Feb. 7, 1928. 1,658,404

W. M. BRUCE, JR

TELEGRAPHY

Filed June 23, 1924 5 Sheets-Sheet 1

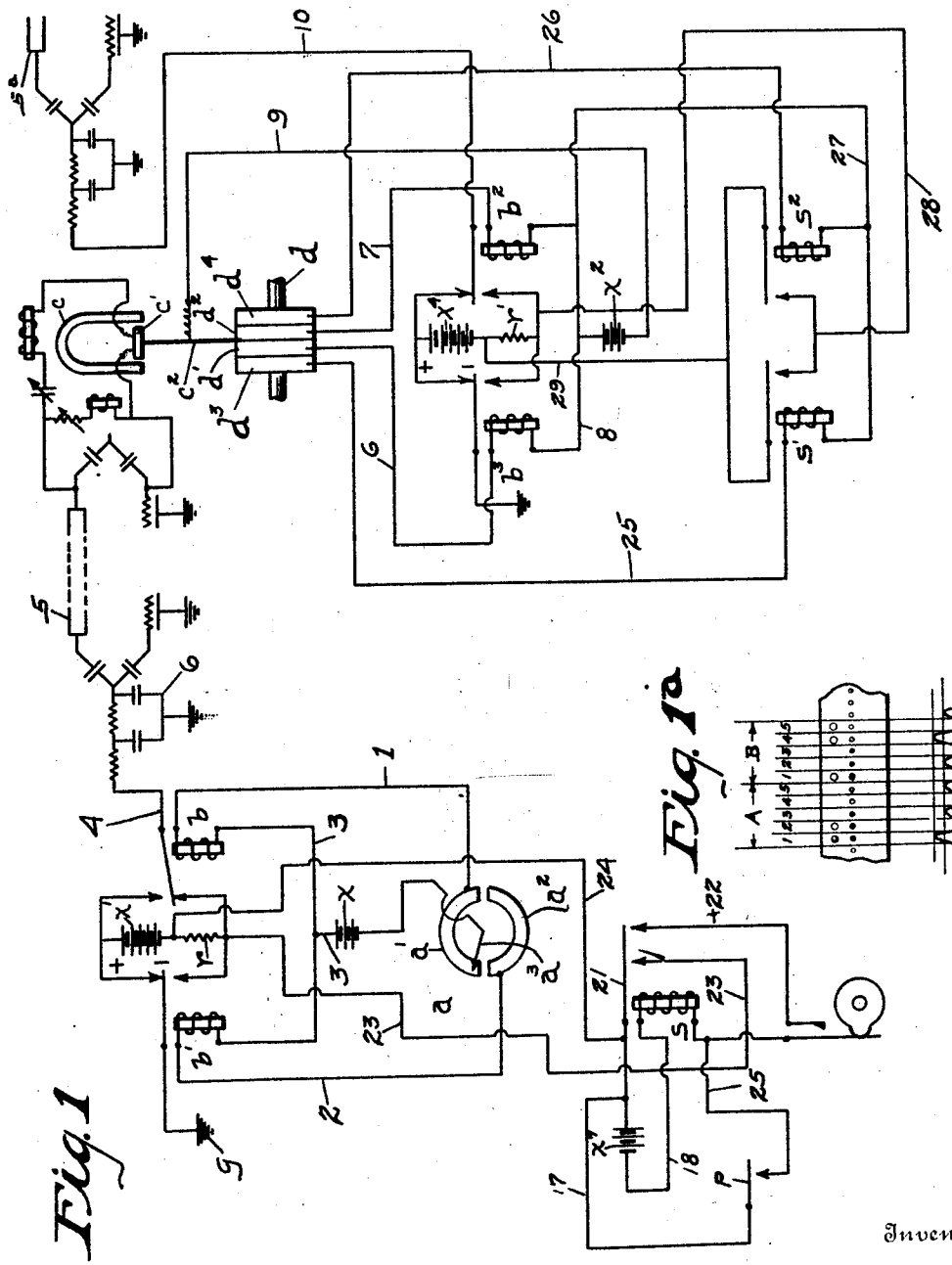


Fig. 1

Fig. 1a

Inventor

William M. Bruce Jr.

