No. 883,530.

PATENTED MAR. 31, 1908.

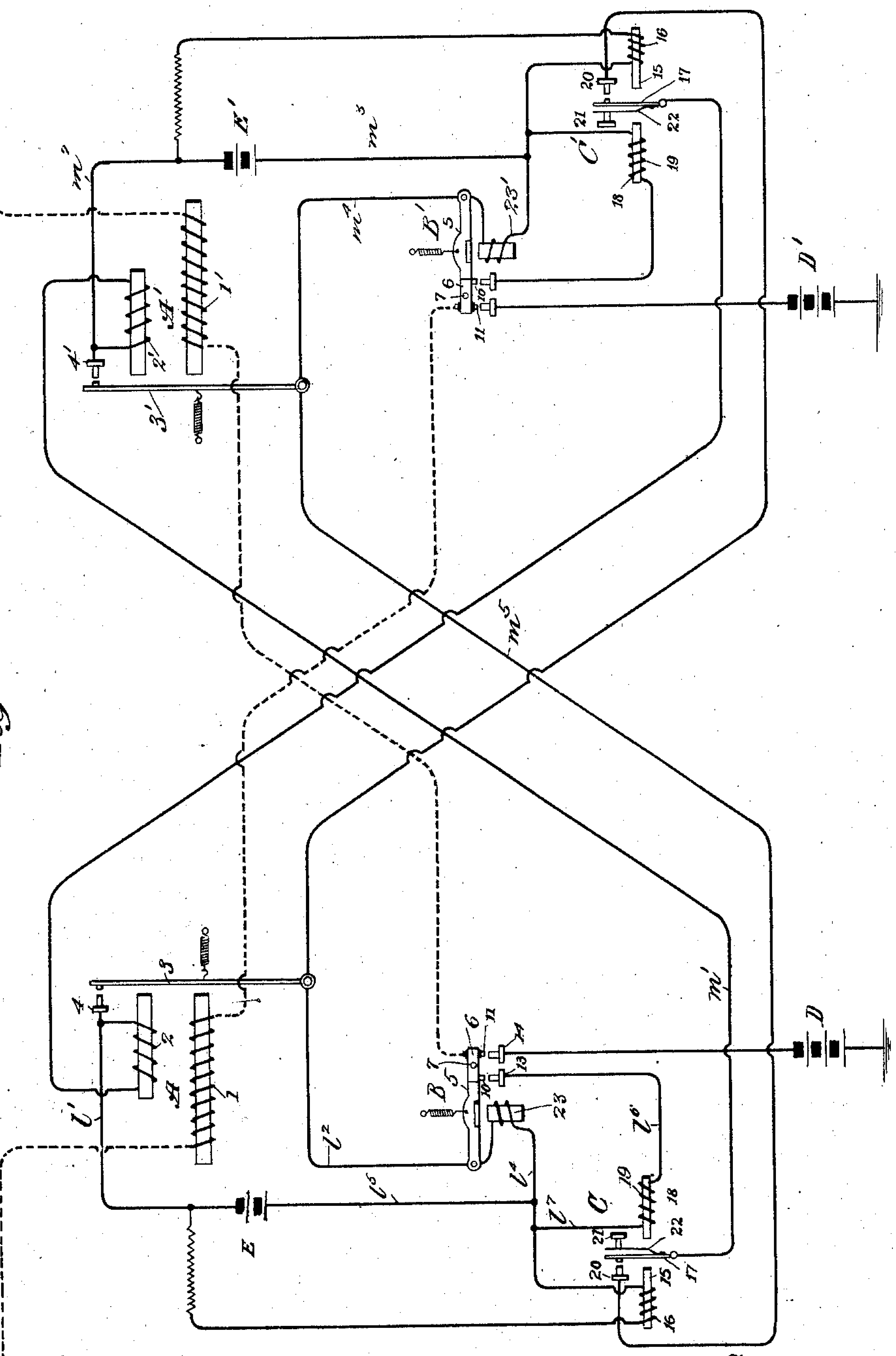
S. D. FIELD.

TELEGRAPH REPEATER.

APPLICATION FILED JUNE 20, 1907.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 2.

