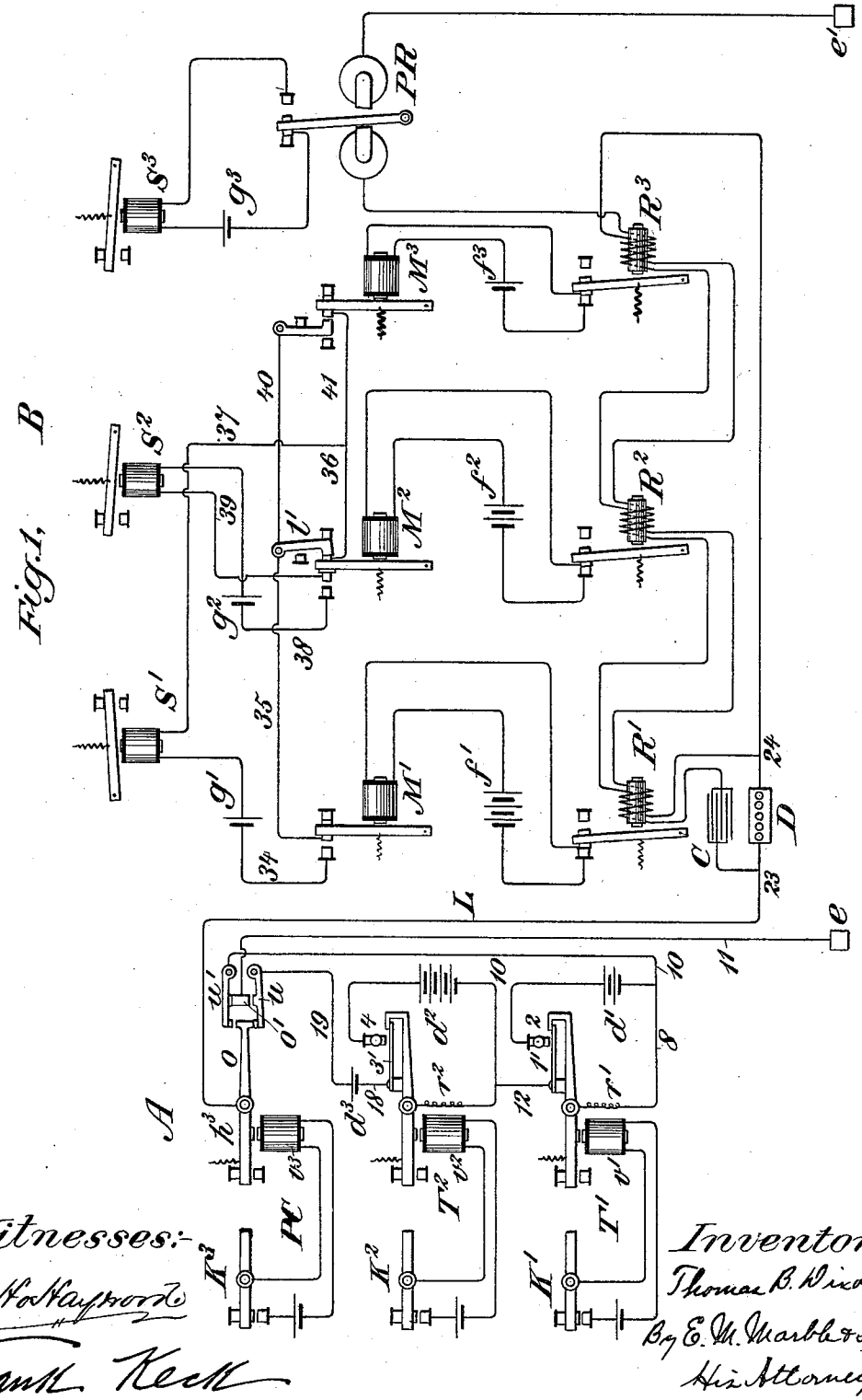
(No Model.) 2 Sheets—Sheet 1.

T. B. DIXON.

SYSTEM OF MULTIPLEX TELEGRAPHY.

No. 543,984. Patented Aug. 6, 1895.



Witnesses:-
D. McKaynorth
Frank Keck

Inventor:-
Thomas B. Dixon
By E. M. Marble & Son
His Attorneys.

(No Model.) 2 Sheets—Sheet 2.

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SYSTEM OF MULTIPLEX TELEGRAPHY.