By Whitney Wm Bowman

Attorneys

Feb. 7, 1928. 1,658,404

W. M. BRUCE, JR

TELEGRAPHY

Filed June 23, 1924 5 Sheets-Sheet 2

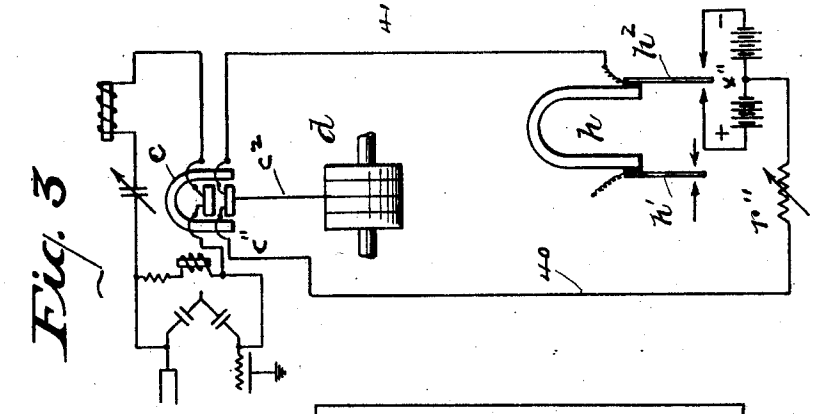


Fig. 3

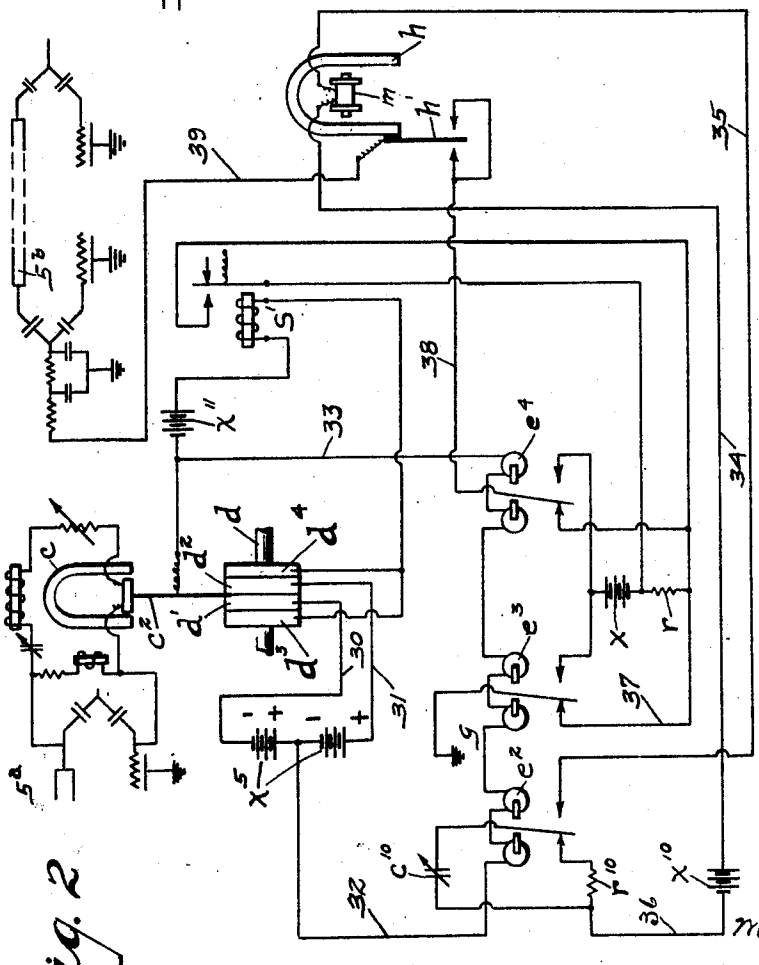


Fig. 2

Inventor

William M. Bruce Jr.

