I. KITSEE.

QUADRUPLEX TELEGRAPHY.

APPLICATION FILED JUNE 3, 1912.

1,218,274.

Patented Mar. 6, 1917.

2 SHEETS—SHEET 1.

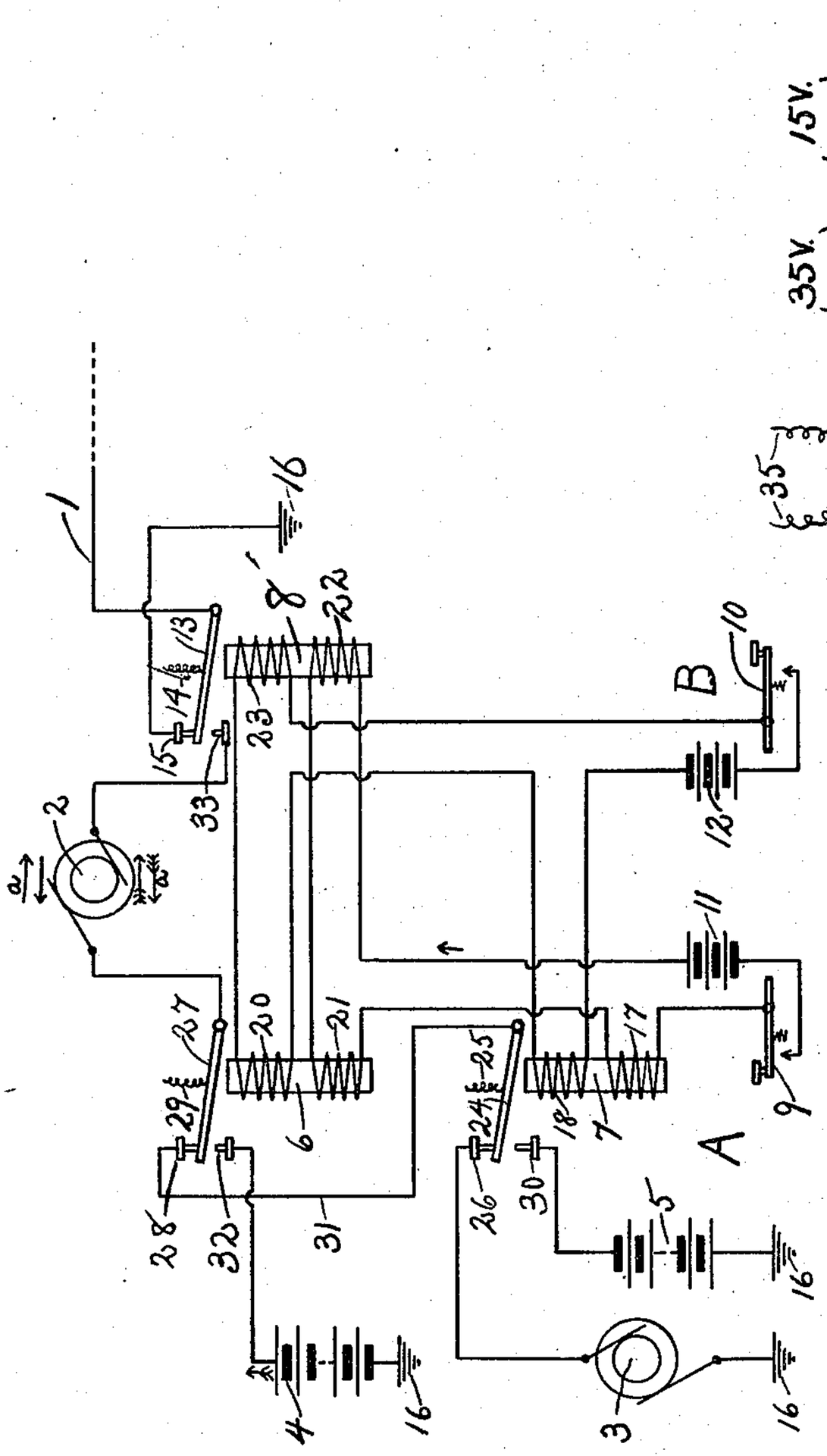