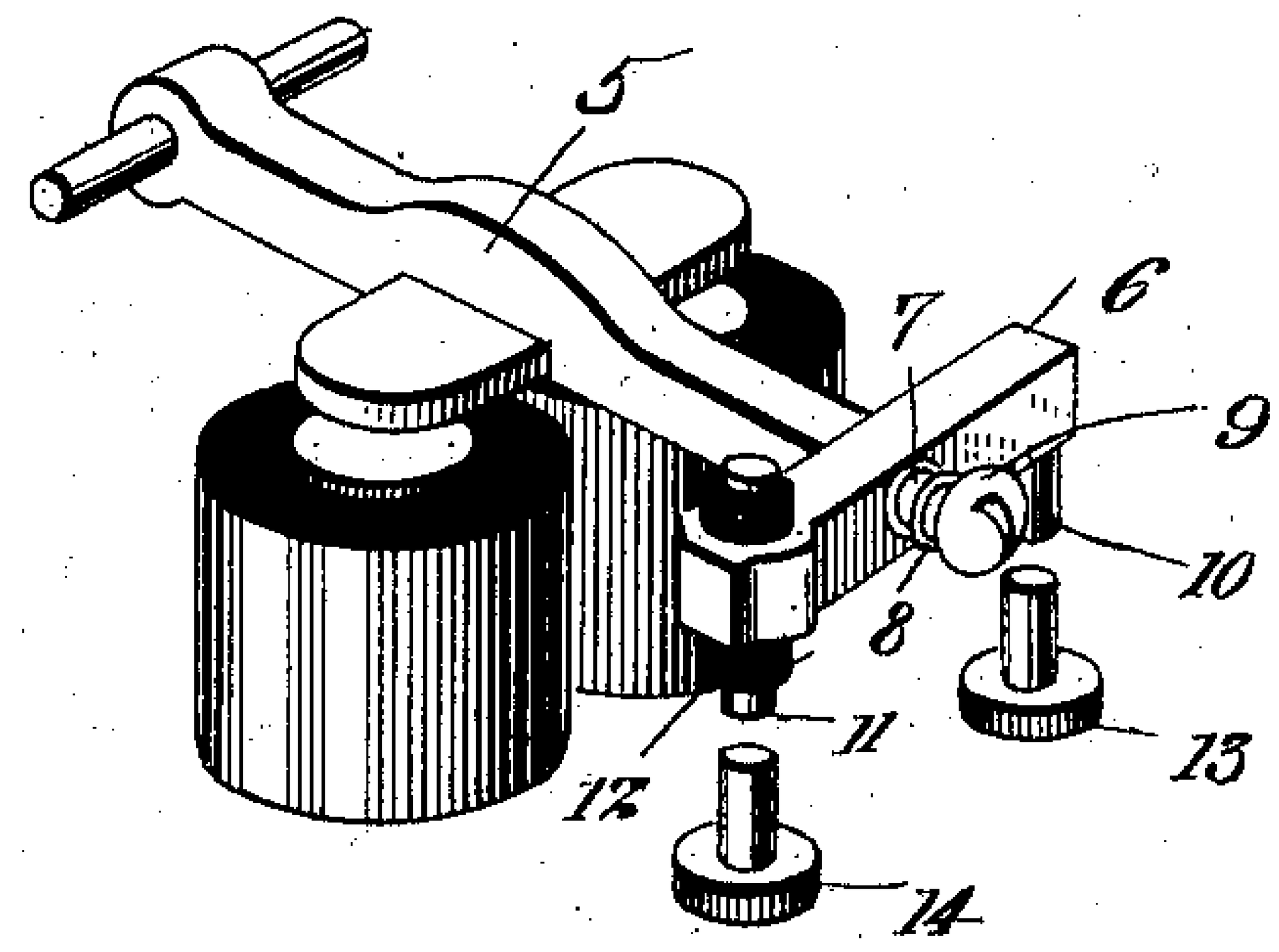
