I. KITSEE.

METHOD OF AND MEANS FOR QUADRUPLEXING CABLES.

APPLICATION FILED AUG. 2, 1911. RENEWED DEC. 30, 1916.

1,219,110.

Patented Mar. 13, 1917.

2 SHEETS—SHEET 1.

Fig. 2.

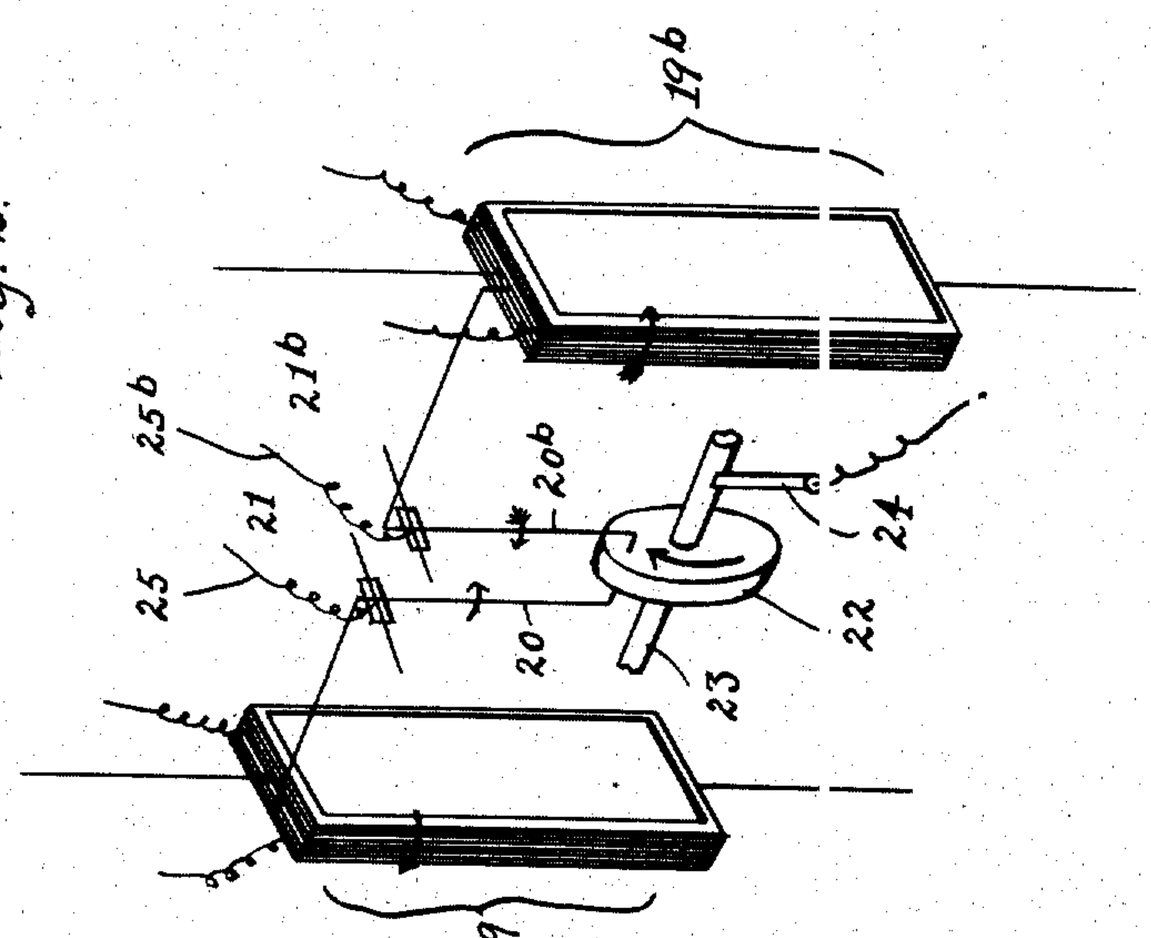
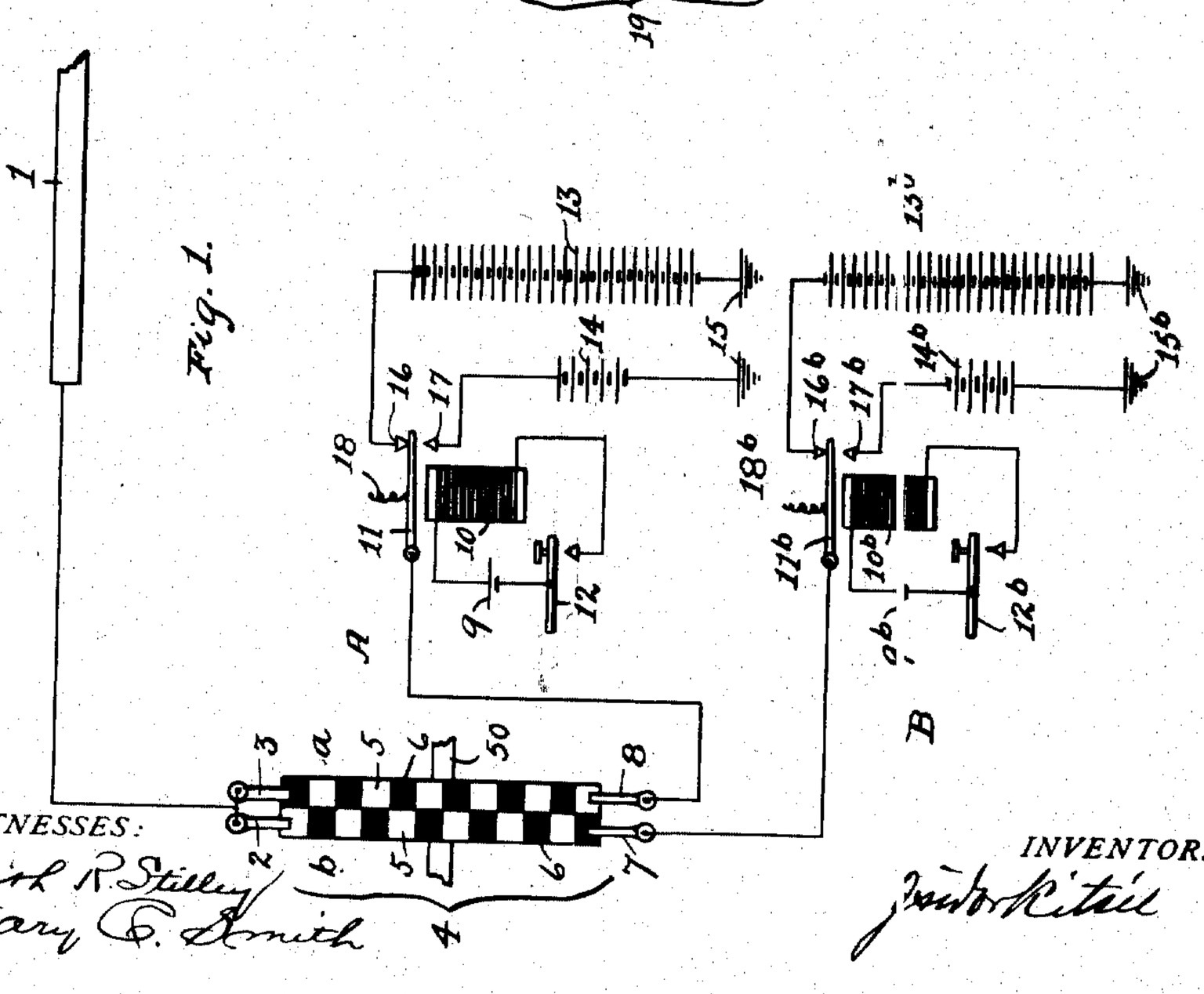


