F. A. HOWARD.

CARBURETER VALVE.

APPLICATION FILED AUG. 9, 1915.

1,315,727. Patented Sept. 9, 1919.

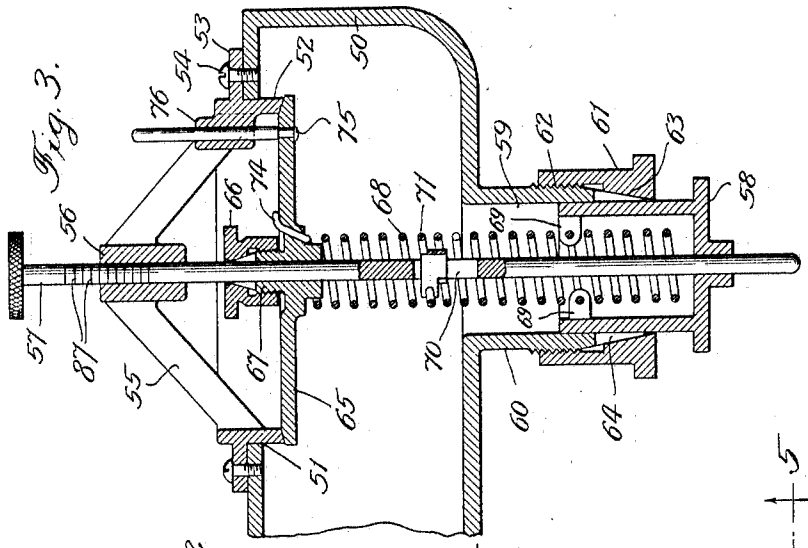


Fig. 3.

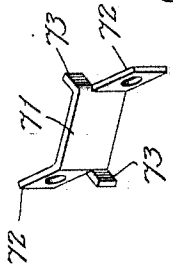


Fig. 4.

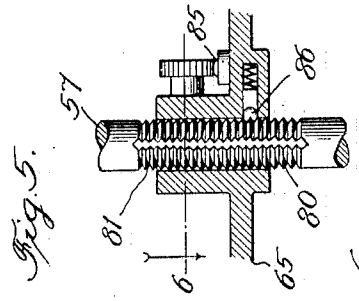


Fig. 5.

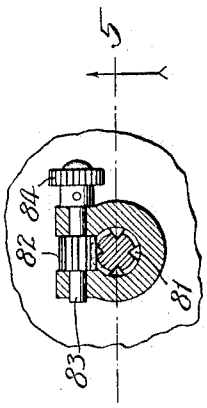


Fig. 6.

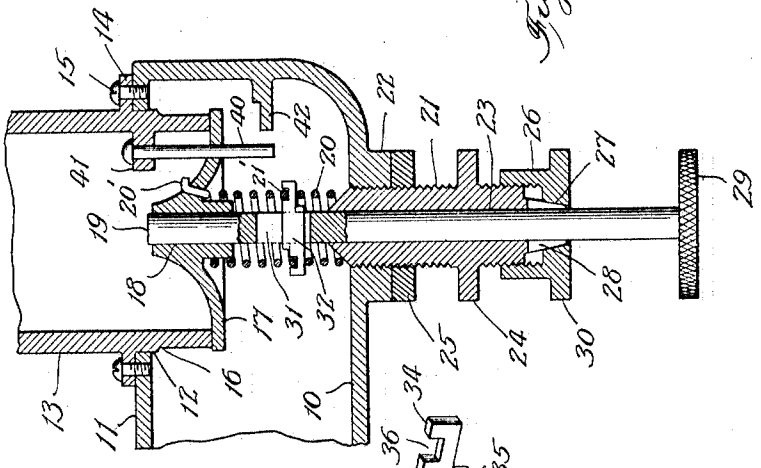


Fig. 1.

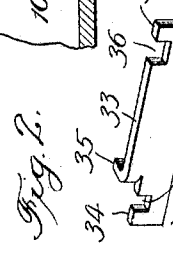


Fig. 2.

