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F. G. CREED ET AL

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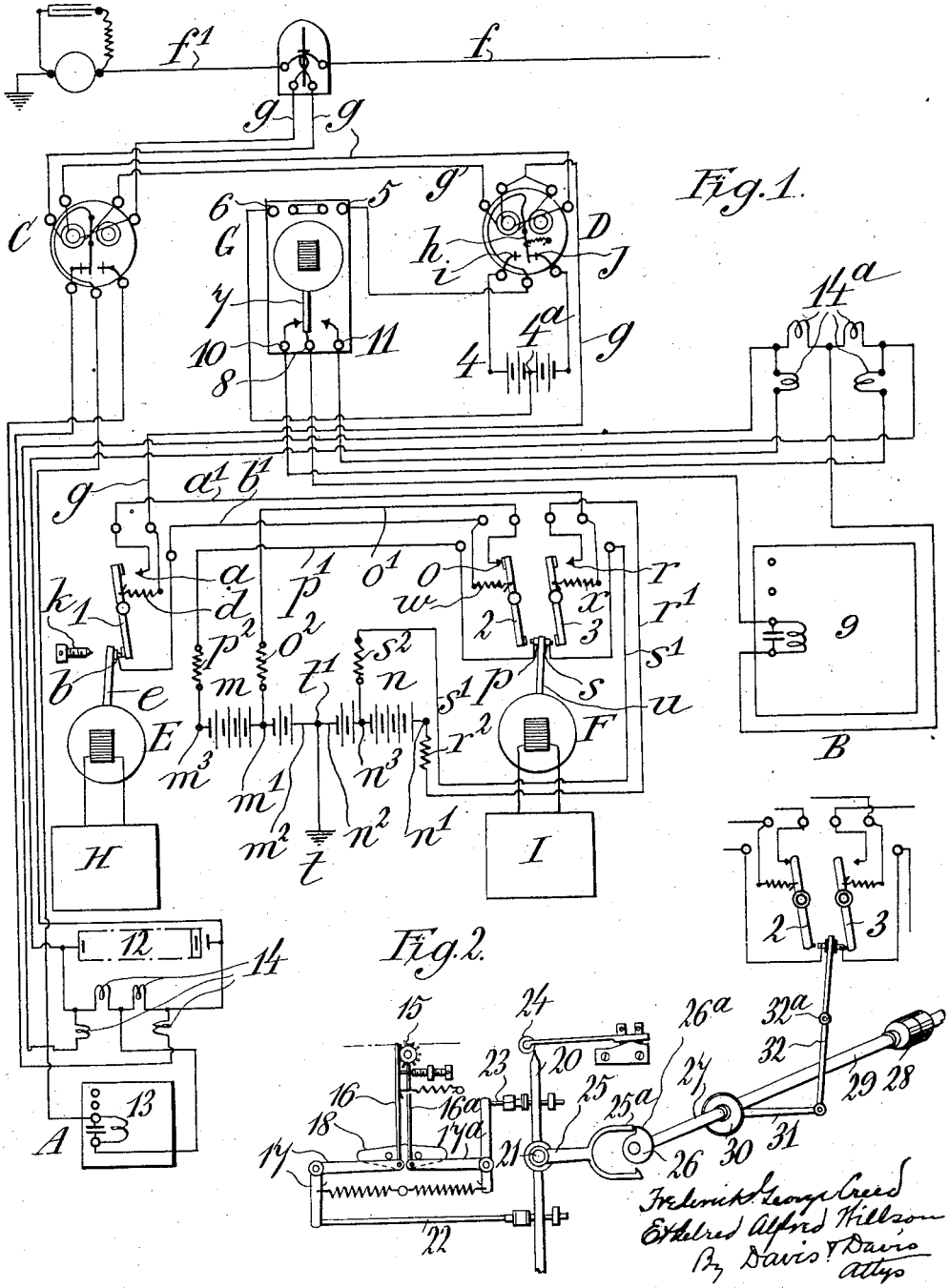

Fig. 1.

Fig. 2.

