May 12, 1925. 1,537,255

J. MILLS

CARRIER CURRENT SYSTEM

Filed Dec. 28, 1920

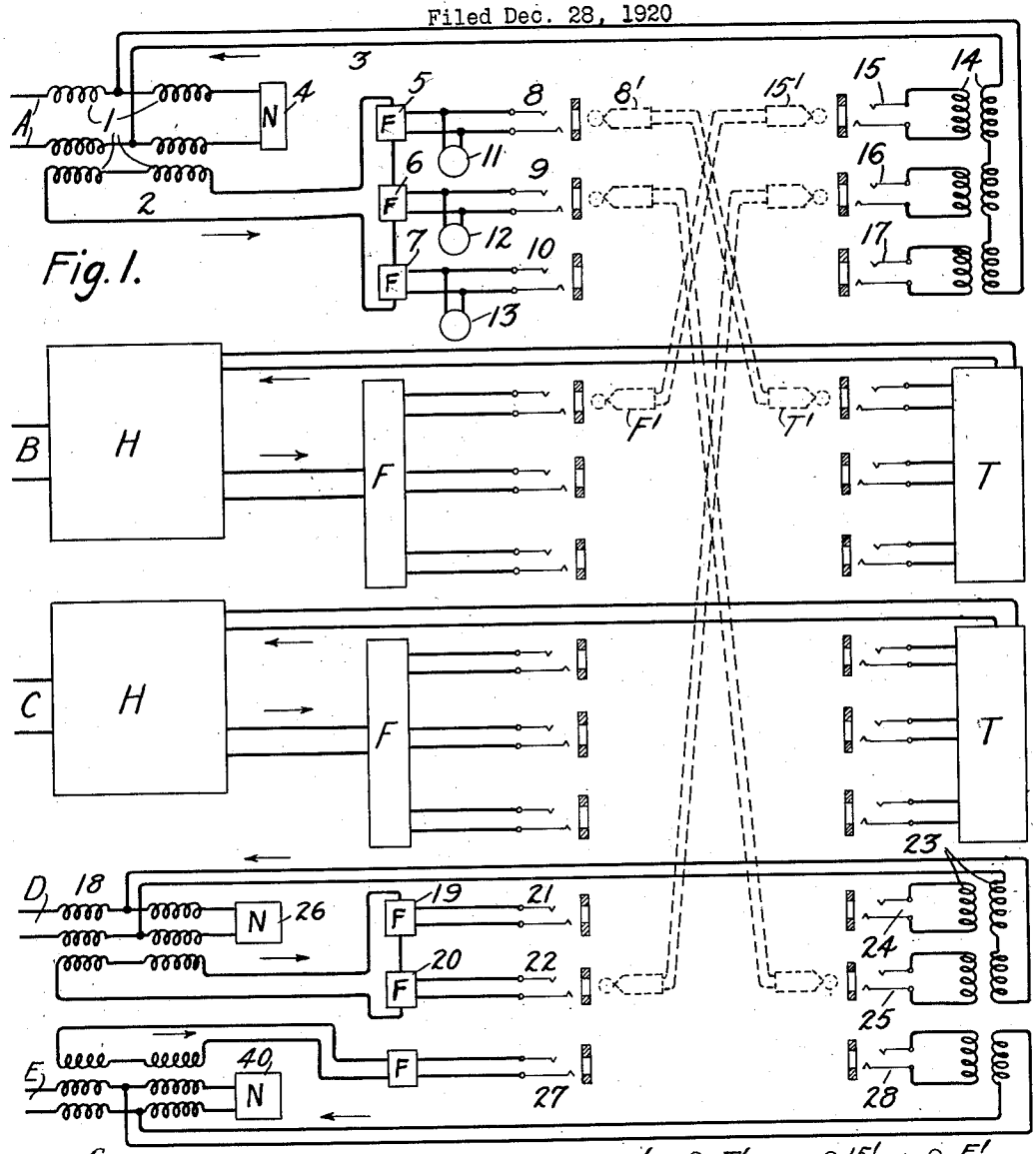

Fig. 1.

