

I. KITSEE.

QUADRUPLIX TELEGRAPHY.

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

1,220,238.

Patented Mar. 27, 1917.

2 SHEETS—SHEET 1.

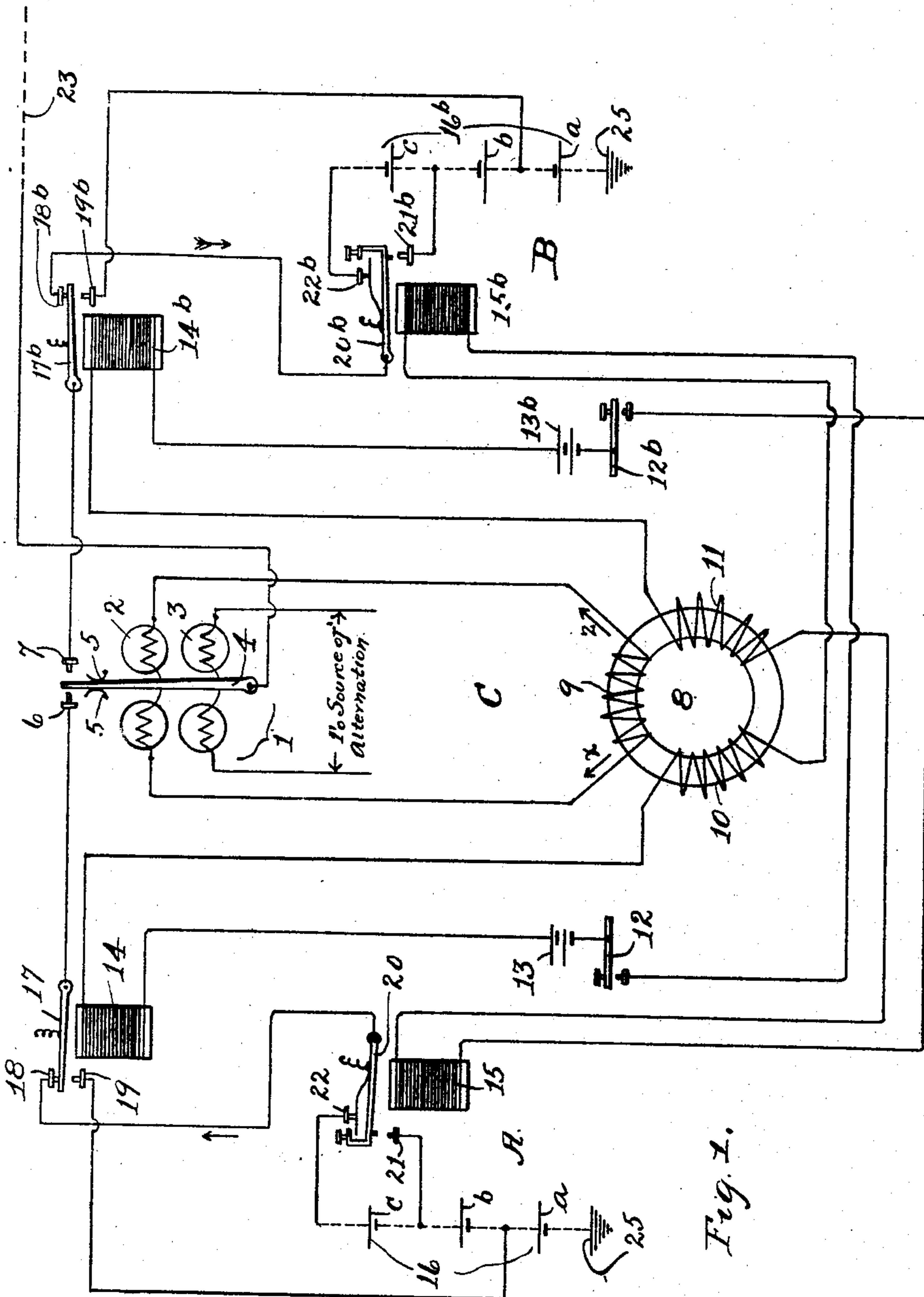


Fig. 1.

