

Nov. 7, 1933.

H. C. KELLOGG

1,934,548

PRESSURE RESPONSIVE DEVICE

Filed Dec. 24, 1928

2 Sheets-Sheet 1

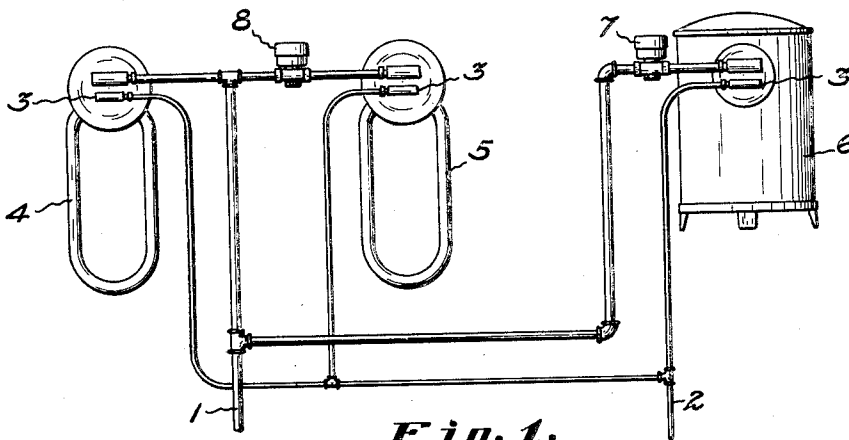


*Fig. 1.*

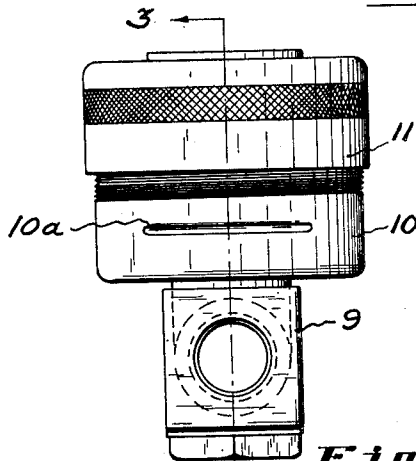


*Fig. 2.*

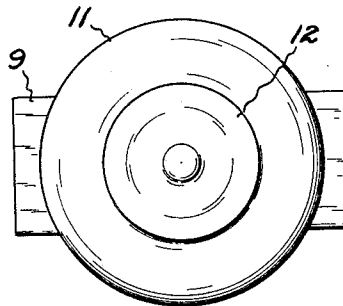


*Fig. 4.*

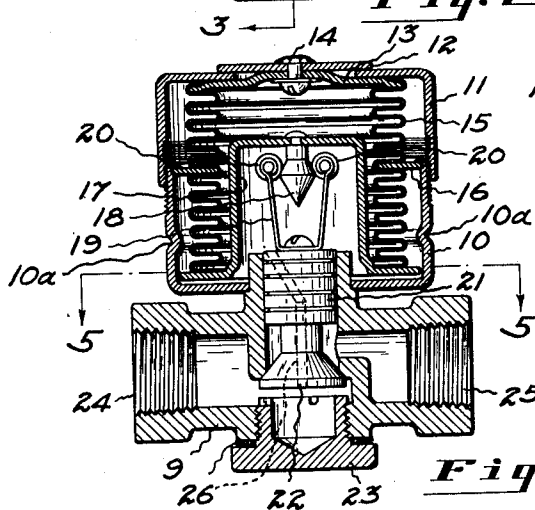


*Fig. 3.*

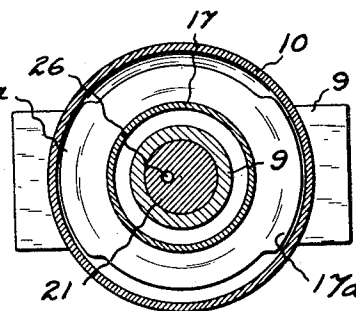


*Fig. 5.*

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2 Sheets-Sheet 2

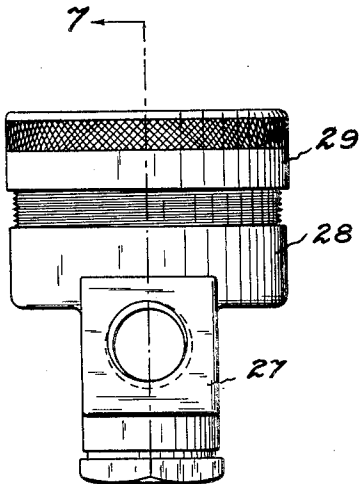


**Fig. 6.**

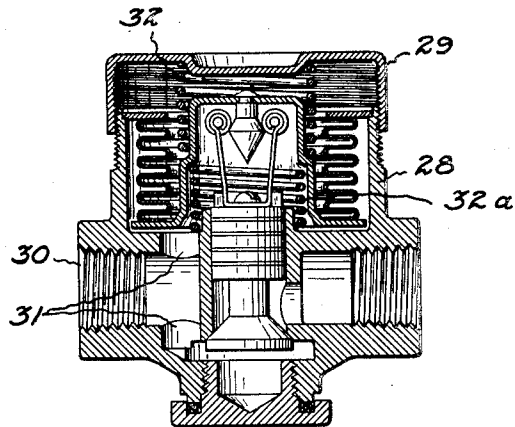


**Fig. 7.**

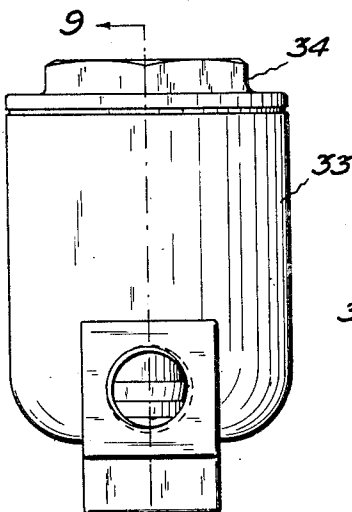


**Fig. 8.**

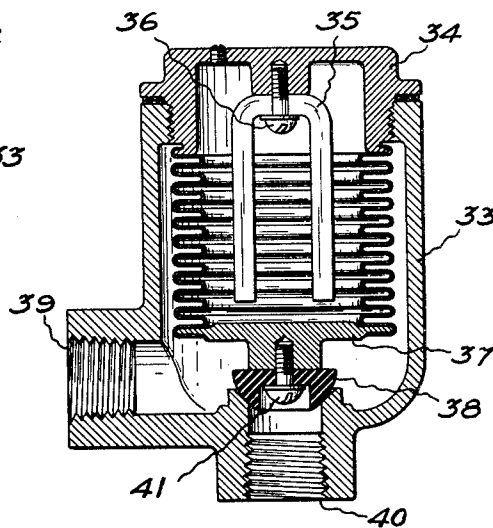


**Fig. 9.**

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## UNITED STATES PATENT OFFICE

1,934,548

## PRESSURE RESPONSIVE DEVICE

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Application December 24, 1928  
Serial No. 328,268

11 Claims. (Cl. 50—14)

This invention relates to pressure responsive devices and in particular to devices embodying an expansible chamber that is adapted to respond to fluid pressures for the actuation of mechanism operatively associated therewith.

It is often necessary or desirable, in the class of devices to which this invention relates, to have means for readily varying the operating characteristics of the device. In general, this result has been accomplished by the introduction of auxiliary mechanism, such as an adjustable spring positioned exteriorly of the expansion member of the device to oppose its movement.

One of the objects of this invention is to provide a pressure responsive device that may be readily adjusted to operate over various pressure ranges and under predetermined operating conditions.

