

May 10, 1932.

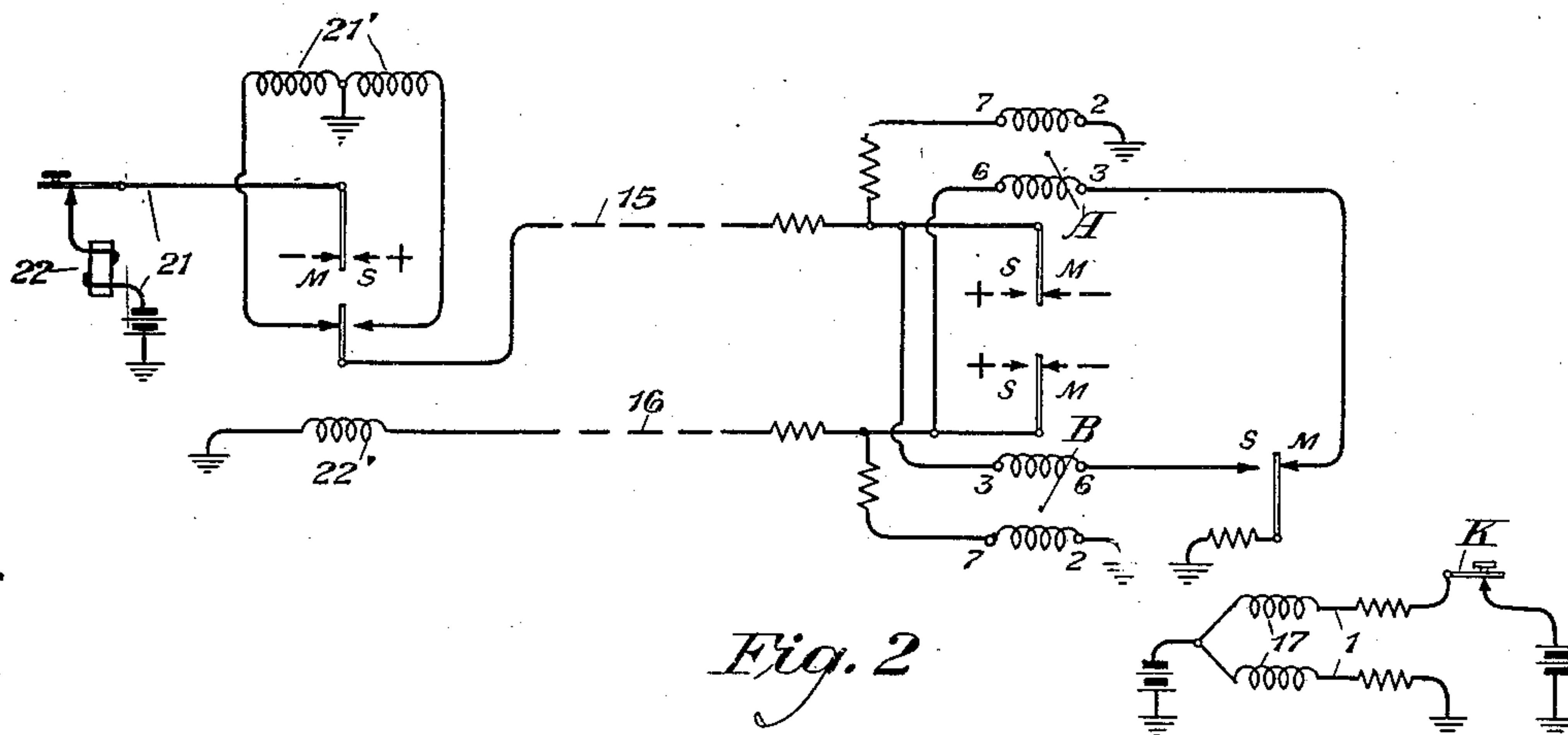
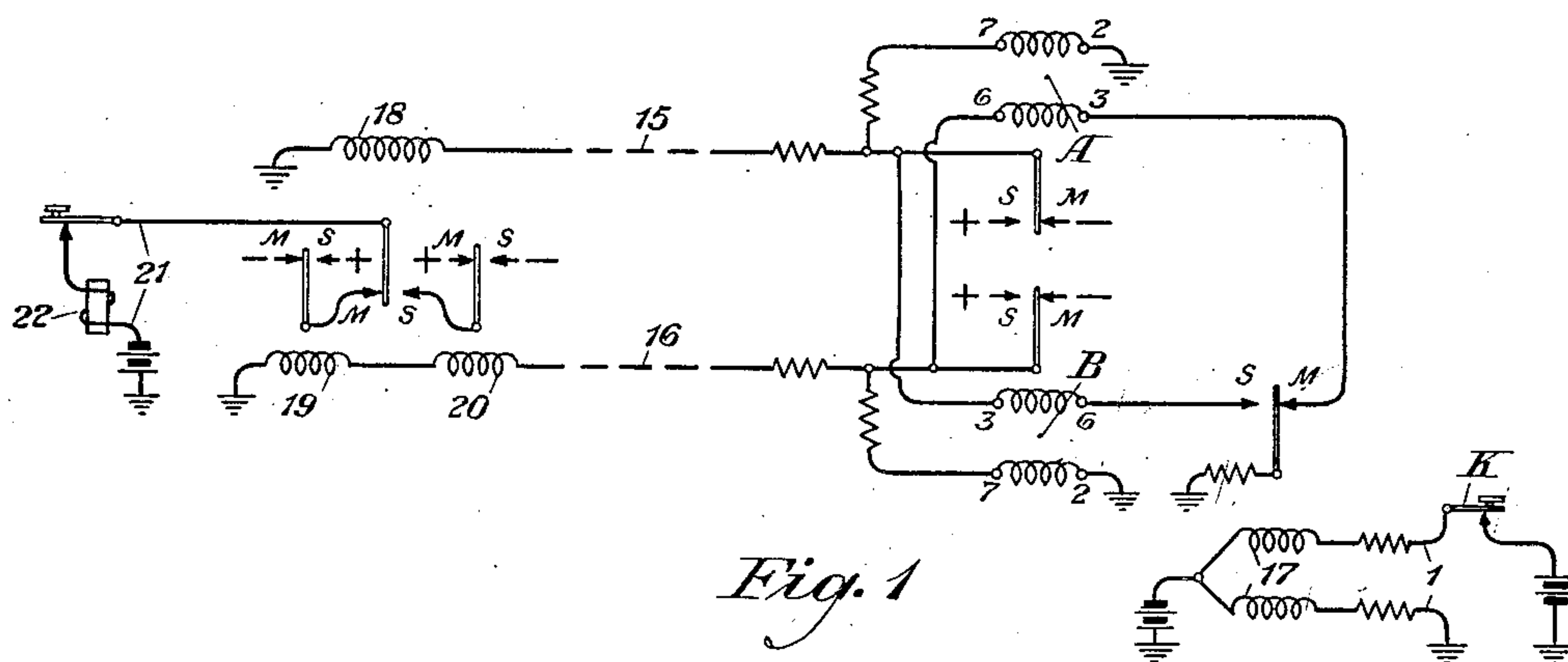
W. T. REA

