

Dec. 30, 1924.

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L. ESPENSCHIED

SELECTIVE CIRCUITS FOR MULTIPLEX TRANSMISSION

Filed Sept. 23, 1919

2 Sheets-Sheet 1

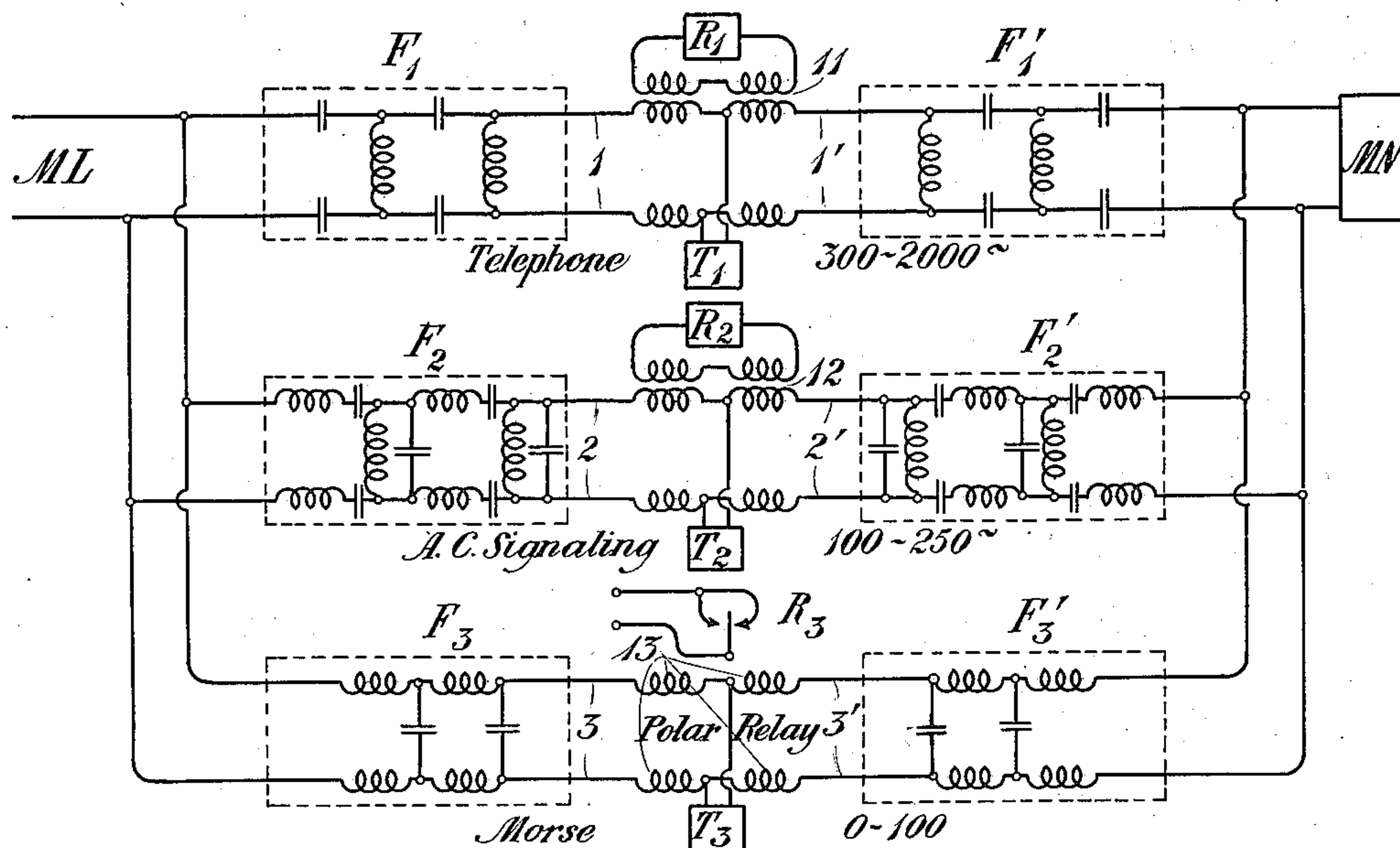


Fig. 1

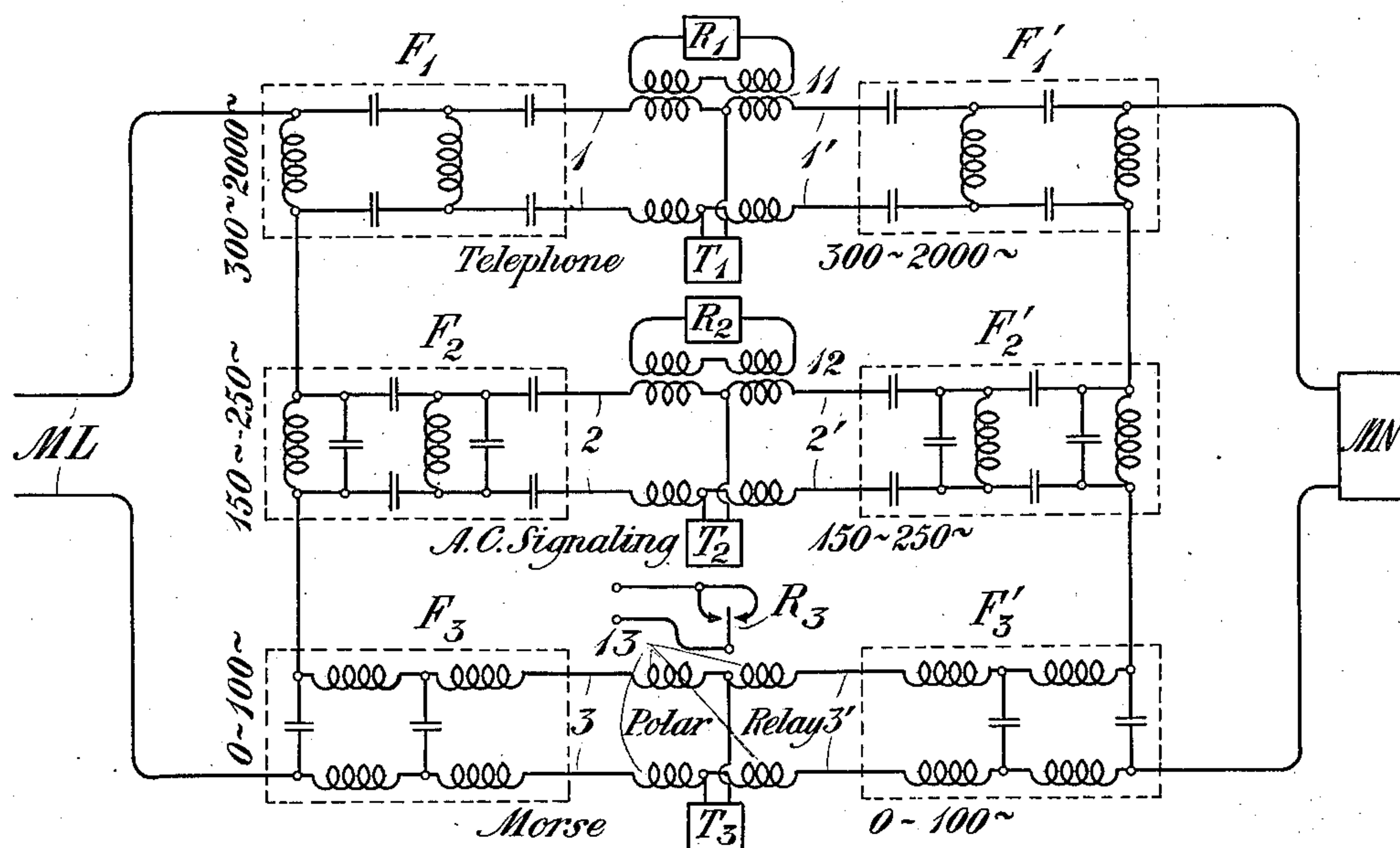


Fig. 2

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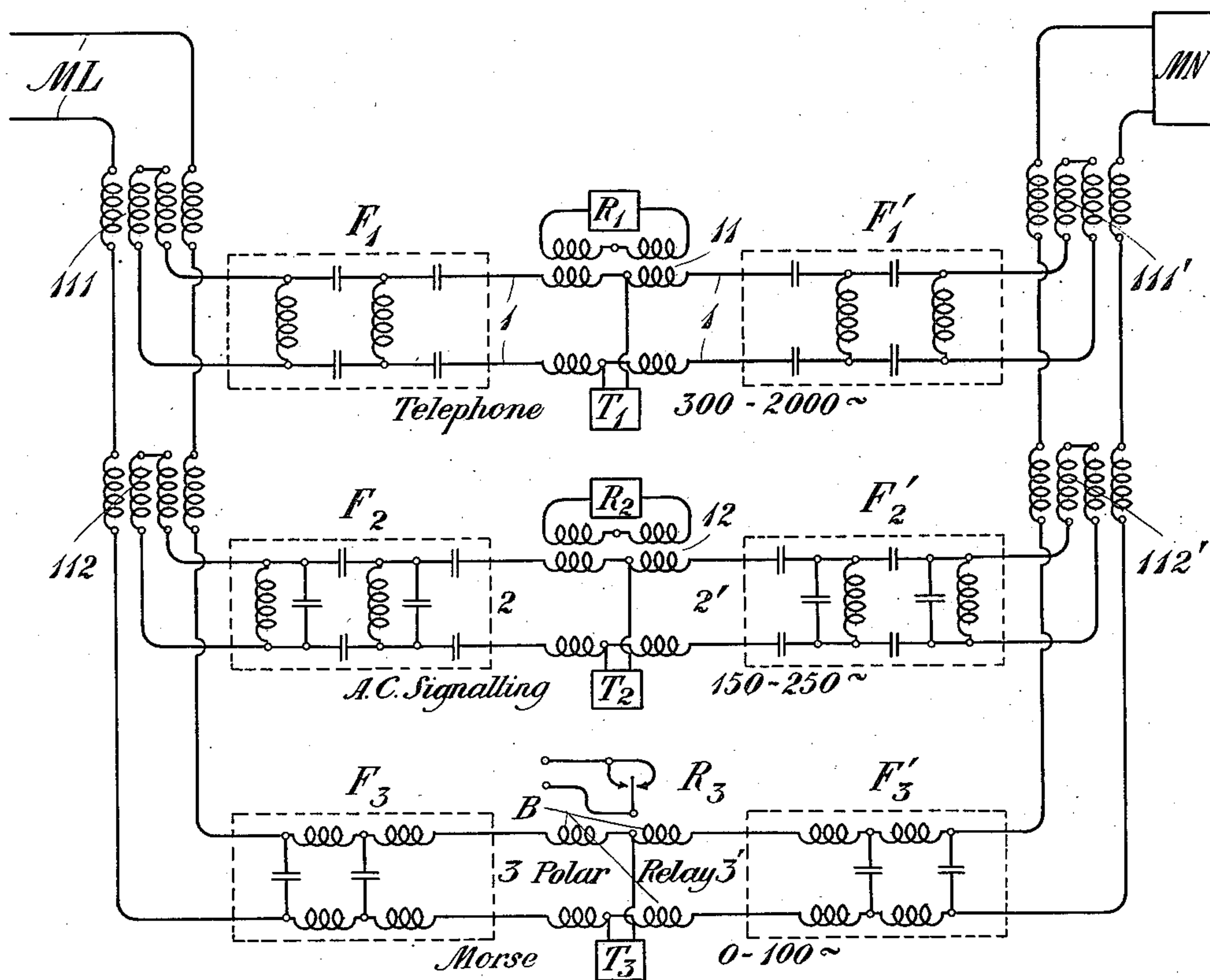


Fig. 3

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UNITED STATES PATENT OFFICE.

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SELECTIVE CIRCUITS FOR MULTIPLEX TRANSMISSION.

Application filed September 23, 1919. Serial No. 325,678.

To all whom it may concern:

Be it known that I, LLOYD ESPENSCHIED, residing at Hollis, in the county of Queens and State of New York, have invented certain Improvements in Selective Circuits for Multiplex Transmission, of which the following is a specification.

This invention relates to signaling circuits and more particularly to signaling circuits whereby a plurality of signals may be simultaneously transmitted over the same circuit.

One of the features of this invention resides in a circuit arrangement whereby a plurality of signaling paths are arranged in bridged relation between a main transmission circuit and a balancing artificial line, each of said paths having transmitting and receiving apparatus associated therewith.

Another feature of the invention resides in such an arrangement of the bridge paths of a circuit such as just described that said paths will be serially related with respect to each other and also with respect to the transmission circuit and artificial line.

Still another feature of the invention resides in providing a circuit of the character previously referred to, with filters for the several signaling paths, said filters being of different types; for instance, one path may be provided with a filter of the so-called low pass type, a filter of this type being arranged to transmit, in a frequency spectrum extending from zero cycles to an infinite number of cycles, a band extending from zero to an upper limit less than infinity. The filter in another of said paths may be of the so-called high pass type which is arranged to transmit a band of frequencies extending from a lower limit greater than zero, up to infinity. The filter in still another of said paths may be a band filter adapted to transmit a band of frequencies whose lower limit is greater than zero and whose upper limit is less than infinity.

