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QUADRUPLEX OR MULTIPLEX TELEGRAPHY.

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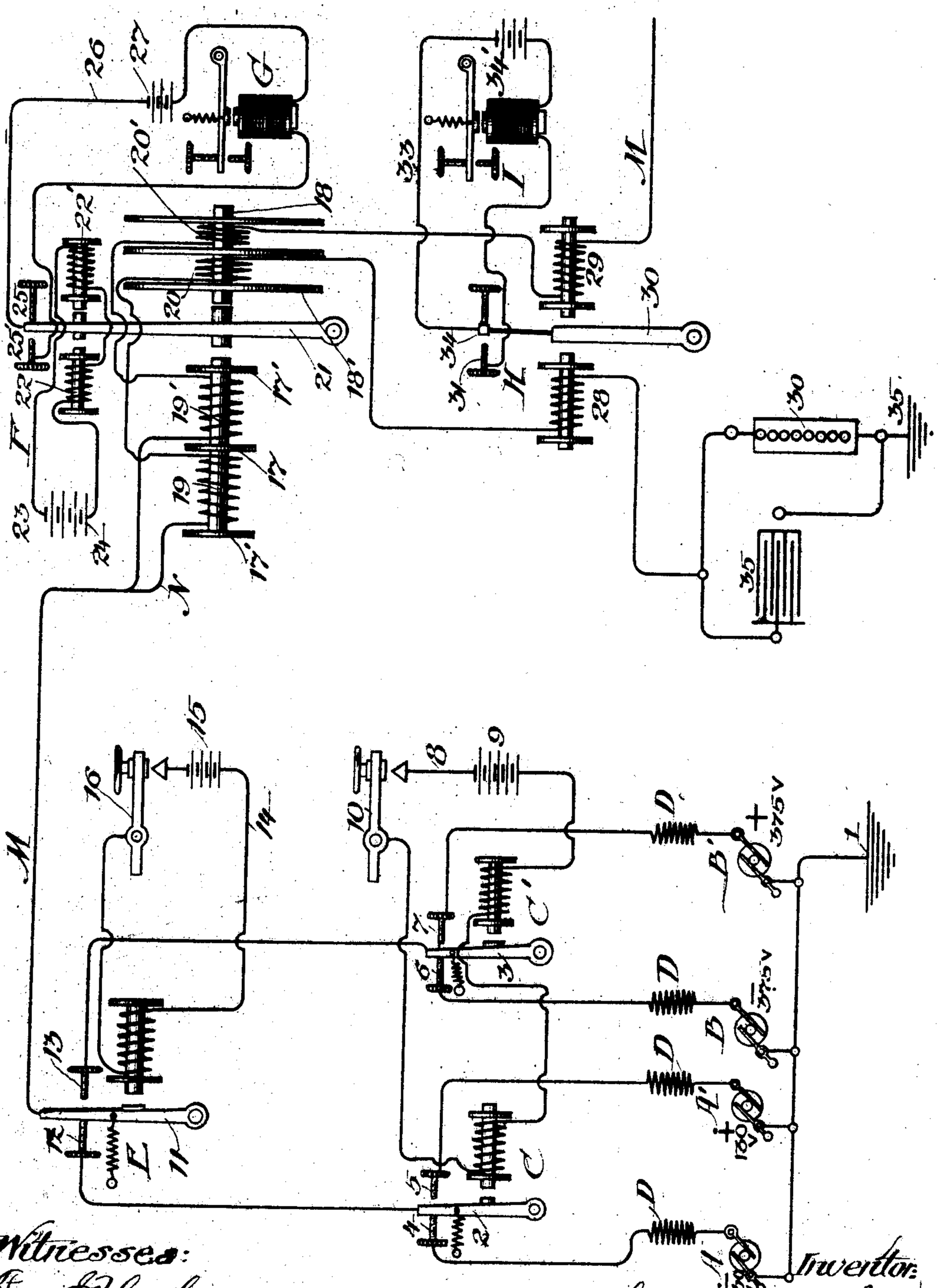

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QUADRUPLEX OR MULTIPLEX TELEGRAPHY.

No. 876,312. Specification of Letters Patent. Patented Jan. 7, 1908.

Original application filed July 2, 1906, Serial No. 324,305. Divided and this application filed March 29, 1907. Serial No. 365,339.

To all whom it may concern:

Be it known that I, LAWRENCE CONNELL, Jr., a citizen of the United States, residing at Portland, Multnomah county, State of Oregon, have invented certain new and useful Improvements in Quadruplex or Multiplex Telegraphy, of which the following is a specification.