1,857,259

TRANSMISSION SYSTEM

Filed June 24, 1931

2 Sheets-Sheet 1



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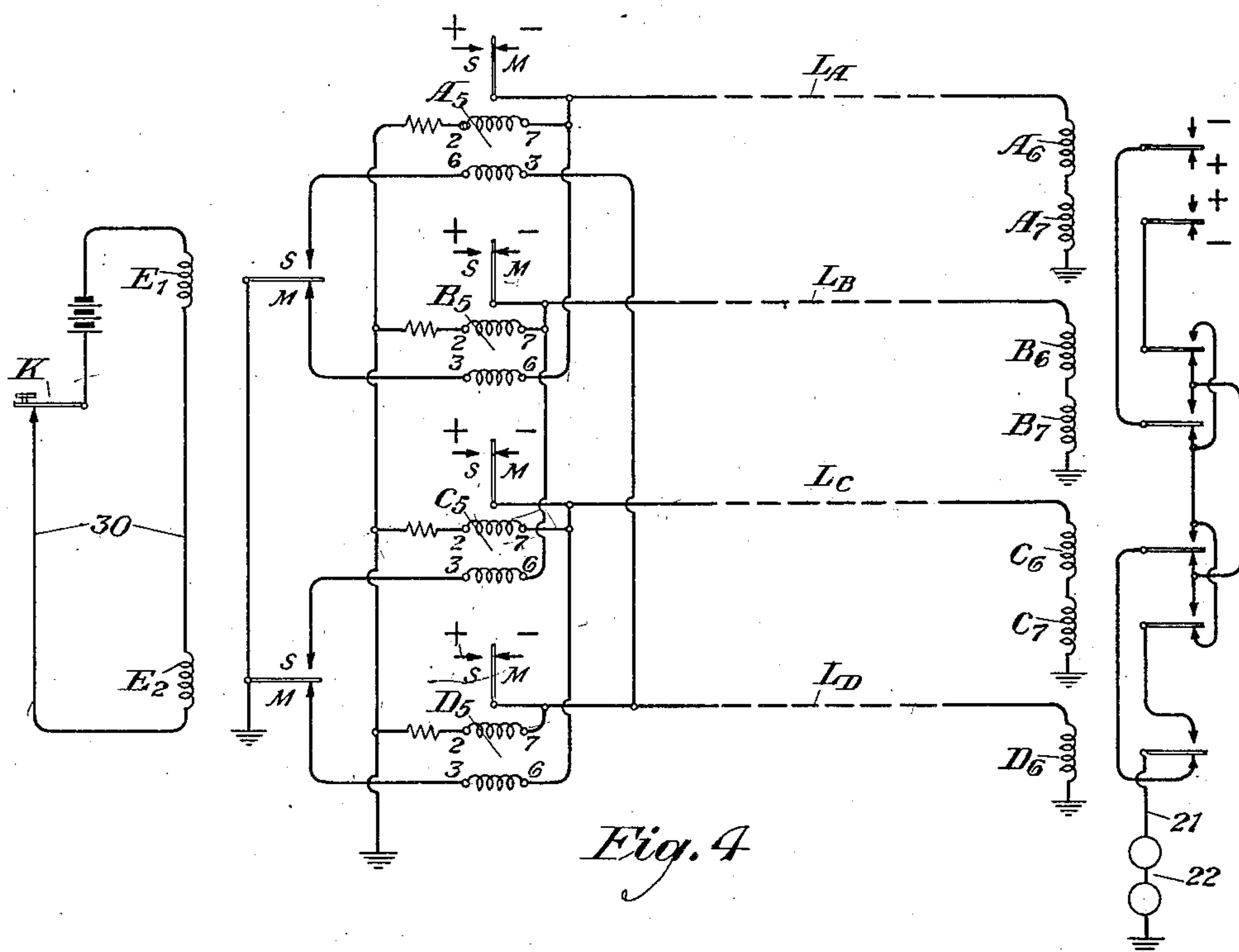
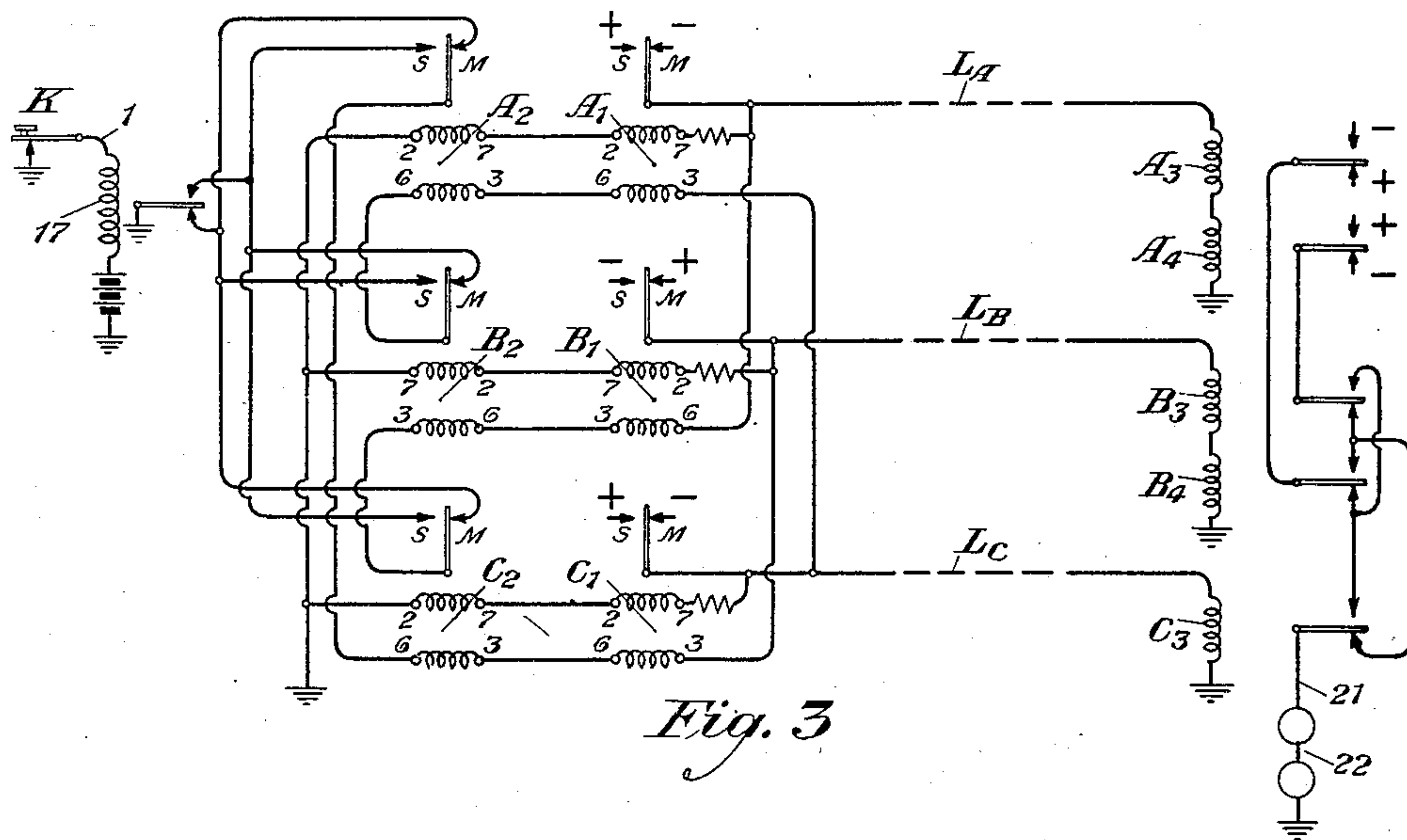
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2 Sheets-Sheet 2