Witnesses

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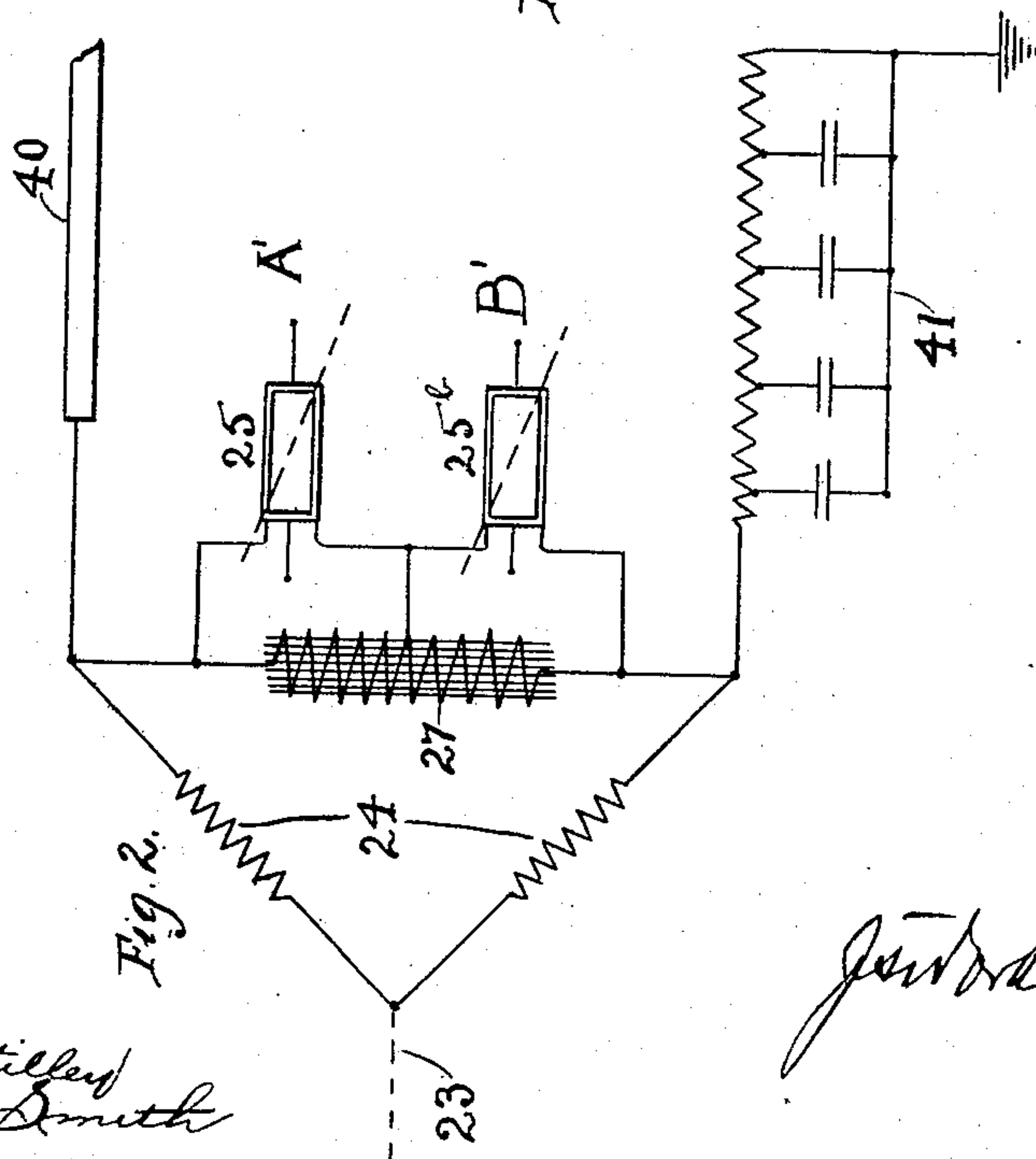
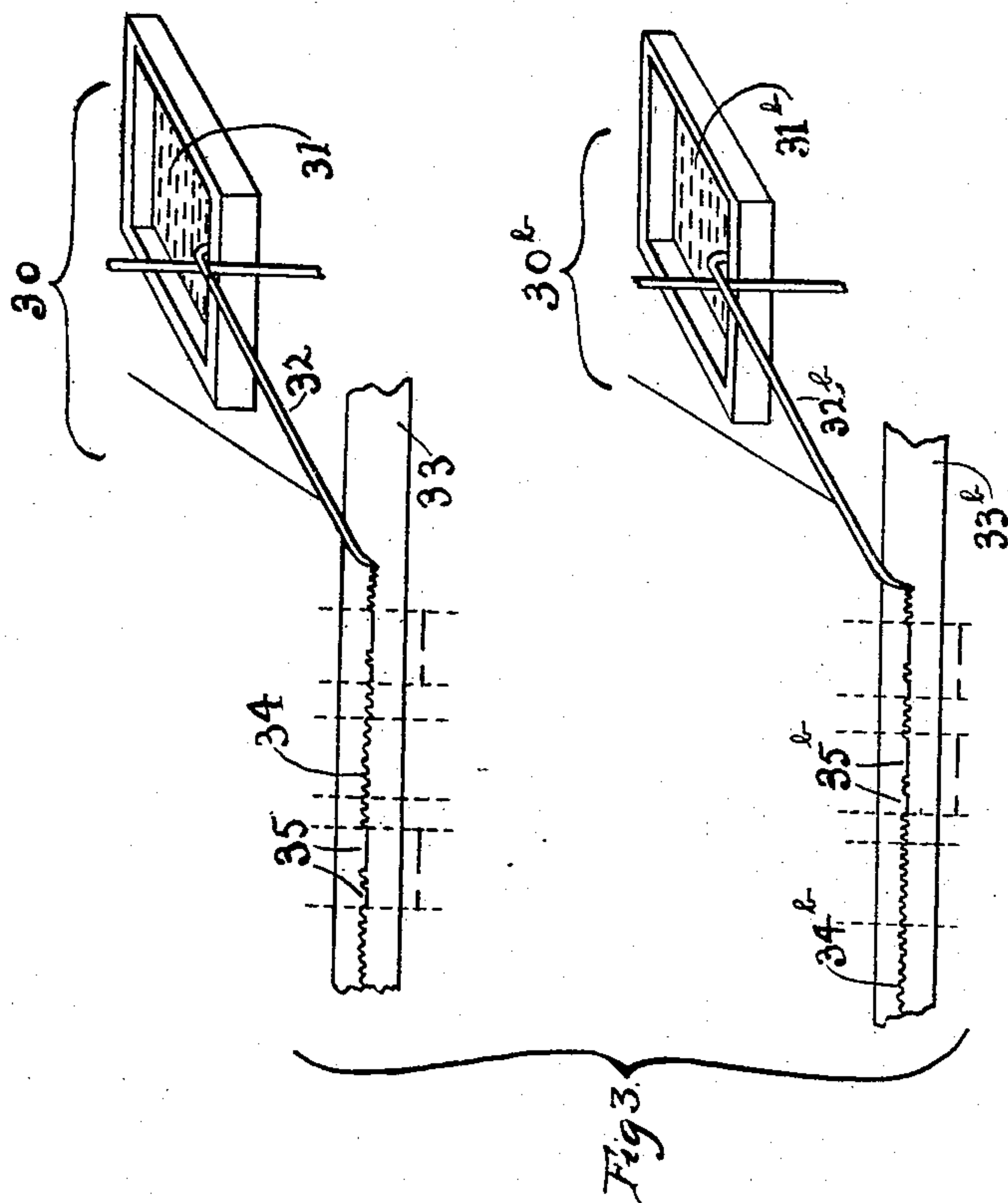
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Inventor



