I. KITSEE.

QUADRUPLEX TELEGRAPHY.

APPLICATION FILED SEPT. 22, 1911. RENEWED DEC. 30, 1916.

1,219,561.

Patented Mar. 20, 1917.

2 SHEETS—SHEET 1.

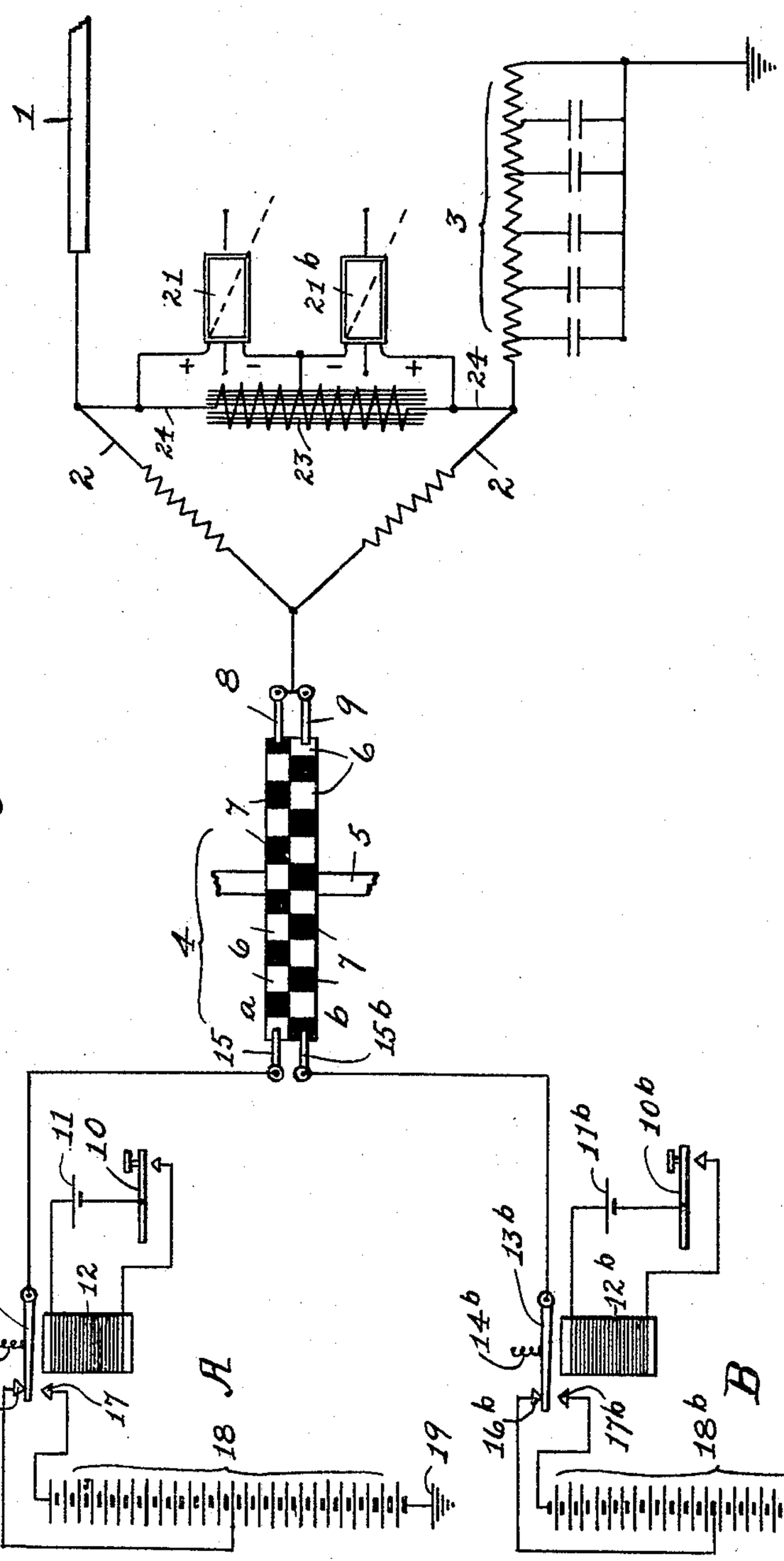

Fig. 1.