Frederick George Creed
Ethelred Alfred Willson
By Davis & Davis
Attys

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FREDERICK GEORGE CREED AND ETHELRED ALFRED WILLSON, OF CROYDON, ENGLAND.

APPARATUS FOR USE IN ELECTRIC TELEGRAPH SYSTEMS.

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This invention has reference to improvements in quadruplex and diplex telegraph systems which provide for the simultaneous transmission of signals in opposite directions, without interference, over a single telegraph line.

Quadruplex telegraph systems are generally based on a combination, at each station, of the single-current and double-current duplex systems. Such systems may be worked according to the differential or bridge method. The single current duplex system permits of the simultaneous transmission of one message in each direction through changes in current intensity, and the double current system, permits of the simultaneous transmission of one message in each direction through changes in current direction. The latter transmission is effected on what is called the A side and the former on what is called the B side of the combined apparatus used for effecting such simultaneous transmission. Each station is provided with two current transmitting keys and two differentially wound receiving relays, one key, arranged on the A side of the combined apparatus employed, and usually called the reversing key, being adapted to reverse the direction of the current sent thereby to line without altering its strength, and the other key, arranged on the B side of the combined apparatus, and usually called the increment key, being adapted to change the strength of the current sent thereby to line without altering its direction, whilst of the two relays, one is a polarized relay arranged on the A side and adapted to control telegraph receiving apparatus on that side, whilst the other relay is a non-polarized relay arranged on the B side and adapted to control telegraph receiving apparatus on that side.

As is well known, in a quadruplex telegraph system of the kind referred to, although it is possible to transmit and receive messages at a high rate of speed on the A side of the respective stations and to use the received signals for automatically operating, at high speed, telegraphic receiving apparatus, as for instance apparatus of the kind known as the Creed receiver, which perforates a tape, messages or signals can only be transmitted and received on the B side of the respective stations at a comparatively slow rate of speed such that they have to be transmitted by hand operated key mechanism and when received, have to be translated by telegraph operators with the aid of a Morse sounder or printer.

This is in part due to the fact that if, during the time that the current increment key on the B side of one station is depressed to increase the current strength, the current reversing key on the A side of the same station is depressed to reverse the direction of the current, the signalling current will fall from the working value of one polarity to zero and then rise from zero to a similar value of the opposite polarity. The momentary cessation of current thus produced in the telegraph line, causes the tongue of the non-polarized relay on the B side of the receiving station to fall away momentarily from the marking contact screw of the relay, thereby causing a break in the B side signals. This action is known amongst telegraphists as the B kick.

Although means have heretofore been adopted with a view to avoiding this disadvantage, such means require frequent adjustment and have never been such as to enable messages to be transmitted and received on the B side of the transmitting and receiving apparatus at high speed like those on the A side of the apparatus.

Now the present invention has for its object to provide apparatus for use in a quadruplex telegraph system of the kind referred to, or in a diplex telegraph system, means whereby the transmission of signals on the B side of each station can be effected as rapidly as those on the A side, and also means to enable the signals received on the B side of each station to be utilized in an effective manner for the automatic operation of receiving apparatus, as for instance a Creed receiver, in the same way that the signals received on the A side of each station can be used for this purpose, and thus to enable the whole of the quadruplex or diplex telegraph system to be operated at high speed and in an automatic manner, so as thereby to increase the capacity of the whole system for quickly dealing with telegraphic work.

In the accompanying illustrative drawings, Fig. 1 shows, diagrammatically, an arrangement of apparatus suitable for use in a quadruplex telegraph system and whereby the object of the invention can be attained. Fig. 2 shows, diagrammatically, a modified transmitter.

In the arrangement shown in Fig. 1, there is provided on the A side of each of two connected stations, a current reversing key comprising a movable contact lever 1 mounted between stationary and movable contacts a and b and acted upon by a spring d that tends to move it towards and against the stationary contact a. The movable contact b is carried by the tongue e of a powerful high speed polarized relay E worked from a high speed transmitter of the Wheatstone or other desired type, indicated diagrammatically at H. The stationary and movable contacts a and b are connected to the current increment key mechanism at the same station, as hereinafter described. The spring controlled contact lever 1 is connected to line f and to the artificial line f^1, through conductors g, a polarized relay C and a non-polarized relay D provided at the same station, for receiving signals transmitted from the second station, which is similarly equipped. The two relays C and D are constructed and coupled up to the lines f and f^1 in the usual manner but the movable tongue h of relay D is arranged to work between two contacts i and j, as and for the purpose hereinafter described.

