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COMMUNICATION SYSTEM

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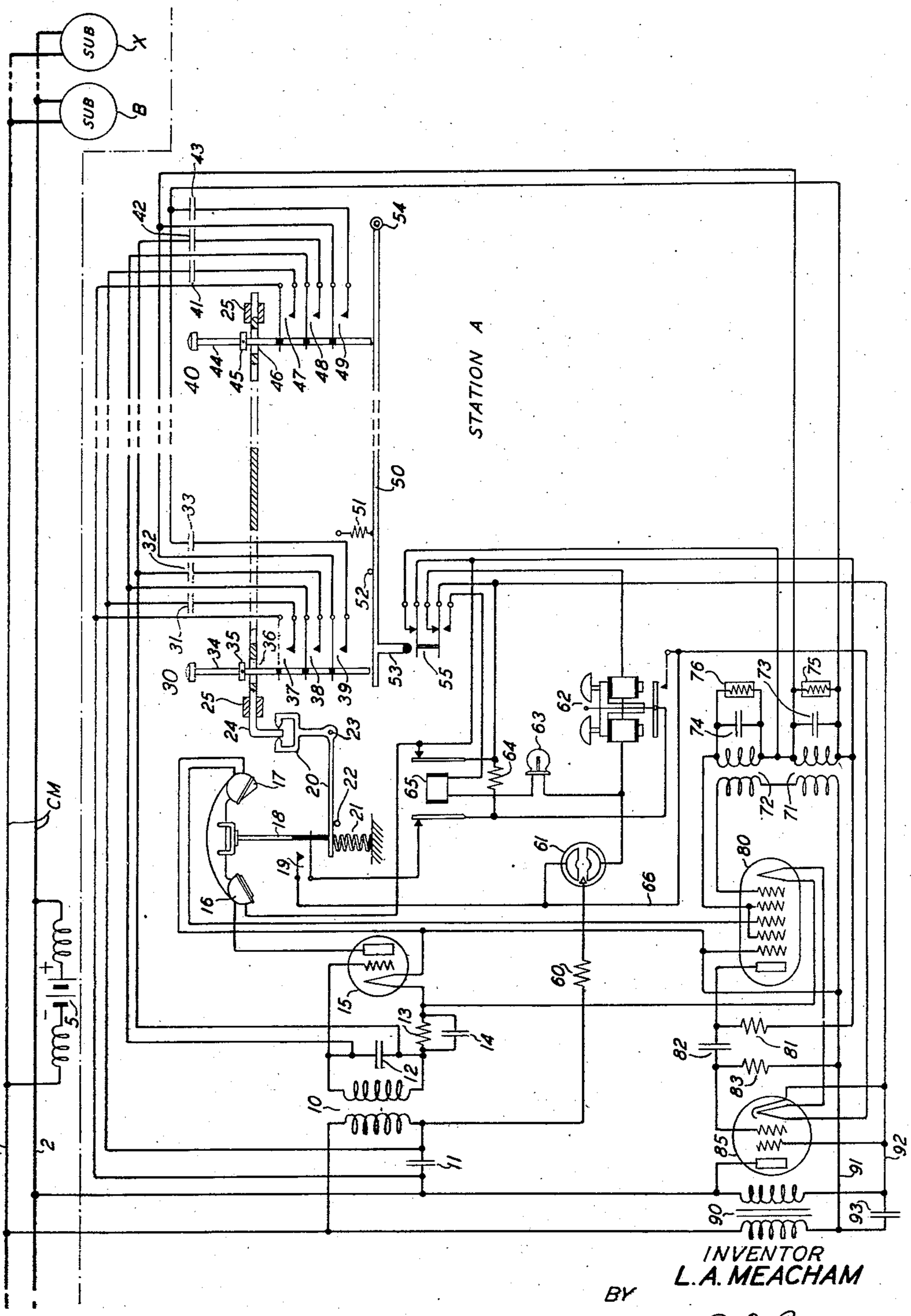

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COMMUNICATION SYSTEM

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10 Claims. (Cl. 179—15)

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This invention relates to telephone systems and particularly to intercommunicating systems in which a plurality of carrier channels are provided in a common transmission medium extending to all of the telephone stations in the system.

