Nov. 20, 1934. E. S. TRUE 1,981,681

ELECTRICAL DEVICE

Original Filed Dec. 23, 1927

Fig. 1.

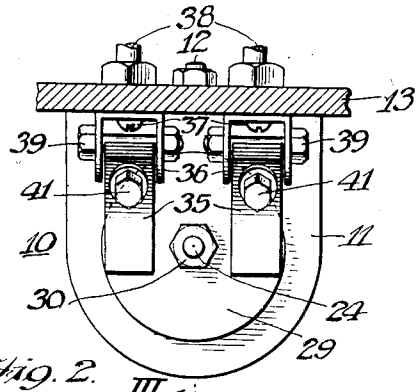


Fig. 2.

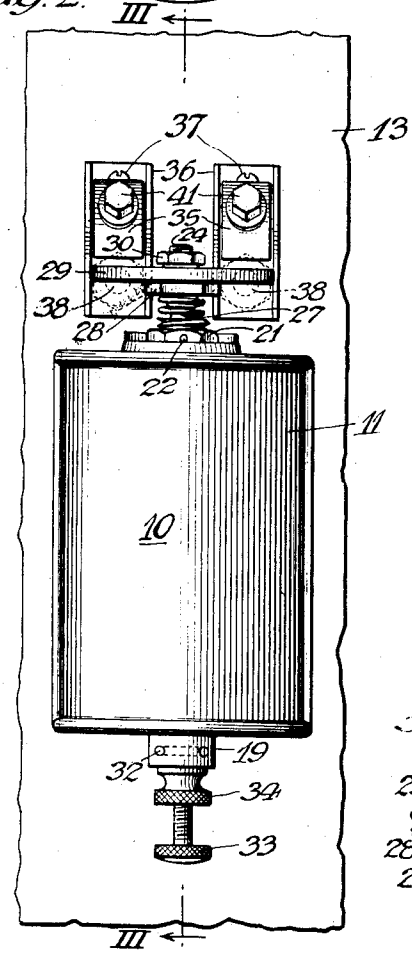


Fig. 3.

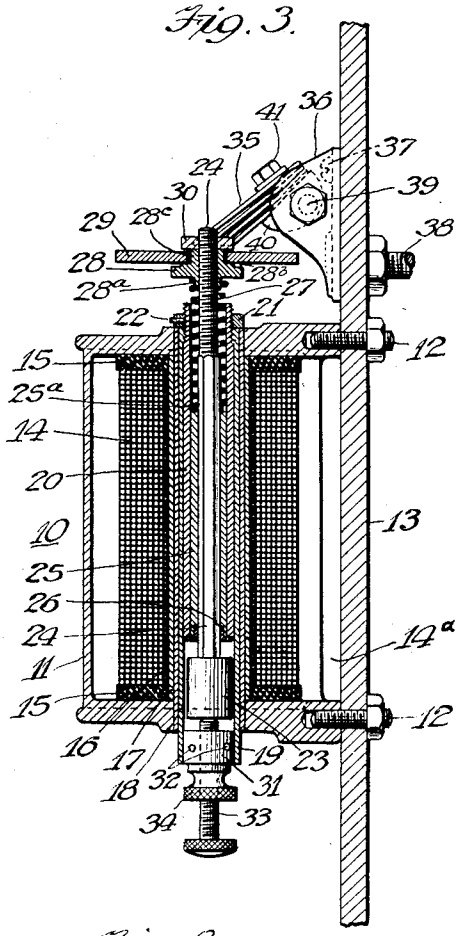


Fig. 4.

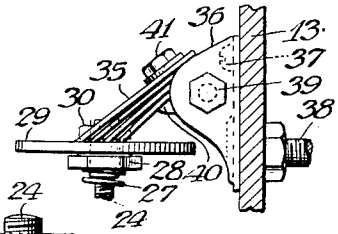
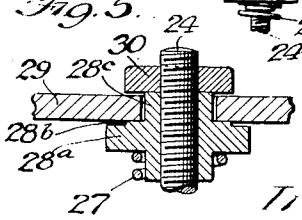


Fig. 5.



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Patented Nov. 20, 1934 1,981,681

UNITED STATES PATENT OFFICE

1,981,681

ELECTRICAL DEVICE

Edwin S. True, Oak Park, Ill.

Application December 23, 1927, Serial No. 242,130
Renewed June 7, 1933

21 Claims. (Cl. 200—95)

My invention relates to electrical devices and has particular relation to electromagnetically operated electric switches.

