Aug. 31, 1926.

1,598,448

W. C. PETERMAN

TELEGRAPH SYSTEM

Filed April 28, 1922

3 Sheets-Sheet 1

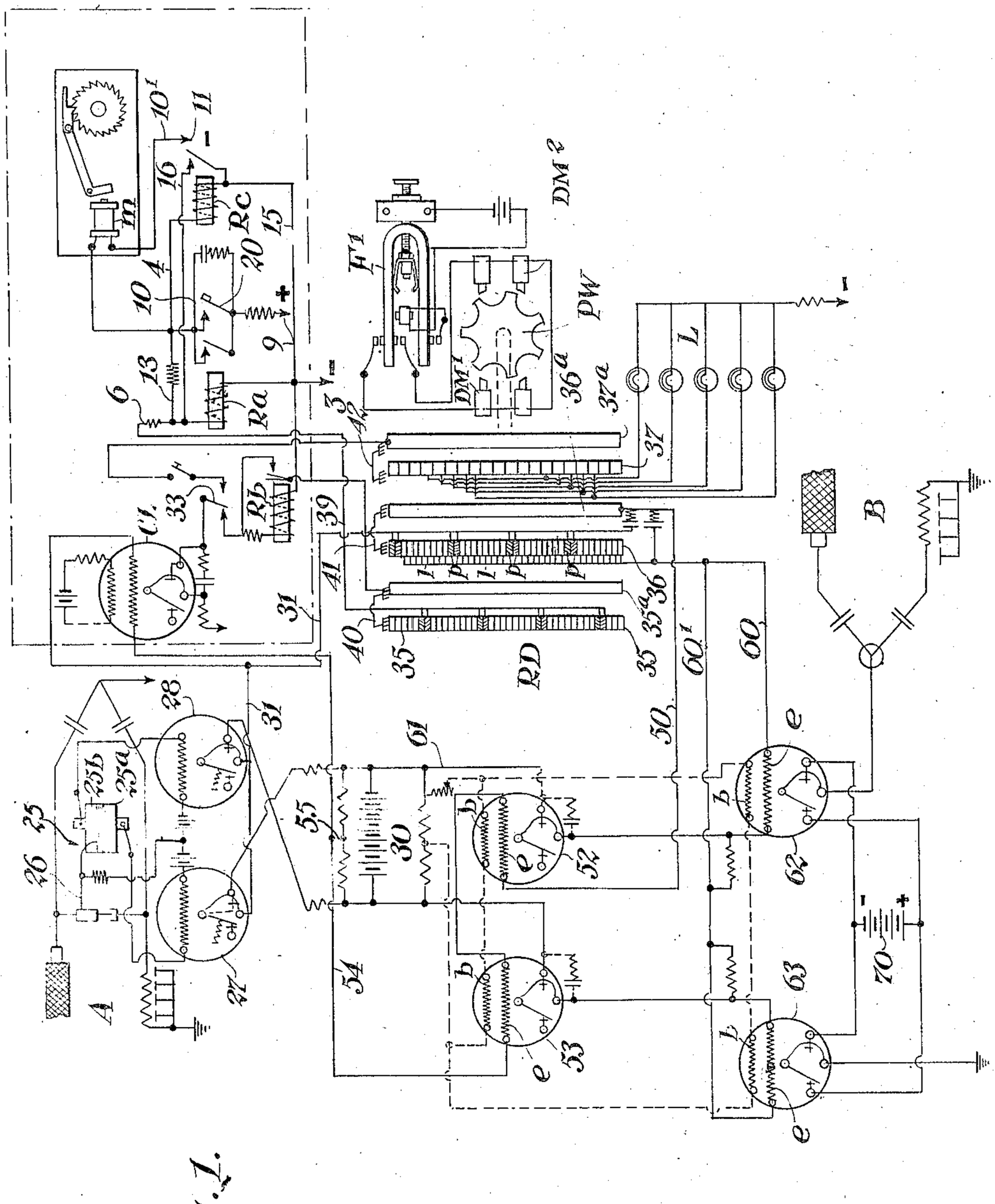


Fig. 1.

Inventor
W. C. Peterman.

