

Nov. 24, 1942.

I. H. RUSSELL

2,303,175

THROTTLING DEVICE

Filed Jan. 24, 1940

Fig. 3

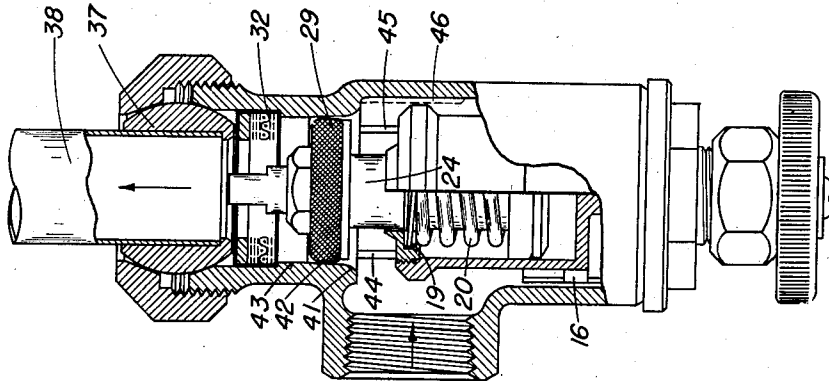


Fig. 2

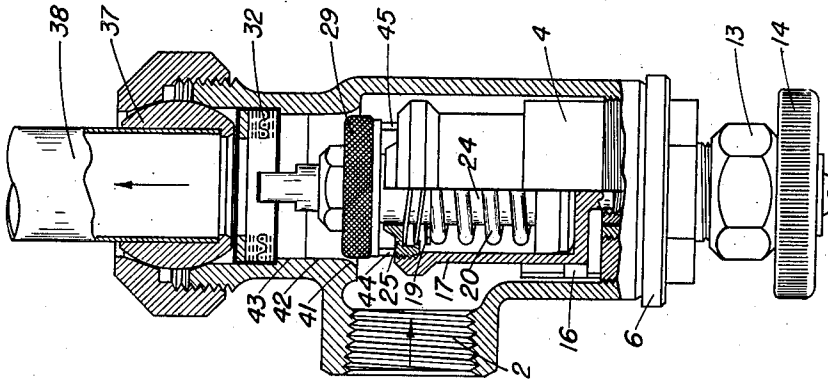
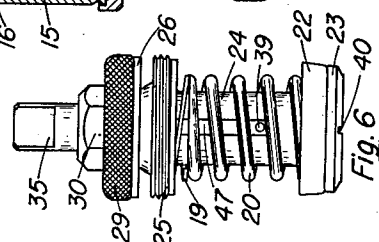
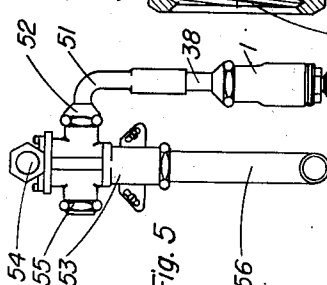
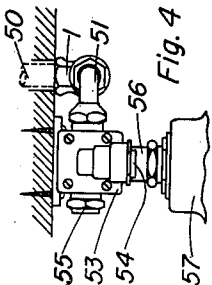
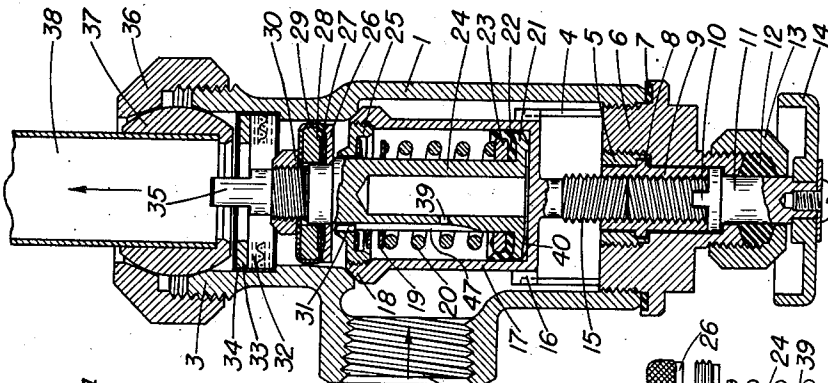


Fig. 1



INVENTOR
IRVING H. RUSSELL
BY *Parker & Carter*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,303,175

THROTTLING DEVICE

Irving H. Russell, Oak Park, Ill., assignor to Sloan Valve Company, Chicago, Ill., a corporation of Illinois

Application January 24, 1940, Serial No. 315,440

8 Claims. (Cl. 137—69)

This invention relates to throttling devices generally, but is concerned more particularly with throttling devices arranged to be self-adjusting to maintain a substantially uniform rate of discharge flow therethrough in spite of wide variations in supply pressure.