The principal object of my invention is to provide an electromagnetically operated electric switch that shall be extremely sensitive in its operation and at the same time capable of controlling circuits that are to be traversed by currents of relatively high values.

It is a further object of my invention to provide a switch of the above-identified character embodying independent means for making numerous desired adjustments.

Further objects and advantages of my invention will appear from a consideration of the following detailed description in connection with the accompanying drawing, in which:

Figure 1 is a top plan view of a switch embodying my invention;

Fig. 2 is a front elevational view of the switch shown in Fig. 1;

Fig. 3 is a vertical sectional view taken along the line III—III of Fig. 2;

Fig. 4 is a fragmentary side elevational view showing the contact members of the switch embodying my invention in cooperative engagement; and

Fig. 5 is an enlarged fragmentary sectional view showing the method of mounting the movable contact member in the switch embodying my invention.

Referring to the drawing, a switch embodying my invention, designated in general by the reference character 10, comprises a casing or supporting frame 11 of magnetizable material that is provided with studs 12 for securing the switch to a mounting panel 13. The casing 11 is of substantially semicylindrical form at the front thereof and the sides of the casing extend backwardly from the semicylindrical portion in substantially perpendicular relation to the panel 13. The casing 11 is open on the side adjacent the panel 13 to permit the insertion of a solenoid coil 14 therein when the device is being assembled previous to being mounted on the panel 13. The side walls of the casing 11 are terminated a short distance in front of the panel 13 to leave a space 14a at each side of the casing to facilitate ventilation of the interior of the casing, thus preventing the coil 14 from attaining a dangerous temperature when it is energized for extended periods.

The coil 14 is wound upon a spool comprising annular end portions 15 of insulating material, such as fiber or the like, a longitudinal tubular member 16 also of insulating material, and a tubular member 17 of non-magnetizable material, such as brass, for maintaining the end portions 15 and the tubular portion 16 in proper relative position. The coil 14 is maintained in position within the casing 11 by means of a tubular sleeve 18 of non-magnetizable material that is securely fitted within suitable apertures in the upper and lower portions of the casing 11. When the device is assembled the sleeve 18 extends through the tubular member 17 of the spool upon which the coil 14 is wound and thus maintains the coil in fixed position within the casing 11.

A core unit for the coil 14 is assembled within a non-magnetizable tubular casing 19 that is adapted to be disposed within the sleeve 18 when the device is assembled. A tubular stationary core member 20 is securely fixed within the upper part of the casing 19 and is provided with an upwardly extending screw-threaded portion that is adapted to be engaged by a correspondingly screw-threaded adjusting nut 21. The vertical position of the core assembly unit may be adjusted with respect to the casing 11 by adjusting the nut 21 as desired. A set-screw 22 is provided to secure the nut 21 in fixed position with respect to the core member 20 when the desired adjustment has been made.

A movable core member 23 of magnetizable material is disposed within the lower portion of the casing 19 and is secured to the lower extremity of a switch-actuating member 24 of non-magnetizable material. The actuating member 24 is preferably of hexagonal cross-section and extends upwardly from the movable core member 23 through an auxiliary tubular core member 25 that is held in place within the stationary core member 20 by an annular member 26 of non-magnetizable material that is fixed within the lower extremity of the opening through the core member 20. The opening through the auxiliary core member 25 is preferably of circular cross-section, whereby a bearing is provided for the actuating member 24 in which it is possible for the members 24 and 25 to engage each other along no more than two lines of contact. The bearing friction between the members 24 and 25 is thus reduced to a minimum, particularly because no opportunity is afforded for particles of dirt or the like to become lodged between said members.

The upper extremity of the auxiliary core member 25 comprises a reduced diameter portion 25a about which the lower extremity of a coiled non-magnetizable compression spring 27 is dis-

posed. The outside diameter of the spring 25 is only slightly less than the inside diameter of the core member 20, so that the spring 27 is maintained in proper position within the said core member. The upper extremity of the spring 27 is disposed around a reduced diameter portion 28a of a non-magnetizable annular member 28 that is screw-threadedly engaged by the actuating member 24 near the upper extremity thereof. The upper surface of the main portion of the annular member 28 comprises another reduced diameter portion 28b upon which a centrally apertured contact member 29 of disc form is supported. The contact member 29 is of copper or other suitable current-conducting material.

