

April 21, 1925.

1,535,073

J. V. FOLL

SYNCHRONOUS TELEGRAPH SYSTEM

Filed Jan. 26, 1923

2 Sheets-Sheet 1

Fig. 1.

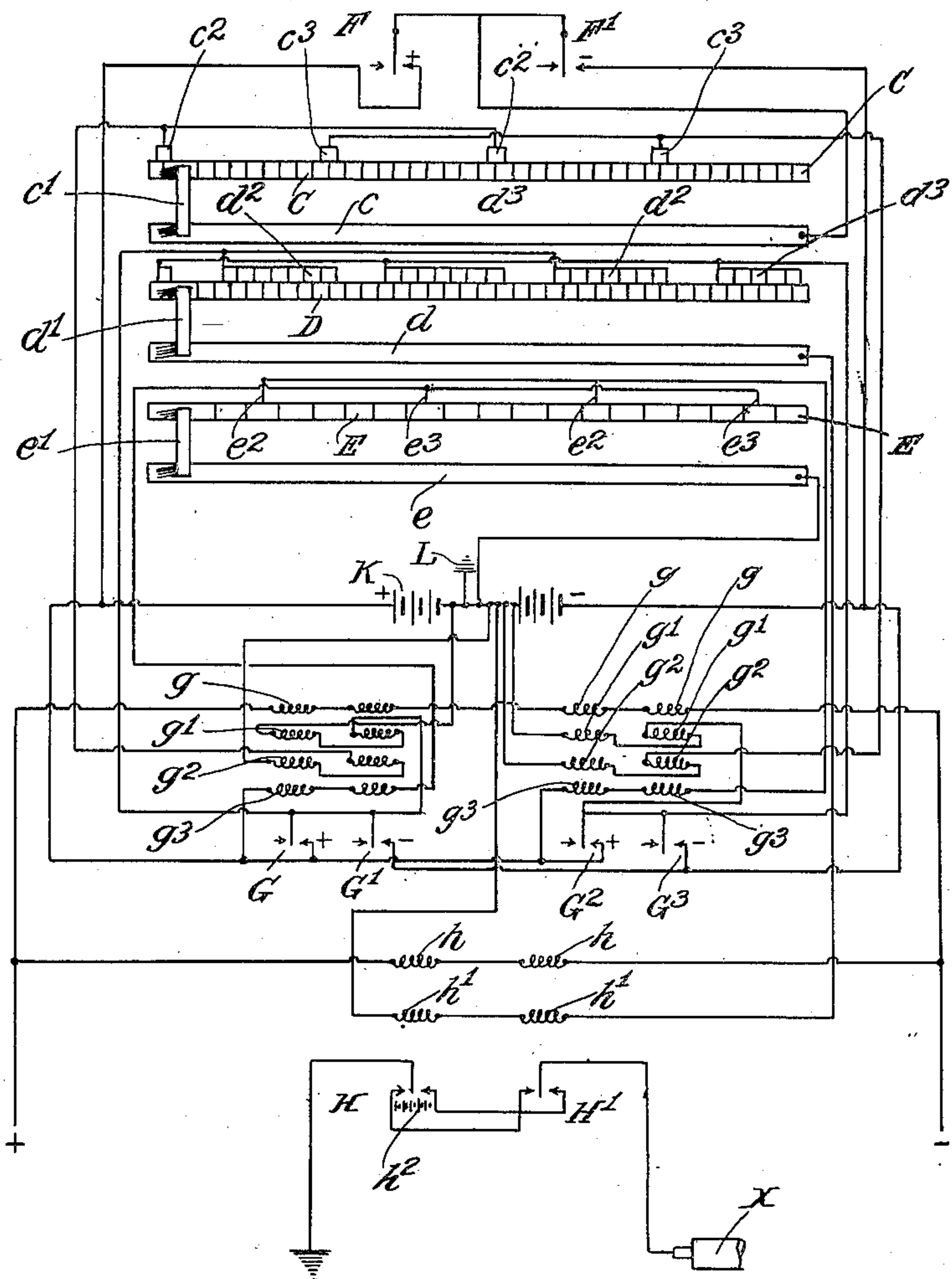
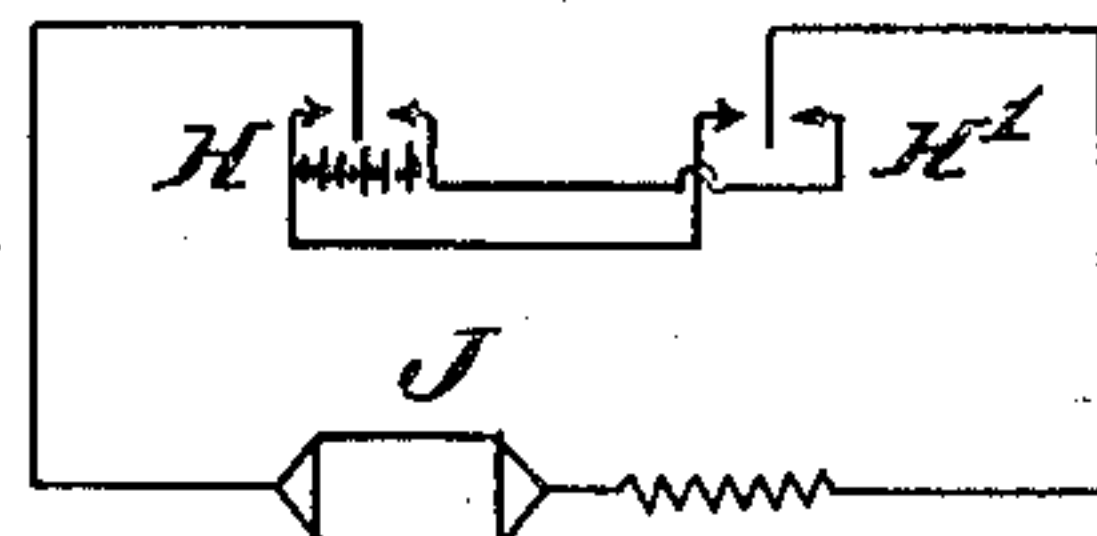