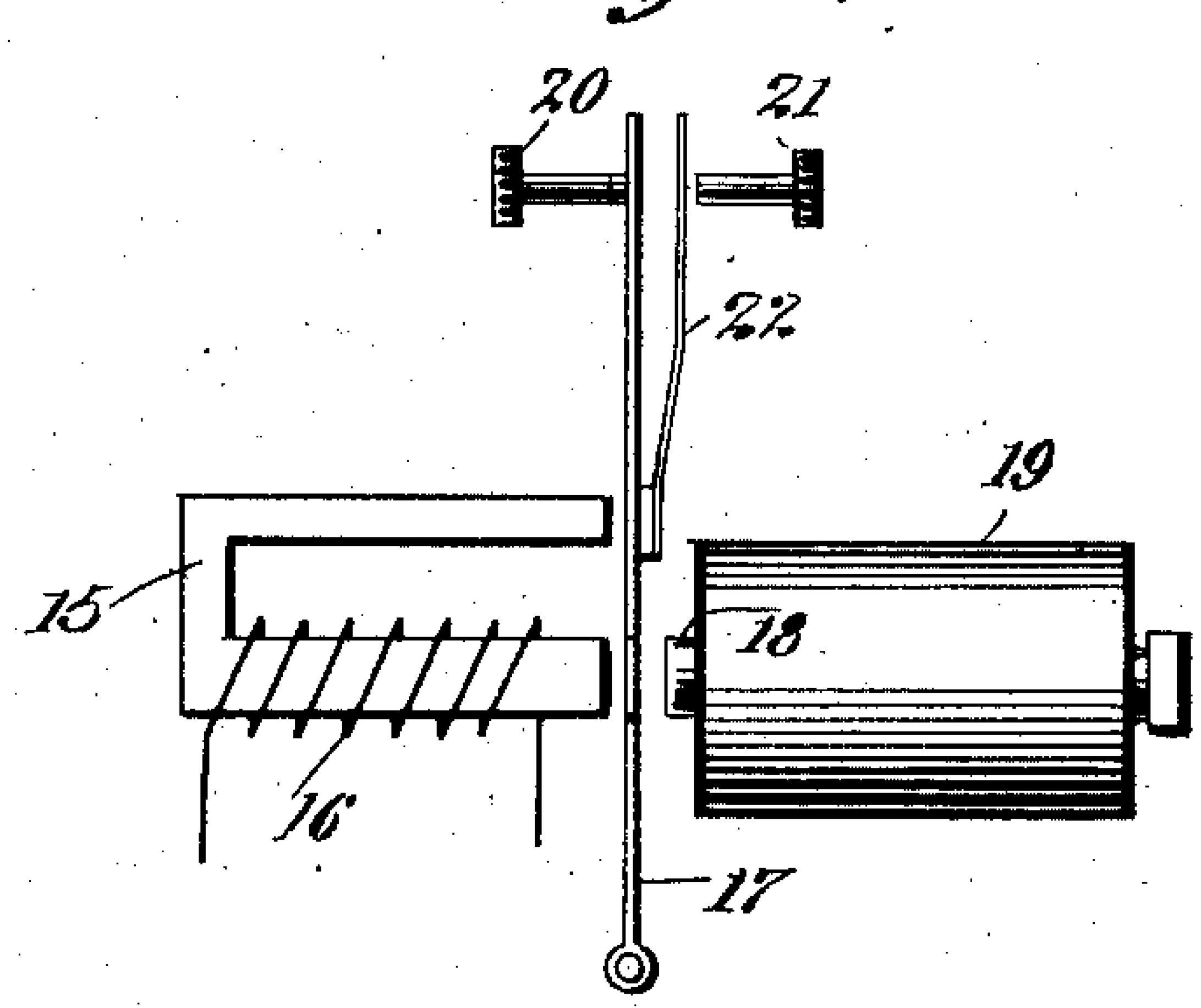


