Aug. 17, 1926. 1,596,087

L. ESPENSCHIED

SELECTING CIRCUITS

Filed Dec. 30, 1921 2 Sheets-Sheet 1

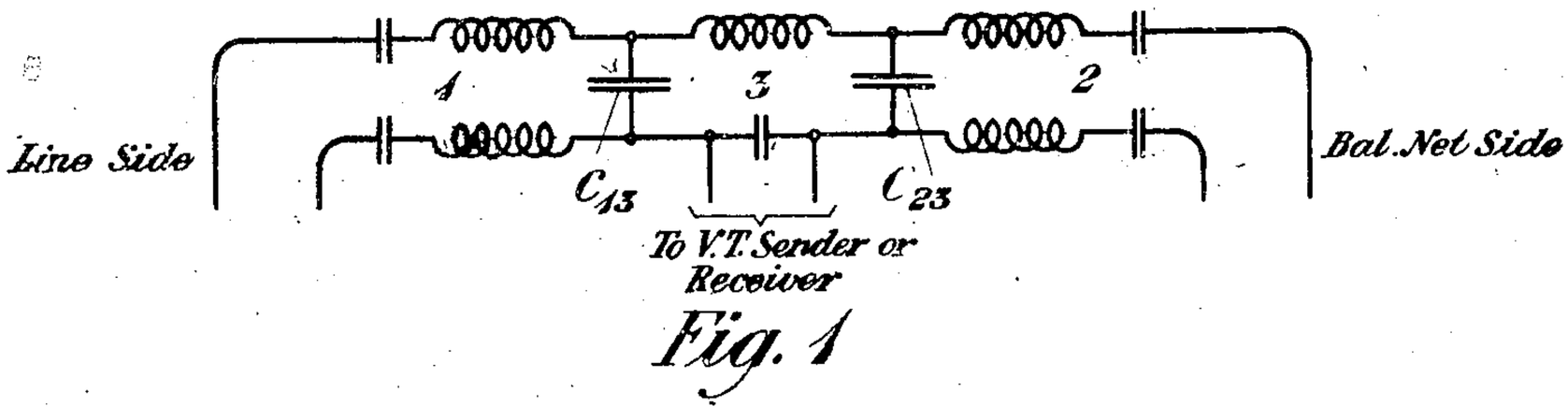