By Eugene C. Brown
Attorney

Aug. 31, 1926. 1,598,448

W. C. PETERMAN

TELEGRAPH SYSTEM

Filed April 28, 1922 3 Sheets-Sheet 2

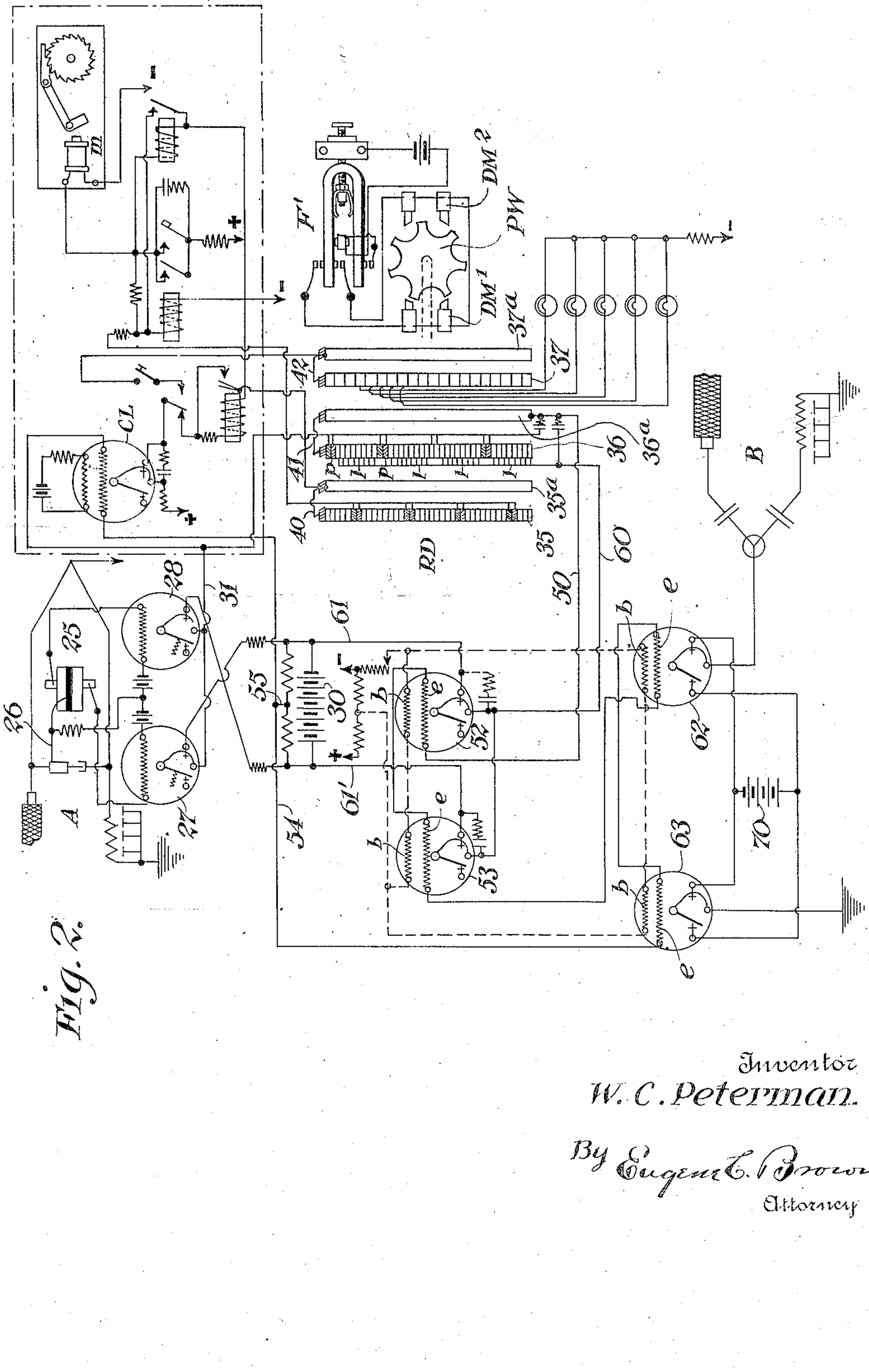


Fig. 2.

Inventor
W. C. Peterman.

