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PHANTOM CARRIER CIRCUITS

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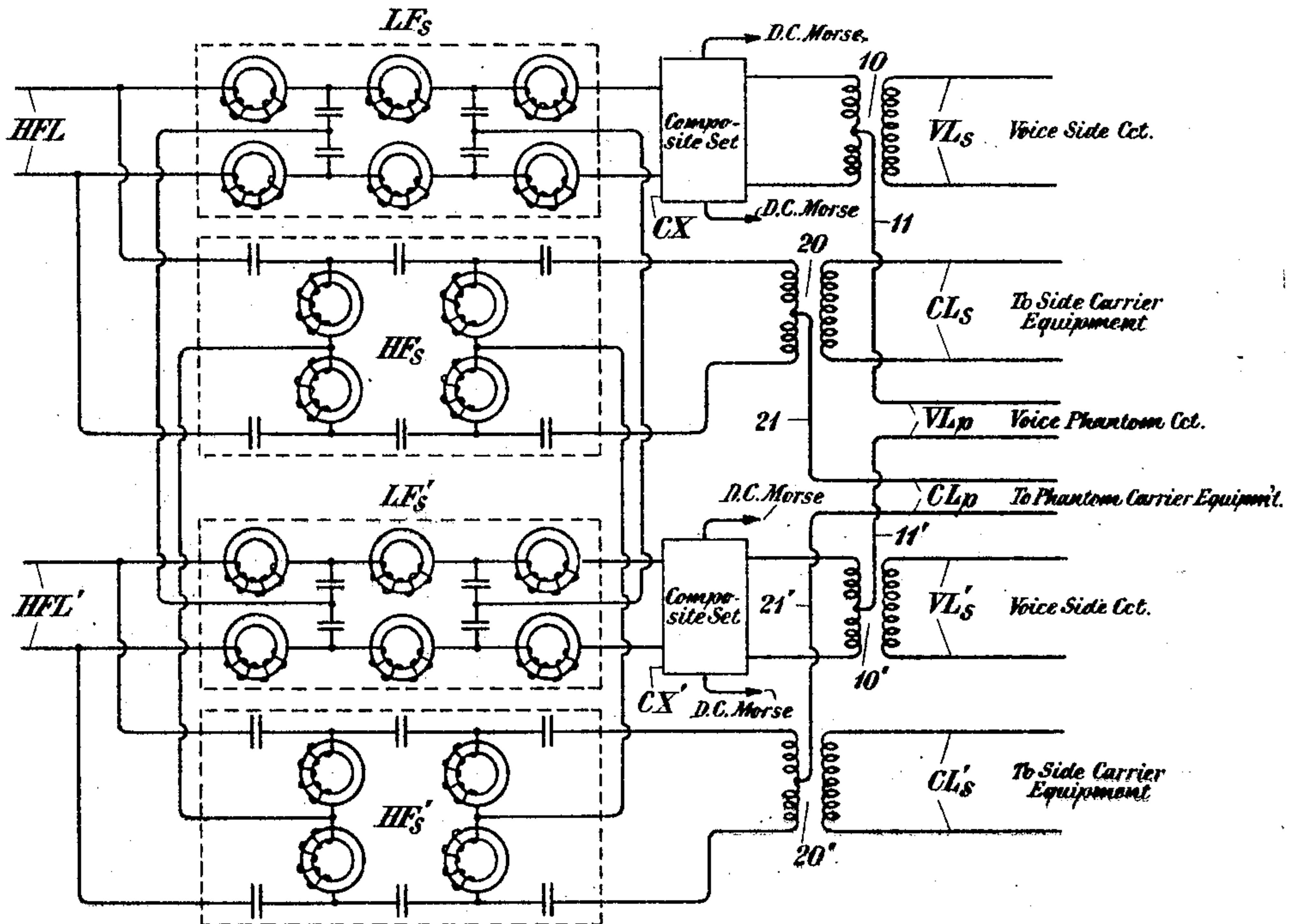