Fig. 1a



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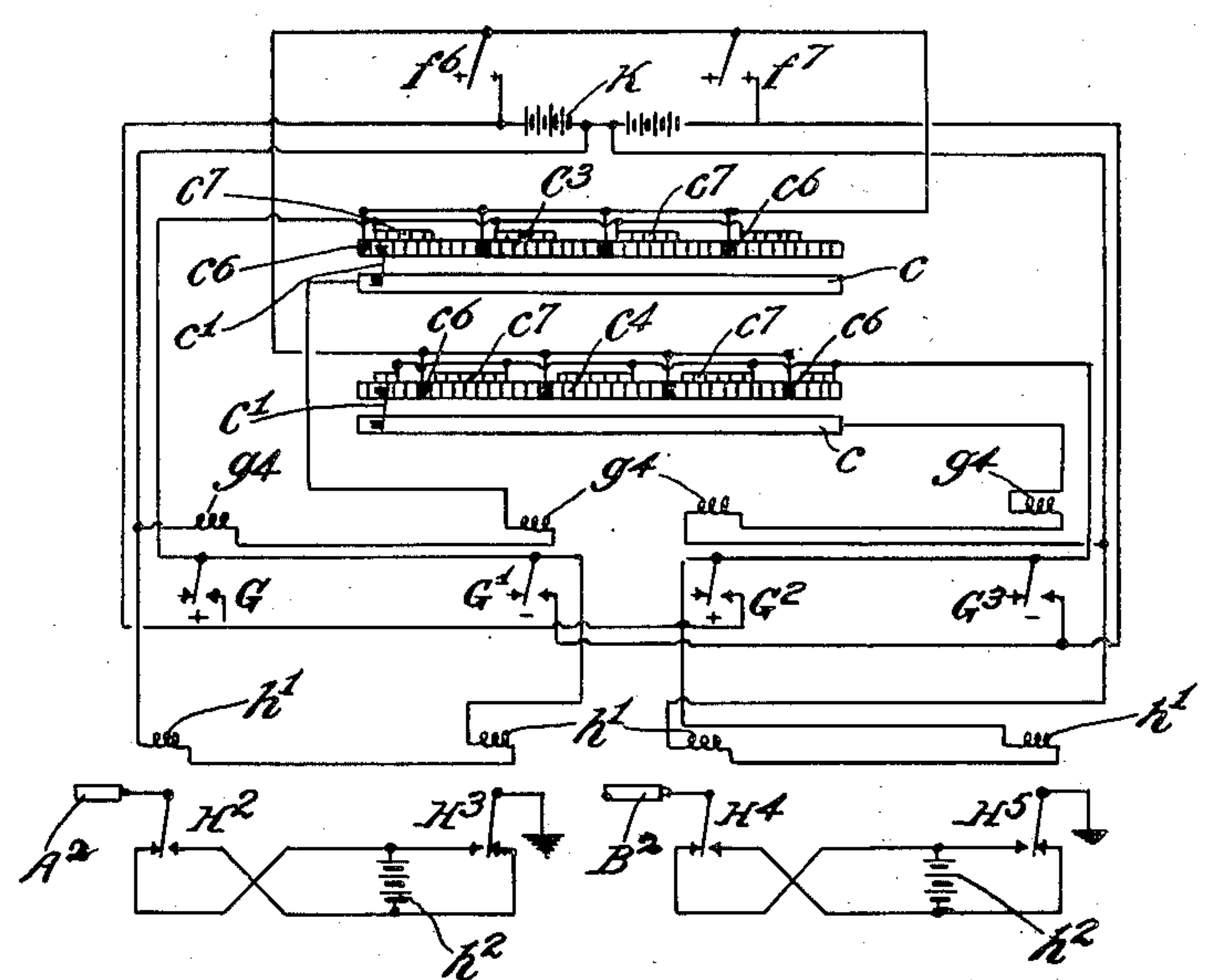
