3 Sheets—Sheet 1.

H. C. NICHOLSON.

QUADRUPLEX TELEGRAPH.

No. 332,549. Patented Dec. 15, 1885.

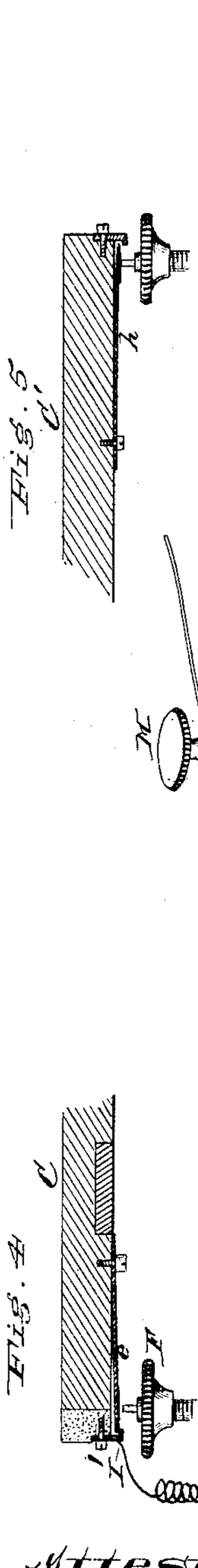

Fig. 3.

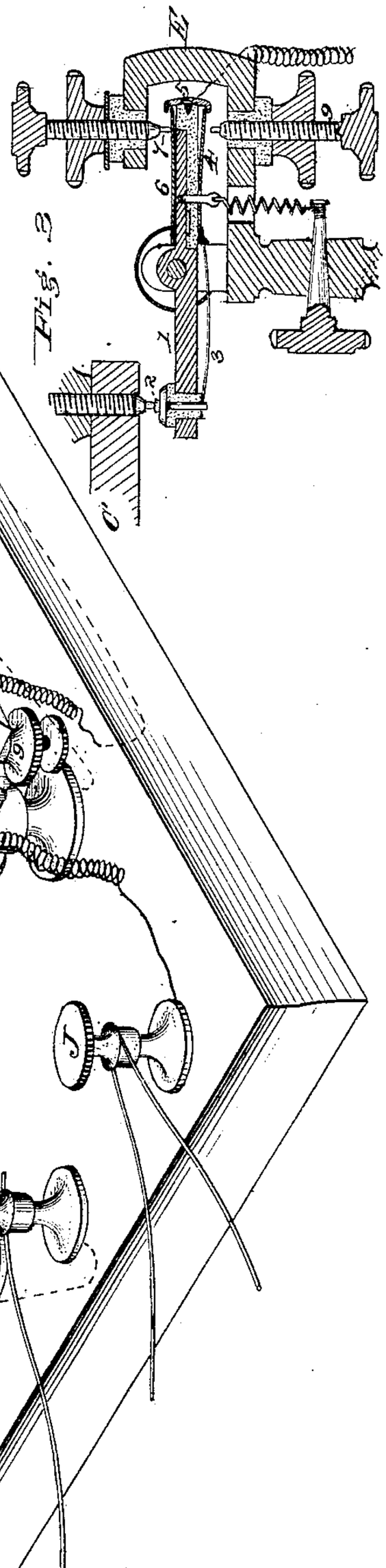

Fig. 2.

Fig. 1.

Fig. 4.

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Fig. 2.