By Stanley Bowman

Attorneys

Feb. 7, 1928. 1,658,404

W. M. BRUCE, JR

TELEGRAPHY

Filed June 23, 1924 5 Sheets-Sheet 3

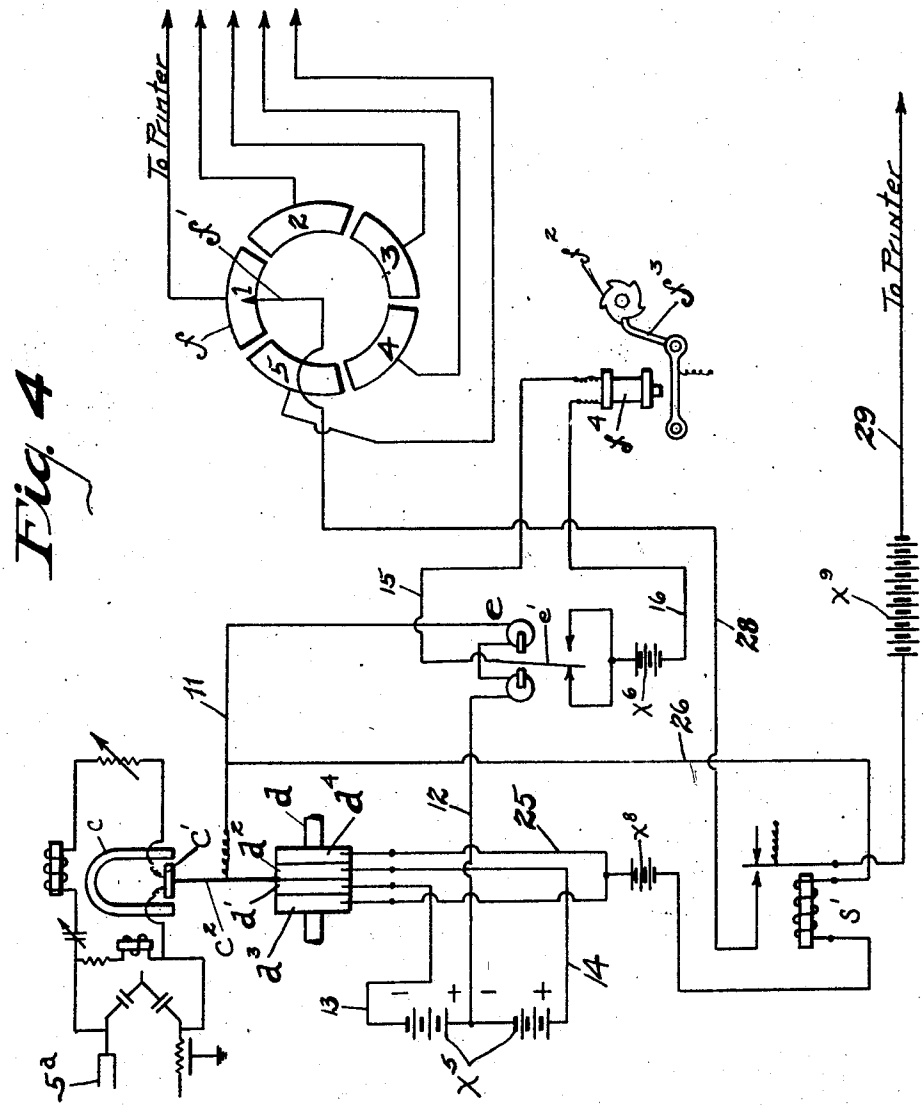


Fig. 4

Inventor

William M Bruce Jr

By Philip Fry Bowman

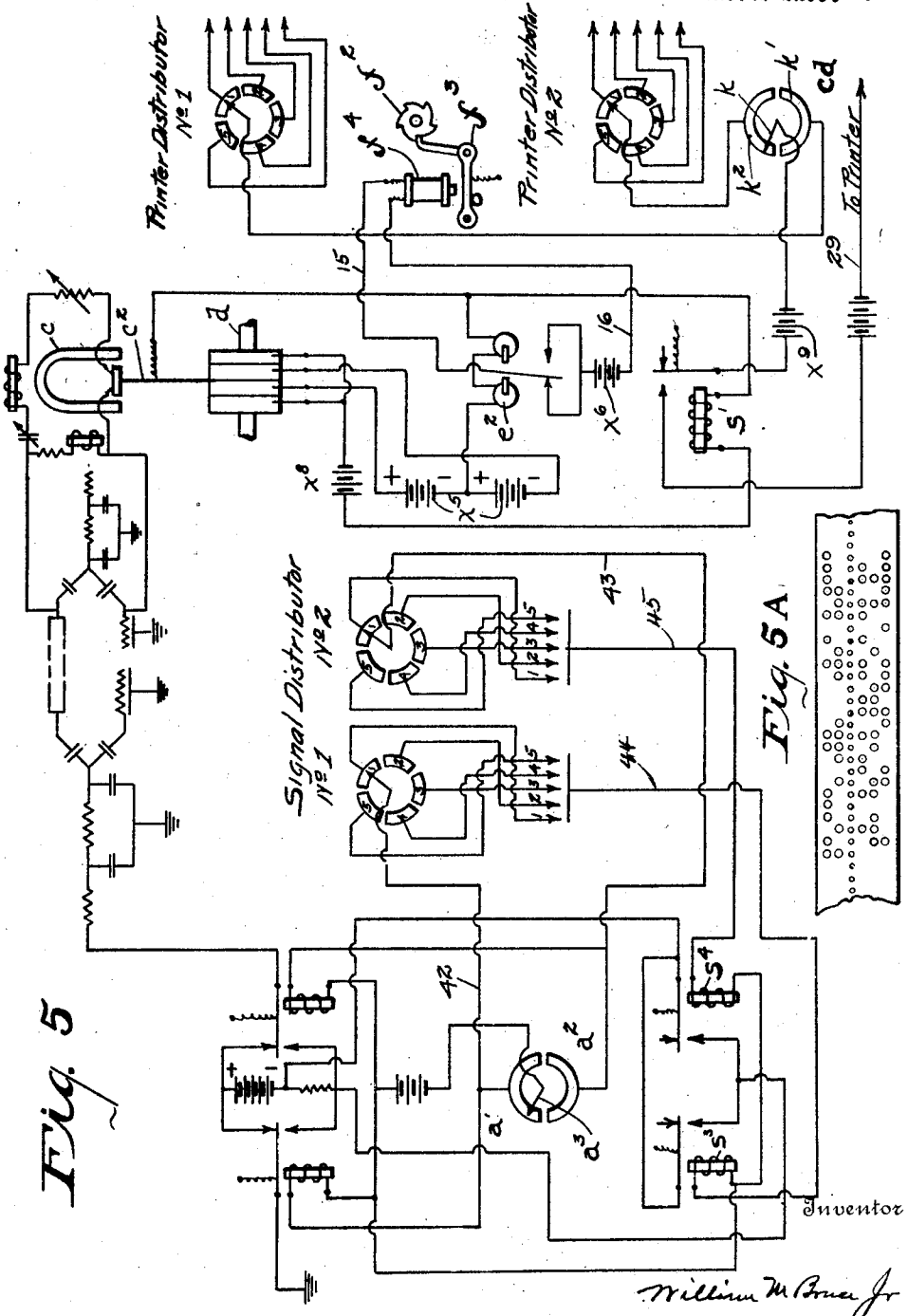
Attorneys

Feb. 7, 1928. 1,658,404

W. M. BRUCE, JR

TELEGRAPHY

Filed June 23, 1924 5 Sheets-Sheet 4



Inventor

William M. Bruce Jr

By Bowman

Attorneys

Feb. 7, 1928.