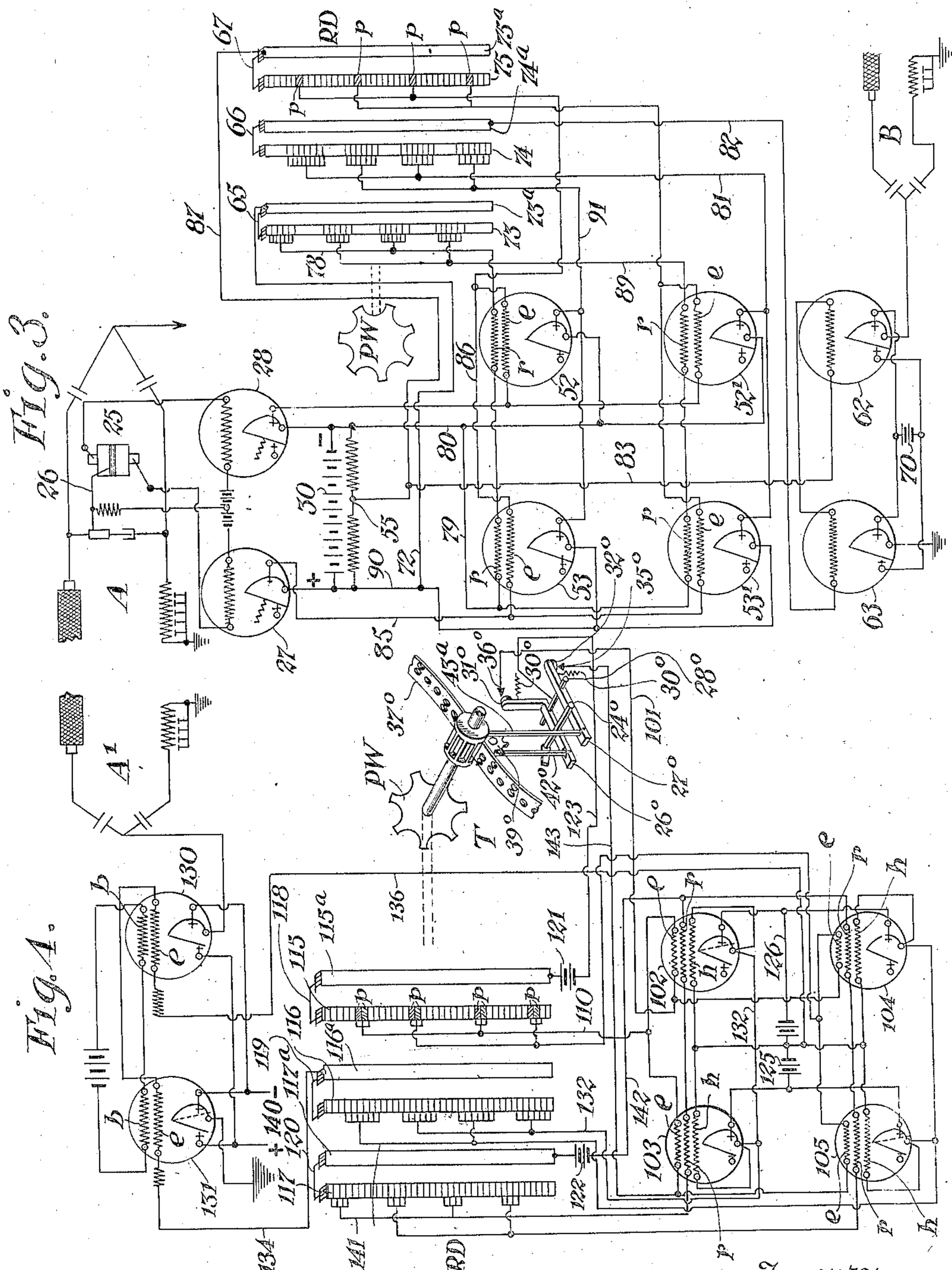
By Eugene C. Brown
Attorney

Aug. 31, 1926. 1,598,448

W. C. PETERMAN

TELEGRAPH SYSTEM

Filed April 28, 1922 3 Sheets-Sheet 3



Inventor
W. C. Peterman.
By Eugene E. Brown
Attorney.

Patented Aug. 31, 1926. 1,598,448

UNITED STATES PATENT OFFICE.

WILLIAM C. PETERMAN, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TELEGRAPH SYSTEM.

Application filed April 28, 1922. Serial No. 557,048.

This invention relates to telegraph systems and more particularly to telegraph repeater systems.

The principal object of this invention is to provide an improved organization of apparatus which will enable the rotary repeater to be used efficiently in repeating from one line section to another line section, as from one submarine cable to another, from a cable to a land line or vice versa or from one land section to another.

It has been pointed out in prior patents by telegraphic engineers of recognized standing, that in the development of telegraphic systems, it has always been recognized that submarine or cable telegraphy relates to a field of signaling practice well defined and distinct from signaling practice in connection with land lines, such divergence being due to the marked difference in the electrical characteristics of submarine cables as compared with land lines. So true is this that a system perfectly satisfactory upon a land line would be unsuited for cable telegraphy and vice versa.

In submarine cable working it has not been possible to obtain speeds in transmission at all comparable with the relatively high speed at which land lines are operated. The electrical constants of different cables differ and require different ratios of current and earthing periods. One of the purposes of my invention is to render it possible to readily vary the duration of current impulses as they are retransmitted by the repeater to suit the conditions of any particular cable and to materially increase the speed of transmission.