Another object of this invention is to provide an improved form of responsive device in which the gradual movement of an expansible-contractible element is transformed into a snap-action movement.

Another object of this invention is to provide a device of the class described, that can be easily and inexpensively manufactured and assembled, that has a minimum number of parts which are relatively rugged and do not require complicated machining operations in their manufacture.

A further object of this invention is to provide a device of the type described in which a single expansible-contractible element serves as an operating means and as an adjustment means for the mechanism with which it is associated.

Stated in general terms, my invention primarily consists in the use of a pressure responsive expansible-contractible element rigidly supported at a point intermediate its ends, so that one end of the element can be used to manually adjust the resistance offered by the other end of the element to the fluid pressures to which it is subjected.

The advantages of my improved device primarily reside in the simplified construction and resultant reduction in cost which are effected by the use of a single element to accomplish two separate and independent objects, namely; the manual adjustment, and the pressure responsive operation, both of the above objects being provided for by a single expansible-contractible element.

Referring to the drawings:

Figure 1 represents a typical set-up of three refrigeration evaporators controlled by my improved pressure-responsive device;

Fig. 2 is a side elevational view of the control valve used on the evaporators shown in Fig. 1;

Fig. 3 is a section taken on line 3—3 of Fig. 2;

Fig. 4 is a plan elevational view of the valve shown in Fig. 2;

Fig. 5 is a section taken on line 5—5 of Fig. 3;

Fig. 6 is a side elevational view of a modified form of valve;

Fig. 7 is a section taken on line 7—7 of Fig. 6;

Fig. 8 is a side elevational view of another modified form of valve structure; and

Fig. 9 is a section taken on line 9—9 of Fig. 8.

As an exemplification and an illustration of one of the practical uses to which my invention may be put, I have shown it embodied in a control valve for refrigerators of the flooded system type, using a multiplicity of evaporators connected to a single pump and adapted to maintain different predetermined temperatures under control of my improved valve.

In any refrigerating machine operating on the compression system there are four distinct steps in the cycle of the refrigerant: Compression, condensation, reduction of pressure, and evaporation. In refrigerators operating on the flooded system the four steps in the cycle of the refrigerant are: First—Heat-laden gas, which is at a low pressure and temperature level, is pumped from the top of the float valve housing of the freezing coil unit by the compressor and compressed to a high pressure and hence high temperature level; Second—The high pressure, high temperature gas which the compressor delivers to the condenser gives up its heat to the surrounding air and condenses to a liquid, which is still under high pressure; Third—The high pressure liquid is carried to the float valve, which admits the liquid to the freezing or evaporating coils, filling them completely. This reduces the pressure of the liquid to a low pressure and hence low temperature level; and Fourth—The low pressure, low temperature liquid, as it receives heat in the freezing coil, evaporates to a low pressure gas. As the gas forms in the freezing coils it rises through the liquid and collects in the top of the valve housing.

In the diagrammatical illustration Fig. 1 of such a refrigerating system the numeral 1 indicates the suction line to the conventional compressor. The compressor is in turn connected to a series of cooling coils into which the gas is pumped and condensed by the increase in pressure and the loss of heat in the condenser. From the condenser coils the liquid refrigerant is

usually led to a liquid reservoir which, in turn, communicates with the liquid line 2 of Fig. 1.

The high pressure liquid in the line 2 is led to three similar float valves, indicated by the numerals 3 located at the inlet side of the evaporating coils 4 and 5 and a similar coil that is positioned in the tank 6. Control valves 7 and 8 are located in the suction line 1 at a point close to the evaporator 5 and to the evaporator that is located in the tank 6. The purpose of the valves 7 and 8 is to maintain predetermined temperatures in the coils to which they are connected. The manner in which this is accomplished will be described in detail presently.

The compressor, cooling or condensing coils, liquid reservoir, and automatic mechanism governing the operation of the compressor may be of any suitable type. These elements are not illustrated because they do not form a part of this invention and their presence is not necessary for its understanding.