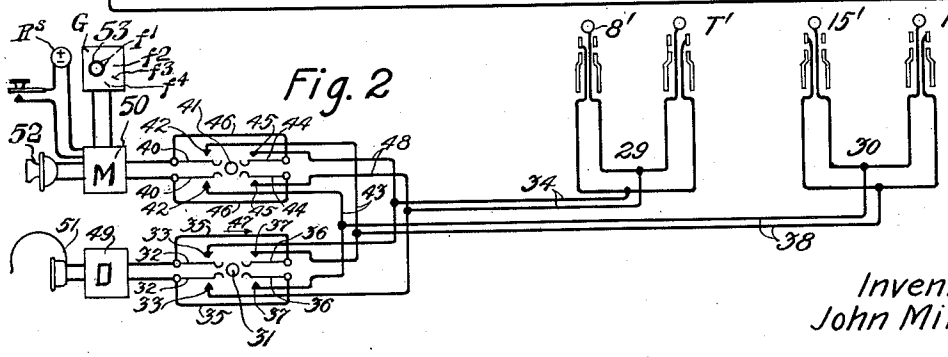

Fig. 2

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by C. C. Sprague. Atty.

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UNITED STATES PATENT OFFICE.

JOHN MILLS, OF WYOMING, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

CARRIER-CURRENT SYSTEM.

Application filed December 28, 1920. Serial No. 433,716.

To all whom it may concern:

Be it known that I, JOHN MILLS, a citizen of the United States, residing at Wyoming, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Carrier-Current Systems, of which the following is a full, clear, concise, and exact description.

This invention relates to a carrier wave transmission system having means for separately interconnecting corresponding carrier channels.

One object of this invention is to devise means whereby any one of a multiplicity of carrier wave channels terminating at an intermediate station may be connected with any one of a number of other carrier channels terminating at said station.

Another object is to provide means whereby the corresponding frequency channels of any number of carrier lines may be interconnected at an intermediate or toll station.

These objects and others which will appear as the nature of the invention is set forth may be accomplished by means of the arrangement described in the following specification and illustrated in the accompanying drawing in which Fig. 1 shows an intermediate station having five carrier transmission lines entering it, and Fig. 2 illustrates a toll station equipment.

Briefly described, this invention as shown in the accompanying drawing comprises an intermediate station having a multiplicity of carrier transmission lines entering it, upon each of which a number of carrier channels are adapted to be superimposed, a balanced transformer for connecting each line to incoming and outgoing paths, filters included in the incoming path for separating the carrier frequencies and switching means, which may be cord circuits, for connecting the corresponding channels of any pair of lines entering said toll station.

In Fig. 1, the station apparatus for three lines is shown in some detail, whereas for the other two lines the disclosure is purely diagrammatic; but it is to be understood that all the lines are connected to the switch terminals in the manner illustrated for lines A, D and E at the top and bottom of this figure. The arrangement at the bottom of the figure shows two lines, one of which is provided with two channels and the other with a single channel, and hence in the former case but two paths can be completed through the intermediate station and in the latter but one channel is available.

Referring to Fig. 1, the line A provided with three carrier channels, which for identification purposes are referred to as A^1, A^2 and A^3, is connected by a balanced transformer 1 to incoming and outgoing paths 2 and 3 respectively and a network 4 adapted to simulate the impedances of the line is associated with the balanced transformer. The incoming path 2 is connected through filters 5, 6 and 7, selective of the respective signal frequencies of the three channels, to terminals of respective jacks 8, 9 and 10. The leads connected to the respective terminals are provided with signal mechanisms 11, 12 and 13, diagrammatically shown, each of which includes a detector of any well-known type and the usual signal indicating means.

The outgoing path connects the midpoint of the balanced transformer with the secondary winding of a transformer 14, which has associated with it a plurality of primary windings respectively connected to the terminals 15, 16 and 17. Lines B and C each provided with three channels B^1, B^2 and B^3 and C^1, C^2 and C^3, are connected to the station terminals assigned to them in a manner similar to line A, the connecting means being diagrammatically indicated by H, F and T.

Line D having two carrier channels is shown connected by a balanced transformer 18, through filters 19 and 20 to the terminals 21, 22 and through a transformer 23 to the terminals 24 and 25, a network 26 being associated with the balanced transformer 18 to simulate the impedance of the line.

Line E has a single carrier channel and is connected to its terminals 27 and 28 in a manner similar to the other lines and a network 40 designed to balance the line is associated with it.