The general object of the invention is to provide a new and improved self-regulating throttling device which can be simply produced and which accomplishes its purpose in a satisfactory and reliable manner.

A specific object is the production of a self-adjusting throttling device of the above character which is compactly arranged and is combined with a valve for shutting off the supply when desired.

A further object of the invention is to provide for regulating the self-adjusting throttling device as regards the rate of flow for which it adjusts itself, whereby such variations as are likely to result in manufacture are compensated for.

It is a further specific object of the invention to so combine the self-adjusting throttle portion of the structure with the shut-off valve portion of the structure that the essential parts of the self-adjusting throttle portion may be removed from the discharge side of the structure, for inspection, repair, or replacement, with the valve portion in closed position, whereby such inspection, repair, or replacement as is likely to be required may be accomplished while the supply pressure is on.

GENERAL DESCRIPTION

It has been chosen to illustrate the invention as applied to a combined self-adjusting throttle and shut-off valve associated with a flush valve used for flushing water closets and other plumbing fixtures. In this embodiment of the invention, the valve structure and the self-adjusting throttle structure are both enclosed in a casing which has a side inlet, and has an outlet at one end thereof, with a bonnet structure secured in the opposite end of the casing.

For the purpose of compactness, the shut-off valve takes the form of a cup having its open end toward the discharge end of the casing, and having the controlling parts for the self-adjusting throttle device contained within this cup. The end of this cup cooperates with a valve seat surrounding the discharge port to act as a shut-off valve when desired.

The self-adjusting throttle device takes the form of a throttle member normally located at the entrance to the discharge port, extending through the discharge end of the casing, and secured on the supporting stem of a spring-restored piston operating within the said cup.

The spring-controlled piston assembly on which the throttle proper is carried is held in place by a retaining gland threaded into the open end of

the valve cup and keyed to the piston assembly so that it can be unthreaded by turning the piston assembly. This gland, the throttle proper, and the other parts associated therewith are sufficiently small that they can all be removed through the discharge port for inspection or repair when the gland is unscrewed from its normal location within the valve cup.

Since the self-adjusting throttle device, within its operating range, maintains the discharge rate therethrough substantially uniform independent of variations of supply pressure, any change of supply pressure within the operating range of the device results in a corresponding change in the pressure drop occasioned by the throttling action. This principle is availed of in securing the desired self-adjustment. The travelling throttle assembly is exposed on the discharge side thereof to a back pressure which is substantially uniform when there is a uniform rate of discharge through the throttle device, while the supply side of this travelling assembly is exposed to the variable supply pressure. A compression spring which opposes the movement of the travelling throttle assembly in the direction of flow is compressed more or less, according as the supply pressure is higher or lower than a given supply pressure.

A feature of the invention is that the discharge throat is provided with a tapered portion which narrows downstreamward toward a straight portion, and the parts are arranged so that the throttle proper operates within this tapered portion over a large part of the pressure range of the device, whereby the discharge area between the throttle piece and the tapered side walls of the throat decreases as the travelling assembly is driven farther downstreamward by the higher supply pressures. Thus, as the assembly moves further responsive to higher pressures, the effective discharge area is progressively decreased in just the measure required to maintain the rate of discharge substantially uniform for all such higher pressures.

A further feature of the invention is that the required range of movement of the travelling assembly is reduced by providing a more abruptly tapered portion for the throat near the entrance thereof, and by providing a second and weaker restoring spring for controlling the travelling assembly in its movements responsive to pressures near the lower limit.

A special feature of the self-adjusting throttle device is that it is so arranged that the flow of liquid therethrough is accomplished in substantial silence, even when the supply pressure is high.

The drawing

Referring now to the accompanying drawing, comprising Figures 1 to 6, they show sufficient

views of the structure embodying the invention to enable the invention to be understood.

