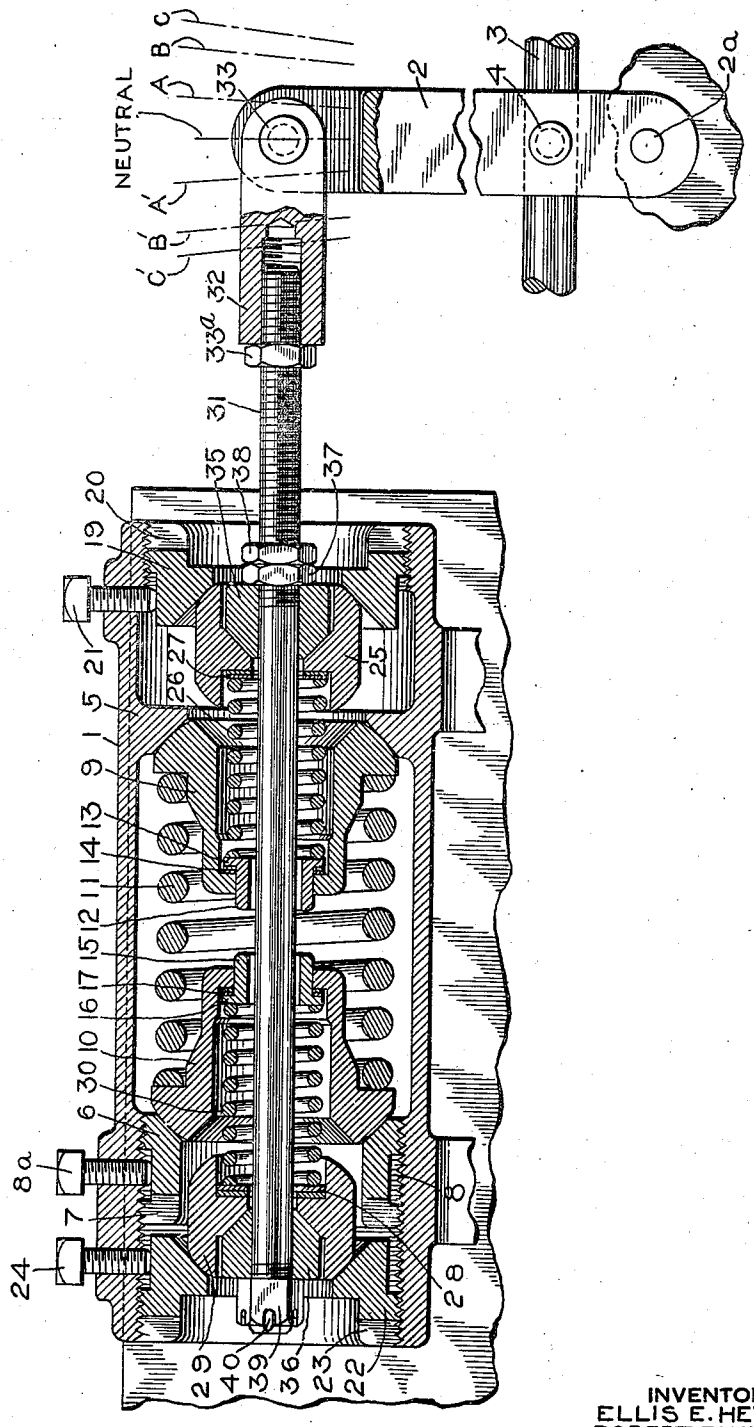
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REGULATING DEVICE

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REGULATING DEVICE

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This invention relates to regulating devices and more particularly to means for opposing movement and for defining different positions of a power operated member.

In the copending application of Roy R. Stevens, Serial No. 463,792, filed October 29, 1942, now Patent No. 2,383,278, of August 21, 1945, there is disclosed a fluid motor embodying a power piston, a pilot piston, and valve means operable by the pilot piston upon movement relative to the power piston to establish a differential in fluid pressures on opposite sides of the power piston for effecting movement thereof. The power piston in turn is operable upon movement relative to the pilot piston to actuate the valve means to effect equalization of the fluid pressures on opposite sides of the power piston for stopping same in a position corresponding to that of the pilot piston. The power piston has a neutral position and at either side of such position has three other positions. The pilot piston has like positions, and a regulating device embodying a plurality of springs confined under pressure is arranged to become effective or ineffective in certain of these different positions for opposing pressure of fluid on the pilot piston and to define such positions. In other words, a certain pressure of fluid provided on the pilot piston will cause a chosen positioning thereof determined by one of the springs while a different pressure of fluid on the pilot piston will cause a different chosen positioning thereof determined by another spring, whereby the power piston may be caused to assume any chosen position by providing the required chosen degree of fluid pressure on the pilot piston.

