

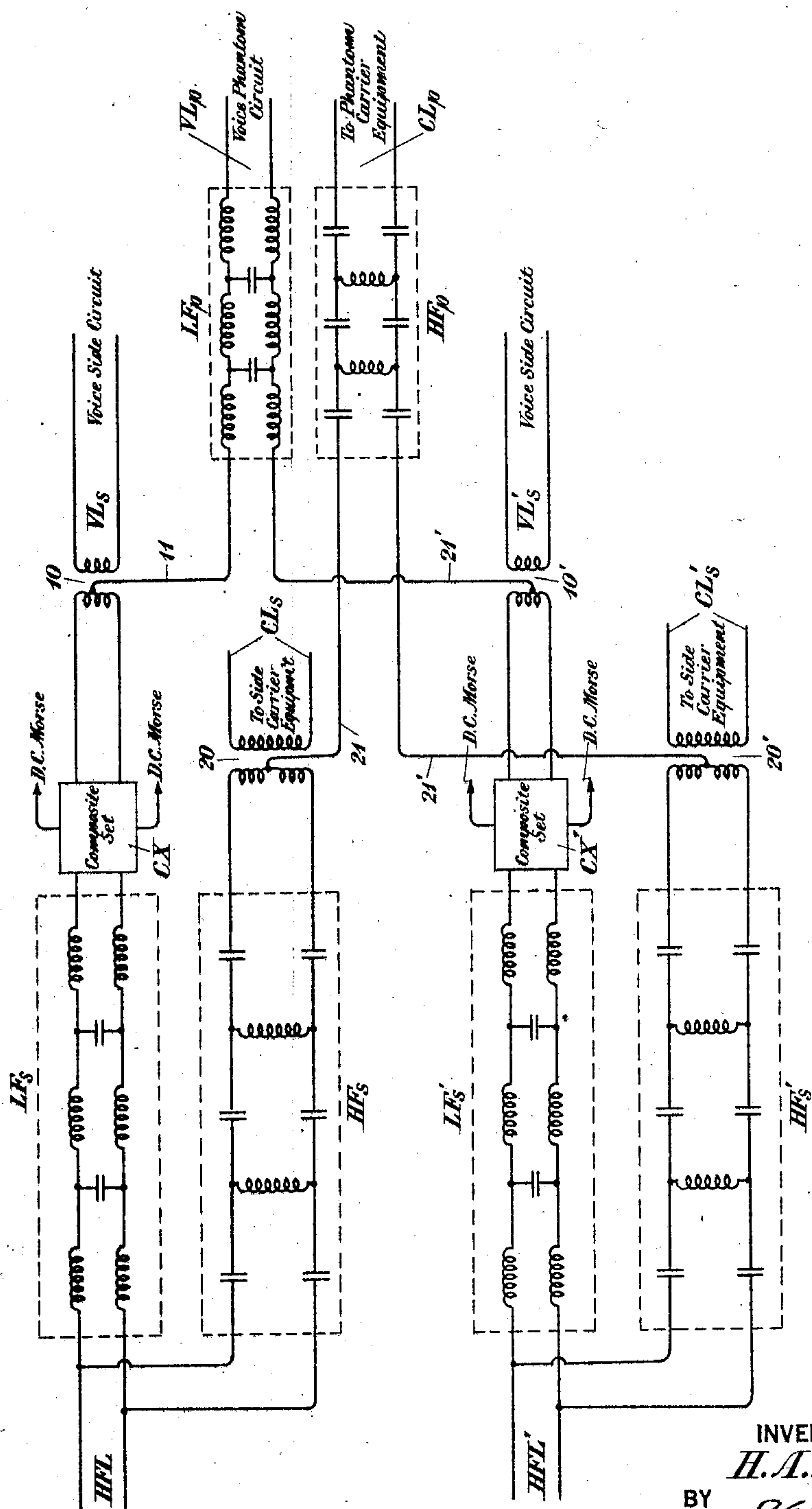
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H. A. AFFEL

PHANTOM CARRIER CIRCUITS

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INVENTOR
H. A. Affel
BY *g. 408*
ATTORNEY

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

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_s to the side carrier circuit CL_s' and the other lead-

ing through the loss 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, therefore, it is proposed to transmit the phantom carrier currents over the carrier branches including the filters HF_s and HF_s' . For this purpose, phantom coils 20 and 20' are included in the circuits CL_s and CL_s' as indicated, and phantom conductors 21 and 21' are led from the mid-points of the phantom coils to form a carrier phantom terminal CL_p . With this arrangement, the phantom carrier currents need only be transmitted through the impedance of the filters HF_s and HF_s' . The shunt elements of these filters are inductance coils bridged across equal potential points (with respect to the phantom) of the two sides of the line forming one side of the phantom and consequently do not introduce any impedance to the currents transmitted over the phantom. The series condensers of the high pass filters, however, are included serially in the phantom circuits but these condensers readily pass the high frequency carrier currents so that the effect of the filters HF_s and HF_s' upon the carrier currents transmitted over the phantom is relatively small.

In order to provide the necessary frequency separation between the voice currents transmitted over the phantom and the carrier currents transmitted over the phantom,

a low pass filter LF_p is included in the voice phantom terminals VL_p and a high pass filter HF_p is included in the carrier phantom terminal CL_p . These filters are similar to the high and low pass filter combinations already described and operate in the same manner. The necessity for these filters arise from the fact that the conductors of the voice phantom circuit are connected to the conductors of the carrier phantom circuit through the filters LF_s and HF_s in series on the one hand, and the filters LF_s' and HF_s' in series on the other hand.

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 adapted to transmit carrier currents from carrier terminal 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 said low pass filter associated with each side circuit to form a phantom circuit for the transmission of voice frequencies, means to establish a phantom connection adjacent one end of said high pass filter associated with each side circuit to form a phantom connection for the transmission of carrier frequencies, a low pass filter in said first mentioned phantom connection to permit the voice frequency currents to be transmitted thereover while suppressing carrier frequency currents, and a high pass filter in said second mentioned phantom connection to permit carrier frequency currents to be transmitted over said second mentioned phantom connection while suppressing voice frequency currents therefrom.

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 and the other branch extending to carrier equipment, a low pass filter in said first mentioned branches of each line and a high pass filter in said second mentioned branches of each line, means to connect a phantom conductor to the first

mentioned branches of each line, a low pass filter included in the phantom conductors thus formed so that voice frequency currents may be transmitted over said phantom, 5 means to connect a phantom conductor to the second mentioned branches of each line, and a high pass filter included in the phantom circuit formed by means of said second mentioned branches whereby carrier 10 currents may be transmitted over said second mentioned phantom circuit to the exclusion of voice frequency currents.

3. In a transmission system, a pair of transmission lines adapted to transmit either 15 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 20 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, said high pass 25 filter comprising a plurality of sections each of which consists of a series capacity and shunt impedance element, a phantom coil interposed between said low pass filter and said voice frequency terminals for each line, 30 a phantom conductor connected to the midpoint of each phantom coil so that the two phantom conductors establish a voice frequency phantom circuit, a low pass filter 35 included in said phantom circuit, a phantom coil interposed between said high pass filter and said carrier terminal for each line, a phantom conductor connected to the midpoint of each of said last mentioned phantom coils so that the two phantom conduc- 40 tors establish a carrier frequency phantom circuit and a high pass filter in said carrier frequency phantom circuit.

In testimony whereof, I have signed my name to this specification this 10th day of 45 August, 1925.

HERMAN A. AFFEL.