This invention relates to improvements in quadruplex or multiplex telegraphy, and this application is a division of my prior application, Serial Number 324,305, filed July 2, 1906, for improvements in electro magnets.

The invention is adapted for use in various connections, but finds a special application when employed in quadruplex or multiplex telegraphy.

The salient object of the invention when so applied is, to overcome or obviate false signals in the neutral relay incident to the working of the pole changers on the polar side of the quadruplex, such signals being due to what are technically termed "moments of no magnetism" in the line. I accomplish this end by so constructing my improved relay that it depends for its operation on no force other than the magnetizing forces developed therein. That is to say, I so construct the relay that it is unnecessary to employ a spring, gravity, or other outside force, to pull the armature back from the front stop, as has heretofore been usual.

It is well understood that in quadruplex telegraphy the common side is subject to false signals and that the system is quite sensitive to unfavorable weather conditions, so that nothing but an extremely perfect adjustment of instruments and conditions on both common and polar sides will permit of its successful operation. The chief and most frequent fault inherent in the instruments of the common side is the false signals induced by moments of no magnetism. Moments of no magnetism are caused by the operation of the pole changers, which in placing first one and then the other pole of the battery to the line, inevitably produce intervals when either both poles are placed to line at once, or neither pole is to line. These moments, although exceedingly brief, are nevertheless sufficient to cause false signals, and this is particularly true in operating long lines, in which the flow of current in the main line does not reach its maximum and minimum strength instantly but the current assumes a wave-like aspect which magnifies the moments of no magnetism.

It will be obvious that a relay, so constructed that its armature is free from the action of external force, such as a spring or gravity and which responds only to variation in the strength of the magnetism induced therein, will be free from the fault of giving false signals, since its armature will remain passive during the moments of no magnetism. The underlying principle which I employ in constructing such a relay is the disproportionate magnetization of a mass of iron under inductive currents of varied strengths. To explain more specifically, it is found that in magnetizing soft iron the increase or decrease of magnetism induced in the iron is not at all proportional to the increase or decrease of current used. If, commencing with an extremely small magnetizing force, this force is gradually increased, the corresponding increase in magnetic density would be as follows: At first the magnetic density would increase more slowly than the magnetizing force until the latter had risen very considerably, but presently the magnetic density would increase faster than proportional to the increase of current and so continue through a considerable period of increase until the iron approached magnetic saturation, whereupon the increase of density would again fall off and be less than proportionate to the increase of current, and as the point of saturation was more and more nearly reached the density would fall off correspondingly more and more rapidly until presently increase of current would be unaccompanied by any increase of magnetic density. Illustrating this principle: If a magnet be wound so comparatively low as to induce only 10,000 lines of force per square inch when magnetized by a twenty milliampere current (the small end of the battery commonly used in quadruplex telegraphy) and this current were then increased to sixty milliamperes (representing the large end of the battery) the magnetic density would be found to have increased to 55,000 lines of force per square inch, or five and one-half times its former strength while the current strength had been increased only three times. If another magnet be wound so high that when excited by the small end of the same battery it would induce 100,000 lines of force per square inch, it would be found

that when the large end of the battery was applied the magnetic density had increased to only about 120,000 lines of force per square inch, or an increase of about one-fifth while the current strength had been trebled. If, now, these two magnets were opposed to each other and excited by the same current it will be obvious that a soft iron amature placed between them would be vibrated toward the one or the other depending upon the increase or decrease of current strength, and this in fact is what occurs in a relay constructed in accordance with my invention.

In the accompanying drawings I have illustrated (partly diagrammatically) a practical and what I deem a preferred embodiment of the invention; only one end or station of the line being shown.

Referring to the drawing, A and A′ designates a pair of low voltage generators having their negative and positive poles connected to line respectively; B and B′ a similar pair of high voltage generators having their negative and positive poles connected to line, each of the series of generators having one pole connected to ground, as indicated at 1.

C and C′ designates a pair of pole-changers (these two instruments are usually made as a single instrument having one armature which controls two pairs of contacts) the armature, as 2, 3, of each of which operates between a pair of front and back contact screws as 4, 5 and 6, 7 respectively. Contacts 4 and 5 are connected with generators A and A′ through resistance D and contacts 6 and 7 are connected similarly with generators B and B′ respectively through other resistance D. The coils of the pole-changer magnets C, C′ are included in series in a local circuit comprising a conductor 8, a battery 9 and a key 10, so that the armatures 2 and 3 move together and in the same direction.

