Nov. 29, 1927. 1,650,655

A. F. ROSE

SYSTEM OF MULTIFREQUENCY CIRCUITS

Filed Jan. 21, 1924 2 Sheets-Sheet 1

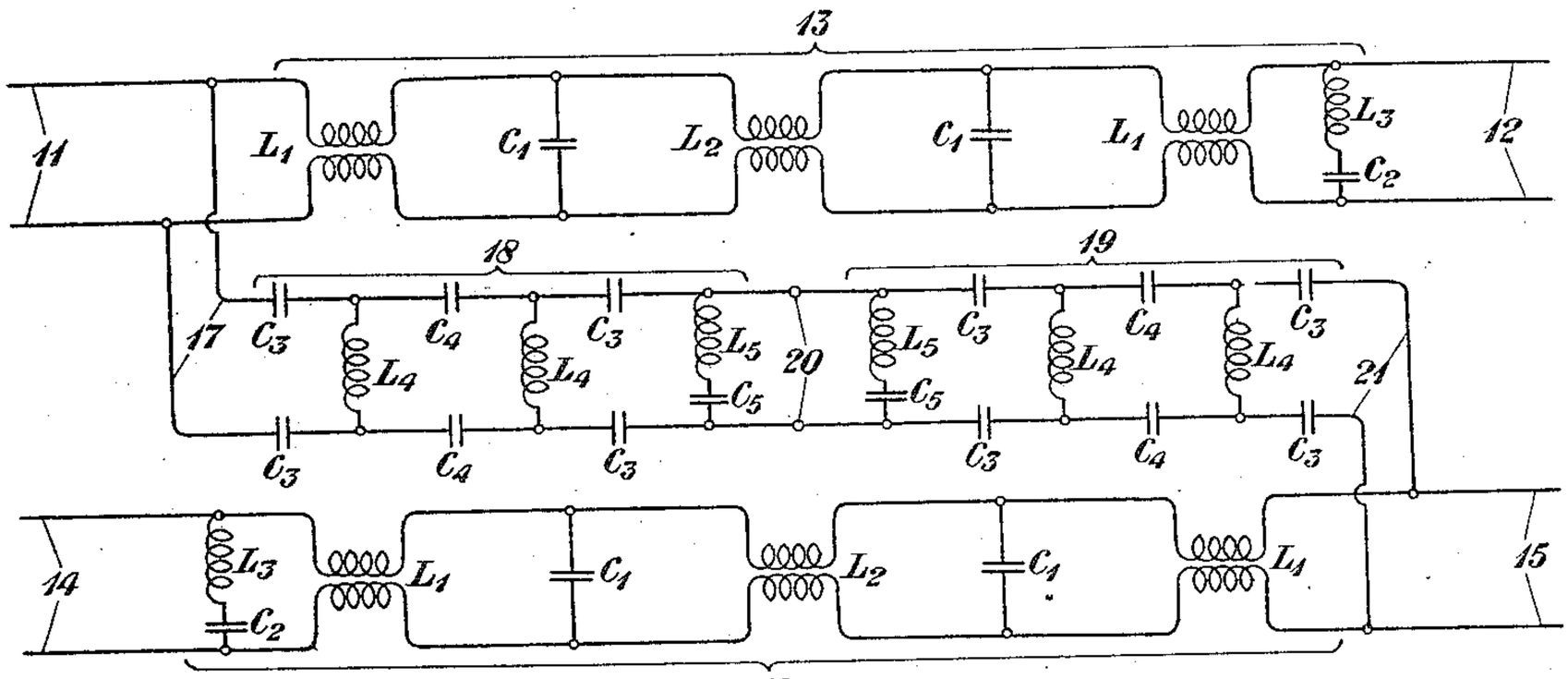

Fig. 1

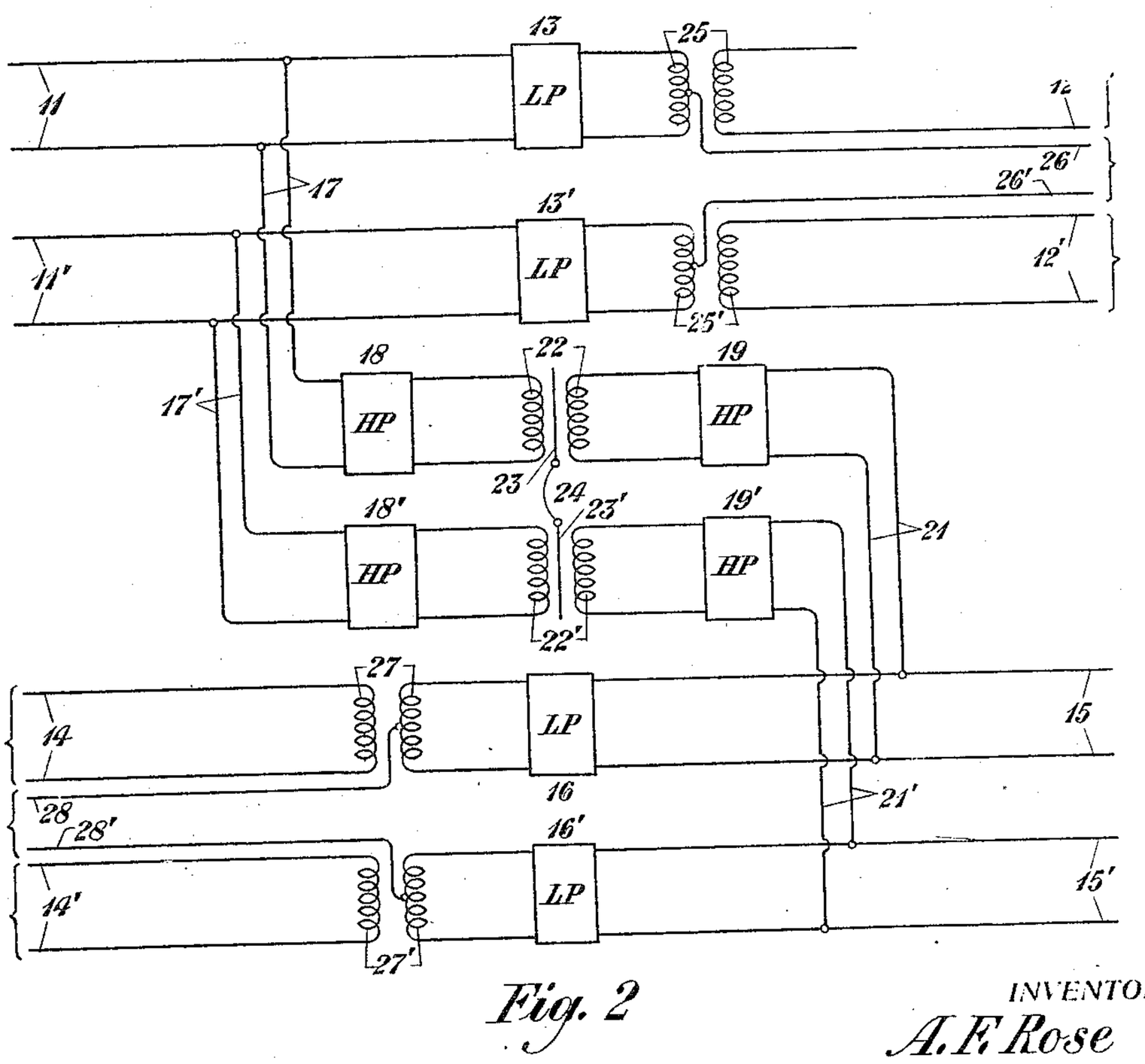

