

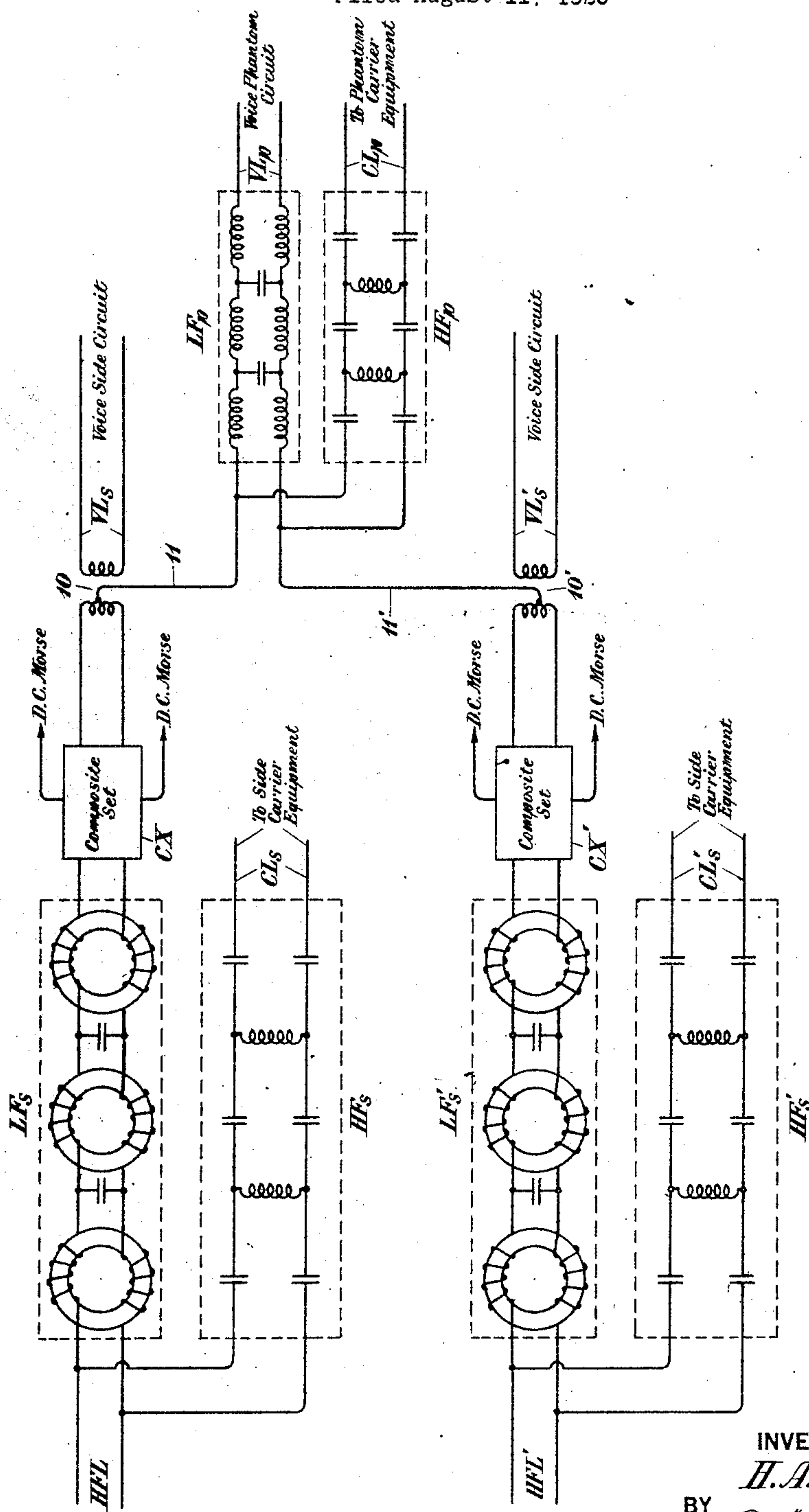
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PHANTOM CARRIER CIRCUITS

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PHANTOM CARRIER CIRCUITS.

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To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, a citizen of the United States, residing at Maplewood, in the county of Essex and State of New Jersey, have invented certain Improvements in Phantom Carrier Circuits, of which the following is a specification.

This invention relates to transmission circuits and more particularly to arrangements for employing carrier transmission upon phantom conductive systems.