A further object of this invention is to provide apparatus which will repeat the impulses from one cable to another in a manner to rectify the repeated impulses true to predetermined form irrespective of distorted or mutilated condition of the received impulses and to restore them to unit time duration in proper relation to the other impulses in the code.

Furthermore I provide means for receiving block signals, wherein an impulse extends over a period representing a plurality of successive unit impulses and for breaking them up into separate impulses corresponding to said original component unit impulses and retransmitting them as regenerated or new unit impulses of proper form and of any desired lengths.

The rotary repeater has heretofore been adapted only to the transmission of code signals having the same number of impulses in each code character such as the five-unit code of Baudot, each of such characters being confined to the segments within a single quadrant of the segmented ring of the rotary repeater. Furthermore, the code characters were made up of only plus and minus impulses. In my present invention the code characters may have different lengths as in the Morse or Cable-Morse Codes and a character may be transmitted through segments extending over successive quadrants of the distributer and may be made up of plus, minus and zero impulses. Moreover the characters may begin at any point in the distributer and follow each other in succession.

In the following description, I shall refer to the accompanying drawings, in which only so much of a telegraphic equipment has been shown as will be necessary to a clear understanding of the invention.

Figure 1 illustrates an equipment suitable for a repeater system embodying my invention and wherein the duration of the repeated impulses are somewhat less than the full marking period; Fig. 2 is an alternative arrangement of the equipment which is capable of transmitting repeated impulses having a duration of the full marking period; Fig. 3 is a further modification of my invention wherein different sets of impulse receiving and storing instruments are actuated alternately and the repeated impulses may have a duration equal to the full marking period; and Fig. 4 represents an equipment suitable for a transmitting station having an automatic tape-controlled transmitter operating in synchronism with the rotary repeater at the repeating station.

Figs. 1 and 2 illustrate repeater organizations which are arranged to repeat impulses received from cable A into cable B. The same reference characters will be employed in so far as may be expedient in designating like or similarly functioning parts.

The impulses are received as usual at the cable terminal A upon a drum relay 25, or other suitable cable relay, the local dot relay 27 or dash relay 28 being selectivelv en-

ergized according to whether the needle arm 26 swings over the disk 25[a] or over the disk 25[b]. If it is assumed that the armature of local relay 27 swings over into dotted line position against its right-hand contact, current will flow from the minus or negative side of the battery 30, through armature of relay 27, conductor 31, the first segment of each quadrant of receiving ring 36 of the disk head of the repeater distributer brush 41, solid ring 36[a], conductor 50, the energizing coils *e* of locking or storing relays 52 and 53, conductor 54, to neutral point 55 of the battery. The armature of relay 52 will be moved against its right-hand contact and as the brush 41 moves from the first segment or pair of segments of the ring 36 onto the set of eight segments which are strapped together and connected to conductor 60, a circuit being thereby established from the negative pole of battery 30 through conductor 61, armature of relay 52 energizing coil *e* of transmitting relay 62, conductor 60, first set of strapped conductors of ring 36, brush 41, solid ring 36[a], conductor 50, coils *e* of locking relays 52 and 53, conductor 54 to the neutral point 55 or "split" of the battery. It is evident that the relays 52 and 53 will be energized or "locked" during the time the brush 41 is passing over said first group of eight strapped segments of the ring 36, thereby maintaining the armature of relay 52 against its right-hand contact and thus energizing the coil of transmitting relay 62 during the entire period required for the brush 41 to pass over said group of eight segments. During the same period the armature of relay 62 is held against its right-hand contact, thereby connecting cable B to the negative pole of the cable battery 70. The manner in which one or the other of the locking or storing relays 52 and 53 respectively control the actuation of one or the other of the transmitting relays 62 and 63 as the brush 41 is moved over the distributer rings 36 and 36[a] will be evident from the circuits above traced. The biasing coils *b* and circuits which serve to normally bias the relay armatures against the left-hand contacts or stops are indicated in dotted lines.