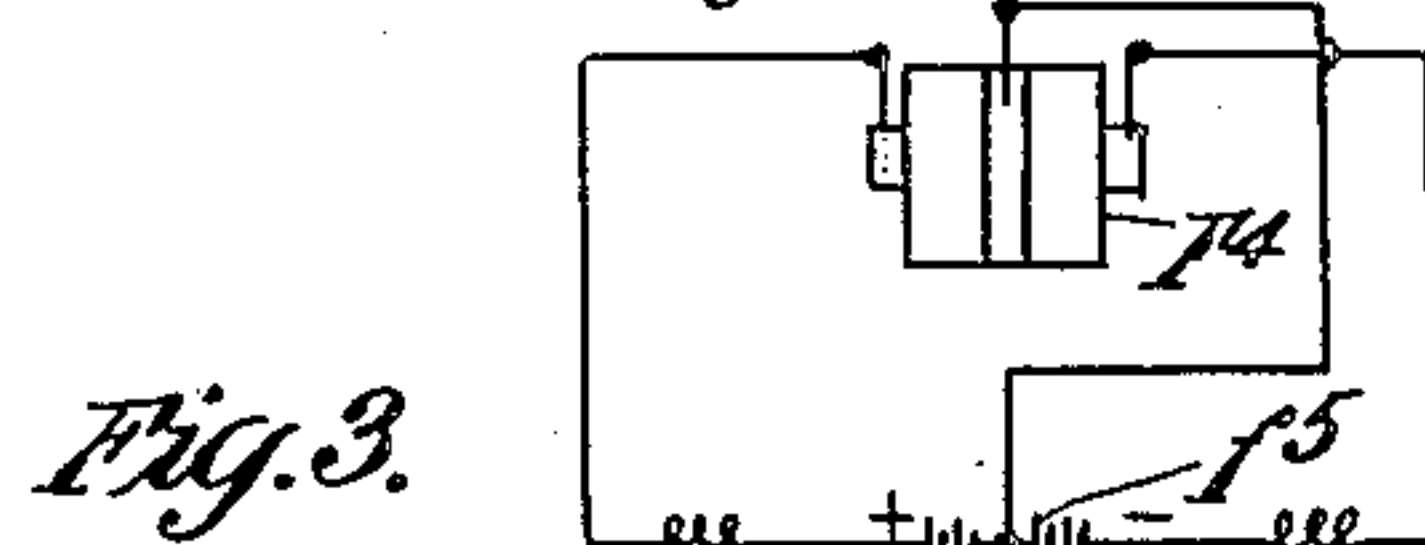
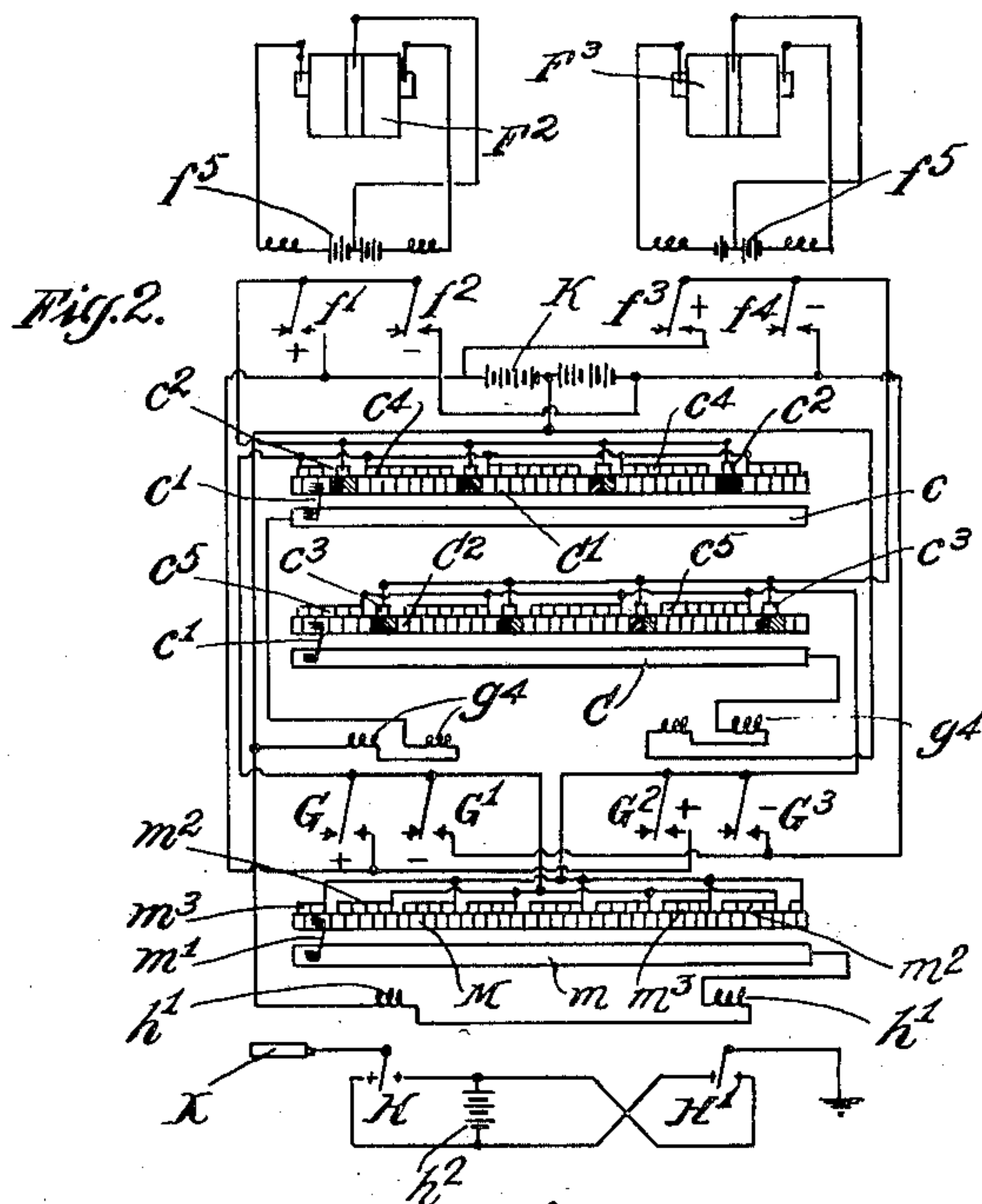
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2 Sheets-Sheet 2