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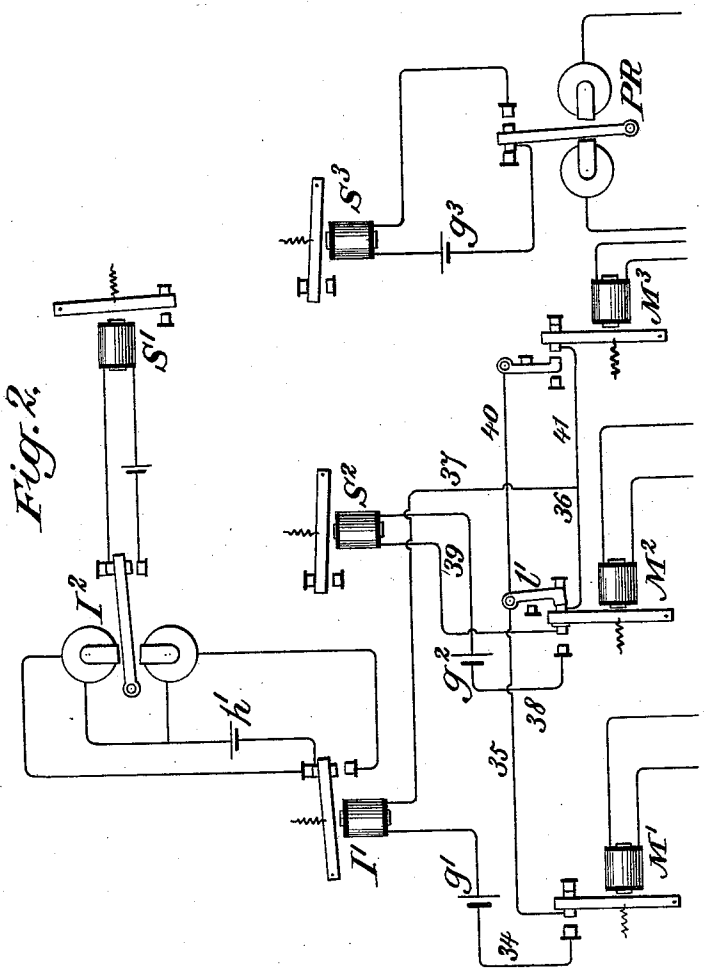
Fig. 2.



Witnesses:-

D. N. Hayford

Frank Keck

Inventor:-

Thomas B. Dixon

By E. M. Marble & Sons

His Attorneys

UNITED STATES PATENT OFFICE.

THOMAS BULLITT DIXON, OF HENDERSON, KENTUCKY.

SYSTEM OF MULTIPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 543,984, dated August 6, 1895.

Application filed October 19, 1894. Serial No. 526,349. (No model.)

To all whom it may concern:

Be it known that I, THOMAS BULLITT DIXON, a citizen of the United States, residing at Henderson, in the county of Henderson and State of Kentucky, have invented certain new and useful Improvements in Systems of Multiplex Telegraphy; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to systems of multiplex telegraphy wherein two or more distinct and separate messages are transmitted over a single line-wire; and my invention consists in the novel means employed for controlling the receiving-instruments, so that each receiving-instrument shall be operated by its corresponding transmitter only, and in the means employed for preventing mutilation of the signals given by the receivers.

The objects of my invention are, first, to provide a system of telegraphy in which two, or more than two, distinct messages may be transmitted in the same direction over a single wire, and which may be combined with well-known methods of double transmission of messages in opposite directions, so that an equal number of messages may be transmitted at the same time, in the opposite direction, over the same line-wire, and without confusion or mutilation of signals; second, to provide means for so operating each receiving-instrument that it may be operated by its corresponding transmitter only, and may be operated by that transmitter whether other transmitters are operating simultaneously therewith or not, and, third, to provide means for preventing mutilation of the signals of the receivers, so that each signal given may be as distinct when all of the transmitters are operating as though it were the only signal being transmitted over the line. These objects are attained in the system of telegraphy herein described and illustrated in the drawings which accompany and form a part of this application, in which the same reference letters and numerals indicate the same or corresponding parts, and in which—

Figure 1 illustrates an arrangement of instruments and circuits for transmitting three distinct messages simultaneously in one direction over one line-wire, there being, therefore, three transmitting-instruments and three corresponding receiving-instruments, with appropriate means for controlling the operation of the receiving-instruments, so that each will respond to the operation of its corresponding transmitting-instrument alone, and with means for preventing mutilation of the signals of the receiving-instruments. Fig. 2 is a detail view illustrating a modified method of controlling the operation of the receiving-instruments, and particularly of the first receiving-instrument, when, as on very long lines, it is found difficult to entirely prevent mutilation of the signals of this receiver by the means shown in Fig. 1, to be hereinafter described.