1,658,404

W. M. BRUCE, JR

TELEGRAPHY

Filed June 23, 1924

5 Sheets-Sheet 5

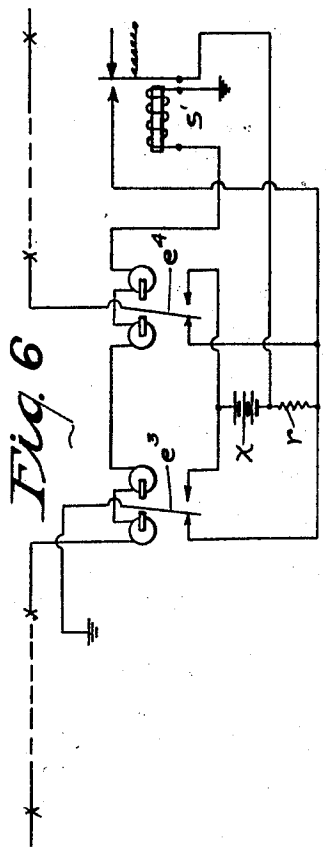


Fig. 6

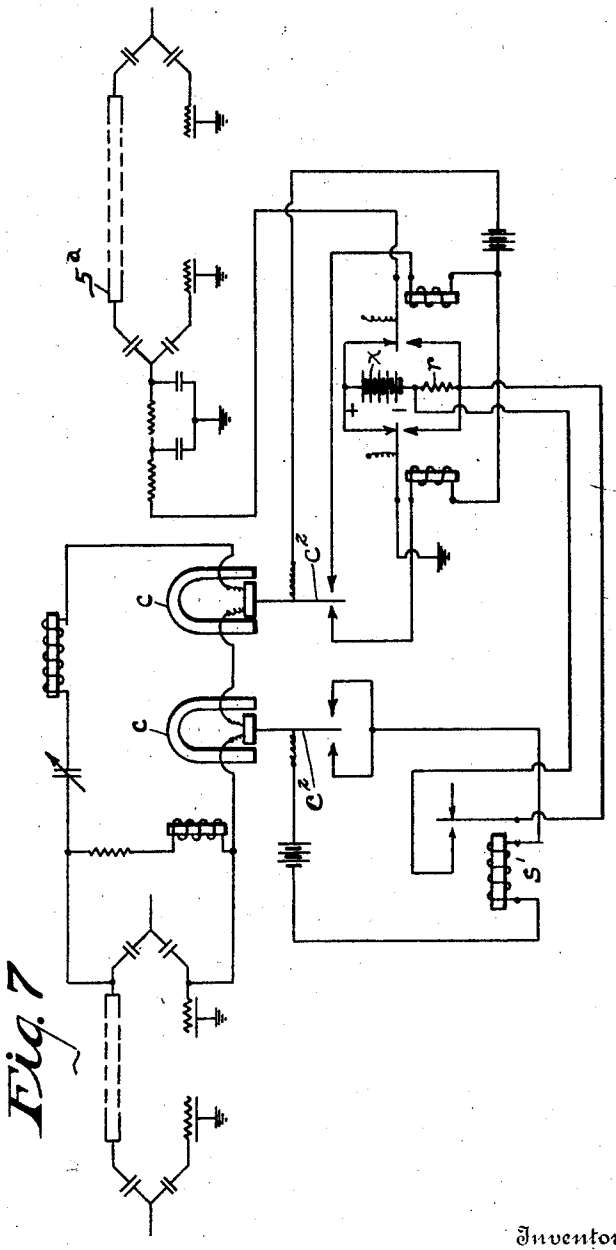


Fig. 7

Inventor,
William M Bruce Jr
By Stanley Bowman
Attorneys

Patented Feb. 7, 1928. 1,658,404

UNITED STATES PATENT OFFICE.

WILLIAM M. BRUCE, JR., OF SPRINGFIELD, OHIO.

TELEGRAPHY.

Application filed June 23, 1924. Serial No. 721,717.

My invention relates to improvements in telegraphy and it especially relates to methods and apparatus for operating printers over long lines or submarine cables having large capacities although it is adapted for almost any kind of telegraphy.

One of the principal objects of this invention is to obviate the use of synchronizing mechanism at repeating or receiving stations, where long lines or a chain of lines or cables are used.

In the present state of the art it has been necessary to provide some form of synchronizing mechanism at repeating or receiving stations in order that the signal impulses may be applied to the particular work to be performed and within the proper time element. These synchronizing devices have been of various forms, those which are corrected locally by means of tuning forks and similar devices and others which have been corrected by the line signal. In all cases, however, of which I am aware more or less intricate and expensive mechanism is necessary in order to effect this synchronism.

By my improved method I dispense with these synchronizing devices by supplying reversals to the conductor from an ordinary terminal battery and supplying these reversals by constantly operating mechanism which will cause these reversals of what I term a fundamental frequency to the line or conductor at all times. Such reversal will be supplied at a speed which is proportioned to the ultimate speed at which the conductor is capable of passing these impulses. These impulses are not of a continuous alternating current character but are broken impulses formed by any satisfactory pole changer and as before stated will be supplied constantly to the conductor over which the signal impulses are to be transmitted.

At the receiving end these impulses will be applied to a suitable receiver which will impart to apparatus at receiving station the same reversals and at the same speed, so as to repeat these reversals or the fundamental frequency into other conductors or other apparatus and at the terminal receiving station utilizing these reversals for operating the mechanism of the printer or other terminal receiving device.

These reversals it should be understood are independent of the signal impulses and are transmitted to the conductor continuously whether signal impulses are supplied to the conductor or not. They may be supplied from the same source of current or from a different source as will be pointed out more particularly hereinafter, but the underlying feature of the invention is to provide means for operating repeating apparatus or translating apparatus such as printers from these continuous reversals of what I have before referred to as a fundamental frequency.

In using the words "fundamental frequency" it should be borne in mind that this frequency need not be constant but is used only in the sense that fundamental frequencies operate certain intermediate and terminal apparatus as distinguished from the signalling impulses which per se have no part in the operation of the apparatus except that part of it which relates specifically to the signal itself.

These fundamental frequencies it should be understood are not necessarily constant because if the speed of the frequency should increase or decrease the intermediate or terminal apparatus thereby will be correspondingly increased or decreased since such apparatus is operated wholly by said reversals or fundamental frequencies.

There are other features of the invention in connection with these fundamental ideas which will be more particularly referred to hereinafter.

In the accompanying drawings:

Fig. 1 is a diagrammatic view showing one method of carrying out this invention, there being indicated a transmitting station at one end of a submarine cable, a receiving station at the other with repeating mechanism for repeating the fundamental frequencies as well as the signalling impulses into a succeeding cable.

Fig. 1[a] is a detail showing an arrangement of a transmitting tape and the corresponding current impulses supplied to the conductor for operating the translating device such as a printer of the five unit code.

Fig. 2 is a diagrammatic view of a receiving or repeating station of somewhat modified form and showing means for utilizing the fundamental frequencies at a receiving station for further operation of terminal or repeating apparatus.

Fig. 3 is a detail view showing an additional modification at a receiving or repeating station.

Fig. 4 is a diagrammatic view of a terminal receiving station with the mechanism adapted for operating a printer.

Figs. 5, 6 and 7 are diagrammatic views of further modifications.

Referring to Fig. 1, a is a continuous rotating pole changing device having segments a^1 and a^2 which are traversed by a rotating brush a^3. These segments a^1 and a^2 are connected by wires 1 and 2 to relays b and b^1 which are connected at the other end by a common battery wire 3 through battery x to the brush a^3. These relays b and b^1 may be the ordinary cable transmitting relays adapted at they are successfully operated to put positive or negative current from the battery x^1 through wire 4 to the apex of the cable or conductor 5 in the usual way.

Between the cable transmitter and the cable I have shown resistance and capacity which is preferably used in a well known manner to round out the impulses which come from the battery x^1 as the relays b and b^1 are successively operated.

At the receiving station we have a suitable receiving device c preferably of the galvanometer or movable coil type, the movable coil c^1 of which is preferably supplied with a contacting device c^2 operating in connection with a rotating drum d. This rotating drum d has four segments d^1, d^2, d^3 and d^4 the inner segments d^1 and d^2 being utilized for transmitting the fundmental frequencies and the outer segments d^3 and d^4 for transmitting the signal impulses as will be hereinafter more fully described. For the present we may consider only the inner segments d^1 and d^2. These segments are connected by suitable brushes and circuits 6 and 7 to relays b^2 and b^3 which through the common battery wire 8 and battery x^2 and wire 9 (from the battery x^2) to the movable contact c^2 will cause these relays b^2 and b^3 to operate successively as the moving contact c^2 engages respective segments d^1 or d^2 of the drum d. These relays b^2 and b^3 to all intents and purposes are identical with the transmitting relays b and b^1 and they are adapted as successively operated to supply positive or negative current from battery x^4 through wire 10 to other apparatus or conductors such as a cable 5^a.

