Nov. 13, 1923. 1,473,682

H. S. OSBORNE

REPEATER APPARATUS FOR CARRIER SYSTEMS

Filed July 24, 1919

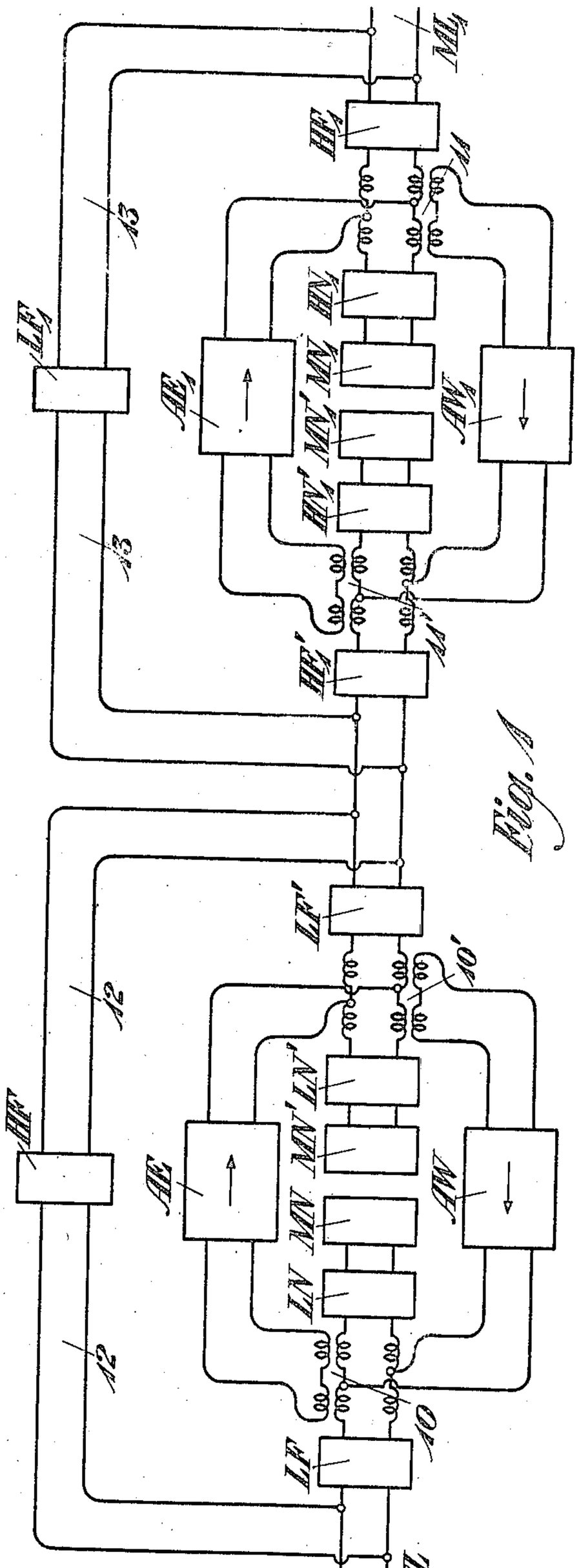

Fig. 1

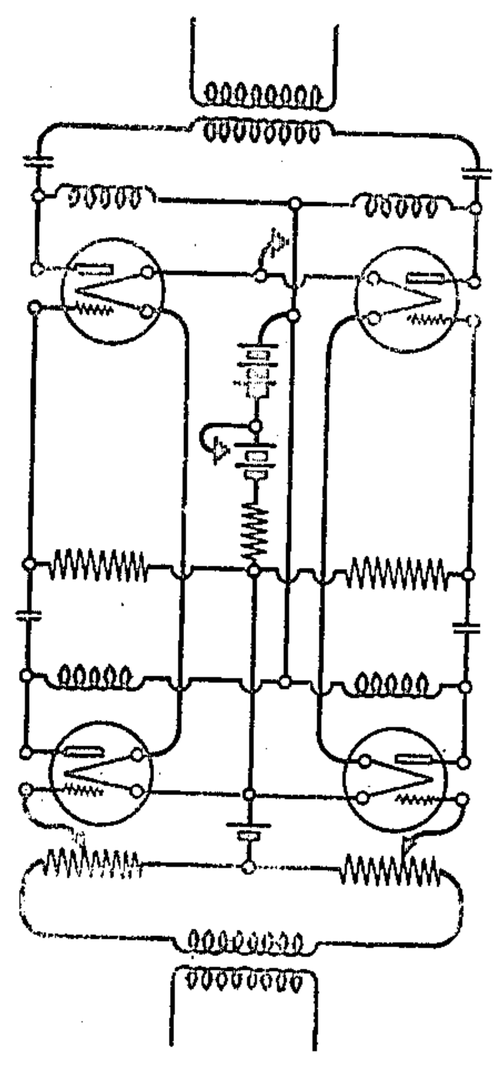

Fig. 5

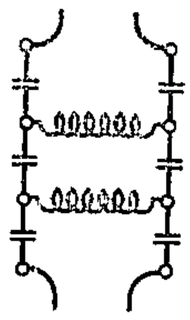

Fig. 3

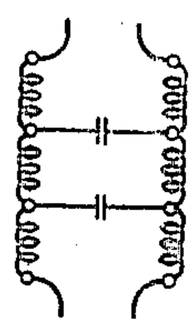

Fig. 4

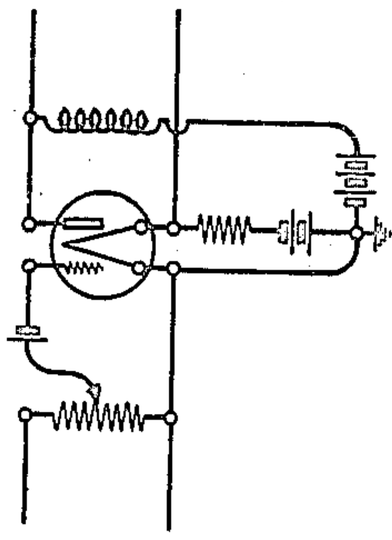

Fig. 2

INVENTOR.
H. S. Osborne
BY
ATTORNEY

Patented Nov. 13, 1923. 1,473,682

UNITED STATES PATENT OFFICE.

HAROLD S. OSBORNE, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

REPEATER APPARATUS FOR CARRIER SYSTEMS.

Application filed July 24, 1919. Serial No. 313,082.

To all whom it may concern:

Be it known that I, HAROLD S. OSBORNE, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Repeater Apparatus for Carrier Systems, of which the following is a specification.

This invention relates to repeater circuits and more particularly to repeater circuits adapted to the amplification of high frequency carrier currents.

Where a carrier system is superposed on an ordinary low frequency transmission line, such as a telephone or telegraph line, and such a line includes a repeater for amplifying the low frequency signals transmitted thereover, it is necessary to make some special provision for amplifying the carrier frequencies transmitted over the line, since the low frequency repeater is not so designed as to efficiently amplify the higher frequencies used for carrier transmission. Since it is desirable to superpose the carrier system upon the low frequency system with the least possible change and reorganization of the latter, it is desirable that some arrangement be provided whereby the high frequency oscillations may be amplified without disturbing the low frequency repeater organization.