The principal object of the present invention is the provision of an improved regulating device or spring arrangement for opposing movement and for defining different positions of a member, such as the pilot piston above described.

Other objects and advantages will be apparent from the following more detailed description of the invention.

In the accompanying drawing the single figure is a sectional view of a portion of a control apparatus embodying the improved regulating device.

Description

In the drawing, the reference numeral 1 indicates the improved regulating device, and the reference numeral 2 indicates a lever which is mounted to turn on a fulcrum pin 2*a* which is fixed with respect to said device.

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The lever 2 may have a "neutral" position in which it is shown and at either side of said position a plurality of other positions such as indicated by dot and dash lines designated by legends "A," "B," and "C" at one side of the "neutral" position, and legends "A'," "B'," and "C'," at the opposite side of the "neutral" position.

An actuating member 3 is connected by a pin 4 to the lever 2 for moving said lever to its different positions, and actuating force may be applied to this member by pressure of fluid on a pilot piston such as above described but which is not shown in the drawing since it is not essential to an understanding of the invention.

The regulating device 1 comprises a tubular casing open at opposite ends and substantially axially aligned with the free end of lever 2 when in "neutral" position. This casing is provided interiorly with a laterally extending annular wall 5 located substantially midway between one end and the center of the casing, while occupying a substantially like position adjacent the opposite end of the casing is an adjustable nut 6 having screw-threaded engagement interiorly with the casing. The outer end of this nut is provided with slots 7 to receive the end of a wrench for adjusting the nut in the casing, while intermediate its ends the nut is provided around its periphery with spaced slots 8. A lock screw 8*a* having screw-threaded engagement with the casing is provided for entering one or another of the slots 8 for securing said nut in an adjusted position.

Two oppositely arranged and axially aligned thimble-like elements 9 and 10 are disposed in the casing between the wall 5 and nut 6 with their smaller ends adjacent each other and their larger and opposite ends arranged for engagement with the adjacent faces of said wall and nut, respectively. A coil spring 11 encircling the two elements 9 and 10 bears at one end against the element 9 and at the opposite end against the element 10. This spring is compressed to a certain degree by proper adjustment of nut 6 in the casing and therefore acts to urge the elements 9 and 10 apart and into engagement with wall 5 and nut 6, and to oppose movement of either of said elements relative to the other out of engagement with said wall or nut, respectively. A sleeve 12 is mounted to slide in an axial bore provided through the smaller end of element 9 and is provided within said element with an annular collar 13 between which and the portion of said element encircling the sleeve is interposed one or more adjusting shims 14. A like and oppositely disposed sleeve 15 is slidably

mounted in an axial bore through the smaller end of element 10 and is provided within said element with an annular collar 16 between which and the portion of said element encircling said sleeve is interposed one or more shims 17. The shims 14 and 17 are of such thickness as to allow the sleeves 12 and 15 to extend substantially the same distance beyond the adjacent ends of the respective elements 9 and 10, and to also obtain a distance between the adjacent ends of said sleeves with said elements in contact with the collar 5 and nut 6, respectively, which corresponds to the distance between the positions indicated by the legends "A" and "B," and "A'" and "B'" at the point of connection between the lever 2 and the regulating device, which will be later described.

In the end of the casing adjacent wall 5 there is a ring-like adjusting nut 19 having screw-threaded engagement with the casing and provided in its outer face with slots 20 for receiving a wrench to adjust the nut. A lock screw 21 having screw-threaded engagement in the casing in alignment with the periphery of nut 19 is provided for turning into contact with said nut to secure same in an adjusted position. An oppositely arranged and like nut 22 is provided in the opposite end of the casing and has screw-threaded engagement interiorly thereof. This nut in its outer end is provided with slots 23 for receiving a wrench to adjust the nut in the casing. A set screw 24 having screw-threaded engagement with the casing in alignment with the periphery of nut 22 is provided for engagement with said nut to secure same in an adjusted position.

