C. A. DAWLEY.

VALVE.

APPLICATION FILED MAY 21, 1907.

939,987.

Patented Nov. 16, 1909.

2 SHEETS—SHEET 1.

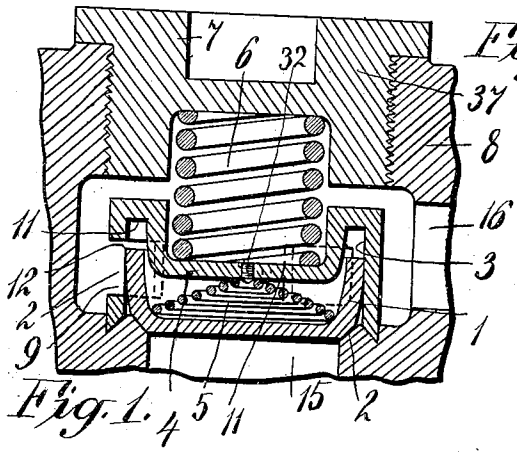


Fig. 1.

Fig. 4.

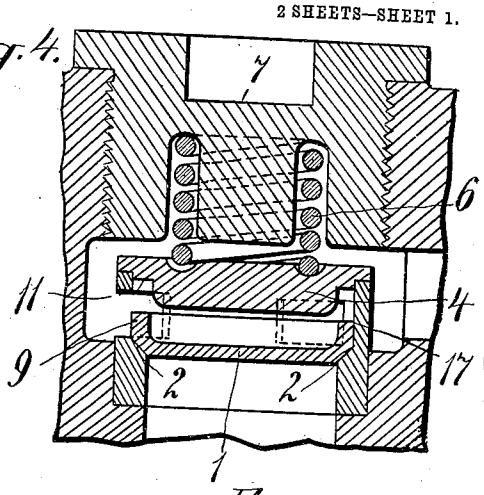


Fig. 2.

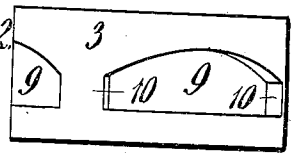


Fig. 5.

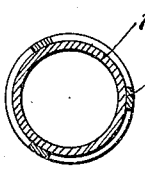


Fig. 8.

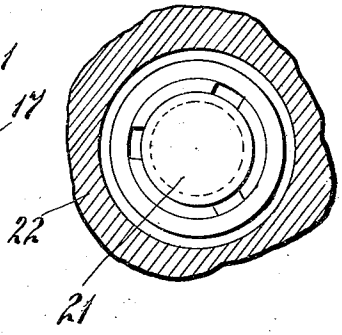


Fig. 3.

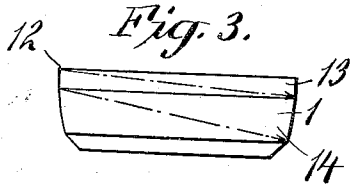


Fig. 6.

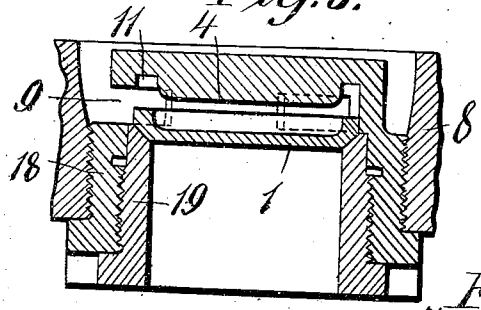


Fig. 7.