The invention may now be more fully understood from the following detailed description when read in connection with the accompanying drawing, Figures 1, 2 and 3 of which constitute circuit diagrams illustrating different embodiments of the invention.

Referring to Fig. 1, ML designates a main transmission line or circuit upon which

a plurality of signals may be simultaneously superposed. While this transmission line or circuit may be of any character, it is herein illustrated as an ordinary telephone transmission line upon which is superposed an ordinary Morse signaling circuit and an alternating telegraph circuit having a frequency lower than the lowest frequency employed in ordinary telephonic transmission. If desired, other signaling channels may also be superposed upon the line by employing alternating carrier currents whose frequencies are greater than those ordinarily employed in telephone transmission.

MN designates an artificial line or network for balancing the main line ML. In order to superpose a plurality of signals upon the line, said line ML is interconnected with the balancing artificial line MN, through the medium of a plurality of bridge circuits such as 1-1', 2-2' and 3-3'.

Telephone transmitting and receiving apparatus T_1 and R_1 may be associated with the bridge path 1-1' through a balancing transformer 11 of well-known type. In order to secure conjugacy between the transmitting and receiving apparatus the transmitting apparatus T_1 is connected to mid-points of the windings of the transformer 11, while the receiving apparatus R_1 is serially associated with the bridge. Alternating current telegraph transmitting apparatus T_2 and receiving apparatus R_2 is conventionally illustrated as being associated in a similar manner with the bridge path 2-2' through a balanced transformer 12. For Morse signaling the receiving apparatus is illustrated as a polar relay having balanced windings 13 connected in the bridge 3-3', the armature of said polar relay controlling a local receiving circuit. The Morse transmitting apparatus T_3 is illustrated as being connected to midpoints of the windings of the polar relay.

In order to insure selectivity between the signaling paths, filters F_1 , F_2 and F_3 are included in the paths 1, 2 and 3 respectively. These filters are preferably of the broad band type illustrated in the U. S. patents to George A. Campbell, Nos. 1,227,113 and 1,227,114, dated May 22, 1917. The filter F_1 may be a so-called high pass filter which transmits a band of frequencies extending from a lower limit greater than zero, up to

infinity. Since the lower limit of ordinary telephonic transmission is in the neighborhood of 300 cycles, the filter F_1 may be arranged to transmit frequencies from 300 cycles up. The filter F_3 is preferably of the so-called low pass type which transmits a frequency band extending from zero to an upper limit less than infinity. Since this filter is adapted for the transmission of Morse frequencies, its upper limit may be in the neighborhood of 100 cycles. The remaining frequency range is available for the transmission of alternating current telegraph signals and in order to prevent interference between such signals and the Morse and telephone currents, it is necessary that the filter F_2 be a band filter, both of whose limits lie between zero and infinity. In the case illustrated the limiting frequencies of this filter may be taken as 100 cycles and 250 cycles.

In order that the condition of balance may obtain, it is necessary that the filters inserted in paths 1, 2 and 3 be balanced by inserting suitable apparatus in the balancing paths 1', 2' and 3'. While the balancing apparatus may be any suitable net work having electrical characteristics simulating those of the filter which is to be balanced, in the case illustrated duplicate filters F_1' , F_2' and F_3' are provided for balancing the filters F_1 , F_2 and F_3 respectively.

The bridge paths in the circuit of Fig. 1 are illustrated as being connected in parallel with each other. From this connection it is apparent that a condition of conjugacy exists between the transmitting apparatus associated with any path and the receiving arrangements associated with all of the paths and vice versa. For instance, a signaling current from the Morse transmitter T_3 flows through the windings 13 in opposite directions, so that the polar receiving relay is not actuated. The components of these currents flowing in the paths 2—2' and 1—1', pass through the windings of the transformers 12 and 11 in opposite directions, so that no currents are induced in the receiving arrangements R_2 and R_1 respectively.

Instead of arranging the signaling paths in parallel with each other as illustrated in Fig. 1, the bridges may be serially related to each other as illustrated in Fig. 2. In this form of the invention, not only are the bridges 1—1', 2—2' and 3—3' serially related to each other, but they are also serially related to the main line ML and the artificial line MN. The operation of this circuit will be similar to that described in connection with Fig. 1 and need not be further considered.