Objects of the invention are the improvement of intercommunicating systems comprising a plurality of carried channels in a common transmission medium extending to all of the telephone stations and particularly in the provision of a system in which privacy is assured and in which a busy signal device is operated at a calling station if the called station is already connected in communication with a third station.

The invention is an improved intercommunicating system in which each of the telephone stations is assigned a different pair of carrier channels in a common transmission medium extending to all of the stations, one of this pair of channels being used as a receiving channel and the other as a transmitting channel on calls incoming from any other station, and in which each of the stations is arranged to select the pair of channels assigned to any other station with which communication is desired. According to a feature of the invention, means are provided for giving a busy signal to a calling station whenever the station with which communication is desired is busy, both when the last-mentioned station is busy in communication with a calling station and when the last-mentioned station is busy in communication with a called station. According to another feature of the invention, means are provided at each station for disabling a calling station when attempting to establish communication with another station which is then in communication with a third station.

Other features will be apparent from the following description of the system disclosed in the drawing, which system constitutes one embodiment of the invention. The invention is not limited, however, to the system and detailed arrangements shown in the drawing but is generally applicable to carrier intercommunicating systems.

Referring to the drawing, which consists of a single figure, the common transmission medium CM interconnects a plurality of stations including stations A, B and X. The station A is shown in detail and each of the other stations is similar thereto. The transmission medium CM may be any pair of conductors 1 and 2, for instance a twisted pair or a shielded pair or a coaxial cable, which is multiplied to all subscribers of a private branch exchange or intercommunicating system.

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The conductors may extend between all subscribers' stations in tandem or be extended to the various stations separately from one or more branch points, thereby to secure optimum economy and flexibility. The direct current power for the subscribers' stations is supplied, over the aforementioned conductors, from a common battery 5 which may be located at one of the stations or at any intermediate point. The common medium affords a plurality of channels, each of a different frequency; and each station in the exchange or intercommunicating system is individually assigned two channels, one for receiving and the other for transmitting speech and signals on calls initiated at any other of the stations. When a station is idle and also when it is answering a call, it is tuned to the frequencies of these two assigned channels. When a subscriber calls another station, the calling subscriber tunes the transmitting and receiving circuits of the calling station to the frequencies of the channels assigned individually to the called station, so that the called station is ready for conversation upon removal of the receiver or handset thereat from its normal position. To afford privacy, each station is arranged so that it is necessary for the calling subscriber to test the common transmission medium for the presence of a carrier of the frequency of the individual transmitting channel of the station with which conversation is desired, before originating the call. If carrier current of this particular frequency is already present, a busy signal is given to the calling subscriber and the calling subscriber's station is rendered inoperative to establish a conversational connection with the busy station.

The station A comprises a telephone handset which is normally positioned in a supporting cradle, station keys, one for each of the other stations, an oscillator-modulator tube 80 for generating and modulating the carriers which are used to transmit speech from station A to the other stations, and an amplifier tube 85 coupling the output circuit of tube 80 to the conductors 1 and 2. The oscillator-modulator tube 80 is controlled by the transmitter 17 and by two tuned circuits, one of which comprises coil 71 and condenser 73 and is tuned by the operation of any one of the station keys to generate a carrier of the frequency of the receiving channel individually assigned to the corresponding station for transmitting speech from station A to the called station. The other of these tuned circuits comprises coil 72 and condenser 74 and is tuned to generate a carrier of the frequency of the transmitting channel in-

dividually assigned to station A and used to transmit speech to any other station when station A is the called station. The tube 80 is also used to generate a carrier of the transmitting frequency individually assigned to station A, when station A is busy as a calling station, thereby to give a busy signal at any other station at which the station A key is actuated to initiate a call to station A. Thermistor elements 75 and 76 constitute amplitude limiters in the oscillator circuit. Reference may be had to my Patent No. 2,303,485, granted December 1, 1942, for a detailed description of similar oscillator circuits for generating a plurality of frequencies.