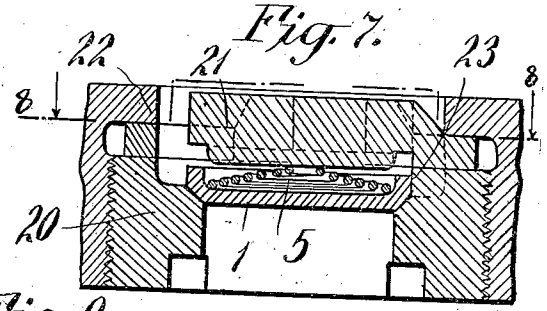
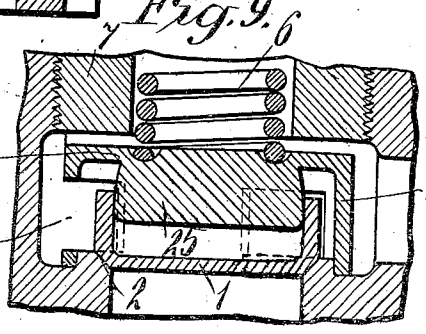


Fig. 9.



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2 SHEETS—SHEET 2.

Fig. 10.

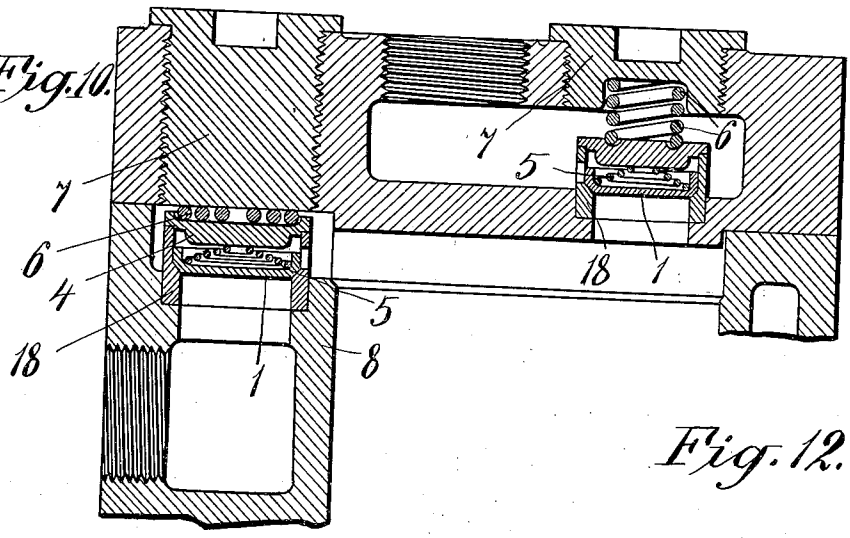


Fig. 12.

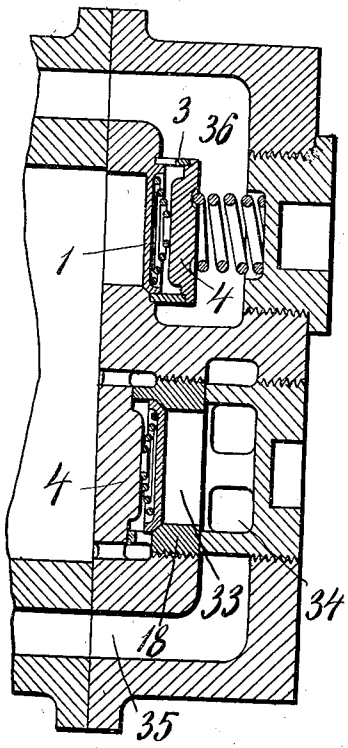
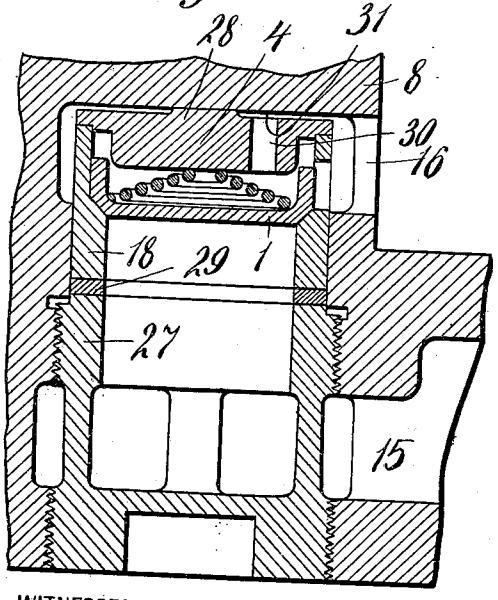


Fig. 11.