The key mechanism on the B side of each station, used for varying the strength of the current signals, comprises two movable spring controlled contact levers 2 and 3, one of which, namely 2, is arranged to work between stationary and movable contacts o and p respectively and the other of which, namely 3, is arranged to work between other stationary and movable contacts r and s respectively. Contact a is connected through a conductor a^1 to lever 3, and contact b is connected through a conductor b^1 to lever 2. Contact o is connected through a conductor o^1 and a resistance o^2 to an intermediate point m^1 or the electric battery m, such that one third part of the battery is included between such point and one pole m^2, say the positive pole, of the battery which is connected to earth t. Contact p is connected through a conductor p^1 and a resistance p^2 to the opposite or negative pole m^3 of the battery m so that the whole of the battery is included between it and earth. Contact r is connected through a conductor r^1 and a resistance r^2 to one pole n^1, say the positive pole, of the second battery n, the opposite or negative pole n^2 of which is connected to earth t. Contact s is connected through a conductor s^1 and a resistance s^2 to a point n^3 in the second battery n, such that a third part of the battery is included between such point and the negative pole n^2 of the battery. The two batteries m and n may, as shown, have a common earthed terminal t^1. Contacts p and s are insulated from each other and carried by the tongue u of another powerful high speed polarized relay F which is worked from another high speed transmitter of the Wheatstone or other desired type, indicated diagrammatically at I. The arrangement is such that assuming lever 2 to be bearing, under the action of its spring w, against contact o and that the tongue u of relay F is, as shown, in its extreme right hand position away from said lever, then, upon the tongue moving to the left, contact p carried thereby will immediately act against lever 2 so as momentarily to short circuit the left hand portion of the associated battery m and then move lever 2, against the action of its spring w, from contact o and will remain in contact with such lever during the further left hand motion of the tongue and also during the right hand motion thereof until lever 2 is again caused, by its spring, to bear against contact o. On this further movement of the tongue to the right, contact s will act against lever 3, momentarily short circuiting the right hand portion of the associated battery n and then immediately move such lever 3 from contact r and will, under the action of the spring x connected to lever 3, continue to bear against that lever during the remainder of the movement of the tongue to the right and also during the movement of the tongue to the left until lever 3 again bears against contact r when the connection between contact s and lever 3 will be opened.

The use of contact levers such as 1, 2 and 3, arranged and actuated as described, constitute an important feature of the present invention.

The arrangement is also such that assuming contact lever 1 is held by its spring d in contact with the stationary contact a and that the tongue e of the polarized relay E carrying contact b is bearing against its back stop k, then, immediately the tongue, on its forward movement, acts upon the contact lever 1 through its movable contact b, the portions of the batteries m and n between the points m^1 and n^3, or the whole of the two batteries m and n, according to the position of the levers 2 and 3, will momentarily be short circuited and the lever 1 caused to break connection with contact a. The connection between contact b and contact lever 1 is maintained during the further forward movement of the tongue and also, owing to the action of the spring d, during the backward movement of the tongue until the contact lever, under the said action of the spring, again bears on the contact a, whereupon the connection between the movable contact b and lever 1 will be broken.

The short circuit current produced as described, is limited in each case, to a safe value by the resistances o^2 and s^2, or p^2 and r^2 in the respective circuits, these resistances being of suitable value for the purpose.

The resistances o^2 and s^2 are those normally used for maintaining the duplex balance when the batteries are, during operation of the increment key mechanism, reduced to one third of their maximum value.