Fig. 1

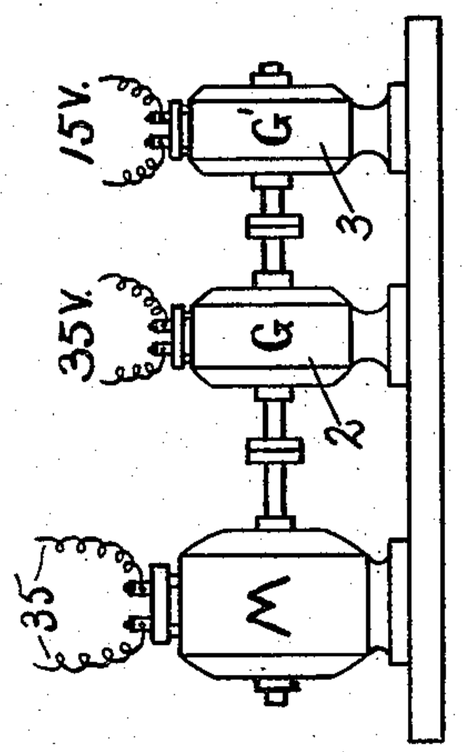

Fig. 2

Witnesses
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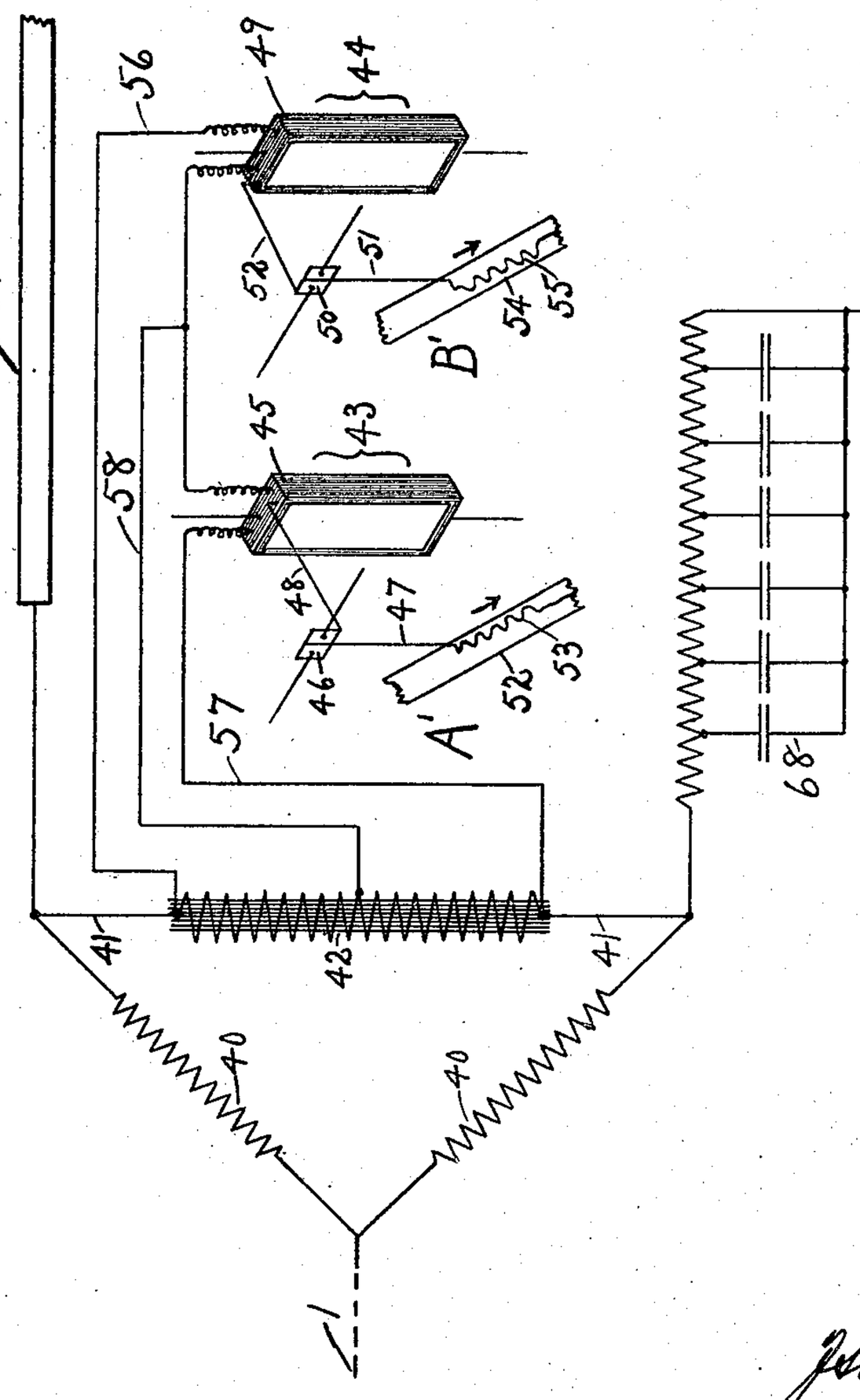