Fig. 2

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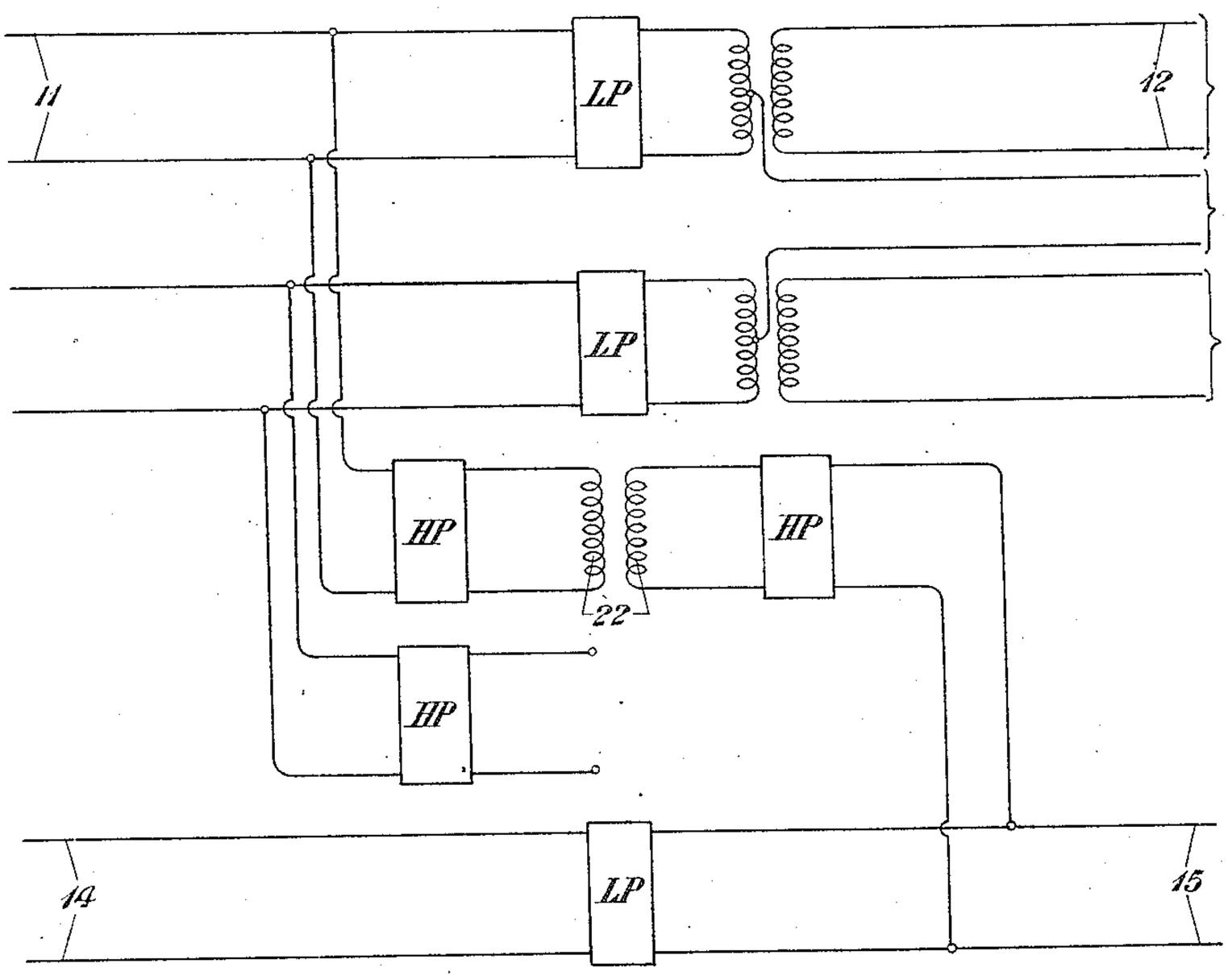

Fig. 3

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Patented Nov. 29, 1927. 1,650,655

UNITED STATES PATENT OFFICE.

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SYSTEM OF MULTIFREQUENCY CIRCUITS.

Application filed January 21, 1924. Serial No. 687,564.