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# UNITED STATES PATENT OFFICE.

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## QUADRUPLEX TELEGRAPHY.

1,220,238.

Specification of Letters Patent.

Patented Mar. 27, 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 Quadruplex Telegraphy, of which the following is a specification.

My invention relates to an improvement in quadruplex telegraphy.

Its great advantage is mostly apparent in quadruplexing lines with large distributed capacity, such for instance as submarine cables, and I will describe my invention here as applied to such cables.

In the accompanying drawing, I have illustrated the transmitting and receiving arrangement of one terminal of a cable, it being understood that the receiving and transmitting arrangement of the second terminal of the cable, not illustrated, is similar to the one illustrated.

In this drawing, Figure 1 is a diagrammatic view of the two transmitting stations of one terminal; Fig. 2 a similar view of the receiving arrangement of said terminal and Fig. 3 a partial diagrammatic and partial plan view of the details of the receiving arrangement.

In Fig. 1; A is one transmitting station; B the second transmitting station and C the intermediate arrangement with the aid of which the required impulses are impressed upon the line or cable.

I will now describe, first, the intermediate arrangement C.

This arrangement comprises here the polarized relay 1, as an entirety, consisting here of the electromagnets 2 and 3 and the armature 4. The armature is biased and held in position between its pole pieces with the aid of springs 5. In juxtaposition to this armature are the connecting stops 6 and 7. 8 is a converter provided with the coils 9, 10 and 11. The coils of the electromagnet 2 are connected to the coil 9 of the converter. The coils of the electromagnet 3 are carried to a source of alternation. This source of alternation may consist of a generator of alternating current, or may consist of a revolving commutator connected to a source of direct current.