Fig. 3

Witnesses
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UNITED STATES PATENT OFFICE.

ISIDOR KITSEE, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

QUADRUPLEX TELEGRAPHY.

1,218,274. Specification of Letters Patent. **Patented Mar. 6, 1917.**

Application filed June 3, 1912. Serial No. 701,293.

To all whom it may concern:

Be it known that I, ISIDOR KITSEE, a 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 and has more special reference to quadruplexing lines with great capacity, such for instance as submarine cables.

To quadruplex land lines, it is only necessary, first, to increase the energy of the transmitting station and to change the polarity of the current. Such procedure was found entirely impractical in the working of lines with great capacity, such as submarine cables. The reason therefor is well understood by persons versed in the art and the peculiarity of the cable prevents the working with one polarity if no "clearing" current of opposite polarity is transmitted between the different signals.

In my invention, I have taken care of this peculiarity and have, in fact, so arranged the different parts forming my invention—transmitting as well as receiving means—so as to conform with all peculiarities of such lines.

In cable telegraphy of today, the so-called siphon recorder is most generally made use of. The moving coil of this device is deflected to the right or left in accordance with the polarity of the impulse arrived and, in its deflection, moves a recording siphon to the right or left coinciding with its own movement. The movement and, therefore, the recording of the siphon in one direction is then translated as one character, say a dot, and the movement of the siphon in the opposite direction is then translated as a second character, say a dash.

In my system, the siphon recorder of today may be employed or may be replaced with a device capable of operating a local circuit (making or breaking the same), but I will describe my invention here as employing the siphon recorder of today.

In this instrument, the cradle carrying the siphon is connected with the coil through two fibers, one fiber compelling the cradle to move with the coil in one direction and the other fiber compelling the cradle to move with the coil in the opposite direction.

For the purpose of my invention, it is necessary that the means adapted to translate the message of one coil should only be able to move in one direction and the means to translate the message of the second coil only be able to move in the opposite direction and, for this reason, the arrangement of the coils has to be changed in certain respects, so as to attain this requirement. Different means may be employed; so for instance may the coil be provided with stops allowing the same only to move in one direction, but I have found that the rebound of the coil, if pressed too hard on the stop through the incoming impulse, greatly interferes with the good working of the system and I, therefore, have recourse to the simple expedient of cutting one connection between the cradle and coil, thereby allowing the cradle to be only moved in one direction through the movement of the coil.

As for quadruplex telegraphy, two receiving instruments are required for each terminal of the line, the connection between the cradle and the coil of one instrument is such that the cradle and, therefore, the siphon attached thereto will only follow the movements of the coil, say to the right, and the cradle and the siphon attached thereto of the second coil will only follow the movements of this coil to the left.

One coil will, therefore, translate the message of one polarity and the second coil only the message if sent in opposite polarity.

For the purpose of illustrating one form my invention may take, I have reference to the accompanying drawing.

In this drawing: Figure 1 is a diagrammatic view of my preferred transmitting arrangement; Fig. 2 a partially diagrammatic and partially plan view of a motor generator used in my invention; Fig. 3 a diagrammatic view of the receiving organism or arrangement at one terminal of the line or cable.

In the drawing, I have only illustrated the transmitting as well as receiving arrangement at one end or terminal of the cable, it being understood that the transmitting and receiving arrangement at the other end or terminal of the cable is only a duplicate of the arrangement as illustrated.