Considering now the apparatus as described up to this time it will be seen that as the hand a^3 of the pole changer a is set in rotation the transmitting relays b and b^1 will be successively operated and supply current from earth at g through battery x^1 to the conductor 5 in exactly the same way that positive and negative impulses are supplied to a cable through an ordinary cable transmitter. These impulses will in turn operate the receiver c to cause the movable contact c^2 to move first in one direction and then in the other in engagement with the segments d^1 and d^2 of the rotating drum d which will in turn operate the transmitting relays b^2 and b^3 and transmit these same reversals to other apparatus or to a succeeding cable 5^a as described.

Passing for the moment to Fig. 4, 4 represents a terminal receiving station in which I employ the same receiver c with a movable coil c^1, contact c^2, drum d with the segments d^1, d^2, d^3, d^4 as in the receiving station in Fig. 1. The contact c^2 and the segments d^1 and d^2 of the drum are in this case in circuit with a polarized relay e and a divided battery x^5 the circuit being traced from contact c^2 by wire 11, polar relay e, wire 12 to the center of the battery x^5 thence by wire 13 to one side of the battery to contact d^1 and by wire 14 from the other side of the battery to contact d^2. As the contact c^2 moves from side to side in response to the reversals received from the cable 5^a or other conductor it will be seen that the polar relay e will be moved in one direction or the other in response to the positive or negative impulses from the divided battery x^5.

In this Fig. 4, f represents the usual distributing device of a five unit code printer whose rotating hand or brush f^1 is rotated by the usual mechanism forming a part of this distributing device. This mechanism is shown in a diagrammatic form in the form of an escapement wheel f^2 operated by a pawl f^3 which in turn is operated by an electro-magnet f^4. This may be considered as typical only as any form of mechanism such as now used may be employed for causing the rotation of the hand f^1 over the segments of the distributor.

The magnet f^4 is in circuit with the moving contact or armature e^1 of the polar relay e which is connected by wire 15 to the magnet f^4 thence by wire 16 through battery x^6 to stationary contacts on opposite sides of the armature e^1 so that as the polar relay is operated in response to the reversals or fundamental frequencies from the transmitting station the motor mechanism for the distributor will be operated in response thereto and will cause this distributor to move at exactly the same speed as the transmitting relays. Inasmuch as the reversals from the transmitting relays operate or control the mechanism for the distributor it will be seen that they will operate in unison even though the speed of the fundamental frequencies should change.

This in a general way explains the method of operating repeaters and the terminal translating device in response to reversals of current from an ordinary battery or other source of direct current supply and by the usual make and break transmitting mechanism as now employed in cable and similar transmission.

It now remains to describe the method of

supplying the signal impulses and as before stated these may be supplied from the same source of energy or from a different source. In the drawings I have shown a method and means for supplying these signal impulses from the same source of energy by providing a resistance which is normally in circuit with the terminal battery and the transmitting device and which will decrease the potential sufficiently to cause the contacting device c^2 of the receiver c to move only to the inner contacts d^1 and d^2 of the drum d when the fundamental frequencies or reversals are being transmitted and I further provide means for shunting this resistance when a signal impulse is being transmitted so that the full potential of the battery will be supplied when a signal impulse is being sent which will cause the contact c^2 of the receiver c to move to the outer contacts d^3 and d^4.

Referring to Fig. 1 with the contacting brush a^3 on the segment a^4 the relay b^1 will be operated from battery x through the brush a^3, segment a^1, wire 1, relay b, wire 3 and battery x. In this position circuit may be traced from earth at g through the battery x^1, resistance r, wire 4 to cable 5. As the brush a^3 passes off of the segment a^1 and before it contacts with segment a^2 the armature of relay b would drop back and the cable would be earthed in the usual way. As the brush contacts with segment a^2, relay b^1 will be operated and the circuit would be traced from ground g resistance r, battery x^1, line 4 to cable 5 sending an impulse of the opposite polarity into the cable but in both instances through the resistance r which will cut down the movement of the receiving device c so that its contact c^2 will engage only the inner segments d^1 and d^2 of the drum d but in a successive manner first one and then the other.

When a signal impulse is to be transmitted means are provided for shunting the resistance r so that the particular impulse which is passing into the cable at the moment when this resistance is shunted will be of a greater potential than and in phase with the fundamental frequency and will cause the receiver c to move its contact c^2 in a larger amplitude and engage one of the segments d^3 and d^4 on the rotating drum.

In this improved system the signal transmitting device may be a single key or circuit breaker as the signal element is to be applied to a particular segment on the printer distributor and it will operate whether signal impulse of increased potential is a positive or negative impulse.

I have shown in diagrammatic form the mechanism for this purpose. At the lower left hand corner of Fig. 1 there is a circuit closer p which may represent the usual pecker pin of an automatic cable transmitter. This circuit closer through wire 17, battery x^7, wire 18, relay s, and wire 25 will when the circuit closer is operated operate the relay s. The cable transmitter will be on the same shaft with the brush a^3 and there is also arranged on that shaft a cam device for a circuit closer p^1 which with the armature 21 of the relay s and wire 22 will form a holding circuit of the usual form to hold the relay operated during a half revolution of the brush a^3. The operation of the relay s through its armature 21 also closes a circuit through wire 23 to the resistance r and from a point between resistance r and the battery x^1 by wire 24 to the armature 21, hence so long as the relay s is operated the resistance r will be shunted through the last named circuit and during a half revolution of the wiper a^3 the full potential of the battery x^1 will be supplied to the cable instead of the limited potential of the fundamental frequency. It will be understood that at each half revolution the circuit closer p^1 will be opened by suitable cam mechanism on the shaft which operates the wiper a^3 of the pole changer and the automatic cable transmitter p.