Between the wall 5 and nut 19 is a circular stop element 25 which is considerably smaller in diameter than the central opening through wall 5 so as to be capable of movement therethrough without contacting said wall. One end of the stop element 25 is arranged for contact with the adjacent face of nut 19, while the opposite end is arranged for engagement with an annular portion of the thimble-like element 9 which extends inwardly of the wall 5. A coil spring 26 bears at one end against the collar 13 of sleeve 12 and at the opposite end against the stop element 25 through the medium of one or more adjusting shims 27. The stop element 25 is assembled in position before applying the nut 19 to the casing and then said nut is adjusted to move said element in the direction of the thimble-like element 9 to a position in which the space between the two elements with the element 9 in contact with wall 5 equals the distance between the positions indicated by the legends "Neutral" and "A'" at the point of connection between lever 2 and the regulating device, which connection will be later described. The number or thickness of shims 27 between the stop element 25 and spring 26 is such as to provide a certain chosen pressure of spring 26 on the element 25 and sleeve 12 when said element is adjusted by nut 19 to this relation with the thimble-like element 9.

A stop element 29, like the element 25, is interposed in the space between the adjacent ends of the thimble-like element 10 and nut 22 and is freely movable through the central opening in nut 6. One end of the element 29 is arranged for engagement with the adjacent end of nut 22 while the opposite end is arranged for engagement with the adjacent end of the thimble-like element 10 over the portion of said element which extends within the nut 6. A coil spring 30 bears at one end against collar 16 on sleeve 15 and at

the opposite end against the adjacent face of stop element 29 through the medium of one or more shims 28.

The stop element 29 is assembled in the casing before applying the nut 22 and then said nut is adjusted for moving said element inwardly of the casing to a position in which the space between said element and thimble-like element 10 when in engagement with nut 6, equals the distance between the positions of lever 2 indicated by the legends "Neutral" and "A" at the point of connection between said lever and the regulating device which connection will be later described. The shims 28 are such that in this adjusted position of the stop element 29 the spring 30 will be so compressed as to exert a chosen degree of force against said stop element and sleeve 15.

In order to insure centering the thimble-like elements 9 and 10 and stop elements 25 and 29 with respect to the casing and to each other the cooperating surfaces on said elements and on the wall 5 and nuts 6, 19, and 22, respectively, are beveled or formed at an acute angle to the axis of the casing. Further, each two of the cooperating surfaces are formed differently so as to provide only a line contact between the surfaces in order to reduce to a minimum the reluctance to separation of the parts on which the surfaces are formed. Preferably the surfaces on the stationary parts constituting the wall 5 and nuts 6, 19, and 22 are provided within such parts in the form of straight line bevels, while the cooperating surfaces on the movable elements 9, 10, 25, and 29 are arcuate in form. For the same reasons, the surfaces on the thimble-like elements 9 and 10 provided for engagement by the stop elements 25 and 29 are within the elements and in the form of straight line bevels while the cooperating surfaces on the elements 25 and 29 are arcuate in form.

A rod 31 loosely extends through axial openings provided in the stop members 25 and 29 and in sleeves 12 and 15 and has one end adjustably connected by screw-threads to one end of a link 32. The opposite end of link 32 is pivotally connected by a pin 33 to the free end of lever 2, this connection between rod 31 and lever 2 constituting the point of connection between said lever and the regulating device 1, hereinbefore mentioned. A lock nut 33a on the rod 31 is provided for engagement with the link 32 for securing said rod in an adjusted condition with respect to said link.

The stop member 25 has axially an annular cavity open at the outer end of said member and connected at its inner end to the larger end of a frusto-conical recess. A follower 35 is disposed in this cavity and has a nose portion disposed in the frusto-conical recess wherein it engages the stop member 25. The diameter of the follower 34 is less than the diameter of the cavity in the stop member 25 in order to allow centering of said follower with respect to said stop member when in contact therewith due to the cooperative action of the tapered engaging surfaces which may be formed like the cooperating centering surfaces heretofore described in connection with other parts of the device, or if desired, both of said surfaces may be formed at the same angle. When the follower 35 is disengaged from the stop element 25, said follower being of smaller diameter than the cavity in said element, provides for a certain free radial movement of the follower relative to said element.

The stop member 29 has axially a cavity open

at the outer end of the member and an inner frusto-conical recess like in the stop member 25, and disposed in this cavity and recess is a follower 36, like the follower 35 but oppositely disposed. The cooperating surfaces on the follower 36 and element 29 are provided for centering said follower with respect to said element, and with said follower disengaged from said element said follower has a certain free radial movement relative to said element.

