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R. W. DEARDORFF

SYSTEM OF MULTIFREQUENCY CIRCUITS

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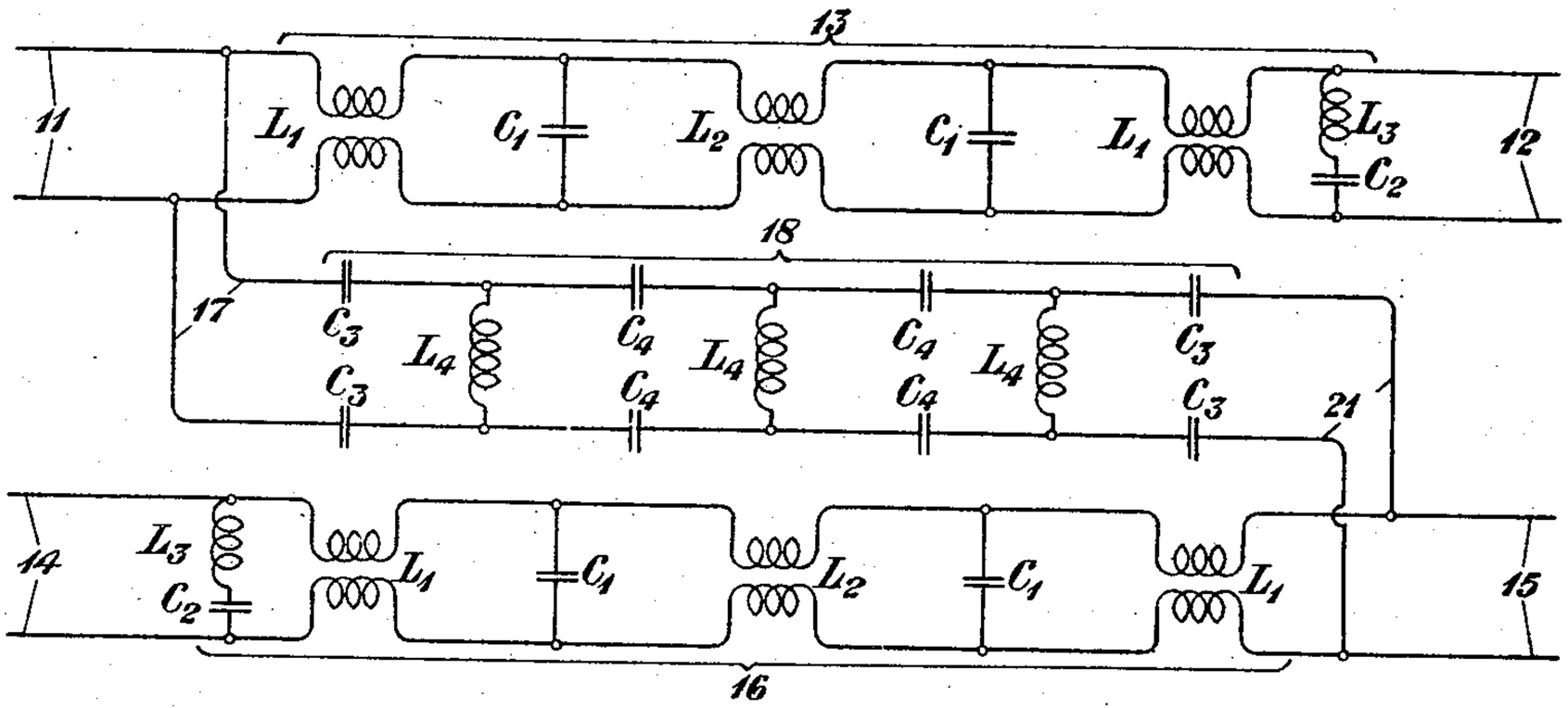

