H. GROB.

MAGNETIC CONTROLLING DEVICE.

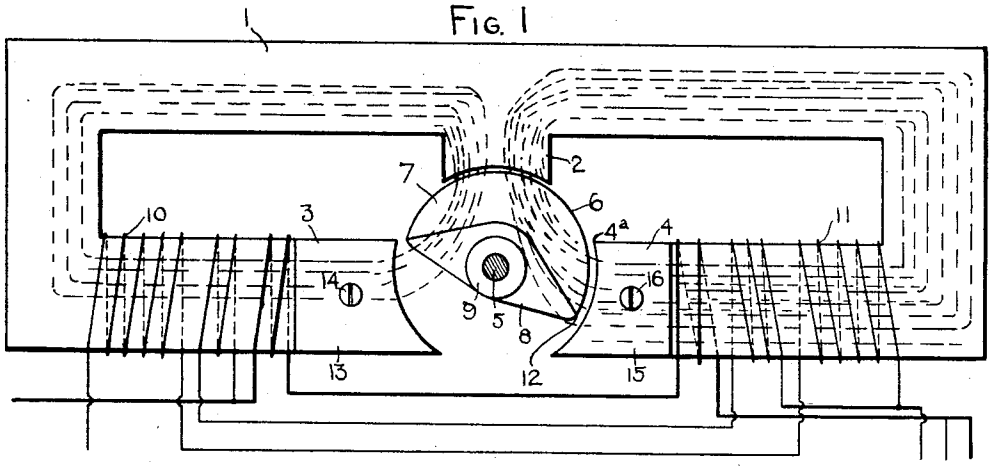
APPLICATION FILED NOV. 4, 1914.

1,161,819.

Patented Nov. 23, 1915.

2 SHEETS—SHEET 1.

FIG. 1



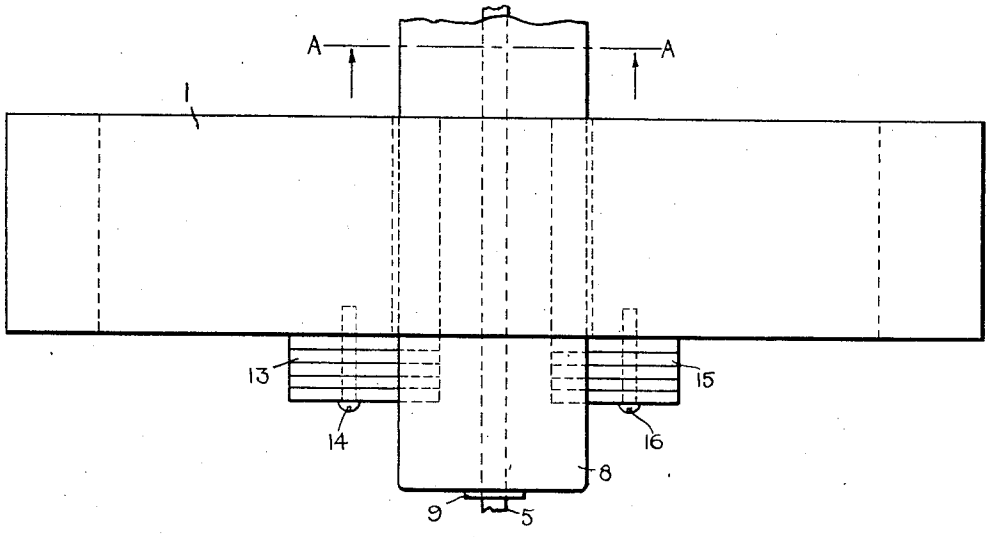


FIG. 2

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2 SHEETS—SHEET 2.