Fig. 1.



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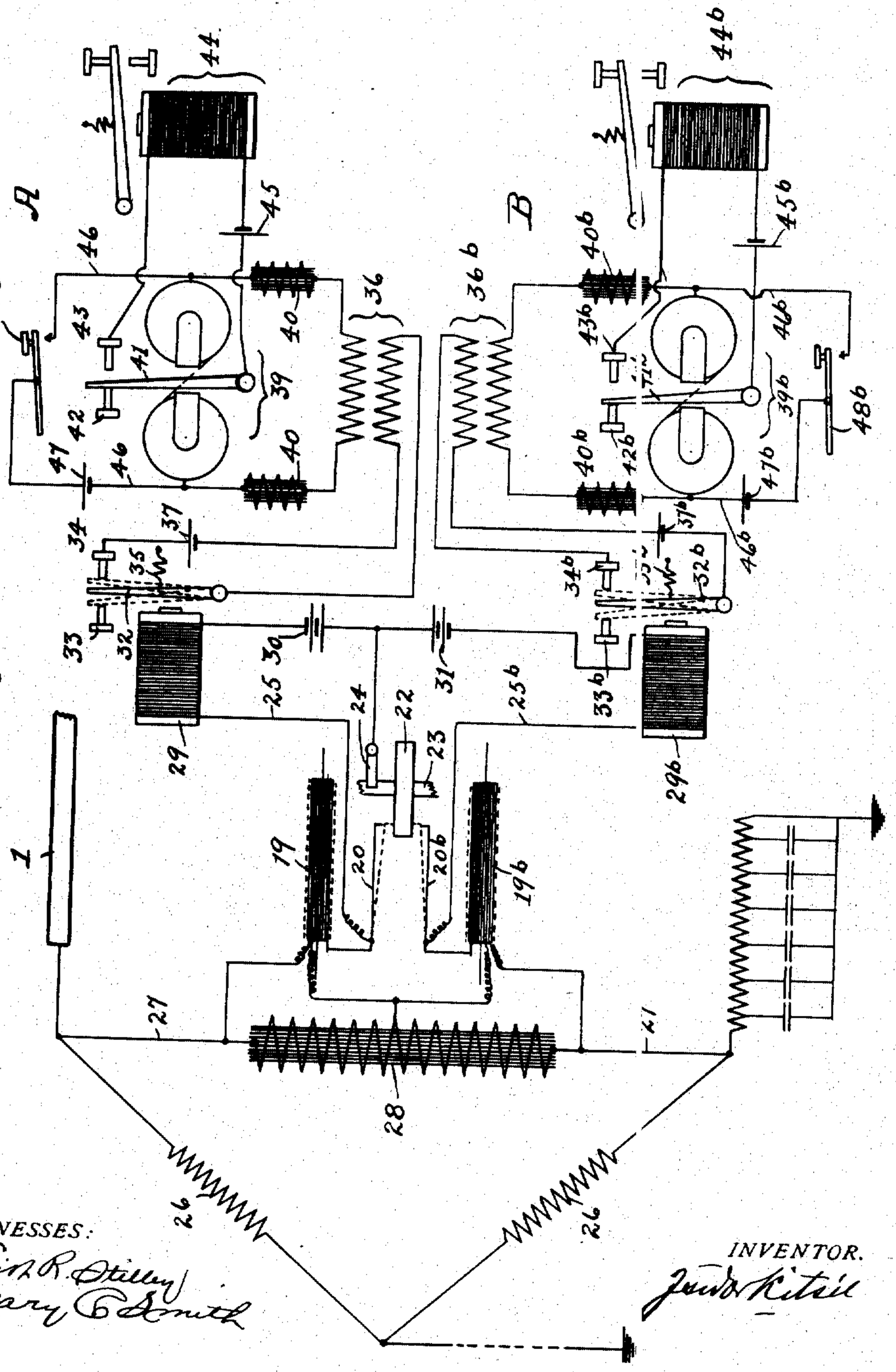

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UNITED STATES PATENT OFFICE.

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METHOD OF AND MEANS FOR QUADRUPLEXING CABLES.

1,219,110. Specification of Letters Patent. Patented Mar. 13, 1917.

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To all whom it may concern:

Be it known that I, ISIDOR KITSEE, citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Methods of and Means for Quadruplexing Cables, of which the following is a specification.

My invention relates to an improvement in the method of and means for quadruplexing cables.

In quadruplex telegraphy on land lines, one message is sent by a weak current of one polarity, the second message by a strong current of opposite polarity, and if two messages are sent simultaneously, a strong current of the first polarity is impressed upon the line.

The peculiar condition of the cable and the necessity of employing delicate instruments for cable work bar the employment of methods such as are used on land lines and new systems have to be evolved.

After long and careful experiments, I have found that the system as will hereinafter be described is well adapted for the purpose of quadruplexing messages over lines with great capacity, such for instance as submarine cables.

I have found by actual experiments on a submarine cable that if true reversals are impressed upon the cable, a greater number of pulses can be taken care of by the receiving instrument than when pulses are transmitted, as is today the case, designating characters, for the reason that the grouping of such characters in the telegraphic alphabet requires very often the impressing upon the line of two or more pulses of like polarity.

The greater efficiency of true reversals was to be expected, but, in my experiments on a submarine cable, I have found that whereas in actual telegraphy with the double key, the speed on a particular cable was limited to two hundred and forty letters per minute requiring—by actual count—somewhat less than five hundred pulses, the same receiving instrument gave perfect results when nine hundred pulses of true reversals were transmitted over the line.

