A. C. EASTWOOD & F. R. FISHBACK.

LIFTING MAGNET.

APPLICATION FILED APR. 4, 1908.

903,552. Patented Nov. 10, 1908.

2 SHEETS—SHEET 1.

FIG. 1.

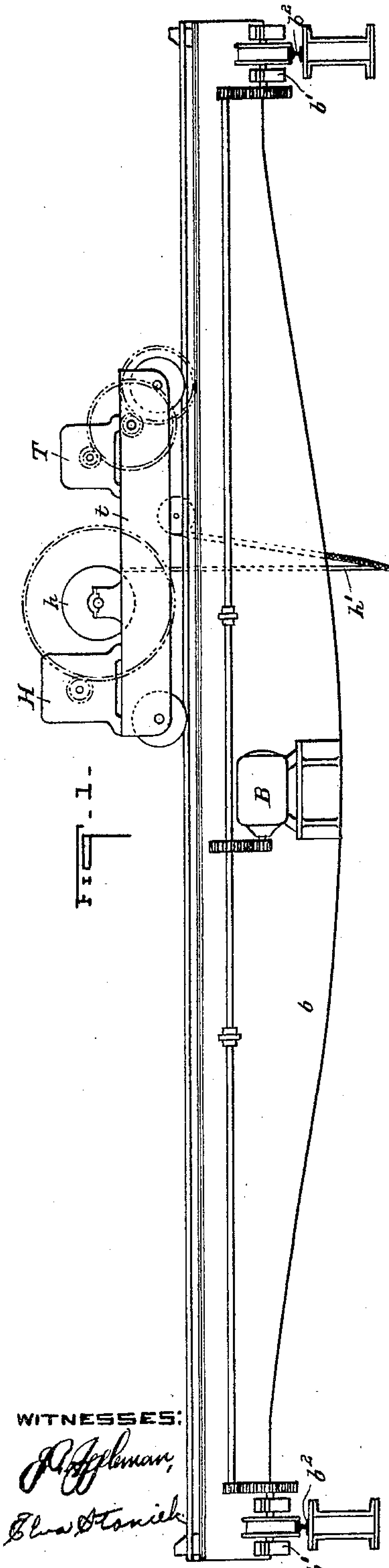
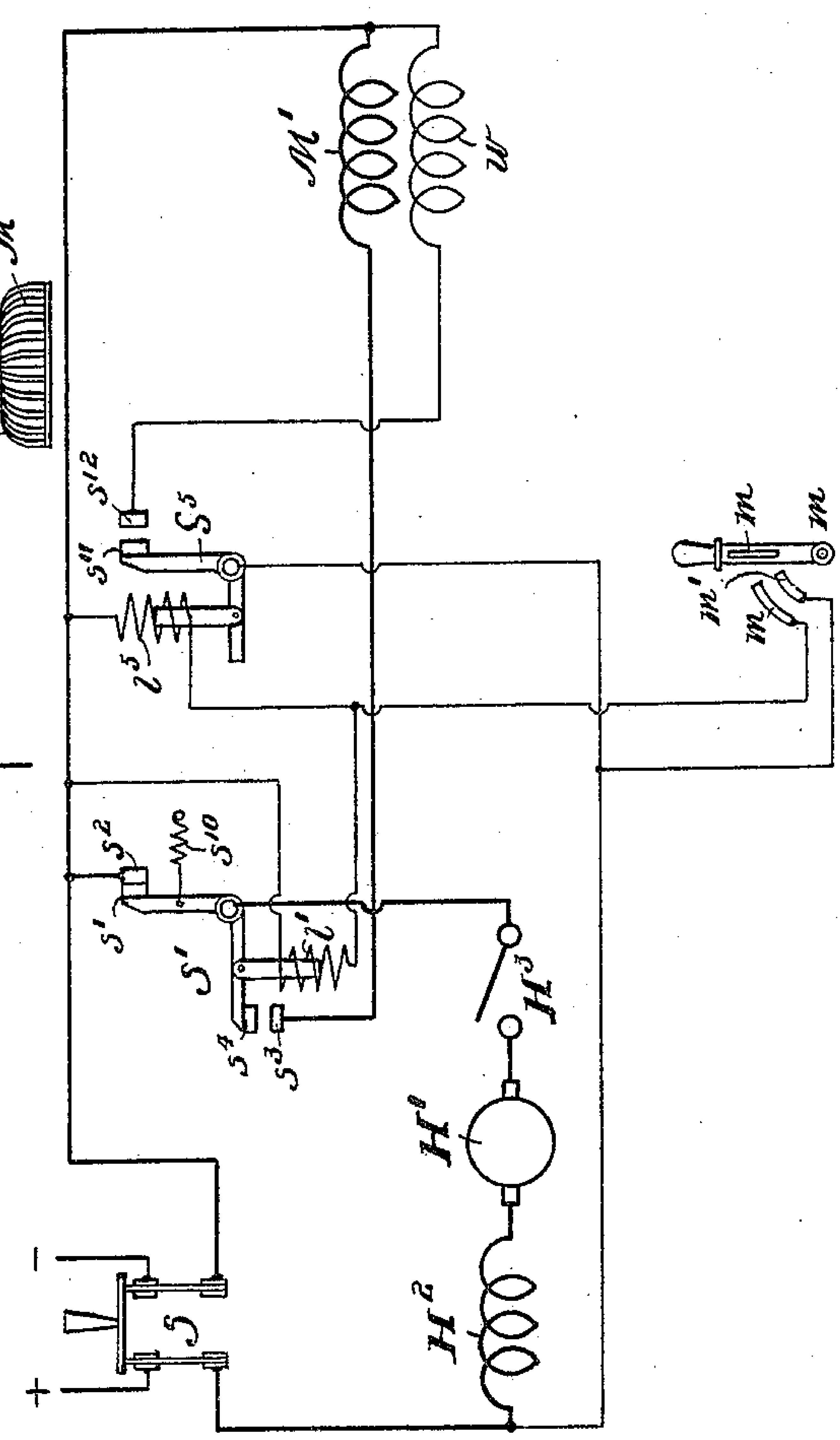