Fig. 1

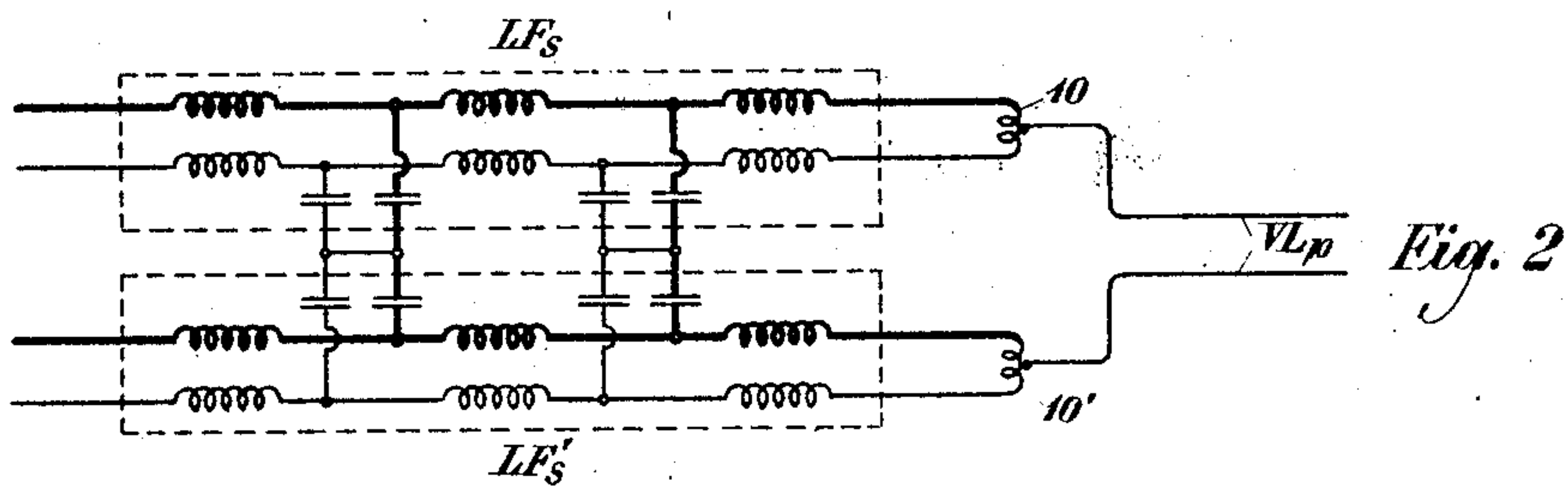


Fig. 2

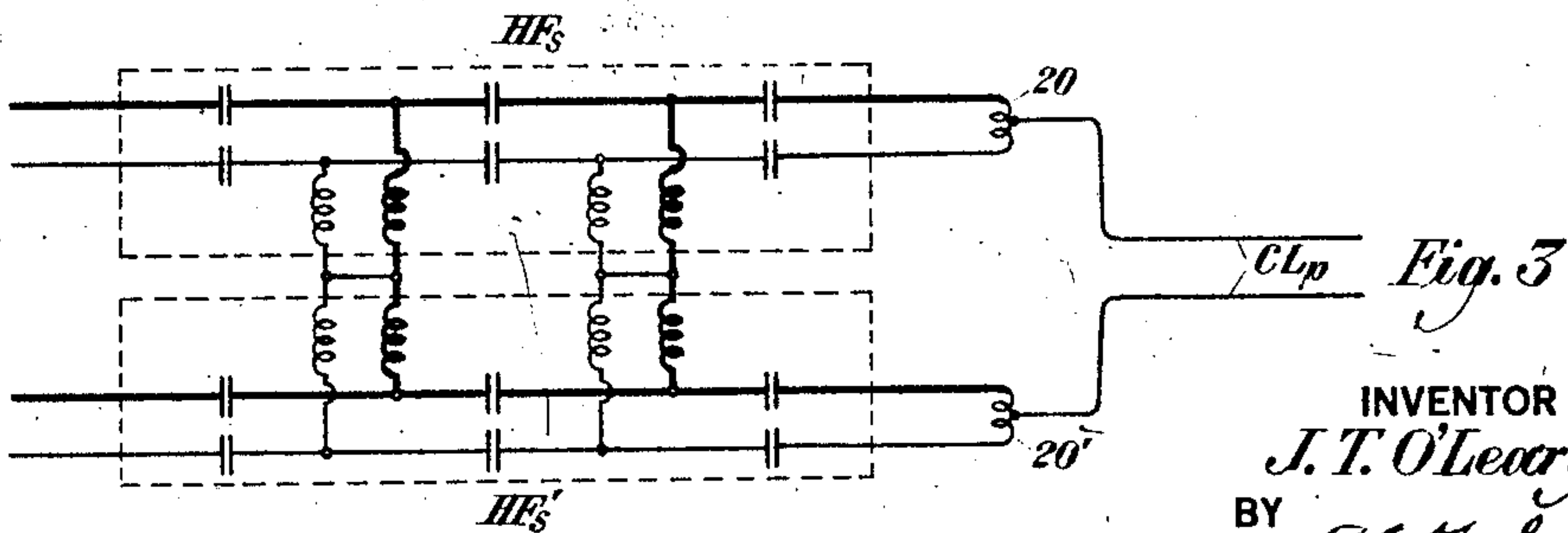


Fig. 3

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PHANTOM CARRIER CIRCUITS.

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To all whom it may concern:

Be it known that I, JOSEPH T. O'LEARY, a citizen of the United States, residing at Elizabeth, in the county of Union 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 drawings, Figure 1 of which shows a circuit diagram embodying the invention in its preferred form and Figs. 2 and 3 of which show how the high pass and low

pass filters function in the phantom circuits.

Referring to the drawing, HFL and HFL' represent two telephone lines, each comprising a pair of conductors which may be phantomed 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 leading through the low pass filter LF_s' to the voice side circuit VL_s' .

5 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
10 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
15 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
20 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, how-
25 ever, 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
30 and the voice phantom must also be overcome.

In accordance with the present invention it is proposed to provide a carrier phantom connection by introducing phantom coils,
40 such as 20 and 20', between the high pass filters HF_s and HF_s' and the side carrier terminals CL_s and CL_s' . Conductors 21 and 21' are led from the midpoints of the phantom coils, as indicated, to form the phantom
45 carrier terminal CL_p , which leads to suitable carrier equipment. The shunt elements of the high pass filters, being inductance elements and being bridged across neutral points of the two conductors of the side circuit with respect to the phantom, would not
50 materially affect transmission of carrier frequencies over the phantom and since the series elements of the high pass filters are capacities the impedance due to these series elements will be relatively small since the