It is to be understood that each of the channels superimposed upon the different lines is provided with a signal indicating device of the type hereinbefore referred to and in a manner similar to that disclosed for line A.

The corresponding channels of the different lines, that is, A^1, B^1, C^1 and D^1; A^2, B^2, C^2, and D^2; and A^3, B^3, C^3 and E^1, are

respectively supplied with carrier currents of the same frequency in any well-known manner. Hence, the channels D^1 and D^2 of line D are designed to transmit the same carrier frequencies as the first and second channels, and line E employs the same frequency as the third channel, of the three first-mentioned lines.

Referring to Fig. 2, there is shown a toll station apparatus consisting of a pair of cords 29 and 30 having plug terminals and an operator's set adapted to be connected to these cords by keys. The plungers of these keys are indicated by 31 and 41. The pairs of jacks connected to the incoming and outgoing paths of each channel will preferably be mounted side by side and the cords may be separate as herein shown or a single cord having four wires and two sets of plugs may be used, but in either case their plug terminals will be arranged side by side. So that, in the act of answering a call, the operator will connect both cords to the incoming and outgoing paths of a channel.

The operator's receiver is connected to a pair of flexible contacts 32 of the key 31 associated with which are a pair of stationary contacts 33 connected by the leads 34 to the cord 29. Contacts 32 are also connected by connectors 35 to a second pair of flexible contacts 36 which are adapted to cooperate with a pair of stationary contacts 37 connected by the leads 38 to the cord 30. The operator's transmitter is connected to a pair of flexible contacts 40 of the key 41 having cooperating stationary contacts 42 connected to the leads 38 by the wires 43. The flexible contacts 44 are designed to cooperate with the pair of stationary contacts 45 connected to the leads 34. Contacts 40 and 44 are connected by the connectors 46.

In answering a call the operator inserts the plugs 8′ and 15′ in the jacks 8 and 15 and throws her keys in the direction indicated by the arrow 47, and hence their plungers 31 and 41 in the opposite direction to actuate contacts 32 and 40 respectively. The incoming signal currents will flow from the plug 8′ through the cord 29, leads 34, contacts 33 to the contacts 32 which are connected to the receiver 51. The transmission circuit includes the contacts 40 and 42, leads 43, conductors 38, cord 30, and plug 15′.

By reversing the position of the keys the operator may receive over the circuit including the plug F′, cord 30, conductors 38, contacts 37, and 36 and connectors 35; and transmission is effected over the circuit including the connectors 46, contacts 44 and 45, conductors 48, leads 34, cords 29 and the plug T′.

The operator's set is provided with any well-known detecting and modulating devices, diagrammatically indicated at 49 and 50, so that she may communicate with the distant stations, either for ringing or talking purposes.

The modulating apparatus 50 may include a plurality of generators one for each channel, though a single adjustable generator G will preferably be used, to supply carrier current to any of the channels, as well as a low frequency ringing source RS and a microphone 52 for modulating the carrier current. If desired, amplifying devices (not shown) may be associated with the detecting and carrier current supply means. The generator G is shown provided with a handle 53 which may conveniently be the handle of the tuning condenser, where the generator is of the regenerative amplifier type, for giving the generator any desired frequency adjustment. Four frequency adjustments f_1, f_2, f_3, and f_4 are indicated, corresponding to respective carrier frequencies employed by the channels.

The operation of the system will be clear from the following description. A call coming in over channel A^1 energizes the signal indicator 11. The operator having plugged the cord terminals 8′ and 15′ into the jacks 8 and 15, and set the keys 31 and 41 as described above, may communicate with the distant station. We will suppose that the A^1 subscriber desires to be connected with channel B^1 of line B. The operator inserts the other plugs F′ and T′ of her cord circuit into the upper jacks of line B and communicates with the station or subscriber to whom this channel is assigned. Having thereby completed the connection and advised the A^1 subscriber that the line is ready the keys are returned to neutral position, and communication between the stations may proceed.

A call originating at the station utilizing channel A^2, that is, the second channel of line A will energize the signal device 12. Having adjusted the oscillator G of her set to supply a carrier frequency f_2 corresponding to the second channel, the operator proceeds as described with reference to channel A^1 and communicates with subscriber A^2. We will suppose that this subscriber desires to communicate with the subscriber using the corresponding channel of line D. The operator will then insert the other plugs of the cord which she is using into the jacks 22 and 25, inform subscriber D^2 that another subscriber desires to communicate with him, advise subscriber A^3 that the line is ready and return her keys 31 and 41 to neutral position.