FIG. 2.



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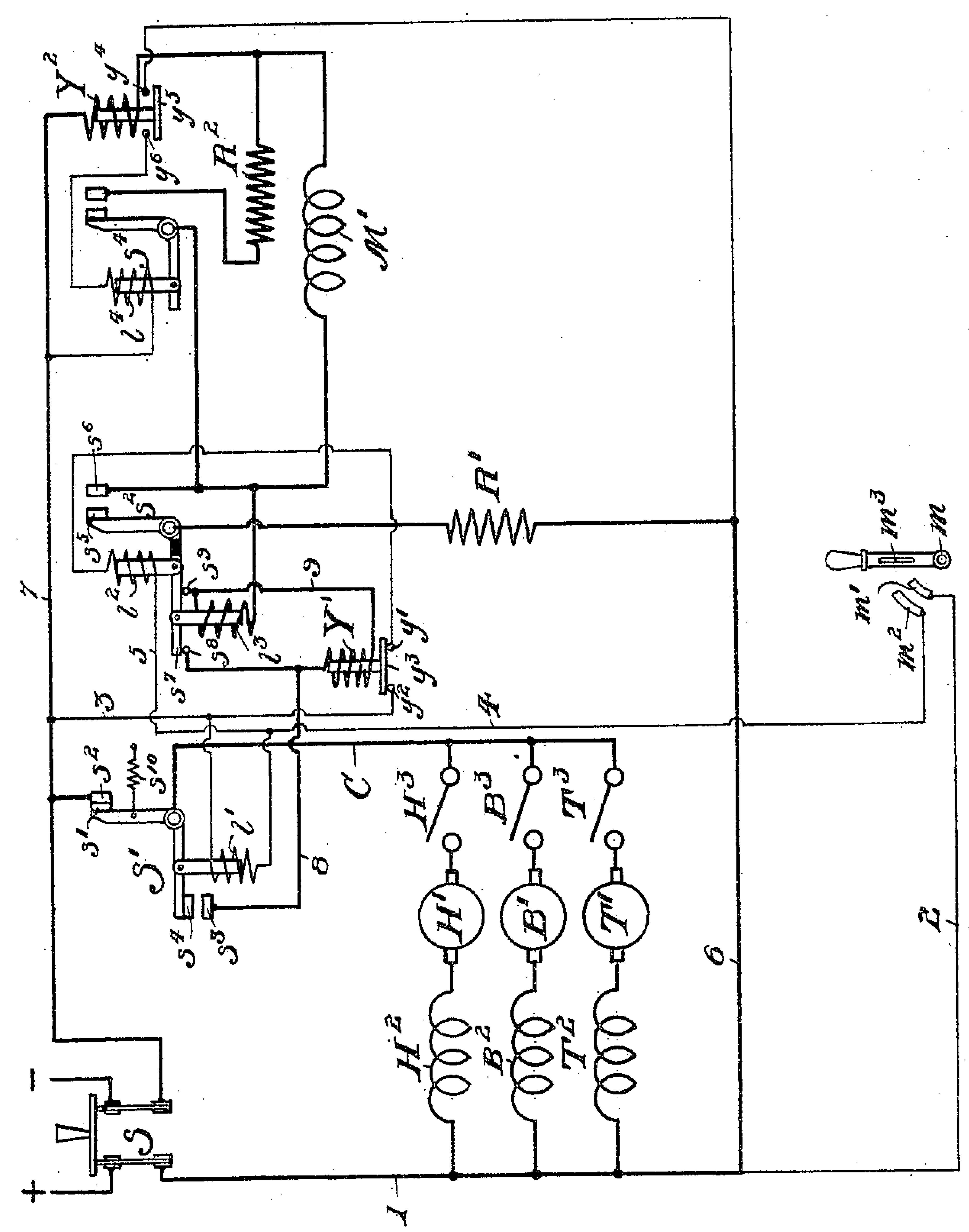
2 SHEETS—SHEET 2.