By means of the hereinbefore described key mechanisms, a pole of battery m or n will be connected to the line f and the artificial line f^1 through the contacts a or b, lever 1, conductors g and relays C and D at the same moment as a pole of the other battery is disconnected therefrom, thus reducing to a minimum, the time during which there will be no current flowing to line. Consequently, the time between the fall of current from a working value of one polarity and the rise of current to a similar value of the opposite polarity will be considerably reduced as compared with that obtaining with known quadruplex telegraph systems of the kind herein referred to. As a result, the B kick heretofore experienced in such system is very considerably reduced though not entirely eliminated. Means are however provided at the receiving end of the line to entirely eliminate the effect of the B kick as hereinafter described.

To enable the signals transmitted as described at a high rate of speed from the B side of the quadruplex apparatus at one station to be received and effectively utilized by the telegraphic receiver at the B side of the quadruplex apparatus at a second station and so as entirely to eliminate the effect of the B kick referred to, there is associated with the non-polarized relay D at that station through which the quadruplex telegraphic signals or messages pass as heretofore, a high speed polarized relay G. This relay is adapted to be actuated by currents derived from a local battery 4 under the control of the movable tongue h of the non-polarized relay D and the two stationary contacts i and j of that relay between which the tongue moves and which are connected to the opposite poles of the said battery 4. One terminal 5 of relay G is connected to the tongue h of the relay D and the second terminal 6 of relay G is connected to the middle point 4^a of the said local battery 4. The movable tongue 7 of relay G is connected to one terminal 8 of a circuit including a high speed telegraphic receiver 9 on the B side of the quadruplex apparatus and works between two stationary contacts 10 and 11 connected to the opposite terminals of a second local battery 12 which may, as in the example shown, be that provided on the A side of the apparatus for working, in known manner, the high speed telegraphic receiver 13 on that side, under the control of relay C. 14 are resistances arranged in known manner in the circuits leading to the telegraphic receiver 13, and 14^a are similar resistances arranged in the circuits leading to the telegraphic receiver 9.

The signals as received in the non-polarized relay D at one station will still be received broken while the reversing key on the A side at the other station is being operated but the breaks will be small and not of sufficient duration to allow the tongue h of the said relay D to move over to the spacing contact i of the relay but merely to cause the tongue to tremble. Relay G being connected up as hereinbefore described, it will be seen that its tongue 7 will not be moved to the spacing side of that relay unless the tongue h of relay D makes definite contact with the spacing contact i of that relay. This entirely eliminates the effect of the reduced B kick. Thus, by the means described, the high speed signals sent, as hereinbefore described, from the B side of the quadruplex apparatus at one station and designed to be dealt with by relay D at a second station, can be accurately reproduced at a high speed by relay G and utilized for operating, in an effective manner, the high speed telegraphic receiver 9 on the B side of the apparatus at the second station.

The high speed polarized relays E, F and G, may advantageously be of the kind described in the specification of application for Letters Patent, Serial No. 497,459, or of the kind described in the specification of another application for British Letters Patent dated 11th March, 1924, and numbered 6,214. It is important that the polarized relay G should be so constructed that firm contact pressure is maintained between the moving contact and one or other of the stationary contacts even though the current in the relay coil or coils falls to zero, at any time, the tongue not moving to the opposite contact until the current is actually reversed. This condition is complied with in polarized relays of the kind referred to. The telegraphic receivers 13 and 9 on the A and B side of the quadruplex apparatus in each station may advantageously be of the automatic type known as Creed receivers, hereinbefore referred to, but other kinds of automatic receivers operated by transmitted currents can be used.

From the foregoing description of quadruplex apparatus, it will be understood that, in the arrangement described, there are employed inter alia at each of two connected stations, current reversing key mechanism and current increment key mechanism, of the special construction described. arranged respectively at the A and B sides of the station, each of these key mechanisms being operated by the movable member or tongue of a high speed polarized relay, the two relays being worked by two high speed transmitters of the Wheatstone or other desired type. Also, as above indicated, two auto-

matic high speed receiving apparatus 13 and 9 are arranged at the A and B sides respectively of each station together with associated relays C, D and G to receive and utilize the two sets of signals transmitted from the opposite station.