It has heretofore been the practice in ordinary telephone transmission to "phantom" the telephone circuits so that each pair of conductors not only acts as a series conductive system or a side circuit, but also acts as one side of a phantom circuit, the two conductors in parallel constituting one conductor of the phantom path while the two conductors of a similar side circuit operate in parallel as the return path for the phantom circuit. It has not, however, been the practice to utilize the phantom circuits thus formed for carrier transmission because the requirements with respect to unbalance and crosstalk at carrier frequencies have been too great. The carrier frequency unbalance and crosstalk of the phantom are gradually being reduced, however, and there is now presented the problem of associating filters with each other so as to properly separate the side voice circuits and side carrier circuits from each other and at the same time separate the phantom voice circuit and phantom carrier circuit from each other and from the side circuit channels.

It is one of the objects of the present invention to provide a suitable arrangement of filters for effecting the necessary separation between the various types of circuits without introducing undesirable transmission losses and without producing any undesirable effects upon the filters due to the presence in the same network of other filters.

These objects as well as other objects of the invention may be attained by means of the arrangements set forth in the following description and illustrated in the accompanying drawing, the figure of which shows a circuit diagram embodying the invention in its preferred form.

Referring to the drawing, HFL and HFL' represent two telephone lines, each comprising a pair of conductors which may be phantom in a well known manner so that

each pair of conductors acting in parallel operates as one side of a phantom circuit. The phantom connections are established by means of transformers 10 and 10', from the middle points of whose windings taps 11 and 11' are led to form the phantom terminals of the system. Composite sets CX and CX' are included in the lines HFL and HFL' by means of which each of the four conductors may be employed for Morse telegraph transmission. The composite sets are merely shown schematically in the drawing, these sets being of a type well known in the art so that detailed illustration is unnecessary.

In order that the line HFL may be employed for carrier transmission, a branch CL_s is provided which leads to carrier equipment of any type well known in the art, and in this branch a high pass filter HF_s is included. This high pass filter is of the broad band type which freely transmits a band of frequencies within certain limits, while sharply attenuating and suppressing the frequencies lying without the limits of the band. The filter is so designed as to pass the various carrier frequencies employed in the system together with their associated side bands, but it will not permit ordinary voice currents transmitted over the line HFL to pass into the circuit CL_s. The ordinary voice currents transmitted over the conductor HFL must be separated from the carrier frequencies and transmitted through the transformer 10 to the voice side circuit channel VL_s. In order to accomplish this result, a low pass filter LF_s is connected in the branch of the line circuit HFL leading to the voice side circuit VL_s. The filter LF_s is of the broad band type and freely transmits all frequencies lying within the voice range while suppressing all frequencies above the voice range. The carrier frequencies are thereby prevented from entering the voice side circuit VL_s.

In a similar manner, the line HFL' is provided with two branches, one leading through the high pass filter HF' to the side carrier circuit CL_s' and the other leading through the low pass filter LF_s' to the voice side circuit VL_s'.

The arrangement so far described is that ordinarily employed for superposing a plurality of carrier channels on an ordinary voice channel. It is possible to phantom a

pair of circuits of this type for ordinary voice transmission by means of the phantom coils 10 and 10' with their phantom conductors 11 and 11'. This follows at once from the fact that the unbalance between the phantom circuit and the side circuits at voice frequencies is no greater with the arrangement above described than in the case of circuits which are not arranged for multiplex carrier transmission, and the voice currents transmitted over the phantom, in so far as any unbalance occurs between the two conductors of the side circuit, are prevented from entering the carrier circuit, such as the circuit CL_s, by the high pass filter. The effect upon the phantom of the filter LF_s in the two conductors of the side circuit is to introduce impedance due to the series coils of the filter but this impedance is not serious at the ordinary voice frequencies. If, however, we attempt to transmit carrier frequencies over the phantom, the inductance of the series elements of the filter LF_s or LF_s' is relatively much greater, so that not only must this problem be overcome but the problem of selection between the carrier phantom and the voice phantom must also be overcome.

In accordance with the present invention the latter difficulty is met by providing the phantom terminal comprising the conductors 11 and 11' with two parallel branches, one branch CL_p leading to the phantom carrier equipment and the other branch VL_p leading to the voice equipment. A high pass filter HF_p of ordinary construction is included in the phantom carrier branch CL_p and a low pass filter LF_p of ordinary construction is included in the voice phantom circuit VL_p.