"A" Cable. "B" Cable.



Inventor

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UNITED STATES PATENT OFFICE.

JOHN VICTOR FOLL, OF LONDON, ENGLAND, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SYNCHRONOUS TELEGRAPH SYSTEM.

Application filed January 26, 1923. Serial No. 615,166.

To all whom it may concern:

Be it known that I, JOHN VICTOR FOLL, a subject of the King of Great Britain, residing at 22 Great Winchester Street, London, England, have invented certain new and useful Improvements in Synchronous Telegraph Systems, of which the following is a specification.

This invention relates to electric telegraph systems employing synchronized transmitters and receivers and more especially to regenerating means for the receiving or retransmission of the signals. The improved system comprises a special arrangement of relays and distributor at the receiving or retransmitting end whereby the relatively feeble or badly proportioned signals received are reproduced in strengthened and clearly and correctly defined impulses. The invention is more particularly intended for cable or line telegraphy but may be adapted to wireless or other electrical systems where synchronism is maintained between the transmitters and receivers.

According to this invention selecting relays operated through a receiving element on the synchronized distributor effect the operation of regenerating relays in co-operation with the distributor, by which regenerating relays the signals are reproduced in new or re-formed impulses of predetermined length of retransmission or operation of receiving apparatus. Correctly shaped signals can therefore be formed and retransmitted under the control of weak or distorted received signals. The invention enables signals to be retransmitted from two cables into a single cable or line, or vice versa: for example, a single land line may be used to serve two (or more) submarine cables; the signals in the two cables having as full a marking period as is required for the transmitting speed, i. e., half the speed of the single line alternating signals. In transmitting from two cables into one the signals in the latter are of course at double the speed or half the length and for receiving purposes a distributor is used to select the two sets of signals and regenerate each set for receiving purposes. This enables human reception to be used when required. The regenerating relays are preferably moved to transmitting position at each operation by a distributor element and

reset at the end of a predetermined marking period. The distributor element determines the length of the regenerated marking impulse and is adjustable to give any desired percentage of marking, in association if required with a clear-out distributor element that effects the resetting of the selecting relays, which when reset automatically reset the associated regenerating relays should these have not already been freed by their distributor element.

In order that the said invention may be clearly understood and readily carried into effect, the same will now be described more fully with reference to the accompanying drawings, in which:—

Figure 1 is a diagram illustrating a receiving and retransmitting circuit according to this invention, Figure 1^a illustrating the modification required for recording.

Figure 2 shows a receiving and retransmitting circuit by which signals are received from two cables or lines and retransmitted into one; and

Figure 3 illustrates an arrangement for receiving from one line and retransmitting into two cables or lines.

Referring to Figure 1, the distributor includes three pairs of rings, receiving or pick-up ring C, sending or locking ring D and clear-out ring E, the segmented rings C, D and E having associated plain collecting rings *c*, *d* and *e* in accordance with the usual arrangement of rotary distributors. The distributor may, of course, also be provided with further rings in accordance with usual practice, only those required for illustrating the present invention being shown. *c'*, *d'* and *e'* are the brushes associated with the respective receiving, sending and clear-out rings. F, F' indicate the main receiving dot and dash relays and G, G', G², G³ are the selecting or pick-up relays, in alternately operated pairs each comprising a dot and dash relay under the control of a series of coils as hereinafter described. The duplication of the relays with alternate operation allows of increase of the speed of signalling while providing for effective and complete regeneration of the signals, but such duplication is not essential unless complete regeneration is desired, i. e. the starting of the new signal independently of the pick-up. Of course, if required, more than two sets of relays could be used, operated in

succession. H, H' are sending-on or regenerating relays, by which the messages may be retransmitted into the cable X or, alternatively, as indicated in Figure 1^a, transmitted to the suspended coil or other recording instrument J connected across the relay circuit in place of the ground and cable connections shown in Figure 1. Each of the pick-up or selecting relays G, G', G², G³ is provided with four coils. In the diagram the coils of the pick-up relays G to G³ reading from top to bottom are respectively biasing or spacing coils *g*, self-locking coils *g'*, pick-up coils *g*² and clear-out coils *g*³. The sending on relays H, H' are each provided with two coils, biasing coils *h* and operating coils *h'*, and battery *h*².