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UNITED STATES PATENT OFFICE.

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CARBURETER-VALVE.

1,315,727. Specification of Letters Patent. Patented Sept. 9, 1919.

Application filed August 9, 1915. Serial No. 44,565.

To all whom it may concern:

Be it known that I, FRANK A. HOWARD, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Carbureter-Valves, of which the following is a specification.

My invention relates to improvements in valve construction. More particularly the invention is concerned with a form of spring-loaded valve especially suitable for use in connection with carbureters for internal combustion engines. The object of the invention is to provide a simple means of adjustment whereby the amount of displacement or opening of the valve under different working conditions can be controlled with great nicety.

In order that my invention may be more readily understood I have illustrated in the accompanying drawings the construction of two common types of valves and the manner in which these valves may be made to embody my invention.

In these drawings—

Figure 1 is a vertical section of one form of valve incorporating the invention. Fig. 2 is a detail perspective view of the intermediate abutment shown in Fig. 1. Fig. 3 is a vertical section of another form of valve incorporating the invention. Fig. 4 is a detail perspective view of the intermediate abutment shown in Fig. 3. Fig. 5 is an enlarged detail section of the central portion of a valve of the type shown in Fig. 3, and illustrating another method of securing the valve to the valve stem, and Fig. 6 is a section on the line 6 of Fig. 5.

Referring more particularly to the drawings, the numeral 10 in Fig. 1 indicates a casting forming a portion of a chamber such as the air inlet chamber of a carbureter. In the upper wall 11 of the casting 10 is formed an opening 12 through which enters the tubular valve seat member 13, the latter having a flange 14 which rests upon the face of the upper wall 11 and is secured thereto to form an air-tight joint by screws 15. The entering end of the valve seat member 13 is shown as being slightly reduced at 16, in order that a valve 17, which is of substantially the same diameter as the opening 12, through which it is introduced, may overlap the valve seat formed by the lower end of the member 13. I have shown the valve 17 as of approximately conoidal form with its apex directed outwardly, as this form of valve offers less resistance to the incoming fluid. The central portion of the valve is bored axially to form a guide bearing 18, through which passes the valve stem 19. The valve is yieldingly held to its seat by a helical or coil spring 20 which bears at its lower end against the end of a threaded abutment 21 which passes through a threaded boss 22 formed on the casting 10. As shown the abutment 21 is in the form of a screw-plug having a longitudinal bore 23 through which the valve stem 19 passes, and provided with an integral collar 24, preferably knurled, for convenience of adjustment. The abutment may be securely locked in any desired position of adjustment by a suitable lock-nut 25. For securing the valve stem 19 within the bore of the abutment I provide the friction locking device shown which comprises an internally-threaded cap 26 formed with a conical central aperture 27 which engages the reduced conical end 28 of the abutment, the latter being slotted as by a plurality of saw-kerfs so as to form in effect a number of resilient fingers which may be pressed inwardly to grip the valve stem 19 by screwing down the cap 26. For convenience of adjustment both the valve stem and the cap may be provided with knurled heads, designated 29 and 30 respectively.

Intermediate the length of the valve stem 29 the latter is slotted axially, as shown at 31 in the drawing, and moving within this slot is the member 32 (shown in Fig. 2) which I call the intermediate abutment. According to the preferred method of construction this member is formed of a single strip of malleable sheet metal, the body portion of the strip designated 33 sliding within the slot in the valve stem, and the ends of the strip being split to form spring perches 34 and bent retaining lugs 35. The spring perches 34 are preferably notched in their upper edges to receive a coil of the spring as shown at 36. One of the retaining lugs 35 may be bent into position when the intermediate abutment is formed. The other lug will then be bent after the abutment has been put in place in the valve stem.