WITNESSES:

Edith R. Stillert

Mary E. Smith

INVENTOR.

Isidor Kitsee

I. KITSEE.

QUADRUPLEX TELEGRAPHY.

APPLICATION FILED SEPT. 22, 1911. RENEWED DEC. 30, 1916.

1,219,561. Patented Mar. 20, 1917.

2 SHEETS—SHEET 2.

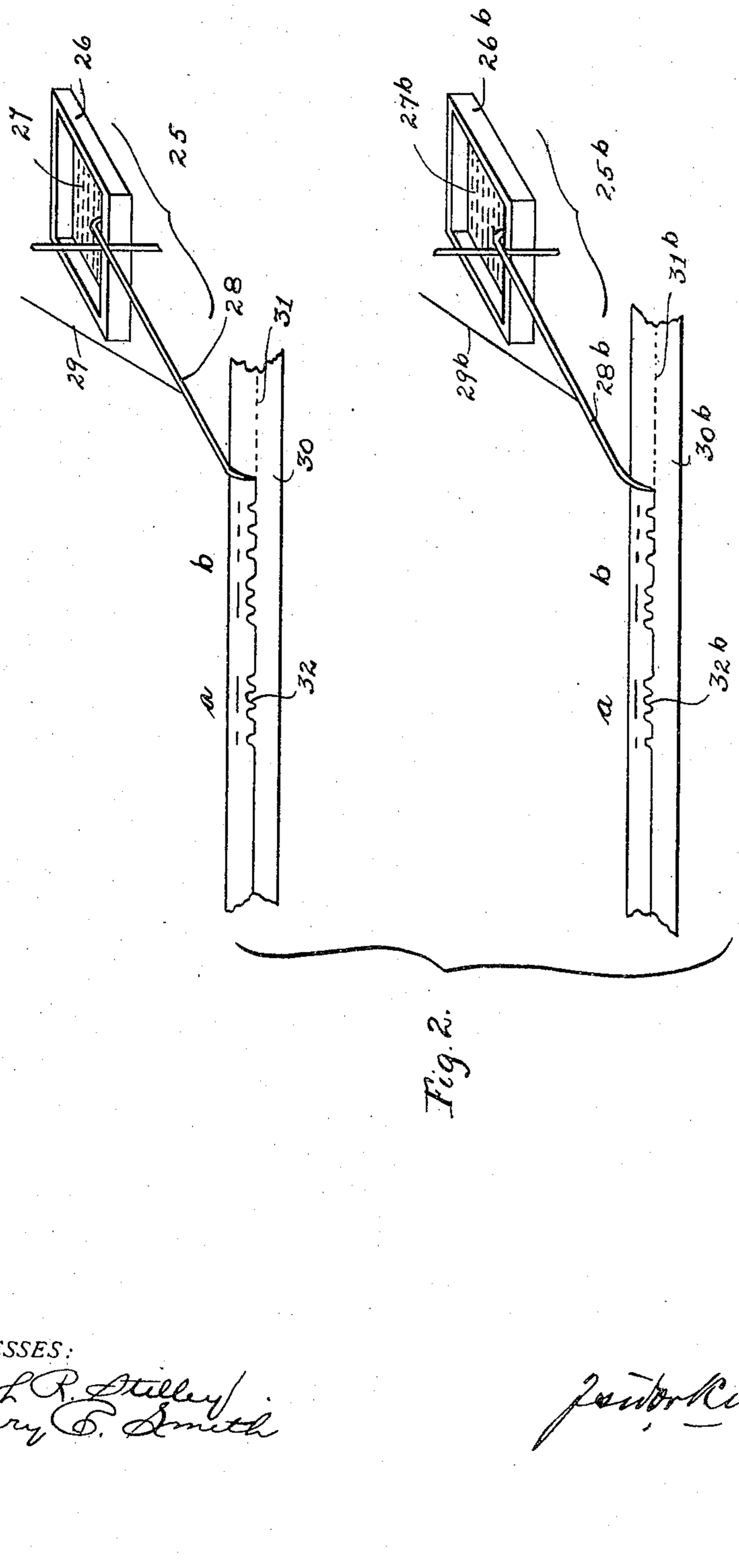

Fig. 2.