The station A further comprises a transformer 10 and detector-amplifier tube 15 for receiving speech modulated carrier currents incoming from any other station with which station A is in communication, the receiver 16 being connected in the output circuit of tube 15. The condenser 11 and primary winding of transformer 10 and the secondary winding of transformer 10 and condenser 12 constitute tuned circuits which, when all station keys are normal, are tuned to the frequency of the receiving channel individually assigned to station A. Station A further comprises a ringer 62 for giving an audible signal when station A is idle and is being called by another station, a busy lamp 63 for giving the subscriber at station A a busy signal if the station with which a conversational connection is desired is busy, and a busy relay 65 for rendering the receiving and transmitting circuits of station A ineffective for communication in case the handset is removed from the cradle while a station key is depressed and the called station is busy. Station A further comprises a gas-filled discharge tube 61 for controlling the ringer 62, lamp 63 and relay 65, and comprises a power filter consisting of retard coil 90 and condenser 93 for supplying power to station A. While the telephone handset is in normal position in the supporting cradle, the contacts 19 are open and the filaments of tubes 15, 80 and 85 are deenergized.

Only two station keys are shown in the drawing, key 30 for operation on a call to station B and key 40 for operation on a call to station X. As many more keys are provided as there are other stations. While the telephone handset is in normal position in the supporting cradle, any of the station keys may be operated; but removal of the handset actuates a locking mechanism which locks any key which was operated at the time of removal and which prevents the operation of any key subsequent to removal of the handset. This locking mechanism comprises a locking plate 24 having openings 36, 46 through which the plungers of the various keys project. The plate is supported horizontally between bearings 25 and is movable therein under the control of an actuating element 20 which engages the bent over end of the plate. The actuating element 20 is pivoted at 23 and, while the handset is in the cradle, the horizontal portion of element 20 is depressed against the compression of spring 21 against the stop 22; and the locking plate is held in its extreme left-hand position in which the locking collars 35, 45 on plungers 34, 44 are in alignment with the openings 36, 46 so that any one of the station keys may be actuated. The actuation of any station key closes the associated contact springs and also depresses the common element 50 to actuate the contact springs 55, the element 50 being pivoted at 54 and normally held by spring 51 against the stop 52. When the handset is out

of the cradle, the cradle supporting element 18 effects closure of contacts 19 and the spring 21 rotates the actuating element 20 thereby to move the locking plate 24 to its extreme right position; in which position, operation of any station key is impossible due to the engagement of its locking collar with the top surface of the locking plate. Any key, which is depressed at the time the handset is removed from the cradle, is locked in its operated position, by the engagement of its locking collar with the lower surface of plate 24, until the handset is replaced. This key locking mechanism illustrates the desired control, which control may be effected by any suitable mechanism.