Fig. 3.



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UNITED STATES PATENT OFFICE.

STEPHEN DUDLEY FIELD, OF STOCKBRIDGE, MASSACHUSETTS.

TELEGRAPH-REPEATER.

No. 883,530. Specification of Letters Patent. Patented March 31, 1908.

Application filed June 20, 1907. Serial No. 379,827.

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 Telegraph-Repeaters, of which the following is a full, clear, and exact description.

My invention relates to the art of telegraphy, and more particularly to an improvement in repeaters, whereby messages may be automatically repeated from one circuit to another without the mutilation which is ordinarily incident to this class of apparatus.

From the first introduction of the Morse system of telegraphy until the present time, signals have been relayed or repeated from one circuit to another by means of contact points mounted on a vibrating lever, and actuated by an electromagnet. It is a characteristic of an electromagnet that it occupies a sensible time in energizing, taking more or less magnetic charge in proportion to the duration of the circuit contact controlling the flow of electricity. Thus a magnet becomes much more highly energized when a circuit is closed during the space of time required to make the Morse signal called a dash than is the case when a dot is transmitted. Prolonged magnetization requires time for demagnetization strictly in proportion to the degree of magnetic saturation established. It follows, that a magnet adjusted to correctly transmit or repeat dots will have a tendency to prolong dashes. And when the dashes are properly adjusted for, the dots become clipped or eliminated. This magnetic mutilation tends to reinforce the distortion encountered in signals by passing over a long circuit and thus greatly hampers the efficiency of the circuit whereon many repetitions are encountered.

In the herein described apparatus, I provide means whereby an automatic compensation is obtained for magnetic lag and at the same time an effective automatic repeating mechanism is obtained.

In order that the invention may be clearly understood I will first describe a practical embodiment thereof, reference being made to the accompanying drawing, and thereafter point out the novel principles of the invention based on this embodiment as a practical illustration of such principles:

In the drawings: Figure 1 is a diagrammatic view showing the circuits of a telegraph repeater embodying the principles of my invention; Fig. 2 is a view of what I shall term the repeating sounder; Fig. 3 is a side view of a device constituting a self-regulating shunt for the magnet of the repeating sounder, and which has other important functions, which will later more fully appear. This device may for convenience be termed an assisting inductance, since its main purpose is to aid the repeating sounder in doing its work of retransmission promptly. This device, however, has additional functions as a relay in the principal embodiment of the invention shown.

Referring to the drawings, and particularly to Fig. 1, the two lines are designated line 1 and line 2.

A and A′ are the line relays at which the signals are received from their respective lines, and certain circuits controlled, with the ultimate effect of retransmitting such signals.

B and B′ are the repeating sounders which act to re-transmit the signals received at the relays A and A′.

C and C′ are the devices above referred to and termed assisting inductances.

D and D′ are the two line batteries, of which D pertains to line 1, while D′ pertains only to line 2.

E and E′ are local batteries, of which E pertains particularly to line 2, and E′ to line 1.

All of the relays or devices A, A′, B, B′, and C, C′, are specially constructed, especially B, B′, and C, C′, which are particularly illustrated in Figs. 2 and 3. The line relays A and A′ are of a known type having a main winding and an auxiliary winding, both acting on a single armature. A preferred form is that in which the magnets act on the armature on lines of attraction which neutralize one another so as to keep the armature absolutely non-polarized. The main windings are indicated at 1, 1′, and the auxiliary windings at 2, 2′. 3 and 3′ indicate the armatures which make contacts at the points 4, 4′, when they are attracted by the windings of the relays.

The repeating sounders B, B′, are each constructed with a pivoted armature 5, which has at its end a yoke or whiffletree 6, centrally pivoted to the end of the armature 5 at 7. 8 indicates a spring which may be screwed down to bear against the yoke 6 by the screw 9. The yoke 6 carries two contact points 10 and 11, equally spaced from the

plane of its pivot connection with the armature 5. The contact point 10 is grounded or connected with the armature 5, but the contact point 11 is surrounded by an insulating bushing 12, and has a separate circuit connection. Both the contact points 10 and 11 engage corresponding fixed contacts 13 and 14. It will be evident that on account of the pivoted yoke or whiffletree construction, that both the contact points 10 and 11 engage the fixed contacts and with equal pressure. If the alinement is not exact it is immediately corrected so that it is automatically kept perfect by the actuation of the device.

The devices C which I have termed assisting inductances, may be constructed as particularly shown in Fig. 3. 15 indicates an electromagnet having a winding 16, and actuating on an armature 17.

18 denotes an additional electromagnet, having a winding 19, which attracts the armature 17 in opposition to the magnet 15. The armature moves between the fixed stops 20 and 21, of which 20 is made the terminal of a circuit connection, while 21 is an insulated back stop. The engagement of the armature with the back stop 21 is not direct, however, but is made through an intermediate spring blade 22, which is quite stiff and resilient so as to resist with a moderate yielding movement the attraction of the magnet 18 under all circumstances. The purpose of this construction will later more fully appear.