The rod 31 also extends through the followers 35 and 36 but not loosely as in the stop elements 25 and 29 and in the sleeves 12 and 15. A nut 37 is provided on the rod 31 for contact with the follower 35 to hold same against movement on the rod in the direction of lever 2, while a lock nut 38 is also provided on said rod for engagement with the nut 37 to secure same in an adjusted position. A castle nut 39 is provided on the end of rod 31 and engages the follower 36, said nut being secured against turning on the rod by a cotter key 40.

With the two nuts 19 and 22 adjusted as before described and with the stop elements 25 and 29 in engagement with said nuts, the nut 37 is adjusted on the rod 31 to urge the two followers 36 and 35 into contact with said stop elements and then the lock nut 38 is adjusted for securing the nut 37 against movement. With the parts of the regulating device in their adjusted condition above described and shown in the drawing, the link 32 on the end of rod 31 is then adjusted relative to said rod for connection with the lever 2 by pin 33 with the lever in its neutral position shown. The pin 33 is then applied to link 32 and lever 2 thereby connecting the regulating device 1 to said lever.

Operation

With the parts of the regulating device 1 in the condition shown in the drawing and above described, it will be noted that the force of spring 11 will urge the thimble-like elements 9 and 10 into contact with the wall 5 and adjusting nut 6 respectively while the pressure of springs 26 and 30 will urge the stop elements 25 and 29 into contact with the adjusting nuts 19 and 22, respectively, for thereby actuating the rod 31 and link 32 to position the lever 2 in its "neutral" position shown.

Now let it be assumed that it is desired to move the lever 2 from its "neutral" position in the direction of the right-hand. To accomplish this end force is applied through rod 3 to lever 2 and thence through rod 31 to the follower 36 and stop element 29. When this force is increased sufficiently to overcome the pressure of spring 30 on element 29, said spring will yield to permit movement of lever 2 as desired and said element will be pulled out of contact with the fixed stop or adjusting nut 22. As the force applied to the lever 2 then continues to increase said lever will continue to move against the increasing force of spring 30 until the stop element 29 engages the thimble-like element 10 which is subject to the precompressed force of spring 11, and which condition will be obtained at the time the lever 2 attains the position indicated by the legend "A." A certain definite force governed by spring 30 is thus required on the lever 2 for moving said lever from "neutral" position to the position "A," and when this latter position is attained, a definite increase in force on lever 2 is required to overcome the precompressed force of spring 11 on the thimble-like element 10 for moving same out of contact with the adjusting nut 6. The difference in force required to move the stop element 29 into contact with the thimble-like element 10 and to then move said element against spring 11 constitutes a range of force which may be applied through the rod 3 for moving the lever 2 to the position "A." The application of any degree of force within this range to the rod 31 will therefore insure movement of the lever 2 to the position "A."

Let it now be assumed that it is desired to move lever 2 to the position indicated by the legend "B." To accomplish this end the force applied to the lever through rod 3 is increased to a degree sufficient to overcome the opposing force of spring 11 following which said spring will yield to permit movement of said lever, and such movement will continue as the force applied to the rod 3 is increased until the end of sleeve 15 moves into contact with sleeve 12 which defines the position "B." Further movement of the lever 2 will then be opposed by the pressure of spring 26 on the sleeve 12, it being noted that at this instant the pressure of spring 26 is less than that of spring 30 which was compressed during the initial movement of lever 2 out of "neutral" position. A certain degree of force is thus required on lever 2 to move the sleeve 15 into contact with the sleeve 12, and a definite increase in this force is then required to overcome the precompressed force of spring 26, the difference between such forces constituting a range of force which may be applied to the lever 2 for obtaining contact between the sleeves 15 and 12 which defines the position "B" of lever 2. It will thus be seen that if a force is applied to lever 2 through rod 3 of a degree anywhere within said latter range, a positive positioning of the lever 2 in the position "B" will be attained.

In order to now move the lever 2 from position "B" and "C," the force applied through rod 3 to the lever 2 must be increased to a degree sufficient to overcome the force of spring 11 in addition to the force of spring 26 and when this force condition is obtained, the lever 2 will move to the position indicated by the legend "C," this position in the specific embodiment of the invention shown in the drawing being defined by means other than in the regulating device 1 and therefore not shown in the drawing.

