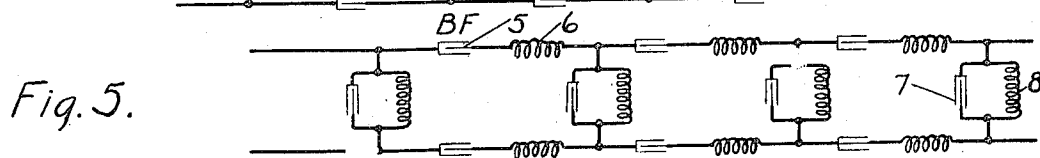
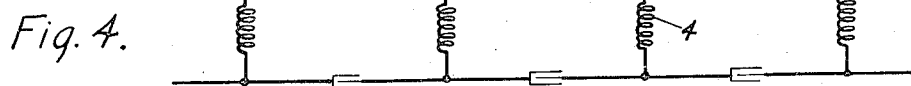
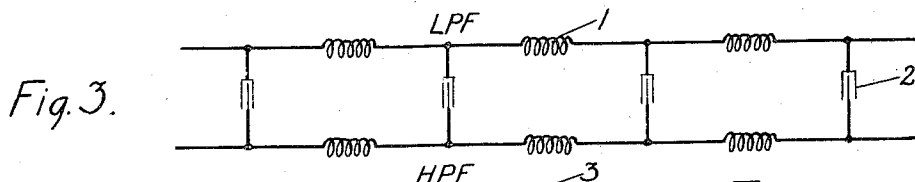
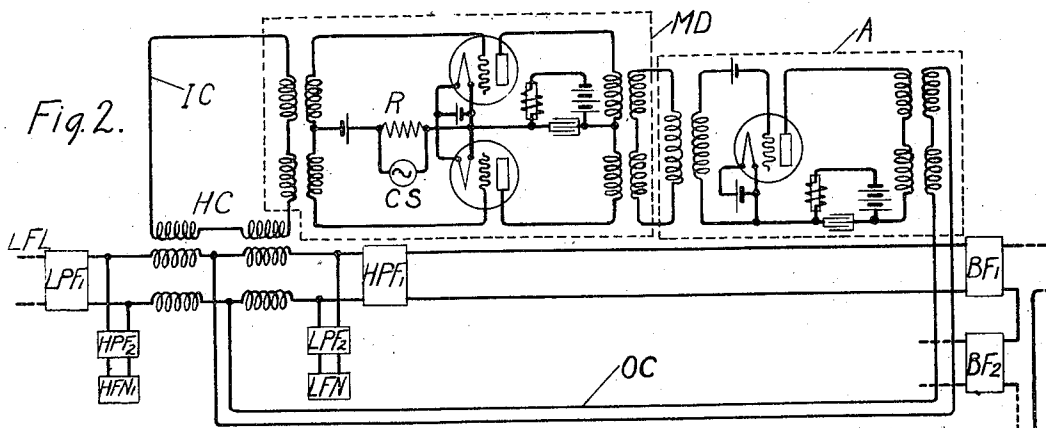
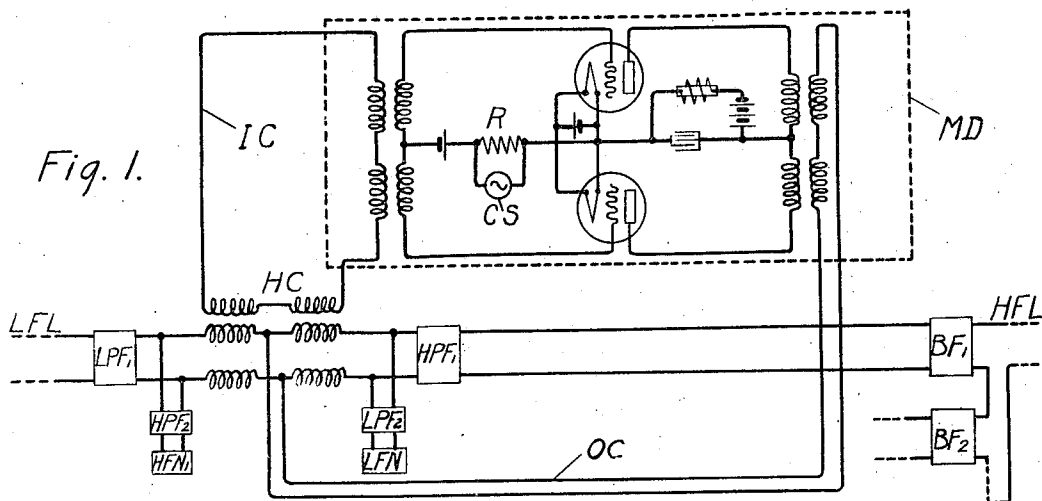


Mar. 13, 1923.

1,448,408.