In Fig. 1, d', d^2, and d^3 are batteries of unequal strength. d^3 may be assumed, for convenience, to be a battery of fifty units current strength, d' a battery of one hundred units, and d^2 a battery of two hundred units, these units indicating not battery strengths absolutely required, but mere ratios of strength, and these ratios of battery strength are not fixed, but may be varied very greatly. For convenience in description, however, it is well to assume some definite ratio of battery strengths. The circuit of battery d^3 is always closed, this circuit being controlled and operated by a pole-changing key, the construction of which is such that the battery is always to the line. The circuits of batteries d' and d^2 are operated by ordinary transmitters T′ and T², respectively, and these batteries are cut out of the line-circuit normally, as shown, each battery being put to the line when its corresponding transmitting-key is depressed. The depressing of each transmitting-key, therefore, adds a certain strength of current to the line. Thus transmitter T′ when operated adds the current of battery d' or one hundred units of current strength to the line, and transmitter T² when operated adds the current of battery d^2 or two hundred units of current strength to the line, and this is true of each transmitter, as will be seen when the circuits are described, whether or not another transmitter is closed and its battery to the line.

PC is a pole-changing transmitter of a well-known type, and the circuits are so arranged

that if the pole-changer be operated while either of the batteries d' or d^2, or both, are to the line, the current of such battery or batteries, as well as that of battery d^3, will be reversed in direction. Normally the current from battery d^3 passes from the positive pole of the battery over wire 19 to the contact-lever u of the pole-changer PC, thence through the arm o of the armature-lever h^3, over the line-wire L to 23 at the receiving-station B, through the rheostat D, through the coils of line neutral relays R′, R², and R³, and the polarized relay PR to earth at e', through the earth to e, over wire 11 to contact-stop o' of the pole-changer PC, through contact-lever u', wires 10 and 8, and resistance-coil r', through the armature-lever and the tongue 1′ of the transmitter T′, wire 12, resistance-coil r^2, the armature-lever and tongue 3′ of transmitter T², and thence over wire 18 to the negative pole of battery d^3.

The pole-changing key PC and the single transmitting-keys, such as T′, are preferably operated by the electromagnets v', v^2, and v^3, respectively, which are in the circuits of local batteries, as shown, these circuits being completed by the depression of the finger-keys K′, K², and K³, respectively. The resistance-coils r' and r^2 are respectively equal in resistance to the batteries d' and d^2. The object of providing these resistance-coils is to maintain the resistance of the line constant, so that the increase in the strength of current will always be directly proportional to the added electromotive force when battery d' or d^2, or both of them, are put to the line.

When one of the single transmitters, as T′, is operated, the arm of the armature-lever which carries the tongue moves upward, bringing the tongue in contact with the upper stop, and then moving upward still farther, breaks the contact of the tongue with the armature-lever. Batteries d' and d^2 have their positive poles connected with the stops 2 and 4, respectively, and their negative poles connected to the wires 10 and 12, respectively, as shown. It will be seen that when that end of a transmitter-lever which carries the contact-tongue is raised contact will be made between the tongue and stop before contact is broken between the tongue and armature-lever, the effect being to cut the corresponding resistance-coil out of the line and to put the corresponding battery to the line, placing it in series with battery d^3, which is always to the line. Therefore the operation of any of the transmitters has the effect of adding current to the line without affecting its resistance. The effect of operating the pole-changing transmitter is to reverse the direction of the current without affecting its strength. There is always a strength of at least fifty (the strength of battery d^3) to the line, and this may be said to represent the normal strength of current on the line. Three different strengths of current may be obtained through the different combinations resulting from putting batteries d' and d^2 to the line singly and together—viz., one hundred and fifty, two hundred and fifty, and one hundred plus two hundred plus fifty, or three hundred and fifty. It will be evident, therefore, that three relays may be placed in the line-circuit, their sensitiveness being so regulated that none of them will be affected by the normal strength of fifty and that it will require a strength of one hundred and fifty to operate the first relay, a strength of two hundred and fifty to operate the second, and a strength of three hundred and fifty to operate the third, and that receiving-instruments may be operated by such relays. At the receiving-station B such an arrangement of relays is shown. These relays are lettered R′, R², and R³. They are all "neutral" relays and are not influenced, therefore, by the direction of the current flowing through their magnet-coils, but only by changes in its strength. Their sensitiveness is such that a current having a strength of one hundred and fifty will operate R′, a current having a strength of two hundred and fifty will operate both R′ and R², and a current having a strength of three hundred and fifty will operate R′, R², and R³. Their sensitiveness is regulated by regulating the strength of the retractile springs which act on the armatures, R′ having the weakest spring and R³ the strongest spring. These relays are provided with two coils of wire, one of these coils being in the line-circuit and the other in the circuit of the condenser C, which is in a loop or branch circuit from the line, the terminals of the loop being at 23 and 24, which are also the terminals of the rheostat D, the function of the rheostat being to produce a considerable difference of potential between the condenser-terminals. The object of this condenser will be explained hereinafter. Bearing in mind that the neutral relays each respond only to strengths of current equal to or greater than the strengths above specified, it will be seen that the operation of transmitter T′ will operate only relay R′, T² will operate both R′ and R², and T′ and T² together will operate R′, R², and R³.