In Fig. 1^a, I have shown an arrangement of the tape for the automatic transmitter for transmitting the letters a and b in a five unit code, the openings in the center of the tape being the usual center holes and those at the top edge of the tape being the perforations through which the pecker pin is operated for transmitting these impulses. Immediately below this tape is shown the characteristics of the impulses which will be transmitted to the cable, the fundamental frequencies being shown in between the signal impulses which appear opposite the respective transmitting perforations whether of positive or negative potential.

At a receiving or repeating station such as shown at the right of Fig. 1 the fundamental frequencies are repeated from battery x^4 through resistance r^1 exactly the same as at the transmitting station and for transmitting the signal impulses this resistance r^1 will be shunted so as to cause the full potential of the battery x^4 to pass into the succeeding cable or other apparatus. The circuit for producing these elements may be described as follows: In this case we employ two what may be termed signal relays s^1 and s^2. The relay s^1 is connected to one of the outer segments d^3 by wire 25. The other relay s^2 is connected to the other opposite segment d^4 by wire 26, these wires being further connected to battery x^2 by the common battery wire 27 and thence from battery x^2 by the wire 9 to the tongue or moving contact c^2 of the receiver c. Whenever the tongue c^2 moves to one of the outer contacts d^3 or d^4 it will be seen that either one or the other of the relays s^1 and s^2 will be oper-

ated and will close a circuit through wires 28 and 29 and the armature of either of said relays which will shunt the resistance r^1 and transmit a signal impulse of the same current flow as that initially transmitted to the cable.

In Fig. 4 a similar circuit is shown in which the signal relay s^1 is operated from either of the outer contacts d^3 and d^4 through a battery x^8 and wires 25 and 26. In this case, however, the signal impulses to operate the printer is transmitted by this relay s^1 from the contact of said relay through wire 28 to the distributing hand f^1 of the distributor f thence back through the common battery wire 29 and battery x^9 through the armature of the relay s^1. Inasmuch as the distributor is operated by the fundamental frequencies or reversals the signal current will be supplied to the exact segment of the distributor which is to receive that particular signal impulse in the setting up of the letter combinations.

It will be understood that whenever a signal impulse is transmitted the movable contact c^2 of the receiver c will pass over one of the inner segments d^1 and d^2 of the drum d in order to contact with the outer segments d^3 and d^4 so that the fundamental frequencies or reversals will be transmitted in either case whether there is a signal impulse or not and thus the distributing apparatus for the final signal impulses will be operated by this fundamental frequency just the same whether there is a signal impulse or whether there is not.

In Fig. 2 I have shown a somewhat modified form of repeating station with means for regenerating the impulses whether they are fundamental frequencies or signal impulses. This may be desirable when a large number of repeating stations are used which might tend to distort impulses passing through them.

In this arrangement I employ in connection with the receiving device such as shown in Fig. 1 a tuned vibrating device such as a tuning fork which is arranged to be vibrated by the fundamental frequencies and kept in phase therewith and to supply the fundamental frequencies as well as the signal impulses to the succeeding cable or apparatus. By this arrangement it may be desirable to use the usual tuning fork or other controlling devices at the transmitting station to keep the fundamental frequencies constant.

In Fig. 2 the receiving relay c having a movable tongue c^2 and the rotating drum d with the segments d^1, d^2, d^3 and d^4 are employed as before. I also preferably employ three polar relays e^2, e^3 and e^4 which are in circuit with the tongue c^2 divided battery x^5 and the segments d^1 and d^2 of the rotating drum d so that each of these relays will be operated in one direction or the other in response to the fundamental frequencies passing through the tongue c^2, contact d^1 or d^2, divided battery x^5, respective relays back to the tongue c^2 the circuit being traced from the segments d^1 and d^2 through wires 30 or 31 and one-half the battery x^5, wire 32 and the relays e^2, e^3 and e^4 and wire 33 to the tongue c^2.

The relay e^2 has one contact in circuit with a battery x^{10} and a magnet m of a tuning fork h, through wires 34 and 35, relay contact and armature and wire 36 to battery. A variable condenser c^{10} short circuited through resistance r^{10} and the other relay contact is employed in the usual way so that the charging and discharging of the condenser will operate the magnet m to insure constant vibration of the tuning fork hh. On one leg of the tuning fork is a contact h^1 which is adapted by its vibrations to close a circuit from ground at g through the back contact on relay e^3, wire 37, resistance r, battery x, contact on relay e^4, wire 38 to the stationary contacts on either side of the movable contact h^1 and through said contact h^1 and wire 39 to a succeeding cable or other device to which the impulses are to be transmitted.

As the relays e^3 and e^4 are operated by the fundamental frequencies their respective contacts will be reversed and the fundamental frequencies will be sent from battery x through resistance r in opposite directions as heretofore described, the operation of relays e^3 and e^4 in this respect being the same as the relays b and b^1 in the transmitting mechanism previously described and shown in Fig. 1.

When a signal impulse is transmitted the tongue c^2 moving to the outer segment d^3 or d^4 will operate the signal relay s^1 from battery x^{11} and thus shunt the resistance r in the manner heretofore described and cause the signal impulse in phase with the particular reversal to pass to the succeeding cable or other apparatus through the contact h^1 of the tuning fork h over the circuit last described so that both the fundamental and signal frequencies are repeated and regenerated through the contact h^1 on the tuning fork.

In Fig. 3 I have shown means for supplementing the fundamental frequencies operating the tongue c^2 by means of local battery impulses. This is accomplished by supplying to the tuning fork h a contact arm h^2 on the opposite leg of said fork from contact h^1. This arm is adapted to vibrate between contacts connected to opposite ends of divided battery x^{11} which is connected through variable resistance r^{11} by wire 40 to a separate coil c^{11} on the receiver c thence by wire 41 to contact h^2. As the fork is vibrated the contact h^2 puts positive and negative impulses to the coil c^{11} so as to

supplement the fundamental impulses coming over the cable and insure the positive action of the tongue c^2 on the revolving drum d. These impulses may be properly adjusted by the variable resistance r^{11}.