The operation of my improved valve is as follows: Assuming that there is a suction or reduced pressure within the chamber

10, as by the suction stroke of an internal combustion engine, the atmospheric pressure acting upon the upper face of the valve 17 will depress the latter, thereby compressing the spring 20, until a point of balance is reached, and the valve will remain stationary at this point so long as the suction remains constant, whereby a constant amount of air will be permitted to pass through the open valve and into the chamber 10. The volume of air thus admitted under any fixed condition of suction will obviously be dependent upon the opening or displacement of the valve 17, and this displacement under a given suction or load will in turn be dependent upon:

1. The "stiffness" of the spring 20, that is, the load required to compress the spring through a unit distance.

2. The initial tension on the spring 20, as applied by screwing up the abutment 21 after the valve 17 has reached its seat.

The "stiffness" of a helical spring of the form shown is dependent upon:

1. The quality and temper of the metal used.
2. Gage of the wire.
3. Diameter of coils.
4. Pitch of coils.
5. Number of coils.

Assuming that the spring 20 is of such "stiffness" that a load of one pound will compress it through a distance of one inch, then if the abutment 21 be screwed up one-half of an inch after the valve is seated, the spring will bear against the valve with a force of one-half pound. The valve will therefore be held to its seat until a load, as of unbalanced atmospheric pressure, equal to one-half pound is applied to its upper surface. If now the load be increased to one pound, the valve would move downwardly one-half inch, and similarly, if the load be further increased to one and one-half pounds the valve would open a distance of one inch; that is, for every pound or fraction of a pound increase of load, the spring would be compressed one inch, or the same fraction thereof. It should be particularly observed that this relation holds true regardless of the position of the adjusting abutment 21. Thus, if the abutment were screwed up three-fourths of an inch, then the valve would remain seated until the load was equal to three-fourths of a pound, but if the load were then increased by one pound, the valve would still open one inch. By the abutment 21 we are therefore able to control the load required to open the valve, but after the valve has started to open, further increments of load will always produce the same increments of displacement of the valve, regardless of the position of adjustment of this abutment. Stated in terms of graphical analysis, the slope of the load-displacement line is dependent only on the "stiffness" of the spring and is unaffected by the adjustment of the initial tension thereof.

In certain classes of service, notably in engine carbureters, a simple helical valve-spring, operating to open in proportion to the load throughout its travel is not satisfactory. Thus it may be that while it is desirable for the valve to open one-half inch under a one-pound suction, it would be fatal to the successful operation of the carbureter if the valve were to open a full inch under a pound and one-half suction load. It, therefore, becomes desirable to provide means whereby the relation of load to displacement may be varied during the travel of the valve, and with this in view various forms of spring arrangement have been proposed. The most common expedient has been the employment of an additional spring, normally out of contact with the valve but in position to be contacted or "picked up" after the valve has traveled some predetermined distance. The movement of the valve beyond such "pick-up" point is thereby resisted by two springs instead of one, and its increased opening under increased suction is proportionably reduced. It has further been common to provide in combination with such pick-up springs, means by which the point of "pick-up" of the valve could be adjusted, whereby the range of travel of the valve under the pressure of the initially acting spring could be varied at will.

By my invention it becomes possible to effect by the use of a single spring of the ordinary helical form the results mentioned above, and it is further possible to readily adjust not only the "pick-up" point of the valve's movement, but also the "stiffness" of the "pick-up" spring action, so as to control to the greatest nicety and by means of simple and accurate adjustments, the movements of the valve under increased loads. These results are accomplished in my construction by an intermediate abutment, selectively adjustable to engage any desired intermediate coil of the spring and operating by an adjustable lost-motion connection to become effective after any desired extent of displacement of the valve. In Fig. 1 of the drawings this intermediate abutment is shown at 32, and consists of the metal spring perch shown in detail in Fig. 2, and slidable in the slot 31 of the valve stem 19. It will be seen from Fig. 1 that as the valve 17 moves downwardly the coils of the spring 20 will be compressed, that is, each coil of the spring will move downwardly toward the abutment 21. This, the normal action of the spring, will continue until the intermediate abutment 32 reaches the bottom of the slot 31. At that moment the interme-

diate abutment will become an abutment in fact, serving as a stationary seat for the coil 21^1 of the spring 20 which lies above it. In the further downward movement of the valve only those coils of the spring lying above the coil 21^1 will be affected, the lower coils lying between the intermediate abutment 32 and the main abutment 21 being dead or inactive.