Referring now again to Fig. 1, I will consider the arrangement of the circuits, and the operation of the relays and mechanism. With the circuits as shown in Fig. 1 the action is as follows: Assuming that the distant operator on line No. 2 opens his key, thus breaking the circuit, magnet 1 becomes deenergized, and releases armature 3, which thereupon breaks its contact at the point 4. The separation of the contacts at 4 interrupts a circuit of the local battery E, through wire l', contact 4, armature 3, wire l^2, and thence through a divided circuit, including magnet 23, wires l^4 and l^5, back to battery E, and also armature 5, wire l^6, magnet 19, and wires l^7 and l^5, back to battery E. The opening of the circuit in line 2 is therefore accompanied by the immediate and simultaneous deënergization of the magnets 23 and 19, of the repeating sounder and the assisting inductance respectively. In order to insure an especially prompt deënergization of the magnet 23, assisting inductance magnet 19 is made with a considerably larger number of turns than that of magnet 23, so that it acts as a clearing out agent for magnet 23 by virtue of its higher inductance. This is because the extra current of winding 19 opposes and overcomes the lesser extra current of the magnet 23. By virtue of the deënergization of magnet 23, assisted as above described by assisting inductance 19, the armature 5 of repeating sounder B promptly moves upward against its back stop, thereby interrupting the circuit of main line No. 1, at the points 11, 14. The repeating sounder B therefore performs its function at this time of retransmitting the signal of line 2 to line 1. I will now consider the way in which the assisting inductance 19 acts as a relay to control circuits which preserve the continuity of line 2.

The opening of the circuit of line 1 at the points 11, 14, is, of course, accompanied by deënergiztion of magnet 1′, of the line relay A′. This would produce a falling off of the armature unless this were prevented in some way. In accordance with my invention it is prevented as follows: It has been noted in the above description that the magnet 19 was deënergized at the time current ceased to flow in line 2. Now the magnet 15 is constantly energized by a direct circuit connection with the local battery E so that this magnet immediately becomes effective to draw the armature 17 against the contact 20. It is obvious that any continuously acting force, such as a spring would accomplish this same result, but not so effectively, because magnet 15 automatically varies its attraction in proportion to the strength of the battery and therefore the strength of the opposing magnet 18. There is accordingly no need of readjustment in case of change in strength of the local battery where an electromagnet 15 is used. Also it will be noted that the strength of magnet 15 is greater at the moment when it is intended to attract the armature, since at this time the local battery E has no other circuits closed, and its full strength is available to energize the magnet 15. The armature 17 thereafter engages the contact 20 and establishes a circuit through the wire m', and auxiliary magnet 2′ of line relay A′, wire m^2, battery E′, wire m^3, coil 23′, wires m^4 and m^5, back to the contact 20. The magnet 2′ is accordingly energized and the armature 3′ is held attracted. The energization of this magnet, and the current which flows through the contact 20, are, however, both very light, because the magnet is directly shunted by the engagement of the armature 3′ at the contact 4′. The strength of the magnet 2′ is, however, bound to be great enough to keep the armature attracted, because immediately that the armature starts to move away from its contact, the magnet 2′ becomes strengthened to the full force of the local battery which would immediately draw the armature back again. In practice the armature rests very lightly against the contact, and the energization of the magnet is just sufficient to maintain this very light engagement. The current flowing through the circuits m', m^2, m^3, etc., is correspondingly feeble. Nevertheless, the

line relay A′ is kept in position to keep the armature of the repeating sounder B′ down, so that the continuity of line 2 is not interrupted. All conditions for the retransmission of a circuit interruption from line 2 to line 1 have now been satisfied, the continuity of line 2 being kept intact, and the promptness of the transmission having been duly assisted as described by the clearing out action of the assisting inductance 19 or the transmitting sounder B.

I will now assume that the distant operator on line 2 again closes his key. This immediately reënergizes magnet 1 of line relay A which attracts its armature. The re-closure of the local circuit l', l^2, etc., reënergizes magnets 19 and 23. 23 is the magnet of the repeating sounder B, so that the circuit of line 1 is immediately closed as required. At the same time the armature 17 is attracted away from the contact 20, and the circuit of holding magnet 2′ accordingly interrupted although armature 3 does not move, being now held by magnet 1′ thus keeping continuity of line 2 still intact. The interruption of this holding or auxiliary magnet 2′ is necessary in case the operator of line 1 should want to transmit, in which case it would be necessary to have line relay A′ respond. The above procedure operates therefore to close the circuit of line 1 either for the purpose of sending a dot or dash in ordinary Morse code signaling, or so that the operator on line 1 can respond. The first condition is, of course, of much the more numerous occurrence.