The segmented rings and the plain or solid rings of the rotary distributer RD of the repeated equipment are shown in developed form after the convention usually employed to represent a rotary distributer. The rotating brushes 40, 41, 42 are carried by the axle of a La Cour phonic motor, illustrated in the usual conventional manner by the rotor PW and field magnets DM′, DM[2]. The current pulsations, which energize the field magnets are maintained substantially uniform by means of the tuning fork F′ in a manner well understood. A suitable known synchronizing arrangement (not shown) will be understood as present to maintain the brushes in step with impulses incoming from the cable A, the preferred synchronizing device being disclosed in U. S. patent to Yorke & Benjamin No. 1,298,622, granted March 25, 1919. In conjunction with said synchronizing device, I employ a mechanical phase corrector illustrated in the usual conventional manner within the dotted rectangle at the upper right-hand corner of the diagram. Inasmuch as this phase corrector is accurately described in U. S. patent to Rothermel No. 1,253,889, granted January 15, 1918, it is unnecessary to describe it herein. In this method of correcting for slight variations in phase, the correction is effected by dot impulses or by reversals in the code impulses, the correction taking place at the instant of change or starting movement of the impulses. The corrector apparatus is controlled by a ring 35 on the rotary distributer RD, which is connected at symmetrical points in each quadrant to the conductor 39. A synchronizing ring 37 on the rotary distributer RD is provided with groups of successive segments which are connected respectively to a series of incandescent lamps. Each of said groups of the ring 37, occupies a position in alinement with the space intervening between two segments on the ring 35 that are connected to the conductor 39. When the solid ring 37[a] is connected through the switch arm 33 with the right-hand contact of the corrector relay CL, the instant of change from one impulse to the next with respect to the segments on the synchronizing ring can be noted by observing which of the lamps is first lighted. The brushes 40, 41 and 42 are then oriented either forward or backward until the instant of change occurs when the brush 42 is on the first of the connected group of segments in the ring 37. It will be observed that the pairs of "pick-up" segments *p* in the ring 36 which are connected to the conductors 60 and 60′, leading respectively to the energizing coils of the transmitting relays 62 and 63 are located midway between the first and last of the connected groups of segments on the synchronizing ring 37 and consequently when the brushes have been oriented to the proper position in the manner above specified so that the beginning of the received impulse occurs when the brushes are in alinement with the segment connected to the first synchronizing lamp, the brush 41 will reach the segments *p* at instants corresponding to the middle portion of the incoming impulses. As a result of this arrangement the transmitting relays 62 and 63 will not be energized until the middle and steadiest portions of the respective incoming impulses are received. The transmitting relay which is energized at any of these middle points of

an incoming impulse will be maintained in "sending-on" position during the entire time required for the brush 41 to pass over the succeeding group of locking segments *l* which maintain the locking or storing relays 52 and 53 in energized or "locked" condition. During this period the cable B is connected to the cable battery 70 either by the relay 62 or relay 63 and at the end of each of these periods the armatures of said relays are moved against their left hand contacts by their biasing coils *b*, thereby connecting the cable B to ground. It is evident that the length of the current impulse sent into the cable and the corresponding length of "curbing" or grounding is determined by the number of segments which are connected together in the groups *l* in the ring 36 and these time periods may be adjusted to suit the conditions of any particular cable.

In the above described repeater system the transmitted impulses are always somewhat shorter than the full unit period of an impulse. I have devised a modification, illustrated in Fig. 2, in which the transmitted impulses may have a period equal to the full unit time of a code impulse. The parts which correspond with those in Fig. 1 have been designated by the same reference characters and consequently require no further explanation. Upon tracing the circuits in Fig. 2 it will be observed that current from the battery 30 impressed upon the segments *p* of the segmented receiving ring 36 flows by way of solid ring 36ª and conductor 50 through the energizing coils *e* of locking relays 52 and 53 and the transmitting relays 62 and 63 in series, back to the neutral point 55 of the battery by way of conductor 54. In this manner one or the other of the transmitting relays connects the cable B with cable battery 70, the instant the incoming impulse, which actuates one or the other of the local relays 27 and 28 is transmitted through the segment *p* of the distributer ring 36. As the brush 41 passes from the segment, or pair of segments *p* onto the succeeding group of connected segments *l*, the locking relays 52, 53 will be maintained in energized condition or "locked-up" by current from battery 30 flowing through either conductor 61 or 61′ and the armature of either relay 52 or relay 53 which was previously moved against its right hand contact and a circuit will be maintained through the coils of the transmitting relays by the same armature. From this it is evident that the transmitting relays may be caused to connect cable B to the cable battery during the entire unit period ascribed to a code impulse.

