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S. D. FIELD.

QUADRUPLEX TELEGRAPHY.

APPLICATION FILED AUG. 20, 1904.

Fig. 1

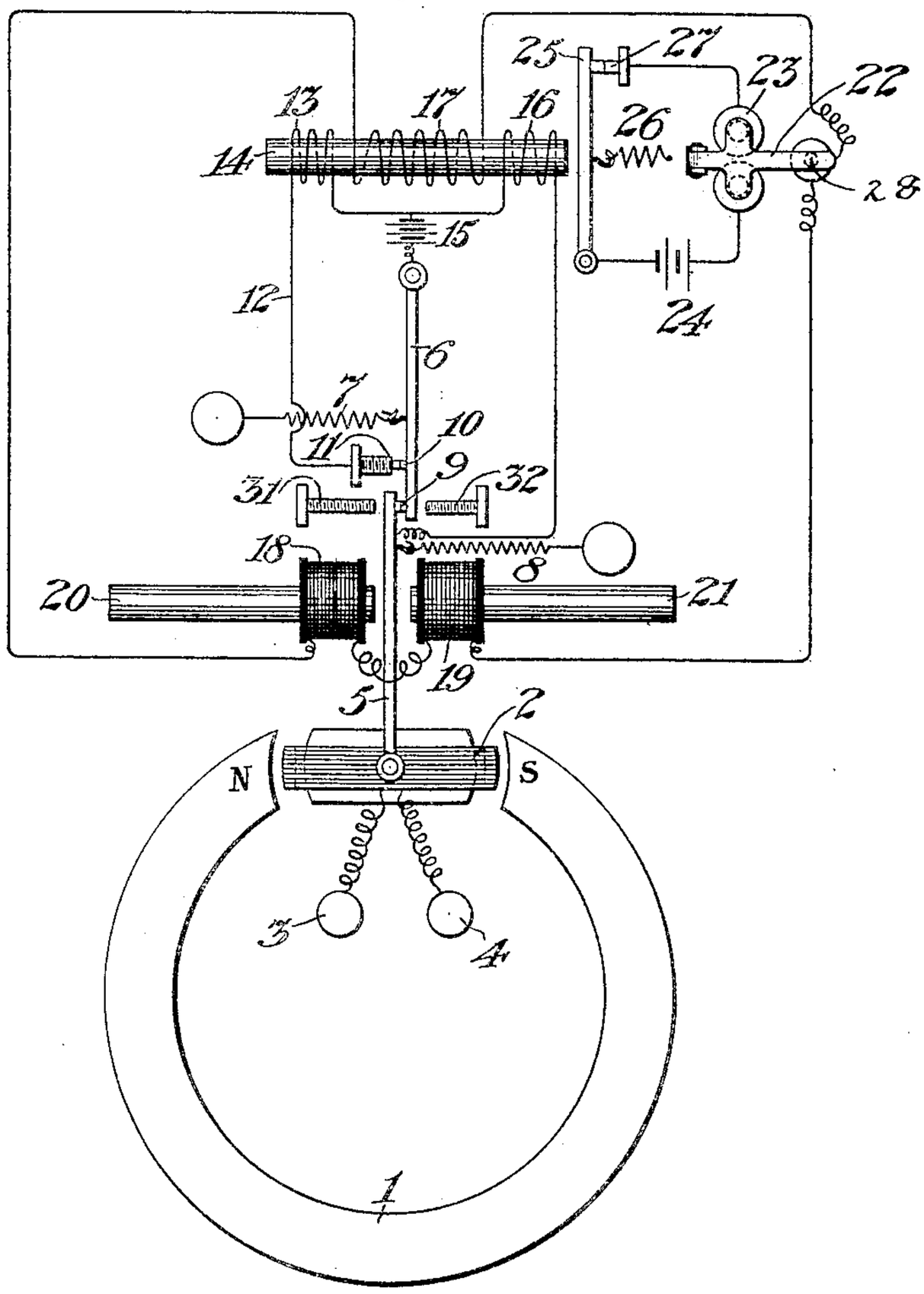
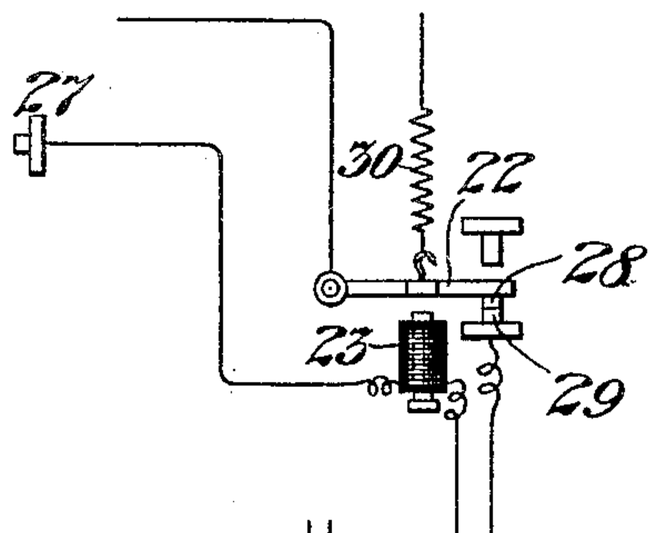