In the arrangement illustrated diagrammatically the segmental rings C, D are provided with ten segments for each signalling time unit, while the clear-out ring E is provided with five segments for each unit. The receiving ring C has two adjacent segments connected up at *c*², *c*³ at intervals of one unit, while the sending or locking ring D, determining the percentage of marking in the retransmitted signals, is shown as having connected up at *d*², *d*³ groups of eight segments for each unit, so that 80 per cent of marking can be obtained. The groups of segments of the rings C and D are connected up alternately at *c*², *c*³, and *d*², *d*³, to the relays G, G' and G², G³, so that as the brushes *c'*, *d'* pass over the corresponding rings the relays G, G' and G², G³ are placed alternately under the control of the rings. Also at every fifth segment *e*², or *e*³ the clear-out ring E is connected up in the selecting relay circuit, the intervening segments being idle. The segments in use at *e*², *e*³ are alternately connected up to the relays G, G' and G², G³.

The operation of the retransmitting or recording circuit is as follows:—Assuming that a dot or positive impulse arrives at the receiving relay and operates the positive relay F, the positive side of the divided battery K is connected up through the relay F to the collecting ring *c*, and the brush *c'* as it passes over the segments of the ring C which are connected at *c*² in the circuit, completes a circuit through the coils *g*² of the corresponding pair of pick-up relays G, G' to which the segments at *c*² are connected, the circuit being continued from the coils *g*² to the middle of the divided battery K, which is connected to ground at L. An impulse is, therefore, sent through the coils *g*² of the pick-up relays G, G' in such a direction that the positive relay G is operated, the negative or dash relay G' being unaffected, as it is operated only by the reverse current.

The closing of the dot relay G closes the circuit through the self-locking coils *g'* so

that the relay remains closed until returned by the clear-out impulse. The operating coils *h'* of the sending relays H, H' are now connected up to the groups of eight interconnected segments of the ring D at *d*² so that the operating coils *h'* remain excited as long as the brush *d'* is passing over the connected segments at *d*². With eight segments connected together the relays H, H' are held over in operative position for 80 per cent of the marking time.

To obtain the return of the relay G, and also, if required, to give fine adjustment of the percentage of marking time for the regenerated impulse, the clear-out ring E may be provided as shown in the diagram. The segments connected at *e*³ produce, as the brush *e'* passes over them, a resetting current through the clear-out coils *g*³ of the relay G, this current being stronger than the self-locking current, so that the relay G is reset ready for the next operation, at the same time restoring the relays H, H' to normal position. The clear-out ring may be made adjustable on the distributor so that the connected segments *e*² and *e*³ can be adjusted relatively to the segments D connected at *d*², *d*³, and bring about the resetting of the relays G to G³ after operation, before the brush *d'* has completely passed over the final connected sending segment D. The clear-out ring can, therefore, be used to give a reduction of the marking percentage which is some fraction of the difference obtained by connecting up one of the segments D thus providing for a refined adjustment of the impulse. The relays G to G³ and H, H' are provided with the biasing coils *g* and *h* respectively, through which a constant current is passed, as indicated by the connections, this biasing current automatically returning the relays to normal position when the currents through the other coils cease.—The biasing current is weaker than the current of the other relay coils, so that the coils *g* and *h* are effective only when the other coils are inoperative.

If a dash impulse is next received, the receiving relay F' is operated and the negative end of the battery K is connected up, so that the dash or negative relay G³ (of the second pair G², G³) is operated as the brushes *c'*, *d'* and *e'* pass on to the next set of segments, the action of the various rings being the same as that already described, but now through the segment connections *c*³, *d*³ and *e*³. The sending relays H, H' are also operated in the opposite direction so as to send on a negative or dash impulse through the cable X.