M′, M², and M³ are selecting-relays corresponding, respectively, to line-relays R′, R², and R³, and each controlled by a local circuit passing through contact-points of its corresponding line-relay, which circuit is normally closed, but is arranged to be broken when the magnet of the corresponding line-relay is energized sufficiently to raise its armature. The batteries of these local circuits vary in strength, f', the battery of relay M′, being the strongest battery, f^2, the battery of relay M², being of intermediate strength, and f^3, the battery of relay M³, being the weakest. Their strengths, therefore, vary in inverse order to the current strengths by which the corresponding line-relays R′, R², and R³ are operated. The armature-springs of selecting-relays M′, M², and M³ likewise differ in strength in inverse order to the strengths of

the local batteries corresponding to those selecting-relays, M′ having the weakest spring and M³ the strongest spring. The current strengths in the local circuits and the strengths of the springs of the selecting-relays are adjusted in the manner described in order to avoid mutilation of the signals of the receiving-instruments. The manner in which this object is attained will be hereinafter described.

Relay M′ is a neutral relay of the ordinary type. Relay M² operates two sets of contact-points, one above and the other below its armature, the upper contact-point being a continuity-preserving contact-point. Relay M³ operates one set of contact-points, which is below the armature, and has a continuity-preserving contact-point.

S′, S², and S³ are receiving-instruments or sounders of the ordinary type. Sounder S³ is operated by a local circuit controlled by polar relay PR, while sounders S′ and S² are operated by local circuits controlled by selecting-relays M′, M², and M³. The circuit for operating sounder S′ passes from the negative pole of battery g' through wire 34, the lower contact of relay M′, which contact is broken normally, since the magnet of relay M′ normally is energized through wire 35 to the contact-lever l' of relay M², which contact-lever normally is in contact with the upper armature-contact of the relay, and through wires 36 37 and the magnet of sounder S′ back to the positive pole of battery g'. The circuit for operating sounder S² passes from the negative pole of battery g^2 through the wire 38, the lower contact of relay M², which contact normally is broken, and through wire 39 and the magnet of sounder S² back to the positive pole of battery g^2.

The operation of the circuits herein described is as follows: Supposing finger-key K′ to be depressed, the magnet of transmitter T′ is energized and its armature is attracted, throwing into the line-circuit battery d', and thereby making the strength of current in the line, according to the assumed values of battery strength, one hundred and fifty units. This current strength is sufficient to cause the armature of relay R′ to be attracted, but is not sufficient to affect the armatures of relays R² and R³. The armature of relay R′ being attracted, the circuit of battery f' is broken and the armature of selecting-relay M′ falls, completing the circuit of battery g' through the lower contact of relay M′, wire 35, contact-lever l' of relay M², the upper contact of this relay, wires 36 and 37, and the magnet of sounder S′, thereby operating this sounder. When the key K′ is released, battery d' is thrown out of the line-circuit, the armature of relay R′ falls, the armature of relay M′ rises, and the circuit of battery g' is broken at the lower contact of relay M′. When hand-key K² is depressed, the armature of transmitter T² is attracted and battery d^2 is thrown into the line-circuit, making the current strength in the line two hundred and fifty units. This current strength is sufficient to cause the armatures of line-relays R′ and R² to be attracted, but does not affect the armature of relay R³. The rise of the armatures of relays R′ and R² breaks the circuits of selecting-relays M′ and M², causing their armatures to fall. The fall of the armature of relay M² closes its lower contact, thereby completing the circuit of sounder S² and operating that sounder. The fall of the armature of relay M′ closes the lower contact of that relay, but does not complete the circuit of sounder S′, which is broken now at the upper contact of relay M², the contact-lever l' being no longer in contact with the armature of that relay. Therefore the sounder S′ is not affected by the fall of the armature of relay M′ when the armature of relay M² likewise falls and only sounder S² is operated when hand-key K² is depressed. When hand-keys K′ and K² are depressed together, both batteries d' and d^2 are placed to the line, giving a current strength in the line of three hundred and fifty units. This current strength is sufficient to cause the armatures of relays R′, R², and R³ to be attracted, breaking the circuits of selecting-relays M′, M², and M³ and causing their armatures to fall. The closing of the lower contact of relay M² completes the circuit of sounder S², and the closing of the lower contact of relay M³ completes the circuit of sounder S′ through the lower contact of relay M′, wires 35 and 40, the lower contact of relay M³, and wires 41 and 37, back to battery. When both transmitters T′ and T² are operated together, therefore, both sounders S′ and S² are likewise operated. If while key K′ is depressed, and consequently while the circuit of sounder S′ is completed through the lower contact of relay M′ and the upper contact of relay M², key K² is depressed, the armature of relay M² will fall; but the armature of relay M³, likewise falling, prevents the circuit of sounder S′ from being interrupted. If the upper contact-point of relay M² and the lower contact-point of relay M³ were ordinary fixed contact-points, there would be a brief interruption of the circuit of sounder S′ in the interval of time after the armature of relay M² had left its upper contact-point and before the armature of relay M³ had reached its lower contact-point; but the upper contact-point of relay M² and the lower contact of relay M³ are both continuity-preserving contact-points, which follow the armature through a portion of its movement, and the adjustment and operation of these contact-points is such that the armature of relay M³ makes contact with its lower contact-point before the armature of relay M² breaks contact with its upper contact-point, when the armatures of these relays fall together, and when the armatures of the relays rise together contact is made by the armature of relay M² with its upper contact-point before contact is broken be-