FIG. 4

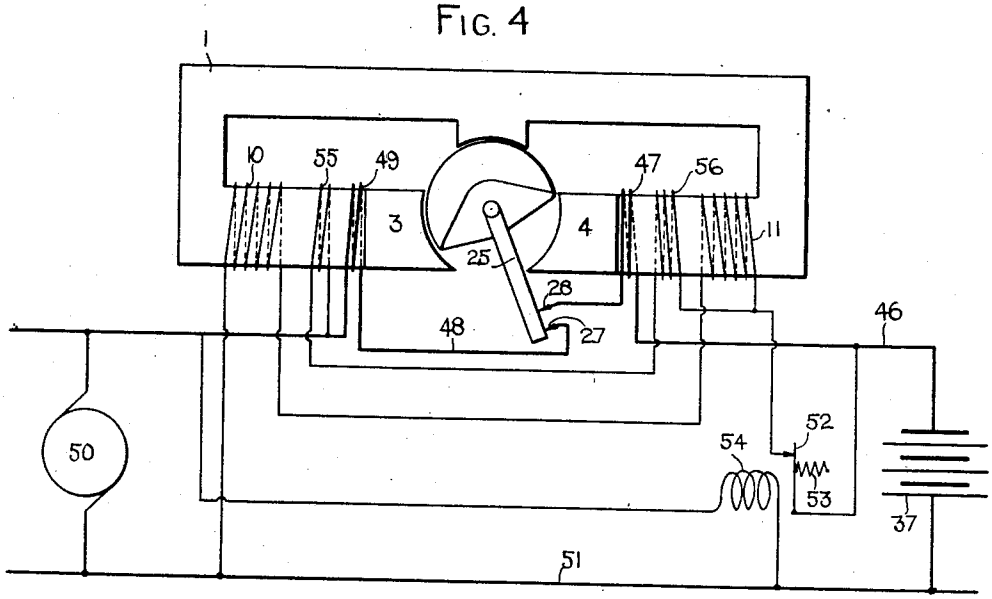


FIG. 5

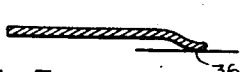


FIG. 3

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MAGNETIC CONTROLLING DEVICE.

1,161,819. Specification of Letters Patent. Patented Nov. 23, 1915.

Application filed November 4, 1914. Serial No. 870,208.

To all whom it may concern:

Be it known that I, HUGO GROB, a citizen of the Republic of Switzerland, residing at Zurich, in the Canton of Zurich, Republic of Switzerland, have invented certain new and useful Improvements in Magnetic Controlling Devices; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

This invention relates to magnetic controlling devices and with regard to certain more specific features thereof, to means for controlling switches for electric circuits.

One of the objects thereof is to provide a magnetic controlling device of simple and practical construction and reliable action.

Another object is to provide a device of the above nature which shall be sensitive and yet effective in performing its functions.

Another object is to provide an efficient circuit-controlling device which is powerful and durable and nevertheless requires a small force for causing its actuation.

Other objects are to provide apparatus of the above types which shall be effective under conditions of use without the need of careful adjustments.

Other objects will be in part obvious from the annexed drawings and in part indicated in connection therewith by the following analysis of this invention.

This invention accordingly consists in the features of construction, combinations of parts, and in the unique relations of the members and in the relative proportioning and disposition thereof; all as more completely outlined herein.

To enable others skilled in the art so fully to comprehend the underlying features thereof that they may embody the same by the numerous modifications in structure and relation contemplated by this invention, drawings depicting a preferred form have been annexed as a part of this disclosure, and in such drawings, like characters of reference denote corresponding parts throughout all the views of which:—

Figure 1 is a diagrammatic side elevation of a magnetic actuating device, together with coils mounted thereon. Fig. 2 is a plan of the parts shown in Fig. 1. Fig. 3 is a sectional elevation taken along the line A—A of Fig. 2, showing additional parts and circuits controlled thereby. Fig. 4 is a diagrammatic plan of circuits. Fig. 5 is a detailed sectional view of a portion of contact members shown in Fig. 3.

Referring now to Fig. 1 of the drawings, there is shown a member 1 of magnetic material which may be, if desired, built up of a series of stampings suitably clamped together. This member is shaped to provide a pole portion 2 and a pair of pole portions 3 and 4, the surfaces of these several pole portions being preferably cylindrical with respect to the axis of a shaft or spindle 5 mounted in any suitable bearings. It may here be noted that terms of the nature of "pole portions" are used in a broad sense to define that portion of a magnetic circuit at which the flux emerges or is received, irrespective of the fact that the exact magnetic pole may be spaced some distance from such surface.