Referring to Figs. 2, 3, 4 and 5, which illustrate the structural details of the control valve, the numeral 9 indicates a valve body the upper portion of which is adapted to support a cup-shaped housing 10 that is externally threaded for engagement with an adjusting cap 11. The housing 10 and cap 11 provide a housing for an expansible-contractible element or bellows 15. The upper end of the bellows is sealed by a disc 13 to which a second disc 12 is secured in any conventional manner, such as by a bolt and nut 14. The open top of adjusting cap 11 is rotatably mounted between the discs 12 and 13. The upper portion of the housing 10 is provided with an annulus 16 to which the bellows 15 is secured by soldering or any other suitable method, so that the lower portion of the bellows is sealed off from its upper portion.

The lower end of the bellows is sealed off by a cup-shaped member 17 which extends for a considerable distance within the bellows 15. The cup-shaped member 17 is movable within the housing 10, its upward motion being limited by the two extended portions 17a engaging inwardly extending ribs 10a formed in opposite sides of the housing 10. The parts 10a and 17a are each less than 90 degrees extent so that the parts 17a may pass between the projections 10a in assembling the device. A conical shaped cam 18 is secured in the central upper portion of the member 17. This cam cooperates with a pair of rollers 20 that are journaled in suitable pins carried in the ends of the U-shaped spring 19. The spring 19 is secured to the cylindrical valve-head guide 21, which is integrally formed with the valve-head 22. A closure cap 23 is provided for the valve body to permit the ready assembly of the valve structure.

The valve body 9 is provided with an inlet opening 24 and an outlet opening 25. The valve head and valve seat are of such size as to provide an opening equivalent to the size of the conduit 1. A passage 26 is formed in the valve-head 22 and its guide 21, to permit fluid pressure at the inlet side of the valve to act upon the lower sealed off portion of the bellows 15. It will be observed that variations in the fluid pressure acting upon the lower end of the bellows 15 will cause it to expand or contract, in accordance with the opposing pressure within the bellows 15. The fluid pressure within the bellows 15 may be manually adjusted by raising or lowering the adjusting cap 11.

Where relatively high pressures are desired

within the bellows it may be partially filled with relatively inert incompressible liquid, such as oil, so that the amount of gas or vapor compressed is quite small—which would require a much higher pressure at the under side of the bellows to move it a given distance.

The motion of the lower end of the bellows is transmitted to the snap-action mechanism, causing the valve-head 22 to move to a fully opened or fully closed position as the high part of the cam 18 passes the plane of the axes of the spring-held rollers 20 in moving upwardly or downwardly respectively.

Referring to the modified form of valve shown in Figs. 6 and 7, the numeral 27 refers to the valve body, in which the upper portion 28 is formed from the same casting. The valve is identical in its operation with the valve just described. In lieu of the fluid pressures maintained within the bellows a compression spring 32 is provided, the tension of which may be varied by means of the adjusting cap 29. An additional spring 32a, preferably of somewhat lighter weight than the spring 32, is used to obtain better regulation of the device and to prevent sucking in of the member 17 when used on sub-atmospheric pressures. By lowering or raising the cap 29 the internal pressure and the tension in the springs 32 and 32a and, consequently, the force exerted against the free end of the bellows is increased or decreased. In order to permit fluid pressures to act upon the lower end of the bellows the valve body 28 is provided with passages 31 which admit fluid pressure to the valve-head and to the bellows.

In Figs. 8 and 9 is shown a modified form of valve structure consisting of an elbow valve 33 formed from a single casting having an inlet 39 and an outlet 40. A bellows is carried within the upper portion of this casting by means of the cap 34. The cap 34 provides a mounting for a permanent magnet 35 which is suitably secured thereto by means of a screw 36. The lower end of the bellows is sealed by means of a disc-shaped member 37 which is made of a magnetic material such as iron and which serves as an armature for the permanent magnet 35. A valve-head 38 of bakelite or any other suitable material is secured to the armature 37 by means of a screw 41.