The station A comprises here the key 12, source of current 13, electromagnet 14, elec-

tromagnet 15 and transmitting battery 16. The electromagnet 14 is provided with the armature 17 and connecting stops 18 and 19. The electromagnet 15 is provided with the armature 20 and connecting stops 21 and 22. The transmitting battery is here shown as to consist of the three sets designated by the letters *a*, *b* and *c*, respectively.

The station B comprises here the key 12<sup>b</sup>, source of current 13<sup>b</sup>, electromagnet 14<sup>b</sup>, electromagnet 15<sup>b</sup> and source of current 16<sup>b</sup>. The electromagnet 14<sup>b</sup> is provided with the armature 17<sup>b</sup> and the stops 18<sup>b</sup> and 19<sup>b</sup>. The electromagnet 15<sup>b</sup> is provided with the armature 20<sup>b</sup> and the stops 21<sup>b</sup> and 22<sup>b</sup>. The source of current 16<sup>b</sup> is here shown as to consist of the three sets designated by the letters *a*, *b* and *c*, respectively. The circuit of the key 12 of station A embraces the coil of electromagnet 14 of its own station, the coil 10 of the converter and the coil of electromagnet 15<sup>b</sup> of station B. The circuit of the key 12<sup>b</sup> of station B embraces the coil of electromagnet 14<sup>b</sup> of its own station, the coil 11 of the converter and the coil of electromagnet 15 of station A.

I will now describe the operation of the transmitting stations.

Normally, the armature 4 of the polarized relay 1 of the intermediate arrangement C vibrates and connects alternately with the stops 6 and 7. The time units of the vibrations or connections with the alternating stops have to be adjusted so that at the receiving station, the siphons should trace a vibratory line, the curves therein sufficient to be distinct. But as the clearness of transmitting signals depends, to a great extent, on the number of normal vibrations per unit of time, these vibrations shall succeed each other in as quick succession as is compatible with the clear definition of the vibrations at the receiving station.

The armature 4 of relay 1 is supposed to be connected through wire 23 with the line of transmission or rather with the duplexing bridge of said line.

When, in the course of its vibration, the armature 4 connects with stop 6, then a circuit is established between the line of transmission and the source of current 16 comprising the following parts:—Armature 4, stop 6, armature 17 of electromagnet 14, stop 18, armature 20 of electromagnet 15,



stop 22 and positive pole of the source of current 16; and as this source of current is grounded at 25 and the line of transmission is supposedly grounded with its other terminal, it is obvious that through each contacting of the armature 4 of relay 1 with stop 6, a positive pulse is impressed upon the line and will flow over said line in the direction of the unfeathered arrow.

When, in the course of its vibration, the armature 4 connects with stop 7, a circuit is established comprising the following parts:—Armature 4, stop 7, armature 17<sup>b</sup> of electromagnet 14<sup>b</sup>, stop 18<sup>b</sup>, armature 20<sup>b</sup> of electromagnet 15<sup>b</sup>, stop 22<sup>b</sup> and negative pole of source 16<sup>b</sup> grounded at 25; and it is obvious that through the contacting of the armature 4 with stop 7, a negative impulse is impressed upon the line and will flow over the same in the direction of the feathered arrow.

When both keys are open and no message is transmitted, the alternations will succeed each other in like succession and it is taken for granted that, as is illustrated, at this state, the whole force of the transmitting batteries 16 and 16<sup>b</sup>, that is, all three sections of each of these sources are available for the purpose of transmitting impulses over the cable; and it is also taken for granted that—at the rapid alternations—this whole force is just sufficient to cause, at the receiving station, vibratory lines of required dimensions.

When the operator at station A desires to transmit messages and when these messages should be transmitted by manual labor and not automatically, the operator depresses his key in the same manner as he depresses his key in usual telegraphy to produce dots and dashes at the far-off receiving station—a short time to denote a dot and a longer time to denote a dash.

Through the depression of this key, the following electrical conditions will arise:—

First:—The electromagnet 14 will be energized; its armature 17, therefore, will be drawn from the contact 18 toward and in contact with the stop 19. The connection of the line of transmission with the whole force of the battery 16 will, therefore, be broken and the connection of this line will be made with only one section of this source; and as it is taken for granted that this source is divided into three equal sections, it is obvious that only one third of the former force is connected now to the line or cable.