In the case however of telegraph systems in which it is only desired to transmit two messages simultaneously at a high speed along one line wire from one station to another station and to transmit a message simultaneously along the same wire from the second station to the first one at hand speed, that is to say, when working on the diplex system, it will of course only be necessary to employ high speed current reversing key mechanism and current increment key mechanism with associated automatic high speed transmitters at the transmitting station, and only two sets of high speed receiving apparatus at the second or receiving station with associated relays C, D and G. For the hand speed messages, it will of course be necessary to supply a Morse key at the one station, and a sounder or Morse inker at the other station.

Instead of causing each Wheatstone or other transmitter to operate the contact lever 1, or contact levers 2 and 3, of the respective key mechanisms by the aid of a high speed polarized relay E or F as hereinbefore described, each lever may be operated mechanically from the transmitter. Fig. 2 shows, diagrammatically, one arrangement for this purpose. In this example, 15 is the tape feed wheel, 16, 16^a the peckers, 17, 17^a the spring controlled bell crank levers connected to the peckers and 18 the rocker beam, actuated by a driving shaft, of an ordinary construction of Wheatstone transmitter. 20 is a lever that is oscillated about an axis at 21 through connections 22 and 23 from the levers 17 and 17^a, and 24 is a spring pressed jockey pulley that acts on one end of the lever 20 to ensure a smart and decided action of the lever 20 in the same way that the contact lever used in a Wheatstone transmitter is controlled. The lever 20 is provided with an arm 25 having a bifurcated end 25^a which constitutes one member of an escapement device the other member of which is constituted by a disc 26 having a tooth 26^a adapted to co-act alternately with the two prongs of the bifurcated member 25^a. The escapement member 26 is fixed upon a spindle 27 driven through a friction clutch 28 from a shaft 29 that is driven at a suitable speed from the driving shaft used for driving the rocker beam 18, feed wheel 15 and associated parts. On the spindle 27 is an eccentric 30, the rod 31 of which is arranged to operate a lever 32 which is pivoted at 32^a and which takes the place of the tongue *e* used for operating the lever 1 of the current reversing key mechanism, or the tongue *u* used for operating the levers 2 and 3, of the current increment key mechanism used in the apparatus shown in Fig. 1. In the example shown, the lever 32 is shown as arranged to operate the levers 2 and 3 of the current increment key mechanism. As will be seen, at each operation of the transmitter, the escapement will act to release the spindle 27 and permit it to rotate through half a revolution and through the eccentric 30 and rod 31, move the lever 32 in one direction or the other.

Quadruplex and diplex telegraph systems, according to the invention, embody, of course, resistances, condensers, galvanometers and so forth, such as are commonly used in such systems for well known purposes.

In quadruplex and diplex telegraph systems, provided with high speed signal transmitting and receiving apparatus of the kind referred to, it is important, in order to obtain the best results in working of the combined apparatus, that the starting of a dot signal by both the current reversing key mechanism on the A side and the current increment key mechanism on the B side, should take place simultaneously and that the stopping of the said dot signals by both sets of mechanism should take place simultaneously, in order that the current impulses produced by the two key mechanisms shall be accurately superimposed upon one another and be transmitted at the same time, that is to say, that they should be in phase with one another, and not follow one another, which would cause splitting of the current signal of increased strength, and interference with the proper transmission, reception and utilization of the respective impulses. To this end, the dot signals are produced simultaneously by the two key mechanisms, accurately in phase with one another, by driving the two high speed Wheatstone or other transmitters H and I used at each of two connected stations, in a quadruplex system, or at one station in a diplex telegraph system, according to the present invention, at the same speed, or at such relative speed, that the dot signals produced by the two transmitters and transmitted to line shall accurately be in phase with one another. Consequently, the starting of a current impulse by the current reversing key mechanism, under the control of the high speed transmitter H, to produce a dot signal in the line wire, and the starting of a current impulse of increased strength by the increment key mechanism, under the control of its high speed transmitter I, also to produce a dot signal in the line wire, will be caused to take place simultaneously, as also will the stopping of the two current impulses, the two current impulses being thus in phase. In this way, splitting of the last mentioned or increased current impulse, when transmit-

ting a dot, can be avoided. When a dash is being transmitted on the B side, the B kick will occur, if dots are being transmitted on the A side, but the dash is not curtailed in length, as it starts and finishes in phase with the dot signals.