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VALVE.

939,987. Specification of Letters Patent. Patented Nov. 16, 1909.

Application filed May 21, 1907. Serial No. 374,836.

To all whom it may concern:

Be it known that I, CLARENCE A. DAWLEY, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Valves; and I do hereby declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in automatic puppet valves, and particularly to valves for high speed compressors; and my invention consists in the novel valve structure taken as a whole, in the novel construction of the valves themselves, in the means for guiding, cushioning and limiting the motion of said valves, in the means for holding the valve stop in place, and in various other features as herein described and pointed out in the appended claims.

It is highly important that the valves of compressors, and particularly of high speed compressors, shall be extremely rapid and positive in action, shall give free opening for the passage of air or other fluid, shall be tight when closed, shall make reduction of clearance space to very low limits possible, and shall not bind or "cock" so as to fail to operate. It is further exceedingly desirable that said valves shall produce little or no noise in operation, shall not pound on their seats or on the stops which limit their travel in the opening motion, shall not "flutter", shall open and close once only during each period of admission or discharge, shall be guided close to their seats, shall be accessible without removing cylinder heads, and that the inlet and discharge valves shall be interchangeable. In the valve structures herein described the above objects and desirable qualities are substantially attained. The valves are very light, are cushioned in their opening stroke to reduce pounding against stops and to add to the rapidity of closing, have no guides, stems, springs, or webs obstructing the narrowest portions of the passages, are self-centering and so not dependent on perfect work for alinement of the valve with its seat; the stops are held in place by elastic pressure means and so held seated independent of the seating of their corresponding valve caps are not liable to be distorted by their retaining means, and are capable, in an extreme case, of yielding somewhat; and the construction of the parts is such that in case a valve spring breaks, the broken pieces cannot find their way into the compressor cylinder. Owing to the extreme lightness of the valves, the shortness of their travel, and their efficient cushioning on the opening stroke, they cannot pound excessively either against seat or stop, and the life of the valves and seats is thereby greatly prolonged.

Various other features of advantage embodied in the valve structures illustrated will be pointed out hereinafter.

In the accompanying drawings, which illustrate certain selected forms only of numerous possible embodiments of my invention, Figure 1 shows an axial section of a valve structure adapted to serve either for the inlet valve or discharge valve of a high-speed compressor; Fig. 2 shows a detail elevation of the valve guide and stop thereof, and Fig. 3 a detail elevation of the valve itself. Fig. 4 is a view similar to Fig. 1 but illustrates an alternative structure in which the valve guide is structurally separate from the valve stop though held in place by the latter; and Fig. 5 shows a transverse section through said valve guide and the rim of the valve. Fig. 6 shows an axial section of a "parallel flow" valve structure, the direction of flow of the entering and departing streams being the same, the construction of the valve structure being in other respects much the same as in Fig. 1; Fig. 7 is a view similar to Fig. 6 showing a structure in which the guide and seat are in one piece, and the stop is a separate piece let into a counterbore in the cylinder head or wall, and held in place by the seat itself; Fig. 8 shows a transverse section through Fig. 7; and Fig. 9 shows an axial section of a valve structure like those of Figs. 1 and 6 except that the valve is inside-guided. Fig. 10 shows a vertical axial section of a portion of a compressor cylinder, the section being taken through the axes of inlet and outlet valves, shown as being both of substantially the same construction, one located in the wall of the cylinder, the other in the cylinder head. Fig. 11 shows a valve structure such as above described set radially in a cylinder head. Fig. 12 shows an axial section through a cylinder head provided with equivalent valve structures, one for inlet the other for discharge.