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TRANSMISSION SYSTEM

Application filed June 24, 1931. Serial No. 546,624.

This invention relates to telegraph systems, and more particularly to improved arrangements whereby signals may be originated and received on such systems at a high signaling speed and whereby such high speed signals may be transmitted between stations over lines suitable only for low speed signals.

To distinguish between low speed and high speed telegraph signals and low speed and high speed telegraph transmission channels for the purpose of this invention, it is pointed out that the speed of the signals may be defined as the number of dots or impulses originated per second. The shortest impulse of a set of message impulses would be utilized to fix the maximum speed of the message signals. The number of these shortest impulses that could be transmitted per second could be termed the speed of the signals or could be characterized as the maximum fundamental frequency of the signaling current.

A telegraph line interconnecting two stations would usually have associated therewith certain selective devices, such as filters or composite sets, and these filters or composite sets might be designed to cut off frequencies above 60 to 70 cycles. Accordingly, such a circuit would be suitable for the transmission of telegraph signals having a maximum speed of less than 60 to 70 impulses per second or, in other words, for a signaling current below such frequencies. This type of circuit might, for the purpose of illustrating this invention, be termed a low speed telegraph circuit. Obviously, it may be desirable to originate and receive signals at a speed faster than 60 to 70 impulses per second and this would result in the utilization of a current of a higher frequency. The use of a higher frequency current would not be possible on the type of circuit heretofore termed a low speed circuit because of the cut-off characteristics of the filters or other apparatus associated with the line. Accordingly, to accommodate high speed signals, the filters or other devices in the line would have to be redesigned to have a higher frequency cut-off characteristic so that the line might be termed a high speed circuit. Obviously, this would necessitate the reconstruction or redesign of

the low speed circuit into a high speed circuit.