An important feature of the present invention is the provision of means for amplifying the high frequency carrier oscillations without disturbing the low frequency repeater. This feature, as well as other aims of the invention, are realized in a specially designed repeater adapted to amplify all of the carrier frequencies transmitted over the low frequency signaling circuit, and in an arrangement of said special repeater whereby it may be connected in series with the low frequency repeater normally associated with the lines. The invention also provides for substantially preventing the carrier oscillations from being transmitted to the low frequency repeater and for preventing the transmission of low frequency signaling currents to the special high frequency repeater. In this manner the low frequency channel and the high frequency channels are maintained distinct from each other and the high frequency apparatus in the repeater stations may be imposed upon the ordinary low frequency system without materially affecting the organization or properties thereof.

The invention may now be more fully understood by reference to the following description when read in connection with the accompanying drawing, Figure 1 of which discloses a schematic diagram of a circuit arrangement embodying the invention, and Figs. 2 to 5, inclusive, of which are circuit diagrams of certain details of the apparatus employed in connection with the invention.

In Fig. 1, ML and ML_1 designate sections of an ordinary low frequency transmission circuit, such as a telephone circuit, these sections being interconnected by a two-way telephone repeater of well known construction comprising amplifiers AE and AW for amplifying low frequency currents transmitted in opposite directions. The repeater apparatus also includes balanced transformers 10 and 10′ of the usual type for interconnecting the input and output circuits of the repeater elements with the line sections, the line ML being balanced by an artificial line or network MN and the apparatus to the right of the transformer 10′ being balanced by an artificial line or network MN′.