The result of this bottoming action of the intermediate abutment will be that the movement of the valve is divided into two periods, *i. e.*, a first period in which all of the coils of the spring 20 are active, and a second period in which only the upper coils of the spring lying above the intermediate abutment are active. At a certain point in the downward movement of the valve the "stiffness" of the spring is thereby altered in exactly the same manner as if the spring 20 had been replaced by a second and heavier spring.

It will further be seen that by loosening the clamping nut 30 and then sliding the valve-stem 19 vertically upwardly or downwardly, without rotating the same, the position of the slot 31 with relation to the abutment 32 may be changed so that the abutment will bottom at any desired point. Thus the valve-stem may be so adjusted that the abutment will bottom and render inactive the lower coils of the spring almost coincident with the initial movement of the valve 17, or the valve-stem may be adjusted downward so that the valve may open almost to its full limit of movement before the abutment 32 contacts with the bottom of the slot 31, or any intermediate position of the valve-stem may be made use of to correspondingly control the point at which the effective stiffness of the spring becomes altered. In addition to this adjustment I am able to effect by my construction a second important adjustment of the mechanism. Thus, if the clamping nut 30 be loosened and the valve-stem rotated without being moved vertically, the abutment 32 will be threaded through the coils of the spring 20, and by a proper adjustment of this description the abutment may be selectively engaged with any desired coil of the spring 20. Since the effective stiffness of the spring is dependent upon the number of coils in action, it will be seen that this last-named adjustment affords a means by which the stiffness of the "pick-up" action may be regulated. Thus, if the valve-stem 19 be rotated to the left or counter-clockwise, as viewed from the head 29, the abutment 32 will be threaded upwardly through the coils of the spring, so as to reduce the number of coils lying above it, and thereby correspondingly increase the effective stiffness of the spring after the abutment has bottomed in the opening movement of the valve. In a similar manner the valve-stem may be rotated in a clockwise direction from the position shown in the drawing to thread the abutment downwardly through the coils of the spring, increasing the number of effective coils lying above the abutment and correspondingly decreasing the effective stiffness of the spring after the abutment has "bottomed."

By the combination of the two adjustments of the valve-stem 19, *i. e.*, by its rotation and by its longitudinal movement, I am therefore able to adjust both the point of "pick-up" and the effective stiffness of the pick-up spring action. Defined in graphical terms these adjustments permit of varying both the location and the slope of the load displacement curve of the valve 17.

In order to maintain the adjustments effected in the manner I have described, it is necessary to prevent the spring 20 from turning relatively to the valve-stem 19, and as a means for accomplishing this I have shown the end 20^1 of the spring as laced through an aperture in the valve 17, and have in addition provided a pin 40 secured in a lug 41 and passing downwardly through an aperture in the valve 17 to secure the latter against rotation. In the form of the device shown in Fig. 1, I have further illustrated a positive stop 42 to limit the opening movement of the valve 17.

In Fig. 3 I have shown an embodiment of my invention in which the valve is secured to the valve-stem and the latter slides in suitable stationary guides. In this embodiment of the invention the numeral 50 designates the inlet casting, which is provided in its top surface with a valve aperture 51 through which is introduced a valve-cage consisting of an annular seat-member 52 carrying a flange 53, suitably secured, as by screws 54, to the casting 50 and having spider-arms 55 which support a guide-hub 56, within the bore of which slides the valve-stem 57. The lower end of the valve-stem is guided by a hollow abutment member 58 which is freely movable both longitudinally and rotatably within the bore 59 of a hollow boss 60 cast integrally with the member 50. To secure the abutment 58 in any desired position of adjustment, I have provided a clamp or gland-nut 61 threaded at 62 to the boss 60 and having a conical bore 63 which engages and is adapted to spring inwardly a series of spring fingers 64 formed upon the end of the boss 60. By this construction, which is similar to the clamping arrangement at the outer end of the abutment 21 in Fig. 1, I am able to release the hollow abutment 58, so that the same may be either rotated or moved longitudinally or both and can clamp this abutment in any desired position of adjustment. Intermediate the length of the valve-stem 57 there is secured thereto a valve 65,