The centrally disposed aperture in the disc 29 is of slightly greater diameter than that of a third reduced diameter portion 28c of the annular member 28, but is of smaller diameter than that of the reduced diameter portion 28b. The thickness of the reduced diameter portion 28c is somewhat greater than that of the disc 29. A lock-nut 30 is adapted to engage the screw-threaded portion of the actuating member 24 and the upper surface of the reduced diameter portion 28c of the annular member 28 to lock the said annular member in any desired position on the actuating member 24. By reason of the construction of the annular member 28, which is more clearly shown in the detailed view of Fig. 5, it will be seen that this member provides a loose mounting for the contact member 29 with respect to the actuating member 24.

A closure member 31 is secured within the lower extremity of the casing 19 by means of laterally disposed pins 32. A centrally disposed screw-threaded opening through the closure member 31 is adapted to receive an adjusting screw 33 which may be locked in any desired position with respect to the member 31 by means of a lock-nut 34. The head of the screw 33 and the lock-nut 34 are provided with knurled portions to facilitate manual adjustment and setting of these members. The upper extremity of the screw 33 extends into the casing 19 to provide an adjustable stop for determining the lowermost position of the movable core member 23.

Two laminated stationary contact members 35 are mounted on brackets 36 which are secured to the panel 13 by means of screws 37 and terminal studs 38. The brackets 36 are provided with parallel side walls extending outwardly from the panel 13 and are adapted to receive transversely disposed clamping bolts 39. The bolts 39 also extend through suitable apertures in rocker members 40 of substantially semicylindrical form disposed in relatively close-fittting relation between the side walls of each of the brackets 36. The contact members 35 are secured to the flat surfaces of the rocker members 40 by bolts or cap-screws 41 and extend at an inclined angle toward the contact disc 29. The laminations of the contact members 35 are of decreasing length, proceeding inwardly from the outer laminations, whereby the lower extremities of the contact members 35 present slightly inclined surfaces toward the flat upper surface of the contact disc 29.

The contact members 35 are so disposed that when the contact disc 29 is actuated upwardly into engagement therewith the outer laminations of the stationary contact members will be engaged first and the interior laminations will be engaged subsequently by the disc 29. When the disc 29 is actuated to its extreme upper position all of the laminations of the stationary contact members 35 are engaged thereby. These laminations, being of resilient material, are separated one from another as illustrated in the detailed view of Fig. 4, when the disc 29 is fully actuated into engagement therewith.

The switch embodying my invention is particularly adapted to be utilized in electrical systems requiring extreme sensitivity of operation combined with relatively large current carrying capacities. An example of a system requiring the provision of such a switch is an electrolysis protective system, in which the main contact members of the switch are connected between a structure to be protected from corrosion and a suitable ground conductor or the like. In such systems it is essential that the switch be closed when a very slight potential of predetermined polarity exists between the structure to be protected and the earth. When the switch is closed in response to the occurrence of this condition, which may be effected in response to the operation of a delicate polarized relay or other suitable device, it is necessary that the switch provide a path of very low resistance to permit relatively heavy currents to traverse the same. Therefore, it will be seen that it is essential that the switch must be extremely sensitive in its operation as well as being so constructed as to be capable of conducting currents of large values.

These objects are obtained in the switch embodying my invention by reason of the resilient mounting for the movable contact member provided by the spring 27. The resiliency of this spring may be varied as desired by adjusting the position of the annular member 28 on the actuating member 24. When the desired adjustment is obtained the position of the annular member 28 on the actuable member 24 is fixed by tightening the lock-nut 30. Previous to making this adjustment the lowermost position of the movable core member 23 with relation to core members 20 and 35 will have been determined by adjusting the screw 33 and locking the same in position by the lock-nut 34.

The magnetic air-gap between the movable core member 23 and the stationary core member 20 is thus determined, which controls the degree of energization of the coil 14 that is required to actuate the core member 23 for any given adjustment of the spring 27. It is preferable to adjust the spring 27 so that the core member 23 is barely lifted from the stop-screw 33 when the coil 14 is de-energized. The entire weight of the moving part is thus supported by the spring 27 and the only force required to actuate the movable members is that required to overcome the inertia thereof plus the slight additional force required to lift these parts as the spring 27 is extended. The lifting force, however, is very slight, since the distance that the moving parts must be lifted to cause the contact disc 29 to engage the stationary contact members 35 is very slight as compared with the length of the spring 27.