In order to exclude frequencies without the telephone range, a low pass filter LF may be inserted in the connection to the main line ML and a similar filter LF′ may be included in the connection between the repeater and the main line section ML_1. Filters LF and LF′ may be of any desired character but are preferably broad band filters of the general type disclosed in U. S. patents to George A. Campbell, 1,227,113 and 1,227,114 dated May 22, 1917. A filter of this type is illustrated in detail in Fig. 4 and comprises a plurality of sections, each consisting of series inductance and shunt capacity so designed as to freely transmit frequencies which lie within the limits of ordinary signal transmission, while substantially extinguishing frequencies lying above said limit. In the special case herein illustrated, in which the arrangement is applied to telephone transmission, the filters LF and LF′ should transmit with negligible attenuation frequencies lying within the range of ordinary telephone transmission, while practically

extinguishing higher frequencies. In order to balance these filters with respect to the low frequency repeater, balancing networks LN and LN′ may be provided in the artificial line connections. These balancing networks may be filters duplicating the filters LF and LF′, or they may simply be networks so designed as to have electrical characteristics simulating those of the filters. The amplifying arrangements AE and AW may be of any well known type but are preferably vacuum tube amplifiers of the type illustrated in more detail in Fig. 2. As these amplifiers are well known in the art, no further description thereof is deemed necessary.

Ordinarily, in the absence of carrier apparatus, the connection between main line sections ML and ML_1 extends through the repeater apparatus comprising amplifiers AE and AW and over a path 13. Where however, the main lines ML and ML_1 are to be used for the transmission of carrier frequencies, as well as ordinary signal frequencies, it is necessary to provide some means for amplifying the carrier frequencies. Accordingly, a specially designed two-way repeater comprising amplifiers AE_1 and AW_1 is connected in parallel with the path 13 and in series with the low frequency repeater AE—AW already described. Amplifiers AE_1 and AW_1 may be of any suitable type, but are preferably of the well known push-pull type in which vacuum tubes are used for securing the desired amplification. The circuit details of one of these amplifiers are illustrated in Fig. 5, but as amplifiers of this character are well known, no further description is deemed necessary.

The input and output circuits of the amplifiers AE_1 and AW_1 are associated with the main line section ML_1 and the connection leading to the main line section ML through balanced transformers 11 and 11′ respectively. Main line ML_1 is balanced by artificial line or network MN_1 and the apparatus to the left of the repeater is balanced by means of an artificial line or network MN_1'.

In order to exclude low frequency signaling currents from the carrier repeater above described, high pass filters HF_1 and HF_1' are provided in the connections leading to the main line sections ML_1 and ML. These filters are also of the general type disclosed in the Campbell patents above referred to and each consists, as illustrated in Fig. 3, of a plurality of sections comprising series capacity and shunt inductance. The elements of these filters are so proportioned as to freely transmit a band of frequencies above the upper limiting frequency of ordinary signal transmission, while substantially extinguishing currents below said limit. In the particular case illustrated, which applies to telephone transmission, the filters HF_1 and HF_1' would be designed to freely transmit frequencies lying above the upper limits of ordinary telephonic transmission, while substantially extinguishing frequencies lying below said limit. In order to balance the filters HF_1 and HF_1', balancing networks HN_1 and HN_1' are provided in the artificial line connections. These balancing networks may simply be filters duplicating the filters HF_1 and HF_1', or they may consist of networks so designed as to have electrical characteristics simulating those of the filters HF_1 and HF_1'.

The arrangement of filter just described provides for the exclusion of low frequency currents from the carrier repeater while permitting carrier frequencies to be freely transmitted to said repeater. In order to prevent carrier frequencies from being diverted around the carrier repeater through the path 13, a low frequency filter LF_1 similar in all respects to filters LF and LF′ already described is included in the path 13. The filters LF and LF′ associated with the low frequency repeater comprising amplifiers AE and AW permit the transmission of low frequency currents through said repeater but substantially exclude carrier frequencies therefrom. It is, therefore, necessary to provide a path independent of the low frequency repeater for transmitting carrier frequencies from the main line ML to the carrier repeater. Accordingly a path 12 is arranged in parallel with the low frequency repeater and a high frequency filter HF is included therein for the purpose of excluding low frequency currents from the path 12, while readily permitting the passage of carrier frequencies. The filter HF is of the same type as the filters HF_1 and HF_1' already described.

The operation is as follows: Low frequency signaling currents incoming from the line ML are transmitted through the filter LF, through the transformer 10 to the amplifier AE. After being amplified, the currents are transmitted through the filter LF′ and over the path 13, through the filter LF_1 to the main line section ML_1. Low frequency currents incoming from the line ML_1 are transmitted over the path 13, through the filter LF_1, through the filter LF′, and by way of transformer 10′ to the amplifier AW. Upon being amplified the currents pass through the filter LF to the main line ML.