In the drawing, Figure 1 is a diagrammatic view of a transmitting device used in my system. Fig. 2 is a perspective view of part of the receiving organism and Fig. 3 is a diagrammatic view of one terminal of the cable provided with the required transmitting and receiving instruments for quadruplexing the cable according to my system.

In Fig. 1; 1 is the cable; 2 and 3 are the brushes connected to said cable; 4 is a commutating device as an entirety consisting of the two parts *a* and *b* mounted on a shaft 50 and adapted to be revolved by any suitable means. Each of said parts is provided with the conducting segments 5 and the nonconducting segments 6. All of the conducting segments 5 are in electrical contact with each other. The same is true of the conducting segments 5 of the commutating part *b*. In reality, the commutating wheel 4 may be constructed of two metallic wheels having cut out portions filled with nonconducting material. 7 and 8 are two brushes, one brush in contact with the part *a* of the commutating device and the second brush in contact with the part *b* of the commutating device. A and B are two transmitting organisms. The organism A comprises here the key 12 connected with the interposition of the battery 9 to the coil of electromagnet 10. The armature 11 of said electromagnet is held upward by the spring 18 and is connected to the brush 8 of the commutating part *a*. 13 and 14 are two sources of current. The source 13 is here shown as to consist of twenty-five cells and the source 14 is here shown as to consist of five cells. Both sources are grounded with their negative poles at 15. The positive pole of the source 13 is connected to the stationary contact 16 and the positive pole of the source 14 is connected to the stationary contact 17.

Normally, that is when the key 12 is open, the armature 11 rests against the contact 16 of the source of current 13. The organism B comprises the key 12^b connected with the interposition of the battery 9^b to the coil of electromagnet 10^b. The armature 11^b of this electromagnet is held upward by the spring 18^b and is connected to the brush 7 of the commutating part *b*. 13^b and 14^b are two sources of current connected with their positive poles to the ground 15^b. The source 13^b is here also shown as to consist of twenty-

five cells and the source 14^b as to consist of five cells. The negative pole of 13^b is connected to the stationary contact 16^b and the negative pole of the source 14^b is connected to the stationary contact 17^b. Normally, the armature 11^b rests against the contact 16^b of the source 13^b.

I will now describe the function of this part of my invention.

The commutating device 4 is revolved at the required speed and the cable 1 will, therefore, alternately connect through brushes 2 and 3 with the conducting segments of the commutating part *a* and the conducting segments of the commutating part *b*. Normally, that is, when the keys of both of the stations A and B are at rest or open, the source 13 of the organism A will connect with its positive pole through brush 8 with the conducting segments of *a* and the source 13^b will connect through its brush 7 with the conducting segments of *b*, when such segments are in alinement with their respective brushes, and as the commutating device is always revolving, it is obvious that the sources 13 and 13^b are alternately connected with the cable 1 and that, therefore, alternate impulses of the same duration and practically the same intensity are impressed upon said cable. Such alternation of pulses I call "true reversals." In my system, therefore, "true reversals" are transmitted over the line when all transmitting organisms are at rest.

It is now supposed that the operator at A depresses his key thereby energizing his electromagnet 10. This operation results therein that the armature 11 is drawn downward and away from the contact 16 and in contact with 17. The connection of the battery 13 with the cable is, therefore, broken and the connection of the cable through the segments of the commutating device made with the battery 14.

The sequence of "true reversals" will, therefore, be interrupted or changed. A strong negative current from the organism B will alternate with a weak positive current from the organism A.

It should be understood that the force of 13 or 13^b is sufficient to actuate its own receiving device at the far end of the cable, but the force of 14 or 14^b is insufficient to operate its receiving instrument but suffices to clear the cable.

As long as the key 12 of organism A remains depressed, the sequence of strong negative and weak positive impulses will remain, but as soon as this key is open, "true reversals" will again be impressed upon the cable. When the key 12^b of station B is depressed, the connection of the battery 13^b with the cable through the segments of the commutating part *b* is interrupted and the connection of the battery 14^b with the cable through said segments is established. The sequence of the "true reversals" is again interrupted or changed, but this time a positive pulse of high intensity alternates with a negative pulse of low intensity, or in other words, the former order in now reversed.

It is now supposed that both, the key 12 of station A and the key 12^b of station B are simultaneously closed. The connection of the battery 13 as well as the battery 13^b with the cable through the respective segments is interrupted, but the connection with the batteries 14 and 14^b is established and, therefore, reversals of low intensity will be impressed upon the cable. These pulses of low intensity will not affect the receiving instruments at the far off station.