Now let it be assumed that with the lever 2 in position "C" it is desired to move said lever back to position "B." To do this the force applied through rod 3 to lever 2 is reduced to a value within the range required to effect movement of sleeve 15 into contact with sleeve 12 but insufficient for moving sleeve 12 inwardly of the thimble-like element 9. As a result of this reduction in force on lever 2 the combined force of springs 11 and 26 applied to the stop element 29 will move the rod 31 in the direction of the left-hand until the force of spring 26 is removed from said stop element by engagement between the collar 13 on sleeve 12 and the shims 14.

In order to then move the lever 2 from position "B" to position "A," the force on lever 2 is again reduced to a value within the range required for moving the stop element 29 into contact with the thimble-like element 10 but insufficient for moving the latter against spring 11. As a consequence, the spring 11 will therefore return the thimble-like element 10 into contact with the adjusting nut 6 while the stop element 29 will be retained in contact with said thimble-like element by the force still applied to lever

2. Thus the lever 2 will be returned from the position "B" to the position "A" and be stopped in the latter position.

To now return the lever 2 from position "A" to its "neutral" position, all force is removed from rod 3 and lever 2 and as a result spring 30 will urge the stop element 29 into contact with its fixed stop or the adjusting nut 22 which defines the "neutral" position of the lever 2.

It will thus be seen that the stop element 29, spring 30, thimble-like element 10, spring 11, sleeves 15 and 12, and spring 26 are effective at different times to positively define the different positions of lever 2 to the right of and including "neutral" position in accordance with the lack of force in rod 3 or in the application of force within two specific ranges or in the application of a certain maximum degree of force to said rod.

When the stop element 29 is moved out of contact with stop or nut 22 upon movement of rod 31 in one direction or out of contact with the thimble-like element 10 upon movement of said rod in the opposite direction, the stop element 29 is capable of certain free radial movement within the nut 6, while at the same time the rod 31 is also free for radial movement in the sleeves 15 and 12 and stop element 25 since the follower 35 is free for movement outwardly of the stop element 25 as may occur with rod 31. The rod 31 is fixed at one end to lever 2, but its opposite end and the stop element 29 are thus in a free floating condition on the end of spring 30 which permits adjustment of said rod to said spring in case the spring is slightly deformed, but of greater importance, it should be noted that there is no friction between parts to interfere with spring 30 accurately determining the position of lever 2 according to the force applied through rod 3 to said lever. This same free condition also exists when the thimble-like element 10 is disengaged from stop 6 and with the sleeves 15 and 12 also disengaged to thereby render the position of lever adjustable by spring 11 with extreme accuracy in accordance with the force applied by rod 3 to lever 2. Such accuracy of adjustment is required in the use of the device only between "neutral" position and position B, and is not required between the positions "B" and "C," and this permits the use of sleeve 12 having sliding contact with the thimble-like element 9 during movement of the lever 2 from the position "B" to the position "C."

When the lever 2 is rocked, the connected end of rod 31 will shift to a slight extent radially of said rod and thereby tend to move said rod slightly out of axial alignment with the regulating device, but this will in no way affect the accuracy of adjustment of the lever, due to the freedom for radial movement of the rod 31 and of the stop elements 29 and 10 within the casing, as above described. In other words, this floating character of the rod 31 and stops 29 and 10 within the regulating device as above described provides for automatic adjustment of the rod 31 to the lever 2 for different angular positions which said lever may assume.

Upon movement of the lever in a counterclockwise direction by force applied to rod 3, stop element 25 is initially moved against the spring 26 into contact with the thimble-like element 9 for defining the position "A'." The thimble-like element 9 may then be moved against spring 11 until the sleeve 12 contacts sleeve 15 which defines the position "B'," following which the stop elements 25 and 9 may continue movement together against the combined forces of spring 11 and spring 30 to the position "C'." Upon proper reductions in force applied through rod 3 to lever 2, the lever may be returned from position "C'" to the position "B'," position "A'" or "neutral" as determined by the degree of force acting on the lever 2. In other words, this operation is identical to that described in detail in connection with movement of the lever 2 to positions at the right hand side of "neutral" position, the stop elements 25 and 9 and sleeve 12 and the springs 26, 11 and 30 functioning in the identical manner. Also during this latter operation the stop element 25 is free for radial movement when disengaged from the stop member 19 and thimble-like element 9, while said thimble-like element is also free for radial movement when disengaged from the wall 5 and since the rod 31 is capable of a certain limited free radial movement within the sleeve 15 and the stop element 29 under these conditions the same floating condition of the rod 31 and of the operating stop element within the casing is obtained as previously described, in order to provide accuracy of adjustment of the position of lever 2 in accordance with the opposing pressure of the controlling spring or springs. A more detailed description of the operation of these parts upon movement of the lever 2 in a counterclockwise direction from "neutral" position is not believed necessary herein since the operation is identical to the operation upon movement of lever 2 in a clockwise direction and above described.