For the space at the end of a letter no impulse is received and the permanent spacing bias holds the relays in reset position.

If the circuit is to operate a receiving or recording instrument instead of retransmit-

ting through the cable X, the regenerating relays H, H' are connected up as shown in Figure 1^a to the recording instrument indicated by J, which is of any suitable standard type.

Referring to Figure 2, which illustrates the circuit for receiving from two cables, say "A" and "B" cables, and retransmitting into a single cable or line X, F², F³ are drum relays belonging respectively to the "A" and "B" cables and controlling knife edge relays f', f² and f³, f⁴ operated in each case respectively by dot and dash impulses received by the drum relay and controlling the connections from the divided local battery f⁵.

C', C² are receiving rings for the "A" and "B" cables respectively, these rings however serving both for selecting and locking. The pick-up relays G, G', and G², G³, which correspond to the similar relays of Figure 1, are connected up to their respective selecting and locking rings C', C² but are shown with single coils g⁴ serving both as pick-up and locking (but not self-locking) coils, the clear-out ring being dispensed with. The relays are of course provided with biasing coils and, if required, with clear-out coils in which case the selecting and locking rings would be separate as in Figure 1. In the simplified arrangement shown the selecting segments on both the rings C' and C² are connected up at c² c³ as in Figure 1, but in each ring instead of making the intervening segments idle as in the previous case they are all connected up at c⁴, c⁵ to the tongues of the relays G to G³.

For the purpose of sending on the signals from the two cables into the single line or cable X, the impulses from the two cables alternating in the single line at half original length, the distributor is provided with the special sending segmented ring M having the associated plain ring m and brush m'. All the segments of the sending ring are active and are connected up in alternate groups serving for the retransmission of signals from the "A" or "B" cables respectively. As shown the connections at m² are to the tongues of the relays G, G' and to the connections c⁴ of the ring C', while the sending connections m³ are to the tongues of the relays G², G³ and to the connections c⁵ of the locking segments of the ring C². The sending on or regenerating relays H, H' are provided as before with the operating coils h' (and biasing coils, not shown) and the action of the sending on relays being similar to that of the corresponding relays of Figure 1.

The operation of the apparatus indicated diagrammatically in Figure 2 is as follows:—

Assuming that a dot or positive impulse is received by the drum relay F² the tongue

of the relay f' is moved over into marking position, connecting up the positive end of the divided battery K to the connections c² of the ring C', the circuit being continued (when the brush c' passes over the corresponding segments) through the ring c and the coils g⁴ of the relays G, G', back to the middle point of the battery K. The positive relay G is then operated, closing the circuit through the corresponding segments of the sending ring M and exciting the coils of the sending on relays H, H', operating these relays in the direction which sends a dot impulse through the cable X, the ring circuit passing back to the middle of the battery K. After the brush c' has passed over the selecting segments of the ring C' on to the succeeding locking segments the coils g⁴ of the relays G, G' remain excited so that the relay G is held in marking position and marking continued as long as the brush c' is on the locking segments c⁴. The sending relays H, H' are operated from the contacts of the relays G, G' through the segments m² and brushes m' of the sending ring M. Similarly, assuming that a dash or negative impulse arrives from the "B" cable, the relay f⁴ is operated, connecting up the negative end of the battery K to the connections c⁵ of the second selecting and locking ring C² and the coils g⁴ of the second pair of relays G², G³ are excited, moving over the tongue of the relay G³ into marking position. The remaining operations follow on the same lines as explained for the relays belonging to the "A" cable, the succeeding impulse transmitted through the single cable X being a dash or negative impulse. At the receiving end of the cable X the alternate signals are selected out by a distributor and restored to their original length as sent into the "A" and "B" cables and recorded on separate receiving apparatus.