The principal object of my invention is to provide a new and improved method and apparatus for the transfer of currents of a particular frequency range from one circuit to another. Another object of my invention is to provide for transferring carrier currents between part of one circuit and part of another circuit while keeping voice frequency currents respectively on each of the two circuits as a whole. Another object of my invention is to provide for the transfer of currents of a certain frequency range between a part of one circuit and a part of another circuit where these circuits are comprised as side circuits in phantom circuits. These and various other objects of my invention will become apparent on consideration of a limited number of specific embodiments which I have chosen to illustrate in the accompanying drawings and describe in the following specification. It will be understood that the invention is defined in the appended claims and that the following description refers more particularly to the specific examples which have been chosen for presentation in this specification.

Referring to the drawings, Figure 1 is a diagram of two through circuits with means to transfer a certain limited frequency range of currents between a part of one of these circuits and a part of the other circuit, Fig. 2 is a diagram showing two pairs of side circuits, each pair being comprised in a phantom circuit with means to transfer currents of a particular frequency range between a part of a side circuit of one pair and a part of a side circuit of the other pair, and Fig. 3 is a diagram illustrating a transfer between a side circuit of a phantom on the one hand and a simple non-phantom circuit on the other hand.

The metallic circuit 11, 12 in Fig. 1 has a low pass filter 13 interposed therein. This low pass filter comprises series and shunt reactances arranged as shown in the drawing. The letters L for inductances and the letters C for capacities are meant to indicate the same values when they have the same subscripts. For example, these values may be as given in the following table, which is complete for Fig. 1:

$L_1 = L_5 = 53.2$ mh.	$C_1 = .1711$ mf.
$L_2 = 65.8$ mh.	$C_2 = .0529$ mf.
$L_3 = 32.9$ mh.	$C_3 = .106$ mf.
$L_4 = 16.4$ mh.	$C_4 = C_5 = .0855$ mf.

With these values, the assembly 13 is a low pass wave filter with its critical frequency at 3,000 cycles per second; that is, frequencies below this value will be transmitted either way along the line 11, 12 but frequencies above this value will be shunted out.

Another similar line 14, 15 has a similar interposed low pass wave filter 16.

It is desired to transmit superposed high frequency carrier currents between the part 11 of the line 11, 12 and the part 15 of the line 14, 15. Accordingly, at 17 and 21 branch circuits are taken off and connected at 20 through two high pass wave filters 18 and 19. Each of these high pass filters 18 or 19 consists of reactances arranged as shown in the drawing and with the values given in the foregoing table. With these particular values, the high pass wave filters 18 and 19 have the critical frequency at 3,000 cycles per second.

Voice frequency currents on the line 11 will not be diverted over the branch conductor 17 because the high pass filter 18 will not transmit them to an appreciable extent. On the other hand, these voice frequency currents will be transmitted through the low pass filter 13 to the line 12. Similarly, voice frequency currents will be confined to the line 14, 15. Carrier currents of relatively higher frequency on the line 11 will not be transmitted by the low pass wave filter 13 but will be transmitted by the tandem high pass wave filters 18 and 19 to the part 15 of the line 14, 15, and vice versa, high frequency carrier currents will be transmitted from the line 15 to the line 11.

With the arrangement shown in Fig. 1, it will be seen that carrier currents can be superposed on voice frequency circuits and can be diverted from a part of one such circuit

to a part of another such circuit at a place where the two circuits pass in proximity to one another.

In Fig. 2, 11, 12 and 11′, 12′ are two side circuits of a phantom, the phantom conductors 26 and 26′ being connected in the usual manner to the middle points of one side each of the respective repeating coils 25 and 25′. At 14, 15 and 14′, 15′ are two more side circuits of another phantom, the phantom circuit terminals 28 and 28′ being connected at the middle points of the proper windings in the respective repeating coils 27 and 27′.

The diagram shows that the part 11 of the side circuit 11, 12 is connected to the part 15 of the side circuit 14, 15 through the high pass filters 18 and 19, so that 11, 15 constitutes a carrier current circuit. The low pass filters 13, 13′, 16 and 16′ are interposed according to the same principles as in Fig. 1. Instead of connecting the high pass filters 18 and 19 as at 20 in Fig. 1, I connect them through a 1-to-1 ratio repeating coil 22. Similarly, the part 11′ of circuit 11′, 12′ and the part 15′ of circuit 14′, 15′ are connected through the high pass wave filters 18′ and 19′ and the repeating coil 22′. Each of the repeating coils 22 and 22′ is shielded with a respective element 23 and 23′. These shields 23 and 23′ are connected together at 24.