Figure 1 is a vertical section of a combined shut-off valve and self-adjusting throttle embodying the invention, the parts being illustrated in the position they occupy when the shut-off-valve portion is closed;

Figure 2 is a similar view, partly in section, showing the parts in the position they occupy when the valve portion is opened to a working position, but when no flow is taking place;

Figure 3 is a view similar to Figure 2, but showing the throttle portion in the self-adjusted position which it occupies when a full throttled flow is occurring from a supply of medium pressure;

Figure 4 is a top view of an installation which includes the device of Figures 1 to 3, a flush valve, and a water closet or other plumbing fixture;

Figure 5 is a front view of the installation shown in Figure 4; and

Figure 6 is a separate view of the self-adjusting throttle assembly of Figures 1 to 3 shown removed from the general structure and rotated ninety degrees about its longitudinal axis from the position which it occupies in Figures 1 to 3.

DETAILED DESCRIPTION

The invention having been described generally, a detailed description of the disclosure will now be given.

The installation, Figures 4 and 5

Referring now particularly to Figures 4 and 5, an installation utilizing the improved device of Figures 1 to 3 is illustrated at 1 therein. Figures 4 and 5 illustrate a flush-valve installation for flushing a water closet or other receptacle, the rearmost portion of which is indicated at 57 in Figure 4. The supply pipe or nipple 50 is shown as coming through a wall to which the flush valve 53 is attached. The valve and throttle device 1 has its inlet threaded onto the end of the supply nipple 50, while its outlet is connected by means of the telescoping supply tubes 38 and 51 to the inlet 52 of the flush valve 53. The outlet of the flush valve 53 is connected through the flush tube 56 to the inlet portion of the water closet or other receptacle 57. The flush valve illustrated is of the push-button type, having the push button 54, an actuation of which causes the flush valve to be opened hydraulically and to reclose slowly to secure the discharge of a predetermined quantity of flushing water. This flush valve has duplicate inlets, the right-hand one being in use in the illustrated installation, while the unused left-hand inlet is closed by the inlet cap 55.

In the illustrated installation, the portion 57 of the plumbing fixture to be flushed is assumed to be the rear or inlet portion of a water closet which is flushed properly when the rate of flow of the water supplied thereto through the flush valve is about twelve gallons a minute. The combined shut-off valve and self-adjusting throttle device shown at 1 in Figures 4 and 5, and illustrated in Figures 1 to 3, is designed so as to perform automatically the degree of throttling necessary to permit a rate of flow of about twelve gallons a minute through the flush valve and into the water closet 57 when the pressure of the water received through the supply nipple 50 is from about five pounds to the square inch to, say, one hundred pounds to the square inch. The well understood advantage of such an arrangement is that it insures that the rate of delivery of water

through the flush valve to the water closet is at or very near the preferred rate of flow (about twelve gallons a minute in the assumed installation) under a wide range of conditions of installation and operation. For example, the supply pressure available in the street main may vary from, say, twenty pounds to one hundred pounds to the square inch. An amount of this supply pressure may be lost in the supply pipe between the street main and the inlet of the self-adjusting throttle device, which amount may vary between almost no loss (with a comparatively short run of large piping and no demand thereon elsewhere at the time flushing is being accomplished), and a large amount of loss (when water is being drawn through other outlets supplied by the same supply connection, particularly when the run of supply piping between the illustrated installation and the street main is long and more or less restricted).

The new and improved self-adjusting throttle device disclosed herein maintains the desired discharge rate therethrough and through the flush valve 53 and into the water closet 57 under the above conditions of variation, as will be explained hereinafter.

The improved construction, Figures 1 to 3

Referring now particularly to Figure 1, wherein the improved shut-off valve and self-adjusting throttle device is shown in shut-off position, the construction of this device will be pointed out. The device is housed in the casing 1, which has the female-threaded inlet 2 and the male-threaded outlet 3. The outlet 3 is arranged to cooperate with the coupling nut 36 to serve as the socket portion of the ball-joint union, including the ball portion 37 affixed to the tube 38, through which water passing the device is supplied to the flush valve 53 of Figures 4 and 5.

The cup-shaped control valve 17 is mounted within the casing 1, and is provided with an annular beveled seat 18, which is shown seated around the outlet port in Figure 1.