The length of the electrical air-gap between the contact disc 29 and the stationary contact members 35 when the moving parts of the switch are in their lowermost positions, that is, when the coil 14 is de-energized, may be varied by adjusting the position of the adjusting-nut 21 on the screw-threaded upper extension of the core member 20. By thus adjusting the position of the nut 21, it will be seen that the entire core unit may be raised or lowered with respect

to the coil 14 and the casing 11 without affecting the adjustments of the spring 27 or the stop-screw 33 in any way. When the desired adjustment of the electrical air-gap is obtained, the adjusting-nut 21 may be fixed in position with respect to the core member 20 by tightening the set-screw 22.

Still another adjustment that may be made independently of all of the adjustments previously described is that of the angle of incline of the stationary contact members 35. This angle, which is commonly designated as the "pitch" of the laminated contact members, may be adjusted by loosening the clamping bolts 39 and turning the contact members 35 and the rocker members 40 thereabout. When the desired pitch is obtained the contact members 35 are securely locked in position by tightening the clamping bolts 39. It is preferable that this adjustment be so made that the longest or upper laminations of the contact members 35 will be engaged by the contact disc 29 before any of the other laminations are so engaged.

The electrical system with which the switch is associated may be so arranged that a circuit of relatively low current-carrying capacity is completed in response to the operation of a very delicate and sensitive control relay, as previously described. The contact members 35 may be so connected in relation to the electrical system that initial engagement between said contact members and the contact disc 29 will complete a circuit shunting the contact members of the control relay to permit a current of a much larger value to traverse the coil 14. The energization of this coil may thus be increased to cause a greater lifting force to be applied to the core member 23, which, in turn, applies a stronger operating pressure to the contact disc 29. This disc is thereupon actuated more firmly into engagement with the stationary contact members 35 to cause successive laminations thereof to be engaged by the contact disc. As increasing pressure is applied to the disc 29 and more laminations of the contact members 35 are successively engaged thereby, the current-carrying capacity of the switch is further increased, with the result that the energization of the coil 14 is likewise increased to actuate the contact disc to its uppermost position, in which all of the laminations of the stationary contact members 35 are firmly engaged by the disc 29. Thus, it will be seen that while the switch embodying my invention is extremely sensitive in its initial operation, it may be arranged to complete a circuit connection of large current-carrying capacity.

When current ceases to traverse the energizing circuit of the coil 14, the movable core member 23 is permitted to return to its original position, as shown in Fig. 3 of the drawing. The downward movement of the moving parts is limited by the adjusting screw 33 to prevent the occurrence of any rebound of the moving parts. The adjusting screw 33 also insures that the spring 27 will never be compressed to a greater degree than that corresponding to the normal de-energized condition of the switch. The calibration of the spring 27, therefore, remains constant, thereby preventing any change from occurring in the degree of energization of the coil that is required to effect initial operation of the switch. By making all of the proper adjustments as hereinbefore described, it is possible to determine very accurately the degree of energization of the coil 14 that is required to operate the switch and it is essential that this value remain constant until one or more of these adjustments are changed.

The bushing member 26 of non-magnetizable material is effective to prevent chattering or sticking of the core member 25. It is thus insured that when the coil 14 is energized the contact disc 29 will be maintained securely in engagement with the contact members 35 and that when the coil 14 is de-energized such engagement will be immediately broken. The relatively loose mounting of the disc 29 with respect to the operating member 24 permits the disc 29 to engage the contact members 35 in the position which establishes the greatest possible area of contact surface. If the contact members 35 were not perfectly adjusted or if there were any slight irregularities in the contact surfaces of these members, the contact disc 29 would not make perfect contact therewith unless this method of mounting were utilized.

From the foregoing description it will be seen that I have provided an electromagnetically operable switch of extreme sensitivity and of great current carrying capacity. This switch embodies means for making numerous essential adjustments and each of these means is entirely independent of all of the other of said means. A switch constructed in this manner is capable of accomplishing all of the functions required of such a switch in the best possible manner and is capable of adjustment over such a broad range as to render the switch adaptable to systems of widely varying requirements.

While I have shown only one specific embodiment of my invention, it will be understood that various changes and modifications may be made in the details of construction without departing from the spirit and scope of my invention, as set forth in the appended claims.

I claim as my invention:

1. A solenoid device comprising a magnet coil, a core therefor comprising a stationary portion and a movable portion, said portions being adapted to be separated by an air gap when said magnet coil is de-energized, parts associated with and supported by said movable portion, resilient means for suspending said movable portion in a vertical balanced position within said magnet coil and opposing only the action of gravity on said movable portion and associated parts when said magnet coil is de-energized, and an adjustable member for varying the length of the air gap between the portions of the core when the magnet coil is de-energized and for limiting the movement of said movable portion.