the securing means consisting of a gland or clamp-nut 66 threaded upon a boss 67 formed integrally with the valve, these parts being identical in construction and operation with the gland-nut 61 and boss 60 employed to adjustably secure the abutment 58. The valve 65 is normally held to its seat against the lower edge of the annular seating 52 by a helical spring 68, which bears against the valve at the top and is held at the bottom by ears 69, of which two or three, or any desired number may be employed, secured within the bore of the hollow abutment 58, and perforated to permit the spring to be threaded through them as shown in the drawing. The valve-stem 57 is provided with a longitudinal slot 70 in which slides an intermediate abutment 71, shown in detail in Fig. 4 of the drawings, and consisting of a single strip of sheet-metal having its ends split to form perforated spring-receiving ears 72 and retaining lugs 73. In this construction of the apparatus also, the spring is preferably secured to the valve as by a bent extremity 74, and the valve is prevented from rotating with relation to the valve-seat member by a pin 75 projecting upwardly from the valve and sliding within the bore of a lug 76 formed on the valve-cage member. In the construction illustrated in Fig. 3 the abutment 58, which replaces the abutment 21 of Fig. 1, is capable not only of being moved vertically upward or downward, to change the initial tension of the spring 68, but may also be rotated, independently of such vertical movement, to cause the ears 69 to be threaded through the coils of the spring and selectively engage any desired coil, whereby the number of effective coils of the spring and therefore its "stiffness," as well as the initial tension of the spring may be adjusted. In this construction of the apparatus the action of the intermediate abutment 71, although the same in principle as that of the abutment 32 shown in Fig. 1, is specifically different. In Fig. 3 the valve-stem 57 and valve 65 are secured to move together as a unit in the operation of the valve. Assuming that by the action of an engine-piston, or through some other means a sub-atmospheric pressure is created within the casting 50, the valve 65 will be forced open, thereby compressing the coils of the spring 68. In this case it will be seen that since each of the coils of the spring 68 approaches the valve 65, the intermediate abutment 71, which is carried by an intermediate coil of the spring will, also, be caused to approach the valve 65 as the latter opens. When the abutment has moved upwardly with relation to the valve until it reaches the upper end of the slot 70, those coils lying above the abutment will become inactive and in any further movement of the valve 65 only the lower coils of the spring, *i. e.*, those coils lying between the abutment 71 and the abutment 58, will be further compressed. The action of the construction shown in Fig. 3 is, therefore, a simple reversal of the action of the form shown in Fig. 1. In the latter case the lower coils of the spring were thrown out of action when the intermediate abutment reached the limit of its travel, while in the former case the upper coils of the spring are similarly thrown out of action. The device shown in Fig. 3 is capable of the same adjustments as to the action of the intermediate abutment as is permissible in the structure shown in Fig. 1. By loosening the clamp or gland-nut 66, the valve-stem 57 may be rotated to cause the intermediate abutment 71 to be threaded through the spring and to selectively engage any coil thereof, and independently of this rotation the valve-stem may be moved longitudinally to adjust the position of the slot 70 and correspondingly limit the lost motion of the abutment. When the desired adjustments have been effected, the gland-nut 66 may be tightened to secure the valve-stem to the valve, and the adjustments are then maintained by the connections between the spring and the valve and between the latter and the cage.