Second:—As a current will flow through the coil 10, an impulse will be generated in coil 9 opposite to the flow of the prime impulse. It is taken for granted that this impulse generated in coil 9 is stronger than any of the impulses of the source of alternation and that this impulse has the tendency to drive the armature 4 of the relay 1 toward

and in connection with contact 7 irrespective of the impulse from the source of alternation.

The closing of key of station A will, therefore, result in impressing upon the line a negative pulse or a pulse from the source of current of station B.

Third:—The electromagnet 15<sup>b</sup> being included in the circuit of key 12 will also be energized and the armature will be drawn away from contact 22<sup>b</sup> and toward and in contact with 21<sup>b</sup>, thereby breaking the connection with the whole force of its source of current and making the connection with only two thirds of its force.

At the receiving station, the resultant effect of this change at the transmitting station will be as follows:—

The receiving device related to station A will cease to trace a vibratory line and will trace instead a straight line, for the reason that one third of the whole force of the transmitting battery 16 is not sufficient to actuate the coil of the receiving device for the purpose of tracing the curves or vibrations.

The receiving device related to station B will only receive impulses of an intensity equal to two thirds of the former impulses, but as the opposing impulses of station A were reduced to a far lower degree, the reduced impulses of station B will yet suffice to produce at the receiving station related to station B the usual curves or vibrations.

As the impulse induced in coil 9 of the converter is only of momentary duration, it is obvious that after a short contacting of the armature 4 with the contact 7, the usual vibrations of the armature will again be resumed, but instead of "true reversals" of the whole force of positive and negative transmitting batteries, reversals will be transmitted consisting of positive pulses of one third of the former value and negative pulses of two thirds of the normal value; the positive pulses not being able to produce vibratory movement in its receiving device, but the negative pulses will still be able to produce these movements in the receiving devices related to it.

As long as the key 12 remains depressed, the electromagnet 14 of station A and electromagnet 15<sup>b</sup> of station B remain energized and the unequal reversals will flow over the line. When now the key 12 is opened, the ceasing of the flow of the current through coil 10 of the converter 8 will induce an impulse in the coil 9 of a direction opposite to the former induced impulse and the armature 4 will connect with contact 6 independent of the alternations flowing through electromagnet 3, thereby impressing upon the line a positive pulse of full value, resulting at the receiving end in a curving of the record-line and thus sharply define the end-



ing of the signal. At the same time, the deenergizing of the electromagnet 14 will allow its armature 17 to again connect with stop 18 and the deenergizing of the electromagnet 15<sup>b</sup> will allow the armature 20<sup>b</sup> to again connect with 22<sup>b</sup>, thereby establishing the regular sequence of pulses of the whole force of the transmitting battery.

When the operator at station B depresses his key 12<sup>b</sup>, the following electrical conditions take place:—

First:—The commencing of the flow of the current through coil 11 of the converter 8 will induce an impulse in the coil 9 adapted to throw the armature 4 in contact with stop 6 independent of the source of alternation and the direction of its flow at that particular moment.

Second:—The energizing of the coil 14<sup>b</sup> will result therein that its armature is thrown out of contact with 18<sup>b</sup> and in contact with 19<sup>b</sup>, thereby disconnecting the whole force of the transmitting battery 16<sup>b</sup> and connecting only one section thereof with the contact 7.

Third:—At the same time, the energizing of electromagnet 15 of station A will result therein that the available portion of the transmitting battery of said station will be reduced one third.

We will, therefore, have as a result of the closing of the key 12<sup>b</sup>, a momentary flow of current from the whole force of station A and then a regular alternation between one third of the transmitting force of station B and two thirds of the transmitting force of station A.

At the receiving station, the receiving device related to station B will cease to record vibrations and will record a straight line; and at the receiving station related to station A the siphon will still be able to record the usual vibratory movements.

It is now supposed that both the operators at stations A and B depress simultaneously their respective keys.

The depression of key 12 will result in an induced impulse in coil 9, say in the direction of the arrow X, and the depression of key 12<sup>b</sup> will result in an induced impulse in coil 9, say in the direction of the arrow Z. These impulses will, therefore, neutralize each other and the armature 4 will continue its regular vibrations. But at the station A, the transmitting force will be reduced to one third of the normal force and at station B, the transmitting force will also be reduced to one third of the normal force and the resultant effect at the receiving stations will be that both the receiving device related to station A as well as the receiving device related to station B will trace straight lines, because one third of the transmitting force is not sufficient to actuate—at the speed of the reversals—the receiving devices sufficient for

the purpose of tracing curves or vibratory lines.