The bonnet 6 is threaded into the end of the casing opposite the outlet 3, the connection being made water-tight by the sealing gasket 7. To enable the device to be adjusted, the adjusting stem 11 is mounted in the bonnet 6 and it extends to the outside of the device, and is provided with the wheel handle 14, by means of which the stem 11 may be turned as desired. Packing member 12 is held in place by packing gland 13 to prevent leakage around the stem 11. The inside end of the stem 11 is shouldered as illustrated to retain the stem 11 in place against outward force.

The hollow stem 9 is mounted for rotation in the bonnet 6 in alignment with the control stem 11, and is held in place by retaining gland 8, in cooperation with the annular shoulder 8 on the hollow stem 9. A transverse key 10, formed on the inner end of control stem 11, fits within a cooperating notch or keyway in the outer end of hollow stem 9 to force the stems 11 and 9 to rotate together.

The inside of the hollow stem 9 is threaded to receive the outside-threaded stem 15 formed integrally with the cup-shaped shut-off valve 17.

Valve 17 is provided with a pair of oppositely disposed lugs 16, through which rotation of valve 17 and the stem 15 are prevented. The lugs 16 operate in a pair of longitudinal slots in the skirt portion 4, formed integrally with the bonnet 6, such skirt portion 4 being divided into two halves by the longitudinal slots in which the lugs 16

operate. With the valve 17 and stem 15 thus prevented from rotating with the stems 9 and 11, rotation of the stems 9 and 11, resulting from the turning of handle 14, results in the valve 17 being raised and lowered as desired.

Valve 17 is centrally guided at its stem end by the bearing contact of threaded stem 15 with the female-threaded stem 9, and is guided near the opposite end by four guide ribs formed in the body. Two of these guide ribs, 44 and 45, may be seen in Figures 2 and 3, but they are hidden from view by the valve 17, in closed position, in Figure 1. The dotted line 46 in Figure 3 exemplifies the profile of one of these guide ribs.

The self-adjusting throttle portion of the device constitutes a travelling assembly which includes the central stem or piston member 24, located principally within the cup formed within valve 17, but having a forward portion which extends into the discharge port. The stem or piston 24 is provided with a head 21 only slightly smaller in diameter than the cup or cylinder inside the valve 17. The packing cup 22 is held between piston head 21 and the loosely fitting washer 23 by spring tension. The serially related coiled springs 19 and 20 exert pressure against washer 23, thereby holding packing 22 in place. At the other end, the serially related springs 19 and 20 bear against the retaining gland 25 which is threaded into the cup 17. The reduced stem portion 24 of the piston passes through the central opening in gland 25, a clearance of a few thousandths of an inch being provided to insure freedom of movement and to permit interchange of water through this clearance space.

The gland 25 is provided with an inwardly projecting key 31 which fits within the longitudinal keyway 47 provided in stem portion 24. The piston 24 is thus prevented from turning with respect to gland 25, whereby the gland may be screwed into place and unscrewed by a turning of the piston or stem 24. Such turning is facilitated by the flattened end portion 35 of the stem.

The stem portion 24 is reduced somewhat in diameter slightly above the upper end of gland 25, forming a shoulder against which washer 26 lies. The throttle proper, composed of parts 27, 28, and 29, is assembled adjacent washer 26, and is held in place by the retaining nut 30.

The throttle piece includes the metal insert 28, the covering 29 of woven-wire mesh which is stamped and draw-formed into a tight covering for insert piece 28. This woven-wire covering is drawn in and folded down at the underside of the throttle member, and is partially pressed into the lead washer 27 to hold it firmly in position.

The annular impact member 32 is provided for the purpose of further silencing the high-velocity jet discharged between the throttle piece 28, 29 and partially silenced by the woven covering 29. This member includes the supporting washer 33, a number of superposed washers 32 stamped from woven-wire sheet material (thirty-mesh Monel cloth, for example), and the shell portion 34 which holds the parts 32 and 33 together in a removable assembly. The impact assembly, including parts 32, 33, and 34, is retained in the illustrated position in an annular groove, and is prevented from moving with the current by the lower end of the union ball 37.

The throttle piece 29 and the impact member 32 are included in the subject matter and claimed in the copending application of William E. Sloan, Serial No. 320,789, filed February 26, 1940.

Operation

The operation of the improved device will now be described. It may be assumed that the device is installed as illustrated in Figures 4 and 5, and that it is installed in its closed-off position, illustrated in Figure 1.