55 impedance of a capacity is relatively low at high frequencies.

While the arrangements above outlined enable the transmission of both voice and
60 carrier frequencies over the phantom circuits without introducing material transmission losses, there remains the problem of providing for frequency separation between the phantom voice channel and the phantom
65 carrier channel. As will be seen, this prob-

lem is solved in accordance with the arrangements of the present invention in such a manner as not only to effect this separation by utilizing the same filters that provide for frequency separation between the voice chan-
70 nel and carrier channel of the side circuits, but, in addition, the filters in the voice and carrier side circuit channels are so arranged that they introduce substantially no attenuation in the corresponding phantom channels. To accomplish these results, the low pass
75 filters, such as LF_s and LF_s' are so constructed that the shunt element of each filter section is formed of two equal capacities. Connections then extend from the midpoint
80 of each shunt element of one filter, for example, LF_s , to the corresponding midpoint of the corresponding shunt element of the other filter, such as LF_s' . Similarly, the high pass filters such as HF_s and HF_s' are
85 formed of sections, each of which comprises a series inductance. These inductances are likewise divided into two equal parts with the midpoints of each series inductance of one high pass filter, such as HF_s , connected
90 to the midpoint of the corresponding shunt inductance of the other high pass filter, such as HF_s' . With the filters thus interconnected, the effect of a given low pass filter in a side circuit branch is to constitute, with the
95 corresponding low pass filter in the associated side circuit branch, a similar low pass filter for the voice frequency phantom. Similarly, the two high pass filters HF_s and HF_s' constitute together a high pass filter
100 of the same type for the corresponding carrier frequency phantom.