The effect of the two filters LF_p and HF_p upon the part of the circuit including the phantom leads 11 and 11' is to effect the same kind of separation between the voice channel and the carrier channels as is effected between the corresponding side channels by means of filter combinations such as LF_s and HF_s. There still remains, however, the problem of preventing the filter LF_s from cutting down the transmission of the carrier frequencies which may be transmitted over the phantom through the high pass filter HF_p. The shunt elements of the filter LF_s are condensers and do not cut down the transmission over the phantom because they are bridged across points of substantially equal potential (so far as the phantom is concerned) between the two conductors of the side circuit. The series inductance coils, however, are directly included in the phantom circuit and must be taken into account. In order to eliminate the effects of these coils, it is proposed in accordance with the present invention to mount the windings included in each line conductor upon a com-

mon core and to so wind the coils about the core that the inductances in the two line conductors neutralize each other. When so wound, it will be clear that for currents flowing serially over the two conductors of the side circuit the coils of the filter will be series-aiding and will introduce the necessary inductance into the several sections of the filter so that it may perform its ordinary function. When current is flowing over the two conductors in parallel, however, the windings being mutually opposed, no inductance is introduced in the circuit and the filter, such as LF_s, is without effect.

It will, of course, be clear that for carrier currents transmitted over the phantom conductor 11, the filter HF_s which is bridged across the side circuit, will be ineffective since said filter is bridged across equal potential points of the side circuit with respect to the phantom carrier current. Consequently, if the two side conductors of the side circuit are properly balanced with respect to the phantom, there will be no interference between the phantom carrier channel and the side circuit carrier channel.

It will 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 and scope of the invention as defined in the appended claims.

What is claimed is:

1. In a transmission system, a pair of side circuits each adapted for the transmission of voice frequency currents and also for the transmission of carrier currents, a pair of terminal branches for each side circuit, a low pass filter in one branch of each pair to permit the transmission of voice currents over said branch while suppressing the transmission of carrier frequency currents transmitted over the conductors of the side circuits in series, a high pass filter in the other branch of each pair to readily transmit carrier currents from terminal carrier equipment to and from the side circuit while preventing voice frequency currents from entering said branch, means to establish a phantom connection adjacent one end of the low pass filter associated with each side circuit to form a phantom circuit, branches for said phantom circuit, a low pass filter in one of said branches to permit voice frequency currents to be transmitted over the phantom to and from said branch while suppressing carrier frequency currents from said branch, and a high pass filter in the other branch to permit the transmission of carrier frequency currents over the phantom to and from said branch while suppressing the transmission of voice frequency currents.

2. In a transmission system, a pair of transmission lines adapted to transmit either

ordinary voice frequency currents or carrier frequency currents, a pair of branches for each line, one branch extending to a voice frequency terminal, the other branch extending to carrier equipment, a low pass filter in said first mentioned branch and a high pass filter in said second mentioned branch of each line, means to connect a phantom conductor to the first mentioned branch of each line so that currents transmitted over the phantom conductor will be transmitted over the two sides of the line in parallel, the phantom conductors of the two lines forming a phantom circuit over which voice frequency currents and carrier frequency currents may be transmitted, a pair of branches for the phantom circuit, one of said branches extending to a voice frequency terminal and the other branch extending to carrier equipment, a low pass filter in said first mentioned branch, and a high pass filter in said second mentioned branch.

3. In a transmission system, a pair of transmission lines adapted to transmit either voice frequency currents or carrier frequency currents, a pair of branches for each line, one branch extending to a voice frequency terminal and the other branch extending to carrier equipment, a low pass filter in said first mentioned branch of each line and a high pass filter in said second mentioned branch of each line, said low pass filter comprising a plurality of sections each

of which consists of a series inductance and a shunt impedance element, the series inductance of each element being divided so that part of the inductance will be in one conductor of the circuit and the other part of the inductance will be in the other conductor of the circuit, said inductances being so wound and related with respect to each other that the coils in the two conductors will be mutually aiding with respect to currents transmitted over the conductors in series but will be mutually opposing with respect to currents transmitted over the conductors in parallel, a phantom coil interposed between said low pass filter and said voice frequency terminals for each line, a phantom conductor connected to the midpoint of each phantom coil so that the two phantom conductors establish a phantom circuit over which voice frequency currents or carrier frequency currents may be transmitted, a pair of branches for said phantom circuit, one of said branches extending to a voice frequency terminal, the other branch extending to carrier equipment, a low pass filter in said first mentioned branch of the phantom circuit, and a high pass filter in said second mentioned branch of the phantom circuit.

In testimony whereof, I have signed my name to this specification this 10th day of August, 1925.

HERMAN A. AFFEL.