Before describing the arrangement and operation of the devices at the receiving stations, I find it necessary to explain some details of the receiving arrangement and the reason therefor.

First:—The relay 1 is provided with two pairs of electromagnets. As I have found that if a common core is used for both coils,—the one going to the source of alternation and the other going to the coil of the converter, the two coils react very unfavorably upon each other and these means, that is, the double core-pair have to be provided so as to eliminate this disadvantage.

Second:—It often occurs in practice that at the moment of the closing of the key, say of station A, the armature of relay 1 is driven in connection with contact 6, thereby transmitting the whole force of the battery 16 over the line. This would result in a curve at the receiving station, and in practical working, it was found that—especially on lines with great capacity,—such impulse is detrimental to the good working of the system, as it shortens the recording of the signal at the receiving station very considerably. For this reason, I have provided means whereby through the closing of the key, the armature is at once driven in connection with the opposite stop, that is, stop 7, thereby transmitting the whole force of the opposing battery and these means are here shown as the coil of the converter 8 and the electromagnets 2.

Third:—When for instance the key of station A is depressed, the electromotive force of the transmitting battery of the station B is reduced to one third. But I have found that it is best to have this battery in full force for the first impulse, for the purpose of “clearing” the line and I have, therefore, provided the armatures of electromagnets 15 and 15<sup>b</sup> with means so as to prolong the contact of the whole battery force for a short period during the time that these armatures are traveling toward the stops 21 or 21<sup>b</sup>, respectively. A relay provided with such an armature is usually called a “dash” relay and the difference between my arrangement and the usual arrangement of dash relays is such that in the dash relay the making of the contact is prolonged, whereas, here the normal contacting itself before the breaking is prolonged.

Fourth:—In cable telegraphy, the electromotive force of the transmitting battery is limited. Usually, sixty volts are considered the limit. In my system, as illustrated, I take it for granted that each of the sections *a*, *b* and *c* comprises a battery of twenty volts.

In practice, I have found that “true reversals”, that is, pulses of alternate polarity



but of equal duration and intensity can be transmitted at a far higher speed (about three to one) than pulses designating messages or signals, for the reason that in messages, often a series of pulses of one polarity have to follow, each other.

I have also found that if the impulse of one polarity is reduced far below the normal limit, the impulse of opposite polarity will still be able to affect its own receiving devices in a manner so as to record a curve even if reduced to an extent at which no curve would be recorded if both polarities would have been reduced to the same extent. In other words, when of a normal transmitting current of sixty volts, the positive pulse of the reversals is reduced to twenty volts and the negative pulse only to forty volts, the negative pulse will still be able to record curves at the receiving station, whereas, if both pulses would be forty volts, hardly any curve would be recorded. This behavior is peculiar to lines with great capacity. On such lines, the influence of the pulses of high electromotive force is—to a certain degree—accumulative, so to speak, if not interrupted by impulses of like intensity. For this reason, to produce signals or straight lines, say at the receiving station of A, the transmitting force of A is reduced two thirds, whereas at the same time the transmitting force of B is only reduced one third.

In this connection, I will state, experience has demonstrated that with low pulses of one polarity, the normal force of the opposite battery is too high and should be reduced and the more equal the pulses of both polarities can be made compatible with the practical working of one side of the receiving organism, the better it is for practical purposes.

It is obvious that the number of the normal volts must differ to suit requirements and it is also obvious that the division of the whole force is arbitrary, as this division has also to suit requirements.

I will now describe the receiving arrangement and function of same, as illustrated in Figs. 2 and 3.

In Fig. 2; 23 is the continuation of the circuit 23 as illustrated in Fig. 1. 24 is the duplexing bridge. The arrangement of this bridge may differ to suit requirements and as for the purpose of my invention, it is immaterial what kind of an arrangement is adopted for this bridge as long as the same is efficient, it is not necessary for me to go into detail of such arrangement.

In the drawing, the two receiving devices 25 and 25<sup>b</sup> are connected to the cross wire of the bridge in shunt with the inductive resistance 27, but it is obvious that other arrangements, if so preferred, may be substituted therefor.

In the drawing, the two receiving devices 25 and 25<sup>b</sup> are illustrated in conventional sign and are supposed to represent two of the well known types of siphon recorders with this exception that each of the siphon recorders should only answer to an impulse of one polarity and it is supposed that the siphon recorder 25 relates to the transmitting station A and should, therefore, answer only to a positive pulse and the siphon recorder 25<sup>b</sup> relates to the transmitting station B and should, therefore, answer only to a negative pulse. I, therefore, designate the siphon recorder 25 also by the letter A' and the siphon recorder 25<sup>b</sup> by the letter B'.