Having now described the general method of operation of the repeater, I will particularly consider the features by which the difficulties mentioned in the preliminary part of this specification are overcome. I have already referred to the fact that in the ordinary apparatus, when a dot is transmitted the magnets do not become very greatly charged or magnetized, but when a dash is sent there is more time for the magnetism to build up, so that the cores become saturated and produce strong extra currents prolonging and distorting the signals at the completion of the dashes. This is a great disadvantage, and by the present invention is overcome in the following way: I have shown that when the armature of repeating sounder B is attracted that it closes the circuit of line 1. At the same time the attraction of this armature closes the circuit through points 10 and 13, and which includes magnet 19. But the circuit is not closed at the points 10 and 13 until the armature 5 has been drawn down. Accordingly when the operator of line 1 closes his key, the full strength of battery E is initially available for the energization of the magnet 23, which can thus attract its armature with great force and promptness. As soon as the armature is drawn down, the circuit of magnet 23 is bridged or shunted by the magnet 19, so that the current strength of magnet 23 is cut down to about half its former value. Under these circumstances, it does not matter if the circuit closure be prolonged into a dash, because the weakened current cannot produce the strengthening of the magnet 23 which would occur if the above shunting or bridging action did not take place. Magnet 23 continues to be energized only feebly no matter how long the current flows, and it is in a condition to release its armature with great promptness at the termination of the dash. As already stated, the magnet 19 has a clearing out effect at this time, which further increases the promptness with which the magnet 23 releases or throws off its armature. On account of these two considerations the release of the repeating sounder armature is as prompt at the termination of a dash as it is at the termination of a dot, and more prompt in both cases than with a simple repeating sounder not having my assisting inductance 19. The action of the assisting inductance in accordance with my invention therefore produces (1) a transmitting sounder attracted by the full battery strength and held by say one-half the battery strength; (2) establishment of a magnetic shunt by this one-half battery strength so withdrawn, so that the sounder armature not only rises with great ease, owing to its weak holding battery, but is also repelled by the kick-back from the magnetic shunt, so that very little opposing or retractile spring in such sounder is necessary; (3) this assisting inductance produces a self-regulating maintaining shunt around the local contacts of the corresponding line relay, no matter how strong the local battery. The holding or auxiliary coil in this shunt circuit will take only just power enough to hold the relay armature in its attracted relation.

To offset the sluggish action in coil 19 due to its being used as a source of induced currents, the arrangement of the spring blade 22 shown in Fig. 3 is employed. This spring is so stiff that the magnet 19 can never overcome it, but will always strain it more or less according to the strength of the local battery. Consequently armature 17 begins to move instantly on weakening of the battery; otherwise it would remain motionless until the inductive currents set up in coil 19 had become sufficiently weakened. Stated in other words, if magnet 19 is very strongly energized it will attract the armature 17 until blade 22 is bent, and then when magnet 19 begins to weaken, as it does without very great suddenness, the tension of spring 22 will impel the armature away from the magnet, so that such armature is already moving rapidly toward the contact 20 by the time

when magnet 19 would be sufficiently weakened to release the armature at all, in the absence of the spring 22. The play of the armature 17 need not be very great because as has been already pointed out, no strong currents flow at any time through contact 20, and the circuits m', m^2, m^3, &c., so that the smallest possible spark gap at 20 is sufficient. On this account the paradoxical result is obtained that the armature 17 of coil 19 moves with the same speed or a little faster than the armature 5 of coil 23 when their joint circuit is interrupted, although coil 19 has much the higher coefficient of self-induction. An analysis of the foregoing will show what actually obtains in practice. Morse signals passing over a line suffer mutilation in that the static capacity has a tendency to shorten the dots and lengthen the dashes in transmission. Were both similarly effected the mutilation would not be so detrimental. But when the receiving apparatus is so adjusted as to catch the clipped dots it is apt to be so sluggish as to run the dashes over into the next signal thus transforming a B into a D, &c.

With my apparatus the same sort of adjustment serves to correct both classes of signals; the prolonged magnetization incident to the dash is compensated for by the shunting of current from the repeating sounder upon the completion of its downward stroke, while the assisting effect of the inductive shunt already described is proportionately very much more pronounced for such dash signal.