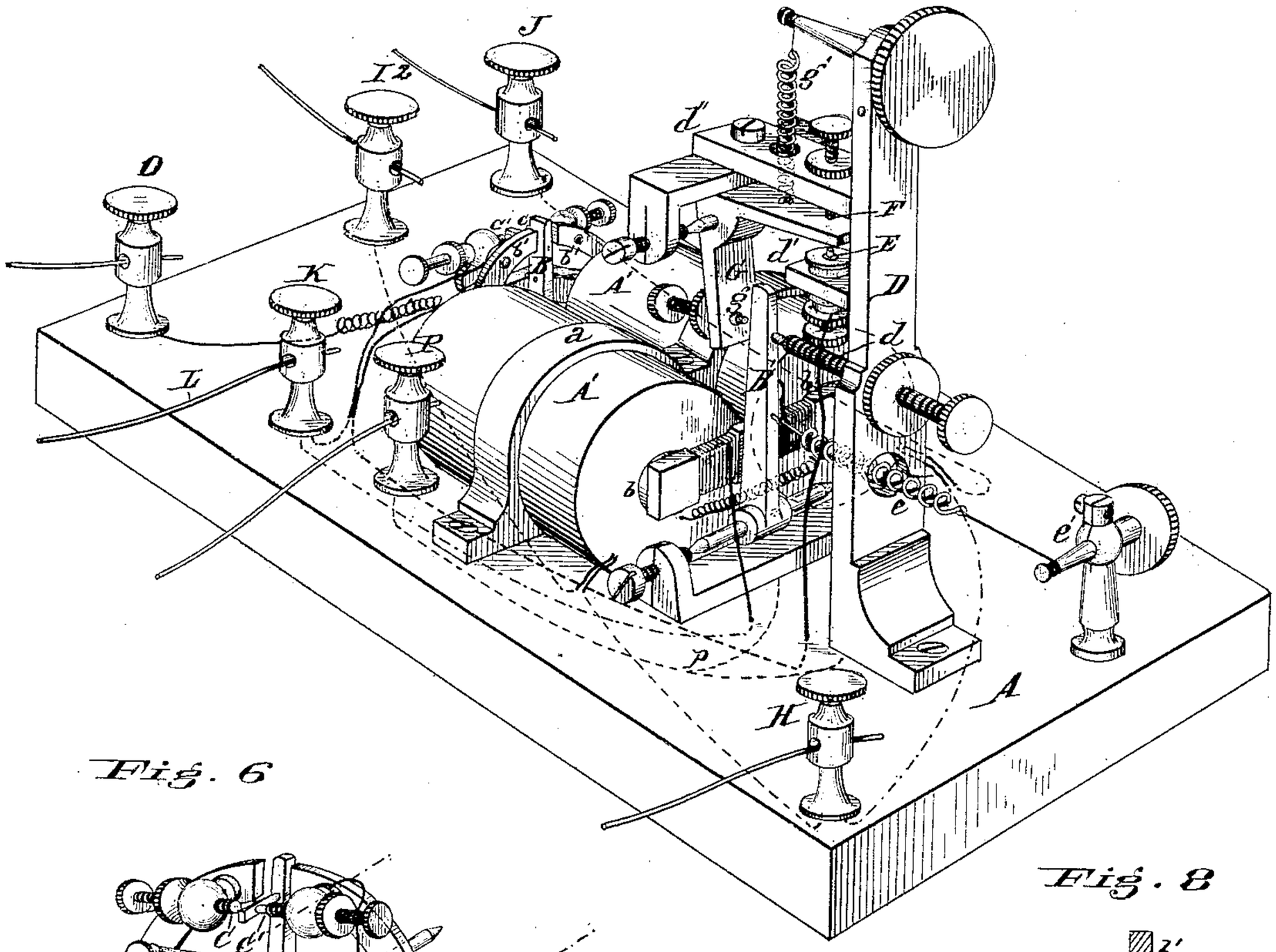

Fig. 6

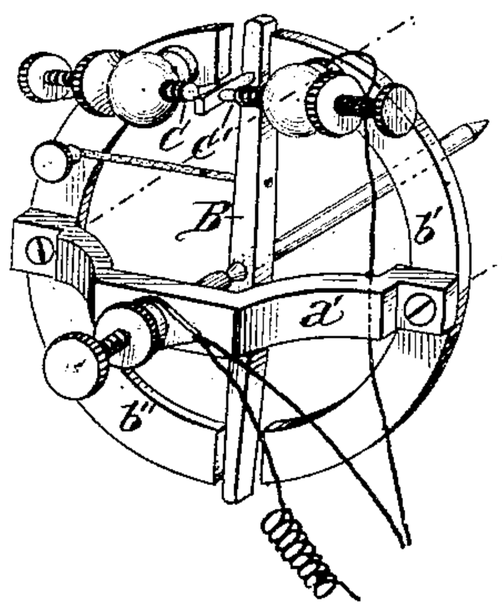

Fig. 8

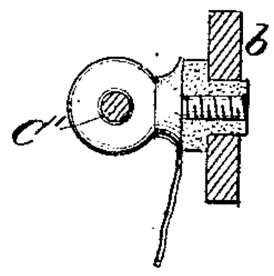

Fig. 7

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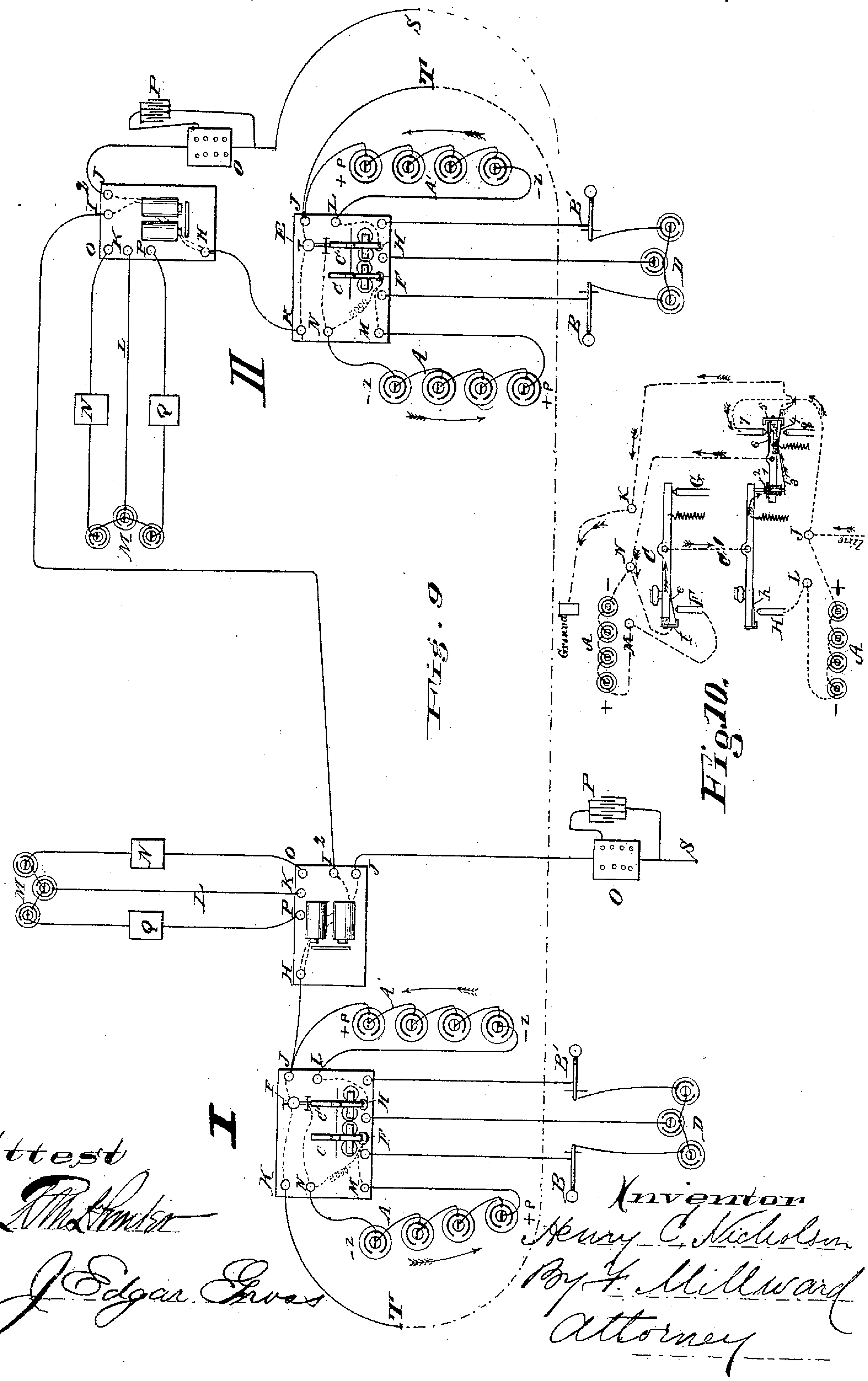

Fig. 9

Fig. 10.

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UNITED STATES PATENT OFFICE.

HENRY C. NICHOLSON, OF KENTON, KENTUCKY, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y.

QUADRUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 332,549, dated December 15, 1885.

