Nov. 22, 1938. D. G. TAYLOR 2,137,550

SWITCHING MECHANISM

Filed May 7, 1937

Fig. 2

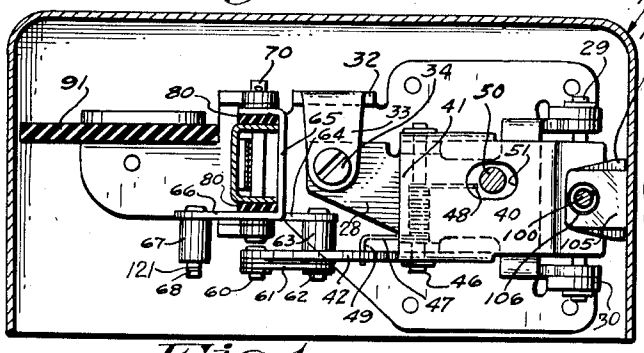


Fig. 7

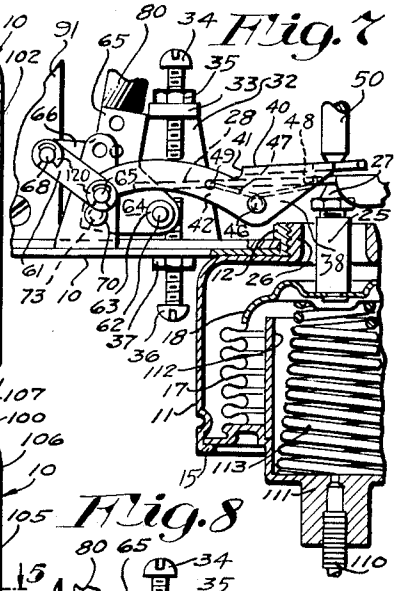


Fig. 1

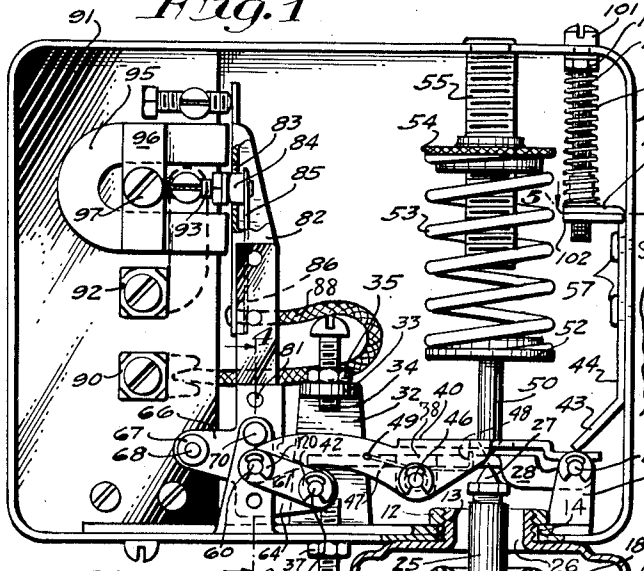


Fig. 8

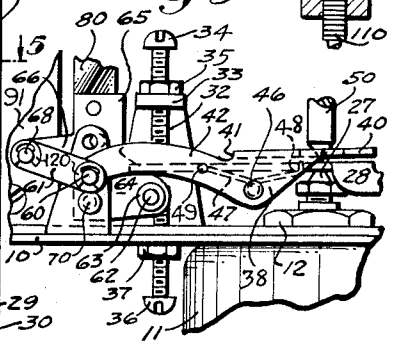


Fig. 6

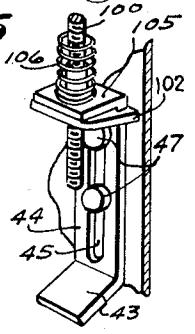


Fig. 3

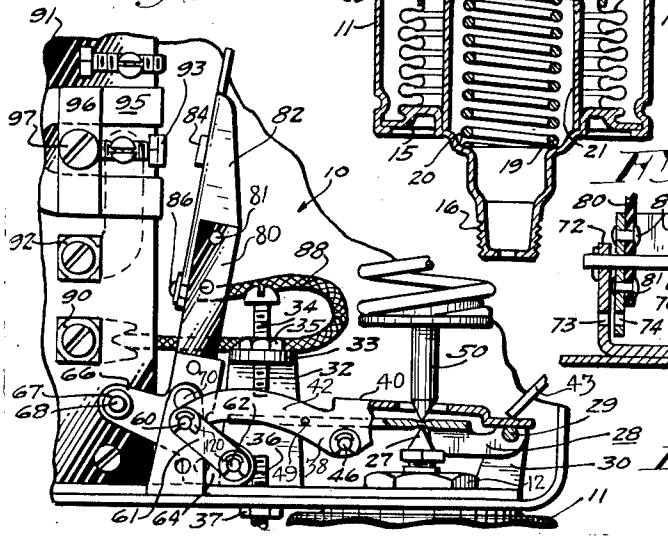


Fig. 5

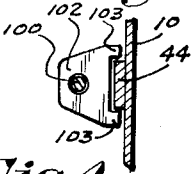
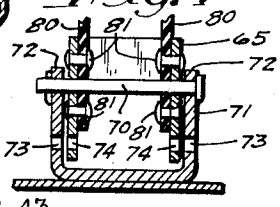


Fig. 4



INVENTOR

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Patented Nov. 22, 1938 2,137,550

UNITED STATES PATENT OFFICE

2,137,550

SWITCHING MECHANISM

Daniel G. Taylor, Minneapolis, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

Application May 7, 1937, Serial No. 141,298

22 Claims. (Cl. 200—83)

This invention relates to switching mechanism and more particularly to that type of mechanism wherein a contact is opened and/or closed in response to variations in the value of a condition, such as temperature or pressure.

In devices of this character it is customary that the condition value at which the switch opens or closes differ from the condition value at which the same mechanism closes or opens. This difference is called the operating differential and it is a primary object of this invention to provide improved structure whereby this operating differential of the instrument may be readily varied.

An additional object is the provision of a leverage arrangement in such a mechanism whereby a lost motion connection is provided between the operating mechanism and the contact structure to provide such a differential.

An additional object is the provision of improved means whereby such a lost motion differential may be simply and readily varied.

An additional object is to provide in combination with an improved leverage arrangement as above mentioned, a linkage arrangement which will insure a substantial multiplication of the effort exerted by the energizing member before transmission thereof to the circuit controlling or switching member.

An additional object is to provide such a mechanism as described in the foregoing paragraph in combination with a relatively rapidly acting switch mechanism, the linkage being so arranged as to amplify the force exerted on the switching member by the energizing member in substantial accordance with, but in opposition to the force exerted thereon by mechanism adapted to impart a relatively rapid action thereto, such as, illustratively, a magnet.