2. A solenoid device comprising a magnet coil, a core therefor comprising a stationary portion and a movable portion, said portions being adapted to be separated by an air gap when said magnet coil is de-energized, adjustable resilient means for suspending said movable portion within said magnet coil, and an adjustable member for varying the length of the air gap between the portions of the core when the magnet coil is de-energized and an adjustable member for limiting the movement of said movable portion.

3. A solenoid device comprising a magnet coil, a core therefor comprising a stationary portion and a movable portion, said portions being adapted to be separated by an air gap when said magnet coil is de-energized, an adjustable stop member for limiting the length of said air gap, resilient means for supporting said movable portion of the core and means for varying the effec-

tiveness of said resilient means independently of said adjustable stop member.

4. A solenoid device comprising a magnet coil, a supporting frame of magnetizable material therefor, a vertical sleeve of non-magnetizable material extending through said magnet coil and supported by said frame, a sleeve core member of magnetizable material fixed within the upper portion of said vertical sleeve, a movable core member of magnetizable material disposed within said vertical sleeve beneath said sleeve core member and resilient means for supporting said movable core member when said magnet coil is de-energized.

5. A solenoid device comprising a magnet coil, a supporting frame of magnetizable material therefor, a vertical sleeve of non-magnetizable material extending through said magnet coil and supported by said frame, a sleeve core member of magnetizable material fixed within the upper portion of said vertical sleeve, a movable core member of magnetizable material disposed within said vertical sleeve beneath said sleeve core member and adjustable resilient means for supporting said movable core member when said magnet coil is de-energized.

6. A solenoid device comprising a magnet coil, a supporting frame of magnetizable material therefor, a vertical sleeve of non-magnetizable material extending through said magnet coil and supported by said frame, a sleeve core member of magnetizable material fixed within the upper portion of said vertical sleeve, a movable core member of magnetizable material disposed within said vertical sleeve beneath said sleeve core member, a non-magnetic rod secured to said movable core member and extending upwardly through said sleeve core member, an electrical contact member supported by said rod near the upper extremity thereof and a compression spring for resiliently supporting said movable core member, rod and electrical contact member with respect to said sleeve core member when said magnet coil is de-energized.

7. A solenoid device comprising a magnet coil, a supporting frame of magnetizable material therefor, a vertical sleeve of non-magnetizable material extending through said magnet coil and supported by said frame, a sleeve core member of magnetizable material fixed within the upper portion of said vertical sleeve, a movable core member of magnetizable material disposed within said vertical sleeve beneath said sleeve core member, a rod of polygonal cross-section secured to said movable core member and extending upwardly through said sleeve core member, an electrical contact member supported by said rod near the upper extremity thereof and a compression spring co-acting between said sleeve core member and said contact member to constitute a resilient support for said movable core member, rod and contact member when said magnet coil is de-energized.

8. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, a stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized, and independent means for adjusting the magnetic air-gap between said spaced core members, for adjusting said resilient supporting means and for adjusting the position of said actuable contact member with respect to said stationary contact member when said electromagnet is de-energized.

9. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, an inclined laminated stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized, and independent means for adjusting the magnetic air-gap between said spaced core members, for adjusting said resilient supporting means, for adjusting the position of said actuable contact member with respect to said laminated stationary contact member when said electromagnet is de-energized, and for adjusting the angle of incline of said laminated stationary contact member with respect to said actuable contact member.

10. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, an inclined laminated stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized, and independent means for adjusting said resilient supporting means and for adjusting the angle of incline of said laminated stationary contact member with respect to said actuable contact member.

11. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, an inclined laminated stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized, and independent means for adjusting the magnetic air-gap between said spaced core members, for adjusting said resilient supporting means, and for adjusting the angle of incline of said laminated stationary contact member with respect to said actuable contact member.

12. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, an inclined laminated stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized and independent means for adjusting the magnetic air-gap between said spaced core members, for adjusting the position of said actuable contact member with respect to said laminated stationary contact member when said electromagnet is energized, and for adjusting the angle of incline of said laminated stationary contact member with respect to said actuable stationary contact member.

13. An electrical device comprising an electromagnet, co-operating spaced stationary and movable core members therefor, a contact member actuable by said movable core member, resilient means for supporting said movable core member and said actuable contact member, an inclined

laminated stationary contact member adapted to be engaged by said actuable contact member when said electromagnet is energized, and independent means for adjusting said resilient supporting means, for adjusting the position of said actuable contact member with respect to said laminated stationary contact member when said electromagnet is de-energized, and for adjusting the angle of incline of said laminated stationary contact member with respect to said actuable contact member.