Where lines or conductors capable of high speeds are employed it may be desirable to send several messages by the method or practice known as channelling. This system lends itself very readily to this method of telegraphing and by its use will also dispense with the distributing and synchronizing device at repeating stations.

I have shown a method of carrying out this plan of telegraphing in Fig. 5 where means for sending two separate messages through separate channels are shown. The apparatus for sending fundamental impulses and the signal impulses are the same as shown in Fig. 1, but in this case the pole changer a is also used as a channel distributor by connecting the respective segments a^1 and a^2 to the rotating brushes of five unit code distributors marked 1 and 2 the segment a^1 being connected to the brush of distributor 1 by wire 42 and the segment a^2 connected to the rotating brush of distributor 2 by wire 43. The rotating hand or brush a^3 on the distributor a will be mechanically connected to the rotating hands or brushes of the distributors 1 and 2 so that the brush a^3 will make one half revolution for each step of segment in the distributors 1 and 2. There will be connected to the respective segments of the distributors the usual multiplex transmitter operated automatically through punched tape in the usual way so that different elements making up various letters will be transmitted as the distributor is rotated. The contact or pecker pin of these multiplex transmitters will when operated close a circuit through signal relays s^3 and s^4 by the wires 44 and 45 so that whenever one of the contacts in either multiplex transmitter is operated the signal relay s^3 or s^4 connected to that particular transmitter will be operated to send the signal impulse. So long as there are no signal impulses the fundamental frequencies will be repeated into the cable through the pole changer a as before.

Assuming a multiplex transmitter was operated to send code units 1, 3 and 5 to distributor No. 1 then at each revolution of the pole changer or distributor a the fundamental frequencies would be sent as before but as brush of distributor contacts with segments 1, 3 and 5 signal impulses would be transmitted through that distributor owing to the contact of the corresponding pins 1, 3 and 5 on the multiplex transmitter, these signal impulses passing through the brush a^3 and segment a^1 of the channel distributor. If the contacts 2 and 3 of the multiplex transmitter for channel distributor No. 2 are operated the corresponding signal relay s^4 would be operated and fundamental frequencies passing from the rotating brush a^3 to segment a^2 would receive the signal impulses and be transmitted through the proper segments 2 and 3 on distributor No. 2.

It will be understood that these multiplex transmitters are operated in the usual way. In fact apparatus now in use can be used without any change when incorporated in the circuits as described.

At the right of Fig. 5 I have shown the circuits for applying these impulses both fundemental frequencies and signal impulses to two or more printers operated by the usual channel distributors.

The receiver c with its movable tongue c^2, receiving drum d with its segments are employed as before with a polarized relay e^2 operating from the divided battery x^5. This relay e^2 is adapted to operate step by step mechanism f^2, f^3 and f^4 for operating the printer distributors the same as shown in Fig. 4 except in this case there are two distributors both operated from the same mechanism and rotating together. These distributors it will be seen, therefore, operate one step for each impulse of fundamental frequency and are continuously operating. The signal relay s^1 operated from battery x^8 from the outer contacts d^3 and d^4 is employed as before and it is adapted to close the circuit from battery x^9 through common battery wire 29 from the respective printers. The circuit to the respective distributor brushes, of the printer distributors passes through a channel distributor cd, the rotary brush k of which will be on the same shaft with the rotating brushes of the respective printing distributors No. 1 and No. 2. The two segments k^1 and k^2 of the channel distributor cd will be connected to the brushes of the respective printer distributors No. 1 and No. 2. As these distributors operate a step by step movement, the brush k will make five steps on one segment and then five steps on the other segment. These respective movements being effected by the fundamental frequencies will always be in phase with the transmitting devices and if code units should cause the signal impulses to be applied to signal distributor No. 1 they would be received on printer distributor No. 1 through rotating brush k and the channel distributor k^1. If the signal impulses are supplied to signal distributor No. 2 these signals would be supplied to printer distributor No. 2 through the segment k^2 and these signal impulses would be used to set up the printing mechanism in the usual way.

In Fig. 6 I have shown a modification at a receiving or repeating station which may be employed on land lines or conductors where high voltage can be used. In this

modification the fundamental frequencies are repeated through polar relays e^3 and e^4 as heretofore described for Figs. 2 and 3, but in this case the rotating drum is dispensed with and the signal relay s^1 in series with the fundamental frequencies relays e^3 and e^4 is adjusted by spring tension so as to be operated only when an impulse of increased potential is received from the line in which case the resistance r will be shunted as before and the signal impulse applied to the fundamental frequency as before described. This arrangement while capable of being used on conductors where high voltage is employed might not be adapted for cable use where the potential must be kept within certain limits but where high potential can be applied as a signal impulse would probably be made to work satisfactorily.

In Fig. 7 I have shown a further modification at a receiving or repeating station in which two receiving relays c are employed and in this way the rotating drum and multiple contacts are dispensed with. One of these relays would have the respective contacts adjusted so that the tongue c^2 would contact on either one or the other side by the fundamental frequency or reversal. The other relay would have this contact so adjusted that while the respective tongues of this receiver move in unison the signal relay would make contact only when a signal impulse comes through. In this figure the relay at the right would transmit the fundamental frequencies from battery w in the same manner as before described through resistance r and the signal relay s^1 operated by signal impulse will shunt resistance r and cause the signal impulses to be repeated in the same manner as heretofore described.

Further modifications may be employed which would readily suggest themselves. In fact the system herein described is capable of use with standard apparatus of various kinds which is now in general use. Inasmuch as the fundamental frequencies are being sent into the conductor continuously duplex balance will be more easily maintained. Both the transmitting and receiving relays are operating constantly, hence there is no zero and the inertia of the receiving relays is materially reduced. In connection with printers the apparatus at the repeating stations is very materially reduced. Synchronism mechanism as ordinarily used may be dispensed with and the apparatus at repeating stations for channel working may be very materially reduced.

In Fig. 5 I have omitted the usual relays in connection with the multiplex distributors for storing up one or more of the impulses to give the transmitter time to advance the tape. This is also true of the printer distributor when certain impulses are stored up to give the printing mechanism time to print all of which is common practice and will readily be understood by one skilled in the art.