The explanation for Fig. 1 will be seen to apply for Fig. 2, and in addition, it will here be pointed out that the transformers at 22 and 22′ prevent the phantom circuit voice currents from getting across between the phantom circuit 11, 11′ and the phantom circuit 15, 15′. Moreover, the shields 23 and 23′ with the connector 24 insure against a capacity current gettting across these phantom circuits due to the proximity of the windings of the coils 22 and 22′. In so far as there is a capacity effect between these coils, the resulting current will be shunted across at 24 and will not be transmitted between 11, 11′ and 15, 15′.

The transformers 22 and 22′ are designed with the proper impedance value so that, as interposed in the line, they do not produce substantial reflection effects.

It will be seen that if a pair of side circuits constituting a phantom circuit passes in proximity to another pair of side circuits constituting a phantom circuit, and if each side circuit and each phantom circuit carries voice frequency currents, then by my invention, superposed high frequency carrier currents can be transferred from the parts extending one way of one pair of side circuits to the parts extending one way of the other pair of side circuits, and the normal transmission of the voice currents on the side circuits and the phantom circuits will not be impaired.

Fig. 3 shows provision for transferring high frequency carrier currents between one side circuit 11, 12 of a phantom pair and a simple non-phantom circuit 14, 15. It will be seen that as far as it goes the system is substantially the same as in Fig. 2. This arrangement is useful in eliminating noise from a phantom circuit when the carrier current on one side of the phantom group is transferred to or from a non-phantom circuit. There is no cross-talk problem involved but the connection of one side of the phantom group through the high pass filters would unbalance the phantom causing noise, and the interposed transformer 22 obviates this disadvantage.

I claim:

1. In combination, two phantom circuits each comprising a pair of side circuits all adapted for through transmission of currents of a certain frequency range, and means comprising a transformer to transfer currents of another frequency range between a side circuit of one pair and a side circuit of the other pair.

2. In combination, two phantom circuits each comprising a pair of side circuits and adapted for through transmission of currents of a certain frequency range, and means comprising a transformer to transfer currents of another frequency range between a part of each side circuit of one pair and a part of a respective side circuit of the other pair.

3. In combination, two phantom circuits each comprising a pair of side circuits, low pass filters interposed in the respective side circuits, and high pass filters interposed between a part of each side circuit of one pair and a part of a respective side circuit of the other pair, the connection that comprises the high pass filter also comprising a transformer.

4. In combination, two phantom circuits each comprising a pair of side circuits, low pass filters interposed in each side circuit, and connections from one part of each side circuit of a pair to a part of a corresponding side circuit of the other pair, each such connection comprising two filters connected through a repeating coil.

5. In combination, two phantom circuits each comprising a pair of side circuits, low pass filters interposed in each side circuit, and connections from one part of each side circuit of a pair to a part of a corresponding side circuit of the other pair, each such connection comprising two filters connected through a repeating coil, the said repeating coils being shielded and the shields being conductively connected.

6. In combination, a phantom circuit, comprising two side circuits, a simple circuit, low pass filters across one of said side circuits and said simple circuit, and a high pass filter connecting said one side circuit on one

side of its low pass filter to the simple circuit on one side of its low pass filter, this connection that comprises the high pass filter also comprising a transformer.

7. A system of interconnected signal transmittitng lines comprising two complete phantoms, low pass filters interposed in the side circuits of each phantom, cross connections from each side circuit of one phantom on one side of its corresponding low pass filter to a side circuit of the other phantom on one side of its low pass filter, double high pass filters in said cross connections, transformers between the parts of such double high pass filters, and connected shields for the transformers.

In testimony whereof, I have signed my name to this specification this 17th day of January, 1924.

ARTHUR F. ROSE.