Another novel feature incident to this apparatus is that I employ no floating or spring contacts in the line or local service. It follows that an attendant listening at a repeating station hears the signals exactly as they go to line and not as they are too often falsely made, by flimsy spring contacts or floating lever points, which owing to their inertia give more or less jarring contacts.

What I claim, is:—

1. In a telegraph repeater, a plurality of lines, separate relays therefor, a plurality of repeating sounders respectively operated by said relays, and means for closing a local metallic circuit around each of said sounders when the armature thereof has been attracted.

2. In a telegraph repeater, a plurality of lines, separate relays therefor, a plurality of repeating sounders respectively operated by said relays, local metallic circuits including inductances for the respective sounders, and means for closing said local circuits around the sounders when the armatures thereof have been attracted.

3. In a telegraph repeater, a repeating sounder having an armature, an inductance, means for shunting said inductance around said repeating sounder when the armature thereof has been fully attracted, and means controlled by said shunt for maintaining the continuity of the line over which the signals are being received.

4. In a telegraph repeater, a repeating sounder having an armature, an inductance shunt, means for bridging said shunt across said sounder when the armature thereof has been fully attracted, and means actuated by said inductive shunt for maintaining the line continuity over which the signals are received.

5. In a telegraph repeater, a plurality of lines, separate relays therefor, repeating sounders actuated by the respective relays and having armatures with a plurality of contacts, transmitting circuits for the respective lines including a contact of each sounder, and local metallic circuits for the respective sounders each including an inductance, and closed by the other contact of its respective sounder.

6. In a telegraph repeater, a repeating sounder having an armature, a yoke pivoted to said armature and having a pair of contacts, a transmitting circuit including one of said contacts, and a shunt around said repeating sounder closed by the other contact.

7. In a telegraph repeater, a line relay having a holding magnet, a repeating sounder, an inductive shunt therefor, and means actuated by said shunt for energizing said holding magnet.

8. In a telegraph repeater, a repeating sounder, a magnet in shunt circuit around said sounder, an armature, for said magnet, and a circuit closed by the movement of said armature for preserving the continuity of the line over which the signals are received.

9. In a telegraph repeater, a line relay having a holding coil, a repeating sounder, a relay constituting an inductance and adapted to be shunted across said repeating sounder, a circuit including a local battery and said holding coil and completed by the operation of said inductance relay.

10. In a telegraph repeater, a repeating sounder, an inductance magnet, means for completing a local metallic circuit to shunt said magnet across said repeating sounder, an armature for said magnet, and a constantly energized magnet adapted to attract said armature in opposition to said inductance magnet.

11. In a telegraph repeater, a repeating sounder, an inductance magnet, means for completing a local metallic circuit to shunt said magnet across said repeating sounder, an armature for said magnet, a local battery, and a magnet energized thereby and adapted to attract said armature in opposition to said inductance magnet.

12. In a telegraph repeater, a repeating sounder, a relay constituting an inductance means for completing a local metallic circuit to shunt said relay across said sounder, said

relay having an armature with a spring blade fixed thereto, and a fixed stop adapted to engage said blade and limit the movement of said armature when the relay circuit is completed.

13. In a telegraph repeater, a repeating sounder, a relay means for completing a local metallic circuit to shunt said relay across said sounder, said relay having an armature with a spring extension, and a stop engaging said extension and limiting the movement of said armature when the relay operates.

14. In a telegraph repeater, a repeating sounder, a relay constituting an inductance, means for completing a local metallic circuit to shunt said relay across said sounder, said relay having an armature, a magnet constituting a retractile force therefor, and spring means for resisting movement of said armature when the relay is operated.

15. In a telegraph repeater, a repeating sounder, a relay constituting an inductance means for completing a local metallic circuit to shunt said relay across said sounder, said relay having an armature, and spring means for resisting the movement of said armature when the circuit of the relay is closed.

16. In a telegraph repeater, a line relay having a holding coil and armature contacts, means for closing the circuit of said holding coil, said circuit having a shunt across said holding coil and including the contacts of the relay.

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

STEPHEN DUDLEY FIELD.

Witnesses:
SAMUEL OLDEN,
J. H. ELLIOTT