The effect of the two filters LF_s and LF_s' in forming a low pass filter for the voice frequency phantom VL_p will be clear from
105 Fig. 2, in which the circuits have been so diagrammed as to show the relation of the elements of the filter in the phantom circuit. If we consider, for example, the elements shown in the heavy line portions of
110 the circuit of Fig. 2, it will be seen that the series inductances in the upper conductor of the upper side circuit, together with the upper halves of the capacities of the filter LF_s , are directly connected to the upper ca-
115 pacities of the filter LF_s' and the series inductances in the upper conductor of the lower side circuit to form a filter which is exactly like the filter LF_s . Now, obviously, since one half of the voice phantom current
120 flows in one direction through the upper conductor of the upper side circuit and returns through the upper conductor of the lower side circuit, and since these conductors have included therein a filter which in all respects
125 is equivalent to the low pass filter in the side circuit, the phantom circuit is limited to the same range of frequencies as the side circuit, and, furthermore, the filter by its very nature subjects the voice frequency cur-
130

rents in portion of the phantom to substantially no attenuation. Similarly, it will be seen that the lower half of the filter LF_s and the lower half of the filter LF_s' constitute together a similar low pass filter for the other two conductors of the phantom, that is, the lower conductor of the upper side circuit and the lower conductor of the lower side circuit. The other half of the phantom current flows through the last mentioned filter without substantial attenuation and the range of frequencies is limited in the same manner as already described. Consequently, the two low pass filters in the side circuits constitute together a low pass filter for the voice frequency phantom and offer substantially no attenuation for voice frequencies transmitted over the phantom.

Referring now to Fig. 3, which shows the relation of the high pass filters in the phantom circuit and noting the parts shown in heavy lines, it becomes at once evident that the upper half of the filter HF_s co-operates with the upper half of the filter HF_s' to form a high pass filter exactly like the filter HF_s itself. Consequently, one half of the carrier frequency energy transmitted over the phantom flowing in one direction over the upper conductor of the side circuit and returning over the corresponding upper conductor of the lower side circuit passes through a high pass filter which offers substantially no attenuation to frequencies in the carrier range and which also restricts the frequencies transmitted over this part of the phantom to the carrier range. Likewise, it will be seen by noting the elements shown in the light lines of Fig. 3 that the lower half of the filter HF_s and the lower half of the filter HF_s' constitute together a high pass filter exactly like the filter HF_s for the other two conductors of the phantom circuit.

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 appended claims.

What is claimed is:

1. 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 phantom conductor connected to the first mentioned branch of each line to form a phantom circuit for the transmission of voice frequency currents, a phantom conductor connected to the second mentioned branch of each line to form a phantom circuit for the transmission of carrier frequency currents, a high pass filter in the first mentioned branch of each line including a plurality of sections,

each comprising a series impedance and a shunt impedance, connections from the midpoints of the shunt impedances of one of said low pass filters to the midpoints of the corresponding shunt impedances of the other low pass filter, a high pass filter in the second mentioned branches of each line, each high pass filter including a plurality of sections, each comprising a series impedance and a shunt impedance, and connections from the midpoints of the shunt impedances of one of said high pass filters to the midpoints of the corresponding shunt impedances of the other high pass filter.

2. 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 phantom coil in the first mentioned branches of each line, a phantom coil in said second mentioned branch of each line, a phantom conductor connected to the midpoint of each of said first mentioned phantom coils so that the two phantom conductors establish a voice frequency phantom, a phantom conductor connected to the midpoints of each of said last mentioned phantom coils so that the two phantom conductors establish a carrier frequency phantom circuit, a low pass filter in each of said first mentioned branches, said low pass filter including a plurality of sections and each section comprising a series inductance in each line conductor and a divided capacity in shunt with the line conductors, a connection extending from the midpoints of the shunt capacities of each high pass filter to the midpoints of the corresponding shunt capacities of the other low pass filter, a high pass filter in the second mentioned branches of each line, each high pass filter including a plurality of sections and each section comprising a series capacity element in each line conductor and a shunt inductance, and a connection from the midpoints of the shunt inductances of one high pass filter to the midpoints of the corresponding shunt inductances of the other high pass filter.

3. 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 phantom conductor connected to the first mentioned branches of each line to form a phantom circuit for the transmission of voice frequencies, a phantom conductor connected to the second mentioned branches of each line to form a phantom circuit for the transmission of carrier frequencies, a low pass

filter in each of said first mentioned branches and a high pass filter in each of said first mentioned branches, said low pass filters being so balanced with respect to the voice frequency phantom and being so related to each other as to jointly comprise a low pass filter for the voice frequency phantom, and said high pass filters being so balanced with respect to the carrier frequency phantom and being so related to each other as to jointly comprise a high pass filter for the carrier frequency phantom. 10

In testimony whereof, I have signed my name to this specification this 5th day of August, 1925.

JOSEPH T. O'LEARY.