The intermediate abutment, as employed in the construction shown in Fig. 3, is also capable of producing an adjustment of the spring not permitted by the construction of Fig. 1. Thus, if the valve-stem 57 be moved upwardly, while the valve is in its normal or seated position, until the abutment bottoms at the lower end of the slot 70, and then be drawn upward some further distance, thereby compressing between the valve and the abutment 71 the upper coils of the spring 68, I may obtain a species of reverse "pick-up" action. Assuming this adjustto have been effected, it will be seen that as the valve is opened only the lower coils of the spring will be compressed, the upper coils being confined in an inactive condition between the intermediate abutment and the valve. As the valve continues its downward movement the tension of the lower coils will approach and eventually become equal to the tension of the coils confined above the abutment, and at this point the whole of the spring will become effective, and for further movement of the valve the abutment 71 will merely slide freely upward within its slot 70. By the construction of Fig. 3 I am therefore able to adjust the spring so that its effective "stiffness" becomes less instead of greater after a certain predetermined movement of the valve. While this form of adjustment will probably not be required in connection with carbureters for internal combustion engines, it may be desired in pressure-relief valves and other arrangements, where it is desirable that slight increases in load, after the loaded

element has started to move, shall produce more than proportionate increases of movement.

In Figs. 5 and 6 of the drawings I have shown an alternative method by which the valve stem 57 may be adjustably connected with the valve 65. In this construction the intermediate portion of the valve-stem will be provided with a series of circumferential grooves 80, which may either be formed as distinct grooves or as screw-threads of any desired pitch, and this grooved portion of the valve-stem will be provided with a number of longitudinal serrations 81. To coöperate with this grooved and serrated valve-stem I will provide the valve 65 with a small pinion 82 mounted on a shaft 83 suitably journaled in the valve, and having a notched head 84 which will be frictionally held against rotation by a spring-pressed plunger 85 (Fig. 5) carried by the valve. The pinion 82 will mesh with the circumferential grooves of the valve-stem, so that by rotating the notched head 84 the valve-stem may be positively raised or lowered with relation to the valve and held in any adjusted position by the frictional lock 85. To coöperate with the longitudinal serrations 81 I provide a second frictional lock 86, which enters these serrations and retains the valve-stem in any position of angular adjustment in which it may be set. I have designed the longitudinal and angular adjustments of the valve-stem, with relation to the valve, to be substantially independent of one another; that is, by turning the notched head 84 the valve-stem may be raised or lowered without being rotated, while the rotation of the valve-stem may be carried out independently of any longitudinal movement of the stem. This latter result is possible only if the grooves 80 be in fact separate grooves instead of screw threads. If the latter construction is used, rotation of the valve-stem will, of course, move it longitudinally as well. If considered desirable, multiple screw-threads of a pitch approximating the pitch of the helical coils of the spring 68 might be employed, instead of independent circumferential grooves, and if this construction be used, rotation of the valve-stem would simultaneously advance it upward or downward in the valve, so that the abutment 71 would be threaded through the coils of the spring, and the valve-stem simultaneously shifted longitudinally to keep the slot 70 in approximately the same position with reference to the intermediate abutment.

It will be understood that, if desired, the form of spring-abutment used in Fig. 3, and illustrated at 58 therein, might also be used to replace the abutment 21 shown in Fig. 1, and thus provide means for adjusting both the initial tension and the initial stiffness of the spring 20 in the same manner as the spring 68 is adjusted. It will also be understood that the locking means shown to adjustably connect the valve 65 and valve-stem 57 in Figs. 5 and 6 might equally well be employed as a connection between the valve-stem 19 and abutment 21 in Fig. 1.

In order to provide a visible indication of the adjustment of the intermediate abutment, I may provide graduations on the externally-projecting portions of the valve-stem, so that the approximate position of the abutment can be ascertained by an inspection of such graduations.

I have illustrated, in Fig. 3, a series of graduations 87, marked upon the upper end of the valve-stem 57. It will be understood that the valve-stem 19 might be similarly marked, and that longitudinal graduations and radial graduations both may be employed to indicate both adjustments of the intermediate abutment.

According to the principles of my invention, as illustrated by the above described specific embodiments of the same, it is shown to be possible to provide such adjustments as to render a helical coil-spring capable of duplicating the functions hitherto obtainable only by the use of a plurality of springs, or by complicated linkage connections between the valve and its loading spring, or by the use of specially formed valves or valve-seats.