Summary

It will now be seen that I have provided a multi-spring regulating device which is operative with extreme accuracy to oppose movement of an operating member and to define positions of said member corresponding to chosen degrees of operating force applied to the member. During operation of the movable position defining stops and the means connecting same to the operating member, such stops and means have connections only with said member, and the respective control spring is thus in a free flowing condition and independent of any other force so that the control spring may determine with a maximum degree of accuracy the position of said member corresponding to the actuating force applied to the member, and regardless of angular changes in the position of said member with respect to the axis of the regulating device. The movable position defining means are also self-centering with respect to each other and the casing, this result being obtained by use of tapered or beveled surfaces on the cooperating parts. These beveled surfaces are also formed to provide only line contacts between the cooperating parts so as to reduce to a minimum the reluctance to separation of the parts in order that such separation may occur upon a slight change in control force on the operating member and thus provide the desired sensitivity of the structure and accuracy of control.

Having now described our invention what we claim as new and desire to secure by Letters Patent is:

1. In combination, a member movable by force, a coil spring, a movable stop engaging one end of said spring, support means carrying the opposite end of said spring and arranged to be engaged by said movable stop for limiting compression of said spring, stop means arranged for engagement by said movable stop to limit expansion of said spring, one of said means having an

axial opening, a rod of smaller diameter than said opening extending therethrough, the surfaces of said movable stop and of said support means and stop means which are provided for engagement being generally frusto-conical in shape for cooperation to centralize said movable stop with said opening upon engagement of said movable stop with either said support means or said stop means, and one of each pair of cooperating surfaces being formed differently than the other to limit the surface of contact to less than the full area of the surface, means connecting said rod to said member, and means connecting said rod to said movable stop, said movable stop and rod being movable against and by said spring upon an increase and decrease respectively in the degree of force applied to said member, and said movable stop and the connected end of said spring and rod being freely movable radially of said opening with said movable stop out of engagement with said stop means and support means.

2. In combination, a movable member arranged to be subjected to an operating force for moving same, and a spring device connected to said member and cooperative therewith to define positions of said member corresponding to the degree of said force applied to said member, said device comprising a casing, two coaxially arranged coil springs in said casing, a first movable stop engaging one end of one of said springs and supporting one end of the other spring, a second movable stop engaging the opposite end of the other spring and arranged after a certain movement against the respective spring to engage said first movable stop and then move same against its spring, stop means fixed with respect to said casing and engageable by each of said movable stops for limiting extension of the respective spring, means on said movable stops and stop means cooperative upon engagement of said movable stops with the respective stop means to centralize said movable stops with each other, said movable stops being freely movable in said casing radially of said springs upon disengagement from said stop means, said first movable stop and said stop means therefore having central openings, and a rod of smaller diameter than said openings extending therethrough and having one end connected to said second movable stop and the opposite end connected to said member and operable by said member upon an increase in force thereon to successively move said movable stops against the respective springs.

3. In combination, a movable member arranged to be subjected to an operating force for moving same, and a spring device connected to said member and cooperative therewith to define positions of said member corresponding to the degree of said force, said spring device comprising a casing having a bore, a first ring-like fixed stop associated with said casing within said bore, a first circular movable stop of smaller diameter than said bore and disposed therein, a spring on said casing acting on said movable stop and operative to move said movable stop into contact with said fixed stop, a second ring-like fixed stop in said casing, a second circular movable stop of smaller diameter than said bore and disposed therein, a second spring interposed under pressure between said first and second movable stops and operative to urge said second movable stop into contact with said second fixed stop and being yieldable to provide for movement of said second movable stop into contact with said first movable stop, the surfaces on said fixed stops engaged by said movable stops being coaxial with said bore and said surfaces and the cooperating contacting surfaces on said movable stops being generally frusto-conical in shape but formed differently to thereby centralize said stops in said bore and to provide a line contact between said fixed and movable stops, said fixed and movable stops having axially aligned openings, and a rod of smaller diameter than said openings and extending through certain of said openings and having a connection with said member, and means connecting said rod to said second movable stop for thereby rendering said springs successively effective to oppose movement of said member upon an increase in the degree of force applied thereto.