FIG-2-



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ARTHUR C. EASTWOOD AND FREDERICK R. FISHBACK, OF CLEVELAND, OHIO, ASSIGNORS TO THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

LIFTING-MAGNET.

No. 903,552. Specification of Letters Patent. Patented Nov. 10, 1908.

Application filed April 4, 1908. Serial No. 425,135.

To all whom it may concern:

Be it known that we, ARTHUR C. EASTWOOD and FREDERICK R. FISHBACK, citizens of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented or discovered new and useful Improvements in Lifting-Magnets, of which the following is a specification.

Our invention relates to new and useful improvements in lifting magnets, particularly to the winding of the magnet and the method and means for connecting it in circuit and supplying the winding with electric current.

In the past, so far as we know, all lifting magnets have been constructed with shunt windings, adapted to be connected across the supply mains directly, or with a certain amount of resistance in series with the magnet winding. In such cases the current which flows when the circuit of the magnet is closed depends upon the resistance of the circuit of the magnet and the voltage across the supply mains at the point when the magnet is connected.

Lifting magnets are commonly used in connection with electric cranes or hoists for hoisting and transporting products of iron and steel. These cranes may be located at a considerable distance from the power generating station on account of which a considerable "drop" or loss in voltage occurs, due to the resistance of the line, when a heavy current is drawn by the motors of the crane. This "drop" is increased by the resistance of the trolley contacts and other connections of the crane itself. Where a lifting magnet is used for lifting such material as pig-iron from a pile, a heavy current is drawn by the hoisting motor in starting due to the fact that the moving parts of the hoisting mechanism, as well as the load, must be accelerated and at the same time a considerable portion of the pile becomes more or less magnetized under the influence of the magnet and the portion lifted must be torn away from the remainder. Under these conditions the drop or loss in voltage is heaviest just as the motor begins to hoist the load. Obviously it is just at this time that the pulling power and hence the magnetizing force applied to the magnet should be at a maximum, it being possible to greatly reduce the magnetizing force after the material has been attracted and lifted clear of the pile. It will be readily understood, that, in the case of a shunt wound magnet, the current which flows through the winding, and hence the magnetizing force, will be at a minimum at the very time when it should be at maximum and, therefore, a very considerable loss in lifting capacity is likely to occur.

Our invention embraces means whereby the magnetizing force is at a maximum at the time the load is being separated from the pile, which tends to increase the lifting capacity of the magnet.

Our invention further embraces means for automatically reducing the flow of current through the winding of the magnet after the load has been separated from the pile.

A further advantage which our invention offers lies in the fact that the windings will have low resistance and hence will be composed of a conductor having relatively large cross-section and few turns. This reduces the amount of insulation required and results in a winding mechanically strong and permanent. Owing to the smaller number of turns, the inductive voltage generated when the circuit of the magnet is opened, is reduced, thereby reducing the strain on the insulation. This gives our magnet a very material advantage over an ordinary shunt-wound magnet, having a large number of turns, when used in damp and exposed locations.