In Fig. 1: 1 is the conductor adapted to be connected to the bridge circuit of the cable. 2 and 3 are two generators of alternating current. 4 and 5 are two sources of direct current. 6 and 7 are two polarized electromagnets. 8 is an electromagnet which may be neutral or unpolarized. The electromagnet or, as I may call it, relay 6 is provided with the coils 20 and 21. The electromagnet or relay 7 is provided with the coils 17 and 18. The electromagnet 8 is provided with the coils 22 and 23. 9 and 10 are the transmitting means, here shown in the form of keys, adapted to be manually operated, but it is obvious that these keys may be replaced by any of the well known automatic means for transmitting pulses. 11 and 12 are two batteries adapted to be operated here through the keys 9 and 10. The conductor 1, which is adapted to be connected to the bridge circuit, is here shown as to be connected with the other terminal to the armature 13 of the electromagnet 8 and this armature is held normally by the spring 14 against the stop 15 connecting with the ground 16. Through this arrangement, the bridge and, therefore, the cable are normally grounded and disconnected from all other parts of the transmitting organism or arrangement.

A is the transmitting arrangement of one operator, as an entirety, and B the transmitting arrangement of the second operator, as an entirety. The transmitting arrangement of A comprises here the key 9, the battery 11 and the polarized electromagnet or relay 7 and of the two coils with which this relay is provided, the coil 17 pertains to the circuit of its own operator or operator A and this coil is here connected with the coil 21 of the electromagnet or relay 6 pertaining to the other operator and also with the coil 22 of the neutral electromagnet 8. The relay 7 is provided with the armature 24 held normally, here shown by the spring 25, against the stop 26. This stop is connected with one terminal of the source of alternation 3, the other terminal of which is connected to the ground 16. The lower stop 30 of the armature 24 is here shown as to be connected to the direct source of current 5 grounded with the opposite pole at 16.

The station B comprises here the key 10, the source of current 12, the polarized electromagnet or relay 6, and a circuit through battery 12, the coil 18 of the relay 7 of station A, the coil 20 of relay 6 of station B and the coil 23 of the neutral relay 8. The relay 6 is provided with the armature 27. This armature rests normally against the stop 28 by means, here shown as the spring 29. The stop 28 connects through wire 31 with the armature 24 of the electromagnet of station A. The lower stop 32 of armature 27 connects with one pole to the source of direct current 4, the other pole of said source being connected to the ground 16. The source of alternation 2 connects with one terminal to the lower stop 33 of the neutral electromagnet 8 and the other terminal with the armature 27 of electromagnet 6.

In practising my invention, I have found that it is necessary to adjust the voltages impressed on the cable for the purpose of signaling, so that the same may not be too high for the safety of the cable and yet sufficiently high for the purpose of allowing the required speed.

In most of the transatlantic cables, the electromotive force with which they are worked today is about fifty volts and I have taken this voltage as adapted to be applied to my system, it being understood that as conditions require, higher or lower voltages may be substituted.

In Fig. 2, M is the motor adapted to be connected through the terminals 35 to a suitable source of current. G is a generator of alternating current adapted to generate pulses of the required electromotive force, here shown as generating thirty five v. or volts. G′ is a generator of alternating current adapted to generate pulses of lower electromotive force, here shown as fifteen v. or volts; and I have designated, for better understanding, the generator G by the numeral 2 and the generator G′ by the numeral 3, so that at a glance, it is easily ascertained which position one or the other of these generators will take if placed in the transmitting circuit.

For better understanding of the operations of the arrangement as illustrated, it is required to state that the electromagnets 6 and 7, are, by preference, polarized in opposite directions, that is, a current of one polarity which would operate the electromagnet 6 should not operate electromagnet 7 and vice versa; and has also to be taken into consideration that the coils of electromagnet 6 are wound in a manner so that if the current from its own battery traverses the same, then the armature is drawn downward; and the second coil is wound in a direction so that if the current from the other station is flowing through it, the armature is not drawn downward but remains at its normal stopping point and if current flows through both coils at one and the same time, then their effect is neutralized and the armature will again remain at rest. In other words, each of the electromagnets 6 and 7 requires the current of its own battery to

energize the same in the proper direction, so as to draw the armature downward; and if both coils of each of these electromagnets are energized at one and the same time, their added effect is *nil* as far as the energizing of the core is concerned. It has also to be taken into consideration that the electromagnet 8 (being neutral or unpolarized) will be properly energized, no matter if coil 22 or coil 23, or both coils, are made active.

