No. 854,015. PATENTED MAY 21, 1907.

G. BAEHR.

LIMIT SWITCH.

APPLICATION FILED NOV. 3, 1906.

3 SHEETS—SHEET 1.

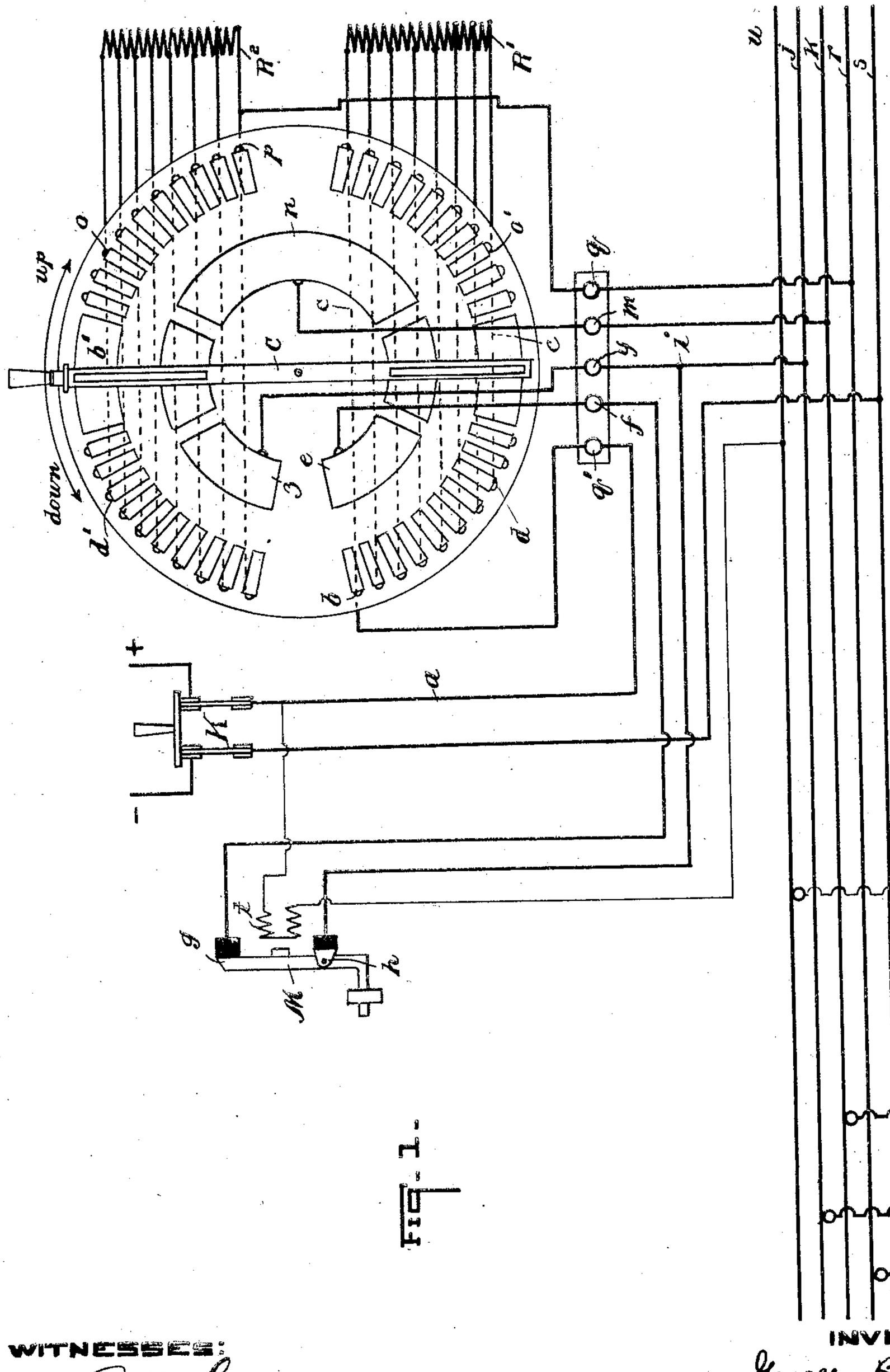

Fig. 1.