One of the primary objects of the arrangements of the invention is to make it possible to utilize the low speed circuit without any change therein for the transmission of high speed telegraph signals. In the arrangements of the invention this is accomplished by resolving a series of high speed signals into a plurality of series of signals of approximately half the original frequency. The signals of this lower frequency may then be transmitted over a plurality of low speed telegraph circuits and may be recombined at the other end of the line to form the original high speed signals.

In the arrangements of the invention the translating means for resolving the high speed signals into low speed signals for transmission over the lines comprise a plurality of polar relays. The translating means at the other end of the line for recombining the transmitted low speed signals to form high speed signals again also comprise a plurality of polar relays. In the arrangements of the invention means are provided for combining two low speed telegraph circuits into one high speed circuit, for combining three low speed telegraph circuits into one high speed circuit, and for combining four low speed circuits into one high speed circuit. Other objects and features of the invention will appear more fully from the detailed description thereof hereinafter given.

The invention may be more fully understood from the following description together with the accompanying drawings in the Figures 1, 2, 3 and 4 of which the invention is illustrated. Fig. 1 shows arrangements of the invention whereby two low speed telegraph circuits may be combined to form one high speed telegraph circuit. Fig. 2 is a modification of the arrangements of Fig. 1. Fig. 3 shows arrangements of the invention whereby three low speed telegraph circuits may be combined to form one high speed telegraph circuit. Fig. 4 shows arrangements of the invention whereby four low speed telegraph circuits may be combined to form one high speed telegraph circuit.

Similar reference characters have been used to denote like parts in all of the figures.

In Fig. 1 is shown a system in which two low speed telegraph circuits may be combined into a high speed telegraph circuit. Two stations are shown interconnected by the lines 15 and 16. These lines might be used for both telephone and telegraph service and might have included therein selective devices such as filters or composite sets. If the lines 15 and 16 were used as composited telephone and telegraph lines, the selective devices might be designed to have a cut off frequency of 60 to 70 cycles and telegraph signals having a greater speed than 60 or 70 dots per second, or in other words requiring a signaling current with a fundamental frequency above 60 or 70 cycles, could not be sent over such lines. Lines of this type may, for the purpose of illustrating this invention, be termed low speed telegraph circuits. Devices other than selective circuits might obviously be associated with these lines to cause them to fall in the category of low speed circuits. At the sending end of the system is shown loop circuit 1 with the key K and the relay 17. Controlled by relay 17 is a circuit including the polar relays A and B. These relays will resolve the high speed signals originating in the loop circuit 1 into two series of low speed signals for transmission over the transmission channels 15 and 16. At the receiving end of the system are the polar relays 18, 19 and 20. These relays will be responsive to the low speed signals transmitted over the transmission channels and will combine these signals into a series of high speed signals to actuate the sounder 22 in the receiving loop circuit 21.

The operation of the arrangements of Fig. 1 is as follows: In the following circuit descriptions it will be assumed that current flowing through a relay winding from terminal 3 to terminal 6 will tend to operate the relay armature to the marking contact, and current flowing from terminal 6 to terminal 3 will tend to operate the armature to the spacing contact. Assume the key K in the sending loop 1 to be closed and the relays A, B and 17 to be in the marking condition, as shown in the drawings. Under these conditions negative marking battery will be connected over the armatures of relays A and B to lines 15 and 16 and the relays 18, 19 and 20 will be in the position shown. Negative or marking battery will thus be connected over the contact of relay 19 and marking contact of relay 18 to the loop circuit 21 and sounder 22.

If the key K is now opened the armature of relay 17 will be operated to its spacing contact, thereby applying ground to terminal 6 of winding 3—6 of relay B. Since negative battery is connected over the armature of relay A to terminal 3 of winding 3—6 of re-

lay B, relay B will be caused to operate to its spacing contact. It will be maintained on its spacing contact by current flowing from spacing battery and armature of relay B through the holding winding 7—2 to ground. This will apply positive spacing battery from the armature of relay B to the line 16. At the same time negative marking battery is being applied from the armature of relay A to line 15. Under such conditions, namely when negative marking battery is applied to line 15 and positive spacing battery is applied to line 16, relay 18 will remain on marking and relays 19 and 20 will operate to spacing. Under such conditions positive spacing battery will be applied from spacing contact of relay 19 and marking contact and armature of relay 18 to the receiving loop 21 and sounder 22.

If the key K is now closed again, the armature of relay 17 will move to its marking contact. This applies ground to terminal 3 of winding 6—3 of relay A and causes the armature of said relay to operate to its spacing contact. This is because spacing battery is applied from the armature of relay B to terminal 6 of winding 6—3 of relay A. The armature of relay A will be maintained on its spacing contact by the spacing current transmitted through its holding winding 7—2 to ground. This will apply positive spacing battery from the armature of relay A to line 15. Thus a condition exists where positive spacing battery will be applied to both lines 15 and 16. Under these conditions relay 18, 19 and 20 will operate to spacing and negative battery will be applied from the contact and armature of relay 20 and spacing contact and armature of relay 18 to the receiving loop 21 and sounder 22.

If the key K is now opened again, ground is applied to terminal 6 of winding 3—6 of relay B and since this winding has positive battery connected to its other terminal over armature of relay A the relay B will be operated to marking. The relay B would be thus operated as its winding 3—6 is oppositely poled with respect to winding 6—3 of relay A. Relay B would be held on marking due to current through its holding winding 7—2. This will apply negative marking current to line 16. Under such conditions, namely when positive spacing current is applied to line 15 and negative marking current is applied to line 16, relay 18 will be operated to spacing and relays 19 and 20 to marking. This will cause positive current to be applied over the contact and armature of relay 20 and spacing contact and armature of relay 18 to the receiving loop 21 and sounder 22.

When the key K is closed again the relays will assume the position shown in the drawings.