In this form of valve, when the pressure at the inlet side of the valve reaches a predetermined amount, the valve is lifted from its seat and the armature brought within the influence of the magnet 35, which draws it against the ends of the magnet and holds it there until the pressure within the valve is sufficiently reduced to cause the fluid pressure within the bellows to separate the magnet from its armature. The operating characteristics of the valves shown may be varied by partially filling their expansible-contractible elements with a suitable liquid or a fluid under different degrees of pressure.

When used in connection with a refrigeration system of the type shown the purpose of any of these valves is to control the temperature of individual evaporators by means of the pressure in the evaporator to which the valve is connected as, where it is desired to use several evaporators under different temperatures, or on one evaporator where it is desired to prevent the temperature from going below a given point.

The valve is so designed as to take advantage of the increased suction pressure on any of the evaporators operating under high temperatures. This is accomplished by a quick-opening and a quick-closing action of the valve, so that when

gas is being removed from an evaporator the valve controlling the temperature or pressure is wide open. This action results in increased pressure to the compressor with an increase in the capacity.

Valves heretofore were designed as pressure reducing valves and consequently did not increase the suction line pressure to the compressor when gas was being taken from the evaporator. A snap-action on the valve is also desirable as such an action assists in keeping the valve clear of foreign material which might become lodged between the valve and seat, causing it to leak.

The valve in this design is balanced to prevent a change in maintained pressures, with widely varying control settings.

The valve is designed to have a set differential suitable for any given type of application, but this differential may be raised or lowered by simply turning the knurled cap 11 of the valve. It will be noted that the valves shown in Figs. 3 and 9 are not balanced in their action by springs, but rather by sealing off of the bellows and holding it immovable in the center, thus allowing the inner end to move with varying pressures and the outer end to be moved manually. A movement of the outer end changes the pressure within the flexible member, thereby varying the pressure necessary to the movement of the free end or creating a range at which the free end will move. This type of valve can be manufactured with any desired differential.

The valve proper is designed so that it may be readily removed or resealed. With its removal all working parts which it may be desirable to replace are removable. The valve is exceedingly simple in construction, compact in size, and easily adjusted.

For matter of explanation we will assume that the valve is used in connection with a soda fountain where an evaporator such as 4 is adapted to be maintained at ice cream temperatures of approximately 0° C.; for the purpose of cooling soda water or other beverages the type of cooler such as indicated by numeral 6 is used. The evaporator 5 is intended to be kept at some temperature intermediate that of the tank 6 and of the evaporator 4. It is desired to hold the temperature of the cooler 6 at approximately 40° or within the range of pressures of from 8 to 14 pounds. As the pressure builds up in evaporation of the cooler 6 the pressure is raised in the chamber surrounding the bellows of the valve 7 until the lower end of the member is raised, causing the snap-action mechanism to lift the valve proper from its seat.

In the case of the valve shown in Figs. 8 and 9, opening of the valve instantly increased the pressure on the lower end of the bellows by an amount proportional to the increased area of the seat of the valve. This brings the armature 37 carried by the lower end of the siphon within the magnetic field of the permanent magnet 35 and the valve is held in an open position. Gas is now taken directly from the evaporator through the valve without restriction until the pressure is lowered to 5 pounds, at which point the difference in pressure inside and outside of the bellows forces the free end of the bellows away from the permanent magnet 35 and out of the magnetic field, allowing the valve to instantly close. The temperature of the evaporator 5 may be controlled in a similar manner by means of the valve 8.