Fig. 1

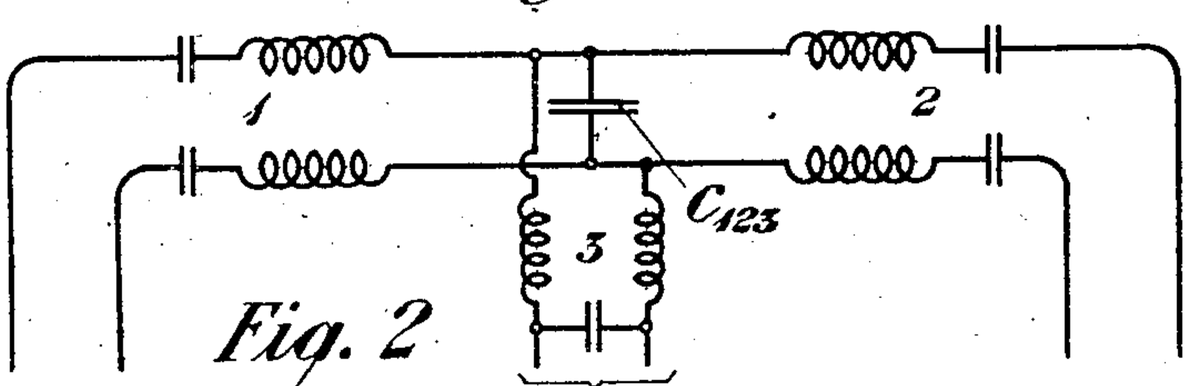

Fig. 2

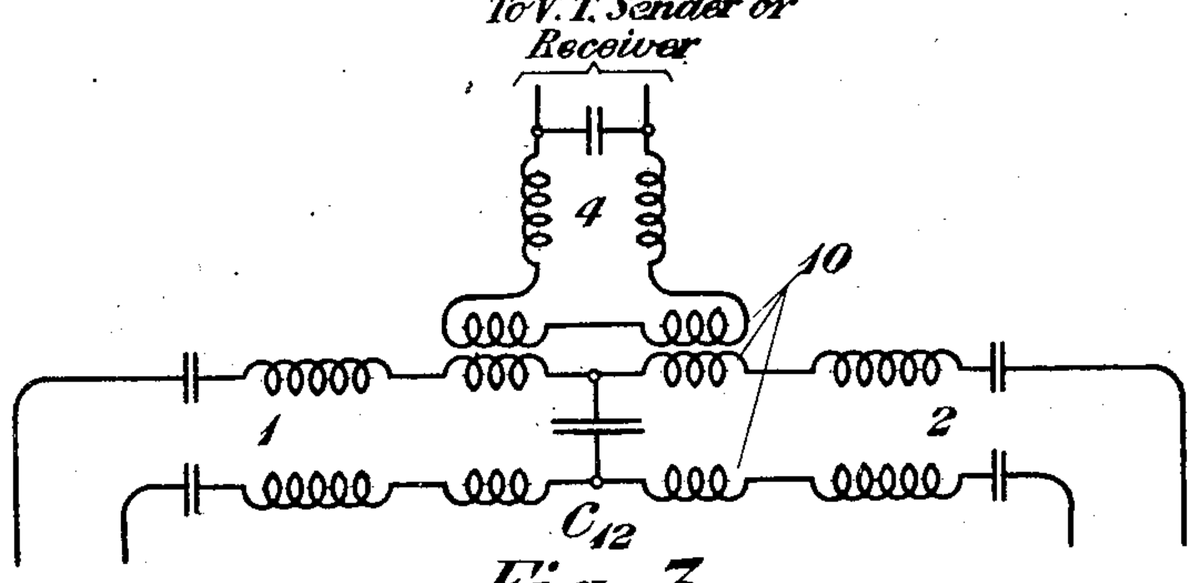

Fig. 3