Application filed October 14, 1874.

To all whom it may concern:

Be it known that I, HENRY C. NICHOLSON, of Kenton, Kenton county, Kentucky, have invented certain new and useful Improvements in Electric Telegraphs, of which the following is a specification.

My invention has for its object the increased usefulness or capacity of a telegraph having a single line-wire by rendering it capable of transmitting an increased number of messages at one and the same time—as the sending of two messages from the same office at the same time, or the sending of one message by the Nicholson double-line alphabet patented by me March 21, 1871; or, in addition to such sending, the simultaneous receiving of a message or messages at the same office. I employ at each office two electrically-connected keys, one of which, when operated, reverses the circuit-connections of the other; also, a polarized relay of peculiar construction which, in connection with two sounders or their equivalents, reproduces the signals of the distant office.

Briefly summarized, my invention consists, first, of the combination, at one station, of two electrically-connected keys, one of which when operated reverses the polarity of the line-current controlled by the other; second, of various combinations of a relay and two local circuits with appropriate sounders, so constructed and connected that a line-current of ordinary tension will operate only the one or the other of the sounders, according to the polarity of the current, while both sounders will respond to a line-current of increased tension.

In the accompanying drawings, Figure 1 is a perspective view of my improved keys. Fig. 2 is a perspective view of my improved relay. Fig. 3 is a vertical section of the reversing portion of the keys. Fig. 4 is a vertical section of the device for breaking or connecting with either ground or line. Fig. 5 is a sectional elevation of the end of one of the keys. Fig. 6 is a perspective view of one end of the relay having a charged steel armature. Fig. 7 is a section through device for opening and closing local sounders. Fig. 8 shows the manner of insulating the bearings for the contact-points of one of the steel armatures. Fig. 9 is a diagram of a complete telegraphic circuit by my method. Fig. 10 is a diagram showing the condition of the circuits at a station when both transmitting-keys are open and the line is excited by a current from a distant station.

In Fig. 9, A A′ are main batteries situated at the ends of a circuit and furnishing positive and negative currents. B B′ are keys actuating the double transmission-keys C C′ by means of a local battery, D. The keys C C′, as shown in Fig. 1, resting upon the bearings *c c′ c″*, are in perfect connection, and are actuated by the local current through magnets *b b′* upon customary armatures.

To keep the armatures free from the magnets, except when influenced by a local current, I provide retaining-springs *c‴ c⁗*. One end of the key C is fitted with an insulated hook, I′, connecting with the frame E of the reverser through point N, as shown by dotted lines, Fig. 1, and has a spring, *e*, to play between this hook and a contact-point, F, connecting with the positive pole of the battery. The other end of key C, when in its normal state, or open, finds a rest on the point G. One end of key C′ has intermittent connection with negative pole of the right battery through point H and point L, and has a spring-connection, to facilitate its intermittent play upon a reverser, E, at its other end. This reverser consists, as shown in Figs. 1 and 3, of a lever, 1, hung in frame E by its center, and forms an insulated intermittent connection from key C′ to east wire, through connecting-spring 6 and insulated point 7 in the frame E. The spring 6 also forms intermittent connection between frame E and west wire, through hook 5. Below spring 4 is an anvil, 9, for breaking the connection between spring 4 and hook 5. The flow of the currents from the main batteries may be described as follows: It must first be stated, however, that the main batteries are normally disconnected entirely from the line, as will be seen by reference to Fig. 10, and also that the connections of the batteries with reference to the line and the ground at one station are the reverse of those at the other station, as clearly shown in Fig. 9. Let the keys at station II be in their normal condition—that is, stand open. If, now, the right key C′ of station I be depressed a positive current

