

F. E. PERNOT AND L. J. RICH.
SELECTIVE RECEPTION OF ALTERNATING CURRENTS.
APPLICATION FILED MAR 30, 1922.

1,426,334.

Patented Aug. 15, 1922.

2 SHEETS—SHEET 1.

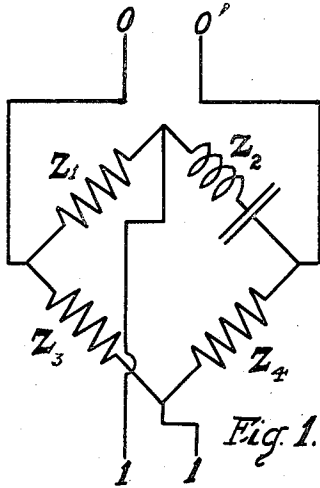


Fig. 1.

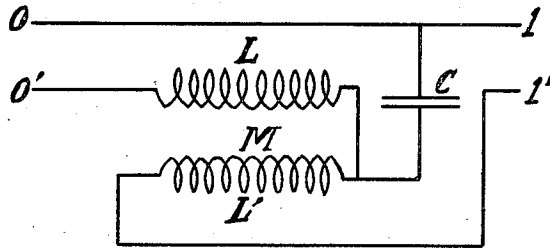


Fig. 2.

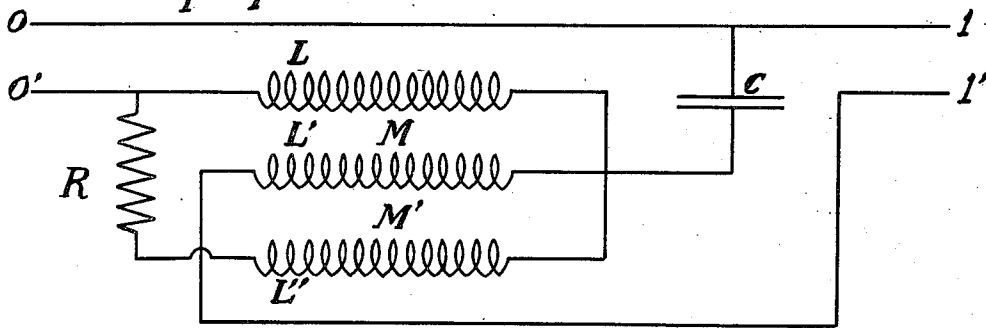


Fig. 3.

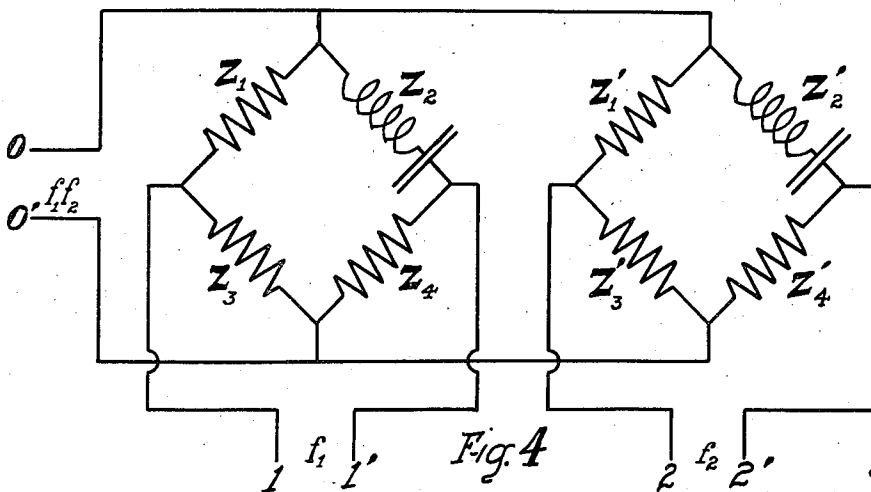


Fig. 4.

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2 SHEETS—SHEET 2.