Fig. 2



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QUADRUPLEX TELEGRAPHY.

No. 800,844. Specification of Letters Patent. Patented Oct. 3, 1905.

Application filed August 20, 1904. Serial No. 221,467.

To all whom it may concern:

Be it known that I, STEPHEN DUDLEY FIELD, a citizen of the United States, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Quadruplex Telegraphy, of which the following is a full, clear, and exact description.

In the operation of that class of diplex telegraph systems which when duplexed become capable of transmitting four simultaneous communications upon the same circuit and which depend upon one transmission by polarity and the other by strength of current a defect is observed when attempts are made to introduce the apparatus on circuits having great impedance or great static capacity, such as long-buried conductors or on what are known as "composite" circuits in telephone service. The prolonged "variable period" of such circuits causes a sluggish action of the receiving apparatus in such a manner that the repeated signals in the local circuit become blurred. For example, in the apparatus now in use suppose a neutral relay to be just starting from its contact to the extent of breaking its local circuit. If at this instant a reversal of line-current occurs, the armature falls back and the sounder having started on its armature excursion responds to the renewed contact, the result being a fluttering or jarring false signal, which is usually unintelligible and productive of errors. Attempts have been made to bridge over this so-called "variable period" of the circuit by the introduction of induction-coils in the line-circuit; but such introduction by bringing in magnetic impedance in the line-circuit increases the static capacity thereof to an extent which is rather more than an offset to the benefits conferred by the devices mentioned.

In the present invention I proceed in a directly opposite manner. Instead of increasing the line impedance I diminish it as much as possible, and instead of holding the relay quiescent at the moment of current change I locally augment its action as much as possible. In carrying out my invention I so arrange the apparatus that a break once started in the local or receiving circuit is caused to locally react on the relay-armature in such a manner as to force it to make its full excursion no matter how slowly the line-current may increase nor how soon a reversal of polarity takes place.

In order to facilitate the understanding of the present invention, I will now describe the same in connection with a certain embodiment thereof as illustrated in the accompanying drawings and will then set forth the special features of said embodiment whereby the advantages above referred to are obtained. In this connection it may be said that the embodiment illustrated is merely given by way of example and that I do not confine myself to the precise arrangement of apparatus shown.

In the drawings, Figure 1 is a diagram of a set of circuits and apparatus adapted to the carrying out of my invention, and Fig. 2 is a detail of the sounder connections at a receiving-station.