I will now describe the method of operating the different transmitting stations.

When station A desires to transmit messages, the operator manipulates the key in the same manner as is at present the case on land telegraphy, that is, he depresses the key for a short period to denote a dot and for a longer period to denote a dash. Through the depression of the key, the following changes take place in the arrangement as illustrated. The circuit of the battery 11 is now closed. Through the closing of this circuit, the current will flow from this battery in the direction of the short unfeathered arrow through coil 22 of the neutral relay 8, through coil 21 of the polarized relay 6 of the station B, through coil 17 of the polarized relay 7 of its own station.

The effect of this flow will be as follows:—

The core of the neutral relay 8 will be energized in the proper direction and the armature of this electromagnet will be drawn downward and in contact with the stop 33, thereby breaking the direct connection of the cable with the ground and connecting said cable with one terminal of the source of alternation 2. The core of the polarized relay 6 will be energized in the wrong direction and the armature will remain at its stopping point. The core of the polarized electromagnet 7 will be energized in the right direction and the armature 24 will be drawn away from its normal stopping point and in contact with the lower point 30 connecting with the source of direct current 5 grounded at 16. A circuit, therefore, will be established from the cable through 1, armature 13, stop 33, the source of alternation 2, armature 27 of polar relay 6, stop 28, conductor 31, armature 24 of polar relay 7, stop 30, source of direct current 5 and ground 16.

As stated above, it is my aim to use a transmitting energy of the usual voltage. The alternator, therefore, has a voltage of thirty-five and the source of direct current 5 should have a voltage of fifteen, but as, in practice, secondaries will be employed and the voltage of each secondary is two, then the source 5 should consist of eight secondaries giving sixteen volts.

As shown in the drawing, the source 5 is connected with the negative pole to the stop 30 and, therefore, when the key of A is closed, the negative pole will be connected with the interposition of the alternator 2 to the cable proper.

As the alternator will revolve at the required speed, it is obvious that when a pulse will be generated in this alternator flowing in the direction of the long unfeathered arrow, then this pulse will be augmented by the force of the battery 5 and when the alternator will develop a pulse flowing in the direction of the long unfeathered arrow *a*, then the force of the current from 5 will oppose this pulse.

During the period that the key is closed, we will, therefore, have the following pulses flowing over the line:—

First:—Pulses of a direction flowing as the current from 5 flows, adding their force to the force of the current from 5, which will give thirty-five volts plus sixteen volts, equal to fifty-one volts.

Second:—Pulses flowing in a direction opposite to the direction of the flow of the current from 5 and, therefore, having its force reduced by the force of the current from 5, which will give thirty-five volts minus sixteen volts, equal to nineteen volts.

As long, therefore, as the key 9 of station A is depressed, unbalanced alternations will flow over the line. The minus sign of these alternations will have a force equal to about fifty-one volts and the plus sign of these alternations will have a force equal to about nineteen volts.

It is taken for granted that the force of fifty-one volts of the minus sign will be able to move at the receiving station the proper coil at a proper distance, but the pulse of nineteen volts of the plus sign will not be able to move the second coil the required distance, but will only be able to clear the line from the effect of the former negative pulse of higher voltage. Therefore, as long as the key at A is depressed, negative pulses of high electromotive force, alternating with positive pulses of low electromotive force will be transmitted over the line; the minus pulses of high electromotive force of sufficient strength to actuate the receiving means adapted to respond to the minus pulses, but the electromotive force of the plus sign insufficient to move the means adapted to respond to such pulses.

When station B desires to transmit messages, then the operator manipulates his key in the usual manner,—closing the key for a short time to denote a dot and for a longer time to denote a dash.