In such a set-up the control of the compres-

sor is taken from the suction line near the compressor or from the 0° C. evaporator. If either or both of the control valves are opened, due to an increase in temperature or pressure, the suction line pressure will be immediately increased, which will cut in the control and continue to hold it until the control valve closes. The compressor will continue to operate until the 0° C. evaporator has reached its lower limit of setting, at which point the compressor will be automatically stopped by means of a pressure control switch (not shown).

This quick-opening and quick-closing action on the part of the temperature control valve will materially increase the capacity of the compressor employed, particularly where a quite high percentage of the total load must be handled by the higher temperatures evaporators.

It is apparent from the description that the valve mechanism could be readily replaced by an electric switch where it is desired to control the flow of electric current by means of pressure variations or that the valve could be used to advantage in connection with apparatus other than refrigerators.

Furthermore, it is to be understood that the particular forms of apparatus shown and described, and the particular procedure set forth, are presented for purposes of explanation and illustration and that various modifications of said apparatus and procedure can be made without departing from my invention as defined in the appended claims.

What I claim is:

1. A valve comprising, a valve body having inlet and outlet openings and a valve port therebetween, a valve head cooperating with said valve port to control fluid flow therethrough, a guide member integrally formed with said valve head and having a passageway extending from the lower face of the valve head to the top of the valve guide, a U-shaped spring carried by said valve guide, rollers rotatably carried in the ends of said spring, a conical cam adapted to be engaged by said rollers and a pressure responsive mounting for said cam whereby upon a predetermined movement of said cam said spring causes said valve head to move to a fully opened or fully closed position.

2. In a device of the character described, a casing having a pressure chamber, a tubular bellows mounted in said casing and having a head movable in response to variations of pressure in said chamber, an axially disposed cam carried by said head, said cam having an enlarged portion intermediate its ends and oppositely tapering portions inwardly and outwardly of the enlarged portion, a valve axially aligned with said head, and resiliently supported rollers carried by said valve and pressing against opposite sides of said cam.

3. In a pressure responsive valve mechanism, a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, a valve seat in said chamber coaxial therewith and interposed between said passages, a valve reciprocally mounted in said valve chamber for cooperation with said valve seat, a tubular bellows mounted within said pressure chamber and having a head movable in response to variations of pressure in said pressure chamber, said pressure chamber being in open communication with said inlet passage at all times, and cooperative means on said valve and head for increasing the speed

of movement of the valve relative to said head during a portion of its movement to cause said valve to open and close rapidly with a snap action.

4. In a pressure responsive valve mechanism, 5  
a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, a valve seat in said chamber coaxial therewith and interposed between said passages, a valve 10  
reciprocably mounted in said valve chamber for cooperation with said valve seat, a tubular bellows mounted within said pressure chamber and having a head movable in response to variations of pressure in said pressure chamber, said pressure 15  
chamber being in open communication with said inlet passage at all times, and cooperative means on said valve and head for increasing the speed of movement of the valve relative to said head during a portion of its movement to cause said 20  
valve to open and close rapidly with a snap action, said means comprising a cam secured to said head and having oppositely disposed tapered surfaces, and cam contacting means mounted on said valve for yieldable engagement with said 25  
cam.

5. In a pressure responsive valve mechanism, a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, 30  
a valve seat in said chamber coaxial therewith and interposed between said passages, a valve reciprocably mounted in said valve chamber for cooperation with said valve seat, a tubular bellows mounted within said pressure chamber and having 35  
a head movable in response to variations of pressure in said pressure chamber, said pressure chamber being in open communication with said inlet passage at all times, cooperative means on said valve and head for increasing the speed of 40  
movement of the valve relative to said head during a portion of its movement to cause said valve to open and close rapidly with a snap action, and means for changing the degree of resistance of said head of said bellows to movement.