In the repeating system last described in connection with the diagram shown in Fig. 2, there is a possibility of slight variations in the length of the transmitted impulses, due to any variations which may occur at the instant of starting in the impulses received. For the purpose of overcoming the possibility of this slight variation and making it possible to form the transmitted impulses of full unit length with exceeding accuracy, I have devised a further modification illustrated in the diagram shown in Fig. 3, wherein two independent sets of locking relays are employed alternately to control the transmitting or "sending-on" relays. I have shown the rotary distributer of the repeater provided with only three sets of rings but it will be understood that other rings for the synchronizing and phase correcting mechanism will be employed in the same manner as described in connection with the repeater systems illustrated in Figs. 1 and 2. Furthermore, I have shown only the rotor PW of the La Cour motor for driving the brushes in Figs. 3 and 4, omitting also the illustration of the controlling tuning fork F illustrated in the other figures.

The operation of the repeater shown in Fig. 3 will be understood by engineers by following the diagram of circuits. Thus, assuming that the brushes of the rotary distributer are moving downwardly in the diagram, as the brush 65 moves over the first four segments of the ring 73, a circuit will be closed through the resetting coils *r* of the locking relays 52, and 53 as follows:—from the plus side of battery 30 through conductor 72, solid ring 73ª, brush 65, first set of strapped segments in ring 73, conductor 78, resetting coils *r* of the relays 52 and 53, conductors 79 and 80 to the minus pole of the battery. This will cause the armatures of the relays 52 and 53 to move against their left hand stops. As the brushes continue their movement, the brush 66 traverses the first set of strapped segments of the transmitting ring 74. Assuming that the preceding incoming code signal impulse has been set up on the locking relay 52′ by causing its armature to swing over against its right hand contact, a circuit will be established through the brush 66 as follows:—from the negative pole of battery 30 through conductor 80, armature and right hand contact of locking relay 52′ conductor 81, first upper set of strapped segments in ring 74, brush 66, solid ring 74ª, conductor 82 coils of cable transmitting relays 63, 62 and conductor 83 to the neutral point or "split" 55 of the battery. This causes the armature of the relay 62 to move against its right hand contact, thereby connecting the cable B with the negative pole of the cable battery 70. The period of this impulse may be made any desired length up to the full unit length by strapping together the required number of

segments in the ring 74. During the transmission of the impulse which has been locked up on the relay 52′, as above described, the brush 67 will cross the first segment *p* in the "pick-up" ring 75 and close a circuit from one or the other of the local relays 27 or 28 of the incoming cable, through the energizing coil *e* of the corresponding locking relay 52 or 53. Thus assuming that an incoming impulse over the cable A has caused the armature of the local relay 27 to move against its right hand contact. A circuit will then be established by the brush 67 as it moves upon said first segment *p* as follows:—from the positive pole of battery 30 through the armature of relay 27, conductor 85 energizing coil *e* of locking relay 53, conductor 86, segment *p*, brush 67, solid ring 75ª and conductor 87 back to the neutral point or "split" of the battery. The armature of the polarized relay 53 moves over and remains against its right-hand contact, thereby "locking up" a plus impulse through its armature which will be employed subsequently to actuate the cable relay 63. As the brushes continue their movement and just as the brush 66 leaves the first set of strapped segments in ring 74, the brush 65 moves onto the second set of strapped segments of ring 73, thereby establishing a circuit from the battery 30 through the resetting or clearing-out coils *r* of the relays 52′ and 53′, by way of the conductors 72, 89, 79 and 80. The armatures of the polarized relays 52′ and 53′ are thus reset against their left-hand stops and are ready to receive the next incoming cable impulse. Noting again the progress of the brushes, as the brush 66 moves onto the second set of strapped segments in the ring 74, a circuit is closed through the armature of relay 53, (which it will be remembered was previously set or "locked" against its right-hand contact when the brush 67 crossed the first segment *p* of ring 75), as follows:—from the positive pole of battery 30, through conductor 90, armature of relay 53, conductor 91, second set of strapped segments of ring 74, brush 66, solid ring 74ª, conductor 82, coils of cable transmitting relays 63 and 62, and conductor 83 to the "split" of the battery 30. The armature of relay 63 is thereby moved over against its right-hand contact, thus connecting cable B to the plus pole of cable battery 70.

It appears from the above detailed description of the circuits of Fig. 3, that one set of locking relays is cleared or "reset" and again receives and holds a new incoming impulse while the other set of locking relays is causing the previous impulse to be sent into the cable B, each set of locking relays being thus independent of the other set. It has been further observed that the number of segments in the transmitting ring 74, which are tied or strapped together to determine the length of the impulse transmitted, may be varied as desired up to unit length of a code impulse and that the location of the "pick-up" segments *p* in each quadrant of the ring 75, may be such that the locking-up or storing relays are actuated at the instant when the incoming impulses over the cable A, have reached their middle or best and steadiest portion.