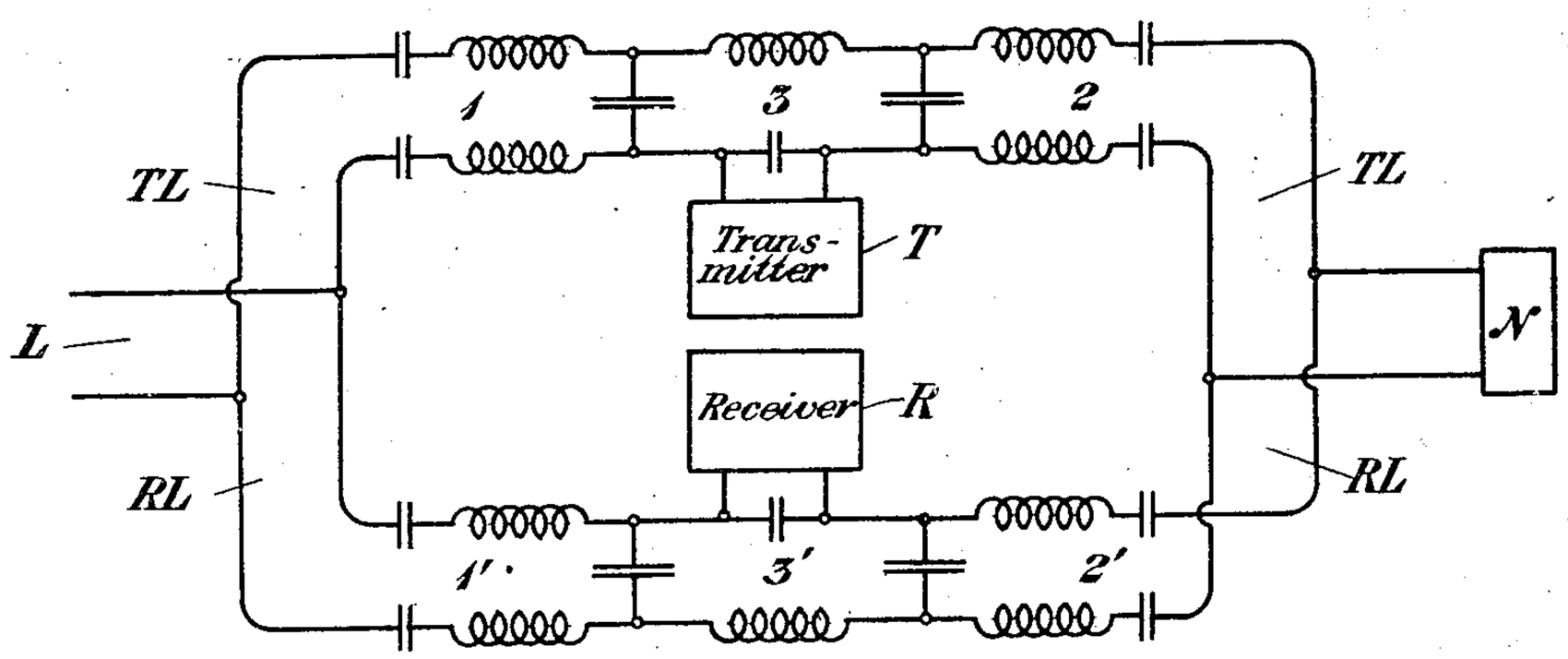

Fig. 4

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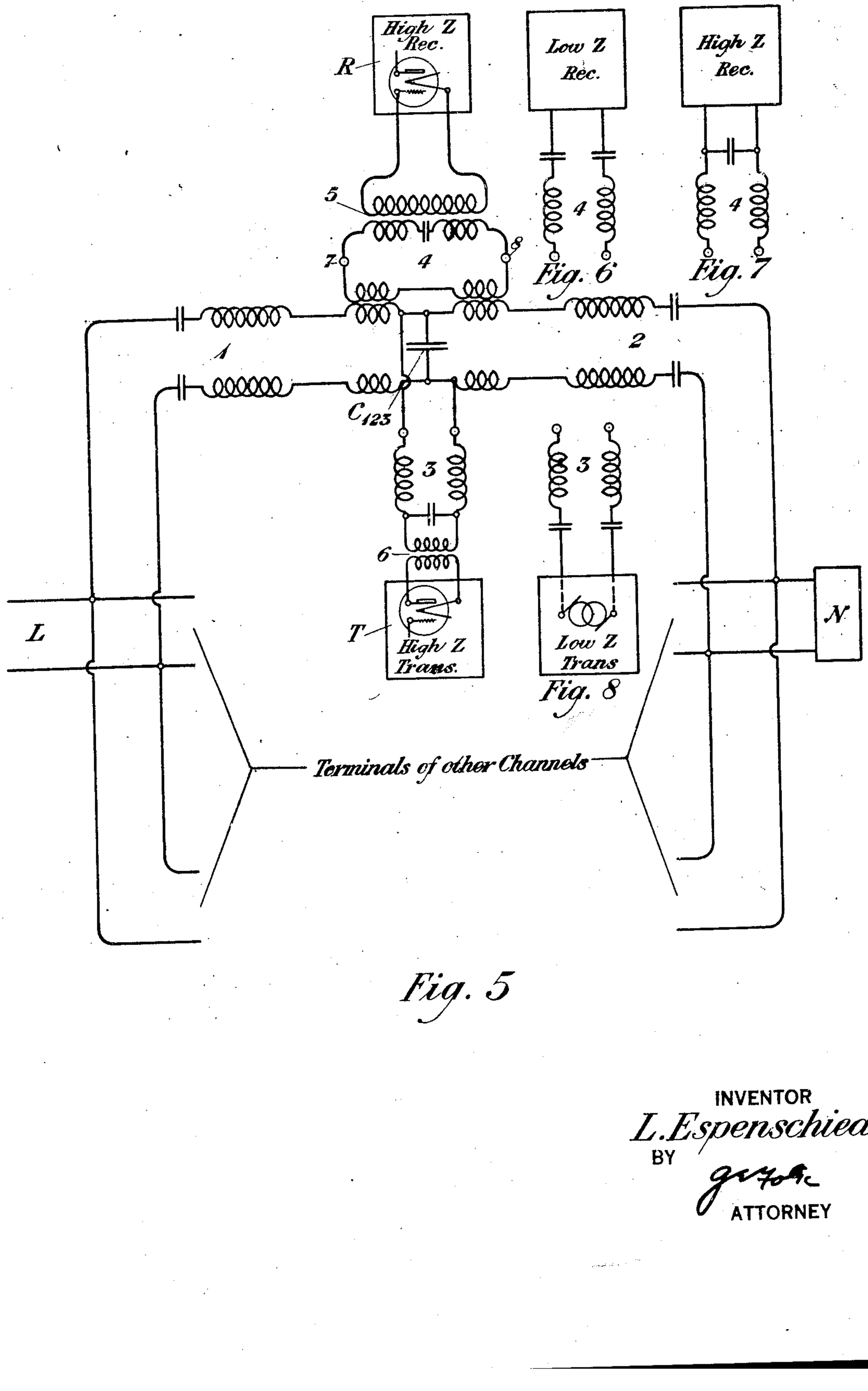