Two high speed Wheatstone or other transmitters combined with a single motor, or driving means common to them, and suitable for use in telegraph systems generally wherein it is desired simultaneously to transmit two sets of signals in the same direction and in phase, along a single line wire, from one station, or from each of two stations, forms the subject of a separate application for British Letters Patent filed by us, dated 4th July 1923 and numbered 17396. As will be obvious, decrement key mechanism may be used instead of increment key mechanism. Such decrement key mechanism is to be understood as the alternative of increment key mechanism and both kinds of such mechanism are to be understood as included in the term current augmenting mechanism used in the appended claims.

The details of construction of apparatus embodying the present invention may be modified without departing from the essential feature of the invention.

Quadruplex and diplex telegraph apparatus embodying the invention can be used not only for signalling by the Morse land line code but it can also be used for transmitting and receiving signals according to the five or other multiple unit systems and start and stop systems. Also, instead of using the apparatus to form a single channel system as herein described, several sets of such apparatus may be used to constitute a multiple channel system.

What we claim is:—

1. In a telegraph system comprising a transmitting station, a receiving station and a line circuit between said stations, means adapted simultaneously to transmit reversed currents and augmented currents through said line circuit, each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another.

2. In a telegraph system comprising a transmitting station, a receiving station and a line circuit between said stations, means located at the transmitting station adapted simultaneously to transmit reversed currents and augumented currents through said line circuit, each reversed current impulse, representing a dot, and each augmented current impulse representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another, and receiving means located at said receiving station comprising a polarized relay and a non-polarized relay and separate automatic receiving devices controlled by the respective relays.

3. In a telegraph system comprising a transmitting station and a receiving station, a line circuit, current reversing means and current augmenting means associated with the line circuit at the transmitting station and adapted to transmit two sets of signals simultaneously, and two sets of signal receiving means associated with the line circuit at the receiving station, said circuit transmitting means being adapted to act in unison so that when two sets of signals are being transmitted simultaneously, each reversed current impulse, representing a dot and each augmented current impulse representing a dot, will start simultaneously and will stop simultaneously so that the two impulses will accurately be in phase with one another.

4. In a telegraph system comprising a transmitting station and a receiving station, a line circuit connecting said stations, current reversing means and current augmented means arranged at the A and B sides respectively of the transmitting station for transmitting two sets of signals simultaneously to said line circuit, two telegraphic transmitters adapted to actuate said current reversing means and current augmenting means in unison so that each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, will start simultaneously and will stop simultaneously so that the two impulses will accurately be in phase with one another, signal receiving devices arranged at the A and B sides of the receiving station, and automatic receiving apparatus, also arranged at the A and B sides of the receiving station and respectively controlled by the signal receiving devices at the corresponding sides of the receiving station.

5. In a telegraph system comprising a transmitting station and a receiving station, a line circuit connecting said stations, means adapted to transmit current of reversed sign and also means for transmitting currents of augmented strength, simultaneously to said line circuit and located at the A and B sides respectively of the transmitting station and two telegraphic transmitters adapted to cause the two current transmitting means to work in unison so that each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, will start simultaneously and will stop simultaneously so that the two impulses will accurately be in phase with one another, a polarized relay and a non-polarized relay arranged in the line circuit and

at the A and B sides respectively of the receiving station and separate automatic receiving devices controlled by the respective relays.

6. In a telegraph system comprising two stations and a line circuit between said stations, current reversing key mechanism and current augmenting key mechanism arranged at one station and adapted to transmit two sets of signals simultaneously to said line circuit, said current reversing key mechanism comprising a stationary contact, a movable contact, said contacts being electrically connected to the current augmenting key mechanism, a movable arm carrying said movable contact, a current reversing lever mounted to work between said stationary and movable contacts and connected to said line circuit, a spring tending to move said lever towards and against said stationary contact and a telegraphic transmitter adapted to oscillate said arm and cause electric signals of alternately opposite sign to be transmitted to the line circuit under the control of the transmitter.