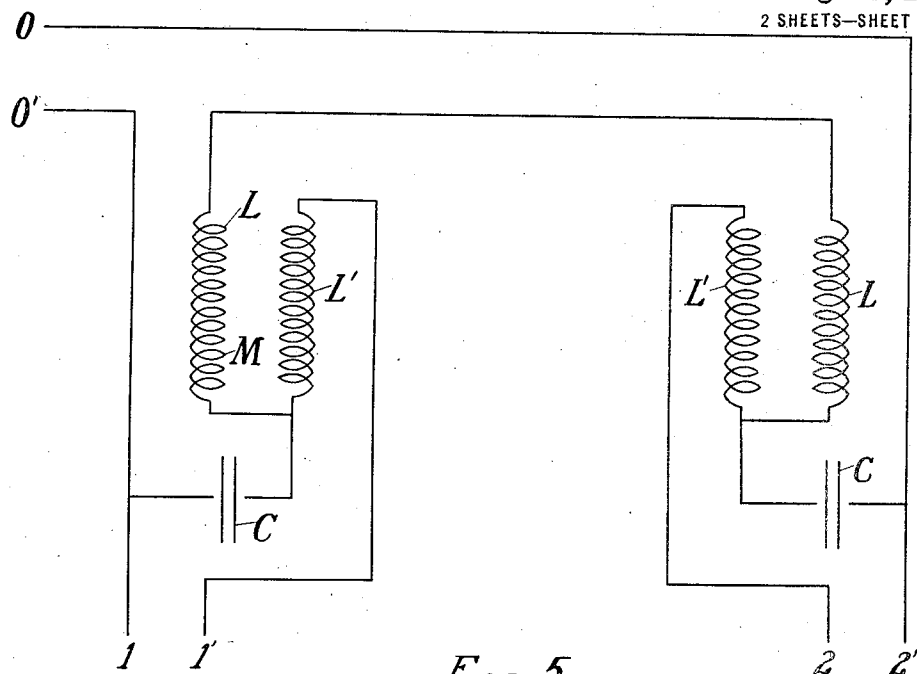


Fig. 5.

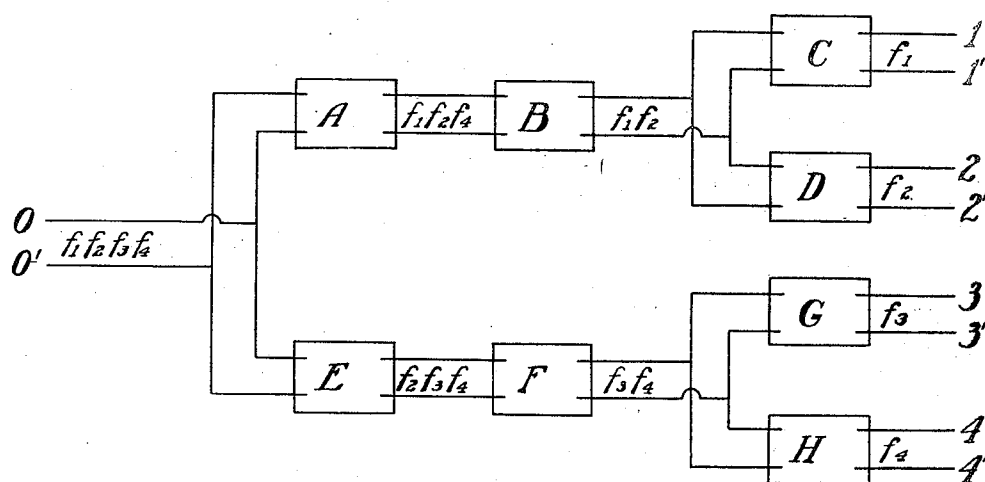


Fig. 6.

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SELECTIVE RECEPTION OF ALTERNATING CURRENTS.

1,426,334.

Specification of Letters Patent. Patented Aug. 15, 1922.

Application filed March 30, 1922. Serial No. 548,254.

To all whom it may concern:

Be it known that we, FREDERICK E. PERNOT and LESTER J. RICH, citizens of the United States, and residents, respectively, of Washington, D. C., have invented certain new and useful Improvements in Selective Reception of Alternating Currents, of which the following is a specification.