In telegraphic systems embodying rotary distributer equipment at the repeater stations, it is desirable that the transmitting station should also embody rotary distributers having means for varying the percentage of marking up to the full unit value of a code impulse. I have accordingly provided a transmitting equipment, shown diagrammatically in Fig. 4, which includes two sets of locking relays used alternately in a manner similar to the arrangement at the repeater station shown in Fig. 3. I employ a tape-controlled transmitter of the well-known Wheatstone type but modified to permit the use of zero impulses as well as plus and minus impulses, and operated by a La Cour phonic motor, the operating shaft of the transmitter being operatively connected to the axle of the motor which drives the brushes of the rotary distributer.

I have indicated the La Cour motor in Fig. 4 merely by the rotor or phonic wheel PW. The fragmentary illustration of the tape-controlled transmitter and the manner of connecting it to the La Cour motor will be understood by reference to U. S. patent to Donald Murray No. 670,964 dated April 2, 1901. For convenience in applying the parts indicated to the corresponding parts in the patent, the same parts have been designated by the same reference characters with the exponent *o*.

As the tape 37° is moved through the transmitter T the striking arm 24° which is constantly reciprocated up and down by the motor PW rocks the levers 26° and 27° about the pivot rod 28°, thereby depressing the tape engaging pins 42°, 43°, the tape being simultaneously stepped forward by the sprocket 39°. As the striking arm 24° moves upwardly, the pins 42°, 43° are moved upwardly against the tape by their springs 30°. If the pin 42° passes through a perforation, its contact 31° engages the fixed contact 36°, closing a circuit through conductor 101, (thereby energizing coil *e* of relay 102) through conductor 110, pick-up segment or segments *p* of "setting up" ring 115, of the rotary distributer RD, brush 118, solid ring 115ª, battery 121, and conductor 123 and this results in moving the armature of "dash" relay 102 against its right-hand contact. This closes a locking or holding circuit from battery 125, through conductor 126, armature of relay 102, locking or hold-

ing coil *h* of said relay, back to the neutral or "split" of battery 125. As the brush 119 moves onto the second set or group of strapped segments of transmitting ring 116. the "dash" impulse which is now locked up on relay 102 is sent on to the cable "dash" relay 130 through a circuit from battery 125, conductor 126, armature of relay 102, conductor 132, the second set of strapped segments of transmitting ring 116, brush 119, solid ring 116ª, conductor 134, energizing coils *e* of cable relays 131 and 130, in series, and conductor 136 to the "split" of battery 125. The armature of the "dash" relay 130 is thus moved against its right hand stop and connects the cable battery 140 to the cable A′, the impulse being continued for a period depending upon the number of said segments of the transmitting ring 116 that are strapped together. The next operation in sequence occurs as the brush 120 moves over the third group or set of strapped segments in the "resetting" ring 117 of the rotary distributer, thereby closing a circuit from battery 122, through solid ring 117ª, brush 120, the third group of strapped segments of ring 117, conductor 141, resetting coils *r* of relays 103 and 102, and conductor 142, back to battery 122. This energizes the resetting coils *r* and causes the armature of relay 102 to move to the left against its back stop.

If the next succeeding reciprocation of the pins of the transmitter T causes the "dot" pin 43° to enter a perforation in the tape 37°, thereby rocking the lever 27° and moving the contact 32° against the contact 35°, a circuit will be closed through one or the other of the storing "dot" relays 103, 105 which will be transmited to the "sending on" cable "dot" relay 131 in a manner which will be clear from the previous description of the operation of the "dash" relay circuits.

If now the next position of the transmitter tape should have no code perforations, neither pin will be able to pass through the tape and consequently the contacts 31° and 32° will not close against the corresponding fixed contacts 36° and 35° so that no impulse will be transmitted to the relays. Accordingly the cable will be grounded through the back-stops of the relays 130 and 131 during the time period of this code impulse. That is, in telegraphic parlance, a "zero impulse" is transmitted to the cable. It will be observed that the Wheatstone transmitter has been modified in construction to thus provide for a "zero impulse" when the tape contains no perforations in any position. It will be further observed that the tape is operated continuously by the actuating mechanism connected to the rotor PW of the La Cour motor which rotates the brushes of the distributer RD in synchronism with the impulses of the code characters. This continuous operation of the tape mechanism in cooperation with the synchronously operating distributer greatly facilitates the transmission of the code messages and by employing separate pairs of relays which alternately receive and transmit the code impulses, I am enabled to accurately predetermine the time period of the impulses and to make them the full unit period or any desired portion thereof allotted to an impulse of a code character. The duration of the impulses are determined by the number of segments tied or strapped together in the groups of segments in the transmitting ring 116, the percentage of marking and corresponding "curbing" depending upon the electrical constants of the particular cable.