7. In a telegraph system comprising two stations and a line circuit between said stations, current reversing key mechanism and current augmenting key mechanism arranged at one station and adapted to transmit two sets of signals simultaneously to said line circuit, two batteries common to the two key mechanisms and connected at one pole to earth, said current reversing key mechanism comprising a stationary contact, a movable contact, an arm carrying said movable contact, a current reversing lever mounted to work between said stationary and movable contacts and connected to said line circuit and a spring tending to move said lever towards and against said stationary contact, and said current augmenting key mechanism comprising two separate levers, a stationary contact and a movable contact associated with each of the two last mentioned levers, a spring associated with each of said two levers and tending to move the corresponding lever against the corresponding stationary contact, a second movable arm arranged between the said two levers and carrying at opposite sides thereof the two movable contacts associated with the said two levers, one of the said two levers being connected to the movable contact of the current reversing key mechanism and the other of the two said levers being connected to the stationary contact of the said current reversing key mechanism and the stationary and movable contacts associated with the said two levers being insulated from each other and connected substantially as herein described to said electric batteries, and telegraphic transmitters adapted to work in unison with one another, one transmitter being arranged to cause the oscillation of the lever of the reversing key mechanism and the other to cause the oscillation of the two levers of the current augmenting key mechanism, substantially as described.

8. A telegraph system comprising two stations and a line circuit between them, current reversing mechanism and current augmenting mechainism located at one station and associated with the line circuit, separate relays associated with the current reversing mechanism and current augmenting mechanism and adapted to operate the same and separate telegraphic transmitters adapted to operate said relays and thereby enable two sets of signals to be transmitted simultaneously to the line circuit, said transmitters being driven in unison so that each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, will start simultaneously and will stop simultaneously so that the two impulses will accurately be in phase with one another.

9. A telegraph system comprising two stations and a line circuit between them, current reversing means and current augmenting means located at the A and B sides of one station and adapted simultaneously to transmit to the line circuit two sets of signals, each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another, a polarized relay and a non-polarized relay arranged at the A and B sides respectively of the other station and in the line circuit and automatic high speed receiving devices arranged at the A and B sides of the second station and separately controlled by the relays at the corresponding sides of the station.

10. A telegraph system, comprising two stations and a line circuit between them, current reversing means and current augmenting means located at the A and B sides of one station and adapted to transmit simultaneously to the line circuit two sets of signals, each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another, a polarized relay and a non-polarized relay arranged at the A and B sides respectively of the other station and in the line circuit, an automatic high speed receiving device arranged at the A side of the second station, a local battery controlled by the non-polarized relay, a high speed polarized relay arranged at the B side of the second station and actuated by current from said local battery under the control of the non-polarized relay and an

automatic high speed receiving device controlled by the said high speed polarized relay.

11. A quadruplex telegraph system comprising two stations, a line circuit between said stations, means located at each station adapted to transmit simultaneously to said line circuit, reversed currents and augmented currents, each reversed current impulse, reproducing a dot, and each augmented current impulse, representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another, a polarized relay and a non-polarized relay arranged in series with each other and with said line circuit at each station and two high speed receiving devices located at each station, one controlled by the polarized relay and the other by the non-polarized relay at the corresponding station.

12. A quadruplex telegraph system comprising two stations, a line circuit between said stations, current reversing means and current augmenting means located at the A and B side of each station adapted to transmit simultaneously to said line circuit reversed currents and augmented currents, each reversed current impulse, representing a dot, and each augmented current impulse, representing a dot, starting simultaneously and stopping simultaneously, so that the two impulses will be accurately in phase with one another, a polarized relay and non-polarized relay arranged at the A and B sides respectively of each station and in series with one another and the line circuit, a local battery at each station, a high speed polarized relay at the B side of each station, energized by current from the local battery at the corresponding station under the control of the non-polarized relay at the same station, and two high speed automatic receiving devices at each station, one receiving device being controlled by the polarized relay at the A side of the corresponding station and the other controlled by the high speed polarized relay at the B side of the corresponding station.

Signed at London, England, this twelfth day of May 1924.

FREDERICK GEORGE CREED.
ETHELRED ALFRED WILLSON.