The present invention has reference to improvements in a novel method for the electrical transmission of signals, having for an object to provide a method whereby to effect the separation of currents differing in frequency from one another, as well as for the combination, without mutual interaction of currents of different frequencies.

In order that the invention and its mode of application may be readily understood by workers skilled in the art, we have in the accompanying illustrative drawings and in the detailed following description based thereon, set out practical embodiments of the invention.

In these drawings:

Figure 1 is a schematic view of one form of apparatus for separating currents of different frequencies;

Figure 2 is a modified form thereof;

Figure 3 is a similar view showing another modified form;

Figure 4 is a like view illustrating a still further modified means for separating currents of different frequencies;

Figure 5 is a schematic view of yet another modified form of the invention; and,

Figure 6 is a schematic view of a still further modification of our invention.

Having more particular reference to the drawings, in connection with which like reference characters will designate corresponding parts throughout the several views, preferably, the separation of current of one particular frequency is accomplished by elimination, one by one or sequentially, of the currents of all other frequencies which may be present. The elimination of any frequency is accomplished by the adjustment of a network of impedances, a single unit of such an arrangement or network being represented in Figure 1.

In Figure 1, O and O' indicate conductors for bringing in currents of different frequencies, one of which is to be suppressed by that portion of the network or the unit illustrated in the figure, while the currents of

other frequencies pass on by way of conductors 1 and 1'. Four impedances, designated at Z_1 , Z_2 , Z_3 , and Z_4 , in form of a Wheatstone bridge or provided, the same being made of combinations of resistance, inductance, and capacity, either in series or in parallel. By adjusting the values of these impedances so that for the frequency which it is desired to eliminate $Z_1 Z_4 = Z_2 Z_3$, no current of this particular frequency can flow from the mesh O and O' into mesh 1 and 1'. If the impedances are further selected so that the relation expressed by the above equation does not hold for any other frequency, currents of all other frequencies will pass from mesh O and O' to mesh 1 and 1'.

An alternative method of suppressing a single frequency is shown in Figure 2 wherein O and O' are conductors for bringing in currents of several different frequencies, one of which is to be suppressed, while the others pass on through conductors 1 and 1'. A condenser C is arranged in this particular form, while inductances L and L' are also provided, there being a mutual inductance M between L and L'. Thus, if one of these frequencies is to be suppressed, such frequency being herein indicated for convenience by the letter f , this will be accomplished when M and C are so adjusted that the relation expressed by the following equation holds good.

$$f^2 - \frac{1}{4\pi^2 MC} = 0$$

In Figure 3 an elaboration of the form of invention illustrated in Figure 2 is shown, except, in this particular embodiment, a circuit containing a resistance R and an inductance L' has been added to the arrangement. A mutual inductance indicated at M' will be found to occur between the inductances L' and L''. By the provision of this additional circuit, it is to be understood that the same will compensate for any leakage or power loss in the condenser C.

The forms of invention hereinbefore described have been set up as unit systems for the elimination of one particular frequency and are well known in the art of electrical measurements, their application having been mainly to a comparison of the physical properties of the component parts of the network. The novelty of the present in-

vention may be stated to reside in the use of systems of this character for the separation of currents of different frequencies used in the alternating current multiplex systems of signal transmission and in the manner of combination of individual units. The terminals of the unit systems previously described are conjugate and therefore, the action as set forth, takes place regardless of the direction of transmission of energy through the unit system; that is, for any such unit system there is a particular frequency which it cannot transmit in either direction, while transmitting other frequencies independently of the direction.

To separate currents of different frequencies several of the units as described above must be suitably interconnected. Practical embodiments of the possible methods of interconnecting unit systems in order to separate currents of two different frequencies, are illustrated in the Figures 4 and 5. In Figure 4, which may be termed the preferred form of connection for separating only two frequencies, indicated in the figures by f_1 and f_2 , the two unit systems, such as illustrated in Figure 1, are connected in parallel at one of their terminals and from this parallel connection go the conductors O and O', which constitute any desired portion of the complete system designated to carry currents of two frequencies. The other terminals 1 and 1' and 2 and 2' of the unit systems are reserved for connection to that portion of the apparatus from which it is desired to exclude all currents except those of a single frequency. Network indicated at Z_1 , Z_2 , Z_3 and Z_4 is arranged as described in connection with the equation first noted in this specification in connection with the Figure 1 to suppress currents of frequency f_2 so that currents of frequency f_2 produced anywhere else in the entire system cannot appear at terminals 1 and 1'. Similarly, network Z_1' , Z_2' , Z_3' , and Z_4' is arranged so that the frequency f_1 is suppressed and therefore, no currents of this frequency produced anywhere else in the system can appear at the terminals 2 and 2'.