WITNESSES:
Edith R. Stilley
Mary E. Smith

INVENTOR.
Isidor Kitsee

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.

1,219,561. Specification of Letters Patent. **Patented Mar. 20, 1917.**

Application filed September 22, 1911, Serial No. 650,789. Renewed December 30, 1916. Serial No. 139,964.

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 quadruplexing lines with great capacity, such for instance as submarine cables.

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. Each of these systems has to take into consideration that if a series of pulses of one polarity is transmitted over the cable, the large capacity of the cable merges—so to speak—the individual pulses into one pulse of long duration, and when a recording receiver is employed, the recording stylus or siphon will form a curve too large to be readable, and if the working with one polarity is prolonged for a considerable time, the recording siphon or stylus will be thrown out of contact with the paper.

In the system as will hereinafter be described, illustrated in the drawing and more particularly pointed out in the claims following this specification, I have taken care of this and other pecularities of the cable and I have found that the arrangement hereinafter to be described is well fitted for quadruplexing cables with very large capacity, as this arrangement was tested on a line with over five thousand ohms resistance and over four hundred microfarad capacity.

In the drawing, Figure 1 is a diagrammatic view of part of a quadruplex system showing one terminal of a cable equipped with means to transmit two messages and equipped with means to receive two messages.

Fig. 2 is a diagrammatic view of part of the two receiving devices with their recording tapes for one terminal.

In Fig. 1; 1 is the cable. 2, 2, the duplexing bridge connected with one side to the cable 1 and with the other side to the artificial line 3. 4 is a double commutator consisting of the two parts *a* and *b* mounted on the shaft 5 and adapted to be revolved by any suitable means. Each of the two parts of the commutator is provided with the conducting segments 6 and the non-conducting segments 7. All of the conducting segments 6 are in electrical contact with each other. In reality, the double commutator 4 may be constructed of two metallic wheels having cut-out portions filled with non-conducting material. The point of junction of the two bridge sides 2, 2, is connected through brush 8 with the commutating part *a* and through brush 9 with the commutating part *b*. A and B are two transmitting stations. The transmitting station A comprises here the key 10 connected with the interposition of the battery 11 to the coil of electromagnet 12. The armature 13 of said electromagnet is held upward by the spring 14 and is connected to the brush 15, contacting with the commutating part *a*. 16 is the upper contact against which the armature 13 normally rests. 17 is the lower contact normally out of connection with said armature. 18 is a source of current consisting here of twenty six cells, but it is obvious that the number of cells may be increased or decreased to suit requirements. The positive pole of the whole series of cells is connected to the lower contact 17 and the negative pole is connected to the return or ground 19. The positive pole of part of the series of cells, here including one half of said series, is connected to the upper contact 16.

The transmitting station B is equipped with identical devices as the station A and these devices are connected to each other in the same manner as in station A with the exception that the source of current is connected, in its entirety, with its negative pole to the lower contact of the armature, and with its positive pole to the return or ground, and is connected, in part, with the positive pole to the upper contact of the armature. In this station, similar parts are designated by similar numerals to those of station A with the exception that the letter "b" is added to each of the numerals. 21 and 21^b are two receiving devices. preferably of the well known siphon recorder type and

here illustrated only in conventional sign. The coils of these two devices should be connected in opposition as to each other, so that if one coil is deflected—say to the right—through a positive pulse, the other coil should be deflected to the right through a negative pulse. 23 is an inductive device connected to the cross wires 24, 24, of the bridge circuit.

The two receiving devices 21 and 21^b are connected in shunt to the inductive device in such manner that each receiving device forms its own circuit, such, for instance, as connecting one terminal of each of the receiving devices to the middle of the induction coil, as shown.

The purpose of this arrangement will be later on more fully described.

In Fig. 2, 25 is part of the recording mechanism, as an entirety, of the receiving device 21, and 25^b is part of the recording mechanism, as an entirety, of the receiving device 21^b. The recording mechanism 25 is here illustrated as consisting of the ink well 26, the ink 27, the siphon 28 and part of the means 29 to suspend said siphon. The recording tape is designated by the numeral 30. The imaginary zero line, illustrated in dotted lines, is designated by the numeral 31, and the vibratory curve, designating the character of the alphabet received, is designated by the numeral 32.