Figure 3 deals with the inverse action to that described in connection with Figure 2, alternating signals received through a single cable, say "X" cable, being now transmitted through cables A² and B². F⁴ is a single drum relay belonging to the cable and operating a pair of knife edge relays f⁶, f⁷. Two selecting and locking rings C³, C⁴, performing somewhat similar functions to the combined rings C', C² of Figure 2, are provided, but the selecting segments connected up at c⁶ are shown as single segments and the locking segments connected up at c⁷ comprise only such a proportion of the total segments as will give the required percentage of marking, as the locking segments in this case determine the marking without the use of separate sending rings. The relays G to G³ correspond to the relays of both of the previously described apparatus, single coils g⁴ only being shown as in Fig-

ure 2. Instead, however, of the two pairs of regenerating or selecting relays operating through a single ring as in Figure 2, they operate through two pairs of sending 5 on or regenerating relays H^2 , H^3 , and H^4 , H^5 , one pair H^2 , H^3 for the A^2 cable and the other pair, H^4 , H^5 for the B^2 cable.

The two receiving and locking rings C^3 , C^4 are set so as to separate alternately and 10 consequently the selecting and locking relays G , G' and the corresponding sending on relays H^2 , H^3 are operated by one set of alternating impulses received from the single cable X , while the relays G^2 , G^3 and 15 H^4 , H^5 are operated by the alternating impulses received from the same cable. The method by which the relays are controlled by the rings C^3 , C^4 , is similar to the method already described with regard to Figure 20 2. In this case the signals from the single line are increased in length in the two cables according to the percentage of marking required, the signalling speed being now half of the speed in the single line.

I have thus explained how the signal impulses received over the two cables A and B , (Fig. 2) are sent in alternation as half 25 period impulses through the single cable X , and are received at the distant end of cable X upon the relay F^4 (Fig. 3) and 30 again separated into their original order and sent into the two cables A^2 and B^2 as full period regenerated signals. Therefore the signals sent over the cable A are retransmitted over the cable A^2 and signals 35 sent over the cable B are retransmitted over the cable B^2 .

It will be evident that the signal impulses which are sent alternately into the cable X 40 by the distributor and relays of Fig. 2, may originate from two synchronously operated transmitters instead of the cables A and B . In other words two separate messages from two synchronously operated transmitters 45 may be simultaneously transmitted over a single cable, the impulses of said two messages being shortened to half length and alternately sent into the cable by the apparatus of Fig. 2, and at the distant end of 50 the cable X the impulses may be segregated into their original order and sent into separate channels or cables A^2 , B^2 or other receiving apparatus by means of the arrangement shown in Fig. 3.

It is obvious that by increasing the number of rings and relays, messages may be 55 transmitted from one line or cable into more than two cables and vice versa, the rings

being set so as to operate in succession. The regenerating system may be used with any 60 code, such as the Morse cable code or codes with letters of equal length as in Baudot, Murray and other automatic systems. Also the method is not restricted to cable or line 65 systems but may be employed for retransmission of messages from wireless to cable systems or vice versa. The distributing apparatus described is of the rotating ring type, but it is to be understood that the 70 invention is not restricted to any particular construction of apparatus and any suitable synchronized distributor may be employed.

Having now particularly described and ascertained the nature of my said invention 75 and in what manner the same is to be performed, I declare that what I claim is:—

1. In a synchronous telegraph system, a transmitting equipment comprising a rotary distributor, positive and negative poled 80 receiving relays, two pairs of oppositely poled transmitting relays connected alternately to the segmented rings of the distributor, each pair being connected thereto at a plurality of equally spaced intervals, 85 whereby said pairs of relays are connected alternately to the receiving relays and are cleared between successive impulses, and means effective through said distributor equipment for repeating the received sig- 90 nal impulses by connecting the corresponding poles of a current source with a line or cable.

2. In a synchronous telegraph system, as set forth in claim 1, means for varying 95 the length or period of the retransmitted impulses.

3. In a synchronous telegraph system a transmitting station having a distributor 100 equipment comprising segmented rings interconnected to receive signal impulses in alternation from a plurality of sources and means effective through said equipment to transmit said alternately arranged impulses 105 into a single conductor, and a receiving station having a distributor equipment comprising segmented rings interconnected to receive said impulses upon alternate segments and means effective through said last 110 mentioned distributor equipment to segregate said impulses into separate channels in the order of the original separately received signals.

In testimony whereof I affix my signature.

JOHN VICTOR FOLL.