In the Figure 5 we have shown another method of connecting the two unit systems, such as shown in the Figure 2 to accomplish those results as set up in connection with the Figure 4. The terminals of this system which are to be acted upon by the currents of both frequencies, are connected in series, instead of in parallel, as is done in the Figure 4. The fact that in Figure 3 a different kind of unit system from that shown in Figure 4 is used, has no bearing upon the manner in which the terminals are connected, and here, it may be noted that in this particular figure, L and L' indicate the inductances between which there is a mutual inductance M, while C designates

the condensers used in connection with these several units.

In the Figure 6, a still further arrangement is illustrated and is capable of being employed when a greater number of frequencies are to be separated. In this particular form, four frequencies are separated. At the terminals O and O', currents of four different frequencies may be present, while at the terminals 1 and 1', 2 and 2', 3 and 3', and 4 and 4', currents of any one of the four frequencies indicated adjacent the terminals O and O' by f_1 , f_2 , f_3 , and f_4 will be present. Assuming for the sake of clarity, the currents of four frequencies, f_1 , f_2 , f_3 , and f_4 enter at the terminals O and O', the operation of the apparatus will be as follows: The four frequencies enter unit system A where f_3 is suppressed, leaving the frequencies f_1 , f_2 , and f_4 to pass on into the unit system B, whereat the frequency f_4 is suppressed. The remaining frequencies f_1 and f_2 are separated by the unit systems C and D as described in connection with the Figures 4 or 5, so that finally, at terminals 1 and 1', only the frequency f_1 is present and at the terminals 2 and 2' only the frequency f_2 appears. The unit systems E and F suppress frequencies f_1 and f_2 in the same manner as systems A and B suppress frequencies f_3 and f_4 . Systems G and H separate frequencies f_3 and f_4 so that f_3 appears at terminals 3 and 3' and the frequency f_4 appears at terminals 4 and 4'. As in the case of Figure 5, the first systems A and E may be connected in series instead of in parallel as shown, as is also true with systems C and D and systems G and H.

Although we have hereinbefore described our apparatus as only separating currents of different frequencies entering at terminals O and O', it is to be fully understood that it serves also as a means for combining currents of different frequencies when they are impressed at the terminals 1 and 1', 2 and 2', 3 and 3', and 4 and 4', the manner of the combination being such that the current impressed at any one pair of terminals does not appear at any other pair except O and O'. As illustrating the action of the several systems, consider current of frequency f_2 to be supplied to terminals 2 and 2'. With the systems adjusted as hereinbefore described, the current can pass from 2 and 2' to O and O', for neither A, B, nor D is adjusted to suppress this frequency. They cannot appear at 1 and 1' because C is adjusted to suppress this particular frequency. The current cannot appear at terminals 3 and 3' and 4 and 4' because system F is adjusted to suppress this same frequency. The same is true for any other one of the four different frequencies.

It is to be further understood, that to separate currents of any number of frequencies

cies, suitable extensions or additions of the systems herein described are capable of being successfully employed.

Manifestly, the apparatus shown are capable of considerable modification and such modification as is within the scope of our claim, we consider within the spirit of our invention.

We claim—

10 A system for the selective transmission of a plurality of currents of different frequency between a common transmission circuit and circuits individual to said frequencies, comprising a plurality of branches for said
15 common circuit and sub-branches for each

branch, selective suppressing devices for each frequency comprising input and output circuits conjugate to one another as to a single frequency and connected into the branches and sub-branches so as to provide 20 for each frequency a single selective path extending from the common circuit to its individual circuit by way of a branch, a sub-branch and selective frequency devices for each of the other frequencies, whereby said 25 other frequencies are individually and successively suppressed.

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