In placing into practice the organism as described, the following rules have to be observed:—

The higher the speed of the commutating device, the more efficient the system, but the speed should only be quick enough to allow a succession of pulses not quicker than the cable and receiving devices inserted at the far end of same are capable of taking care of; and the number of signaling characters produced by the operation of the key of each transmitting organism should be less than the number of pulses impressed as true reversals upon the line from that particular transmitting organism.

I have in this drawing referred to the different signal batteries as to consist of twenty five individual cells, but it is obvious that the number of these cells may be changed in accordance with requirements. I have also illustrated the—what I call—"clearing" cells as to consist of one fifth of the number of the signaling cells, but it is also obvious that this ratio may differ.

The reason why this system provides for the so-called "clearing" cells is, that should only one message be transmitted for a comparatively long time over the cable and, therefore, one polarity be depressed for such length of time, the cable would, as it is technically called, "choke". The accumulation of the current of one impulse due to the great capacity of the cable would be such as to make the signaling nearly, if not quite, impossible.

In actual practice, I have found that a small current of a polarity opposite to the signaling current suffices to obviate this difficulty. In this system. therefore, the following method is employed:—

1st:—No operator signaling. In this instance, "true reversals" are impressed upon the line and received as such at the far off station, thereby actuating there the receiving device operatively related to the transmitting station A and the receiving device operatively related to the transmitting station B.

Normally, therefore, at the receiving station, both instruments will be actuated, and as this actuation follows in quick succession and alternately between the two instruments, it can be said that both receiving instruments inserted in the cable will normally vibrate.

2nd:—If the operator at A transmits messages, his own signaling current is entirely depressed and, therefore, the vibration of the receiving instrument adapted to be operated through his signaling current will cease, but as soon as his transmitting key comes to rest, this vibration will again commence.

3rd:—When the operator at B transmits a message, he depresses his own signaling current and the receiving device adapted to be operated by this current will cease its vibration and will come to rest.

4th:—When both, the operator at A and B, simultaneously transmit signals, then both signaling currents are depressed and at the far off station, both receiving devices come to rest.

In Fig. 2; 19 and 19^b are two receiving devices here illustrated in conventional sign as two moving coils. Different types of receiving devices may be employed as long as the sensitiveness and correctness of same meet requirements. The coils, as illustrated, may represent the coils of the well known siphon recorder used today in cable work. In such case, one of the connecting fibers should be placed out of service, so that the coil, in its movement, should only be able to affect the movement of the contacting device in one direction. These contacting devices are here shown as conducting strips or rods provided with contacts at their ends and are designated by the numerals 20 and 20^b, respectively. The cradle with its suspension is designated by the numerals 21 and 21^b, respectively.

It has to be borne in mind that the siphon of the usual recorder and the contact arms substituted therefor, have a normal position and will always return to this position after the effect of the signaling current has died away.

22 designates contacting means here shown as a conducting roller or cylinder adapted to be revolved with the aid of the shaft 23 by any of the well known means. The shaft and roller are in electrical connection with each other. 24 is a contacting brush adapted to be connected to an outside circuit. 25 designates the means to connect to an outside circuit the conducting strip or rod 20; and 25^b the means to connect to an outside circuit the conducting strip or rod 20^b.

The long unfeathered arrow illustrates the direction in which the coil of the device 19 is supposed to move through the impression upon the line of a positive pulse and the small unfeathered arrow indicates the direction in which the conducting rod 20 is supposed to move through the deflection of the coil of the device 19. The long feathered arrow indicates the direction in which the coil of the device 19^b is supposed to move through the impression upon the line of a negative pulse; and the small feathered arrow indicates the direction in which the conducting rod 20^b is supposed to move through the deflection of the coil of device 19^b.