Assume now that station A is idle, with the handset in the cradle and all station keys normal. Under this condition, the detector 15 is tuned to the frequency of the receiving channel which is individual to station A. At this time the oscillator-modulator 80 is tuned to generate a carrier of the frequency of the transmitting channel which is individual to station A, the tuned circuit comprising coil 71 and condenser 73 being short-circuited by the upper contact of springs 55. Assume further that a person at station A desires to communicate with someone at station B. To this end, key 30 is operated prior to removal of the receiver to determine whether or not the called station is busy. The depression of key 30 actuates contacts 37, 38, 39 and 55. The closing of contact 37 connects condenser 31 in parallel with condenser 11 and connects condenser 32 in parallel with condenser 12 thereby to tune the receiving circuits and detector of station A to the frequency of the transmitting channel individual to the called station B. The actuation of springs 55 opens the short-circuit across the tuned circuit comprising coil 71 and condenser 73, and the closing of contact 39 connects condenser 33 in parallel with condenser 73 thereby to tune the oscillator 80 to generate a carrier current of the frequency of the receiving channel individual to station B. The actuation of springs 55 also opens the normally closed circuit path through ringer 62 and connects the winding of busy relay 65 and lamp 63 to conductor 92. If station B is busy when key 30 is operated, carrier current of the frequency of the transmitting channel individual to station B is being transmitted therefrom over the common medium CM, and, since the receiving network comprising transformer 10 and condenser 11 has been tuned to this frequency, a sufficiently high potential is thereby applied through resistor 60 to the control element of tube 61 to cause breakdown of the tube and energization of busy lamp 63 and busy relay 65. The subscriber at station A will thereupon release the key 30 without removing the handset from the cradle. If, however, the subscriber ignores the busy lamp signal and removes the handset, the subscriber at station A is unable to communicate with station B because relay 65 holds open the receiver circuit and the filament circuit through resistor 64. If station B is idle, lamp 63 is not lighted and relay 65 is not operated; and the calling subscriber thereupon proceeds to remove the handset from the cradle while holding key 30 depressed, thereby locking key 30 in its operated position until the handset is replaced. The actuation of contact 19 closes the filament energizing circuit through resistor 64 and the actuation of springs 55 opens the normally closed short-circuit across condenser 73; and with condenser 33 connected in parallel with condenser 73, tube 80 generates carrier current of the frequency of the re-

celving channel assigned individually to station B. This carrier current is modulated by the speech oscillations produced in transmitter 17 and the modulated carrier current is transmitted through amplifier 85 and the common medium to station B. Tube 80 also generates current of the frequency of the transmitting channel assigned individually to station A and this current is transmitted through amplifier 85 and common medium CM to operate the busy lamp and relay at any other station at which the station A key may thereafter be operated, to indicate to any other subscriber who may wish to communicate with station A, that station A is busy and to prevent any such subscriber from communicating with station A and to prevent any such subscriber from hearing the conversation between stations A and B. When conversation with station B is completed, the handset is replaced in the cradle thereby opening contact 19 to deenergize tubes 15, 80 and 85. The replacing of the handset also restores elements 18, 20 and 24 to normal position thereby unlocking key 30; and the return of key 30 to normal opens contacts 37, 38 and 39 and effects the restoration of springs 55 to normal position. Since carrier current of the frequency of the transmitting channel individually assigned to station A is no longer being transmitted therefrom, any other station may now establish communication with station A by depression of the corresponding station key and removal of the handset from normal position.

When the handset and station keys at station A are normal, the ringer 62 is connected to one of the two main electrodes of the gas-filled discharge tube 61, the control element of tube 61 being connected through the primary winding of transformer 10 to conductor 1 of the common transmission medium and through condenser 11 to conductor 2 of this medium. With none of the station keys operated, the primary winding of transformer 10 and condenser 11 are tuned to the frequency of the receiving channel individually assigned to station A. When carrier current of this frequency is transmitted over conductors 1 and 2 from some calling station, responsive to operation of the key corresponding to station A and removal of the receiver, the impedance offered by the primary winding of transformer 10 and condenser 11 to current of this particular frequency is low enough to cause to be impressed on the control electrodes of discharge tube 61 a high enough voltage to effect the breakdown of tube 61. The voltage similarly and simultaneously impressed on the control electrodes of the discharge tubes at other idle stations is insufficient to effect the breakdown of the discharge tubes thereat because the corresponding transformer windings and condensers at each of these stations offer a high impedance to current of the frequency of the receiving channel individually assigned station A. When tube 61 breaks down, the ringer 62 is actuated in a circuit traced from the positive pole of battery 5, conductor 2, right winding of retard coil 90, conductor 92, lower normally closed contact of springs 55, windings of ringer 62, main electrodes of tube 61, conductor 66, filaments of tubes 85, 80 and 15 in the order named, conductor 91, left winding of retard coil 90 and conductor 1 to the negative pole of battery 5. The filaments of the tubes 85, 80 and 15 are energized by the current in this circuit to prepare for the reception and transmission of speech currents. When ringer 62 is energized it closes a shunt circuit from conductor 92, through