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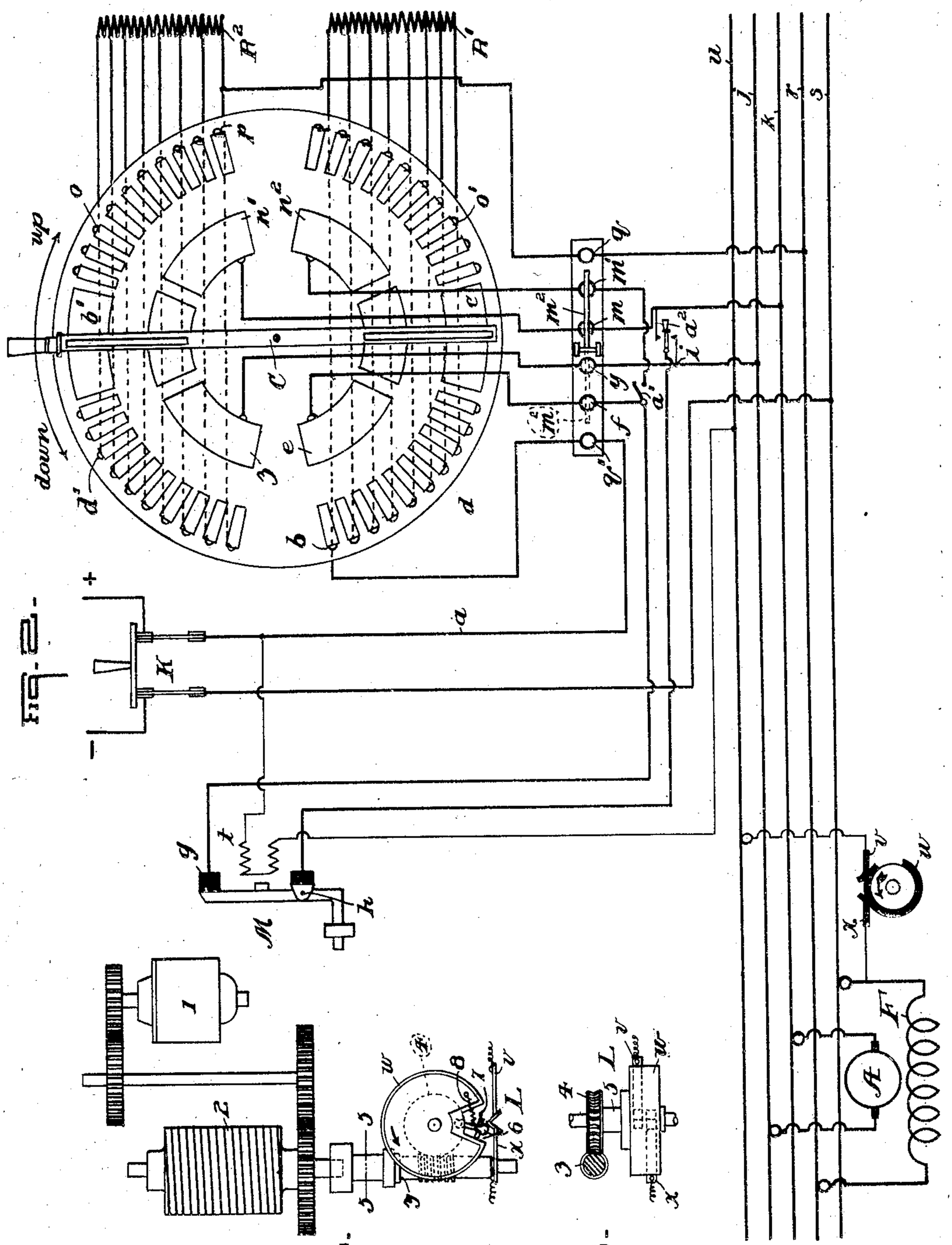

Fig. 2.

Fig. 4.

Fig. 5.