E designates as a whole the common transmitter, the armature 11 of which operates between the usual pair of contacts 12 and 13, which are respectively connected with the armatures 2 and 3 of the pole-changers. The coil of transmitter E is included in a local circuit comprising a conductor 14, battery 15 and key 16. The parts thus far described are all constructed and arranged in a usual manner.

F designates as a whole a relay connected in the system shown in a manner corresponding to the connections of the usual neutral relay, and accordingly hereinafter designated as the neutral relay. This relay comprises two main magnet spools 17 and 18, each differentially wound as indicated at 19, 19′ and 20, 20′; an armature 21, interposed and pivoted to vibrate between the poles of the two spools, and a pair of steadying magnets 22 and 22′ connected in series in a local circuit comprising a conductor 23 and a battery 24. Armature 21 vibrates between contacts 25′ and 25, the former of which is included in a local sounder circuit comprising a conductor 26, battery 27, and sounder G.

H designates as a whole the polarized relay comprising the usual opposed magnet spools 28 and 29, armature 30, and back and front contacts 31 and 32, respectively. Contact 32 is included in a local sounder circuit comprising a conductor 33 having one end connected with a contact 34 carried by the armature and its opposite end connected with the contact 31 and including a battery 34′ and a sounder 1.

M designates the main line, which is connected with armature 11 of the transmittter E, extends thence to and includes the windings 19′ and 20′ of the neutral relay (both wound in the same direction), thence extends to and includes the windings of magnet 29 of the polarized relay and thence to the distant station.

N designates the artificial line which branches from the main line at a point between transmitter E and the neutral relay, includes the windings 19 and 20 of the neutral relay, extends thence to and includes the winding of the magnet 28 of the polarized relay, and thence passes to ground at 35 through the usual rheostat 36; a condenser being arranged in shunt with the rheostat, as usual.

The differentially wound spool 17 of the neutral relay F is constructed with a core containing a relatively large amount of iron, and is wound low as to both windings 19 and 19′ so that a small current will have comparatively small magnetizing effect upon this spool while it is capable of taking a comparatively large current and becoming magnetized to a relatively high degree of density. Accordingly this spool is shown as made relatively long and the turns of the windings comparatively few in number, as indicated by the small diameter of the spool heads 17′. The spool 18, on the contrary, is so constructed as to have a relatively small amount of iron in its core, and the core is wound high as to both windings; this construction being indicated by the short core and the spool heads 18′ of relatively large diameter.

The steadying magnets 22 and 22′ of this relay simply serve the purpose of holding the armature steady against vibration during moments of no magnetism in the main spools. To this end these magnets are of equal strength, symmetrically disposed with reference to the vibrating end of the armature, so wound that they oppose each other, and included in a closed circuit so that they are constantly energized.

The operation of the apparatus constructed and arranged as described should be entirely obvious from the foregoing description but may be described as follows: Assuming a message to be sent over the polarized

side from the station shown, the pole-changing key 10 is operated. When this key is open, armatures 2 and 3 engage contacts 4 and 6, respectively, and, armature 11 of transmitter E being at this time in engagement with contact 12, the negative generator A of low voltage is placed to line. When key 10 is closed, armatures 2 and 3 close, thus placing the positive generator A′ of low voltage to line. Inasmuch as the circuit from the two high voltage generators is at this time open at contact 13, the latter generators are not concerned in the transmission over the polarized side. If a message is to be transmitted over the common side from the station shown, key 16 is operated. In the normal or open position of this key the negative low voltage generator A is placed to line through contact 4, armature 2, contact 12, and armature 11. When key 16 is closed the negative generator B of high voltage is placed to line through contact 6, armature 3, contact 13, and armature 11. In other words, current of 130 volts and current of 375 volts is placed alternately to line without changing the polarity. Neutral relay F being differentially wound as to both of its spools and half of the current going to ground at 35 over the "artificial line" and the other half over the main line, it follows that the neutral relay is unaffected by current sent from the home station whether it be increased or decreased, or reversed in polarity. Furthermore because the artificial and the main line includes the windings 28 and 29 of the polarized relay H which are opposed to each other, the latter instrument is unaffected by signals of either strength or polarity sent from the home station.