Referring to the drawings, 1 is a permanent magnet serving to hold the line-coil 2 in a strong magnetic field. The terminals of the line-coil are shown at 3 and 4. The coil 2 is supported upon trunnions, to which is also secured an armature-lever 5, of magnetic material. The armature 5 turns with the coil 2, as will be readily understood. Coöperating with the armature-lever 5 is a companion lever 6, supplemental thereto and adapted to contact therewith. The lever 6 is held against the lever 5 by means of an adjustable retractile spring 7. A similar retractile spring 8 acting on the lever 5 tends also to hold the levers 5 and 6 together. The levers above referred to are provided with contact-points, (shown at 9,) such points being preferably of platinum or other good conducting material not easily corroded. On the lever 6 is a contact-point 10, which engages in one position of the said lever with an adjustable contact-point 11, as shown. The last-named contact-point is connected by a wire 12 with a coil 13 on a core 14, and the said coil is connected with a battery 15, the opposite pole of which is joined to the pivotal point of the lever 6. The said battery is also connected with a coil 16, the opposite end of which coil is joined to the lever 5. The coils 13 and 16 constitute differential windings on the core 14. On the core 14 is wound a third coil 17, which is connected in a closed circuit with the coils 18 and 19 of the polar magnets 20 and 21. This closed circuit is controlled by the armature 22 of a sounder 23, the circuit of which sounder contains a battery 24 and is itself controlled by the position of an armature 25, arranged in operative proximity to one end of the core 14. When the said core 14 is not energized, as when the coils 13 and 16 are both traversed by counterbalancing currents from the bat-

tery 15, the armature 25 is held by a spring 26 against a back stop 27, thereby maintaining the local sounder-circuit closed and causing contact to be made between a contact-point 28 on the armature 22 and the front stop 29 of the said armature. The armature 28 is subject to the influence of a spring 30, tending to draw it away from contact with the stop 29. Assuming a current to arrive by way of the terminals 3 and 4 and to traverse the coil 2 and cause it to turn with the lever 5—say to the right, as shown in Fig. 1—thus overcoming the tension of the spring 7 and opening the contact between the points 10 and 11, it will be seen that the first action will be to open the circuit from the battery 15 through the coil 13. The coil 16 is accordingly in a position to energize the core 14 and attract the armature 25. The magnetization of the coil 16 in this manner sets up a momentary current in the coil 17, which current passing through the coils 18 and 19 attracts the lever 5 momentarily to the right, thus perpetuating the initial impulse which first separated the contacts 10 and 11. Once separated the said contacts cannot again come together until the signal has been executed in its entirety. Should the arriving current be in a direction to deflect the armature-lever 5 to the left, a separation will take place between the contacts shown at 9, in which case the coil 16 will be cut out and the coil 13 energized. In this case the coil 17 will be momentarily affected, as before, by an induced current, but in a reverse direction. Consequently the magnet-coils 18 and 19 will exercise a momentary inductive influence, tending to urge the armature-lever 5 to the left, thereby perpetuating the signal intended, as in the previous instance. The springs 7 and 8 are put under such tension that weak potentials cannot overcome the force thereof. Accordingly such potentials will have no effect in bringing about a separation of the contacts as described above. So long as these contacts remain closed the entire arrangement is maintained in a state of rest. Limiting-stops 31 and 32 are provided and so adjusted as to give any desired range to the excursion of the armature-lever 5. In general it may be said that the longer and slower the line-circuit is the farther apart these stops should be separated.

The object of having the induction-circuit, including the coils 17, 18, and 19, pass through the contact-points 28 and 29, controlled by the sounder or recording apparatus 23, is to prevent any action of the induction-coil 17 on the magnet-coils 18 and 19 at the instant when the contacts at 9 or the contacts 10 and 11 come together. If it were not for this break in the circuit, the closure of either of these sets of contacts would result in the passage of a current from the coil 17. In the case of a closure of the contacts 10 and 11 this current would be in a direction to force a separation of the contacts at 9 by virtue of the action of the coils 18 and 19 on the armature 5. Since, however, the contacts 28 and 29 cannot come together until after the local relay has performed its function of closing the contacts at 25 and 27, it will be seen that the inductive effect on the coil 17 will have passed before the points 28 and 29 come together. Consequently the coil 17 is quiescent or inoperative at the time of the closure of the contacts, but is highly energized after the closure when the local relay has performed its function and brought the contacts 28 and 29 together.