Referring first to Figs. 1, 2 and 3, 1 desig-

nates the valve proper, 2 the valve seat, 3 the guide for the valve, 4 the valve stop (in this case integral with the valve guide) 5 a light valve spring which is here shown used to supplement the action of the air cushion, hereinafter mentioned, for closing the valve, but the use of which is in many cases entirely optional, 6 is a spring which holds the valve stop in place, distributing the pressure by which it is held and so preventing distortion of the stop and permitting it to be made thin, and at the same time permitting the stop to yield slightly and relieve the shock of impact if the valve 1 should come into actual contact with said stop. 7 is the cap closing the opening in the engine cylinder or other similar part, 8, in which the valve and stop are inserted, 9 are openings in the sides of the guide 3, and 10 are the ribs of metal between which are the openings 9 and which form the real guides for the valve. The annular space 11 in the combined valve guide and stop, and the interior of the cup valve 1 constitute cushioning spaces which cushion the ascent or opening stroke of the valve. The upper edge 12 of said valve 1 in its lowermost or seated position, is slightly below the extreme upper edges of ports 9 so that the cushioning action does not begin until after the valve has started to open; the valve being thereby permitted to open freely before being checked by the air cushion in annular space 11 and in the interior of the valve.

As shown particularly in Fig. 3, only a very small portion 13 of the valve actually bears upon the guide ribs 10; the intermediate portion 14 of the valve being relieved so as not to bear upon the guides at all. Preferably, and as shown, this intermediate portion 14 of the valve is spherical, having a radius not greater than the distance from any point on the upper edge 12 of the valve to a diametrically opposite point on the lower edge of the cylindrical part 13 of the valve. This construction makes "cocking" of the valve, that is to say, jamming of the valve in an oblique position, substantially impossible, for the portion 13, while wide enough to guide the valve properly, is too narrow to permit cocking, and all dimensions of the valve falling outside portion 13 are no greater than those falling within portion 13. This valve is adapted for use interchangeably as an inlet valve or as a discharge valve. If opening 15 of the valve chamber be connected to the cylinder and opening 16 of such chamber be connected to the discharge of such cylinder, then the valve will serve as a discharge valve; but if opening 16 be connected to the cylinder and opening 15 be connected to the outside air or to other source of supply, another cylinder for example, then the valve will serve as an inlet valve. It will be observed that the valve itself is very light and therefore that it will open and close quickly and with very little pounding. The combined stop and guide may also be very light since, owing to efficient cushioning it has very little work to perform, and since it is held down by the distributed elastic pressure of the spring 6 and so is not subject to distortion. If for any reason the valve should strike the stop violently or should be forced against it, said stop can yield slightly, the spring 6 permitting this. It will be observed that since the valve spring 5 is within the cup-shaped recess of said valves, and since the stop spring 6 is partly within the cup-shaped recess of said stop and partly within the recess of the valve cap 7, if either of these springs should be broken it is impossible for broken parts to find their way into the cylinder. Neither can the valve itself be displaced and find its way into the cylinder, since it is inclosed by the stop. Owing to the shape of the valve, the proximity of its guide to its seat, the great relative diameter of the guiding portion and the ease with which the valve seat and the counterbore for the valve guide may be machined at one setting, accurate alinements of the valve and its seat are easily obtained.

Heretofore most of the cup valves used in air compressors have been inside guided; that is, the guide engages the inner surface of the cup valve, said valve working on the outer side of the guide; and the cushioning of the valve has been in the space inclosed by the inner surface of the valve. In the structure above described, however, the valve is outside guided, its outer surface working against the inner surface of the guide; and not only the interior of the valve cup, but also the annular space 11, constitutes cushioning space. By these constructions I obtain a greater diameter of guiding surface, which reduces greatly the possibility of binding or of imperfect seating, and I also obtain increased cushioning effect.