An additional object is the provision in a switching mechanism embodying a magnet, of a leverage arrangement whereby the magnetic attraction is so compensated as to reduce the differential produced thereby without materially affecting the snap action function.

A still further object is the provision of means in a single instrument whereby the switching mechanism may be readily converted from a device of the type in which the contacts are closed upon condition value change in one direction to an instrument wherein the contacts are opened on condition value change in the same direction or vice versa, without the necessity of providing separate complicated mechanism.

An additional and more specific object is the provision of yieldable means in association with the adjusting means mentioned above whereby strain upon the instrument will be obviated in the event that excess pressure is exerted upon certain of the component parts thereof.

A still further specific object is the provision of such a mechanism which will be reliable in operation, simple of manufacture, and durable and sturdy in construction.

Other objects will in part be obvious and in part be pointed out hereinafter.

The invention accordingly consists in the combinations of elements, arrangements of parts, and features of construction, all as will be more fully described hereinafter and disclosed in the accompanying drawing.

The leverage for actuating the contact arm in this application is in some respects similar to that shown in my copending application Serial No. 141,297, filed May 7, 1937. The adjustable differential is of the same type as that disclosed in an application of Albert L. Judson, Serial No. 141,299, filed May 7, 1937.

In the drawing, wherein is shown one of the various possible embodiments of this invention;

Figure 1 is a side elevational view partly in section disclosing one embodiment of the invention, certain parts thereof being omitted for the sake of clarity;

Figure 2 is a sectional view taken along the line 2—2 of Figure 1 as viewed from the top;

Figure 3 is a fragmentary view disclosing certain portions of the mechanism shown in Figure 1 in a different position of adjustment;

Figure 4 is a sectional view taken along the line 4—4 of Figure 1 as viewed from the left;

Figure 5 is a sectional view taken along the line 5—5 of Figure 1 as viewed from the top;

Figure 6 is a fragmentary perspective view of certain details of construction;

Figure 7 is a fragmentary view disclosing certain of the mechanism shown in Figure 1 in a different position of adjustment; and

Figure 8 is a fragmentary view disclosing the mechanism shown in Figure 7 in a still further adjusted position.