Thus it will be seen from the above that

the sounder 22 in the receiving loop will follow the operation of the key K in the sending loop 1. When the key K is closed to transmit a marking signal, negative marking current will be applied to sounder 22; when key K is next opened to transmit a spacing signal, positive spacing current will be applied to sounder 22; when key K is next closed to transmit a marking signal, negative marking current will be applied to sounder 22; and when key K is next opened to transmit a spacing signal, positive spacing current will be applied to sounder 22. The sounder in the receiving loop will thus operate at the same or high speed as the key in the transmitting loop, whereas the signals passing over lines 15 and 16 will be of approximately half that speed.

In Fig. 2 is shown a modification of the arrangements of Fig. 1. The sending arrangements are identical in both figures. In the receiving arrangements of Fig. 2 only two polar relays 21' and 22' are used instead of three relays as in Fig. 1. As the sending arrangements in both figures are identical in operation no description thereof will be given. In Fig. 2 the right hand winding of relay 21' is reversed with respect to the left hand winding of said relay.

The operation of the arrangements of Fig. 2 is as follows: When both of the telegraph circuits 15 and 16 have marking current applied thereto, relays 21' and 22' will be operated to marking. Under these conditions negative battery will be connected to loop 21 and sounder 22. When spacing current is applied to line 15 and marking current to line 16 relay 21' will be spacing and relay 22' marking. Under these conditions positive battery will be connected to the loop 21 and sounder 22. When spacing current is applied to both lines 15 and 16 relay 22' will be operated to spacing and will connect line 15 over its spacing contact to the right hand winding of relay 21'. As this winding is reversed with respect to the other winding, relay 21' will be operated to marking and negative battery will be connected to loop 21 and sounder 22. With marking current applied to line 15 and spacing current applied to line 16, negative marking battery from line 15 will be applied to the right hand reversed winding of relay 21'. This will operate relay 21' to spacing and connect positive battery to loop 21 and sounder 22.

Thus it will be seen that the operation of the sounder 22 in the receiving loop will follow the operation of the key K in the transmitting loop.

Fig. 3 shows a system in which three low speed telegraph circuits may be combined into one high speed telegraph circuit. Two stations are shown interconnected by the lines L_A , L_B and L_C . These lines might, as in the cases heretofore referred to, be used for both

telephone and telegraph service and might have included therein selective devices or composite sets, which would for the purpose of this invention cause them to fall into the category of low speed circuits individually. At the sending end of the system is shown a loop circuit 1 including the key K and the relay 17. Controlled by relay 17 are circuits including the polar relays A_1 , A_2 , B_1 , B_2 , C_1 and C_2 . These relays will resolve the high speed signals originating in the loop circuit 1 into a plurality of series of low speed signals for transmission over the lines L_A , L_B and L_C . At the receiving end of the system are the polar relays A_3 , A_4 , B_3 , B_4 and C_3 . These relays will be responsive to the low speed signals transmitted over the lines and will recombine these signals into a series of high speed signals to actuate the sounder 22 in the receiving loop circuit 21.

The operation of the arrangement of Fig. 3 is as follows: Assume key K to be closed. Current will then be flowing in loop circuit 1, holding the armature of relay 17 on the lower contact. Assume also that relays A_1 , A_2 , B_1 , B_2 , C_1 and C_2 are operated to their marking contacts M and are maintained thereon by current flowing in holding windings 2—7. These holding windings are so arranged that when marking battery is applied to them from the armature of the relay they will maintain that armature on the marking contact M and, when spacing battery is applied, they will maintain the armature on the spacing contact S. Current will also be flowing from the marking contact M and armature of relay B_1 through operating windings 6—3 of relays C_1 and C_2 , through the armature and marking contact M of relay A_2 and the lower contact and armature of relay 17 to ground. However, the effect of this current will be such as to aid the holding windings of relays C_1 and C_2 to maintain their armatures on the marking contacts. Current will also flow from the marking contact M of relay A_1 through windings 3—6 of relays B_1 and B_2 , through the armature and marking contact of relay C_2 and the lower contact and armature of relay 17 to ground. The effect of this current will be to maintain the armature of relays B_1 and B_2 on the marking contacts.

Under these conditions, negative battery will be applied to lines L_A and L_C and positive battery to line L_B , thereby operating relays A_3 , A_4 , B_3 , B_4 and C_3 to their lower contacts. Current will flow from negative battery through the lower contact and armature of relay A_4 , the armature and lower contact of relay B_3 , and the lower contact and armature of relay C_3 through loop circuit 21 and sounder 22, thereby holding the sounder in the marking condition.

If key K is now opened, current will cease to flow in loop circuit 1 and the armature of

relay 17 will move to the upper contact, thereby applying ground through the marking contact M and armature of relay B₂ to windings 6—3 of relays A₂ and A₁. Since these windings have negative battery applied to them from the marking contact M and armature of relay C₁, current will flow in such a direction as to cause the armature of relays A₁ and A₂ to operate to the spacing contacts S. Positive battery will thereby be applied to line L_A, operating relays A₃ and A₄ to their upper contacts and causing positive battery to be applied from the upper contact and armature of relay A₄, through the armature and lower contact of relay B₃, and the lower contact and armature of relay C₃ to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed, the armature of relay 17 will move to its lower contact, applying ground through the marking contact M and armature of relay C₂ to windings 3—6 of relays B₂ and B₁. Since these windings now have positive battery applied to them from the spacing contact S and armature of relay A₁, they will cause the armatures of relays B₁ and B₂ to operate to the spacing contacts S. Negative battery will thereby be applied to line L_B, operating relays B₃ and B₄ to their upper contacts. Since relays A₃ and A₄ are still maintained on their upper contacts and since relay C₃ is still maintained on its lower contact, negative battery will be applied from the upper contact and armature of relay A₃, through the armature and upper contact of relay B₄, and the lower contact and armature of relay C₃ to loop circuit 21 and sounder 22, operating the sounder to the marking condition.