I have found that to obtain effective cushioning of a rapidly moving valve such as valve 3 is intended to be, it is essential that the distance between the bottom of the cup of the valve and the end of the stop projection 4 shall not be greater than half the internal diameter of the cup, and preferably shall be less than half such diameter. I have also found it important that the ports 9 in the guide 3 shall be open at the top when the valve is seated, so that effective cushioning shall not begin until after the valve has opened somewhat; otherwise the valve may be sluggish in opening.

In practice the straight or guide surface 13 of the valve should be from one quarter to one eighth of the diameter of the valve, or even less. In the construction shown in Fig. 1, which is intended for a vertically

mounted valve, the length of the guiding surface is much less than one quarter the diameter of the valve. Access to all the parts of the valve structure may be gained by unscrewing the valve cap 7.

The valve structure shown in Fig. 4 is similar to that shown in Fig. 1 except that the valve guide, here numbered 17, is separate from the valve stop 4 and is formed integrally with the valve seat 2; said combined valve guide and seat being held in place by the stop 4 and its spring 6. This is an obvious equivalent of the construction shown in Fig. 1. The valve 1 here shown is also considerably shorter than that shown in Fig. 1, obviating the necessity of relieving a portion of the surface of the valve, as shown at 14, Fig. 3.

Figs. 6, 7 and 8 illustrate valve structures of the "parallel flow" type, the direction of flow of the gas after leaving the valve being the same as its direction of flow toward the valve. The structure of Fig. 6 is in general the same as that of Fig. 1, except that the combined valve stop and guide, here numbered 18, is arranged to screw into a corresponding opening in the wall or other suitable part 8 of the cylinder or other member to which the valve structure is to be applied, the valve seat, here numbered 19, also screwing into said combined valve stop and guide 18. In this construction I have shown no spring 5 for the valve, the use of such a spring being optional as above explained; and the valve 11 shown is so short that there is no need of rounding it off to prevent sticking in the guide. In the similar construction shown in Figs. 7 and 8, there is a combined valve seat and guide 20, screwing into the wall or like part of the cylinder or other member to which the valve structure is to be applied, the valve stop, here numbered 21, being separate from the valve guide, but being held in place against a shoulder 22 of said cylinder or like part, by the combined valve seat and guide 20. Such valve seat and guide is provided with guide ribs 23. In this construction as shown, the valve is not cushioned, except by spring 5.

In the construction shown in Fig. 9, the combined valve stop and guide comprises a member 24 having a central part 25 which forms both the guide for the valve and the stop for the valve, the valve in this construction, unlike the other construction previously described, having a bearing on the outside of a guide. The outer part 26 of the member 24 is altogether clear of the valve.

Fig. 10 illustrates the use of a single compressor cylinder of like valve structures for admission and discharge valves, the figure showing a section of one end of a cylinder through said inlet and discharge valves, both valves being substantially like that shown in Fig. 4 except that they are provided with light closing springs 5.

It will be observed that all of the various valve structures of this case comprise the same elements, namely, a valve proper, a seat therefor, a guide therefor, a stop therefor, and a cap; and they may or may not, as preferred or as conditions dictate, comprise a valve spring and a spring holding the guide and seat in position. The valve cap is not to be regarded as an essential element of these structures but rather as one which is convenient, since by its removal it makes access to the parts of the valve structure very easy. The various valve structures shown, although comprising substantially the same elements, differ in form, construction and arrangement of parts mainly to adapt the valve structure to different locations or conditions of use. The structures shown in Figs. 1, 4 and 7 are particularly adapted for cases where the valve is located in the cylinder head or in the side wall of the cylinder, with axes parallel to the axis of the cylinder, as indicated in Fig. 10 and in Fig. 12, hereinafter described. The structures shown in Figs. 6, 7, 8 and 11 are particularly suitable where the valve is to be arranged radially. Fig. 11 in fact shows a valve structure arranged radially in a cylinder head 8, the combined valve seat and guide 19 being in this case forced up against the stop 4 by a ported hollow screw bushing 27. The stop 4 in this construction is provided with a lug 28 bearing against the end of the bore in the cylinder head in which the valve structure is mounted. There is a ring of packing material 29 between the combined valve seat and guide 18 and the screw bushing 27.