4. In combination, a movable member arranged to be subjected to an operating force for moving same, and a spring device associated with said member and cooperative therewith to define positions of said member corresponding to the degree of said force, said device comprising a casing having a bore, two ring-like fixed stops spaced apart within said bore, a coil spring in said bore, a first movable stop in said bore of smaller diameter than said bore and subject to pressure of said spring which is effective to move same into contact with one of said fixed stops, a second movable stop of smaller diameter than the opening through said one fixed stop and arranged to move therethrough from a position in contact with the other fixed stop to a position in contact with said first movable stop, means included in said fixed and movable stops cooperative upon interengagement to centralize said movable stops in said bore and to centralize said movable stops with each other upon interengagement, a sleeve slidably mounted in said first movable stop axially thereof and having an enlarged proportion arranged for contact with said first movable stop on the side adjacent said second movable stop, a spring interposed under pressure between said sleeve and second movable stop and effective to urge said second movable stop against said other fixed stop and to yield to allow movement of said sleeve in the opposite direction, said second movable stop and said fixed stops having axially aligned openings aligned with the opening in said sleeve, a rod of smaller diameter than said openings extending therethrough and having a connection with said member, and means connecting said rod to said second movable stop for rendering said springs effective to oppose movement of said member by force.

5. In combination, a movable member arranged to be subjected to an operating force for moving same, and a spring device associated with said member and cooperative therewith to define positions of said member corresponding to the degree of said force, said device comprising a casing, two fixed stops spaced apart in the said casing, a coil spring in said casing, a first movable stop in said casing subject to pressure of said spring which is effective to move same into contact with one of said fixed stops, a second movable stop in said casing movable axially through said one fixed stop from a position in said casing in contact with the other fixed stop to a position in contact with said first movable stop, a sleeve slidably mounted in said first movable stop axially thereof and having an enlarged portion arranged for contact therewith on the side adjacent said second movable stop, a spring interposed under pressure between said sleeve and said second mov-

able stop effective to urge said second movable stop against said second fixed stop and yieldable to allow movement of said sleeve inwardly of said first movable stop, said second movable stop and said first fixed stop having axially aligned openings aligned with the opening through said sleeve, a rod loosely extending through said openings and having a connection with said member, means connecting said rod to said second movable stop for rendering said springs effective to oppose movement of said member by force, said second fixed stop being adjustable in said casing for adjusting the distance between the two movable stops when in contact with the respective fixed stops, adjusting shims interposed between the enlarged portion of said sleeve and said first movable stop for adjusting the position of said sleeve therein, and other shims interposed between the last named spring and said second movable stop for adjusting the pressure of said last named spring.

6. In combination, a member having a neutral position and movable by force out of said neutral position in either one direction or the opposite direction, and a spring device for moving said member to said neutral position and for opposing movement thereof in either direction from neutral position comprising a casing, two ring-like fixed stops in said casing, a rod connected to said member and extending through said stops and capable of free movement in said stops radially thereof, two movable stops loosely encircling said rod and disposed between said fixed stops, each fixed stop and the adjacent movable stop having generally frusto-conical nose and recess portions for interengagement to centralize the movable stop with the respective fixed stop, said movable stops being capable of free movement radially of said fixed stops upon disengagement therefrom, spring means acting on said movable stops for urging same apart into contact with the respective fixed stops and for opposing movement of said movable stops out of contact with said fixed stops, and means connecting each movable stop to said rod for movement therewith in a direction to move the respective movable stop against the spring means and providing for side movement of said rod in and relative to the other movable stop.

7. A regulating device comprising a tubular casing, four ring-like fixed stops therein spaced from each other in coaxial relation, two oppositely arranged inner movable stops of smaller diameter than the bore of said casing disposed between the two intermediate fixed stops and arranged to engage the adjacent faces thereof, a coil spring under pressure interposed between and acting on said movable stops, an outer movable stop of a diameter less than the inside diameter of the two intermediate fixed stops interposed between each of the outer fixed stops and the adjacent inner movable stop and arranged to move between the respective outer fixed stop and the adjacent inner movable stop for engagement therewith, a coil spring under pressure interposed between each of the outer movable stops and the adjacent inner movable stop, all of said movable stops having a central opening, a rod of smaller diameter than said central openings extending through the movable stops, and means connecting said rod to opposite ends of the two outer movable stops.