"Blowing out" the piping

After the installation is made, and the supply pressure has been applied to the supply pipe 50 (Figure 4), the handle 14 is turned slowly in such a direction that the resulting turning of stems 11 and 9 results in a lowering of the non-rotating stem 15 and the resultant lowering of the valve 17. The seat portion 18 is thus brought down from its seated position around the discharge orifice. This opening of the valve 17 admits the supply pressure to the inlet of the flush valve 53, but no more than a momentary flow may take place until the flush valve 53 is tripped.

The opening operation is continued until the valve 17 reaches its most fully open position, the movement being stopped when the lower end of valve 17 comes against the opposed face of the bonnet 6. In the illustrated embodiment, the total opening movement is approximately seven-sixteenths inch. The opening movement carries the self-adjusting throttle device further away from the discharge port than its normal working position, whereby a rate of flow much larger than the working rate of flow may be obtained through the piping system to enable any loose debris that may be contained therein to be washed out.

The flush valve 53 is now actuated one or more times (by tripping the button 54). This operation is known as "blowing out" the piping, for on each operation of the flush valve, a substantially full and unthrottled flow thereupon takes place through the piping system to clean it out. The self-adjusting throttle arrangement does not function at this time because of the free discharge path through the device.

Setting the device in its working position

After the supply piping has been washed free of debris as above described, the handle 14 may then be turned in the opposite direction about one full turn to thereby move the valve 17 and the self-adjusting throttle assembly carried thereby about one-eighth inch back toward closed position, being about the position in which the device is shown in Figure 2. The throttle 29 is thereby advanced sufficiently far into the entrance of the discharge port that it is in a position to be forced further into the discharge port when the rate of flow substantially exceeds the preferred value, about twelve gallons a minute in the assumed example.

Low-pressure operation

Assuming now that the supply pressure is sufficiently low, with respect to the length of the supply pipe 50, of Figure 4, that the rate of flow does not rise above the preferred value when the flush valve 53 is tripped by the push button 54 to cause the water closet 57 to be flushed, the pressure drop through the annular throat defined by the throttle 29 and the discharge port is sufficiently small that the piston which carries the throttle 29 is not moved against the tension of compression springs 19 and 20. The device, therefore, remains in the comparatively unthrottled position illustrated in Figure 2 to permit the maximum flow to occur under the

assumed conditions. During the flow under this assumed condition, the pressure existing at the inlet 2 of the device is comparatively low.

Medium-pressure operation

Let it be assumed now that the supply pressure is sufficiently high, with respect to the length of the supply piping, that the rate of flow, unless additionally throttled by the illustrated device, would substantially exceed the preferred rate of flow of about twelve gallons a minute. Under this condition, when the flush valve is tripped and the flow starts and rises to and tends to exceed the preferred value, the self-adjusting throttle assembly begins to move with the current against the tension of restoring springs 19 and 20. This movement occurs because the rate of flow then occurring is accompanied by a sufficient drop in pressure of the water in flowing around the throttle device 29 that the back pressure exerted against the downstream side of this throttle device is substantially lower than the pressure existing at the inlet 2 and on the upstream side of the self-adjusting throttle assembly.

The pressure existing on the upstream side of the throttle 29 is extended to the interior of the cup valve 17 and around the stem 24 of the piston, by way of the annular space between the inside diameter of the retaining gland 25 and the outside diameter of the stem 24. The pressure existing around the stem 24 is further extended through by-pass opening 39 (see Figures 1 and 6) to the hollow interior of the stem 24 and thence to the space between the end of the piston and the end of the cup or cylinder in which it operates. It will be noted that a shallow depression is milled in the end of the piston head 21, leaving an annular contact rim. This rim is broken at the groove 40 (Figure 1) to permit the pressure within the hollow interior of stem 24 to pass freely through the gap 40 to thus be exerted over the entire area of the enclosed end of the piston.

As illustrated, the compression spring 20 is made of round stock (stainless steel wire, for example) and is comparatively powerful. On the other hand, the shorter spring 19 is made of flat stock (stainless steel strip, for example) and is a comparatively weak spring. As a result, very little compression of the strong spring 20 occurs when the movement of the self-adjusting assembly is comparatively small, for nearly all of the movement then occurring is represented by compression of weak spring 19. For those low-inlet pressures just above the minimum, a comparatively large movement for each unit of increased inlet pressure occurs because spring 19 is comparatively weak.