Having reference now to Figure 1, there is generally indicated at 10 a casing to which is secured a housing 11 as by the engagement of a lock nut 12 with a threaded portion 13 of housing 11 extending through a suitable aperture 14 in the bottom wall of casing 10. The base portion 15 of housing 11 is provided with an apertured nipple 16 adapted for engagement with a pressure tube (not shown) leading from any siutable

source of pressure or other condition which it is desired the instrument control. A bellows 17 positioned within housing 11 is secured at its lower extremity to base portion 15 and at its upper extremity to a plate 18. A spring 19 seated on a shoulder 20 of base portion 15 abuts plate 18 and biases the same upwardly. A shield 21 is positioned circumferentially about spring 19 to preclude the possibility of inter-engagement of spring 19 with the corrugations of bellows 20. An operating rod 25 is secured to plate 18 and extends upwardly through an aperture 26 in threaded portion 13 of housing 11 and terminates in a point 27. Point 27 is positioned for engagement with a central portion of a lever 28 pivoted as on a pivot pin 29 to an upwardly extending bracket 30 secured to the base of casing 10. Thus it will be seen that an increase in pressure or other condition at the source of pressure or other condition change will be transmitted through bellows 17 and operating rod 25 to lever 28 which will move in accordance therewith.

A bracket 32 is provided with an inwardly turned apertured portion 33 through which aperture projects a screw 34 provided with a lock nut 35 to form a stop to limit the upward movement of lever 28. A second screw 36 provided with a lock nut 37 projects upwardly from the base of casing 10 to provide a stop for the lower limit of lever 28.

Positioned substantially parallel to and above lever 28 is a lever 40 which comprises a portion 41 of relatively wide extent and an extending portion 42. Portion 41 is positioned adjacent a relatively central portion of lever 28 and upon upward movement of lever 28 such movement occasions abutment of lever 28 with portion 41 and moves the same and hence lever 40 upwardly. The distal end of lever 40 rests upon pivot pin 29 and is biased downwardly by an extending portion 43 of a member 44 which is provided with a slot 45 (see Figure 6) through which is passed a pair of studs 57 secured to the side wall of casing 10. Additional reference will be made to member 44 and its function hereinafter.

A pin 46 passes through suitable apertures in downwardly depending portions 38 of lever 40 below lever 28 to hold levers 28 and 40 in related assembly, and a coil spring 47 is wound about pin 46, one end thereof being secured as at 48 to a relatively central portion of lever 28 and the opposite end thereof being secured as at 49 to a mid portion of extending portion 42 of lever 40, the spring 47 being so arranged as normally to bias levers 28 and 40 resiliently towards each other.

A rod 50 extends from a boss 52 downwardly into engagement with a portion of lever 28 directly opposite that portion abutted by point 27, through an aperture 51 (see Figure 2) in lever 40. Secured to the opposite side of boss 52 is one end of a spring 53, the other end of which is suitably secured to a second boss 54 having a knurled rim and a threaded interior aperture, which in turn engages a screw 55 fixedly secured to the top wall of casing 10. Thus the force exerted by spring 53 opposes the force exerted by rod 25 through bellows 17 and spring 19, and by suitable rotation of boss 54 and consequent positioning of the same on screw 55 a variable opposing force may be exerted to provide for variations in the pressure at which it is desired the instrument operate.

Referring back to lever 40, portion 42 thereof has a pivot pin 60 adjacent its outer extremity to which is secured a link 61, the opposite end of link 61 being pivotally secured, as shown in Figures 1, 2 and 3, to a projection 62 carried by an extension 63 of an arm 64 comprising a portion of a U-shaped bracket 65 (see Figure 2). Bracket 65 is also provided with a second arm 66 carrying a similar extending portion 67 having a projection 68, the purpose of which will be more fully described hereinafter, and is pivoted as by means of a pivot pin 70 (see Figure 4) to a U-shaped bracket 71 provided with a pair of registering apertures 72 adapted to accommodate pin 70 and a second pair of registering apertures 73 in alignment with a second pair of apertures 74 formed in U-shaped member 65, the purpose of which will be more fully pointed out hereinafter.