By properly actuating the key 31, the operator is enabled to supervise all connections, since with this key in one position she may listen to subscriber A^1 and with this key in the reverse position she may listen to subscriber B^2. Obviously, a single key may be used to connect the operator's receiver with

the two cords 29 and 30 simultaneously so that the conversation between the two subscribers may be heard.

In a manner similar to that described above with reference to channels A′—B′ and B^2—D^2, the third channel of line A may be connected with channel B^3, C^3 or E^1; channel A^2 with channel C^2 or D^2 and channel C^1 with channel A^1, B^1 or D^1, when desired. Thus, it will be seen that any channel of the several lines may be connected to a corresponding channel of any other line.

A single station equipment is herein shown, but it is to be understood that a plurality of cords and a corresponding number of keys, each adapted to connect the operator's set with one of the cord circuits, will be used, and that by actuating the proper keys the operator's set may be connected to any desired cord circuit.

While a system having five carrier transmission lines, some of which have three signal channels, another two and a third one for connecting a toll station with a plurality of distant stations has been described, it is evident that in principle there is no limit to the number of lines which may be associated with said intermediate station and that, within practical limits, any number of channels may be superimposed on each line.

Obviously, the transmission lines may be associated with the distant stations in any desired manner, that is to say, each line may extend to a different station, a plurality of distant stations may be associated with a single line, a carrier channel being assigned to each, or several lines may be used for communication between each of the distant stations and the toll station, should traffic conditions demand it.

From the preceding description it will be evident that this arrangement provides a carrier current system of great flexibility, since any frequency channel of any system may be connected to the corresponding channel of any other system extending between the toll station and the distant stations. Moreover, the operator at the toll station may communicate with any subscriber or station and may also supervise all connections.

Although this system is described as particularly adapted to a carrier system in which each channel employs the same incoming and outgoing frequency, it may also be applied to a system in which each channel has a different incoming and outgoing frequency, provided each carrier frequency in one direction is always associated with a definite carrier frequency in the opposite direction. In this case it would be impossible to connect together two channels having the same outgoing frequency with respect to the terminal stations.

The invention is not, of course, limited to systems in which the carrier wave channels are superposed on a conducting line circuit, but applies equally well to systems employing any other type of medium for transmission of the carrier waves.

Certain specific details have been herein shown and described merely for the purpose of disclosing the principles of the invention and it is to be understood that this invention is not limited to these specific features but only by the scope of the appended claims.

As will have been seen from the foregoing description and the drawing, the term "carrier wave channel" or "carrier channel," or equivalent expression, is used herein to designate the apparatus which is individual rather than common to the carrier waves. Thus there is a transmitting channel for each carrier wave at each point of the system from which transmission is to take place on the respective carrier wave. There are also individual receiving channels for the waves at stations at which the waves are to be separately received. "Channel branch" is generic to transmitting and receiving channel and designates a circuit or connection which is appropriated for separate and independent use by and in connection with a particular carrier wave.

What is claimed is:

1. A signaling system comprising a multiplicity of lines having a plurality of carrier current channels employing carrier currents of different frequencies superimposed on each line and means at an intermediate station for connecting any channel of one line with a channel of any other line.

2. A signaling system comprising a multiplicity of lines, a plurality of separate communication channels superposed on each line, employing corresponding carrier frequencies, and means at an intermediate station for interconnecting the corresponding frequency channels of any of said lines.

3. A signaling system comprising an intermediate station, a multiplicity of lines entering said station, a plurality of carrier current channels employing different carrier frequencies superimposed on each line, individual channel branches at said station and means for connecting corresponding channel branches at said station.

4. A signaling system comprising an intermediate station, a multiplicity of lines entering said intermediate station, a plurality of carrier current channels employing different carrier frequencies superimposed on each line, individual channel branches at said station and switching means for connecting corresponding channel branches at said station.

