receiver SR , the equipment is now in readiness for conversation. At the conclusion of the conversation, the operation of the switch-hook causes the equipment to restore to normal.

One or two further points in connection with the arrangement of Fig. 2 may now be noted. The transmission from one subscriber to another may be accomplished either directly or via the antenna of the central station, the original source of carrier frequency being at the central station. In case the carrier frequency is received by the subscriber at a sufficiently high level, it may be found possible to use this frequency unamplified for demodulation, modulation and re-radiation, so that the auxiliary circuit for amplifying the incoming carrier frequency might be omitted.

Radio transmission between subscribers who are provided with the station arrangement of the type shown in Fig. 2 may be accomplished directly, using any suitable type of antenna. However, in order to obtain substantially line-of-sight transmission for the ultra-short range of frequencies, the transmission path may be carried over obstacles which intervene between the antennas of individual subscribers by employing an arrangement of the type shown in Fig. 3.

Referring to this figure, the frequencies transmitted by the various subscribers are carried through a central repeating station where they are received on the antennae CA_1 and CA_2 and re-radiated from said antennae. These antennae CA_1 and CA_2 may be located upon a tall building or some other place having sufficient elevation. Each subscriber's antenna may be designed to radiate a beam toward the antennae CA_1 and CA_2 and to receive radiation from said antennae. Antennae CA_1 and CA_2 also radiate all the carrier frequencies which are needed by the subscribers in the area, which are generated by the apparatus CO .

As has been explained, the subscriber station arrangement of Fig. 2 is designed to provide a direct 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 one of several frequencies assigned for that purpose, and the connection completed over suitable interoffice trunks. The method is illustrated schematically in Fig. 4. The central office apparatus to be used in carrying out this method might be patterned after that shown in Fig. 2. The types of trunks which may be used to interconnect the central offices are well known in the art.

In the arrangements which have been described for selecting channels, the entire selec-

tion has been accomplished at the channel frequency. It will be evident that this method of selection might be replaced by the well-known superheterodyne method, with partial selectivity provided at the channel frequency and the remaining selectivity furnished by a sharp, intermediate frequency selecting circuit or filter.

It will be evident to those skilled in the art that arrangements for automatically controlling the volume of the signals delivered by the subscriber's equipment may be incorporated in any of the subscribers' station arrangements which have been described, so that conversation between different subscribers may take place over a substantially constant transmission equivalent.

It will be noted that in the subscriber station arrangement described above, the apparatus is designed to prevent a subscriber from listening in on the conversations of other subscribers. This, of course, is a very desirable feature for a telephone exchange system.

In the arrangements described it has been assumed that free space is employed as the common transmitting medium. There will now be described arrangements in which transmission over a high-frequency conducting or guiding path is 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.

Probably the simplest form of such a network would be one comprising ordinary two-conductor circuits suitably interconnected and branched so that the common circuit will be available at all desired points. The circuits comprising the network might, for example, consist of pairs of open-wire or cable conductors. A network of this kind is shown schematically in Fig. 5, where each line represents a pair of conductors, C designates the central office and S a subscriber's station.

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 circuit consisting of two conductors disposed coaxially with respect to one another. Such a circuit 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. In this form of circuit, low attenuation at high frequencies may be obtained by the employment of conductors whose high-frequency resistance is suitably small and by the employment of a substantially gaseous dielectric. The outer conductor provides shielding against external disturbances, which shielding becomes more nearly perfect as the frequency is increased, so that at high frequencies the noise due to thermal agitation in the conductors becomes the factor which determines the minimum transmission level.

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 Leibe, 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. An advantageous form of such a wave guide 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 wavelength.

It is contemplated in accordance with the invention that the subscriber set which has 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.