Similar parts of the recording mechanism 25^b are designated by similar numerals with the exception that the letter "b" is added to each of the numerals.

In this system, it is of importance that one of the siphon recorders employed should only answer to a positive pulse and the other of the siphon recorders should only answer to a negative pulse and it is preferred that the characters recorded should be recorded in both instances above an imaginary zero line.

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 adapt the same for my purpose.

It is well known that the siphon recorder of today is generally provided with two suspensions 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, and 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 such manner that the recorder of one instrument is able to follow the movements of the coil only through a positive pulse and the recorder of the second instrument is able to follow the movements of the coil only through a negative pulse; and as it is preferred that both recorders record the incoming signals above an imaginary zero line, the two coils of the two instruments should be connected in opposition to each other so that if a positive pulse arrives, one siphon is deflected and marks the incoming pulse by a curve above the imaginary zero line and when a negative pulse arrives, the other siphon is deflected and marks the incoming impulse by a curve also above the zero line.

I will now describe the function of the devices employed in the transmitting stations A and B of the terminal illustrated, it being understood that the devices and their functions of the far-off terminal (not illustrated) are similar to the devices hereinafter to be described.

I prefer that the commutator be revolved at the required speed no matter if a message is transmitted or not and I prefer that normally, that is, when no message is transmitted, alternations of a comparatively weak current should be impressed upon the line. The electromotive force of these alternations should be such that they will not affect the receiving devices at the far-off stations.

Taking it for granted that at the speed at which the commutator is revolved, the electromotive force of the transmitting battery has to be at least—say—fifty two volts for the purpose of actuating the receiving device at the far off station, then it is suggested that the electromotive force of the batteries, normally alternating, should be about one half of this or less.

Normally, therefore, at each terminal, true reversals are impressed upon the line, but of such low electromotive force that they do not affect the far off instruments at all and if siphon recorders are employed as receivers, the siphon of each of these receivers will normally trace a straight line on the paper.

It is now supposed that the operator at the transmitting station A desires to transmit a message. He will operate his key in the same manner as the operator on land lines operates his key for the transmission of dots and dashes. Through the depression of the key, the electromagnet connected to said key is energized and the armature, formerly resting on the upper stop, is drawn downward and comes to rest and connects with the lower stop. The connection of the armature with part of the transmitting cells

is broken and the connection of the armature with the whole set of the transmitting battery is made.

It is taken for granted that the transmitting battery of A is, as is illustrated in the drawing, connected with the positive pole to the stop adjacent to the armature and with the negative pole to the ground; and it has to be taken for granted that the commutator is revolving at the required speed.

The effect of the connection of the armature with the whole set of battery will result therein that the positive pulses impressed upon the line are now increased in force, whereas, the negative pulses impressed upon the line still remain at the former comparatively low force.

It has also to be taken for granted that the full electromotive force of the transmitting battery of A suffices to transmit pulses (with the aid of the commutator) over the line of sufficient strength so as to actuate the receiving coil at the far-off station adapted to be actuated by a positive pulse of required strength.

If the key is closed for a sufficient length of time, reversals will be sent over the line, but in these reversals, the positive pulse will be of a far higher electromotive force than the negative pulse and, in fact, the positive pulse will be of a strength so as to actuate its receiving device at the far-off station, whereas, the negative pulse will be able to clear the line but will not be able to actuate its receiver at the far-off station.

The result at the far-off station will be—if a siphon recorder is employed—that the siphon of the instrument answering to the positive pulse will trace a vibratory line for a length of time practically coinciding with the length of time that the key at the transmitting station is closed. As soon as the key is opened, the electromagnet 12 is deënergized and the armature is drawn away from the lower contact and toward and in connection with the upper contact. The strength of the transmitting battery is, therefore, instantaneously reduced and is equivalent to the strength of the battery transmitting impulses from B, that is, sufficient to clear the line but not sufficient to actuate its instrument.