In Fig. 3, which, as stated above, illustrates one terminal of a cable embodying my system of quadruplexing said cable, 1 is part of the cable. 26, 26, are the two bridge arms as usually employed in duplexing cables; 27, 27, are the cross wires of the bridge; to these cross wires is here shown to be connected the impedance 28. For the purpose of practising my invention, this impedance is not necessary, but the same is placed here in shunt to the receiving organism later on to be described, as it was found that through such impedances the incoming impulses are sharpened and may, therefore, be better adapted to produce desired results. In shunt to this impedance are positioned the receiving devices 19 and 19^b with their respective armatures or connecting rods 20 and 20^b; and in juxtaposition to these armatures or connecting rods is placed the movable contacting device 22 with the shaft 23 and the contacting brush 24. To the connecting rods or armatures are connected the wires 25 and 25^b. This part of the system is clearly illustrated in Fig. 2. 29 and 29^b are two electromagnets preferably of the neutral type. The coil of electromagnet 29 is connected with one terminal to wire 25 and with the other terminal with the interposition of the source of current 30 to the brush 24. The coil of electromagnet 29^b is connected with one terminal to wire 25^b and with the other terminal, with the interposition of the source of current 31 to the brush 24. The armature 32 of electromagnet 29 is provided with the two stops 33 and 34, and is normally held against the stop 34 by suitable means here shown as the spring 35. 36 is a converter or inductorium, the primary thereof connected with the interposition of the source 37 to the stop 34 and armature 32, respectively; the secondary of this converter or inductorium is connected to the polarized relay 39. In the circuit of this polarized relay are here shown the impedances 40, the purpose of which will be later on described. 41 is the armature of the polarized relay provided with the stops 42 and 43. 44 is a translating device here shown as a sounder and this translating device is connected with the interposition of the source 45 to the armature 41 and stop 43, respectively. The

whole organism is designated by the letter A corresponding with its transmitting station A.

The arrangement of the second receiving organism is a duplicate of the arrangement of the organism just described and similar parts are designated by similar numerals with the exception that the letter *b* is added to these designations. This second organism, as an entirety, is designated by the letter B corresponding with its transmitting station B.

It has to be added that the polarized relay of each organism is provided with a reset circuit here shown as to consist of the wires 46, 46, source 47 and key 48.

As was clearly stated in the description of Fig. 2, the armature or connecting rods of the receiving devices 19 and 19^b have their own zero position, that is, if the armatures are deflected through the movement of the coils, they return to their normal position when the movement of the coils ceases. Should, therefore, no pulses be impressed upon the line, then the armatures 20 and 20^b of the receiving devices will remain at their zero position. This zero position is indicated by a full and unbroken line.

When an impulse is transmitted over the line adapted to actuate the coil—say—of device 19, then its armature will move in a direction as indicated by the dotted lines and will, therefore, connect with the revolving contacting device 22; and when the impulse impressed upon the line is such as to actuate the coil of the device 19^b, then its armature 20^b will move in a direction as indicated by the dotted lines and connect with the revolving contacting device 22.

As now in my system, normally, that is, when the keys at both transmitting stations are at rest, "true reversals" are transmitted from these stations in quick succession, it is obvious that the armatures 20 and 20^b will alternately be moved from their respective zero positions in a direction toward and in contact with the device 22.

I will now describe the effect of this vibratory movement of the armatures of the receiving devices and I will take for this description the organism as illustrated at A, it being understood that the organism as illustrated at B is a duplicate thereof.

As long as the armature 20 of the receiving device 19 is at its zero position, that is, out of contact with the device 22, the circuit including the localized electromagnet 29 is open and its armature drawn by the spring toward and in contact with stop 34 will remain there and a circuit including the primary of the inductorium 36 is made. No current, therefore, will be generated in the secondary and the polarized device 39 will remain unaffected; its armature, which is unbiased, will, therefore, remain at that stop where the last impulse has driven it. If this stop is the one connected to the circuit of the translating device 44, then the translating device will be actuated, but if the last impulse has driven the armature to the stop 42, then the circuit including the translating device will remain open.

It is now supposed that "true reversals" are impressed upon the line from the transmitting station; and it is supposed that the receiving device 19 is actuated by positive pulses transmitted from the station A. The armature 20 of this receiving device 19 will, therefore, be brought in contact with the connecting device 22 as often as positive pulses are impressed upon the line; and as these reversals follow in quick succession, it is also obvious that the armature 20 will alternately connect and break the connection with the device 22. The making of this connection will close the circuit including the electromagnet 29 and the breaking of this connection will open the circuit including this electromagnet. The armature 32 of the electromagnet 29 will vibrate in unison with the vibration of the armature 20 of the device 19 and will alternately connect with the stop 34 and break this connection, thereby alternately making and breaking the circuit including the primary of the inductorium 36.

It is now supposed that the making of this circuit will induce in the secondary of the inductorium an impulse adapted to drive the armature 41 of the polarized device 39 toward and in contact with the stop 43 of this device; and it is supposed that the breaking of the circuit including the primary of the inductorium 36 will induce in the secondary an impulse adapted to drive the armature 41 of the device 39 in a direction opposite to the former movement, that is, in the direction of the stop 42.