It is frequently desirable to have only a slight regulated cushioning of the opening of the valve. In such case I may provide a relief port 30 (Fig. 11) connecting the cushioning space within the cup of the valve with the discharge port of the valve. In the structure shown in Fig. 11 this port 30 passes through the valve stop 4 to a space 31 between said stop and the end of the bore in the cylinder head in which the valve structure is located. The lug 28 above mentioned, keeping communication between this space 31 and the annular space surrounding the valve guide 18 and communicating with the valve port 16. In the structure shown in Fig. 1 I have also indicated a similar cushion relief port 30 but have shown the same closed by a screw plug 32; the intention being that when little cushioning effect is desired, this plug shall be removed; but when full cushioning effect is desired the plug shall be replaced. The degree of cushioning will ordinarily be regulated in advance by regulating the size of the cushioning relief port if such port be provided.

Fig. 12 shows a structure where both the admission valve and the discharge valve of a compressor are located in a cylinder head, the inlet valve structure 33 being similar to that of Fig. 7, except that the valve stop 4 is here integral with the cylinder head, and except that the combined valve seat and guide 18 has side ports 34 communicating with the admission port 35 of the cylinder. The discharge valve structure 36 is in general the same as that of Fig. 4, except that the valve seat is integral with the cylinder head, the valve guide 3 being, in this case, separate from the valve stop 4 but being set into a slight counterbore in the cylinder head adjacent to the valve seat.

The counterbores in which the valve guides are shown seated in Figs. 1, 7 and 12, are easily turned out at the time of fixing the valve seat, and without any resetting of the piece in the boring mill or other machine tool, and thus it is easy to insure absolute concentricity of the valve seat and of the valve guide, which in turn substantially insures accurate setting of the valve itself. It is common to hold valve stops in place by means of a set screw or like part; and I do not restrict myself from the use of such holding means; but I prefer a spring such as 6, for holding the valve stop and guide in place because, such spring being used, the cap 7 may be screwed down until its external flange 37 seats upon the end of the cylinder or cylinder head or other part in which such cap screws, the valve stop and guide being held seated by the elastic pressure produced by the screwing in of such cap; whereas; if the cap itself were to hold the valve stop and guide seated and at the same time were to be screwed down until its flange 37 came to a bearing on the cylinder head or like part, extreme nicety of fitting would be necessary. A separate set screw in the cap 37 to hold the valve stop and guide in place, although practicable, is not desirable; the spring 6 being much preferable. Such a set screw is apt to work loose, and is apt to cause distortion of the valve seat and guide, unless the latter be made very strong. With the construction shown, the valve stop and guide may be very light and yet the pressure is distributed to it so uniformly and yieldingly by the spring 6, that distortion of such valve stop and guide is impossible. Moreover, this spring permits the valve stop and guide to yield under extraordinary circumstances—for example, in case some part of the valve structure breaks and gets into such a position as to require yielding of such valve stop and guide.

What I claim is:—

1. A valve structure comprising in combination a valve chamber and seat, a valve, a combined valve guide and stop on the opening side of the valve seat engaging the valve on its outer side, and seated in a seat surrounding the valve seat, and a spring holding said guide and stop in place.

2. A valve structure comprising in combination a valve chamber and seat, a cup valve, and a combined valve guide and stop on the opening side of the valve seat engaging the valve on its outer side and seated in a seat surrounding the valve seat, and having an annular recess adapted to receive the edge of said cup valve.

3. A valve structure comprising in combination a valve chamber and seat, a cup valve, a valve guide engaging the outer edge of said cup, and seated in a seat surrounding the valve seat, and a valve stop projecting into said cup, there being between said guide and stop, a recess adapted to receive the edge of said valve cup.