tween the armature of relay M^3 and its lower contact-point. There is no momentary interruption in the circuit of sounder S', therefore, when the armatures of relays M^2 and M^3 rise, which interruption, did it take place, would lead to mutilation of the signal of sounder S'. The release of key K' while key K^2 is depressed, and the consequent rising of the armature of relay M^3, does not affect the circuit of sounder S^2, which is controlled by the relay M^2 only.

In practice it is found that it is impossible to entirely avoid the mutilation of the signals of sounder S' by simply adjusting the continuity-preserving contact-points of the relays M^2 and M^3, owing to the fact that relay R^2 being more sensitive than relay R^3, and relay R' being more sensitive than relay R^2, the armatures of the more sensitive relays move more rapidly than the armatures of the less sensitive relays when the magnets of the relays are energized and move more slowly than the armatures of the less sensitive relays when the magnets are de-energized, this being due to the difference in the strength of the retractile springs of the line-relays. These differences in the times of movement of the armatures of the line-relays will cause mutilation of the signals of sounder S', unless special means be employed to prevent, and will render the signals unintelligible. The manner in which this mutilation may occur may be best understood by assuming that the selecting-relays are operated by equal strengths of current and are of equal sensitiveness, having retractile springs of the same strength. If then battery d^2 is put to the line while battery d' is not to the line the armature of relay M' may close contact with its lower stop or contact-point before the armature of relay M^2 breaks contact with its upper contact-point, thus causing sounder S' to give a momentary click, and when battery d^2 is again cut out of the line-circuit and the armatures of relays M' and M^2 are again attracted by their respective magnets contact may be closed between the armature of relay M^2 and its upper contact-point before contact is broken between the armature of relay M' and its lower contact, with the result of causing again a false click of the sounder S'.

Again, assuming that battery d' is to the line, so that sounder S' has its circuit completed as above described, and that while it is so completed battery d^2 is put to the line, so that the armatures of relays R^2 and R^3 are raised, the armature of relay R^2 will break contact with its lower contact-point a little before the armature of relay R^3 does likewise, and therefore the armature of relay M^2 will begin to move before the armature of relay M^3 does so and will break contact with its upper contact-point a moment before contact is made by the armature of relay M^3 with its lower contact-point, the result being that the circuit of sounder S' is momentarily broken. Likewise, when battery d^2 is cut out of the line, so that the armatures of relays R^2 and R^3 fall, the armature of relay R^3 will close contact with its lower contact-point an instant before the armature of relay R^2 will do likewise, so that the armature of relay M^3 will break contact with its lower contact-point an instant before contact is completed between the armature of relay M^2 and its upper contact-point, the interruption of the circuit of sounder S' being greater when battery d^2 is cut out of the line than when it is put to the line, because in the first case the armatures of relays R^2 and R^3 break contact with their lower contact-points almost the instant they begin to move, while in the second case each armature must move through a considerable distance before it makes contact with its contact-point, and the armature of relay R^3, being acted upon by a much stronger spring than that of relay R^2, will close contact sooner. It will be seen, therefore, that in order to prevent this mutilation of the signals of sounder S' the following conditions must be complied with: Upon the putting of batteries to the line the armatures of the selecting-relays affected thereby either must move simultaneously, so as to make and break contact simultaneously, or else must move in such a manner that when their armatures fall contact will be broken by the armature of relay M^2 with its upper contact-point before the armature of relay M' closes contact with its lower contact-point and will be closed by the armature of relay M^3 with its lower contact-point before the armature of relay M^2 breaks contact with its upper contact-point, and when batteries are cut out of the line the armatures either must move simultaneously, so as to make and break contact simultaneously, or else contact must be broken by the armature of relay M' with its lower contact-point before contact is completed by the armature of relay M^2 with its upper contact-point and contact must be completed by the armature of relay M^2 with its upper contact-point before contact is broken by the armature of relay M^3 with its lower contact-point. In order to accomplish these results, I make the retractile springs, which act upon the armatures of relays M', M^2, and M^3, of unequal strength, the spring of relay M^3 being the strongest and the spring of relay M' being the weakest, and cause these relays to be operated by currents of different strengths, the current of relay M' being the strongest and the current of relay M^3 being the weakest. When, therefore, the hand-key is depressed, so that battery d^2 is put to the line and through the operation of the line-relays the armature of relay M' is released an instant before the armature of relay M^2 is released, the armature of relay M^2 will break contact, nevertheless, with its upper or continuity-preserving contact-point before the armature of relay M' closes contact with its lower contact-point, because the retractile spring of relay M^2 is stronger than