It will, therefore, be seen that the vibratory movements of the armature 32 of the device 29 are reproduced in the vibratory movements of the armature 41 of the device 39.

The circuit including the device 44 and the device itself are so conditioned that it requires a good contact of a predetermined length of time between the armature 41 and the stop 43 of the device 39 to actuate this translating device and it is taken for granted that the vibrations of the armature of 39 are of such short duration, starting from the resting place of stop 42, that this armature either does not touch at all the stop 43 or remains there for a time insufficient to produce the required good contact. The translating device 44 will, therefore, remain unaffected during such vibrations.

The circuit connecting the secondary of the inductorium 36 with the polarized relay 39 is provided with means so as to produce the necessary lag and these means are here

shown as the impedances 40, the value of which should be varied in accordance with requirements.

It is now supposed that the operator at the transmitting station A desires to transmit a message. He depresses his key in the usual manner,—a short time to denote a dot and a long time to denote a dash. The depression of the key of the transmitting station A will disconnect the positive signaling current from the cable and only negative signaling pulses will be transmitted alternating with weak "clearing" pulses. The device 19, therefore, will not be actuated and its armature 20 will come to rest at its zero position and will remain there as long as the key at the transmitting station A remains depressed. The circuit including the electromagnet 29 will, therefore, remain broken for the same length of time and the armature 32 will remain during this time at the stop 34, closing the circuit including the primary of the inductorium. This operation will generate in the secondary a pulse adapted to drive the armature 41 of the device 39 toward and in contact with stop 43 and, as no other pulse will follow, the armature will remain there for a time sufficient to actuate the translating device 44. But as soon as the key of the transmitting station A is opened, the positive signaling currents will be impressed upon the line and the vibration of the armature 20 of device 19 will commence, thereby making inoperative the translating device 44.

It will, therefore, be seen that the length of operation of the device 44 will always coincide with the length of time that the key 12 of transmitting station A is depressed.

When the operator at B desires to transmit messages, he depresses his key in the usual manner. Through the depression of this key, the connection of the cable with the negative signaling current is broken and the armature 20^b of the device 19^b will come to rest at the zero position and will cease its vibrations. The vibrations of the armature 32^b will cease and its effect on the armature 41^b of the device 39^b are the same as the ceasing of the vibrations of the armature 32 and the armature 41 and this time, the translating device 44^b will answer.

When, now, the key at the transmitting station A and the key at the transmitting station B are simultaneously depressed, then the connection of the positive signaling current as well as the connection of the negative signaling current with the cable is broken. Both of the armatures 20 as well as 20^b will cease their vibrations and the effect of the ceasing of the vibrations of both armatures will be that the armatures of 29 and 29^b will come to rest at their respective stops 34 and 34^b and will actuate the armatures 41 and 41^b, in a manner so that both the translating device 44 as well as the translating device 44^b will be actuated and both, therefore, will translate the time of the closing of the keys into readable characters.

In the practical working of my invention, care should be taken that the different circuits in the receiving organism are so conditioned and arranged that the short closing periods of the armatures of the receiving devices inserted in the cable should not be sufficient to actuate the translating device, but that the time unit to make a dot at the transmitting station should suffice to actuate the translating device.

In practice, the impedances 40 may be such value so as to entirely depress the vibrations of the armature 41 of the device 39 as long as the vibrations of the armature 32 of the device 34 follow each other in quick succession.

When for one reason or the other the system is to be out of commission for a comparatively long time, say for hours, and when the transmitting operator has notified the receiving operator to this effect and when the armature 41 is resting against 43, after the notification of the transmitting operator that he has taken off entirely the transmitting organism, then it would only be a waste of current and undesirable that the circuit including the translating device should remain closed; and to obviate this disadvantage, each of the polarized devices 39 as well as 39^b is provided with the shunt circuit 46, 46, as above described.

When the receiving operator desires to drive the armature 41 from the stop 43 toward and in contact with 42, he depresses the key 48 for a short period and it is supposed that the current from 47 will actuate the relay in a manner so as to produce this effect.

The question may be raised if the effects as outlined could not be produced by an arrangement by which the armatures 20 and 20^b of the devices 19 and 19^b are normally in contact with the device 22 and are brought out of contact through the impressed impulses on the cable affecting their respective coils.