The weaker spring 19 permits a comparatively large movement of the self-adjusting assembly responsive to a comparatively small pressure drop through the annular throttling throat at the low-pressure end of the range, where a small pressure change is a comparatively large proportion of the total existing pressure and, therefore, requires a comparatively large change in the amount of throttling to maintain the flow uniform.

As successively greater inlet pressures are encountered, requiring successively greater movement of the travelling assembly, the position is soon reached at which the weak spring 19 "makes

solid," that is, becomes fully compressed. After this occurs, each further unit of increased inlet pressure results in less movement of the travelling assembly because all further movement is resisted by the stronger compression spring 20, after the weaker spring 19 has been fully collapsed.

Figure 3 shows the device in the position which it assumes at some medium inlet pressure sufficiently great to cause enough movement to compress the spring 19 completely and to substantially compress the stronger spring 20.

Assuming now that the supply conditions are such that the medium inlet pressure exists during the preferred rate of flow which requires adjustment of the travelling assembly to the working position illustrated in Figure 3, the movement of the device from the normal position illustrated in Figure 2 to the medium-pressure working condition existing in Figure 3 will be explained.

When the flush valve 53 of Figures 4 and 5 is actuated by a pushing of the button 54 under the assumed conditions, the flush valve 53 opens hydraulically in the usual manner to permit the desired discharge of water to occur. As the flow increases upon the opening movement of the flush valve, the pressure differential across the throttle piece 29 exceeds the restoring force of the weak spring 19, whereupon the self-adjusting assembly moves upwardly with the current to fully compress spring 19. To avoid overthrow of the travelling assembly and a consequent jumpy operating movement thereof during the ensuing flushing operation, the movement of the travelling assembly is damped by the disclosed piston-cylinder couple or dash-pot. The packing cup 22 makes sealing engagement with the associated cylinder wall to prevent water from flowing between the piston and the inside wall of the cylinder. The water can thus flow behind the moving piston only as fast as it can flow through the small by-pass opening 39, the preferred size of which is about one-sixteenth inch diameter.

Under the assumed condition, movement does not stop upon the complete collapse of weak spring 19, but continues to compress the stronger spring 20 until the travelling assembly reaches the position illustrated in Figure 3.

When the flow decreases and stops, as the flush valve 53 recloses, the travelling assembly slowly returns to the normal position illustrated in Figure 2.

High-pressure operation

The operation of the device under a condition of high inlet pressure, when the preferred rate of flow is occurring, is the same as described previously, except that the pressure differential across the throttle 29 is sufficiently higher that the spring 20 is compressed still further, and the throttle 29 is moved still further into the narrowing discharge port. The particular device illustrated is designed for a maximum pressure of about one hundred pounds to the square inch. When this pressure is applied to the inlet during a flushing operation, the large pressure differential then existing across the throttle 29 causes the travelling assembly to be driven into the inlet port until the forward end of throttle 29 passes into the straight portion 43 and closely approaches the upstream side of the silencing impact member 32.

Shaping the discharge port

From the preceding description, it will be seen that, with a uniform discharge pressure during the preferred rate of flow (about four pounds to the square inch in the assembled example), the serially related compression springs 19 and 20 yield collectively an amount in each case, depending upon the amount by which the inlet pressure exceeds the discharge pressure after the self-adjustment has been accomplished. Keeping in mind that the calculation of the rate of flow passing through a variable orifice and resulting from a varying pressure differential is affected by many factors other than the net area through the orifice, the shape of the discharge port which gives the most uniform results over the entire pressure range is best obtained in each separate design by what is usually termed trial and error. In this type of device, it has been found that the amount of movement of the self-adjusting throttle resulting from a given pressure differential is substantially independent of the effective area of the discharge orifice, and consequently independent of the resulting rate of flow. That being the case, in designing a device of this sort, an effective procedure is to provide a trial discharge port and note for each selected applied pressure differential the position assumed by the throttle within the port and the rate of flow occurring in such position. For any of these determined positions, if the rate of flow is higher than desired, the surrounding wall of the discharge port may be brought inwardly to thereby reduce the discharge area effective at that position of the throttle. On the other hand, if the rate of flow is too low at any determined position of the throttle, the associated surrounding portion of the discharge port may be suitably enlarged to thereby provide the desired increase in the rate of flow for the concerned determined throttle position and the accompanying pressure differential which causes the throttle to assume this position.