5. A signaling system comprising a toll station, a multiplicity of lines entering said station, a plurality of carrier current channels employing different carrier frequencies superimposed on each line, balancing means

at said station for connecting two-way transmission paths to each line, individual channel branches at said station and means for connecting the corresponding channel branches of said lines.

6. A carrier current system for connecting a plurality of terminal stations through an intermediate station comprising an intermediate station, a plurality of lines between respective terminal stations and said intermediate station, a plurality of carrier channels employing different carrier frequencies superposed on each line and means at said intermediate station for interconnecting a channel of any of said lines from one terminal station with a channel of any line from another terminal station.

7. A carrier current system for connecting a plurality of terminal stations through an intermediate station, comprising an intermediate station, a plurality of lines between each terminal station and said intermediate station, a plurality of carrier channels employing different carrier frequencies superposed on each line and means at the intermediate station for interconnecting the corresponding channels of any of said lines.

8. A carrier current system for connecting a plurality of terminal stations through an intermediate station, comprising an intermediate station, a plurality of lines between each terminal station and said intermediate station, a plurality of carrier channels employing different carrier frequencies superposed on each line and means at the intermediate station for interconnecting a channel of any of said lines from one terminal station with a corresponding channel of any one of said lines from another terminal station.

9. A signaling system comprising a multiplicity of lines having a plurality of carrier current channels employing different carrier frequencies superimposed on each line, individual means at an intermediate station for interconnecting pairs of said channels and supervising means at said station for the interconnected channels.

10. A signaling system comprising a multiplicity of lines, each provided with a plurality of separate communication channels of corresponding carrier frequencies, means at an intermediate station for interconnecting the channels of one of said lines and the corresponding frequency channels of other of said lines and means at said station for supervising any channel interconnection.

11. A carrier current system for connecting a plurality of terminal stations through an intermediate station comprising an intermediate station, a plurality of lines between respective terminal stations and said intermediate station, means associated with each line for permitting a plurality of carrier channels employing different carrier frequency currents superposed on each line and means at said intermediate station for interconnecting channels of each of said lines from one terminal station with channels of any of said lines from the other terminal stations, and supervising means at said intermediate station.

12. A carrier current system for connecting a plurality of terminal stations through an intermediate station, comprising an intermediate station, a plurality of lines between each terminal station and said intermediate station, carrier channels employing different carrier frequencies superposed on each line, means at the intermediate station for interconnecting the corresponding channels of any of said lines and means at said station for supervising any channel connection.

13. In a carrier signalling system, an interconnecting station, respective carrier receiving channel and carrier transmitting channel terminals thereat, an interconnecting circuit for extending connection from a receiving channel terminal to a transmitting channel terminal, local apparatus including a carrier wave transmitter and receiver, and switching arrangements for operatively connecting said local apparatus to said interconnecting circuit.

14. In a carrier current system, carrier current lines each having respective receiving channel and transmitting channel terminals, the channels of each line employing a plurality of different carrier frequencies, an interconnecting circuit for extending connection from a receiving channel terminal to a transmitting channel terminal, a local carrier current transmitter having a source of carrier currents, means for deriving from said source a carrier current of the carrier frequency of the transmitting channel to which connection is extended, and means to utilize the derived current for talking over the connected transmitting channel.

15. In a carrier wave system, an interconnecting station, a plurality of receiving carrier channel terminals and a plurality of transmitting carrier channel terminals, the receiving channels and the transmitting channels employing wave frequencies respectively corresponding, a pair of interconnecting cords for extending connection between a receiving channel terminal and a transmitting channel terminal and another connection between a receiving channel terminal and a transmitting channel terminal which are oppositely directed to the first receiving and transmitting channels, an operator's set including carrier wave transmitting and receiving sets, and switching arrangements for connecting either the receiving set or the transmitting set to either cord circuit at will.

16. In a carrier wave signaling system, an interconnecting station, a plurality of in-

coming carrier channel terminals thereat employing carrier waves of respective frequencies, a plurality of groups of outgoing carrier channel terminals at said station, the outgoing channels of each group employing carrier waves of respective frequencies, and interconnecting means for extending a connection from any incoming carrier channel terminal to a terminal in any one of said outgoing groups of carrier channel terminals for enabling the incoming channel to repeat into the connected outgoing channel.

In witness whereof, I hereunto subscribe my name this 20th day of December A. D., 1920.

JOHN MILLS.