No doubt, similar effects, as above outlined, may be produced with such arrangement but it was considered more beneficial in practical work to use the arrangement as illustrated.

It is obvious that the arrangements and circuits may be altered or changed in detail without departing from my invention.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. The method of quadruplexing lines with great capacity, which consists in impressing upon the line true reversals of comparatively high electromotive force to de-

note that no message is transmitted, reducing but not interrupting the positive pulse of said reversals to denote that one message is transmitted, reducing the negative pulse of said reversals to denote that a second message is transmitted, and reducing the electromotive force of both polarities of said reversals to denote that two messages are simultaneously transmitted.

2. In a system of quadruplex telegraphy, a line of transmission, means for each terminal of said line to normally impress thereon reversals, means for one station of each terminal to depress the positive pulses of said reversals, means for the second station of each terminal to depress the negative pulses of said reversals, two receiving devices for each terminal, a local circuit for each device of each terminal, both devices at each terminal alternately making and breaking said local circuit in quick succession through the transmission of said reversals, an electromagnet for each local circuit of said devices, a translating device operatively related to each of said electromagnets and means whereby each of said translating devices is silent as long as its receiving device is operative and means for each of said translating devices to make the same operative as soon as its receiving device becomes silent.

3. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of the line, a source of current for each of said stations, means to normally connect said source of current to said line of transmission, means for each of said stations to reduce but not interrupt the electromotive force of said source of current, and means to connect one or the other of said sources alternately to the line.

4. In quadruplexing lines with distributed capacity, two receiving stations for each terminal of the line, one station of each terminal provided with a receiving device adapted to be actuated by a positive current, the second station of each terminal provided with a receiving device adapted to be actuated by a negative current, an armature for each of said receiving devices, a contacting device in juxtaposition to the armatures of the receiving devices of each station, a local circuit for each of said armatures, a source of current and electromagnet in each local circuit, an armature for each of said electromagnets, a translating device in operative relation to each of said armatures and means to make the translating device operative through the inoperativeness of the armature of its electromagnet and make said translating device inoperative during the time that said armature is operative.

5. In quadruplex telegraphy, a receiving station comprising the following instrumentalities:—a polar relay inserted in the line of transmission, a localized relay operatively related to said line relay and means for said localized relay to generate locally pulses of alternate direction in accordance with the movement of the movable part of the line relay.

6. In quadruplex telegraphy, a line relay for each receiving station, a localized polar relay for each of said line relays, and means for each polar relay operatively related to the line relay to vibrate each of said polar relays in quick succession to denote that no message is received and to cease said vibrations for each polar relay to denote that two messages are received simultaneously.

7. In telegraphy, in combination, a line instrument, an electromagnet adapted to be operated by said line instrument, an electric circuit for said electromagnet, a second electromagnet in operative relation to said electric circuit and retarding means to produce a lag of the flow of the current through said second electromagnet.

8. The method of receiving signals in quadruplex telegraphy, which consists in causing at each receiving station the development of rapidly recurring impulses to denote that no message is received, causing the development of such impluses to cease at one receiving station to denote that a single message is received, and causing a development of such impulses to cease at both stations to denote that two messages are simultaneously received.

9. The method of receiving signals in quadruplex telegraphy, which consists in causing the development at each receiving station of rapidly recurring impulses to denote that no message is received, the impulses for the two stations being of opposite polarity, and causing the development of such impulses to cease at both stations to denote that two messages are simultaneously received.

10. The method of receiving signals in quadruplex telegraphy, which consists in causing the development at each receiving station of rapidly recurring impulses to denote that no message is received, said impulses at the two stations being of opposite polarity, causing the development of such impulses to cease at one station to denote that one message is received, and causing the development of such impulses at both stations to cease to denote that two messages are simultaneously received.

11. As an improvement in the art of transmitting a plurality of signals over a line or cable, the method which consists in normally impressing upon the line or cable impulses of substantially equal strengths alternating in polarity, and simultaneously reducing the impulses of both polarities to lower and substantially equal strengths to simultaneously transmit two signals.

12. As an improvement in the art of simultaneously transmitting a plurality of signals over a line or cable, the method which consists in normally impressing upon the line or cable successive impulses of substantially equal strengths and alternating in polarity, reducing the strength of impulses of one polarity to represent one signal, and reducing the strength of the impulses of the other polarity to represent another signal.

In testimony whereof I affix my signature in presence of two witnesses.

ISIDOR KITSEE.

Witnesses:
EDITH R. STILLEY,
MARY C. SMITH.