Mounted upon spindle 5 to rock freely thereon is an armature 6, the magnetic portion 7 of which is roughly crescent-shaped in cross-section and is mounted as by the brass webs 8 upon the sleeve 9. The upper surface of the portion 7 of the armature is preferably concentric with respect to the surfaces of the several pole portions and it may be noted that the air gap at the point of junction with the pole portion 2, is made as small as is practicable.

Operatively positioned with respect to one side of the member 1, is a coil 10 and similarly related with respect to the opposite side is a coil 11. These coils, upon being supplied with electric current, are so wound as to generate magnetic flux in opposite directions in the two lower portions of the member 1, these fluxes being carried by the latter member and join in the pole portion 2 through which they pass and thence branch to the respective pole portions 3 and 4. In this manner, the member 1 forms a pair of opposing magnetic circuits and the member 7 is so positioned that it is always interposed in the line of flux of both of these circuits. The latter member is so shaped that in its range of movement it offers a substantially constant aggregate magnetic conductivity in these two circuits, irrespective of its angular

position with respect to the spindle 5. This will be understood from the fact that the range of movement is preferably limited, as hereinafter described, within angular positions in which its lower surface or edge is opposite the upper surface of the adjacent pole piece. For example, in Fig. 1 the member 7 is at its extreme position toward the right and at its opposite extreme, the point 12, would be substantially opposite the point 4a. It will thus be seen that as the member 7 swings between these extreme positions, its total overlapping with the portions 3 and 4 is constant and, the thickness of the air gap at these points being constant, any decrease in overlapping and corresponding increase in magnetic conductivity of one of these magnetic circuits, due to angular swinging of the member 7, is compensated for an exactly equal increase in overlapping and decrease of conductivity of the other magnetic circuit. For this reason, assuming equal magneto-motive forces in the two magnetic circuits the member 7 will embrace a substantially constant number of lines of force in all positions within its range of movement and hence, under these conditions, there is no tendency for this member either to move out of any given position or to adhere to any given position. In other words, the armature 7 is in stable equilibrium throughout its range of movement. This is based upon the rudimentary principle of magnetic circuits, which is perhaps crudely expressed in the statement that any magnetic member tends to acquire and maintain the position in which it transmits or embraces the greatest number of lines of magnetic force. If now, the distribution of magnetic flux is disturbed, as by a slight excess of magneto-motive force in one of these magnetic circuits with respect to the other, there instantly arises one position, and one only, in which the member 7 will embrace the maximum number of lines of force, and that is the position of its greatest overlap with respect to the pole portions 3 or 4 through which passes the magnetic flux of the circuit having the excess magneto-motive force. Moreover, the member 7 will tend to take and maintain this position irrespective of what position it occupies when this excess arises, for the reason that in such position it will embrace a greater number of lines of force than it could embrace in any other position and, as it moves toward such position, the flux passing therethrough is progressively increased. In order that this action may be accurate and to do away with the necessity for ultra-careful machining of the parts, the following adjustment of the relative magnetic conductivities of the two magnetic circuits is provided and it may be noted that once these conductivities are adjusted, the device requires no further adjustment. The member 7, with its mounting, is carried in an axial direction beyond the several pole pieces, as indicated in Fig. 2 of the drawings. Also, the pole portion 3 is built out by a series of registering plates or sheets 13 in such manner as to increase its magnetic effect, or in substance adjust the magnetic conductivity in the different angular positions of the member 7 in order to eliminate the influence of unequal air-gaps or unequal permeability of the iron portions of the two circuits. These plates are secured in position as by a screw 14 and are readily changed in number as by removing the screw and adding or taking away plates. Similarly, the pole portion 4 is provided with a number of thin plates 15, held in place by the screw 16. By varying the relative number of the plates 13 and 15, the increment or decrement in magnetic conductivity as the member 7 changes its angular position, may be adjusted.