Secured to U-shaped member 65, as better shown in Figure 4, are a pair of insulating members 80, such securing means taking the form illustratively of rivets 81 and secured to the upper portions of insulating members 80 is a channel-shaped member 82 having an aperture 83 therein through which projects a contact button 84 carried by a leaf spring 85 which is in turn secured as at 86 to the lower portion of channel-shaped member 82. A wire 88 leads from terminal 86 which is in electrical association with contact button 84 to a terminal 90 carried by an insulating panel 91 secured in any suitable manner within casing 10. Insulating panel 91 has a second terminal 92 positioned thereon in electrical association with a contact member 93 positioned for engagement and disengagement with contact button 84. A horseshoe magnet 95 secured and held in engagement with insulating panel 91 as by a bar 96 and screw 97 is so positioned that the opposite poles of magnet 95 are on opposite sides of contact member 93. Magnet 95 thus exerts a pull on channel-shaped member 82 which pull increases as the member is moved towards magnet 95 and decreases as member 82 is moved away from the same at a variable rate in accordance with known magnetic laws. Suitable wires (not shown) may lead from terminals 90 and 92 to any desired condition controlling apparatus.

Thus from the foregoing it will be seen that as lever 28 is moved upwardly in the manner previously described, its engagement with lever 40 through pin 46 will cause the latter to move upwardly about a fulcrum comprised of portion 43 of member 44, which in turn will produce an upward movement of portion 42. Such movement will produce a substantial rotary movement of link 61 which in turn will exert a force upon projection 62 to cause relative downward movement of the same as viewed in Figures 2 and 3 to cause channel-shaped member 82 to rotate about pivot 70 and a consequent movement of contact 84 away from contact 93. Upon a downward movement of lever 28 occasioned by spring 53 upon a reduction in pressure in bellows 17, projection 62 will be moved upwardly by link 61 until the parts return to the position shown in Figure 1 and contact 84 again engages contact 93 to close a circuit between terminals 90 and 92 for any desired purpose.

It will be seen that due to the unique leverage arrangement above described a variable ratio drive is provided between member 42 and member 82, since as link 61 approaches the vertical, or a right angled relationship with member 42, the force exerted thereby upon pin 62 and hence member 82 approaches zero. Conversely, as link

61 approaches parallelism with the center line between pivots 60 and 29 of member 42 the ratio of travel of member 82 and hence contact 83 is decreased with respect to the travel of member 42 and due to this decreased mechanical advantage the force with which member 82 is moved is greatly amplified at this point. Thus, assuming the parts to be in the position shown in Figure 1 as member 42 is moved upwardly, pivot 60 is shifted and the angle of link 61 with member 42 is increased. In the initial stages of such movement a relatively great force is exerted on pin 62 and hence member 82 and contact 84 to overcome the attraction of magnet 85 but as the movement progresses and pin 60 more closely approaches pivot 70 and link 61 moves toward right angular relationship with member 42, the speed of travel of contact 83 is increased and correspondingly the force exerted thereby decreases as the pull of magnet 95 decreases. Thus it will appear that as contact 84 is moved away from contact 93 and as the magnetic force exerted by magnet 95 decreases at a variable rate in accordance with the known laws of magnetic attraction, and as the force exerted by bellows 17 decreases at a substantially constant rate due to the increasing compression of spring 53, the linkage arrangement hereinbefore described through its variation of the force exerted on member 82 by member 42 serves to compensate for the variable magnetic force sufficiently to maintain the variation of the same at a substantially constant rate. Conversely, as contact 84 approaches contact 93 and the force exerted by magnet 95 increases at the same variable rate, the force exerted through the linkage also increases in variable ratio to maintain the rate of magnetic attraction substantially constant relative to the decreasing force exerted by spring 53 as above.

In other words, in devices of this character it is desirable that the restraint or attraction of the magnet vary at a relatively constant rate in accordance with the decrease or increase in force exerted on the operating lever by the spring. By means of the linkage arrangement described, a variable force is exerted on member 82 which varies directly with respect to the magnetic attraction of magnet 85 but in variable ratio to compensate for the same and provide a substantially constant rate of restraint or attraction. Thus the forces exerted on member 82 and hence contact 84 by the linkage and by magnet 85 tend to counterbalance each other in such manner that the increase and decrease of the magnetic attraction of magnet 85 varies at a uniform rate, which is, in the illustrative embodiment shown, preferably, slightly in excess of the rate of pressure increase or decrease exerted on lever 28 and hence member 42 by spring 53.