In this drawing, I have designated the cable by the numeral 40 and the artificial line by the numeral 41.

I am well aware that recorders, or in fact receiving devices of other types may be employed, but as it is my desire to enable companies using my invention to employ as much as possible existing devices and as the siphon recorder of today answers to a positive and negative pulse, it is necessary to change the recorder so as to adopt the same for my purpose.

It is well known that the siphon recorder of today is generally provided with two suspension fibers connecting the movable coil with the cradle, one of these fibers compelling the cradle and, therefore, the siphon attached thereto to follow the movements of the coil to the right, the other of the fibers compelling the cradle and, therefore, the siphon attached thereto to follow the movements of the coil to the left. If, now, one of the fibers is cut, then the siphon is only capable of following the movement of the coil in one direction.

To prepare, therefore, two siphon recorders for my special purpose, it is only necessary to cut one fiber of each instrument in a manner so that the recorder of one instrument should only be able to follow the movements of the coil through a positive pulse and the recorder of the second instrument should only be able to follow the movements of the coil through a negative pulse; and as it is preferred that both recorders should record the vibrations above an imaginary zero line, the two coils of the two instruments should be connected in opposition as to each other so that if a positive pulse arrives, one siphon is deflected and marks the incoming pulse by a slight curve above the imaginary zero line and when a negative pulse arrives, the other siphon is deflected and marks the incoming pulse by a slight curve also above the zero line.

In Fig. 3, in which I have only illustrated the ink-well, the siphon proper with part of its suspension fiber, part of the recording slip and recorded lines thereon, 30 is the arrangement as an entirety supposed to be



part of the device 25 and 30<sup>b</sup> the arrangement as an entirely supposed to be part of the device 25<sup>b</sup>.

The arrangement 30 comprises here the ink-well 31, the siphon 32, the paper 33, the recorded vibratory lines 34 and the recorded signals 35. The arrangement 30<sup>b</sup> comprises here the ink-well 31<sup>b</sup>, the siphon 32<sup>b</sup>, the paper 33<sup>b</sup>, the recorded vibratory lines 34<sup>b</sup> and the recorded signals 35<sup>b</sup>.

Normally, that is, when no signals are transmitted from any of the far-off transmitting stations, both of the receiving devices 25 and 25<sup>b</sup> will trace vibratory lines on the paper.

When the operator at the transmitting station A closes his key and thereby reduces the force of his battery, the receiving device 25 will cease to be actuated sufficiently so as to trace the vibratory line and the siphon will record a practically straight line coinciding in time unit with the time unit the key at its transmitting station is closed. As soon as this key is opened and the whole force of the battery is again impressed upon the line, the pulses will be sufficient to actuate the receiving device 25 strong enough so as to change the straight line into a vibratory one.

When the operator at the transmitting station B operates his key, the closing and opening have the same effect on the receiving device 25<sup>b</sup> as the closing and opening of the key of station A had on the receiving device 25, and when both keys are closed simultaneously and the transmitting force of both batteries is simultaneously reduced, then the siphons of both receiving devices will cease to record vibratory lines and will record straight lines and the time-unit of these straight lines will also coincide with the time-unit that both keys are closed.

It is believed that with the above explanations, the explanation referring to the transmitting organism and the explanation referring to the receiving organism, persons versed in the art will be sufficiently informed so as to practise this, my invention, which, as it stands today, has proven satisfactory on lines with large capacity.

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

1. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of said line and an intermediate organism operatively related to both of said stations, said intermediate organism adapted to impress upon the line reversals of equal intensity and duration, each of said transmitting stations provided with means to change the sequence of said reversals independent of the means normally controlling said organism.

2. In quadruplex telegraphy, a line of

transmission, two transmitting stations for each terminal of said line and an intermediate organism operatively related to both of said stations, a source of alternation at each terminal, said intermediate organism comprising a converting device and a polarized relay, two pairs of electromagnets for said relay, one pair of said electromagnets connected to said source of alternation, the second pair of said electromagnets connected to a converting device.

3. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of said line and an intermediate organism operatively related to both of said stations, a source of alternation at each terminal, said intermediate organism comprising a polarized relay and a converter, said converter provided with three coils, one of said coils in operative relation to said relay, one of said coils in operative relation to the transmitting means of one station and one of said coils operatively related to the transmitting means of the second station.

4. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of said line, each transmitting station comprising a source of current, transmitting means and means operatively related to said transmitting means to connect the whole force of said battery, more than half of said force or less than half of said force, to said line of transmission.

5. In quadruplex telegraphy, a line of transmission and two stations for each terminal of said line, each of said stations comprising a transmitting battery, transmitting means, an electric circuit for said transmitting means and two electromagnets in said electric circuit, one of said electromagnets adapted to reduce the transmitting force of the transmitting battery of its own station and the second of said electromagnets adapted to reduce the transmitting force of the transmitting battery of the second station.

6. In quadruplex telegraphy, a line of transmission, two transmitting and two receiving stations for each terminal of said line, means at each terminal and operatively related to both transmitting stations of said terminal to normally transmit true reversals and means at each receiving station of each terminal to normally record a vibratory line; means at each transmitting station of each terminal to reduce the intensity of one half of the reversals impressed upon the line to denote a signal and means at each receiving station of each terminal to record a straight line to denote the desired signal.

7. In quadruplex telegraphy, two transmitting stations and one intermediate organism for each terminal of the line, the intermediate organism provided with means to connect the transmitting batteries of the two stations alternately to the line, transmitting



means for each station, each of said transmitting means adapted to vary the transmitting force of its own battery to one intensity and to vary simultaneously the transmitting force of the battery of the second station to another intensity.

8. In quadruplex telegraphy, means to normally impress upon the line reversals of a predetermined electromotive force, two transmitting stations, transmitting means for each station and means adapted to be operated conjointly by both of said transmitting means to reduce simultaneously the electromotive force of both halves of said reversals to a new and low level.

9. In quadruplex telegraphy, means to normally impress upon the line reversals of a predetermined electromotive force, two transmitting stations, transmitting means for each station, the transmitting means of one station adapted to reduce simultaneously the electromotive force of the transmitting battery of the other station to one level and the transmitting battery of its own station to a second and lower level.

10. In quadruplex telegraphy, two transmitting stations for each terminal of the line, each transmitting station provided with means to impress upon the line normally and automatically an impulse of a predetermined polarity and predetermined electromotive force, each of said transmitting stations provided with transmitting means and two electromagnets, one of said electromagnets adapted to reduce the transmitting force of its own battery and the second of said electromagnets adapted to reduce the electromotive force of the transmitting battery of the other station.

11. In quadruplex telegraphy, the improvement, which consists in transmitting from one terminal reversals of like character to denote that no message is transmitted, in transmitting reversals of reduced intensity but unlike character to denote that one message is transmitted and in transmitting reversals of reduced intensity but like character to denote that two messages are transmitted simultaneously.

12. In quadruplex telegraphy, the method of transmitting telegraphic signals, which consists in first normally impressing on the line a cycle of given intensity, reducing one half of the cycles normally transmitted to a comparatively low intensity and reducing at the same time the other half of said cycles to an intensity lower than the normal but higher than the opposite half.

13. The method of diplexing lines of transmission, which consists in normally impressing upon the line or cable successive impulses alternating in polarity, causing a

pair of receiving devices to selectively respond, each to one of said polarities, varying the strength of impulses of one of said polarities to indicate a single signal, and depressing simultaneously the impulses of both polarities to indicate two simultaneous signals.

14. 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 the impulses of one polarity and reducing the strength of the impulses to the other polarity to a different degree when a signal is transmitted.

15. 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, modifying said impulses for each of independent signals transmitted into a succession of impulses alternating in polarity and of different strengths, producing from the normally impressed energy independent vibratory lines when no signal is transmitted, selectively producing a vibratory line from the modified energy whose impulses of one polarity are of the greater strength, and selectively producing a substantially straight line from the modified energy corresponding with the impulses of other polarity and lesser strength.

16. In a telegraph system, the combination with a line or cable, of means for normally impressing thereon impulses of substantially equal strengths and alternating in polarity, a transmitter for modifying said energy into successive impulses alternating in polarity and of different strengths to represent one message, a second transmitter for modifying said energy into successive impulses alternating in polarity and of different strengths for representing a second message, the impulses of lesser strength produced by said second transmitter corresponding in polarity with the impulses of greater strength produced by the first transmitter, a receiver for each transmitter, one receiver responding to impulses of one polarity, and the other receiver responding to impulses of opposite polarity.

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

ISIDOR KITSEE.

Witnesses:

EDITH R. STILLEY,  
MARY C. SMITH.