Fig. 1

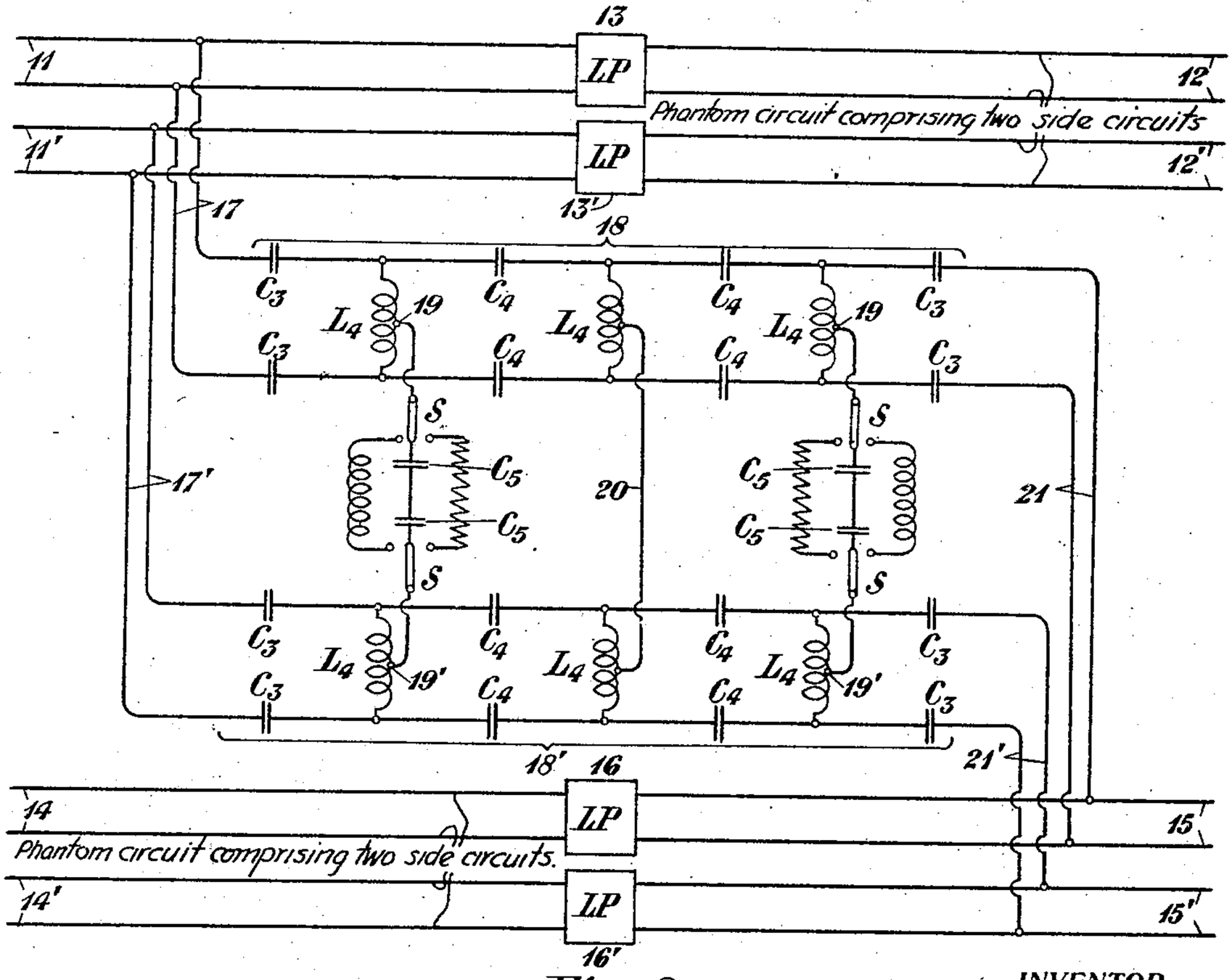

Fig. 2

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UNITED STATES PATENT OFFICE.

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SYSTEM OF MULTIFREQUENCY CIRCUITS.

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The principal object of my invention is to provide 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 transmitting high frequency currents part way on a part of a low frequency circuit and then transferring them and transmitting them the rest of the way on a part of another low frequency circuit. Still another object of my invention is to provide for transferring currents of a certain frequency range from the side circuits of a phantom circuit to the side circuits of another phantom circuit. These and 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. It will be understood that the following specification refers more particularly to these examples of my invention, leaving the scope of the invention to be defined in the appended claims.