Fig. 6 shows an arrangement for using a guiding medium with the subscriber arrangement herein disclosed, wherein coaxial lines extend in several directions from a central point. Each line is terminated in a resistance R_T which approximates its characteristic impedance. At the central point each of the inner conductors of the various branches is brought through a resistance J_R to a common junction point. The function of the resistance J_R is to avoid high-frequency reflections which otherwise would be produced at the junction. The hybrid coil H_B is shown connected to the common junction through a resistance J_R , though it would be possible to omit this resistance if a suitable value were assigned to the others. The opposite side of the hybrid is terminated in a resistance B_R which is equal to J_R plus the parallel impedance of all the branches. The various transmissions arriving at the central point are amplified by the amplifier AM and retransmitted.

In addition, the carrier frequencies required by the subscribers are supplied from the source CS at the central point. To use Fig. 6 in conjunction with the subscriber station arrangement of Fig. 2, the antenna connection of Fig. 2 would be replaced by a connection to the coaxial line. It would also be possible to omit the auxiliary circuit shown in Fig. 2 (between lines $a-a$ and $b-b$) for amplifying the carrier.

While the entire preceding discussion has been restricted to systems wherein a common transmission medium is employed for the provision of telephone exchange service between subscribers, it will be understood that the invention contemplates the use of the same general methods for other types of communication. In particular, it will be seen that there has been disclosed a medium which is capable of handling a wide band of frequencies from which a substantial number of television channels may be derived.

It will furthermore be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit

of the invention as defined in the following claims.

What is claimed is:

1. In a system for the exchange of intelligence over a common transmission medium between any one and any other of a plurality of stations taken in pairs, the method which consists in transmitting a plurality of controlling frequencies from a common station to all of the other stations, and at any one of said plurality of stations selecting exclusively and utilizing one of those frequencies for two-way communication over said common medium with another station corresponding to the selected frequency.

2. In a system for the exchange of intelligence over a common transmission medium between any one and any other of a plurality of stations taken in pairs, the method which consists in transmitting a plurality of controlling frequencies from a common station to all of the other stations, and selecting exclusively at any one of those stations a frequency corresponding to another station and utilizing it for two-way communication between said pair of stations.

3. A system for the interchange of intelligence comprising a central station and a plurality of subscribers' stations, a common transmission medium extending to each of said stations, means for transmitting from said central station a plurality of carrier frequencies to each of said subscribers' stations, and means at each of said subscribers' stations for selecting exclusively and utilizing any one of said carrier frequencies for two-way communication with a chosen one of the other subscribers' stations, the frequency utilized depending upon the station with which communication is established.

4. A system for the interchange of intelligence comprising a central station and a plurality of subscribers' stations, a common transmission medium extending to each of said stations, means for transmitting from said central station to all of said subscribers' stations a plurality of carrier frequencies, and means at each of said subscribers' stations for selecting exclusively and utilizing any one of said carrier frequencies for both transmission and reception in two-way communication with another subscriber's station which corresponds to the selected frequency.

5. A telephone exchange system, comprising a central station and a plurality of subscribers' stations, a common transmission medium extending to each of said stations, means for transmitting from said central station a plurality of frequencies, and means at each of said subscribers' stations for selecting exclusively and utilizing any one of said frequencies to establish a two-way telephone connection directly with any other of said stations, the frequency selected and utilized depending upon the other station with which connection is established.

6. A central station and a plurality of subscribers' stations, a common transmission medium extending to all of said stations, means for transmitting from said central station a plurality of frequencies, different ones of said frequencies being individually assigned to said subscribers' stations as called stations, and means enabling any one of said subscribers' stations to be operated selectively and exclusively to utilize the frequency assigned to any other subscriber's station to establish two-way communication therewith.

7. A telephone exchange system, comprising a central station and a plurality of subscribers' stations, a common transmission medium extend-

ing to each of said stations, means for transmitting from said central station a plurality of frequencies, means at each of said subscribers' stations for selecting and utilizing any one of said frequencies to establish a two-way telephone connection with any other of said stations, and means for preventing any other station than the two connected from utilizing said frequency after said connection has been established.