14. An electrical device comprising two co-operating contact members, one of said contact members being composed of flexible laminations arranged to provide a contact surface inclined with respect to the contact surface of the other of said contact members when said members are not in engagement, and means for adjusting the angle of such incline comprising a rocker member, means for securing the laminated contact member to said rocker member, a bracket member for supporting said rocker member, and means for clamping said rocker member in any desired fixed position with respect to said bracket member.

15. An electrical device comprising a plurality of stationary contact members, a movable contact member adapted to engage said stationary contact members, a member for actuating said movable contact member substantially perpendicularly with respect to the contact face thereof, and means for tiltably mounting said movable contact member on said actuating member whereby said movable contact member may assume a position conforming to the positions of said stationary contact members when actuated into engagement therewith, said stationary contact members being of laminated formation with the laminations thereof set at an angle with respect to the contact face of said movable contact member whereby said laminations may be flexed upon engagement thereof by said movable contact member while the tilting of the latter insures the making of contact with all of said laminations.

16. An electrical device comprising a plurality of stationary contact members, a movable centrally apertured contact disc adapted to effect electrical circuit connection therebetween, a screw-threaded rod for actuating said contact disc and means for supporting said contact disc on said rod comprising an internally screw-threaded annular member co-operating with said rod and having a reduced diameter cylindrical portion of greater thickness than the contact disc and substantially less in diameter than the centrally located aperture in said disc, and a locknut of greater diameter than said aperture for co-operating with said rod and said annular member to maintain said disc in tiltably supported relation to said rod.

17. An electrical device comprising an electromagnet, a supporting frame of magnetizable material therefor, a tubular casing of non-magnetizable material extending through said electromagnet and supporting frame, a stationary core member of magnetizable material secured within said casing, a movable core member of magnetizable material disposed within said casing in spaced relation to said stationary core member, an actuating member secured to said movable core member, an actuable contact member adjustably mounted on said actuating member, a co-operating stationary contact member, resilient means co-acting between the stationary core member and the actuable contact member and controlled by the adjustment of the actuable contact member, and independent means for adjusting the position of said casing within said electromagnet and supporting frame to vary the position of said actuable contact member with respect to said stationary contact member when said electromagnet is de-energized.

18. A device of the character described, comprising a magnet coil, a magnetizable core therefor including a tubular stationary portion extending into one end of said coil and a movable portion extending into the other end of said coil, with a magnetic air gap between said portions, a stationary contact member, a cooperating movable contact member actuable by said movable core portion, a member secured to said movable core portion, extending through said tubular core portion and carrying said movable contact member therebeyond, and means for independently adjusting the lengths of the magnetic air gap and the contact air gap whereby variations in the operating pressure between the contact members may be effected.

19. A device of the character described, comprising a magnet coil arranged on a vertical axis, a magnetizable core therefor including a tubular stationary portion extending within the upper portion of said coil and a movable portion extending within the lower portion of said coil, with a magnetic air gap between said portions, a stationary contact member, a cooperating movable contact member actuable by said movable core portion, a member secured to said movable core portion, extending upwardly therefrom through said tubular core portion, and carrying said movable contact member thereabove, and means for independently adjusting the lengths of the magnetic air gap and the contact air gap whereby variations in the operating pressure between the contact members may be effected.

20. A device of the character described, comprising a magnet coil arranged on a vertical axis, a magnetizable core therefor including a tubular stationary portion extending within the upper portion of said coil and a movable portion extending within the lower portion of said coil, a movable contact member actuable by said movable core portion, a member secured to said movable core portion, extending upwardly therefrom through said tubular core portion and carrying said movable contact member thereabove, resilient means opposing the action of gravity on said movable core portion, and means for adjusting the pressure of said resilient means to vary the degree of energization of said magnet coil which is required to actuate said movable core portion.

21. A device of the character described, comprising a magnet coil adapted to be variably energized, a magnetizable core therefor including a tubular stationary portion extending into one end of said coil and a movable portion extending into the other end of said coil, a movable contact member actuable by said movable core portion, a member secured to said movable core portion and extending through said tubular core portion and carrying said movable contact member therebeyond, resilient means for holding said movable core portion in predetermined position with respect to said fixed core portion, and means for adjusting the position of said movable core portion when said magnet coil is de-energized.

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