It will be understood that the synchronizing and phase correcting mechanism at each repeating station maintains the moving parts of the rotary distributers at the retransmitting stations in suitable time relation or synchronization with the associated moving parts at the transmitting stations. When no code characters are being transmitted, it is to be understood that impulses are sent periodically to maintain the rotary distributers in synchronism. For the purpose of explaining my invention, I have merely shown a single channel operation, but it will be evident to engineers that it may be readily adapted to multi-channel operation.

I claim:—

1. In a telegraph system, the combination with a plurality of line sections, of a rotary distributer operating synchronously with the transmitted current impulses, a plurality of relays coacting therewith to receive, store and transmit the separate impulses in sequence, said distributer operating to clear out the storing relays after each successive impulse of a code character, thereby permitting the distributer to receive the initial impulse of a code character at any point in its operation and permitting the use of code characters composed of equal or unequal numbers of impulses and of varying lengths.

2. In a telegraph system, the combination with a plurality of line sections, of a relaying equipment comprising a rotary distributer and a plurality of relays operatively associated therewith to repeat telegraphic impulses between said line sections, said distributer operating to cause the relays to be cleared out between successive impulses of a code character.

3. In a telegraph system, the combination with a plurality of line sections, of a relaying equipment comprising a source of current, a rotary distributer having a plurality of segmented contactor paths, relays operatively connected to receive signal impulses from one line section and to transfer corresponding impulses to said distributer, stor-

ing and transmitting relays, each interconnected to operatively respond from a plurality of segments of said contactor paths, the movable elements of said distributer operating in synchronism with the current impulses received from one line section and coacting with the segments of said contactor paths in conjunction with said relays, to store said received impulses, to transmit to a second line section from said current source, impulses of predetermined strength and duration determined by the number of segments in said contactor paths that are connected together, and to clear out the storing relays between successive current impulses, thereby restoring the repeated signal impulses to the desired form, duration and strength.

4. In a telegraph system, the combination with a plurality of line sections, of a relaying equipment comprising sources of current, a rotary distributer having a plurality of segmented contactor paths, receiving, storing and transmitting means, each of said means being interconnected to operatively respond a plurality of times during each cyclic movement of said distributer, the movable elements of said distributer operating in synchronism with the received current impulses and acting jointly with said relays to receive, store and transmit said impulses separately in proper sequence between said line sections.

5. In a telegraph system, the combination of a plurality of line sections, of a relaying equipment connecting said sections through a single channel comprising a rotary distributer, receiving, storing and transmitting relays, said storing relays being arranged in a plurality of sets or groups, said distributer coacting with said relays to repeat telegraphic signals from one line section to another and causing successive current impulses to alternately actuate said sets of storing relays and to clear out each set after each actuation.

6. In a telegraph system, the combination with a plurality of line or cable sections, of a relaying equipment comprising distributer means and a plurality of relays operatively associatel therewith and operating to receive a block signal from one line section having a duration equal to several component impulses of a code character, other relays associated with said distributor and receiving separate impulses therefrom corresponding to said several component impulses, but each having any desired length independent of the length of said component impulses, said other relays operating to transmit said separate impulses to a second line or cable section.

7. In a telegraph system, the combination with a plurality of line or cable sections, of a relaying equipment comprising a distributor having a plurality of segmented contactor paths, a set of relays operatively connected to receive from one line or cable section block signals having a duration equal to the combined lengths of the successive impulses of like sign in a code character and to transfer said signals to the distributor, another set of relays interconnected to operatively respond from a plurality of segments of said distributor and to transmit to a second line or cable section, successive separate impulses corresponding to the several component impulses in the code character but having any desired predetermined duration.

8. In a telegraph system, the combination with a plurality of line or cable sections, of a relaying equipment comprising a rotary distributor having a plurality of insulated segments, a pair of relays operatively associated therewith to hold the signal impulse for a duration of time depending upon the number of segments connected together in a group, and a second pair of relays operatively associated with said distributor to transmit the signal impulses to another line or cable section for a duration of time depending upon the number of segments connected together.

9. In a telegraph system, the combination with a plurality of line or cable sections, of a relaying equipment comprising a rotary distributor having a plurality of insulated segments, a pair of relays operatively associated therewith to hold the signal impulse for a duration of time determined by connecting a certain number of segments together, and a second pair of relays operatively associated with said distributor to transmit the signal impulses to another line or cable section for a duration of time determined by a different number of segments connected together.

In testimony whereof I affix my signature.

WILLIAM C. PETERMAN.