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[54] **SPOUT END APPARATUS**
19 Claims, 6 Drawing Figs.

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 137/504, 138/46, 239/546, 239/570, 239/590.3
 [51] Int. CL. **B05b 1/30**
 [50] Field of Search 239/452,
 534, 535, 546, 553.5, 562, 569, 570, 575, 590,
 590.3, 602; 137/495, 504, 513.5; 138/42, 43, 45,
 46

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ABSTRACT: Covers a fluid flow control device or pressure regulator suitable for a spout end structure for a plumbing fixture. The equipment includes two tandem arranged disks which may be inserted into the spout end structure. The first disk, which is made of rubber and is flexible, includes an upstream surface which is flat and a downstream surface which includes a considerable number of flexible projections. The first disk also includes a plurality of substantially identical cylindrical parallel apertures through which the fluid flows. The second or downstream disk, which is a rigid disk made of plastic or metal, includes a greater number of substantially identical but smaller cylindrical parallel apertures. The two disks are positioned closely adjacent to each other so that, in the absence of pressure or under low-pressure conditions, the projections on the first disk barely contact the adjacent surface of the second disk. As the fluid pressure applied to the first disk rises above a predetermined value or varies above that level, the projections on the first disk will be somewhat flattened and driven pursuant to the increased pressure against the second disk. Consequently, the flattening of those projections caused by increased pressure will proportionally reduce the fluid flow passageways so that fluid emission through the second disk and through the spout end will remain substantially unchanged, notwithstanding the change or rapid rate of change of pressure of the applied fluid.

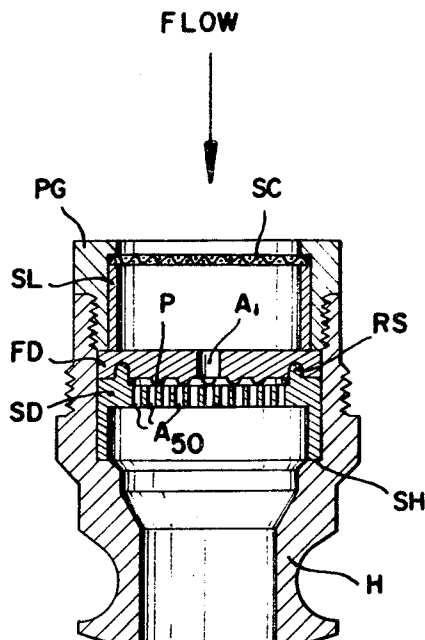


FIG. 1

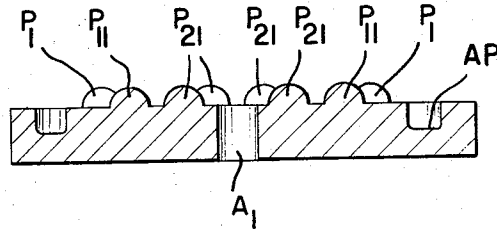
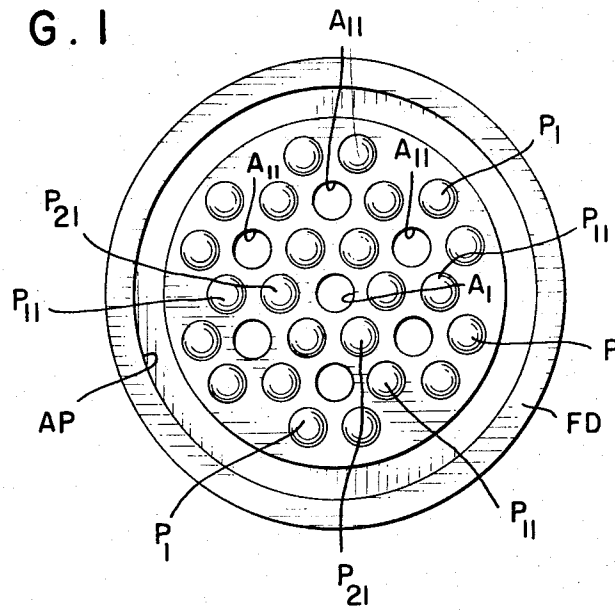