If key K is again opened, the armature of relay 17 will move to its upper contact, and ground will be applied through the spacing contact S and armature of relay A₂ to windings 6—3 of relays C₂ and C₁. Since negative battery is applied to these windings from the spacing contact S and armature of relay B₁, relays C₁ and C₂ will be operated to their spacing contacts S, thereby applying positive battery to line L_C and operating relay C₃ to its upper contact. Positive battery is thereby applied from the upper contact and armature of relay A₄ through the armatures and upper contact of relay B₃, and the upper contact and armature of relay C₃ to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed, relay 17 will operate to its lower contact, applying ground through the spacing contact S and armature of relay B₂ to windings 6—3 of relays A₂ and A₁. Since positive battery is applied to these windings from the spacing contact S and armature of relay C₁, the armatures of relays A₁ and A₂ will be operated to their marking contacts M, applying positive battery to line L_A

and operating relays A₃ and A₄ to their lower contacts. Hence, negative battery will be applied from the lower contact of relay A₄, through the armature and upper contact of relay B₃ and the upper contact and armature of relay C₃ to loop circuit 21 and sounder 22, thereby operating the sounder to the marking condition.

If key K is again opened, releasing relay 17, ground will be applied through the spacing contact S and armature of relay C₂ to windings 3—6 of relays B₂ and B₁. Since negative battery is applied to these windings from the marking contact M and armature of relay A₁, the armatures of relays B₁ and B₂ will operate to their marking contacts M, applying positive battery to line L_B and operating relays B₃ and B₄ to their lower contacts. Positive battery will thus be applied from the lower contact and armature of relay A₃, through the armature and lower contact of relay B₄ and the upper contact and armature of relay C₃ to loop circuit 21 and sounder 22, operating the sounder to the spacing condition.

If key K is again closed, the armature of relay 17 will move to its lower contact, thereby applying ground through the marking contact M and armature of relay A₂ to windings 6—3 of relays C₂ and C₁. Since these windings now have positive battery applied from the marking contact M and armature of relay B₁, the armatures of relays C₁ and C₂ will be operated to their marking contacts M, applying negative battery to line L_C and operating the armature of relay C₃ to the lower contact. All relays will thus be returned to their original positions, and loop circuit 21 and sounder 22 will be operated to the marking condition.

It will thus be evident that sounder 22 will follow the signals transmitted by key K, whereas the fundamental frequency of signals passing over transmission channels L_A, L_B and L_C will be approximately one-third the frequency of those transmitted by the key and received by the sounder.

It will be noted that the armature of one relay of any pair, such as A₁, supplies battery to the operating winding of the next pair of relays, in the sequence, such as B₁ and B₂, and that the other relay of the first mentioned pair supplies ground from the contacts of the main operating relay 17 to the windings of the second pair of relays in sequence, such as C₁ and C₂. It will also be noted that the battery polarities connected to the marking and spacing contacts of successive relays are reversed and that likewise the operating and the holding windings of successive pairs of relays are reversed. In a like manner, the contacts of the left-hand relays of each successive pair are oppositely connected to the contacts of relay 17. By adding pairs of relays and still maintaining

the conditions above imposed, the sending relay chain may be extended to any odd number of relay pairs. The receiving relay chain may be likewise extended by inserting in the loop circuit pairs of relays whose armatures are connected in a reversing switch arrangement, and connecting the windings of each pair of relays to one of the lines extending to a pair of sending relays.

In Fig. 4 is shown a system in which four low speed telegraph circuits may be combined into one high speed circuit. Two stations are shown interconnected by the lines L_A , L_B , L_C and L_D . These lines might, as in the cases heretofore referred to, be used for both telephone and telegraph service and might have included therein selective devices or composite sets, which would for the purposes of this invention cause them to fall into the category of low speed circuits individually. At the sending end of the system is shown a subscriber's loop circuit 30 including the key K and the relays E_1 and E_2 . Controlled by these relays are circuits including the polar relays A_5 , B_5 , C_5 and D_5 . These relays will resolve the high speed signals originating in the loop circuit 30 into a plurality of low speed signals for transmission over the lines L_A , L_B , L_C and L_D . At the receiving end of the system are the polar relays A_6 , A_7 , B_6 , B_7 , C_6 , C_7 and D_6 . These relays will be responsive to the low speed signals transmitted over the lines and will recombine these signals into a series of high speed signals to actuate the sounder 22 in the receiving loop 21.

The operation of the arrangements of Fig. 4 is as follows: Assume key K to be closed. Current will then be flowing in loop circuit 30, holding the armatures of relays E_1 and E_2 on their marking contacts M. Assume also that relays A_5 , B_5 , C_5 and D_5 are operated to their marking contacts M and are maintained thereon by current flowing in holding windings 2—7. Current will also be flowing from the marking contact M and armature of relay A_5 , through operating winding 3—6 of relay B_5 and the marking contact M and armature of relay E_1 to ground. The effect of this current will be such as to aid the holding winding of relay B_5 to maintain the armature on the marking contact. Current will also flow from the marking contact M of relay C_5 , through winding 3—6 of relay D_5 and the marking contact M and armature of relay E_2 , to ground. The effect of this current will be to maintain the armature of relay D_5 on the marking contact M.