In carrying out our invention, we provide the magnet with a winding of low resistance suitable for connection in series with the circuit of the hoisting motor or other motors driving the hoist or crane, in connection with which the magnet is to be used. By so arranging and connecting the winding of the magnet, a maximum current flows through it at the instant of separating the load from the pile. After the load is lifted from the pile, the current taken by the hoisting motor and the magnet is gradually and automatically reduced as the motor speeds up. In cases where the crane or hoist is provided with other motors besides the hoisting motor, we provide means whereby the magnet may also receive its supply of current in whole or in part from the circuit of the other motors, and in any case provide a separate circuit by which the magnet may be supplied with current independently of the motor or motors.

Our invention also includes automatic switching mechanism controlling the supply of current to the magnet and so devised and arranged that the magnet will not drop its load even in case the supply of current be cut off from all the motors of the crane.

Our invention will be more fully understood by reference to the accompanying drawings which form a part of this specification and in which

Figure 1 is a side elevation of an electric traveling crane provided with a lifting magnet and Fig. 2 is a simplified diagram of electrical connections for a crane and magnet equipped and connected in accordance with our invention. Fig. 3 is a modified diagram of the wiring connections.

We have illustrated our invention in connection with an overhead electric traveling crane as being, in general, the best arrangement for the economic and speedy handling of material. Our invention, however, may be used in connection with hoists and cranes of various kinds.

In Fig. 1, b is one of the girders of the crane provided at its ends with trucks b', b' upon which the crane structure may be propelled along the rails b^2, b^2 of an elevated runway by the bridge motor B. The girders b, b are also provided with rails upon which a trolley t may be propelled by a trolley motor T. The trolley is provided with a hoisting drum h connected through suitable gearing to a hoist motor H. The hoisting drum is equipped with chain or cable h', by means of which the magnet M with the load which it attracts and holds may be hoisted and lowered. The winding of the magnet is supplied with current through the cable m.

In Fig. 2, S is a switch which connects the various circuits of the crane with a suitable source of current.

H′ is the armature and H^2 the series field winding of the hoisting motor H.

B′ is the armature and B^2 the series field winding of the bridge motor B, and T′ and T^2 the similar parts of the trolley motor T.

H^3, B^3, and T^3 are switches which, for the sake of simplicity, we have shown as a means of closing the respective motor circuits. Ordinarily, reversing controllers would be used for the purpose in the well known way.

The motor windings are connected through their switches to the common return C which is connected through switch contacts s' and s^2 to the negative side of the switch S. The contacts s' and s^2 are normally held in engagement by the spring s^{10}. If the switch H^3 be closed, current will flow from the positive side of the switch S through the field H^2 and the armature H′ of the hoisting motor, the switch H^3, the common return C, and switch contacts s' and s^2 to the negative side of the switch S. If all of the switches H^3, B^3, and T^3 be closed, the combined current of the motors will flow through the common return C.

M′ represents the winding of the lifting magnet, which as previously noted is of such section as to adapt it for series operation.

The operation of the magnet is controlled by an operating switch m. When this switch is in the position shown,—the circuit of the magnet is open. If the switch lever be moved to the left so that the brush m^3 spans the contacts m' and m^2, circuits are established as follows: from the positive side of the switch S, through the wires 1 and 2, the contracts m', m^3, and m^2, the wire 4, the switch operating coil 1′ and the wire 3 to the negative main. This causes the coil 1′ to draw in its plunger, which opens the switch contacts s' and s^2 and closes the contacts s^3 and s^4. A second circuit is established by the said movement of the switch m as follows: from the positive side of the switch S through the wires 1 and 2, the contacts m', m^3, and m^2, the wires 4 and 5, the switch operating coil 1^2, the relay contacts y', y^3, y^2, and the wire 3 to the negative main. This completes the circuit of the coil 1^2 which draws in its plunger and closes the switch contacts s^5 and s^6; which close what we will call the "supplementary circuit" as follows:—from the positive side of switch S, through the wires 1 and 6, the resistance R′, the switch contacts s^5 and s^6, the magnet winding M′, the relay winding Y^2, and the wire 7 to the negative main. The resistance R′ limits the flow of current through the magnet winding M′ to the proper value.