For the illustratively assumed purpose, it was found that a comparatively simple and easily produced shape of discharge port serves to give regulation within the working limits of the installation over the required pressure range. The following table gives the observed operation of the improved device in the illustrated installation for inlet pressures ranging from one hundred pounds to the square inch down to five pounds to the square inch:

Inlet pressure	Outlet pressure	Self adjustment	Flow G. P. M.
		Inches	
100	4¾	32¼	12½
85	4¾	29¼	12½
75	4½	25¼	12
55	5½	18¼	13½
35	5¼	13¼	13¼
25	4½	10¼	12¼
20	4½	9¼	12¼
15	3¾	7¼	11¼
12	5½	2¼	13½
9	4	2¼	11½
7	3¼	0	10½
5	3	0	10

The first two columns of the above table give the pressure at the inlet and at the outlet, respectively, of the self-adjusting throttle device, the pressures being indicated in pounds to the square inch; the third column gives in sixty-fourths of an inch the amount of movement of the travelling assembly incident to self-adjust-

ment at the given pressures; and the fourth column gives the resulting rate of flow in gallons per minute for each of the applied inlet pressures given in the first column.

The above tabulated results were obtained with the illustrated contour of discharge port. This discharge port includes the cylindrical upper section 43, about a quarter inch in length; the tapered section 42, about a quarter inch in length, and having a taper of about two degrees on a side; and the curved entrance portion which has a radius of curvature of about five thirty-seconds of an inch.

As will be noted from the preceding description and from the data given in the above performance table, the adjustable throttle 29 cooperates with the curved entrance portion 41 for low pressures; cooperates with the two-degree-tapered portion 42 for intermediate pressures; and cooperates with the cylindrical portion 43 for high inlet pressures.

Inspection under pressure

When it becomes necessary or desirable, the travelling assembly can be removed for inspection while the supply pressure is on. For this purpose, the handle 14 is turned to close the valve 17 so that the seat 18-carried thereby makes sealing engagement around the discharge port as shown in Figure 1. The valve 17 being an imperforate cup, no flow can then take place through the device.

The discharge tube 38 and union ball 37 can then be removed by removing the union nut 36. The impact or cushion assembly 32 enclosed in casing member 34 is next removed, following which the flattened stem portion 35 of stem 24 is turned to unscrew the retaining gland 25 from the valve 17. It will be recalled that the internal lug or key 31 of the gland 25 lies within the keyway 47 in stem 24 to force the gland 25 to rotate with stem 24.

When the gland 25 has been unscrewed, the entire self-adjusting assembly may be removed through the now unobstructed discharge port. This self-adjusting assembly, when removed and rotated ninety degrees about its longitudinal axis from the position shown in Figures 1 to 3, appears as illustrated in Figure 6. The assembly shown in Figure 6 may be taken completely apart by simply removing the retaining nut 30.

By the above-described feature, the self-adjusting throttle assembly may be removed for inspection or repair with the associated stop valve closed off, thus enabling the self-adjusting throttle assembly to be inspected, repaired, or completely renewed if desired, without shutting the water off from other fixtures, as would be required if the entire valve assembly had to be taken apart by removing the bonnet member 6.

The previously described feature enabling the device to be opened further than the working position illustrated in Figure 2 for the purpose of securing large rates of flow right after installation to "blow out" the supply line, operates also to enable adjustment to be made to compensate for variations in manufacture. For example, if the manufacturing variations are such as to cause the throttle piece 29 to stand too far out of the discharge port when the operating handle is turned to the intended working position, this fact is made manifest by too high a rate of flow, and is compensated for by turning the adjusting handle to advance throttle piece 29 a corresponding amount. On the other hand, if the manufac-

turing variations are in the opposite direction, and the throttle piece 29 extends normally too far into the discharge port when the device is set in its expected working adjustment, then the adjusting handle can be turned to withdraw the throttle piece 29 correspondingly further out of the discharge port.

What is claimed is:

1. In a valve structure, a valve casing including an inlet and an outlet interconnected by a flow passageway, a valve within said casing adjustable between an open position and a closed position in which it closes said passageway, said valve having the form of a cup aligned with said passageway, a self-adjusting throttle controlling the flow through the passageway when the valve is in its open position, and means within said cup for stabilizing the adjusting action of said throttle, said stabilizing means comprising a piston slidably arranged within said cup valve and having a hollow stem provided with means for restricting liquid flow from one side of said piston to the other, said throttle being supported upon said piston stem, and means for preventing relative rotation between said cup valve and said piston.