Through the operation of this key, the following changes will take place in the arrangement as illustrated. The closing of this key closes the circuit including the battery 12. A current will, therefore, flow through the coil 18 of the polar relay 7 of station A, energizing this core in the wrong

direction, and the armature of this polar relay will remain at rest at its upper stop. A current will also flow through coil 20 of the polar relay 6 of station B, energizing the core in the proper direction and the armature 27 will be drawn away from the stop 28 and in contact with the lower stop 32, thereby connecting one terminal of the alternator 2 with the source of direct current 4 grounded at 16. The current will also flow through coil 23 of the neutral relay 8, energizing the core in the proper direction and drawing the armature 13 toward and in contact with the lower stop 33, thereby disconnecting the direct connection of the cable with the ground and connecting the cable with one terminal of the alternator 2. We will, therefore, have—as long as this key remains depressed, a connection of the cable through 1 with armature 13, lower stop 33, one terminal of the alternator 2, the opposite terminal thereof connected to armature 27 of polar relay 6, lower stop 32, source of direct current 4 and ground 16. Through these connections, the pulses from the alternator 2 will flow over the line in the following manner:—

When a positive pulse is developed in the alternator flowing in the direction of the long feathered arrow, then this pulse will be augmented by the force from the direct current 4, for the reason that this source of direct current is connected with the positive pole to the source of alternation 2 and with the negative pole to the ground and its current will flow in the direction of the short feathered arrow, that is, in the same direction as the pulse from the alternator flowed; but when a negative pulse is developed in the alternator 2 flowing in the direction of the long feathered arrow *a*, its force will be reduced by the force of the current from 4, because this current will flow in a direction opposite to the direction of the pulse developed in this alternator.

The electromotive force of the source of direct current 4 should be equal to the elecmotove force of the source of direct current 5, that is, if secondaries are employed, the source 4 shall consist of eight cells equal to sixteen volts.

During the period that the key at station B is closed, we will, therefore, have the following pulses flowing over the line:—

First:—Pulses of a direction flowing as the current from source 4 flows, adding their force to the force of the current from source 4, which will give thiry-five volts plus sixteen volts equal to fifty-one volts.

Second:—Pulses flowing in a direction opposite to the direction of the flow of the current from 4 and, therefore, having their force reduced by the force of the current from 4, which will give thirty-five volts minus sixteen volts, equal to nineteen volts.

As long, therefore, as the key 10 of station B is depressed, unbalanced alternations will flow over the line. The plus sign of these alternations will have a force equal to about fifty-one volts and the minus sign of these alternations will have a force equal to about nineteen volts.

It is taken for granted, as in the case of station A, that the force of fifty-one volts of the plus sign will be able to move, at the receiving station, the proper coil at the required distance, but the pulse of nineteen volts of the minus sign will not be able to move the other coil and will only be able to clear the line from the effect of the former positive pulse of higher voltage.

As long, therefore, as the key at B is depressed, positive pulses of high electromotive force, alternating with negative pulses of low electromotive force, will be transmitted over the line. The plus pulses of high electromotive force are of sufficient strength to actuate the receiving means adapted to respond to plus pulses, but the electromotive force of the minus sign insufficient to move the means adapted to respond to minus pulses.

It is now supposed that both, the operator at A as well as B, close simultaneously their respective keys.

The closing of both keys at one and the same time will result in the following:—

Through the closing of key 9, coil 17 of polar relay 7 will become active, thereby energizing the core in the proper direction, but at the same time, the coil 18 of the same polar relay will become active, energizing the core in the opposite direction and, therefore, the effect of both coils will be neutralized on the core and the instrument will not answer. So also will the coil 20 of polar relay 6 become active, energizing the core in the proper direction, but, at the same time, the coil 21 of this polar relay will also become active, energizing the core in opposite direction and the effect of both coils on the core will be neutralized and the instrument will not answer. At the neutral relay 8, both the coil 22 and the coil 23 will also become active, but as the effects of both of these coils are alike in their action on the core, the core will become magnetized to a degree about double that if only one coil would be active; and the resulting effect of the activity of both coils will be, that the instrument will become active and the armature 13 will be drawn toward and in contact with the lower stop 33.

The following circuit will be established:—

The cable, bridge of same, wire 1, armature 13, lower stop 33, alternator 2, armature 27, upper stop 28, conductor 31, armature 24 of 6, upper stop 26, alternator 3 and ground 16.

As the armatures of both of the alterna-

tors 2 and 3 are revolved by the same shaft and the construction of both of these alternators is alike with the exception that at the same speed, one will develop thirty-five volts and the other will develop fifteen volts, it is obvious that when both are connected in series, the combined voltage of each half of the cycle will be fifty volts and we will, therefore, have, during the time that both keys are simultaneously depressed, pulses flowing over the line of alternating direction, but always of the same voltage or pressure; and as the receiving devices at the far off stations are made to answer at this voltage or pressure, it is obvious that both the receiving devices,—the one answering to the plus sign as well as the one answering to the minus sign,—will be actuated.