The special features of the apparatus above described, which, as has been stated, may be varied as to details, may be summarized as follows: The apparatus consists of a coil floating in an intense magnetic field and hung on trunnions to which an armature of magnetic material is attached. This armature makes contact with contact-points mounted on a companion lever in such a manner as to form a continuity-preserving key, all points of which are in contact during the time of low-line potential, being held together by suitable retractile springs. From the relay-armature lever on the one hand and the companion lever on the other I lead wires to separate branches of a differentially-wound local relay, the same being for convenience so connected that a single battery operates on either or both branches of the local relay in opposite and substantially equal ways. As a result when either branch of said local relay is opened its opposing branch will magnetize the core and attract the sounder-armature which is in operative relation to the said core. Wound on the core of the local differential relay is a third coil, all the coils being preferably wound in the same plane and occupying as nearly as possible the same magnetic position on the relay-core. Assuming that the armature of the line-relay starts in either direction in response to a line-current of full potential, one or the other of its contact-points will be moved away from the coöperating point, thus leaving but one of the local relay-coils in circuit with the local battery. This coil will then energize the local relay-core, attracting the armature of the local sounder or recording circuit and make a signal or a record thereon. At the same time the current in this local relay-coil sets up an induced current in the third coil upon the local relay-core, which induced current passes through the polarized magnet set on either side of the line-relay armature. Accordingly the said armature receives a momentary impulse from the induced current in the polarized magnet, said current being of such a character as to develop magnetism in the magnet in such a direction as to continue for an instant the initial movement of the line-relay armature. This causes the

said armature to make an excursion of any predetermined length before restoring the original contacts. Plainly, then, the relay-armature having once commenced its excursion is forced by local means to complete the same to the fullest extent. This being the case, the time occupied on this return journey to the original position of contact will prove ample to allow the line-current to obtain sufficient strength on the occurence of a full potential reversal to promptly separate the points, and thus prevent a false signal on the sounder or recording instruments. The retractile springs which are connected with the other relay-armature lever and its companion lever are put under tension to a point sufficient to overcome the attraction of the polarized magnet and also to overcome the bias given to the armature-lever by a low-current potential.

It will be understood that the system herein described is adapted to relays having electromagnets as actuating elements for the armatures in place of the permanent magnet shown in Fig. 1 of the drawings. In such cases also it will be found advantageous to provide means for forcing the armature-lever to make a complete excursion for each signal.

I claim as my invention—

1. In a receiving apparatus, an armature-lever, means for affecting the armature-lever through the medium of the line-current, and local means controlled by the armature-lever for continuing the excursion of the said lever.

2. In a receiving apparatus, an armature-lever, means for affecting the said lever through the medium of the line-current, and local means for continuing the excursion of the said lever when once started by the line-current, such local means consisting of a local relay wound with two differential windings, means for cutting out one of the said windings on the initial movement of the armature, thereby energizing the other winding, a coil in operative proximity to the said energized winding, and a polarized magnet in operative relation to the armature-lever.

3. In a telegraphic receiving apparatus, an armature-lever adapted to be affected by line-currents, a companion lever making contact therewith, compensating or balancing means for the said levers, a local circuit including the contacting parts of the said levers and also including two differential windings on a suitable core, and means whereby on a movement of the first-named armature-lever in response to line-currents one or the other of the said differential windings will be cut out, and the other winding made effective for operating a local sounder or recorder.

4. In a telegraphic receiving apparatus, an armature-lever adapted to be affected by line-currents, a companion lever making contact therewith, compensating or balancing means for the said levers, a local circuit including the contacting parts of the said levers and also including two differential windings on a suitable core, and means whereby on a movement of the first-named armature-lever in response to line-currents one or the other of the said differential windings will be cut out, and the other winding made effective for operating a local sounder or recorder, all in combination with a coil wound on the same core with the differential windings, and a polarized magnet adapted to be operated by induced currents developed in the said coil.

5. In a receiving apparatus, an armature-lever adapted to be actuated by line-currents, in combination with local means set into operation by the armature-lever for continuing the excursion of the armature-lever when once begun, and adjustable means for limiting the said excursion in either direction.

In witness whereof I subscribe my signature in the presence of two witnesses.

STEPHEN DUDLEY FIELD.

Witnesses:

GEO. SEYMOUR,

ADAM SCHILLING.