As previously noted the excitation of the coil 1′ has caused switch S′ to operate, separating contacts s' and s^2 and closing contacts s^3 and s^4. If one of the crane motors be operating, say the hoist motor, a main, or series, circuit will be established through the magnet as follows: from the positive side of the switch S, the wire 1, the field H^2, and the armature H′ of the hoisting motor, the switch H^3, the contacts s^4 and s^3 of the switch S′, the wire 8, the winding of the relay Y′, the wire 9, the coil 1^3, the magnet winding M′, the winding of the relay Y^2, and the wire 7 to the negative main. Under this condition the magnet winding is supplied with current both through the supplementary circuit and the series circuit. In the event that sufficient current flows through the series circuit to properly excite the magnet (which will ordinarily be the case when either the hoist or bridge motors are operating) the relay Y′ will act causing the bridging member y^3 to open circuit with the contacts y' and y^2. This opens the circuit of the coil 1^2 of switch S^2 which causes contacts s^5 and s^6 to separate, thus opening the supplementary circuit. As the contacts s^5 and s^6 open, the contacts s^8 and s^9 are bridged by the member s^7 of the switch S^2. This short circuits the winding of the relay Y′ causing it to drop its plunger thus connecting contacts y' and y^2 through the bridging member y^3. This reëstablishes the circuit through the winding 1^2 of switch S^2. The parts of switch S^2 are then put under strain, the coil 1^2 tending to operate the switch to close contacts s^5 and s^6 to reëstablish the supplementary circuit, and the series coil 1^3 tending to prevent this closure. The instant, however, that the current in the series circuit falls below a certain value the pull of coil 1^2 overcomes the pull of the coil 1^3 and the contacts s^5 and s^6 close. This, of course, will occur in case current is cut off from the motors of the crane by bringing the controllers to the off position. By having the parts of the switch S^2 under strain and constantly tending to close the contacts s^5 and s^6, this action takes place so promptly upon failure of the series current, that the supplementary circuit is reëstablished before the magnet can become demagnetized. This prevents the magnet from dropping its load upon failure of the series current.

S^4 is a normally open magnetic switch having an operating coil 1^4 which, when excited closes a circuit containing the resistance R^2 in shunt with the winding M of the magnet, thus reducing the amount of current in the magnet winding. The circuit of the coil 1^4 is controlled by the relay Y^2 which has its winding in series with the magnet winding M′. In case the current through the magnet exceeds a given maximum the relay Y^2 acts, causing the member y^5 to bridge the contacts y^4 and y^6. This completes the circuit of the coil 1^4 and causes the switch S^4 to close, thus placing the resistance R^2 in shunt with the magnet. When the current drops to a proper value, the relay Y^2 drops its plunger, thus causing the switch S^4 and the shunt circuit to open. When it is desired to deënergize the magnet to cause it to release its load, the switch m is simply brought to the vertical or "off" position, which opens the circuits of the coil 1′ of the switch S′ and the coil 1^2 of the switch S^2, thus opening both the series and supplementary circuits through the magnet and cutting off all supply of current therefrom. At the same time contacts s' and s^2 of switch S′ are closed, thus short-circuiting the series circuit through the magnet and permitting the various motors of the crane to operate independently of the magnet.

Fig. 3 is a diagram of connections of a modified plan which we have devised for preventing deënergizing the magnet when current is cut off from the motor. In this case, the magnet is provided with a series winding M′ and a shunt winding w, the winding w being connected across the supply mains at all times when the magnet is in operation. It will be understood that this winding w with its connections takes the place of the supplemental circuit in Fig. 2, the winding w being so proportioned as to prevent dropping of the load upon the failure of current through the series winding M′.

In Fig. 3, when it is desired to operate the magnet, the lever of the magnet controller m is moved to the left so that the brush m^3 connects the contacts m' and m^2. This completes the circuit of coil 1^5 of the switch S^5 and the coil 1′ of switch S′, causing the switch S^5 to close, connecting contacts s^{11} and s^{12} and causing the switch S′ to open the contacts s' and s^2 and close the contacts s^3 and s^4. The closure of switch S^5 completes the circuit through the shunt winding w of the magnet, and the opening of contacts s' and s^2 and closure of contacts s^3 and s^4 connects the series winding M′ of the magnet in the return circuit of the hoisting motor. When the switch H^3 of the hoisting motor is closed, the motor current will flow through the winding M′, thus increasing the magnetizing force applied to the magnet as and for the purpose already described.

While in Fig. 3, we have shown the magnet used in connection with but a single motor, it is obvious that the same arrangement of a magnet having a compound winding can readily be connected with its series winding in the return of several motors and the series winding protected from overload as shown, for instance in Fig. 2.

We claim—

1. As a new article of manufacture, a lifting magnet having a winding of low resistance adapted for operation in series with an electric motor.

2. In combination with a lifting magnet, means for causing the excitation of the magnet to be at a maximum at the instant of lifting the load irrespective of fluctuations in the voltage at which current is supplied to the winding of the lifting magnet.