will proceed from the right battery A′ of such station to line, by way of point J, and reach the earth T at the distant station II by the following route at said station II—namely, through point K, thence through the reverser, by way of hook 5 and springs 3 and 4, thence through the keys C′ and C, thence by way of spring *e* and hook I′ of key C, through point N, thence back through the reverser by way of its elements 1, 6, and 7, and thence, finally, through point J. The negative pole of battery A′ at station I is at the same time brought in connection with the ground T at this station, completing the circuit by way of point L, point H, keys C′ and C, and points G and K, if such points are connected, as shown. Otherwise the route from key C passes by way of its spring *e* and hook I′ to point N, thence through the reverser by way of its elements 1, 6, and 5, and thence, finally, through point K. When the left key C is depressed at station I, a negative current will proceed from the left or west battery A of that station to the line by way of point N, thence through the reverser by way of its parts 1, 6, and 7, and thence through point J. It will reach the earth T at station II by the same route described as the one followed by the positive current. The positive pole of battery A at station I, to complete the circuit, is at the same time brought in connection with the earth T at this station by way of point M, point F, keys C and C′, thence through the reverser by way of its parts 2, 3, 4, and 5, and thence finally through point K. When both keys are depressed simultaneously, battery A at station I will be reversed, so that its negative pole, instead of connecting with the line, will be to the earth T at this station by way of point N, through the reverser by way of its parts 1, 6, and 5, and through point K. At the same time its positive pole forms a connection with the negative pole of battery A′, so that the batteries join forces by way of point M, point or post F, keys C and C′, spring *h* of key C′, post H, and point L. The result is that a positive current of increased intensity proceeds to line through point J from the positive pole of battery A′, reaching the earth T at station II by the route heretofore described, while the negative pole of battery A, by connecting with the earth T at station I in the manner already stated, completes the circuit. A depression of either one or both keys C and C′ at station II, while the keys at station I stand open, will cause circuits to be made through the stations in the same manner, except that the batteries here being reversed the line-currents consequent upon the closing of either or both keys will also be of reverse polarity. The outgoing current is divided at the post H of relay A, Fig. 2, into two currents of equal intensity, which run in opposite directions through the helices of an ordinary differential electro-magnet of this relay, neutralizing each other so as to leave the electro-magnet unaffected. One of the currents then passes through the line to the distant station, while the other makes a short circuit through the rheostat O and condenser P, the resistance of which is regulated to equal that of the line. An incoming current passing through only one of the helices of the differential electro-magnet will produce an effect thereon. The play and interplay of the currents is quite complicated, but a lengthy explanation thereof would be out of place, since any one skilled in the art can, from the foregoing description, readily formulate the different conditions that may arise. It is sufficient to state generally that the play of the keys at one station controls always in the same degree the nature of the effective currents of the differential magnet at the relay at the other station. The relay controls the effect of the different currents on the local circuits of the two receiving-instruments or sounders N and Q in such a manner that only the one or the other of these will operate, according as the differential magnet is excited by a negative or a positive current, either not exceeding a certain intensity, while both sounders will operate when the differential magnet is excited by a current of increased tension. To the accomplishment of these ends the relay is constructed and connected to the main and local circuits in the following manner:

B and B′ are steel armatures at opposite ends of the differential magnet. The poles at *b* are the ends of the cores of the magnet, while at *b′ b″* they are semicircles, which are attached to the cores and between which the armature B plays on an axis resting in frames *a a′*. These poles *b′ b″* do not act themselves as anvils, but uphold two insulated anvils, *c c*, as shown in Fig. 8. The armatures B B′ are both of steel and permanently charged. The frame D upholds an insulated anvil, *d*, for the armature B′ to rest against when not actuated by a passing current. It also upholds in an arm, *d″*, a contact-point, F, and a swinging L-lever, G, or any other desirable shape, having a contact-point, *g*, on one of its arms for the armature-gate B′ to play against, while its other arm plays between the points E and F.

To keep the lever G against the point F, I provide a retaining-spring, *g′*.

To keep the armature B′ from the anvils *b*, I provide a retaining-spring, *e*, regulated by pin *e′*. The armatures B and B′ are attracted one only by negative currents, the other only by positive currents. Since the intensified currents proceeding from the respective stations are of opposite polarity, it is necessary that the polarities of the armatures B and B′ of the relay at one station should be reversed in the relay at the other station, in order that the armatures B′ of the two relays may always be attracted by the intensified currents. If the current is from the right key C′, it will