that of relay M′ and will cause it to move with a sufficiently greater velocity to compensate for the difference in time of starting. When battery d' is already to the line and battery d^2 is put to the line the armature of relay M^3 will close contact with its lower contact-point before the armature of relay M^2 breaks contact with its upper contact-point, because of the greater strength of its retractile spring, thus preventing the interruption of the circuit of sounder S′. If both keys K′ and K^2 be depressed simultaneously it will be seen that no mutilation can occur, since the armature of relay M^3 will complete contact with its lower contact-point before the armature of relay M^2 can break contact with its upper contact-lever.

If while battery d^2 is to the line, so that the armatures of relays M′ and M^2 are in contact with their lower contact-points, the battery d^2 be cut out of the line-circuit, so that relays R^2 and R′ release their armatures, the armature of relay R^2 will make contact with its lower contact-point before the armature of relay R′ will do so; but there can be no mutilation, because battery f' is stronger than battery f^2 and will cause the armature of relay M′ to break contact with its lower stop before the armature of relay M^2 can have moved through the space required for it to engage with its upper contact-lever. If when both batteries d' and d^2 are to the line, so that the armatures of all three of the selecting-relays are in contact with their lower contact-points, battery d^2 be cut out of the line-circuit, the armature of relay R^3 will be released slightly before that of relay R^2, and, owing to its stronger retractile spring, will move more rapidly and will reach its lower contact-point before the armature of relay R^2 does so; but the fact that battery f^2 is stronger than battery f^3 compensates for this, causing the armature of relay M^2 to move with greater rapidity than the armature of relay M^3, so that although the armature of relay M^3 begins to move first the armature of relay M^2, because of its greater velocity, will close contact with its contact-lever before the armature of M^3 can break contact with its contact-lever. It will be seen, also, that the desired effects to be produced by making the batteries f', f^2, and f^3 of an unequal strength will be enhanced by the fact that the strengths of the retractile springs which the selecting-relay magnets have to overcome are in inverse order to the strengths of the batteries.

If, when batteries d' and d^2 are to the line, so that the magnets of all three of the selecting-relays are de-energized, both batteries be cut out of the line-circuit, the armature of relay R^3 will reach its lower stop first, that of relay R^2 second, and that of relay R′ last, and the circuits of the selecting-relays will be completed in corresponding order. There can be no interruption and mutilation of the signal of sounder S′, however, since the operation of relays M^2 and M^3 relatively to each other is in nowise different from the operation in the case just described, wherein battery d^2 alone was cut out of the line, and the circuit of sounder S′ will not be interrupted until the armature of relay M′ begins to return to normal.

Instead of producing the difference in current strength in the local circuits operating the selecting-relays by using batteries of different strengths, all of the local circuits may be supplied from one battery, the differences in current strength in the different local circuits being obtained by placing suitable resistance in the circuits.

So far the operation of transmitters T′ and T^2 and of receiving-instruments S′ and S^2, with the instruments and circuits by which they are operated, alone have been considered. When the hand-key K^3 is depressed pole-changing transmitter PC is operated, changing the direction of the current in the line without affecting the continuity of the circuit. Neutral relays R′, R^2, and R^3 are not affected by the change in the direction of the current in the line, except that during the exceedingly brief instant while the current is changing its direction the magnets of the neutral relays may be de-energized, but the change in direction of the line-current deflects the armature of polar relay PR, closing the circuit of sounder S^3 and causing that sounder to give a signal. When the hand-key K^3 is released the armature of relay PR returns to its first position. During the instant when the current in the line is changing direction there is an exceedingly brief instant during which no current is flowing through the line. To prevent any danger of the armatures of the line-relays being released during this brief instant the condenser C is employed. When the strength of the current drops during the time that it is changing direction the condenser discharges, setting up a current of the same direction as the new direction of the line-current, and so preventing the magnets of the line-relays from being de-energized. The condenser likewise acts to cause the armatures of the line-relays to move more promptly, for when the strength of current in the line is increased the condenser charges, current passing through the condenser-coils of the line-relays in the same direction as the line-current, and when the current in the line is decreased the condenser sends through the condenser-coils of the line-relays a current passing in the opposite direction from the line-current, and therefore opposing and momentarily decreasing the residual magnetism of the magnets.