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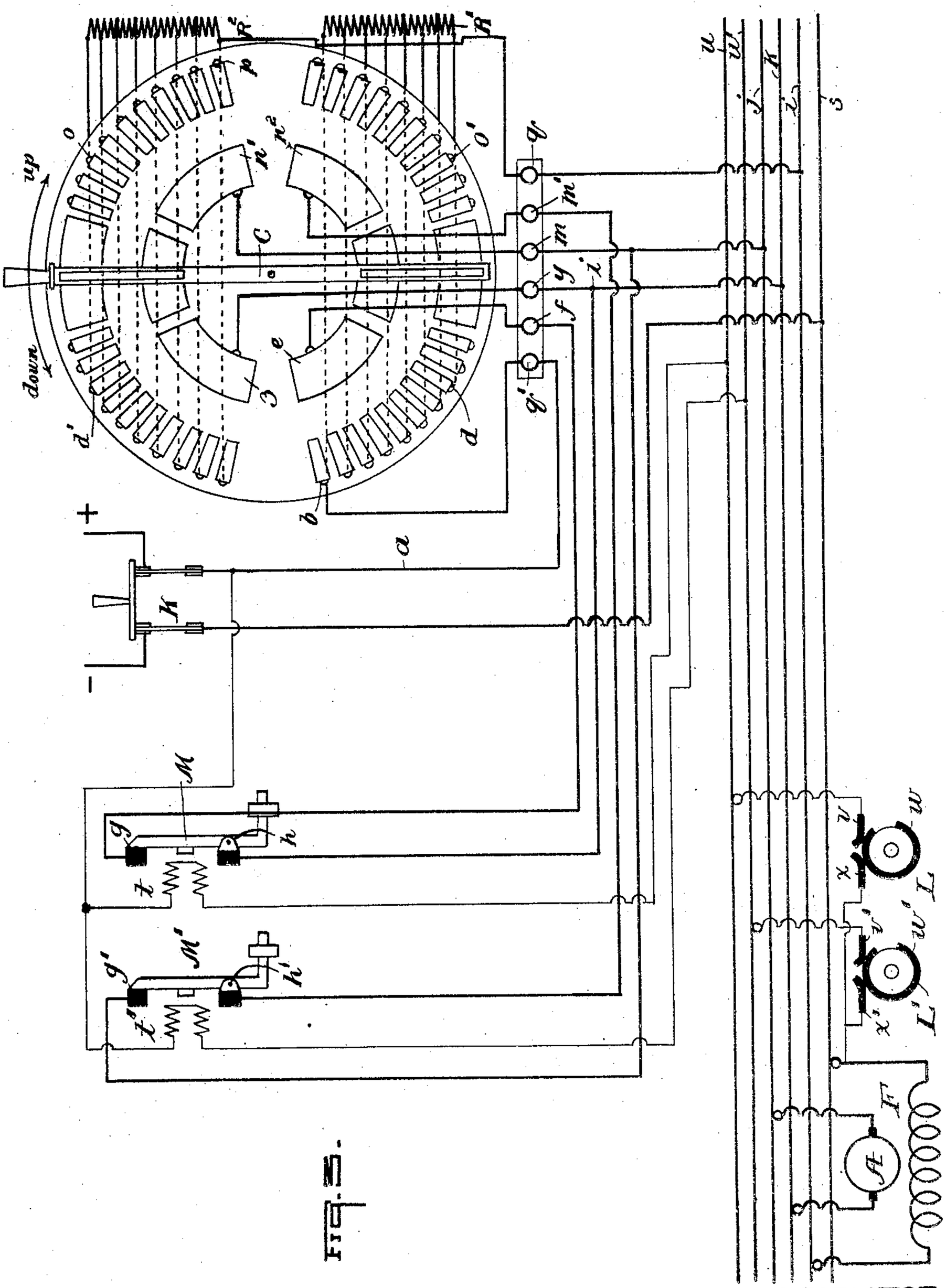

FIG. 3.

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UNITED STATES PATENT OFFICE.

GEORGE BAEHR, OF McKEESPORT, PENNSYLVANIA, ASSIGNOR TO ELECTRIC CONTROLLER AND SUPPLY COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

LIMIT-SWITCH.

No. 854,015. Specification of Letters Patent. Patented May 21, 1907.

Application filed November 3, 1906. Serial No. 341,938.

To all whom it may concern:

Be it known that I, GEORGE BAEHR, a citizen of the United States, residing at McKeesport, county of Allegheny, and State of Pennsylvania, have invented or discovered new and useful Improvements in Limit-Switches, of which the following is a specification.

My invention relates to devices for automatically limiting the motion or travel of any machine driven from an electric motor.

It has been particularly designed for opening the circuit of the hoisting motor on an electric crane when the limit of travel is reached, but it may be otherwise used.

Referring to the drawings which form a part of this specification, Figure 1 is a diagrammatic view of a limit switch arranged to open the circuit of the motor when the load approaches the up or high position. Fig. 2 is a similar view showing the limit switch arranged to open the motor circuit at either end of the travel of the machine, but not at both ends. Fig. 3 is a similar view showing the limit switch arranged to open the motor circuit as both limits of travel of the mechanism are reached. Fig. 4 is a view showing the mechanical connections between my limit switch mechanism and a hoisting device. Fig. 5 is a section on the line 5—5 of Fig. 4.