High frequency carrier oscillations incoming from the main line ML are excluded from the low frequency repeater by the filter LF and pass over the auxiliary path 12, through the filter HF and then through the filter HF_1', and by way of transformer 11′ to amplifier AE_1. Upon being amplified, the high frequency currents are transmit-

ted through the filter HF_1 to the main line section ML_1. High frequency carrier currents incoming from the line section ML_1 are transmitted through the filter HF_1, and through the transformer 11 to the amplifier AW_1. After being amplified, the currents are transmitted through filter HF_1' and over the path 12, through the filter HF to the line section ML.

While the invention has been disclosed as applied to a telephone transmission circuit, it is equally applicable to other types of signal transmission such as, for instance, ordinary telegraph circuits. Where the low frequency range is quite narrow the low frequency filter may be replaced by any equivalent means having the desired selectivity, such as tuned circuits or anti-resonant combinations. Similarly, if but one carrier channel is superposed on the low frequency transmission line, the high frequency filters may be replaced by some simple form of tuning arrangement.

In general, while it has been deemed desirable in the interest of clear understanding to illustrate the invention as embodied in a specific form of circuit arrangement, it will be obvious that the general principles herein disclosed may be employed 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 signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, means to permit only frequencies within one range to be impressed upon one of said repeaters, and means to permit only frequencies within another range to be impressed upon another of said repeaters.

2. In a signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, an arrangement of filters whereby only frequencies within a certain range will be impressed upon one of said repeaters, and another arrangement of filters whereby only frequencies within another range will be impressed upon another of said repeaters.

3. In a signaling system, a transmission line adapted to transmit signaling currents and alternating carrier currents upon which signals may be impressed, a plurality of amplifying repeaters in said line in series, means to permit only signaling currents to be impressed on one of said repeaters, and means to permit only alternating carrier currents to be impressed upon another of said repeaters.

4. In a signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, an arrangement of filters to permit only signaling currents to be impressed on one of said repeaters, and another arrangement of filters to permit only alternating carrier currents to be impressed upon another of said repeaters.

5. In a signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, a parallel path around each repeater, means associated with one repeater for permitting only frequencies within one range to be impressed upon said repeater, means in the parallel path about said repeater to permit only frequencies within a second range to be transmitted thereover, means associated with a second repeater to permit only frequencies within said second range to be impressed upon said second repeater, and means in the parallel path about said second repeater to permit only frequencies within said first range to be transmitted thereover.

6. In a signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, a parallel path around each repeater, a filter associated with one repeater for permitting only frequencies within one range to be impressed upon said repeater, a filter in the parallel path about said repeater to permit only frequencies within a second range to be transmitted thereover, a filter associated with a second repeater to permit only frequencies within said second range to be impressed upon said second repeater, and a filter in the parallel path about said second repeater to permit only frequencies within said first range to be transmitted thereover.

7. In a signaling system, a transmission line adapted to transmit signaling currents and alternating carrier currents upon which signals may be impressed, a plurality of amplifying repeaters in said line in series, parallel paths around each repeater, means associated with one of said repeaters for permitting only signaling currents to be impressed upon said repeater, means in the parallel path about said repeater to permit only alternating carrier currents to be transmitted thereover, means associated with a second of said repeaters to permit only alternating carrier currents to be impressed upon said second repeater, and means in the parallel path about said second repeater to permit only signaling frequencies to be transmitted thereover.

8. In a signaling system, a transmission line adapted to transmit signaling currents and alternating carrier currents upon which signals may be impressed, a plurality of amplifying repeaters in said line in series, parallel paths around each repeater, a filter

associated with one of said repeaters for permitting only signaling currents to be impressed upon said repeater, a filter in the parallel path about said repeater to permit only alternating carrier currents to be transmitted thereover, a filter associated with a second of said repeaters to permit only alternating carrier currents to be impressed upon said second repeater, and a filter in the parallel path about said second repeater to permit only signaling frequencies to be transmitted thereover.

9. In a signaling system, a transmission line adapted to transmit currents of different frequencies, a plurality of amplifying repeaters in said line in series, and means so arranged that one of said repeaters operates to amplify primarily frequencies within one range, and the other repeater operates to amplify primarily frequencies within another range.

In testimony whereof, I have signed my name to this specification this 22nd day of July, 1919.

HAROLD S. OSBORNE.