6. In a pressure responsive valve mechanism, a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, a valve seat in said chamber coaxial therewith and 50  
interposed between said passages, a valve reciprocably mounted in said valve chamber for cooperation with said valve seat, a tubular bellows mounted within said pressure chamber and having a head movable in response to variations 55  
of pressure in said pressure chamber, said pressure chamber being in open communication with said inlet passage at all times, cooperative means on said valve and head for increasing the speed of movement of the valve relative to said head 60  
during a portion of its movement to cause said valve to open and close rapidly with a snap action, said means comprising a cam secured to said head and having oppositely disposed tapered surfaces, cam contacting means mounted on said 65  
valve for yieldable engagement with said cam, and means for changing the degree of resistance of said head of said bellows to movement.

7. In a pressure responsive valve mechanism, a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, a valve seat in said chamber coaxial therewith and interposed between said passages, a valve reciprocably mounted in said valve chamber for 75  
cooperation with said valve seat, a tubular bellows

mounted within said pressure chamber and having a head movable in response to variations of pressure in said pressure chamber, said pressure chamber being in open communication with said inlet passage at all times, cooperative means on 80  
said valve and head for increasing the speed of movement of the valve relative to said head during a portion of its movement to cause said valve to open and close rapidly with a snap action and means for changing the degree of resistance 85  
of said head of said bellows to movement, said last mentioned means consisting of a portion of said casing comprising the pressure chamber being threadably rotatable on the remainder thereof to increase or decrease the resistance of said 90  
bellows to contraction.

8. In a pressure responsive valve mechanism, a casing having axially aligned valve and pressure chambers, inlet and outlet passages in said casing communicating with said valve chamber, a valve seat in said chamber coaxial therewith and interposed between said passages, a bellows supported in said pressure chamber and having a portion movable in response to variations in pressure of said chamber, a valve actuated by 100  
the movable portion of said bellows, said valve having an opening therein for placing said inlet passage in communication with said pressure chamber, and means independent of the fluid pressure in said inlet passage and said pressure 105  
chamber for increasing the speed of movement of the valve during a portion of its movement to cause said valve to open and close with a snap action.

9. In a pressure responsive valve mechanism, 110  
a casing having a pressure chamber and a valve chamber, each coaxial with the other, inlet and outlet passages in said casing communicating with said valve chambers, a valve seat in said valve chamber coaxial therewith and interposed 115  
between said passages, a pressure responsive actuating element having a portion movable in response to variations of the pressure in said chamber a valve member in said valve chamber actuated by said pressure responsive 120  
actuating element for opening and closing the port formed by said valve seat, said valve member having a passageway therein placing said inlet passage in communication with said pressure chamber, and means for independently and 125  
automatically accelerating the speed of movement of said valve member during a portion of the movement of the said actuating element.

10. A valve comprising a casing, a partition in said casing, a valve seat in the casing, an outlet 130  
port between said seat and said partition, a bellows attached to one side of said partition and having a fluid-tight head, an inlet port in open communication with the exterior of said bellows, a valve structure including a piston rigid therewith and serving to seal said outlet port from said 135  
bellows, a second bellows attached to the other side of said partition and an opening through said partition providing unrestricted and free communication between the interiors of said 140  
bellows, a fluid-tight head for said second bellows, means carried by the head of said bellows for operating said valve structure, and means for manually adjusting the head of said second bellows toward and away from the head of the first 145  
mentioned bellows.

11. A valve comprising a casing, a valve seat in said casing, a bellows disposed within the casing and having one end making fluid-tight connection with the side walls of said casing and hav- 150

ing a fluid-tight head on its free end, a valve seat in said casing, an outlet port between said seat and the connection of the casing side walls with the bellows, an inlet port in open communication with the exterior of said bellows, a valve head actuated by said bellows to and from said valve seat, packing means interposed between said valve head and said outlet port for substantially sealing said outlet port from said bellows, a second bellows having one end making fluid-tight connection with the side walls of said casing and having a fluid-tight head on its free end, said bellows being in free and open internal communication with each other and mutually forming a sealed chamber, and means for manually adjusting the head of the second bellows toward and away from the head of the first mentioned bellows.

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