Referring to Fig. 1 it will be supposed that the contact disk *w* of the switch L rotates as shown by the arrow and that the controller arm C is thrown to the "up" position so as to bridge the contacts *d* and *e*, and *n* and *o*. The current then passes from the plus side of the switch K through the line *a*, the terminal *q'* to the controller contact *b*, the cross connection *c*, all of the resistance R^1, the contact *d*, the lower end of the arm C to the contact *e*, thence through the terminal *f*, the top-contact *g*, the magnetic switch M, held closed by the action of the winding *t* on the switch; from the switch M through the contact *h*, the trolley wire *j*, the armature A, the trolley wire *k*, the terminal *m*, the contact-plate *n*, the upper end of the controller arm C, the contact *o*, the whole of the resistance R^2, the terminal *q*, the trolley wire *r*, the field F of the motor, the trolley wire *s*, to the minus side of the switch K. Current will also flow from the wire *a* through the winding *t* of the switch M, the trolley wire *u*, the finger *v*, the contact ring *w*, and the finger *x* to trolley wire *s* and thence to the negative side of the switch K. The latter circuit is maintained as long as the disk *w* bridges the fingers *v* and *x*. As long as these fingers remain bridged, the winding *t* will hold the switch M closed, and as long as the switch M remains closed the motor circuit will be closed. As soon as the hoisting mechanism turns the switch L enough to cause the circuit to open at the finger *v*, the coil *t* will be deënergized and the switch M will automatically open, breaking the motor circuit.

In Figs. 4 and 5 I have shown the form of switch L, which I prefer, in connection with a hoisting mechanism. The electric motor 1 drives the hoisting-drum 2, to whose shaft is connected in any desired manner the worm shaft 3, driving the worm-wheel 4. The shaft 5 of the latter carries the disk *w*, having a ring of conducting material with the notch 6 therein. To the bottom of the notch is pivoted the trigger 7 which is connected by the spring 8 to the disk. The contact-fingers *v* and *x* have their ends spaced apart, but both rest on the contact ring *w* except where they are opposite the notch 6. As the ring *w* nears its limit of travel, the ends of the fingers engage the outer-end of the trigger 7 and pull the same against the side of the notch against the force of the spring 8. When the end of the trigger passes the ends of the contact fingers, the trigger instantly flies to the opposite side of the notch, breaking the circuit between the fingers, quickly, and thus preventing injurious arcing and the burning of the said fingers.

To lower the load, it is only necessary to move the controller arm C to the "down" position when the motor circuit is established as follows: from the plus side of the switch K through the wire *a*, the terminal *q'*, the contact *b*, the cross connection *c*, the resistance R^1, the contact *o'*, the lower end of the controller arm C, the contact-plate *n*, the terminal *m*, the trolley wire *k*, the armature A, the trolley wire *j*, to the point *i*. As the switch M is open, the current passes from the point *i* through the terminal *y*, the contact-plate *z*, the upper end of the controller arm C,

the contact d', the cross-connection b', the resistance R^2, the contact p, its terminal q, the trolley wire r, the field F, and the trolley wire s to the minus side of the switch. The motor connections are thus complete but the current passes through the armature A in a direction the reverse of what it did when the arm C was on the "up" position, causing a reverse rotation of the motor and the lowering of the load. After the motor has rotated the disk w a short distance in a direction opposite the arrow, the disk w will bridge the fingers v and x, which will complete the circuit of the switch coil t and close the motor circuit at g.

Referring now to Fig. 2, the parts are the same except that the switch m^2 is arranged in one position to connect the terminals m and m' and in the opposite position to connect the terminals f and y; that the contact plate n is divided into two sections n^1 and n^2 connected respectively to the terminals m and m'; that there is the switch a^1 to connect the switch M to the terminal m'; and that the wire running from the switch M may be connected at will by the switch a^2 with the point i or the trolley wire k. If the parts are as shown on Fig. 2 except that the switch a^2 connects the trolley wire j to the point i, and if the arm C is moved to the "up" position, the circuits will be precisely as in Fig. 1 when the arm C thereon is in the up-position. When the arm C is thrown to the "down" position, the circuits are the same as in Fig. 1, the plate n^2 taking the place of the plate n. If the switch m^2 be made to connect the terminals f and y, the switch a^1 be closed, and the switch a^2 be closed on the upper contact, thus connecting the bottom of the switch M with the trolley-wire k, the circuits will be as follows when the arm C is thrown to the "down" position: from the plus side of the switch K through the wire a, the terminal q', the contact b, the resistance R^1, the contact o', the lower end of the arm C, the plate n^2, the terminal m^1, the switch a^1, the switch M (supposing the same to have been closed) the switch a^2, the trolley wire k, the armature A, the trolley wire j, the terminal y, the plate z, the upper end of the arm C, the contact d^1, the resistance R^2, the terminal q, the trolley-wire r, the field F and the trolley-wire s to the minus side of the switch K. The circuit of the coil t is as in Fig. 1. The switch L being properly set, the switch M will be opened when the load reached the limit of its descent.