FIG. 2

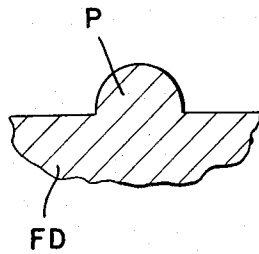


FIG. 6

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FIG. 3

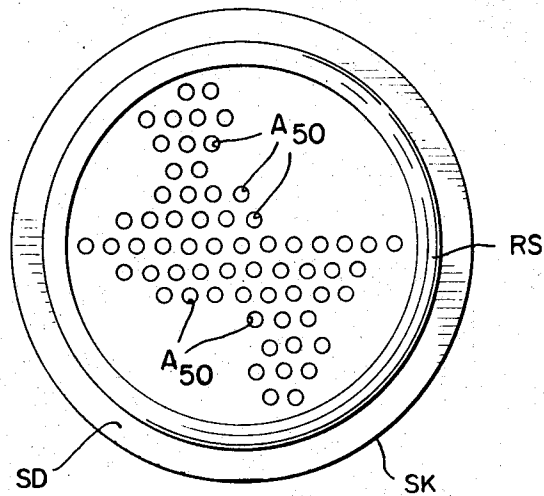


FIG. 5

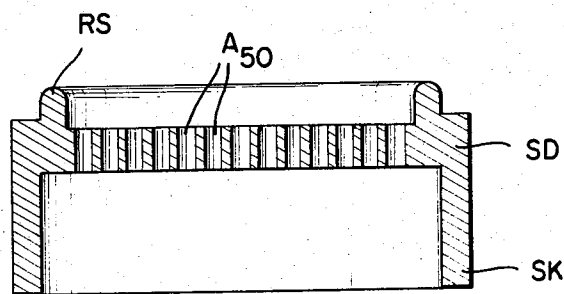
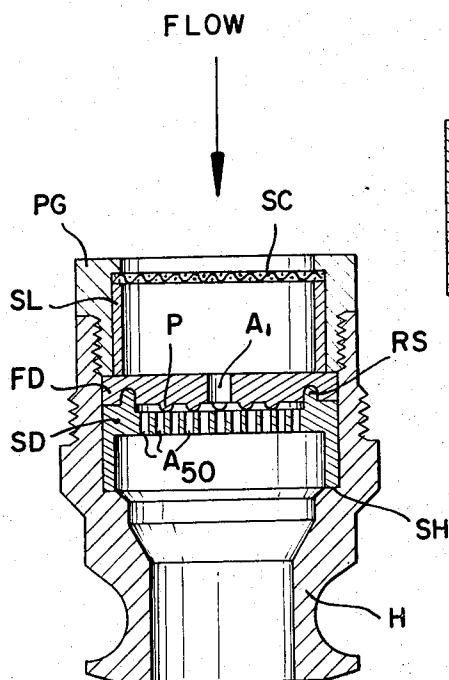


FIG. 4

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SPOUT END APPARATUS

This invention relates generally to fluid flow control devices and to pressure regulators.

In many types of fluid flow systems, it is desirable to provide a relatively unrestricted flow of fluid when the pressure behind the fluid is at a relatively low level and to relatively restrict the flow so that the level of the flow will remain at a substantially constant level as the pressure rises to higher levels or varies considerably and rapidly. Previous devices differ materially from the structure of the present invention in that, as the pressure of the incoming fluid rapidly rises, the volume of fluid traversing the structure is also increased substantially for a short period of time and sometimes increased to a volume which is undesirable. If used in a trajectory path, any substantial change in flow rate, even for a short time period, can also materially affect the length of the flow path.

It should be noted that a rapid rise in the pressure of a fluid traversing a spout is the usual occurrence when a faucet valve is opened. With the faucet valve turned off, the pressure in the spout above and below any flow control device in a spout becomes atmospheric or zero gage pressure. When the faucet is turned on quickly, the pressure upstream of the flow control rises almost instantaneously to near line pressure. Thus, the usual or conventional spout structure may be subjected to rapidly changing pressure fluctuations even in the absence of changes in the line pressure of the external or conventional water supply source.