Fig. 6

Fig. 7

Fig. 8

Fig. 5

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Patented Aug. 17, 1926. 1,596,087

UNITED STATES PATENT OFFICE.

LLOYD ESPENSCHIED, OF QUEENS, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

SELECTING CIRCUITS.

Application filed December 30, 1921. Serial No. 525,897.

This invention relates to signaling circuits and more particularly to a form of selective terminal circuit adapted to permit of superposing alternating current of carrier current channels upon ordinary telephone and telegraph circuits.

One of the objects of the present invention is to provide a low frequency carrier channel employing frequencies of the order of 100 to 300 cycles per second, although the invention is equally applicable to high frequency transmission. Such a channel may be used for any signaling purpose as, for example, telegraph or telephone control signaling in which the signaling frequency is low relative to the carrier frequency.

In carrying out the objects of this invention the carrier channel is balanced in multiple with other channel terminals, such as telephone and direct current telegraph channels, for the purpose of avoiding interference between the oppositely directed transmissions of the different channels. It is also proposed to use sharply tuned selective circuits for the terminal frequency selective circuits of the terminals frequency selecting system and preferably a capacitive type of loose coupling will be employed between the individual sharply tuned circuits. The capacitive type of coupling has an important advantage over the inductive coupling in that it tends to suppress the transmission of the harmonics of the carrier frequency which would otherwise tend to interfere with the channels operating on higher frequencies, particularly with the telephone channel, the frequency band of which embraces a number of harmonics of the lower frequency of the carrier which it is preferred to use in connection with the type of channel forming the subject matter of the present invention.

The invention may now be more fully understood from the following description when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which show different types of selecting circuits embodying the principles of the present invention, Figs. 4 and 5 of which illustrate circuit arrangements for signaling systems employing the selective circuits shown in Figs. 1, 2 and 3, while Figs. 6, 7 and 8 illustrate different arrangements for associating the transmitting and receiving apparatus with the circuit of Fig. 5.