In Fig. 2 is illustrated a detail view of a means for preventing mutilation of the signals of the sounders, and particularly of the first sounder S′, which may be used where mutilation of the signals is not entirely prevented by the devices employed in Fig. 1, as may happen on very long lines. In this arrangement an intermediate relay I′ is substi-

tuted for the sounder S′ in the circuits of Fig. 1 and controls a second intermediate relay I^2, which is what may be termed a "dead-beat" relay. This relay consists of an armature pivoted to swing between two magnets placed on opposite sides of the armature, the circuit of each magnet being independent of the other. The relay I′ is arranged to complete the circuit through the one magnet of relay I^2 or the other, according as the armature of relay I′ is in proximity to its magnet or is away therefrom. For this purpose the relay has both upper and lower contacts engaging with its armature. The negative pole of a battery h' is connected to the armature, and to the upper and lower contacts are connected two wires, each leading through one of the magnet-coils of relay I^2 to a return-wire leading to the positive pole of battery h'. It will be seen therefore that if the armature of relay I′ is in contact with its upper contact-point the armature of relay I^2 will be deflected to the left and if the armature of relay I′ be in contact with its lower contact-point the armature of relay I^2 will be deflected to the right.

Relay I^2 is termed a "dead-beat" relay because of the fact that its armature, when deflected in one direction, remains in that position until deflected in the other direction. It may be a polar relay, with the magnet-coils connected with the battery in the manner described, but is not necessarily a polar relay, since the magnetized armature, characteristic of the polar relay, is not necessary.

There are two means by which a false signal of sounder S′ may be caused and which a device for preventing mutilation must prevent. One is a momentary false completion of the circuit through conductors 34 and 35, when transmitter T′ is not closed, and this circuit should be broken. The other is a momentary breakage of the circuit through conductors 34 and 35, when transmitter T′ is closed, and this circuit should be closed also. In the first case the armature of relay I′ will be down. A momentary completion of the circuit will cause the armature to make a slight kick upward, breaking the circuit of relay I^2, but not causing the armature of relay I^2 to move, since in order to move the armature of this relay it is necessary that the circuit through the right-hand magnet of the relay shall be completed for an appreciable period of time and the armature of relay I′ will not remain up long enough to deflect the armature of relay I^2, since the false current through conductors 34 and 35 can exist for only an exceedingly-brief period of time. The sounder S′ will not be affected by this momentary completion of the circuit through relay I′ therefore. If, on the other hand, while the circuit of relay I′ is completed through the closing of transmitter T′, so that the armature of relay I^2 is to the right and the circuit of sounder S′ is completed, the circuit of relay I′ be momentarily interrupted through a mutilation caused by the operation of the selecting-relays controlling other sounders, the armature of relay I′ will fall, but because the time during which the circuit of relay I′ will be interrupted is exceedingly brief the armature of relay I′ will not be down long enough to complete the circuit through the left-hand magnet of relay I^2 and to cause the armature of that relay to be deflected, so that the circuit of sounder S′ will not be interrupted. It will be seen, therefore, that by using the device shown in Fig. 2, in connection with the circuits of Fig. 1, mutilation of the signals of the sounders may be prevented where the means for preventing mutilation (shown in Fig. 1) are insufficient.

By increasing the number of transmitters, transmitting-batteries, line and selecting relays, and receivers it is possible to transmit a greater number of signals in one direction than three, the only obstacle being the number of line and selecting relays that must be used when the number of signals to be transmitted is four or more and the high potential in the line when all of the transmitters are closed.

By combining the circuits shown in Fig. 1 with any of the well-known duplex systems the system may be adapted for transmitting an equal number of signals in the opposite direction, so that with three transmitters and receivers at each end of the line six messages may be transmitted simultaneously, each message being distinct from all of the others.

Having thus completely described my invention, what I desire to secure by Letters Patent is—

1. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, and transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter or transmitters vary the strength of said line current, of line relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said transmitters, a receiving instrument corresponding to each transmitting instrument, circuits for controlling said receiving instruments, selecting relays corresponding to said line relays and adapted to prevent the operation of a receiving instrument when the transmitting instrument corresponding thereto is not affecting the current strength in the line, local circuits controlled by said line relays for controlling said selecting relays, the strengths of current in said local circuits varying in inverse order to the sensitivenesses of the line relays, and retractile springs for the armatures of said selecting relays varying in strength in inverse order to the strengths of the currents operating the selecting relays, substantially as described.

2. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, and two

transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter varies the strength of said line current, of three line relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said transmitters, two receiving instruments corresponding to said transmitters, circuits for controlling said receiving instruments, three selecting relays corresponding to said line relays and operated thereby, the first of said selecting relays being adapted when operated to close the circuit of the first receiver, the second of said selecting relays being adapted when operated to break the circuit of the first receiver and to close the circuit of the second receiver, and the third of said selecting relays being adapted when operated to close the circuit of the first receiver around the second selecting relay, and means for preventing the mutilation of the signals of the first receiver when the second receiver is operated, substantially as described.

3. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, and two transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter varies the strength of said line current, of three line relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said transmitters, two receiving instruments corresponding to said transmitters, circuits for controlling said receiving instruments, three selecting relays corresponding to said line relays and operated thereby, the first of said selecting relays being adapted when operated to close the circuit of the first receiver, the second of said selecting relays being adapted when operated to break the circuit of the first receiver and to close the circuit of the second receiver, and the third of said selecting relays being adapted when operated to close the circuit of the first receiver around the second selecting relay, and means for regulating the times of movement of the armatures of said selecting relays, substantially as described.

4. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, and two transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter varies the strength of said line current, of two receiving instruments corresponding to said transmitters, three line relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said transmitters, a selecting relay corresponding to each line relay, local circuits controlled by said line relays for controlling said selecting relays, the strengths of current in said local circuits varying in inverse order to the sensitivenesses of the line relays, retractile springs for the armatures of said selecting relays varying in strength in inverse order to the strengths of the currents operating the selecting relays, and contact points operated by said selecting relays and controlling said receiving instruments, the first of said selecting relays being adapted when operated to close the circuit of the first receiver, the second of said selecting relays being adapted when operated to break the circuit of the first receiver and to close the circuit of the second receiver, and the third of said selecting relays being adapted when operated to close the circuit of the first receiver around the second selecting relay, substantially as described.

5. In a system of telegraphy, the combination with a line conductor and a transmitting instrument arranged to vary the line current, of a receiving instrument corresponding to said transmitter and operated by a dead beat relay, and a second relay operated by variations in the line current, controlling said dead beat relay and arranged to cause the armature of said dead beat relay to be deflected in one direction or the other, according to the position of the armature of said second relay, substantially as described.

6. In a system of telegraphy, the combination with a line conductor and a transmitting instrument arranged to vary the line current, of a receiving instrument corresponding to said transmitter, a relay for operating said receiving instrument, having an armature and independent magnets acting oppositely on said armature, a circuit for each of said magnets and a second relay operated by variations in the line current, controlling the circuits of said magnets, and arranged to cause current to pass through one or the other of said magnets according to the position of the armature of said second relay, substantially as described.

7. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, and transmitting instruments connected to said line conductor, of a receiving instrument corresponding to one of said transmitters, a dead beat relay controlling said receiving instrument, a second relay controlling said dead beat relay and adapted to cause the armature of said dead beat relay to be deflected in the one direction or the other according as the armature of said second relay is in proximity to its magnet or away from said magnet, and means operated through changes in the line current for operating said second relay, substantially as described.

8. In a system of multiple telegraphy, the combination, with a line conductor, means for

supplying current to the line, and two transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter varies the strength of said line current, of three line relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said transmitters, three selecting relays corresponding to said line relays and operated thereby, means for regulating the times of movement of the armatures of said selecting relays, a relay I′, a dead beat relay I^2 controlled by said relay and arranged to deflect its armature to one side or the other according as the armature of said relay is in proximity to its magnet or is away from said magnet, a receiving instrument controlled by said dead beat relay I^2, contact points of said selecting relays for controlling said relay I′, the first selecting relay being adapted when operated to close the circuit of said relay I′, the second selecting relay being adapted when operated to break the circuit of said relay I′ and to operate a second receiving instrument, and the third of said selecting relays being adapted to complete the circuit of said relay I′ around said second selecting relay, substantially as described.

9. In a system of multiple telegraphy, the combination, with a line conductor, means for supplying current to the line, current varying transmitting instruments each adapted when operated to vary the current strength of the line to a degree different from that by which the other transmitter or transmitters varies the strength of said line current, and a pole changing transmitter connected to said line conductor and adapted when operated to change the direction of current in the line, of line neutral relays of different sensitivenesses each corresponding to and adapted to respond to one of the different strengths of current produced by the operation of said current varying transmitters, a line polar relay adapted to respond to the reversal of the line current by said pole changing transmitter, a receiving instrument corresponding to said pole changing transmitter and a circuit controlling said receiving instrument and controlled by said polar relay, a receiving instrument corresponding to each of the current varying transmitting instruments, local circuits for controlling said last named receiving instruments, selecting relays corresponding to said line relays and adapted to prevent the operation of a receiving instrument when the transmitting instrument corresponding thereto is not affecting the current strength in the line, local circuits controlled by said line relays for controlling said selecting relays, the strengths of current in said local circuits varying in inverse order to the sensitivenesses of the line relays, and retractile springs for the armatures of said selecting relays varying in strength in inverse order to the strengths of the currents operating the selecting relays, substantially as described.

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

THOMAS BULLITT DIXON.

Witnesses:

JANDINE LYNG,

H. M. MARBLE.