Under these conditions negative battery will be applied to lines L_A , L_B , L_C and L_D , thereby operating relays A_6 , A_7 , B_6 , B_7 , C_6 , C_7 and D_6 to their lower contacts. Current will flow from negative battery through the lower contact and armature of relay A_7 , the armature and lower contact of relay B_6 , the lower

contact and armature of relay C_6 , and the lower contact and armature of relay D_6 , through the loop circuit 21 and sounder 22, thereby holding the sounder in the marking condition.

If key K is now opened, current will cease to flow in loop circuit 30 and the armatures of relays E_1 and E_2 will move to the spacing contacts S, thereby applying ground to winding 6—3 of relay A_5 and to winding 3—6 of relay C_5 . Since negative battery is applied from the marking contact M and armature of relay D_5 to winding 6—3 of relay A_5 , this relay will be operated to its spacing contact, applying positive battery to line L_A and operating relays A_6 and A_7 to their upper contacts. The application of ground to the winding of relay C_5 only causes the armature to be maintained on the marking contact M. Positive battery will now be connected from the upper contact and armature of relay A_7 through the armature and lower contact of relay B_6 , the lower contact and armature of relay C_6 and the lower contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed the armature of relays E_1 and E_2 will move to the marking contacts M, applying ground to windings 3—6 of relays B_5 and D_5 . Since the winding of relay D_5 is connected to negative battery through the marking contact M and armature of relay C_5 , the armature of this relay will not be operated. However, positive battery is now applied from the spacing contact and armature of relay A_5 to winding 3—6 of relay B_5 . The armature of relay B_5 will, therefore, be operated to the spacing contact S, applying positive battery to line L_B and operating relays B_6 and B_7 to their upper contacts. Negative battery will thereby be applied from the upper contact and armature of relay A_6 through the armature and upper contact of relay B_7 , the lower contact and armature of relay C_6 and the lower contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the marking condition.

If key K is again opened relays E_1 and E_2 will be permitted to release and their armatures will move to the spacing contacts S, applying ground to winding 6—3 of relay A_5 and winding 3—6 of relay C_5 . Since the winding 6—3 of relay A_5 is still supplied with negative battery from the marking contact M and armature of relay D_5 , relay A_5 will not operate. The winding 3—6 of relay C_5 , however, is now supplied with positive battery from the spacing contact S and armature of relay D_5 . It will, therefore, cause the armature to move to the spacing contact S, thereby applying positive battery to line L_C and operating relays C_6 and C_7 . Positive battery will thereby be applied from the up-

per contact and armature of relay A_7 through the armature and upper contact of relay B_6 , the upper contact and armature of relay C_6 and the lower contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed, the armatures of relays E_1 and E_2 will be caused to move to their marking contacts M, applying ground to windings 3—6 of relays B_5 and D_5 , respectively. Since winding 3—6 of relay B_5 is supplied with positive battery from the spacing contact S and armature of relay A_5 , its armature will remain operated to the spacing contact S. However, since the previous operation of relay C_5 applied positive battery to winding 3—6 of relay D_5 , the armature of this relay will operate to the spacing contact S, applying positive battery to line L_D and operating the armature of relay D_6 to the upper contact. Negative battery will, therefore, be applied from the upper contact and armature of relay A_6 through the armature and upper contact of relay B_7 , the upper contact and armature of relay C_7 and the upper contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the marking condition.

If key K is again opened relays E_1 and E_2 will release, applying ground to winding 6—3 of relay A_5 and winding 3—6 of relay C_5 . Since the latter winding still has positive battery applied to it from the spacing contact S and armature of relay B_5 , the armature of relay C_5 will remain upon its spacing contact S. The winding of relay A_5 , however, has positive battery applied to it from the spacing contact S and the armature of relay D_5 and since it is a reversed winding the armature of relay A_5 will be caused to move to its marking contact M, thereby applying negative battery to line L_A , and operating relays A_6 and A_7 to the lower contacts. Positive battery will thereby applied from the lower contact and armature of relay C_6 through the armature and upper contact of relay B_7 , the upper contact and armature of relay C_7 , and the upper contact and armature of relay D_6 , to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed the armatures of relays E_1 and E_2 will be operated to their marking contacts M, applying ground to windings 3—6 of relays B_5 and D_5 . The winding of relay D_5 still has connected to it positive battery from the spacing contact S and armature of relay C_5 , whereas the winding of relay B_5 now has negative battery connected to it from the marking contact M and armature of relay A_5 . Relay B_5 will hence be operated to the marking position, applying negative battery to the line L_B and operating relays B_6 and B_7 to their lower contacts. Negative battery will, therefore, be

applied from the lower contact and armature of relay A_7 through the armature and lower contact of relay B_6 , the upper contact and armature of relay C_7 and the upper contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the marking condition.

If key K is again opened relays E_1 and E_2 will release, applying ground to windings 6—3 of relay A_5 and windings 3—6 of relay C_5 . Since the winding of relay A_5 is still supplied with positive battery from the spacing contact S and armature of relay D_5 it will remain in the marking condition. Winding 3—6 of relay C_5 is now supplied with negative battery from the marking contact M and armature of relay B_5 . The armature of relay C_5 will, therefore, be operated to its marking contact M, applying negative battery to line L_C and operating relays C_6 and C_7 to their lower contacts. Positive battery will be applied from the lower contact and armature of relay A_6 through the armature and lower contact of relay B_7 , the lower contact and armature of relay C_7 , and the upper contact and armature of relay D_6 to loop circuit 21 and sounder 22, thereby operating the sounder to the spacing condition.