Referring to Figs. 1, 2 and 3, three or more tuned circuits may be coupled together either individually or in common. For example, let us suppose we have a selecting system comprising a tuned circuit for the line connection of the system, a tuned circuit for the balancing connection of the system, and a third tuned circuit associated with the drop, that is, the transmitting or receiving apparatus. In such a system as shown in Fig. 1 the line tuned circuit 1 and the network tuned circuit 2 are coupled individually through coupling condensers C_{13} and C_{23} respectively to the drop side tuned circuit 3. Each of the three tuned circuits is electrically similar, the tuning being determined by suitable inductances and capacities in a well known manner. The capacities of the condensers C_{13} and C_{23} are quite large as compared with the capacities of the tuning condensers in the circuits 1, 2 and 3, and their sole purpose is to provide a loose coupling between the individual circuits. The coupling condensers are bridged across the circuit and, owing to their large capacity, form paths of practically negligible impedance for high frequencies so that if a generator is associated with the tuned circuit 3 for example, the harmonics of the generator will not be transmitted beyond the condensers C_{13} and C_{23}, as these condensers will practically short-circuit the apparatus beyond the condensers so far as the flow of the higher frequencies is concerned. In associating a transmitter or a receiver with the tuned circuit 3, for example, the connection may be made across any two points of different potential. In the case illustrated, the connection is made to opposite terminals of the tuning condenser of the circuit 3.

Fig. 2 illustrates an arrangement for coupling the three circuits in common. In this case, the tuned circuits 1 and 2 are loosely coupled by a capacitive coupling comprising a condenser C_{123} similar in its function to the condensers C_{13} or C_{23} already described. A third tuned circuit 3 to be associated with the drop, for example, may be connected to the terminals of the coupling condenser C_{123} in the same manner as the circuits 1 and 2, so that all three

tuned circuits are coupled together in common by means of the same loose coupling. This arrangement is especially advantageous for connecting a transmitting device associated with the tuned circuit 3 with the other two tuned circuits, one of which may be associated with the line and the other with the balancing circuit. This is for the reason that the tuned circuit 3 is in effect bridged across the other two tuned circuits and will form a neutral connection with respect to a receiving circuit where one is employed, as will be described later.

Fig. 3 shows an arrangement in which the tuned circuits 1 and 2 are loosely coupled together through a condenser C_{12} and the third tuned circuit 4 is loosely coupled to the tuned circuits 1 and 2 through an inductive coupling partaking of the nature of a hybrid coil 10. This inductive type of coupling is suitable where the circuit is to be employed for receiving, in which case it is not necessary to guard against harmonics. The receiving circuit may be associated, for example, with the terminals of the tuned circuit 4.

Fig. 4 shows an arrangement illustrating how a selecting circuit of the type shown in Fig. 1 may be employed for two-way operation. Two channels TL and RL may be connected in multiple to the line connection L and to the balancing network N. Each channel includes three tuned circuits coupled as illustrated in Fig. 1. The transmitting apparatus T, which may be of any type, is connected to opposite terminals of the tuning condenser of the circuit 3 and the receiving apparatus, conventionally illustrated at R, is similarly connected across the tuning condenser of the circuit 3'. The two channels may be made conjugate with respect to each other for similar connections of the transmitting and receiving apparatus to the individual channels by reversing the connections of one of the channels, as shown in connection with the channel RL, where it is connected to the network N.

The circuits of Figs. 2 and 3 may be readily combined to form a two-way circuit as illustrated in Fig. 5. The tuned circuits 1, 2 and 3 are loosely coupled in common through the coupling condenser C_{123} and the transmitting device T is connected to the tuned circuit 3. A fourth tuned circuit 4 is inductively coupled by the hybrid coil arrangement of Fig. 3 to the circuits 1 and 2 and the receiving apparatus R is connected to the tuned circuit 4 through a transformer 5. It will be obvious that the transmitter and receiver will be conjugate with respect to each other and the channel including the circuits 1 and 2 may be bridged to the line L and the network N in parallel with other channels for employing other carrier frequencies or employed for ordinary telephone or direct current telegraph transmission.