I will now describe the receiving organism or arrangement and its operation, as illustrated in Fig. 3.

In this figure, 1 is part of the conductor as illustrated in Fig. 1, for the purpose of connecting the transmitting organism to the bridge circuit. 40, 40, are the two sides of the bridge.

I have not shown here in this bridge any means of changing the resistance and I have not placed in this bridge any condensers or similar instruments, as my invention does not relate to the mode or method of producing a bridge, for the purpose of allowing messages from both terminals to travel over the line simultaneously.

It suffices here that the bridge circuits as now employed may be used with this, my invention, or such circuits as are practical for the employment in cable telegraphy. 41, 41, is the cross circuit of the bridge and I have here provided this cross circuit with the impedance 42. To this impedance are connected the two receiving devices 43 and 44.

As stated at the beginning of this application, it is my purpose to enable the persons in charge of the cable to use the so-called siphon recorder of today with a slight change of cutting one of the fibers connecting the siphon proper to the moving coil and, in this drawing, I have only illustrated in conventional sign the moving coil, the suspended cradle and the siphon attached to the cradle and, instead of the two connections of the coil with the cradle, I have only illustrated one connection of the coil with the cradle and it is supposed that if the coils move to one side, say to the right, only one siphon will answer, say the siphon of station A′, and if the coils move to the opposite side, say to the left, only the siphon of station B′ will answer; and it is supposed that the coil of station A′ is the receiving device for the transmitting station A and the coil of station B′ is the receiving device for the transmitting station B.

Of the receiving device 43, the coil is designated by the numeral 45; the cradle by the numeral 46; the siphon by the numeral 47 and the connecting thread by the numeral 48.

Of the receiving device 44, the coil is designated by the numeral 49; the cradle by the numeral 50; the siphon by the numeral 51 and the connecting thread by the numeral 52.

In proximity to the siphon 47 is the paper 52 supposed to be moved in the direction of the arrow with the record line 53, and in juxtaposition to the end of the siphon 51 is the paper 54 with the record line 55. Both coils are connected to the impedance 42; but in a manner so that each coil shall have its own circuit.

Experiments have taught me that if both coils are connected in series as to each other and in one circuit, the moving of one coil induces a slight movement in the second coil and the operation of the two coils together is not as efficient as if each coil would be connected to its own circuit.

In the drawing; one terminal of coil 49 is connected to the impedance through wire 56 and with the other terminal to one terminal of the coil 45. The coil 45 is connected to the impedance through wire 57; and 58 is the common return for both of said coils.

With this arrangement, the pulses generated, through the moving of a coil, are short circuited—so to speak—and will only flow through their own circuit.

59 is the cable or line of transmission. 68 is the artificial line here shown only in conventional sign.

The operation of this part of my invention is as follows:—

Normally, that is, when no impulse is transmitted over the line, both siphons will record a straight line on the moving tapes.

When the operator of station A manipulates his key and sends pulses over the line, both coils will be moved in the same direction (if the connection of these coils is alike), but only the siphon of the coil of station A′ will answer, because the movement of the coil of station B′ in that particular direction will not be able to actuate its own siphon. The siphon, therefore, of station A′ will record the signals. These signals will be above or below an imaginary zero line, as the case may be, and each signal will be represented by a curve more or less square in accordance with the effect of the impedance 42.

When the key at station A is depressed for a short time and only about one full cycle flows over the line, then the curve will only be a short one, but when the key is depressed for a longer period (say for a dash), then the curve will be a compara-

tively large one. This second curve will, if looked upon through a magnifying glass, show a vibratory line, but this will not interfere with the clear reading of the signals.

When the operator at station B manipulates his key, at the receiving station both coils will again be deflected in the same direction, but only the siphon of station B′ will be able to answer to the movement of its coil, for the reason aforesaid and will record the received impulse in either a short or long curve in accordance with the shorter or longer depression of the key at the transmitting station B; and when the operators at both transmitting stations simultaneously depress their keys, both coils will move alternately in opposite direction and both siphons will record,—one at one-half of the cycle and the other at the second half of the cycle.