4. A valve structure comprising in combination a valve chamber and seat, a cup valve, an outside guide for the valve, and means projecting into the cup of said valve when the latter is open and occupying the greater part of the cross-section of the cup space and serving, with the valve, to inclose in said cup space an air chamber of minimal dimensions adapted for efficent cushioning.

5. A valve structure comprising in combination a valve chamber and seat, a cup valve, and means for guiding the valve, said valve structure comprising an annular cushioning recess which the edge of the valve enters.

6. A valve structure comprising in combination a valve chamber and seat, a cup valve, a guide engaging the outside of said valve, and cushioning means comprising an annular cushioning recess which the edge of the valve enters.

7. A valve structure comprising in combination a valve chamber and seat, a ported guide bushing, a cup valve therein, and cushioning means comprising an annular cushioning recess which the edge of the valve enters.

8. A valve structure comprising in combination a valve chamber and seat, a ported guide bushing, a cup valve therein, and cushioning means comprising an annular cushioning recess which the edge of the valve enters, the edge of the valve being below the top of the guide port in the closed position of said valve.

9. A valve structure comprising in combination a valve chamber and seat, a cup valve, a guide therefor engaging the exterior surface of said valve, and means projecting into said cup serving to restrict the space therein for cushioning purposes, there being between said projecting means and said guide an annular cushioning space adapted to receive the edge of said valve.

10. A valve structure comprising in combination a valve chamber and seat, a cup valve, a guide therefor engaging the exterior

surface of said valve and having a port the upper end of which is uncovered when the valve is seated, and means projecting into said cup and serving to restrict the space therein for cushioning purposes, there being between said projecting means and said guide an annular cushioning space adapted to receive the edge of said valve.

11. A valve structure comprising in combination a valve chamber and seat, a cup valve, and a combined valve stop and guide seated in a seat provided therefor outside of said valve seat but adjacent thereto and centered with respect thereto, said stop and guide comprising a sleeve surrounding said valve and having a port open at the upper end when the valve is seated and a projection fitting within said cup.

12. A valve structure comprising in combination a valve chamber and seat, a valve guide, and a cup valve having a narrow guiding zone, the remainder of the valve of less diameter so that the valve has no greater width than that of the guiding zone, said valve adapted to override the upper edge of said guide port when it opens, there being between said valve and guide an air space of minimal dimensions adapted for efficient cushioning, the closing of the guide port by said valve against escape from this cushioning space being gradual owing to the tapering of the upper edge of said port.

13. A valve structure comprising in combination a valve chamber and seat, a sleeve constituting a valve guide and a cup valve within said sleeve having a narrow guiding zone, the remainder of the valve of a less diameter so that the valve has no greater width than that of the guiding zone, there being between said valve and guide an air space of minimal dimensions adapted for efficient cushioning, escape from said space being through the said guide port closed by the valve when the latter opens.

14. A valve structure comprising in combination a valve chamber and seat and a ported guide surrounding said seat, and closed at the top, the upper edge of the guide port tapering, and a valve within said guide, the upper edge of said valve when seated being below the top of the guide port, the space between the top of said guide and said valve serving, upon closure of the port of said guide at the top, as a cushioning space.

15. A valve structure comprising in combination a valve chamber and seat and a guide surrounding said seat, and closed at the top, and a valve within said guide having an edge adapted to override a port of said guide, such port being open when the valve is seated and closed when the valve is open, the space between the top of said guide and said valve serving, upon closure of the port of said guide at the top, as a cushioning space.

16. A valve structure comprising in combination a valve chamber and seat, a valve, and a cup-shaped valve stop and a spring holding the same in place and seated in said cup.

17. A valve structure comprising in combination a valve chamber and seat, a cup valve, and a combined valve stop and guide comprising a sleeve surrounding said valve and a projection seated within said cup.

In testimony whereof, I affix my signature, in the presence of two witnesses.

CLARENCE A. DAWLEY.

Witnesses:

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H. M. MARBLE.