8. A plurality of subscriber stations and a central station, a common transmission medium extending to all of said stations, means for supplying from said central station a plurality of frequencies, different ones of said frequencies being individually assigned to said subscribers' stations as called stations, means whereby a two-way telephone connection may be established over said medium between any one and any other of said stations, selecting and utilizing for this purpose that one of a plurality of frequencies being radiated by said central station which is assigned to the called station, and means whereby a plurality of such connections may be established and simultaneously maintained.

9. A central radio station and a plurality of subscribers' radio stations, means at said central station for radiating a plurality of carrier frequencies corresponding respectively to said subscribers' stations, and means at each of said subscribers' stations as a calling station for choosing and utilizing any of said carrier frequencies for transmission to and reception from the corresponding called station.

10. A central radio station and a plurality of subscribers' radio stations, means at said central station for radiating a plurality of carrier frequencies corresponding respectively to said subscribers' stations, and means at each of said subscribers' stations for choosing and utilizing any of said frequencies to establish a telephone connection with another of said subscribers' stations corresponding to the chosen frequency.

11. A central radio station and a plurality of subscribers' radio stations, means at said central station for radiating a plurality of carrier frequencies corresponding respectively to said subscribers' stations, means at said subscribers' stations for choosing and utilizing any one of said frequencies to establish communication with the corresponding subscriber's station, and means for preventing any other station from utilizing any frequency which is in use for connection between two stations.

12. A central radio station and a plurality of subscribers' radio stations, means at said central station for radiating a plurality of carrier frequencies, means at each of said subscribers' stations for selecting any one of said carrier frequencies and utilizing said selected frequency for transmitting and receiving for establishing communication with a second subscriber's station, means to modulate said carrier frequency with a tone, means at each subscriber's station responsive to the receipt of tone modulated carrier frequency for preventing the use by the station of a carrier frequency in use.

13. A central station and a plurality of subscribers' stations, a common transmission medium extending to each of said subscribers' stations, means at said central station for radiating a plurality of carrier frequencies, means at each of said subscribers' stations for selecting at will and receiving exclusively any one of said carrier frequencies for two-way communication with any selected one of said subscribers' stations, means for modulating said received carrier frequency, and means for transmitting the modulated carrier frequency in communicating with the selected station.

14. A central station and a plurality of subscribers' stations, means at said central station for radiating a plurality of carrier waves, means at each of said subscribers' stations for selecting at will and receiving exclusively any one of said carriers for two-way communication with any selected one of said subscribers' stations, means for amplifying said received carrier, means for modulating said carrier, and means for transmitting said modulated carrier in communicating with the selected station.

15. A central station and a plurality of subscribers' stations, means at said central station for radiating a plurality of carrier frequencies, means at each of said subscribers' stations for selecting at will and receiving any one of said carrier frequencies, means for modulating said received carrier, and means for demodulating received signals with said carrier.

16. A central station and a plurality of subscribers' stations, means at said central station for radiating a plurality of carrier frequencies, means at each of said subscribers' stations for selecting at will and receiving any one of said carrier frequencies, and a modulator capable of simultaneously modulating said received carrier with other signals and demodulating incoming signals.

17. In a telephone exchange system, a central station and a plurality of subscribers' stations, means for radiating from said central station a plurality of carrier frequencies, one of said carrier frequencies being assigned to each of said subscribers' stations, means at each of said subscribers' stations for selecting at will any one of said carrier frequencies, and means for utilizing said received frequency to establish two-way communication with the subscriber's station assigned that frequency.

18. A plurality of stations associated with a common transmission medium, means at each station for transmitting and receiving on any of a plurality of carrier frequencies, each of said stations being continuously prepared to receive on a different carrier frequency, means at a calling station for transmitting a tone modulated on a carrier frequency for actuating a signal at a called station, and means at a called station for transmitting back to the calling station a different tone modulated on a carrier frequency, means at the calling station responsive to the receipt of said last mentioned tone at said calling station to stop the transmission of said first tone.

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