It should here be pointed out, however, that the position of extending portion 43 of member 44 may be varied, the means for the accomplishment of such variation comprising a screw 100 having a head 101 extending exteriorly of casing 10 and threadedly engaging a member 102 having extended portions 103 (see Figure 5) which extend on opposite sides of member 44. Member 44 is provided at its upper extremity with an inwardly turned portion 105 having a suitable aperture therein which loosely surrounds screw 100 at a position above that of member 102. A spring 106 is positioned between a nut 107 surrounding screw 100 adjacent its upper extremity and inwardly turned portion 105 and serves to bias portion 105 into juxtaposition with member 102. Thus it will be seen that upon rotation of screw 100 by means of head 101, member 102 being precluded from rotation by projections 103, will be moved upwardly or downwardly and that such movement will in turn be imparted through portion 105 to member 44 and hence to inwardly extending portion 43, the limits of such movement being defined by the engagement of studs 47 with the extremities of slot 45. It will further be seen that as member 43 is moved upwardly a clearance is provided between the same and the adjacent end of lever 40. Consequently, assuming member 43 to have been moved upwardly to provide a lost motion as above mentioned, when lever 28 is moved upwardly as viewed in Figure 1, upon its abutment with lever 40, lever 40 will be moved upwardly as an entirety until such time as its distal end abuts extending portion 43 whereupon contacts 84 and 93 will be separated in the manner previously discussed. However, immediately upon reverse movement of operating rod 25 occasioned by a reduction in pressure on other condition in bellows 17, the contacts will again close since such motion will permit a substantially immediate return of the adjacent end of lever 40 to a position of abutment with pin 29, which pin, it will be understood, serves as the fulcrum for lever 40 upon reverse motion of the mechanism. Thus it will be seen that the condition value at which the contacts 84 and 93 separate may be varied with respect to the condition value at which they close merely by a variation in the position of abutment 43 and the consequent variations in lost motion permitted lever 40. As, for example, if it is desired that the contacts open upon the achievement of a given pressure, as illustratively 10 lbs., adjacent bellows 17 and reclose when the pressure has been reduced to, say illustratively 8 lbs., a slight clearance is provided by adjustment of screw 100 between extending portion 43 and the end of lever 40. Should it be desired that the contacts separate at a pressure of 12 lbs. and re-engage at a pressure of 8 lbs., a still wider clearance is provided, and should it be desired that the contacts open at a pressure of, illustratively, 8 and a fraction pounds, extending member 43 is moved into abutting relationship with lever 40 in the position shown in Figure 1. Correspondingly, should it be desired to vary the pressure at which the contacts close, from the illustrative 8 lbs., to 10 lbs. a rotation of boss 54 will impart the necessary added pressure to lever 28 to provide for the variation mentioned. Reverse rotation of boss 54 will, it will readily be seen, produce an opposite effect and cause closure of the contacts at a pressure in any desired lesser amount.

Having reference now to Figures 7 and 8, there is disclosed a construction substantially identical to that of Figures 1 and 2 with the exception that, for the purposes of illustration, a capillary tube 110 is disclosed as being secured to a member 111 secured to the base of housing 11. A shield 112 similar in purpose and construction to shield 21 is positioned within bellows 17 and a spring 113 similar to but of a greater strength than spring 19, to compensate for the reduced effect exerted by a volatile fluid on bellows 17, is positioned in abutting relationship with plate 18. Capillary tube 110, it will be understood, extends to a suitable volatile fluid filled bulb (not shown) which is positioned at any desired source of temperature or other condition change. The remaining portions of the mechanism shown are identical with the

exception that link 61 is secured instead of to projection 62 to projection 68 and pivot pin 70 is inserted through apertures 73 and 74 instead of through apertures 72.