By the use of my invention, I may employ any simple form of valve and valve-seat, and may hold the valve to its seat by a simple helical coil-spring, and at the same time I am able to so vary the relation between the load on the valve and the displacement of the valve as to approximate closely enough, for almost all practical purposes, the functions desired of any automatic valve structure. In terms of graphical analysis, my valve and spring-controlling arrangement therefor gives a compound load-displacement curve made up of two straight lines, and by the adjustments provided these straight lines may be shifted both as to their origins, slopes, and points of intersection, so as to approximate with the greatest nicety the actual curve of load-displacement theoretically desirable for the valve.

The principal advantage claimed for the structure shown, however, is its capability of adjustment to meet the widest range of operating conditions. Thus, while for any particular service it might be cheaper and easier to design either a special spring or special valve, giving the desired load displacement curve, such special spring or valve would be incapable of modification to meet altered conditions of service. By the use of my invention, the desired load-displacement curve may be approximated closely enough for practical purposes, and any subsequent changes in operating conditions which call

for changes in the operation of the valve may be as readily and as accurately compensated for by a simple readjustment of the spring governing means.

While I have shown and described in considerable detail some specific embodiments of my invention, and in this description have considered my device mainly from the standpoint of its adaptability for service in gas-engine carbureters, it is to be understood that I do not regard my invention as limited to the specific constructions disclosed, nor to the use of the same in this particular art, but, on the contrary, I wish it to be understood that my invention is to be considered as limited only by the terms of the following claims, in which it is my intention to claim all novelty inherent in the invention as broadly as is permissible, in view of the prior art.

What I regard as new and desire to secure by Letters Patent, is:

1. In combination, a reciprocatable element, a helical spring resisting the movement of said element in one direction, an end abutment for said spring, and means to arrest the movement of an intermediate coil of said spring on a predetermined movement of the coil.

2. In combination, a reciprocatable element, a helical spring resisting the movement of said element in one direction, an end abutment for said spring, means adapted to arrest the movement of an intermediate coil of the said spring on a predetermined movement of the coil, and means for adjusting said arresting means to cause it to engage a predetermined coil of the spring.

3. In combination, a reciprocatable element, a helical spring opposing the movement thereof in one direction, an end abutting device for the said spring, an intermediate abutment engaging an intermediate coil of said spring, and a support for said abutting device having a lost motion connection therewith to permit limited movement thereof.

4. In combination, a reciprocatable element, a helical spring opposing the movement thereof in one direction, means for adjusting the initial tension of said spring by initially compressing the coils thereof, and means for adjusting the initial stiffness of said spring by initially adjusting the effective length thereof.

5. In combination, a reciprocable element, a helical spring arresting the movement thereof in one direction, an abutment for the fixed end of the said spring, said abutment having its spring engaging member arranged to thread upon the spring, and supporting means for said abutment permitting independent longitudinal and angular movements thereof, whereby the said abutment may be adjusted to engage a predetermined coil of the spring and to initially compress the said spring.

6. In combination, a reciprocable element, a helical spring opposing the movement thereof in one direction, a supporting stem extending axially through the said spring, and an abutting device carried by said stem and having a lost motion connection therewith and engaging an intermediate coil of spring.

7. The combination with a reciprocatable valve of a loading means therefor comprising a helical spring bearing against the said valve at one end and against a relatively stationary abutment at the other end, means for changing the initial tension of said spring and for changing the initial stiffness of said spring, and means arranged to arrest the movement of an intermediate coil of the spring upon a predetermined displacement of the said valve.

8. The combination with a reciprocatable valve of a loading means therefor comprising a helical spring bearing against the said valve at one end and against a relatively stationary abutment at the other end, means for changing the initial tension of said spring, and for changing the initial stiffness of said spring, an intermediate abutment member engaging an intermediate coil of the said spring, an adjustable lost-motion connection supporting said intermediate abutment, and means for adjusting said intermediate abutment to selectively engage any intermediate coil of the said spring.

FRANK A. HOWARD.

In presence of—
O. C. AVISUS,
D. C. THORSEN.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."