In the drawings, Figure 1 is a diagram of two low frequency circuits provided with means for transferring high frequency currents from a part of one such circuit to a part of the other such circuit. Fig. 2 is a diagram showing two pairs of side circuits, each pair belonging to a phantom circuit, with means to transfer high frequency currents from a part of each side circuit of one pair to a part of a respective side circuit of the other pair, while maintaining the normal transmission over the side and phantom circuits of both pairs.

In the transmission line 11, 12, a low pass filter 13 is interposed as shown in Fig. 1. This low pass filter consists of reactance elements arranged as shown, and in the particular instance here disclosed, the reactance values are as given in the following table. For the sake of completeness, the table also comprises all the reactance values in Figs. 1 and 2.

mh.		mf.	
L_1	=53.2	C_1	=.1711
L_2	=65.8	C_2	=.0529
L_3	=32.9	C_3	=.106
L_4	=16.4	C_4	=.0855
		C_5	=.16

With the values given in the foregoing table, the critical frequency for the low pass filter 13 is 3,000 cycles per second. That is, frequencies below this value will be transmitted between the lines 11, 12 and frequencies above this value will be shunted out.

At 14, 15 a similar transmission line is shown with a similarly interposed low pass filter 16.

The high pass wave filter 18 is connected at 17 and 21 between the parts 11 and 15 of the respective lines 11, 12 and 14, 15. This high pass filter 18 is made up of reactances arranged as shown in the drawing and with the particular values given in the foregoing table. Its critcial frequency is 3,000 cycles per second, meaning that frequencies above this value will be transmitted between 11, 17 and 15, 21 but that frequencies below this value will not be transmitted.

Voice frequency currents on the line 11, 12 will pass readily through the filter 13 and will not be diverted at 17. Similarly, voice frequency currents will pass on the line 14, 15 without diversion at 21. But high frequency currents on the part 11 of the line 11, 12 will not pass to the part 12 but will pass at 17 through the filter 18 to the part 15 of the other line 14, 15, and vice versa, from 15 to 11.

It will be seen that at any place where two voice frequency transmission lines pass in proximity, filters like 13 and 16 can be interposed and another filter like 18 can be connected across so that high frequency currents may be transferred from one part 11 of one line to one part 15 of the other line.

In Fig. 2 I have shown two side circuits 11, 12 and 11′, 12′ which together make a phantom circuit. Similarly, 14, 15 and 14′, 15′ are the two side circuits of another phantom circuit. In each side circuit there is interposed a respective low pass filter 13, 13′, 16 and 16′. High pass filters 18 and 18′ are connected across between parts of respective side circuits in a manner similar to that described for Fig. 1. At the middle points 19 and 19′ of the terminal shunt coils L_4, connections are made across from one high pass filter 18 to the other high pass filter 18′. These connections 19 and 19′ are made through interposed condensers C_5. The middle coils L_4 have their middle points dirrectly connected at 20.

It will be seen that the four side circuits shown in Fig. 2 will each carry voice frequency currents, the respective low pass filters LP transmitting these currents freely.

Also, for voice frequency currents on any side circuit, the high pass filters 18 and 18′ will not transmit, the principle being the same as in Fig. 1. This is not altered by the connections at the middle points of the coils L_4 in Fig. 2, because these points are neutral points on the side circuits.

High frequency currents on the side circuits will be blocked by the low pass filters LP and will be transmitted by the high pass filters 18 and 18′. Here again the connections at the middle points of the coils L_4 will not affect this result, because these points are neutral points on the side circuits.

Low frequency currents on the phantom circuits will be readily passed by the low pass filters as may be seen from Fig. 1, Where the inductances L_1 are non-inductive for currents the same way in both conductors. In the absence of the connections 19—19′ and 20, phantom currents, though of low frequency, would get through the condensers C_3 and C_4 in some degree between the lines 11, 11′ and 15, 15′. But the cross connections 19—19′ and 20 shunt out such phantom currents so that no substantial phantom current gets across between 11, 11′ and 15, 15′. The capacities C_5 are given a compromise value; if too large, they would shunt out so much current across 11, 11′ or 15, 15′ as seriously to attenuate the phantom current along the phantom circuit 11, 12, 12′, 11′ or 15, 14, 14′, 15′. On the other hand, if the capacities C_5 were made too small, there would be an appreciable transfer of phantom current between 11, 11′ and 15, 15′. By putting condensers of proper value at C_5, it is possible to put a direct connection at 20 so that substantially no currents are transferred across from one phantom circuit to the other.