Referring now to Fig. 3, a second limit switch L' and a second circuit breaker switch M' have been added, the coil t' having its positive end connected to the positive feed-wire of the coil t. The remaining end of the coil t' is joined to an extra trolley wire u' which leads to the limit switch L', the switches L and L' having a common return through the trolley wire s. When the controller arm is thrown to the "up" position, the contacts v and x being bridged and the switch M closed, the circuits are as follows: from the plus side of the switch K through the terminal q', the resistance R^1, the lower end of the arm C, the plate e, the switch M, the armature A, the plate n^1, the upper end of the arm C, the resistance R^2 and the field F to the minus side of the switch K. The current through the coil t passes from the positive wire a through the finger v, the ring w and the finger x to the trolley wire s and the negative feed wire. When the ring rotates so that it no longer bridges the fingers v and x, the switch M is opened as in Fig. 1. As the switches L and L' are preferably on the same shaft, the circuits through the coil t' and the switch L' are closed and opened simultaneously with that in the coil t and the switch L. The switches M and M' operate simultaneously also, though there is current through only one at a time. When the arm C is thrown to the "down" position, the currents will be as in the "down" position in Fig. 2, the circuits through the coils t and t' and the switches L and L' remaining unchanged.

It will be noticed that the system herein described has several important advantages, among which are the following: The circuit breaker or magnetic switch M is entirely automatic in its action; does not require manipulation by hand; has no small mechanical latches, fingers or other parts subject to disarrangement; and has no overload coils or other device requiring calibration or adjustment. The limit switch L is simple, has few parts and is entirely dust and weather proof. It is small and has a rather large range of capacity and gear reduction and can generally be attached to some shaft or gear in almost any geared mechanism to give the desired limit of travel, without changing the speed reduction with which it was originally equipped. This allows it to be manufactured in quantities instead of being made up special for each particular geared mechanism. The arrangement of circuits and the design of the apparatus is such that when the motor circuit is once opened it is only necessary to reverse controller arm to reëstablish the motor circuit in the opposite direction to continue the operation of the machine. It is unnecessary for the operator to close by hand the circuit breaker, thus avoiding confusion to the operation and accident to the machine. It is readily seen that if it were necessary to close circuit breaker by hand the operator might do so before he had reversed the controller; the machine would then continue to run in the same direction as before which would probably result in an accident to the machine.

I am aware that circuit opening devices

have been constructed in which the circuit breaker is opened by energizing an electro-magnetic tripping device.

It should be noted that in my arrangement the main circuit is opened, not by energizing an electro-magnet, but by opening the circuit of the electro-magnet *t* and I consider this construction possesses valuable advantages. In the movable open-circuited arrangement above mentioned, if any of the connections to the tripping coil become opened during the action of the hoist it will fail to act when the limit of the travel is reached and a disastrous wreck may occur. With my arrangement if any of the connections to the coil *t* become opened the switch M will at once open, cutting off power from the motor till the defect is remedied.

I claim—

1. A motion-limiting device for motor-driven machinery, embracing a reversing controller, a limit switch and means for including the said switch in the motor circuit in one direction of motion, and for bypassing the switch when the controller is reversed.

2. A motion-limiting device for motor-driven machinery, embracing a reversing controller, a limit switch, and means for opening the same automatically when the limit of travel in one direction is reached and for bypassing said switch when the controller is reversed.

3. A motion-limiting device for motor-driven machinery, embracing a reversing controller, a limit switch in the motor circuit, means for automatically opening said switch when the limit of travel in one direction is reached and means for bypassing the switch when the controller is actuated in the reverse direction, the said switch being automatically closed by the reverse motion of the driven machinery.

4. In a system of control for electric motors, the combination of a reversing controller, an electro-magnet, a limit switch in the motor circuit normally held in a closed position by the electro-magnet, a second switch actuated by a driven member for opening the circuit of said electro-magnet when the limit of travel in one direction is reached, and means for bypassing said limit switch when said controller is reversed.

Signed at McKeesport, Pa., this 9th day of Oct. 1906.

GEORGE BAEHR.

Witnesses:
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CORA LENHART.