J. S. JAMMER.
 DUPLEX CARRIER WAVE SYSTEM.
 FILED JAN. 21, 1920.



Inventor:
 Jacob S. Jammer.
 by C. C. Sprague. Att'y.

UNITED STATES PATENT OFFICE.

JACOB S. JAMMER, OF NEW YORK, N. Y., ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

DUPLEX CARRIER WAVE SYSTEM.

Application filed January 21, 1920. Serial No. 352,932.

To all whom it may concern:

Be it known that I, JACOB S. JAMMER, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Duplex Carrier Wave Systems, of which the following is a full, clear, concise, and exact description.

This invention relates in general to duplex transmission or signaling systems and more particularly to carrier current telephone systems. The principles of the invention are more particularly adapted for application in systems employing conductive circuits throughout but may be applied in systems in which the high frequency transmission is carried on through the natural media.

An object of the invention is to provide systems of the type wherein a single apparatus is used to modulate waves passing in one direction and to detect waves passing in the other direction with improved line balancing impedance means. Individual means are provided for balancing the high frequency line separately for each carrier frequency. Since with carrier currents of the frequencies ordinarily used, a high frequency line often varies considerably and irregularly in impedance for the various frequencies it is of considerable advantage to balance the line separately for each frequency.

A further object is to provide means in connection with the modulator-detector for compensating for the attenuation produced in the circuit by the various apparatus.

A preferred form of the invention adapted for multiplex systems of carrier current wire transmission wherein several low frequency lines are connected to a single high frequency line comprises a single modulator-detector preferably of the push pull repeater type, but in general, of any suitable type, connected between each low frequency line and the high frequency line by means of a hybrid coil. By the expression "hybrid coil" is meant a three-winding transformer having four pairs of terminals, one pair being adapted for connection to a line, another pair being adapted for connection to a balancing impedance means, and the third and fourth pairs being conjugate with respect to each other when the

first and second mentioned pairs are connected to identical impedances. Band filters separate the various high frequency carrier waves, while high-pass filters keep the low frequency out of the high frequency line and the high frequency balancing network, and low-pass filters keep the high frequency out of the low frequency line and the low frequency balancing network.

The invention is illustrated in the accompanying drawings wherein Fig. 1 diagrammatically represents one arrangement of apparatus comprising a modulator-detector station; Fig. 2 includes in addition to the elements of Fig. 1, an amplifier; while Figs. 3, 4 and 5 represent typical forms of low-pass filter, high-pass filter and band filter respectively, adapted for use in the circuits of Figs. 1 and 2.

Referring to Fig. 1, a low frequency line LFL is connected to a hybrid coil HC through a low-pass filter LPF¹. A reentrant circuit including input circuit IC, modulator-detector MD, and output circuit OC is connected at each terminal to the hybrid coil. The secondary winding of the hybrid coil is included in the input circuit IC of the modulator-detector system MD across the resistance R of which is connected a suitable source CS of carrier current which is to be modulated in accordance with the speech frequency or signaling waves incoming from the line LFL. The modulated high frequency waves having a carrier frequency corresponding to the frequency of the source CS are impressed upon the output circuit OC which is connected to the balanced points of the hybrid coil. These waves will pass through the high-pass filter HPF¹ and the band filter BF¹ to a high frequency line or circuit HFL along which they are propagated to be detected or otherwise received by means of any suitable detecting and receiving apparatus which, in accordance with the present invention, will preferably comprise a modulator-detector system which is a duplicate of that described. In general a high-pass filter is one which passes all frequencies above a certain value and excludes those below approximately the same value. A low-pass filter, on the contrary, passes low and excludes high frequencies.

In shunt to the line at a point between the low-pass filter LPF¹ and the hybrid



coil is connected a high-pass filter HPF^2 to the opposite terminal of which is connected a high frequency balancing net work HFN^1 which is designed to balance the impedance of the high frequency line at the particular range of frequencies which is transmitted through the band filter BF^1 . Shunted across the line at a point between the high-pass filter HPF^1 and the hybrid coil is a low-pass filter LPF^2 to the opposite terminals of which is connected a low frequency balancing net work LFN which is designed to balance the impedance of the low frequency line for the range of frequencies which the said line is intended to transmit. Although the low-pass filter LPF^2 and the net work LFN is effective, shunt relation to the terminal element of the filter HPF^1 which will, in general, transmit a certain amount of low frequency current. This is compensated for by the terminal element of the high-pass filter HPF^2 through which likewise a certain portion of the low frequency current will pass. The shunting effect of the terminal element of the low-pass filter LPF^1 on the high frequency net work is similarly compensated for by the filter LPF^2 .

For multiplex transmission over the high frequency line a number of other band filters BF^2 , etc., are connected in series to the filter BF^1 with respect to the high frequency line. To each additional filter is connected a modulator-detector and a low frequency line in the same manner as to the filter BF^1 . Each modulator-detector will have a carrier supply source CS of a frequency differing sufficiently from each of the others as to allow separation of the modulated waves by the filters BF^1 , BF^2 , etc.