It should be noted that by making the connections at the middle points of the coils L_4, these coils become non-inductive to phantom currents, so that they offer no impedance whatever in the cross connections 19—19′ and 20.

I have shown the reactances at C_5 in Fig. 2 in the form of capacities but it will be understood that any substantial reactances for the voice frequency range might be employed at these points. Instead of the capacities represented by the condensers C_5, inductances or resistances may be interposed as indicated in Fig. 2 by throwing the switches S to the proper contacts. If the switches S are thrown so as to substitute the inductances for the condensers C_5, the combination of which these inductances are a part would act as a high pass wave filter to the phantom circuit 11—11′—15—15′.

It will be seen that if the phantom circuit comprising the side circuits 11, 12 and 11′, 12′ passes in proximity to the phantom circuit comprising the side circuits 14, 15 and 14′, 15′, then it becomes possible to superpose high frequency currents on parts 11, 11′ of the side circuits of one pair and the parts 15, 15′ of the side circuits of the other pair and to transfer these high frequency currents across either way.

I claim:

1. In combination, two phantom circuits each comprising a pair of side circuits, low pass filters interposed in said side circuits, and connections between the parts of the side circuits one way of one pair to the parts of the respective side circuits one way of the other pair, these connections each comprising a high pass wave filter and means to shunt out phantom currents across said high pass filters.

2. Two phantom circuits, each comprising a pair of side circuits, low pass filters interposed in each said side circuit, high pass filters connecting each side circuit on one side in each phantom with a corresponding side circuit on one side in the other phantom, and connections between the midpoints of corresponding shunt elements of the said last mentioned filters, the connections for the end shunt elements comprising switches and various impedance elements which may be interposed by means of said switches.

3. In combination, two phantom circuits passing in proximity and each comprising a pair of side circuits, low pass filters interposed in the respective side circuits, connections across from one part of each side circuit of a pair to a part of a respective side circuit of the other pair, high pass wave filters interposed in these connections, said high pass wave filters comprising the usual shunt and series reactances, and connections from the middle points of the shunt reactances of one high pass wave filter to the corresponding points of the other high pass wave filter.

4. In combination, two phantom circuits passing in proximity and each comprising a pair of side circuits, low pass filters interposed in the respective side circuits, connections across from one part of each side circuit of a pair to a part of a respective side circuit of the other pair, high pass wave filters interposed in these connections, said high pass wave filters comprising series condensers balanced in pairs and alternately disposed shunt inductances, the terminal shunt inductances, of each filter being connected at their middle points through condensers to the like points of the other filter, and the intermediate inductances being connected at their middle points directly to the like points of the other filter.

5. In combination, two phantom circuits each comprising a pair of side circuits all adapted for through transmission of cur-

rents of a certain frequency range, means to transfer currents of another frequency range between a side circuit of one pair and a side circuit of the other pair, and means to prevent current of said first frequency range from getting across from one phantom circuit to the other.

6. In combination, two phantom circuits each comprising a pair of side circuits and adapted for through transmission of currents of a certain frequency range, means 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, and means to prevent current of said first mentioned frequency range from getting across from one phantom circuit to the other.

7. In combination, two phantom circuits each comprising a pair of side circuits, low pass filters interposed in the respective side circuits, high pass filters interposed between a part of each side circuit of one pair and part of a respective side circuit of the other pair, and means to prevent low frequency currents on either phantom circuit from getting across through the connections afforded by said high pass filters.

8. In combination, two phantom circuits passing in proximity and each comprising a pair of side circuits, low pass filters interposed in the respective side circuits, connections across from one part of each side circuit of a pair to a part of a respective side circuit of the other pair, high pass wave filters interposed in these connections, said high pass wave filters comprising series condensers balanced in pairs and alternately disposed shunt inductances, the terminal shunt inductances of each filter being connected at their middle points through impedance elements to the like points of the other filter, and the intermediate inductances being connected at their middle points directly to the like points of the other filter.

In testimony whereof, I have signed my name to this specification this 29th day of January, 1924.

RALPH W. DEARDORFF.