Referring now to Fig. 3 of the drawings, there is shown formed upon and carried by the member 7 an extension 17 which may be of brass or other suitable material. This extension is provided with a pair of spaced stop pins 18 and 19 and with a contact plate 20 insulated therefrom, as indicated at 21. Loosely mounted upon the spindle 5 as by the sleeve 22 is a swinging member 23, the extreme range of movement of which is limited by the stop plate 24. Carried by arm 23 is an arm 25 which has mounted thereon and insulated therefrom a metallic switch member 26 adapted to electrically connect and short-circuit the stationary contacts 27 and 28 upon the member 23 being swung to the right. Member 23 has mounted thereon and insulated therefrom at 29 a pair of swinging contacts 30 and 31. Mounted adjacent the right-hand end of members 30 and 31, having reference to Fig. 3 of the drawings, is a plate 32 having thereon stationary contacts 33 and 34, each of which is insulated from plate 32 as at 35. Each end of each of the contact members 30 and 31, these members being preferably of resilient material, is turned downwardly as indicated in Fig. 5 of the drawings, and provided with a rounded tip 36 to coact with the several stationary contacts. Accordingly, when one of these rounded tips 36 is opposite one of the stationary contacts, an electrical connection is made between such contact and the member upon which the tip is formed, but if this tip passes beyond the stationary contact upon the relatively insulated parts it prevents contact between the spring member 30 or 31 and the contact member beyond which it has passed.

Considering now, the action of the parts shown in Fig. 3 of the drawings, it is to be noted that the coils 10 and 11 are serially connected with a source of voltage, such as

the storage battery 37 and are so wound as to form in effect voltage coils. From one extreme of these two coils a conductor 38 leads to the plate 34 and from the other extreme a conductor 39 leads to the plate 33. From a point of the circuit between coils 10 and 11, a conductor 40 leads to the contact plate 20. With the parts in the position shown, the member 7 has been swung to occupy its extreme clockwise position in which the stop pin 18 has engaged and swung the arm 23 to the limit of movement toward the left (clockwise), permitted by the member 24. The device will remain in this condition so long as the magneto-motive force in the circuit comprising pole piece 4 is in excess of or equal to that in the other circuit. Assuming, however, that there arises, as from the cause hereinafter described, a slight excess of magneto-motive force in the left-hand circuit, having reference to Fig. 1 of the drawings, for the reasons hereinbefore pointed out, the member 7 will immediately tend to swing counter-clockwise toward its opposite extreme, as any movement in that direction increases the number of lines of force which it transmits. This movement will result in a slight movement of the contact 20 in the direction indicated by the arrow in Fig. 3 of the drawings, and will bring the left-hand tip of contact member 31 upon the contact plate 20. This results in the formation of a short-circuit through conductor 40, contact 20, member 31, contact 33 and conductor 39 about the coil 11, thus substantially deënergizing that coil. Moreover, the short-circuiting of this coil greatly reduces the total resistance in the circuit comprising coils 10 and 11 and thus results in a correspondingly large excess of current in the coil 10. It will be noted that this movement is opposed merely by the frictional resistance of the contact members 30 and 31 and this may be reduced to a negligible value by properly proportioning the pole pieces 3, 4, 13 and 15. Upon coil 11 being short-circuited, however, and coil 10 increased in effective force as above described, the movement of the member 7 is continued with relatively great power, and pin 19 swinging against the arm 23 rotates the latter about the spindle 5 to bring the main contact into operative relation to the stationary members 27 and 28. The complete movement thus caused and limited by the shoulder 41 of the member 24 results in the right and left-hand tips of the contact member 31 occupying the positions indicated by the small dotted circles 42 and 43 respectively, whereas the corresponding tips of the member 30 are moved to 44 and 45 respectively. It will be seen that this complete movement breaks the connection between the member 31 and the stationary contact 33, thus breaking the short-circuit about coil 11 and consequently reducing the current in coil 10. The magneto-motive-forces in the two circuits, due to coils 10 and 11, are at this stage again equal and any excess of magneto-motive force in the right-hand magnetic circuit will quickly return the parts to the positions shown in full lines in Fig. 3 of the drawings.