It has to be stated here that the key should be closed for a time sufficient to have the brush connecting with the commutator to at least connect with one conducting segment to denote a dot and to connect with at least two conducting segments to denote a dash.

In practice, the commutator should revolve at a speed just sufficient to enable both receivers to actuate at the far-off station to become active if the whole force of both batteries of both transmitting stations is impressed upon the line through this commutator.

When A, therefore, alone transmits messages, he employs the positive pulse as a signaling current and the negative pulse as a clearing current.

It is now supposed that the operator at A has ceased to transmit messages and the operator at B desires to transmit messages. He operates the key in the same manner as the operator at A manipulates his key;—he depresses the same a short time to denote a dot and a longer time to denote a dash. Through the depression of his key, the armature of his electromagnet will be drawn from the upper contact and into connection with the lower contact, thereby connecting the whole series of his transmitting battery through the armature with the commutator. The former weak impulse impressed upon the line will now be strengthened and will be of sufficient force to actuate the receiving device at the far-off station answering to a negative pulse; but as the key of the station A is open, the negative pulse of high electromotive force will alternate with the positive pulse of low electromotive force.

When B, therefore, alone transmits messages, he employs the negative pulse as the signaling current and the positive pulse as the clearing current.

It is now supposed that both, the operator at A as well as the operator at B desires to transmit messages and that both simultaneously depress their respective keys to transmit a telegraphic character over the line.

At the station A, the whole force of the transmitting battery will be connected to the commutator and at station B, the whole force of the transmitting battery will also be connected to the commutator. At station A, the transmitting battery will impress upon the line a positive pulse and at station B, the transmitting battery will impress upon the line a negative pulse. These pulses will alternate and both of these pulses will be of a strength sufficient to actuate their respective receiving device. The recorder (if a siphon recorder is employed) answering to the positive pulse will trace a curve or vibratory line above the zero line as soon as the positive pulse of the reversal has arrived and the recorder answering to the negative pulse will trace a curve or vibratory line above the zero line as soon as the negative pulse of the reversal has arrived; and as these reversals follow each other in quick succession, it is obvious that the character transmitted from the station A will be translated into a readable sign with the aid of the receiving device answering to the positive pulse and the char-

acter transmitted from the station B will be translated into a readable sign with the aid of the receiving device answering to the negative pulse.

It has to be stated right here that actual experiments on a submarine cable have proven that if true reversals are impressed upon said cable, a far 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; and I was able to transmit and receive on a submarine cable over nine hundred pulses of true reversals, whereas, in actual telegraphy with the double key, the speed on such cable was limited to two hundred and forty letters per minute, requiring—by actual count—somewhat less than five hundred pulses. I may state that when the speed of the true reversals was increased to one thousand pulses, the curves were still clearly defined and the trial for greater speed was only barred on account of the incapability of the automatic transmitting apparatus.

Coming now to the receiving station, it has to be noted that the coils of the recorders may connect directly to the cross wire of the bridge, but it was found that the insertion of an impedance, in multiple arc to said coils, greatly facilitates the clear cut record of the siphon.

In practice, I have found that if two movable coils of siphon recorders are connected in series as to each other, the effect induced by one moving coil upon the other is detrimental to the perfect working of these instruments and I, therefore, have provided for each of these coils a separate circuit, whereby the induced pulse generated in one coil, through its movement, is short circuited by its own circuit and is barred from influencing the other coil.

I have not illustrated condensers as inserted in the line or bridge, or cross circuit of such bridge, but it is obvious that such devices may be employed in accordance with the will of the operator.

It is also obvious that instead of hand sending, automatic or machine sending may be employed.

By "message" in the claims is meant a succession of dots or dashes, or equivalent readable characters, *i. e.*, something more than a single dot or a single dash.

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

1. The method of quadruplexing cables, which consists in impressing on the line at the sending station a series of coördinated pulses, and at the receiving station recording a straight line to denote that no message is received, a large series of curves to denote that a dash is received, and a lesser number of curves to denote that a dot is received.

2. In quadruplex telegraphy, the method, which consists in transmitting positive pulses to denote one message, transmitting negative pulses to denote a second message and transmitting alternately positive and negative pulses to denote that two messages are transmitted, and recording the characters of said messages in a series of curves, each message consisting of two or more coördinated impulses.