Where the transmitter T is a high impedance device, as will be the case when the transmitting apparatus includes a vacuum tube, it should be connected in parallel with the tuning element of the circuit 3, as, for example, by connecting it across the terminals of the tuning condenser of the circuit 3 through a transformer 6. Similarly, the receiving device R, where it is of high impedance, is associated with the tuned circuit 4 through the transformer 5. Where a low impedance transmitter is used, such, for example, as an alternator, it may be included serially in the tuned circuit 3 as illustrated in Fig. 8. A low impedance receiver may also be connected in series with the tuned circuit 4 as illustrated in Fig. 6, the apparatus of which may replace the apparatus above the terminals 7 and 8 in the circuit of Fig. 5. Fig. 7 shows an alternative arrangement for connecting a high impedance receiver, the receiver being connected in parallel with the tuning condenser of the tuned circuit 4 and the apparatus of Fig. 7 being likewise intended to replace the apparatus of Fig. 5 above the terminals 7 and 8.

Where the transmitting and receiving apparatus are coupled together by means of a conjugate arrangement such as that shown in Fig. 5, it is, of course, necessary to use the same frequency for transmitting and receiving as all of the circuits 1, 2, 3 and 4 must be tuned to the same frequency.

The loose coupling between the several circuits is necessary in order to prevent the double peak effect of the frequency amplitude curve observed where tuned circuits are closely coupled. The arrangement of Fig. 4, on the other hand, permits of the use of different frequencies for transmitting and receiving, as the three tuned circuits in the channel TL may be tuned to different frequencies from those in the channel RL, owing to the fact that the two sets of tuned circuits are not coupled together. The three tuned circuits in a given channel as, for example, in the transmitting channel, will, of course, be tuned to the same frequency.

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 of the invention as defined in the following claims.

What is claimed is:

1. In a selective system, a transmission path and a balancing path, circuits in each path tuned to the same frequency and so loosely coupled together as to be independently resonant, a third tuned circuit coupled to each of the other tuned circuits, and a

translating device associated with the third tuned circuit.

2. In a selective system, a transmission path and a balancing path, circuits in each path tuned to the same frequency and so loosely coupled together through a capacity coupling as to be independently resonant, a third tuned circuit coupled to each of the other tuned circuits, and a transmitting device associated with the third tuned circuit.

3. In a selective system, a pair of tuned circuits loosely coupled together, a third tuned circuit loosely coupled to each of the first two tuned circuits in the same manner, and a fourth tuned circuit coupled to each of the first two tuned circuits through connections which are similar to each other, the coupling for the third and fourth tuned circuits being so arranged that said third and fourth circuits will be conjugate with respect to each other.

4. In a selective system, a pair of tuned circuits loosely coupled together through a capacitive coupling, a third tuned circuit coupled to each of the first two tuned circuits through the same capacitive coupling, and a fourth tuned circuit loosely coupled to the first and second tuned circuits, said last mentioned coupling being so arranged that said third and fourth circuits will be conjugate.

5. In a selective system, a pair of tuned circuits having common terminals, a third tuned circuit also connected to said common terminals, a capacitive loose coupling bridged across said common terminals for loosely coupling the three tuned circuits together, a fourth tuned circuit inductively coupled to said first and second circuits through windings arranged on each side of said common terminals, whereby said third and fourth circuits will be substantially conjugate.

6. In a selective system, a transmission path, a balancing path, a tuned circuit in each path, a capacitive coupling for loosely coupling the two tuned circuits, a transmitting apparatus, a third tuned circuit associated therewith, said third tuned circuit being loosely coupled to the first and second tuned circuits through said common capacitive coupling, a receiving apparatus, a fourth tuned circuit associated therewith, said fourth tuned circuit being loosely coupled to the tuned circuits in said transmission path and balancing path in such a manner as to be conjugate with respect to said third tuned circuit.

7. In a selective system, a transmission path, a balancing path, tuned circuits in each of said paths, said tuned circuits having common terminals, a transmitting apparatus including a tuned circuit, said tuned circuit also being connected to said common terminals, a capacity bridged across said terminals for loosely coupling the three tuned circuits together, a receiving apparatus including a fourth tuned circuit, said fourth tuned circuit being inductively coupled to the tuned circuits in said transmisison path and said balancing path through windings on either side of said common terminals whereby the transmitting and receiving apparatus will be substantially conjugate.

In testimony whereof, I have signed my name to this specification this 29th day of December 1921.

LLOYD ESPENSCHIED.