resistor 64, and front contact of ringer 62 to conductor 66, thereby causing the deenergization of tube 61 to interrupt the energization of ringer 62. As soon as the ringer 62 deenergizes, the shunt circuit through resistor 64 is opened and tube 61 again breaks down to reenergize ringer 62. Thus ringer 62 is alternately energized and deenergized to give an audible calling signal as long as carrier current of the receiving frequency of station A is being transmitted over the common medium CM and the handset at station A is in normal position. When the handset at station A is removed from the cradle to answer the call, a shunt circuit is closed by contacts 19 through resistor 64 thereby effecting the deenergization of tube 61 and preventing its reenergization while a conversational connection is maintained between station A and the calling station. While the handset is removed at station A, the oscillator-modulator tube 80 generates current of the frequency of the transmitting channel assigned individually to station A, this current being modulated by speech, amplified by tube 85 and transmitted over conductors 1 and 2 to the calling station. If the station key corresponding to station A is depressed at another station while station A is busy on a call from a first one of the other stations, the carrier current being transmitted from station A will effect the energization of the busy lamp and busy relay at this other station and prevent the subscriber thereat from interfering with or hearing the conversation between station and said first other station. When the handsets are restored at both the calling station and at station A, station A is rendered selectable for communication with any other calling station.

What is claimed is:

1. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of channels each of a different particular frequency, a pair of said channels being individually assigned to each of said stations, one channel of the pair assigned to each station being used for transmitting speech to and the other channel of the pair being used for receiving speech from any other calling station, receiving means and transmitting means at each of said stations, the transmitting means at each station comprising a carrier source of the frequency of the assigned individual transmitting channel and a carrier source of variable frequency, means at each station normally tuning the receiving means thereat to the frequency of the assigned individual receiving channel and normally tuning the variable carrier source thereat to the frequency of the assigned individual transmitting channel, means at each station for tuning the carrier source of variable frequency thereat to the frequency of the receiving channel assigned individually to any other station with which communication is desired and for tuning the receiving means thereat to the frequency of the transmitting channel assigned individually to any other station with which communication is desired, and signal means at each station normally responsive to carrier current of the frequency of the assigned individual receiving channel.

2. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on a call from any other of said stations, one of said channels as a receiving

channel and another of said channels as a transmitting channel, receiving means at each of said stations normally tuned to the frequency of its assigned individual receiving channel, transmitting means at each of said stations comprising a carrier source tuned to the frequency of the assigned individual transmitting channel and a carrier source tunable to the frequency of any one of the receiving channels assigned individually to the other stations, and signal means at each of said stations normally responsive to carrier current of the frequency of the assigned individual receiving channel.

3. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on a call from any other of said stations, one of said channels as a receiving channel and another of said channels as a transmitting channel, receiving means at each of said stations normally tuned to the frequency of its assigned individual receiving channel, transmitting means at each of said stations comprising a carrier source tuned to the frequency of the assigned individual transmitting channel and a carrier source tunable to the frequency of any one of the receiving channels assigned individually to the other stations, signal means at each of said stations normally responsive to carrier current of the frequency of the assigned individual receiving channel, other signal means at each of said stations for responding to carrier current of the frequency of any one of the transmitting channels individually assigned to the other stations, and means at each of said stations for tuning said other signal means to the frequency of the transmitting channel which is individual to any particular one of the other stations with which communication is desired.

4. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on a call from any other of said stations, one of said channels as a receiving channel and another of said channels as a transmitting channel, receiving means at each of said stations normally tuned to the frequency of its assigned individual receiving channel, means at each of said stations for tuning the receiving means thereat to the frequency of the transmitting channel individual to any other station with which communication is desired, transmitting means at each of said stations comprising a carrier source tuned to the frequency of the assigned individual transmitting channel and a carrier source tunable to the frequency of any one of the receiving channels assigned individually to the other stations, and signal means at each of said stations normally responsive to carrier current of the frequency of the assigned individual receiving channel.

5. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on a call from any other of said stations, one of said channels as a receiving channel and another of said channels as a transmitting channel, receiving means at each of said stations normally tuned to the frequency of its

assigned individual receiving channel, means at each of said stations for tuning the receiving means thereat to the frequency of the transmitting channel individual to any other station with which communication is desired, transmitting means at each of said stations comprising a carrier source tuned to the frequency of the assigned individual transmitting channel and a carrier source tunable to the frequency of any one of the receiving channels assigned individually to the other stations, signal means at each of said stations normally responsive to carrier current of the frequency of the assigned individual receiving channel, other signal means at each of said stations for responding to carrier current of the frequency of any one of the transmitting channels individually assigned to the other stations, and means at each of said stations for tuning said other signal means to the frequency of the transmitting channel which is individual to any particular one of the other stations with which communication is desired.

6. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on calls from another of said stations, one of said channels as a receiving channel and one of said channels as a transmitting channel, a telephone receiver at each of said stations, means at each station comprising demodulating means connecting the receiver thereat to said common medium, a busy relay and a busy signal at each station, control means at each station connected to said common medium for controlling the operation of the busy relay and signal thereat, the control means at each station normally operatively tuned to the frequency of the assigned individual receiving channel of the station, keys at each station, one for each other station, means at each station rendered effective by the operation of any one of the keys thereat for operatively connecting the busy relay and busy signal thereat in circuit with the control means thereat, and means individual to each of said keys at each station for tuning the connection between the common medium and the control means thereat to the frequency of the transmitting channel assigned individually to the station corresponding to any operated key.

7. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto, for use on calls from another of said stations, one of said channels as a receiving channel and one of said channels as a transmitting channel, a telephone receiver at each of said stations, means at each station comprising demodulating means connecting the receiver thereat to said common medium, means at each station normally tuning the demodulating means thereat to the frequency of the assigned individual receiving channel, a busy relay and a busy signal at each station, control means at each station connected to said common medium for controlling the operation of the busy relay and signal thereat, the control means at each station normally operatively tuned to the frequency of the assigned individual receiving channel of the station, keys at each station, one for each other station, means at each station rendered effective by the operation of any one of the keys thereat for op-

eratively connecting the busy relay and busy signal thereat in circuit with the control means thereat, means individual to each of said keys at each station for tuning the connection between the common medium and the control means thereat to the frequency of the transmitting channel assigned individually to the station corresponding to any operated key, and contact means at each station actuated by the energization of said relay thereat, when the station corresponding to an operated one of the keys is busy, for disabling the receiver thereat.

8. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto for use on calls from another of said stations one of said channels as a receiving channel and one of said channels as a transmitting channel, a telephone receiver at each station, means at each station comprising demodulating means connecting the receiver thereat to said common medium, means at each station normally tuning the demodulating means thereat to the frequency of the assigned individual receiving channel, a busy relay and a busy signal at each station, control means at each station comprising a gas-filled discharge tube connected to said common medium for controlling the operation of the busy relay and busy signal thereat, the control means at each station normally operatively tuned to the frequency of the assigned individual receiving channel of the station, selective means at each station individual to each of the other stations for operatively connecting the busy signal and busy relay in circuit with the control means thereat and for tuning the connection between the discharge tube thereat and common medium to the frequency of the individual transmitting channel assigned to any other station with which communication is desired, thereby to enable the energization of the busy signal and busy relay at a calling station responsive to carrier current of the frequency of the individual transmitting channel of the station with which communication is desired.