When the pole-changing key at the distant station is operated, the polarized relay H will respond in the usual and well understood manner. In transmitting a message over the common side, the low voltage generator is normally closed to line as hereinbefore described, and accordingly the low voltage current flowing through the coils of the neutral relay will magnetize the high wound coil to a greater degree than it does the low wound coil, with the result that the armature 21 will normally be closed with front contact 25 and the sounder G held in open position. When the distant transmitter key 16 is closed, and the generator of higher voltage placed to line, the increase of current flowing through the two coils of the neutral relay will bring up the magnetic density of the low wound coil to such extent that it overpowers the opposing high wound coil and the armature 21 will be drawn away from contact 25, thus closing the sounder circuit and causing the signal. The manner in which the current of higher voltage causes the low wound coil to overpower the high wound coil has been hereinbefore fully explained. In a word, the low voltage current which is normally flowing through the coils of the neutral relay enegizes the high-wound coil to a degree approaching saturation, and when the high voltage generator is placed to line, the high wound coil, being already nearly saturated, increases in strength but little, while the opposed coil, owing to its larger size, increases in strength approximately proportionately to the increase of current and thus overpowers the smaller coil. At the moments of no magnetism during the operation of the pole changer key, the armature of the neutral relay obviously remains passive or without movement because there is no exterior force acting upon and tending to move it.

As hereinbefore stated, the inductively opposed windings, and the iron or fields magnetized thereby, may be variously arranged to effect the vibration of an armature under the inductive force generated in two windings opposed to each other in accordance with the principle of this invention. For instance, it will be obvious that polarization of the armature may be effected by including it in a field subject to the inductive action of opposed high and low windings, in accordance with this invention. Therefore the appended claims are to be interpreted broadly except in so far as they are made specific in terms.

I claim as my invention:

1. In a multiplex telegraph system, the combination with a line wire extending between stations, of a receiving and transmitting apparatus at each station, comprising a neutral relay having an armature and two main energizing coils, one composed of two differentially-disposed high windings, and the other of two differentially-disposed low windings, one of said high windings and the low winding of similar direction being included in series in said main line, an artificial line connected with the main line at each station, including the remaining two main windings of said neutral relay in series and connected to ground, a sounder and sounder-circuit controlled by said neutral relay, a source of variable strength current connected with said main line at each station, and transmitter mechanism comprising a magnet, an armature therefor, a transmitting key, and a transmitting key circuit controlling the flow of current to line.

2. In a multiplex telegraph system, the combination with a line wire extending between stations, of a receiving and transmitting apparatus at each station, comprising polarized relay and a neutral relay having an armature and two main energizing coils, one composed of two differentially-disposed high windings, and the other of two differentially-disposed low windings, one of said high windings and the low winding of

similar directions being included in series in said main line, and one coil of said polarized relay being also included in series in said main line, an artificial line connected with the main line at each station, including the remaining two main windings of said neutral relay in series and the second coil of said polarized relay, and connected to ground, a sounder and sounder-circuit controlled by said neutral relay, a sounder and sounder-circuit controlled by said polarized relay, a source of variable strength current connected with said main line at each station, a common or non-polarized transmitter mechanism comprising a magnet, an armature therefor, a transmitting key and transmitting key circuit, and a polar transmitter mechanism comprising a magnet, an armature therefor, a transmitting key and transmitting key-circuit.

3. In a multiplex telegraph system, in combination with a line wire circuit and means for transmitting current of two or more differentiated kinds over said circuit, a relay comprising an armature actuated solely by inductive forces and mounted to remain passive in all positions when not subject to inductive force, a main energizing coil having two equal but oppositely-wound high windings, a second main energizing coil having two equal but oppositely-wound low windings, suitable circuit-conductors connecting two of said coils of similar direction with the main line, an artificial line, and suitable circuit-conductors connecting the other two of said windings with said artificial line.

4. In a multiplex telegraph system the combination, with a main line, of a station apparatus comprising a neutral relay, said relay comprising an armature, two main energizing coils arranged at opposite sides of the armature, one of said coils being composed of two differential high windings and the other, of two differential low windings, one of said high windings and the low winding of similar direction being included in series in said main line, an artificial line connected to the main line, and including the other high and low winding of the neutral relay in series and connected to ground, means for steadying the armature of said relay during instants of no magnetism, and a receiving instrument controlled by said neutral relay.

5. In a multiplex telegraph system the combination, with a main line, of a station apparatus comprising a polarized relay, a neutral relay having an armature and two main energizing coils, one of said coils being composed of two differential high windings and the other, of two differential low windings, one of the high windings and the low winding of similar direction being connected in series in said main line and one coil of the polarized relay, an artificial line connected with the main line, said artificial line including in series the other two windings of the neutral relay and the other coil of the polarized relay, means for steadying the armature of the neutral relay during instants of no magnetism, and a receiving instrument controlled by the polarized relay.

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