3. In a system of quadruplex telegraphy, two transmitting stations for each terminal of the line, each transmitting station provided with two sources of current oppositely connected to the line, means for each of said stations to connect the whole or part of said source to said line, means for one of the receiving stations to translate the message of one polarity into a series of curves, and means for the second receiving station to translate the message of opposite polarity into a series of curves.

4. In quadruplex telegraphy, two receiving stations for each terminal of the line, the receiving stations of each terminal comprising a bridge, an inductive resistance in the cross circuit of said bridge and two receiving devices, each in shunt with part of said inductive resistance, each of said receiving devices forming its own shunt circuit, one of said devices answering to positive and one of said devices answering to negative pulses.

5. In quadruplex telegraphy, two transmitting stations for each terminal of the line, a source of direct current for each of the two stations of each terminal, part of each of said sources normally connected to the line, a transmitting key for each of said stations, and means operatively related to each of said transmitting keys to break the normal connection of the line with part of its source of current and make the connection of said line with the whole force of its source of current.

6. In quadruplex telegraphy, a line of transmission and two transmitting stations for each terminal of said line, each station equipped with means to transmit for each telegraphic character, one or more signaling pulses of a predetermined polarity and each station equipped with automatic means to transmit a clearing pulse of opposite polarity after the transmission of a signaling pulse by the other station and receiving means for each station to record the signaling pulses as curves and the clearing pulses as spaces between said curves.

7. In quadruplex telegraphy, in combination with a line of transmission, two transmitting stations at each end of said line, each comprising a divided source of current, an electromagnet and a transmitting key, the electromagnet normally connecting only part of said source to the line of transmission, and means operatively related to the transmitting key to break said connection and connect the line to the full force of said current.

8. In quadruplex telegraphy, the method which consists in impressing on the line at a sending station a series of coördinated pulses, and at each receiving station recording simultaneously a series of curves to denote two messages, recording curves at one station only to denote one message, and recording straight lines at both stations to denote no message.

9. In quadruplex telegraphy, a line of transmission, two receiving devices for each terminal of the line, each of said receiving devices comprising a movable coil adapted to swing in both directions and a recorder mechanically connected to said coil but adapted to respond to the movement of the coil in one direction only.

10. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of the line, a source of current for each of said transmitting stations, the source of current of one station grounded with the negative pole and provided with means to connect the positive pole to the line of transmission and also provided with means to connect part of said source to said line of transmission, the source of current of the second station grounded with the positive pole and provided with means to connect the negative pole to the line of transmission and also provided with means to connect part of said source to said line of transmission.

11. In quadruplex telegraphy, a line of transmission, two transmitting stations for each terminal of the line, a source of current for each of said transmitting stations, the source of current of one station grounded with the negative pole and provided with means to connect the positive pole to the line of transmission and also provided with means to connect part of said source to said line of transmission, the source of current of the second station grounded with the positive pole and provided with means to connect the negative pole to the line of transmission and also provided with means to connect part of said source to said line of transmission; in combination with a commutating device adapted to alternate the flow of the current from said two sources over the line of transmission.

12. In quadruplex telegraphy, a transmitting station comprising the following instrumentalities:—a divided source of direct current grounded at one pole, an electromagnet, a source of current and transmitting key connected to the coil of said electromagnet, an armature for said electromagnet, two contacts for said armature, one of said contacts connected to one pole of the whole source of current and the other contact connected to part of the whole source of current and a commutating device.

13. In a quadruplex system, in combination with a line of transmission, two transmitting stations for each terminal of said line and adapted to transmit reversals of true as well as unlike alternations, a bridge circuit, two receivers in the cross circuit of said bridge circuit and means for one receiver to translate an impulse of one polarity and means for the second of said receivers to translate an impulse of opposite polarity into a curve.

14. In quadruplex telegraphy, the improvement, which consists in impressing upon the line reversals, the different parts of each cycle of different electromotive force to transmit one message and impressing upon the line reversals, all parts of the cycles of which are of practically uniform electromotive force to transmit two messages simultaneously from one terminal and translate the same into curves.

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

ISIDOR KITSEE.

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