If key K is again closed, operating the armatures of relays E_1 and E_2 to their marking contacts M, ground will be applied to winding 3—6 of relay D_5 and since the other terminal of this winding is now supplied with negative battery from the marking contact M and armature of relay C_5 , the armature of relay D_5 will operate to the marking contact M, applying negative battery to line L_D and operating relay D_6 to the lower contact. All relays are thus returned to their original position, and sounder 22 will be operated to the marking condition.

It will thus be evident that sounder 22 will follow the signals transmitted by key K, whereas the fundamental frequency of signals passing over transmission channels L_A , L_B , L_C and L_D will be approximately one-fourth the frequency of these transmitted by the key and received by the sounder.

It will be noted that in the sending arrangement each relay in the sequence obtains its operating battery from the armature of the preceding relay and that alternate relays obtain their ground from the spacing and marking contacts, respectively, of control relays such as E_1 and E_2 . By adding pairs of relays to the sequence and still supplying each relay with battery from the armature of the preceding relay, and by adding a control relay for each pair of sequence relays, the sending relay chain may be extended so as to transmit into any even number of lines. The receiving relay chain may be likewise extended by inserting in the loop circuit pairs of relays whose armatures are connected in a reversing switch arrangement and con-

necting the windings of each pair of relays in series with one of the lines extending to a sending relay.

Accordingly the principle embodied in the 5 arrangements of the invention, whereby low speed circuits may be combined to form a high speed circuit, are not limited to the use of two circuits. By varying the relay combinations at the sending and receiving 10 ends of the transmission system a greater number of circuits may be utilized in the combination if desired. The principles of the invention may furthermore be utilized in connection with secret transmission systems, 15 since the transmitted signal is not understandable except in the presence of all of its components. The arrangements of the invention may be utilized on lines which do not include filters or composite sets if the 20 frequency characteristics of the lines themselves make it desirable. The arrangements of the invention are furthermore applicable to other types of telegraph systems from those illustrated, such for example as carrier 25 telegraph and radio systems.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable it is understood that it is capable of embodiment in many 30 and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A telegraph system comprising two 35 lines interconnecting two stations, sending apparatus at one of said stations comprising two polar relays each having its armature connected to one of said lines and having 40 sources of marking and spacing current connected to the contacts of said armatures, operating circuits for said polar relays, a single switching means for controlling said operating circuits, said operating circuits being so 45 arranged that the initial positioning of said switch will cause marking currents to be applied to both of said lines, the subsequent operation of said switch will cause marking current to be applied to the first of said lines 50 and spacing current to the second of said lines, the subsequent operation of said switch will cause spacing current to be applied to both of said lines, and the subsequent operation of said switch will cause spacing current to be applied to the first of said lines 55 and marking current to the second of said lines; and receiving apparatus at the other of said stations, said receiving apparatus comprising polar relays in each of said lines, a receiving loop circuit, and means controlled 60 jointly by said polar relays for applying signals of different polarities to said loop circuit, said last mentioned means being so arranged that the application by said sending apparatus of marking currents to both 65 of said lines will cause marking current to be

applied to said loop, the subsequent application by said sending apparatus of marking current to the first of said lines and spacing current to the second of said lines will cause spacing current to be applied to said loop, the 70 subsequent application by said sending apparatus of spacing current to both of said lines will cause marking current to be applied to said loop, and the subsequent application by said sending apparatus of spacing current to 75 the first of said lines and marking current to the second of said lines will cause spacing current to be applied to said loop.

2. The combination of a high speed telegraph circuit with a plurality of low speed 80 telegraph circuits, a translating device for resolving the original high speed signals into a plurality of series of low speed signals for transmission over said low speed circuits, said translating device comprising a 85 chain of polar relays arranged in pairs and having operating circuits so arranged that the armature of one relay of any pair supplies battery to the operating windings of the next pair of relays in the sequence and the armature of the other relay of the first mentioned pair supplies ground over the con- 90 tacts of a relay in the high speed circuit to the windings of the second pair of relays therefrom in the sequence, the battery polarities connected to the marking and spacing 95 contacts of successive relays being reversed and contacts of the other relay of each successive pair being oppositely connected to the contacts of the relay in the high speed circuit. 100

3. The combination of a high speed telegraph circuit with a plurality of low speed telegraph circuits, a translating device for 105 resolving the original high speed signals into a plurality of series of low speed signals for transmission over said low speed circuits, said translating device comprising a chain of polar relays arranged in pairs and having 110 operating circuits so arranged that the armature of one relay of any pair supplies battery to the operating windings of the next pair of relays in the sequence and the armature of the other relay of the first mentioned pair supplies ground over the contacts of a 115 relay in the high speed circuit to the windings of the second pair of relays therefrom in the sequence, the battery polarities connected to the marking and spacing contacts of successive relays being reversed and con- 120 tacts of the other relay of each successive pair being oppositely connected to the contacts of the relay in the high speed circuit, and receiving arrangements for said system 125 comprising a plurality of polar relays included in said low speed circuits and controlled by the series of low speed signals transmitted thereover, a receiving loop circuit, and means controlled by said last mentioned relays for 130

applying signals of different polarities to said receiving loop circuit.

4. The combination of a high speed telegraph circuit with a plurality of low speed telegraph circuits, a translating arrangement for resolving the original high speed signals into a plurality of series of low speed signals for transmission over said low speed circuits, said translating arrangement comprising a plurality of control relays included in said high speed telegraph circuit and a chain of polar relays, each of said polar relays being connected to one of said low speed circuits, each of said relays in said chain obtaining its operating battery from the armature of the preceding relay in the chain and alternate relays in said chain obtaining their ground from the spacing and marking contacts respectively of said control relays.

20 In testimony whereof, I have signed my name to this specification this 22nd day of June, 1931.

WILTON T. REA.

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