Thus, as better shown in Figure 7, link 61 is extended in an opposite direction to that shown in Figures 1, 2 and 3, and upon an increase in pressure within bellows 17 causing an upward movement of rod 25 and its associated levers 28 and 40, a downward movement of portion 42 of lever 40 results in a rotative movement of link 61 occasioning a rotative movement of bracket 65 about pivot 70 in a direction opposite to that discussed in connection with the mechanism with the parts in the position shown in the Figures 1, 2 and 3. It will be readily understood that changing the position of pivot pin 70 in the manner above described to the position in which it is shown in Figure 7, in addition to the application of the force exerted by lever 40 and link 61 on the opposite side of bracket 65, will result in an opposite movement of bracket 65 and hence contact 84.

Thus by positioning the parts, including link 61, in the position shown in Figures 7 and 8 an increase in pressure or other analogous condition causes the contacts 84 and 93 to separate while a decrease in pressure causes the same to engage.

The linkage arrangement as now positioned acts, with respect to the pull of the magnet, in a manner similar to the leverage arrangement as described in connection with Figure 1, the force exerted thereby increasing in variable ratio as the movable contact approaches the fixed contact and decreasing correspondingly as it moves away from the same.

It may here be pointed out that one manner of securing link 61 to projections 60, 62 and/or 68 may take the form of spring clips 120 engaging suitable grooves in the above named projections, one of which grooves is shown at 121 in Figure 2. While spring clips 120 are suitable for this purpose and provide a connection which may be readily assembled and dis-assembled as occasion requires, it will be understood that any other suitable detachable means for the same purpose may be employed.

Thus from the foregoing it will be seen that there is herein provided a mechanism for accomplishing the objects of this invention and others in an improved and satisfactory manner.

Since many embodiments may be made of this invention and since many modifications may be made in the above described and illustrated embodiment, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In a device of the character described, in combination, a permanent magnet, means movable toward and away from said magnet, condition responsive means to move said first mentioned means, and means between said first and second means to transform the variable rate of restraint and attraction of said magnet to a substantially constant rate, said last mentioned means comprising a linkage arrangement between said first and second mentioned means so arranged as to vary the speed of travel of said first mentioned member in substantially direct proportion to the distance between said magnet and said first mentioned member.

2. In a device of the character described, in combination, a movable member, a lever fulcrumed at an end, said member positioned to abut said lever at an intermediate point, a second lever substantially parallel to and adjacent said first lever fulcrumed adjacent said first mentioned fulcrum, said second lever being so arranged that said first lever abuts the same at an intermediate point, means to vary the position of the fulcrum of said second lever, and mechanism operated by the distal end of said second lever.

3. In a device of the character described, in combination, a movable member, a lever fulcrumed at an end, said member abutting said lever at an intermediate point, a second lever substantially parallel to and adjacent said first lever, said second lever being fulcrumed between the proximal end of said first lever and an abutment, said second lever being so positioned that said first lever abuts the same at an intermediate point, means for moving said abutment whereby upon movement of said first lever the distal end of said second lever remains stationary until the proximal end of said second lever encounters said abutment whereby to vary the relative movement of said second lever with respect to the relative movement of said first lever, and mechanism operated by said distal end of said second lever.

4. In a device of the character described, in combination, a movable member, a lever fulcrumed at an end, said member positioned to abut said lever at an intermediate point, a second lever substantially parallel to and adjacent said first lever fulcrumed adjacent said first mentioned fulcrum, said second lever being so arranged that said first lever abut the same at an intermediate point, means to vary the position of the fulcrum of said second lever, a contact movable by the distal end of said second lever, an opposed contact adjacent said first mentioned contact, and magnetic means adjacent said second mentioned contact to impart a snap action to the movement of said first mentioned contact.

5. In a device of the character described, in combination, a movable member, a lever movable by said member, a second lever substantially parallel to said first mentioned lever and adjacent thereto, said first lever so positioned as to abut an intermediate portion of said second lever whereby movement of said movable member is transmitted to said second lever only through said first lever, means to vary the position of said second mentioned lever with respect to said first mentioned lever, a contact movable by the distal end of said second lever, a second contact positioned for engagement with said first mentioned contact, and magnetic means adjacent one of said contacts to impart a snap action to the movement of said first mentioned contact.

6. In a device of the character described, in combination, a condition responsive element, a member movable thereby, a lever movable by said member, a second lever adjacent said first mentioned lever and movable by the engagement of the distal end of said first lever with an intermediate portion thereof, a link having one end pivotally secured to said second lever, a bell crank lever pivoted adjacent said link, the opposite end of said link being secured to one arm of said bell crank lever, said link being in substantial alignment with the axial plane of said second lever in one position of adjustment of said lever whereby a relatively slight movement of said movable member is by disruption of said alignment transmitted to a relatively great movement of said bell crank lever, and mechanism operated by said bell crank lever.