Referring now to Fig. 4 of the drawings in which an example of the connections of this apparatus is more fully shown in order that its action may be the more fully understood, the battery 37 is connected at one terminal to a conductor 46 which comprises a coil 47 adjacent the pole piece 4, and terminates upon the stationary contact 28. From the remaining main contact 27 a conductor 48 leads through a coil 49 adjacent the pole portion 3 and thence to a generator 50 which may be susceptible to varying voltage, as for example a car lighting dynamo for the charging of battery 37. The remaining terminal of generator 50 is connected with remaining terminal of battery 37 by a conductor 51. The coils 10 and 11 are connected across the terminals of battery 37 through a switch 52 which is normally retracted by spring 53 and is held closed by voltage coil 54 connected across the generator 50. Also mounted upon the respective lower portions of the member 1 are a pair of coils 55 and 56, the circuit of which also leads through the switch 52. Coils 55 and 56 serve in this embodiment as the actuating element for disturbing the distribution of flux in the member 1. Coil 55 is wound to act cumulatively with respect to coil 10 and coil 56 is wound to act differentially with respect to coil 11 when the main-switch 27—28 is open and the generator voltage exceeds the battery voltage. Normally, coils 10 and 11 are equal and opposite in effect, but if any current flows through coil 55 in the direction which has above been assumed as cumulative and which would be in this case from the generator toward the battery, then coil 10 is strengthened in effect whereas the differential coil 56 weakens coil 11. This current in the coils 55 and 56, even though insignificant in value, thus gives rise to an excess of magnetic flux in the left-hand magnetic circuit and swings the member 7 counter-clockwise toward the pole piece 3. This, as above described, swings the contact arm 25 toward the right, making connection between contacts 27 and 28 and consequently closing the main circuit connection between generator 50 and battery 37. This action takes place whenever the generator voltage slightly exceeds that of the battery, because there will then flow through coils 55 and 56 the current above referred to which is effective even though of extremely small value. If the generator voltage sinks to a low value, the

spring 53 opens the switch 52 thus breaking the circuit of coils 10, 11, 55 and 56. In this manner, waste of current is prevented.

The coils 47 and 49 carrying the main charging current, tend to render the device more certain in action and to hold it more firmly in its closed position without in any way decreasing its sensitiveness to release instantly when the generator voltage drops below that of the battery.

The coils 55 and 56 are preferably of a different number of turns in order to permit, if desired, an arrangement whereby the circuit of these coils is closed before that of the coils 10 and 11 without tending to throw the member 7 into a mid-position which it would tend to assume if the magneto-motive-forces of the two circuits were equal and in series instead of opposing.

It is to be understood that by the term "movement" or "movable" as used herein is meant relative movement irrespective of which part changes its position to bring this about.

It will thus be seen that there is provided apparatus in which the several objects of this invention are achieved and which apparatus is well suited to meet conditions of the hardest practical use.

As many changes might be made in the above construction, and as many apparently different embodiments might be made of this invention without departing from the scope thereof, it is intended that all features herein described or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus revealed this invention, I claim as new and desire to secure the following combinations of elements, or equivalents thereof, by Letters Patent of the United States:—

1. In apparatus of the class described, in combination, a member, means forming a pair of magnetic circuits having opposing attractions upon said member, and means adapted upon said member being moved by the effect of one of said circuits to increase the magneto-motive-force of said circuit relative to that of the other circuit.

2. In apparatus of the class described, in combination, a member, means forming a pair of magnetic circuits having opposing attractions upon said member, and means adapted upon said member being moved by the effect of one of said circuits to increase the magneto-motive-force of said circuit and decrease that of the other circuit.

3. In apparatus of the class described, in combination, a member, means forming a pair of circuits having opposing attractions upon said member, means adapted upon said member being moved by the effect of one of said circuits to increase the magneto-motive-force of said circuit relative to that of the other circuit, a device adapted to control an electric circuit, and a connection between said member and said device adapted to permit said member to make the first portion of its movement free of said device and thereafter to actuate said device.

4. In apparatus of the class described, in combination, a magnetic circuit including a fixed portion and movable magnetic means, and a second magnetic circuit including a fixed portion and the same means, said means throughout its movement maintaining constant the sum of the fluxes through said means with equal and constant magneto-motive forces in the two circuits.

5. In apparatus of the class described, in combination, a magnetic circuit including a fixed portion and movable magnetic means, a second magnetic circuit including a fixed portion and the same means, and windings normally energized to produce equal magneto-motive forces in the two circuits, said means in any of its positions including normally the same total flux, whereby said means in any of its positions is responsive to a slight inequality in the two magneto-motive forces.

6. In apparatus of the class described, in combination, an electromagnet, an armature coöperating therewith and movable in response to relatively slight changes in the flux due to the magnet, and contact means actuated by the armature in its initial movement and adapted to deënergize certain of the turns of the magnet to accentuate the changes in the flux, to increase thereby the force available for effecting further movement of the armature.