8. A regulating device comprising a tubular casing, four ring-like fixed stops therein arranged in coaxial relation and spaced from each other,

two oppositely arranged inner movable stops of smaller diameter than the bore of said casing disposed between the two inner fixed stops and arranged to engage the adjacent faces thereof, a coil spring under pressure interposed between and acting on said movable stops, an outer movable stop of a diameter less than the inside diameter of the two intermediate fixed stops interposed between each of the outer fixed stops and the adjacent inner movable stop and arranged to move between the respective outer fixed stop and the adjacent inner movable stop for engagement therewith, a sleeve slidably mounted centrally in each of the inner movable stops, each of the two sleeves having on opposite ends a collar for limiting movement through the respective movable stop in the direction of each other to a position providing a chosen space between their adjacent ends with said inner movable stops in contact with the respective fixed stops, a coil spring under pressure interposed between and bearing against each of the outer movable stops and the adjacent collar, all of said movable stops having a central opening, a rod of smaller diameter than the central openings in said movable stops and extending therethrough, and means connecting said rod to opposite ends of the two outer movable stops.

9. A regulating device comprising a tubular casing, four ring-like fixed stops therein spaced from each other in coaxial relation, two oppositely arranged inner movable stops of smaller diameter than the bore of said casing disposed between the two intermediate fixed stops and arranged to engage the adjacent faces thereof, a coil spring under pressure interposed between and acting on said movable stops, an outer movable stop of a diameter less than the inside diameter of the two intermediate fixed stops interposed between each of the outer fixed stops and the adjacent inner movable stop and arranged to move between the respective outer fixed stop and the adjacent inner movable stop for engagement therewith, a coil spring under pressure interposed between each of the outer movable stops and the adjacent inner movable stop, all of said movable stops having a central opening, a rod of smaller diameter than said central opening extending through the movable stops, and means connecting said rod to opposite ends of the two outer movable stops, one of said fixed stops being fixed with respect to said casing, and all other fixed stops being removable from said casing and adjustable therein.

10. A regulating device comprising a tubular casing, four ring-like fixed stops therein spaced from each other in coaxial relation, two oppositely arranged inner movable stops of smaller diameter than the bore of said casing disposed between the two intermediate fixed stops and arranged to engage the adjacent faces thereof, a coil spring under pressure interposed between and acting on said movable stops, an outer movable stop of a diameter less than the inside diameter of the two intermediate fixed stops interposed between each of the outer fixed stops and the adjacent inner movable stop and arranged to move between the respective outer fixed stop and the adjacent inner movable stop for engagement therewith, a coil spring under pressure interposed between each of the outer movable stops and the adjacent inner movable stop, all of said movable stops having a central opening, a rod disposed in the openings in said movable stops loosely thereof radially of said openings, and

means secured to said rod engaging opposite ends of the two outer movable stops, the surfaces of said means and outer movable stops arranged for engagement being generally frusto-conical in form for centralizing said rod with said outer movable stops.

11. A regulating device comprising a tubular casing, four ring-like fixed stops therein spaced from each other in coaxial relation, two oppositely arranged inner movable stops of smaller diameter than the bore of said casing disposed between the two intermediate fixed stops and arranged to engage the adjacent faces thereof, a coil spring under pressure interposed between and acting on said movable stops, an outer movable stop of a diameter less than the inside diameter of the two intermediate fixed stops interposed between each of the outer fixed stops and the adjacent inner movable stop and arranged to

move between the respective outer fixed stop and the adjacent inner movable stop for engagement therewith, a coil spring under pressure interposed between each of the outer movable stops and the adjacent inner movable stop, all of said movable stops having a central opening, a rod disposed in the openings in said movable stops loosely radially of said openings, and means secured to said rod engaging the opposite ends of the two outer movable stops, the engaging portions of said fixed stops and movable stops being generally frusto-conical in form for centralizing said movable stops with said fixed stops, and the engaging surfaces of said means and said outer movable stops being also generally frusto-conical in form for centralizing said rod with said outer movable stops.

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