affect the armature B′, and if it is from the left key C it will affect the armature B. These armatures act upon points so connected that they produce their effect upon sounders or registers. The armature B completes a local circuit by way of point C′, point K, wire L, local battery M, local sounder N, point O, and the axis *c* of the armature. The armature B′ completes a local circuit by way of point *g* in lever G, point F, frame D, point P, sounder Q, battery M, wire L, point K, and thence to the armature B′ again, around which it passes and completes a circuit by way of splice *p*, to retain its magnetic properties. Thus the armature B causes an action in sounder N and armature B′ causes an action in sounder Q when the currents actuate them singly; but when the currents from the distant station act together they, in passing in at point I², produce an increased effect upon armature B′ above the resistance of spring *g′*, attached to lever G, and consequently the lever breaks from point F to point E. In this position the sounder N is in circuit or closed by way of armature B′, lever G, point E, axis *c* of armature B, point O, through itself, the battery, point K, and thence back to the armature. At the same time the sounder Q is in circuit or closed by way of armature B′, lever G, frame D, point P, through itself, the battery, point K, and thence back to the armature. The rheostat and condenser have also a ground-connection, S S, as well as from the relay, as shown in Fig. 9, thus forming a resistance equal to the current, whether it leaves the office by the east or west wire.

In practice I have found that the increased current need not be as strong as both single currents, so I dispense with one-half of the right battery, and, changing the ground-wire at the rear end of the left key to the middle of the left battery, I bring into play one-half of the left battery, thereby making the right battery fully as strong as before, and also decreasing the unnecessary strength by half of the right battery of the combined batteries when the increased current is playing.

I am aware that rheostats and condensers have been used for various purposes; and I am also aware that polarized relays have been used before, and I do not claim what is old; but I do claim the right to use them in a double-duplex telegraph, as described above.

For transmitting from one line of telegraph to another in long circuits, I attach the points P K O to the transmitting-keys C C′ of the other line, and operate them in the same manner as I would a pair of sounders.

When this apparatus is used for the transmission of messages by the aforesaid Nicholson alphabet, the finger-keys B and B′ are placed close together, after the fashion illustrated in my aforesaid patent.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a single-line telegraphic system, the combination at one station, substantially as specified, of two independent electrically-connected keys, one of which—say the first key—when operated reverses the circuit controlled by the second key, independently of the position or action of this second key.

2. At one station of a single main line, a reversible circuit including two independent transmitting-keys, one of which keys successively reverses said reversible circuit, substantially as specified.

3. A reversible circuit having two distinct routes to the main line and including two independent transmitting-keys, one of which keys successively reverses said reversible circuit, and alternately brings either one of said routes in circuit while cutting out the other route to line, substantially as specified.

4. At one station two electrically-connected transmitting-keys, one of which—say the first key—simply opens and closes a battery connecting through the second key with the main line, while the second key successively reverses the direction of the main-line circuit through the circuit-connections between the two keys, and by such reversal either determines or reverses the polarity of the battery controlled by the first key, according as said first key is open or closed, substantially as specified.

5. A quadruplex telegraph, substantially as specified, provided at each station with the following instrumentalities, viz: first, a rheostat; second, suitable relays adapted to respond to incoming currents, but not affected by outgoing currents; third, two main batteries or a divided main battery; fourth, two electrically-connected transmitting-keys, one of which—say the first key—simply opens and closes the battery connecting through the second key with the main line, while the second key successively reverses the direction of the main-line circuit through the circuit-connections between the two keys, and by such reversal either determines or reverses the polarity of the battery controlled by the first key, according as said first key is open or closed.

6. The combination of a double battery, A A′, transmitting-keys C C′, reverser E, polarized relay A, sounders or registers N Q, rheostat O, and condenser P, all connected and constructed substantially as described, and operating as and for the purpose specified.

7. The combination, substantially as specified, with a single electro-magnet, of two polarized armatures, one at each end, and local circuit-connections, so arranged that one armature shall close one local circuit when the line is charged positively and the other shall close a different local circuit when the line is negatively charged.

8. The combination, substantially as specified, with a single electro-magnet, of two polarized armatures, one at each end, and local circuit-connections, so arranged that one arma-

ture shall close one local circuit when the line is charged positively and the other shall close a different local circuit when the line is negatively charged, and a lever which, whenever a current of high tension and appropriate polarity is sent over the wire, will be vibrated in opposition to the stress of a spring by the adjacent polarized armature, and close the local circuit ordinarily controlled by the other polarized armature.

In testimony of which invention I hereunto set my hand.

H. C. NICHOLSON.

Witnesses:
EDGAR J. GROSS,
J. L. WARTMAN.