2. In a combined shut-off valve and throttle, a casing having a plug removably connected therewith, the inside end of said plug carrying a cup disposed longitudinally of said plug, a shut-off valve having the form of a cup aligned with the first-named cup, means including a stem working within said plug for telescoping the cup valve more or less within the first-named cup to open and close the shut-off valve, cooperative means on both of said cups for preventing relative rotation of said cups while said shut-off valve is being opened and closed, and a throttle device including a portion telescopable a variable amount within the valve cup to effect a variable throttling while the valve is in open position.

3. In a self-adjusting throttle, a casing having an inlet and an outlet in communication with each other through a throttle port, a throttle movable into said port under the influence of an occurring flow, two serially related springs for limiting the extent of movement of said throttle according to the pressure differential accompanying the flow and for restoring said throttle when the flow subsides, one of said springs being comparatively weak, both springs being effective to permit movement of the throttle by their combined flexibility responsive to comparatively small pressure differentials, and means for controlling further movement of the throttle, responsive to higher pressure differentials, according to the lesser flexibility of the stronger spring.

4. In a self-adjusting throttle, a casing having an inlet and an outlet in communication with each other through a throttle port, a throttle movable into said port under the influence of an occurring flow, and a weak spring and a strong spring serially related to variably oppose the said movement according to the extent thereof.

5. A unit-replaceable assembly for a self-adjusting throttle device including a throttle-control piston having a piston head, a screw-threaded retaining gland surrounding said piston and slidable longitudinally thereon, said gland and piston being keyed to prevent relative rotation thereof, a restoring spring surrounding said

piston between the head thereof and the retaining gland, a throttle secured to and carried by said piston beyond said retaining gland, and a portion extending beyond said throttle enabling said piston to be turned thereby to turn said screw-threaded retaining gland into and out of assembled position.

6. A unit-replaceable assembly for a self-adjusting throttle device including a throttle-control piston having a piston head, a piston-retaining gland surrounding said piston and slidable longitudinally thereon, said gland being adapted to be secured in and loosened from assembled position responsive to rotation thereof, said gland and said piston being keyed together to prevent relative rotation thereof, a throttle secured to and carried by said piston, and means facilitating the turning of said piston to thereby turn said gland to secure it in and loosen it from assembled position.

7. In a combined fluid shut-off valve and throttle, a casing having a chamber therein and a bonnet closing one end thereof, inlet and outlet passages in said chamber, said outlet passage having a valve seat therein, a cup-shaped valve in said chamber, adjustment means extending through said bonnet for adjusting said valve into open and closed position with said seat, cooperative means between said valve and said bonnet for preventing axial rotation of said valve as it is adjusted, and self-adjusting throttle control means located within said cup-shaped valve comprising a piston head slidable within said valve and having a stem portion extending outside said valve into said outlet passage, a throttle member supported on the piston stem in said outlet passage and located downstreamward of said valve seat, a retaining gland surrounding said piston stem and closing the open end of said valve, cooperative means between said retaining gland and said piston stem for preventing axial rotation of said piston, and a throttle control spring surrounding said piston stem and extending between said retaining gland and said piston head.

8. In a combined fluid shut-off valve and throttle, a casing having a chamber therein and a bonnet closing one end thereof, inlet and outlet passages in said chamber, said outlet passage having a valve seat therein, a cup-shaped valve in said chamber, adjustment means extending through said bonnet for adjusting said valve into open and closed position with said seat, cooperative means between said valve and said bonnet for preventing axial rotation of said valve as it is adjusted, and self-adjusting throttle control means located within said cup-shaped valve comprising a piston head slidable within said valve and having a stem portion extending outside said valve into said outlet passage, a throttle member supported on the piston stem in said outlet passage and located downstreamward of said valve seat, a retaining gland surrounding said piston stem and closing the open end of said valve, cooperative means between said retaining gland and said piston stem for preventing axial rotation of said piston, a throttle control spring surrounding said piston stem and extending between said retaining gland and said piston head, and a stabilizing means for said throttle comprising restricted passages extending between said retaining gland, said piston stem and said piston head.

IRVING H. RUSSELL,