7. In a device of the character described, in

combination, a condition responsive element, a member movable thereby, a lever movable by said member, a second lever adjacent said first mentioned lever and movable by the engagement of the distal end of said first lever with an intermediate portion thereof, a link having one end pivotally secured to said second lever, a bell crank lever pivoted adjacent said link, the opposite end of said link being secured to one arm of said bell crank lever, said link being in substantial alignment with the axial plane of said second lever in one position of adjustment of said lever whereby a relatively slight movement of said movable member is by disruption of said alignment transmitted to a relatively great movement of said bell crank lever, contact means carried by said bell crank member, additional contact means positioned adjacent said first mentioned contact, and magnetic means to impart a snap action to the movement of said first mentioned contact means.

8. In a device of the character described, in combination, a condition responsive element, a member movable thereby, a lever movable by said member, a second lever adjacent said first mentioned lever and movable by the engagement of the distal end of said first lever with an intermediate portion thereof, a link having one end pivotally secured to said second lever, a bell crank lever pivoted adjacent said link, the opposite end of said link being secured to one arm of said bell crank lever, said link being in substantial alignment with the axial plane of said second lever in one position of adjustment of said lever whereby a relatively slight movement of said movable member is by disruption of said alignment transmitted to a relatively great movement of said bell crank lever, means for varying the position of a proximal end of said first mentioned lever with respect to said second mentioned lever, and mechanism operated by said bell crank member through movement of the distal end of said second mentioned lever.

9. In a device of the character described, in combination, a condition responsive element, a member movable thereby, a lever movable by said member, a second lever adjacent said first mentioned lever and movable by the engagement of the distal end of said first lever with an intermediate portion thereof, a link having one end pivotally secured to said second lever, a bell crank lever pivoted adjacent said link, the opposite end of said link being secured to one arm of said bell crank lever, said link being in substantial alignment with the axial plane of said second lever in one position of adjustment of said lever whereby a relatively slight movement of said movable member is by disruption of said alignment transmitted to a relatively great movement of said bell crank lever, means for varying the position of the proximal end of said second mentioned lever with respect to said first mentioned lever, contact means carried by said bell crank member, additional contact means adjacent said first mentioned contact means and positioned for engagement therewith, and magnetic means adjacent one of said contact means to impart a snap action to the movement of said first mentioned contact.

10. In a device of the character described, in combination, a movable member, a lever movable thereby, a second lever movable by said first mentioned lever, a link associated with said second lever, a bell crank member associated with said link, said link being so arranged as to lie in substantial alignment with the axial plane of said second lever in one position of adjustment whereby to amplify the movement of said movable member if transmitted to said bell crank member by disruption of said alignment, and mechanism operated by movement of said bell crank member.

11. In a device of the character described, in combination, a movable member, a lever movable thereby, a second lever movable by said first mentioned lever, a link associated with said second lever, a bell crank member associated with said link, said link being so arranged as to lie in substantial alignment with the axial plane of said second lever in one position of adjustment whereby to amplify the movement of said movable member if transmitted to said bell crank member by disruption of said alignment, mechanism operated by said bell crank member, and magnetic means associated with said mechanism to impart a snap action to the movement thereof.

12. In a device of the character described, in combination, a movable member, a lever movable thereby, a second lever movable by said first mentioned lever, a link associated with said second lever, a bell crank member associated with said link, said link being so arranged as to lie in substantial alignment with the axial plane of said second lever in one position of adjustment whereby to amplify the movement of said movable member if transmitted to said bell crank member by disruption of said alignment, means for varying the position of the end of said second lever with respect to said first lever, and mechanism operated by said bell crank member through said second lever.

13. In a device of the character described, in combination, a movable member, a lever movable thereby, a link pivotally secured to said lever, a bell crank member associated with said link and pivotally secured to the opposite end thereof, said link lying in substantial alignment with the axial plane of said lever in one position of adjustment whereby a relatively slight movement of said lever by said movable member is amplified by disruption of said alignment into a relatively great movement of said bell crank member, mechanism operated by said bell crank member, and magnetic means associated with said mechanism to impart a snap action to the movement thereof.