3. In combination, a hoisting mechanism, an electric motor for driving said hoisting

mechanism, and a lifting magnet having its winding adapted for operation in series with said motor.

4. In combination, a hoisting mechanism, an electric motor for driving said hoisting mechanism, and a lifting magnet having its winding adapted for operation in series with said motor or in series with a supplementary circuit containing a resistance.

5. In combination, a hoisting mechanism, an electric motor for driving said hoisting mechanism, and a lifting magnet having its winding adapted for operation in series with said motor or in series with a supplementary circuit containing a resistance, and automatic means for closing said supplementary circuit when the current passing through said motor drops below a predetermined minimum.

6. In combination, a crane driven by electric motors and a lifting magnet having its winding adapted for operation in series with one or more of said motors.

7. In combination, a crane, electric motors for driving the mechanism of said crane, said motors being supplied with current through a common return, and a lifting magnet having its winding adapted for connection in series with said common return.

8. In combination, a crane, electric motors for driving the mechanism of said crane, said motors being supplied with current through a common return, a lifting magnet having its winding adapted for connection in series with said common return, and a supplementary circuit for supplying said magnet with current.

9. In combination, a crane, electric motors for driving the mechanism of said crane, said motors being supplied with current through a common return, a lifting magnet having its winding adapted for connection in series with said common return, a supplementary circuit for supplying said magnet with current, and means for automatically closing said supplementary circuit when the current flowing in said common return drops below a predetermined value.

10. In combination, an electric motor, a lifting magnet having its winding adapted for operation in series with said motor, a switch in said motor circuit normally short-circuiting said magnet winding, a second normally open switch for completing the motor circuit through said magnet winding, and a magnet controlling switch which, when closed, causes said second switch to close and said first switch to open.

11. In combination, an electric motor, a lifting magnet having its winding adapted to connection in series with said motor, a power-actuated switch for including said magnet winding in said motor circuit, a supplementary circuit for said magnet, a second power-actuated switch for closing said supplementary circuit, a magnet controlling switch, which, when closed causes said first power-actuated switch to close and causes said second power-actuated switch to tend to close, and means for preventing said second switch from closing unless the current in the motor circuit is less than a predetermined value.

12. In combination, an electric motor, a lifting magnet having its winding adapted for operation in series with said motor, a supplementary circuit for supplying said magnet with current, a switch controlling said supplementary circuit, said switch tending constantly to close while the magnet is in operation, and a magnet in series with the motor circuit which prevents closure of said switch so long as the current in the motor circuit exceeds a predetermined value.

13. In combination, a motor circuit, a lifting magnet adapted to be supplied with current through the motor circuit or through a supplementary circuit, means for automatically closing said switch when the current in the motor circuit drops below a predetermined minimum, and means for preventing said switch from closing when the current in said motor circuit is above said minimum.

14. In combination, an electric motor circuit, a supplementary circuit, a lifting magnet having its winding adapted for operation in either or both of said circuits, a relay in said motor circuit, a double acting switch having one pair of contacts controlling said supplementary circuit and a second pair of contacts for short circuiting the winding of said relay, one set of contacts being open when the other is closed, and a solenoid for closing said first pair of contacts, said solenoid being controlled by said relay.

15. In combination, a motor circuit, a lifting magnet having its winding adapted for connection in series with said motor circuit, a shunt around said magnet winding, a magnetically operated switch controlling said shunt, and a relay in the circuit of the magnet having contacts controlling said magnetically operated switch.

16. In combination, a motor circuit, a lifting magnet having its winding in said motor circuit, and automatic means for throwing a shunt around the winding of said magnet when the current through said winding exceeds a predetermined value.

17. In combination, a motor circuit, a lifting magnet adapted to be supplied with current through the motor circuit or through a supplementary circuit, a switch for control-

ling said supplementary circuit, means for automatically closing said switch when the current in the motor circuit drops below a predetermined minimum, and means for preventing said switch from closing when the current in said motor circuit is above said minimum.

Signed by the said ARTHUR C. EASTWOOD at Pass Christian, in the State of Miss., this 28th day of March, A. D., 1908, and by the said FRED. R. FISHBACK at Cleveland, in the State of Ohio, this 2nd day of April, A. D., 1908.

ARTHUR C. EASTWOOD.
FRED. R. FISHBACK.

Witnesses for Arthur C. Eastwood:
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Witnesses for Fred. R. Fishback:
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