Operation.—The low frequency line which may be of any suitable length and may include telephone exchanges or other apparatus typifies, in general, a source of signaling frequency waves to be transmitted. Filter LPF^1 is designed to pass these waves and no others. The waves are impressed through the hybrid coil and the circuit IC to the system MD where they cause modulation of the waves from the source CS which modulated waves pass through the circuit OC to the coil HC and through filters HPF^1 and BF^1 to the line HFL . Waves arriving from the high frequency line pass through the filters BF^1 and HPF^1 through the hybrid coil and the circuit IC to the system MD . Due to the action of the system MD upon the combined waves from source CS and the incoming waves, the latter are detected, and the low frequency detected currents are transmitted through the circuit OC , the hybrid coil and the filter LPF^1 to the low frequency line.

The modulator-detector system MD is a type of apparatus well known in the art and

hence need not be described here in further detail.

The arrangement of Fig. 2 is identical with that of Fig. 1, except that there is included in the circuit OC an amplifying system A of any suitable type. The amplifying system functions to increase the energy of both the high and low frequency waves passing therethrough, thereby compensating for attenuation due to the various other apparatus of the system.

Fig. 3 illustrates a typical form of low-pass filter for use in a system of this type. It comprises inductances 1 in series with the line and the capacities 2 in shunt to the line.

Fig. 4 illustrates a typical form of high-pass filter comprising capacities 3 in series with the line and inductances 4 in shunt to the line.

Fig. 5 illustrates a typical form of band filter BF comprising capacities 5 and inductances 6 in the series with the line and inductances 7 and capacities 8 in shunt to the line. The proper values of the electrical elements of these filters will depend upon the range of frequencies to be transmitted thereby, and the methods of computation thereof are well known to those skilled in the art.

For radio transmission the line HFL will be replaced by an antenna.

The novel features believed to be inherent in the invention are defined in the appended claims.

What is claimed is:

1. In a carrier current circuit, a high frequency line, a plurality of low frequency lines connected thereto, means connecting each of said low frequency lines with said high frequency line comprising a low pass filter adjacent each low frequency line, a high pass filter adjacent said high frequency line, a hybrid coil between said filters, a high pass filter and a balancing network for said high frequency line individual to each low frequency line connected between each of said low pass filters and the corresponding hybrid coil, a low pass filter and a low frequency balancing network individual to each low frequency line connected to the circuit between each of said first mentioned high pass filters and the corresponding hybrid coil, and a detector having its input circuit coupled to said hybrid coil and its output circuit coupled thereto in conjugate relation with respect to said first coupling.

2. In a signaling system, a high frequency line, means for transmitting thereover several different bands of signaling waves each adapted to carry a signal characteristic of a given low frequency line, a plurality of balancing networks each adapted to balance said high frequency line at a range of frequencies corresponding to one

of said bands of signaling waves, and a single translating circuit connecting said lines to translate waves received from each low frequency line to higher frequencies for impression on said high frequency line and to translate waves received from said high frequency line to lower frequencies for impression on said low frequency line.

3. A signaling circuit comprising high frequency line terminals, low frequency line terminals, and means connected in the path traversed by energy passing between said circuits comprising in the order named beginning with the high frequency line terminals the following elements; a band filter, a high pass filter, a frequency translating circuit, and a low pass filter.

4. In a duplex transmission circuit comprising a high frequency line and a plurality of low frequency lines connected thereto, duplex transmitting and translating circuits connected between each low frequency line and the high frequency line, each of said circuits comprising a high pass filter for preventing the transfer of low frequency wave energy into said high frequency line, and a band filter on the high frequency line side of said high pass filter for preventing the transmission from said high frequency line to said high pass filter of wave energy other than a limited band within the range of the frequencies freely passed by said high pass filter.

5. A signaling circuit comprising high

frequency line terminals and a plurality of pairs of low frequency line terminals, a frequency translating circuit connected between each said pairs of low frequency line terminals and said high frequency line terminals, and balancing networks individual to each low frequency line for balancing said high frequency line, each said network being connected to said signaling circuit at a point between its corresponding low frequency line and said translating circuit, said networks being disconnected from each other except by paths through the connections aforesaid.

6. A signaling circuit comprising multiple channel conductor terminals and a plurality of pairs of other conductor terminals, a frequency translating circuit connected between each said pair of other conductor terminals and said multiple channel conductor terminals, and balancing networks individual to each said other conductor for balancing said multiple channel conductor, each said network being connected to said signaling circuit at a point between its corresponding one of said other conductor terminals and said translating circuit, said networks being disconnected from each other except for paths through said connections as aforesaid.

In witness whereof, I hereunto subscribe my name this 16th day of January A. D., 1920.

JACOB S. JAMMER.