9. In a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto for use on calls from another of said stations one of said channels as a receiving channel and one of said channels as a transmitting channel, a telephone receiver at each station, means at each station comprising demodulating means connecting the receiver thereat to said common medium, means at each station normally tuning the demodulating means thereat to the frequency of the assigned individual receiving channel, a busy relay and a busy signal at each station, control means at each station comprising a gas-filled discharge tube connected to said common medium for controlling the operation of the busy relay and busy signal thereat, the control means at each station normally operatively tuned to the frequency of the assigned individual receiving channel of the station, selective means at each station individual to each of the other stations for operatively connecting the busy signal and busy relay thereat in circuit with the control means thereat and for tuning the connection between the discharge tube thereat and common medium to the frequency of the individual trans-

mitting channel assigned to any other station with which communication is desired, thereby to effect the energization of the busy signal and busy relay at any calling station responsive to carrier current of the frequency of the individual transmitting channel of the station with which communication is desired, and means at each station for transmitting a carrier of the frequency of the individual transmitting channel whenever the station is busy.

10. On a telephone system, subscribers' stations, a wide band transmission medium interconnecting said stations and constituting a plurality of carrier channels each of a different frequency, each of said stations having individually assigned thereto for use on calls to said station from any other station one of said channels as a receiving channel and one of said channels as a transmitting channel, a source of power common to said stations and connected thereto by the conductors of said common transmission medium, each of said stations comprising a telephone receiver and transmitter, means comprising a detector tube connecting said receiver to said common medium, a ringer, a busy lamp, a busy relay, means comprising a gas-filled discharge tube connecting said ringer, lamp and relay to said common medium, means normally tuning the connection between said detector tube and common medium to the frequency of the receiving channel individual thereto, means normally tuning the connection between said discharge tube and common medium to the frequency of the receiving channel individual thereto thereby to effect the breakdown of said tube responsive to the transmission over said common medium of carrier current of the frequency of said receiving channel to operate said ringer, an oscillator-modulator tube, means in the oscillatory control circuit of said oscillator-modulator tube tuned to the frequency of the individual transmitting channel, other means in the oscillatory control circuit of said oscillator-modulator tube tunable to the frequency of the individual receiving channel of any of the other stations, contacts normally short-circuiting said other means, means comprising an amplifier connecting the output of said oscillator-modulator tube to said common medium, means connecting said transmitter to said oscillator-modulator tube to modulate the oscillatory current generated in said tube, circuit means including said power source rendered effective by the operation of said ringer and by the removal of the receiver from normal for energizing said detector and amplifier and oscillator-modulator tubes, calling keys, one for each of the other stations, means individual to each of said keys and rendered effective by operation of the key to tune the connection between said common medium and the detector tube and the connection between said common medium and said discharge tube to the frequency of the transmitting channel individual to the station corresponding to the operated key and to tune said other means in the oscillatory control circuit of said oscillator-modulator tube to the frequency of the receiving channel individual to the station corresponding to the operated key, means responsive to the operation of any of said station keys for opening the operating circuit of said ringer and for connecting said lamp and relay for operation responsive to transmission over said common medium of carrier current of the frequency of the transmitting channel individual to the station corresponding to the operated key, means actuated by the ener-

gization of said relay for preventing the energization of said tubes and receiver, means responsive to the operation of any of said keys for opening said contacts normally short-circuiting said other means in the oscillator control circuit of said oscillator-modulator tube, locking mechanism common to said keys normally positioned to allow the operation of any key, and means actu-

ating said locking mechanism responsive to the removal of the receiver from normal position to prevent the operation of any of said keys while said receiver is off-normal and to lock operated any key which is operated at the time of removal of the receiver from normal.

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