Having thus described my invention, I claim:

1. A method of operating printers in a telegraph system which consists in supplying to a conductor reversals of positive and negative current impulses of one potential and utilizing said impulses for operating the distributing mechanism and in supplying signal impulses of the same frequency and in phase with said reversals and of a different potential to operate printing mechanism.

2. In a telegraph system, means for continuously supplying reversals of positive and negative impulses of one potential from a source of direct current supply, separate means for supplying signal impulses of the same frequency but of different potential in phase with said reversals, printing mechanism at a receiving station whose distributor is operated by said reversals and whose printing mechanism is operated by said signal impulses.

3. In a telegraph system, a source of direct current supply, means for supplying continuous reversals of positive and negative impulses of one potential from said source of supply and signal mechanism for sending signal impulses of the same frequency in phase with and to increase the potential of certain of said reversals, receiving mechanism at a receiving station with means to repeat said reversals to operate one set of mechanism and to repeat said signal impulse in phase therewith to operate other mechanism.

4. In a telegraph system, a method of operating printing mechanism which consists in supplying to a conductor continuous reversals of positive and negative impulses of current of one potential and employing said reversals to operate repeating mechanism and supplying signal impulses of the same frequency but of a different potential in phase with said reversals for signalling purposes, and repeating said reversals and signal impulses to operate printing mechanism.

5. In a telegraph system in which continuous reversals of positive and negative impulses of one potential are supplied to a conductor, means for supplying signal impulses of the same frequency but of a different potential in phase with said reversals, repeating mechanism comprising a vibrating transmitter operated by said reversals and signal impulses to repeat both reversals and signals from a separate source of supply.

6. The method of repeating and regenerating signals in a telegraph system which consists in supplying to a conductor continuous reversals of positive and negative impulses of one potential and signal impulses of the

same frequency but of a different potential in phase with said reversals utilizing said reversals for operating a repeating device in phase with said reversals and causing said repeating device to send reversals and signal impulses of the same frequency from a separate source of supply in phase with the reversals and signal impulses originally supplied to said conductor.

7. In a system of repeating and regenerating signals a vibrating repeating device operated by and in phase with constantly supplied current reversals of positive and negative impulses of one potential means for supplying signal impulses of the same frequency but of a different potential in phase with said reversals and causing the vibrating repeater to repeat the reversals and signal impulses from a separate source of current supply as set forth.

8. In a telegraph system in combination with a transmitting device for transmitting signal impulses, a constantly moving pole changing device transmitting relays controlled by said device to send reversals of one potential from said source of supply, said transmitter and pole changing device being so connected that the signal impulses from said transmitter will be supplied in phase with the positive or negative reversals with means for increasing the potential of the signal impulses and a receiving mechanism operating at different amplitudes in response to said reversals and said signal impulses and by the different amplitudes to repeat said reversals to one set of mechanism and the signal impulses to other mechanism.

9. In a system of telegraphing, continuously operating mechanism for sending fundamental impulses of positive and negative character and of one potential but of the same frequency from a source of direct current supply, additional means for supplying signal impulses of a different potential in phase with said fundamental impulses, printing mechanism at a receiving station and means for operating the distributor of said printing mechanism by the fundamental impulses and causing the signal impulses to be distributed to said printer.

10. In a telegraph system in which current impulses of a fundamental frequency and of one potential are supplied constantly to a conductor and signalling impulses of a different potential supplied in phase with said fundamental impulses, a receiving device operating at different amplitudes in response to said fundamental impulses and said signal impulses and means controlled by said fundamental impulses to send impulses from a separate source of supply to said receiver to reinforce the fundamental impulses from said conductor to said receiver.

11. In a telegraph system in which a receiving device is caused to move continuously at one amplitude in response to fundamental impulses of one potential and to a greater amplitude by impulses of increased potential in phase with said fundamental impulses, and a separate coil in said receiver, means for supplying current impulses from a different source to said coil in phase with said fundamental frequencies as set forth.

12. In a telegraph system in which current reversals of one potential are supplied constantly to a conductor and signal impulses of a different potential supplied to certain of said reversals in phase therewith, a relay operated by said current reversals and signal impulses and repeating mechanism embodying a tuning fork whose vibrations are controlled by reversals from said relay to repeat both the reversals and signal impulses and separate means on said tuning fork for supplying impulses in phase with said reversals to the relay, as set forth.

13. In a telegraph system, means for supplying current impulses of positive and negative character from a direct source of supply through resistance to a conductor, a signal transmitter in step with said reversal sending mechanism with means operated thereby for shunting the resistance when a signal impulse is to be transmitted, receiving mechanism moved by said current reversals to one position and to a different position by said signal impulses to cause said reversals to be transmitted to one set of mechanism and said signal impulses to a different set of mechanism.

14. In a telegraph system, means for supplying current reversals from a source of direct current supply, a signal transmitter in step with said reversal sending mechanism with means for increasing the potential of one or more of said reversals when a signal impulse is to be transmitted, receiving mechanism moved to one position by said current reversals and to a different position by said signal impulses to cause said reversals to be transmitted to one set of mechanism and said signal impulses to a different set of mechanism.

15. In a system of telegraphy, continuously operating mechanism for sending current reversals from a source of direct current supply, a signal transmitter in step with said reversal sending mechanism for changing the potential of one or more of the current reversals, receiving mechanism moved to one position by said normal current reversals and to a different position by the increased potential of certain reversals, and a printer connected to said receiving mechanism so that the normal reversals are supplied to and operate the distributor of said printer and the signal impulses are transmitted to and operate the recording mechanism of said printer.

16. In a telegraph system, the combination

with a direct source of current supply, of a pole changer and a signal transmitter mechanically connected to operate in step one with the other, and means connected with said transmitter to change the potential of certain of said reversals for signalling purposes, and a printer having a distributor operated by said normal reversals, and a printing mechanism operated by the increased potential from said signal transmitter.

In testimony whereof, I have hereunto set my hand this 20th day of June 1924.

WILLIAM M. BRUCE, JR.