It will, therefore, be seen that if two messages are transmitted over the line, the last record of one message will be finished one-half of a cycle later than the last record of the other message.

It is obvious that instead of the receiving devices substantially as described and illustrated, other suitable and well known devices may be substituted,—recording as well as repeating.

In arranging my system for the transmission of messages over submarine cables, care should be taken that the alternations of the generators 2 and 3 should follow each other at the required speed.

Experiments have taught me that if this speed is too high, then the alternations will not be able to move—at the receiving station—the receiving instrument with required energy and if this speed is too low, then it may happen that by the depression of the key for a dot, only that part of the cycle will be transmitted which is intended to be used only as the "clearing" current.

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

1. In a transmitting arrangement for quadruplex telegraphy, two generators of alternating current, two sources of direct current and two transmitting means, one of said generators adapted to be made operative through the operation of one or the other of said transmitting means, one of said sources of direct current adapted to be made operative through one of said transmitting means and the second of said sources adapted to be made operative through the second transmitting means and the second generator of alternating current adapted to be made operative through the simultaneous operation of both transmitting means.

2. In telegraphy, a line of transmission, two generators of alternating current of different electromotive force, transmitting means for one station adapted to connect one of said generators to the line of transmission, and means when two stations are simultaneously operated to connect both of said generators in series with each other and to the line of transmission.

3. In a telegraphic transmitting arrangement, a generator of alternating current and two sources of direct current and means to connect the generator with one source to denote one message and to connect the generator with the second source to denote a second message.

4. In a telegraphic transmitting arrangement, one generator of alternating current and two sources of direct current, means for one source of said direct current to be connected to one terminal of said generator with the positive pole and means for the second of said sources to be connected to one terminal of said generator with the negative pole.

5. In telegraphic transmitting apparatus, the combination of two electromagnets and transmitting means for each of said electromagnets, each of said electromagnets being provided with means whereby it becomes operative through the manipulation of its own transmitting means, each of said electromagnets being provided with means whereby the effect of its own transmitting means is neutralized by the simultaneous operation of the second transmitting means, and a third electromagnet operatively related to both transmitting means and provided with means whereby it becomes operative through the manipulation of both transmitting means.

6. In a telegraphic transmitting arrangement, two electromagnets and transmitting means for each of said electromagnets, means for each of said electromagnets to become operative through the manipulation of its own transmitting means, each electromagnet provided with means to neutralize the effect of its own transmitting means through the simultaneous operation of the second transmitting means.

7. In a telegraphic transmitting arrangement, a neutral electromagnet and two transmitting means, the neutral electromagnet provided with two coils, one coil connected to one transmitting means and the second coil connected to the second transmitting means, both transmitting means adapted to make operative said electromagnet, in combination with a generator of alternating current adapted to become active through the operation of said electromagnet.

8. In a telegraphic transmitting arrangement, a generator of alternating current, two sources of direct current and two trans-

mitting means and means related to one of said transmitting means to impress upon the line alternations, the positive pulse of which is of higher electromotive force than the negative pulse and means related to the second transmitting means to impress upon the line alternations, the negative pulse of which is of higher electromotive force than the positive pulse.

9. In a telegraphic transmitting arrangement, two alternators, two sources of direct current and two transmitting means, means operatively related to one transmitting means to impress upon the line alternations wherein the positive pulse is of higher electromotive force than the negative pulse, means operatively related to the second of said transmitting means to impress upon the line alternations, wherein the negative pulse is of higher electromotive force than the positive pulse, and means operatively related to both transmitting means to impress upon the line straight reversals of comparatively high electromotive force.

10. In a system of diplex telegraphy, a line of transmission, means operated by one transmitting means to impress upon said line alternations whose positive pulse is of higher electromotive force than the negative pulse, means operated by another transmitting means to impress upon said line alternations whose negative pulse is of higher electromotive force than the positive pulse, the manipulation of both transmitting means impressing upon said line alternations in which both pulses are of like high electromotive force, means when neither transmitting means is manipulated to suppress all current on said line, in combination with two receiving devices in the line of transmission, one arranged to respond to negative pulses of comparatively high polarity and the second arranged to respond to positive pulses of comparatively high polarity, and separate recording means for each of said receiving devices.

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

ISIDOR KITSEE.

Witnesses:
MARY C. SMITH,
ALVAH RITTENHOUSE.