In some instances it may be desirable that the serial connections between the bridges and the main line and artificial line be of

such character that a balance will be obtained between the two sides of the line or artificial line, as the case may be. Such an arrangement is illustrated in Fig. 3, in which the bridge connection 3—3' may be considered as a simple series connection between the line ML and the network MN. The bridges 1—1' and 2—2' are then serially connected with the line and artificial line through balanced transformer arrangements 111—111' and 112—112'. The operation of this arrangement is equivalent to that of the arrangement of Fig. 2, but the circuit of Fig. 3 has the advantage that the disposition of the transformer windings prevents the individual bridge terminal circuits from being, as a whole, at a difference of potential with respect to ground.

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 signaling system, a common transmission line, a plurality of branches from said line, whereby signaling currents of different frequencies may be impressed upon said line, band filters in each branch for readily transmitting to the line the frequencies characteristic of that particular branch, but excluding the frequencies characteristic of the other branches, the filters associated with certain of said branches being so designed as to transmit with uniform negligible attenuation, in a frequency spectrum whose limits are zero and infinity, a range of frequencies, neither of whose limits coincide with the limits of the frequency spectrum, and the filters associated with two other branches being so designed as to transmit with uniform negligible attenuation a band of frequencies lying between a given frequency and a limit of the frequency spectrum, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

2. In a signaling system, a common transmission line, a plurality of branches from said line, whereby signaling currents of different frequencies may be impressed upon said line, band filters in each branch for readily transmitting to the line the frequencies characteristic of that particular branch, but excluding the frequencies characteristic of the other branches, the filters associated with certain branches being so designed as to transmit with uniform negligible attenuation frequencies lying between zero and an upper limit less than infinity, the filters associated with other branches be-

ing designed to transmit with uniform negligible attenuation frequencies lying between infinity and a lower limit greater than zero, and the filters associated with still other branches being designed to transmit with uniform negligible attenuation a range of frequencies whose lower limit is greater than zero and whose upper limit is less than infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

3. In a signaling system, a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus associated with each path and filters in said paths, the filter in one of said paths being so constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies extending from zero to an upper limit less than infinity, and the filter in another of said paths being so constructed as to transmit with uniform negligible attenuation a band of frequencies both of whose limits lie between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

4. In a signaling system, a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus associated with each path and filters in said paths, the filter in one of said paths being adapted to transmit with uniform negligible attenuation a band of frequencies extending from a lower limit greater than zero up to infinity and the filter in another of said paths being adapted to transmit with uniform negligible attenuation a band of frequencies both of whose limits lie between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

5. In a signaling system, a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus

associated with each path and filters in said paths, the filter in one of said paths being adapted to transmit with uniform negligible attenuation a band of frequencies extending from zero to an upper limit less than infinity, the filter in the second of said paths being adapted to transmit with uniform negligible attenuation a band of frequencies extending from a lower limit less than infinity up to infinity, and the filter in still another path being adapted to transmit with uniform negligible attenuation a band of frequencies both of whose limits are between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

6. In a signaling system, a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus associated with each path, filters inserted in each path on each side of the point at which the transmitting and receiving apparatus is associated with the path, the filters in one of said paths being so constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies extending from zero to an upper limit less than infinity, and the filters in another of said paths being so constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies both of whose limits lie between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands a separation not substantially greater than the width of one of the bands.

7. In a signaling system, a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus associated with each path, filters inserted in each of said paths upon each side of the point at which the transmitting and receiving apparatus is associated with the path, the filters in one of said paths being so constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies extending from a lower limit greater than zero up to infinity, and the filters associated with another of said paths being constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies both of whose limits

lie between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit between bands
5 a separation not substantially greater than the width of one of the bands.

8. In a signaling system a transmission circuit upon which a plurality of signaling channels may be superposed, a balancing
10 artificial line, a plurality of signaling paths arranged in multiple and interconnecting said transmission circuit and said artificial line, transmitting and receiving apparatus associated with each path, and filters insert-
15 ed in each of said paths upon each side of the point at which the transmitting and receiving apparatus is associated with the path, the filters in one of said paths being so arranged and constructed as to transmit
20 with uniform negligible attenuation a band

of frequencies extending from zero to an upper limit less than infinity, the filters in another of said paths being so constructed and arranged as to transmit with uniform negligible attenuation a band of frequencies
25 extending from a lower limit greater than zero up to infinity, and the filters in still another of said paths being adapted to transmit with uniform negligible atten-
30 uation a band of frequencies, both of whose limits lie between zero and infinity, and said filters being so designed as to effectually suppress frequencies outside the band transmitted, to such extent as to permit be-
35 tween bands a separation not substantially greater than the width of one of the bands.

In testimony whereof, I have signed my name to this specification this 18th day of September, 1919.

LLOYD ESPENSCHIED.