7. In an apparatus of the class described, in combination, an electromagnet, an armature coöperating therewith and movable in response to relatively slight changes in the flux due to the magnet, means actuated by the armature in its initial movement and adapted to increase the changes in said flux, to increase thereby the force available for effecting the further movement of the armature, and means for restoring the original conditions as the armature completes its movement.

8. In apparatus of the class described, in combination, an electromagnet comprising two normally balanced magnetic circuits, magnetic material mounted upon a movable member and forming part of both circuits and movable in response to a relatively small unbalancing of the circuits, and means operated by the initial movement of said member for increasing materially the unbalancing of the circuits to increase thereby the force available for effecting further movement of the armature.

9. In apparatus of the class described, in combination, an electromagnet including a pair of normally balanced windings, a core

for each winding, magnetic material coöperating with each core and mounted upon a member movable with respect to the cores in response to unbalancing in the windings, a device adapted to be shifted by said member, and a lost-motion connection between said device and said winding, whereby the initial acceleration of said member is effected with said member free of said device.

10. In apparatus of the class described, in combination, an electromagnet including a pair of normally balanced windings, a core for each winding, an armature common to the circuits of both magnets and movable with respect to the cores in response to unbalancing in the windings, a device adapted to be shifted by the armature, and connections between said device and said armature whereby the armature is started free of said device and after an initial movement effects the shifting of said device.

11. In apparatus of the class described, in combination, an electromagnet, a core therefor, an armature movable with respect to the core in response to flux changes in the core, a device adapted to be shifted by movement of the armature and having a lost-motion connection with the armature whereby the initial acceleration of the armature is effected with the armature free of said device, and means operated by the movement of the armature and adapted to effect further flux changes in the core as the armature begins to shift said device, to increase the force available for effecting the further movement of the armature.

12. In apparatus of the class described, in combination, an electromagnet, a core therefor, an armature movable with respect to the core in response to flux changes in the core, a device adapted to be shifted by movement of the armature in either direction and having a lost-motion connection with the armature, and means operated by the armature in either direction to effect further flux changes in the core before the armature begins to shift said device, to increase the force available for shifting said device.

13. In apparatus of the class described, in combination, an electromagnet comprising two normally balanced magnetic circuits, magnetic material mounted upon a movable member and forming part of both circuits, said material including normally the same flux regardless of its position, whereby said member is movable in response to a relatively small unbalancing of the circuits, and means operated by the initial movement of said member from an end-position, for increasing materially the unbalancing of the circuits, to increase thereby the force available for effecting the further movement of the armature.

14. In apparatus of the class described, in combination, two normally balanced magnets, magnetic circuits therefor comprising a core and pole for each circuit and a pole common to the two circuits, and movable means comprising an armature coöperating with the three poles and adapted throughout its movement to maintain normally constant the aggregate flux of the two circuits.

15. In apparatus of the class described, in combination, two normally balanced magnets, magnetic circuits therefor comprising a core and pole for each circuit and a pole common to the two circuits, and movable magnetic means common to the two circuits and coöperating with the three poles and adapted to be rotated upon a slight unbalancing of the magneto-motive forces of the two circuits, the rotation of said means effecting at a predetermined point a material unbalancing of said magneto-motive forces and also effecting at a predetermined point the operation of a switch.

16. In apparatus of the class described, in combination, a plurality of sources of current, a switch controlling current-connections between said sources, an electro-magnetic device controlling the said switch and comprising a movable member, a pair of magnetic circuits having opposing attraction upon said member. said member being in equilibrium at both ends of its stroke, and coils on the said circuit adapted to alter the relative magnetic strength of the said circuits.

17. In apparatus of the class described, in combination, means forming a pair of magnetic circuits, two coils belonging one to each magnetic circuit and being connected in series, means comprising a movable member which is attracted in opposite directions by each of said two magnetic circuits, these circuits and the movable member being in equilibrium in both end-parts of its range of movement, coils on the said circuits, and means adapted upon said member being moved by the difference of the effects of the two magnetic circuits to short-circuit during a part of the range of the movable member the coil belonging to the weaker of the two magnetic circuits.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

HUGO GROB.

Witnesses:
CARL GUBLER,
HERMANN HUBER.