14. In a device of the character described, in combination, a movable member, a lever movable by said member, a second lever adjacent and movable by the distal end of said first lever, a member pivotally mounted adjacent said second lever, said member having a pair of oppositely disposed arms, a contact carried by said member, a fixed contact adjacent said first mentioned contact, a link pivotally secured to the distal end of said second lever, and means whereby said link may be secured to either of said arms whereby when secured to one of said arms said contact moves in one direction upon movement of said lever in one direction but when said link is secured to the other of said arms said contact moves in the opposite direction upon movement of said lever in the same direction.

15. In a device of the character described, in combination, a movable member, a lever movable thereby, a second member pivotally mounted adjacent the distal end of said lever, said member having a pair of oppositely disposed arms, a contact carried by said member, a fixed contact adjacent said first mentioned contact, a link pivotally secured to the distal end of said second lever, and means whereby said link may be se-

cured to either of said arms whereby when secured to one of said arms said contact moves in one direction upon movement of said lever in one direction but when said link is secured to the other of said arms said contact moves in the opposite direction upon movement of said lever in the same direction.

16. In a device of the character described, in combination, a movable member, a lever movable by said member, a second lever adjacent and movable by the distal end of said first lever, a member pivotally mounted adjacent said second lever, said member having a pair of oppositely disposed arms, a contact carried by said member, a fixed contact adjacent said first mentioned contact, a link pivotally secured to the distal end of said second lever, means whereby said link may be pivotally secured to either of said oppositely disposed arms, and magnetic means adjacent one of said contacts to impart a snap action to the movement of said first mentioned contact.

17. In a device of the character described, in combination, a movable member, a lever fulcrumed at an end and movable by said member, a second lever substantially parallel to and adjacent said first lever and fulcrumed between said first mentioned fulcrum and an abutment, said second lever being so arranged that said first lever abuts the same at an intermediate point, means for varying the position of said abutment whereby to vary the position of said second mentioned lever with respect to said first mentioned lever, yieldable means associated with said abutment to prevent breakage thereof upon undue movement of said first mentioned lever, and mechanism operated by the distal end of said second lever.

18. In a device of the character described, in combination, a movable member, a lever movable thereby, a second member pivotally mounted adjacent the distal end of said lever, said member having a pair of oppositely disposed arms, a contact carried by said member, a fixed contact adjacent said first mentioned contact, a link one end of which is pivotally secured to the distal end of said second lever, means whereby the other end of said link may be secured to either of said arms whereby when secured to one of said arms said contact moves in one direction upon movement of said lever in one direction but when secured to the other of said arms said contact moves in the opposite direction upon movement of said lever in the same direction, and magnetic means adjacent one of said contacts to impart a snap action to the movement of said first mentioned contact.

19. In a device of the character described, in combination, a movable member, a lever fulcrumed at an end and movable by said member, a second lever substantially parallel to and adjacent said first lever and fulcrumed between said first mentioned fulcrum and an abutment, said second lever being so arranged that said first lever abuts the same at an intermediate point, yieldable means associated with said abutment to prevent breakage thereof upon undue movement of said first mentioned lever, and mechanism operated by the distal end of said second lever.

20. In a device of the character described, in combination, a magnet, a member, a device, an operative connection between said member and device whereby said device moves said member toward and away from said magnet, and means in said connection for varying the force exerted by said device on said member as said member is moved relatively to said magnet to an extent almost as great as the variation in the force exerted by the magnet on said member due to said relative movement.

21. In a device of the character described, in combination, a magnet, a member, a device, an operative connection between said member and device whereby said device moves said member toward and away from said magnet, and means in said connection for decreasing the force exerted by said device on said member at a rate almost as great as the rate of decrease in the force exerted by said magnet on said member as said member is moved away from said magnet.

22. In a device of the character described, in combination, a first pivoted lever, a condition responsive device for rotating said lever, a second lever pivoted at an intermediate point to said first lever, one end of said second lever being connected to a control member, and means determining the differential of operation of the control member by the condition responsive device comprising two spaced stops between which the other end of the second lever is free to move under the influence of said condition responsive device and before it operates said control member, one of said stops being resiliently mounted whereby excess movement of said second lever by said condition responsive device after said control member has been operated will cause movement of said stop against the force exerted by its resilient mounting.

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