It is one of the main objectives of this invention to provide a flow structure which will be normally inert or inactive as the pressure level of the incoming fluid is relatively low, that is, below a predetermined level, and which will act promptly and positively to restrict the flow through the structure to a substantially constant level when the pressure of the incoming water is above said predetermined level.

The type of structure to which this invention relates may be used as a spout end for a plumbing fixture which is connected to a conventional water supply which may vary in pressure through a rather wide range. By the use of the present invention, the spout end structure of this invention will allow water to flow rather freely through the spout end as the incoming pressure is, let's say, below a predetermined level of 30 p.s.i., but, as the pressure rises above the predetermined level of 30 p.s.i., the water emitted through the spout end will remain substantially constant in volume, notwithstanding rather wide changes in the inlet fluid pressure above the 30-p.s.i. level.

Another objective of this invention is to provide a flow control device that is quiet in operation and substantially free of objectionable noises at the ranges of applied pressures that are normally found in water systems. Such systems may vary from 20 to 125 Previous flow control devices commonly produce an objectionable noise (usually a high-frequency shrill sound) at applied pressures starting from 70 to 90 p.s.i.

Another objective of this invention is the provision of a flow control device which may be easily serviced when located in the spout end. Conventional pressure regulators are too large to be located in the end of the spout and must therefore be installed upstream, making servicing difficult and sometimes practically impossible.

In practice of this invention, two tandem disk-shaped devices are employed, one made of a flexible material, such as rubber, and the other made of a rigid material, such as metal or plastic. These two disk-shaped members are positioned closely adjacent to each other in the flow path and are positioned so that the flexible member is upstream of the rigid disk-shaped member. According to one form of the invention, the flexible member may employ a plurality of identical perforations, which may be, for example, semispherical in shape, and the downstream side of the flexible member has, in addition, to the several openings just referred to, a plurality of projecting flexible elements constituting projections extending downstream. On the other hand, the tandem downstream rigid disk-shaped member includes a large number of smaller identical apertures, for example, 120 in number. When the

two disks are placed closely adjacent to each other, so that the flexible disk may be pressed against the rigid disk when the fluid pressure rises, the projections on the flexible disk barely touch the adjacent surface of the hard disk under zero or low-pressure conditions. When water flows through the combination of the two tandem arranged disks and the pressure is low, for example, a predetermined pressure somewhat below 30 p.s.i., the fluid will pass through the two tandem disks, traversing the several openings of both disks. The net rate of the flow will be substantially unchanged by the presence of the two disks. On the other hand, as the pressure of the incoming water rises above the predetermined level, for example, 30 p.s.i., then the increased pressure on the flexible disk will drive the projections on the flexible disk firmly against the upstream surface of the rigid adjacent disk. The projections will become flattened and the fluid passageways between the projections and also between the edges of the holes in the flexible disk and the rigid disk will decrease. Also the flattened projections will cover an increasing number of holes in the rigid disk. The net effect of the flattening of the projections and the distortion of the flexible disk caused by an increase in applied pressure, results in a total reduction in the relative size of the fluid passageways, whereby the flow of water through the combination of the disks will be substantially reduced to a fixed or a predetermined level. As the pressure increases higher and higher to, let's say, 50, 100, 150 p.s.i., the flow stream through the two disks acting in tandem, and the pattern of the flow stream, will remain substantially unchanged.

Thus, the pressure downstream of the two disks will remain substantially the same notwithstanding the substantially increased upstream pressures of the incoming water. Stated otherwise, the rate of fluid flow (or gallons per minute) delivered by the pair of tandem disks will remain substantially unchanged notwithstanding the increased or varying pressures applied to the water upstream in rising or falling above the predetermined level.

The type of structure according to this invention is especially suitable for use as a spout end for a faucet to be used in the kitchen, bathroom, drinking fountain, etc., in that it assures the delivery of a substantially uniform flow rate of water regardless of the changes in the pressure of the incoming water above a predetermined level. The structure is simple, easily assembled or disassembled, relatively cheap to manufacture and relatively free of operational difficulties.

This invention will be better and more clearly understood from the following description and explanation, hereinafter given when read in connection with the accompanying drawing in which

FIG. 1 illustrates a plan view of one form of flexible disk employed in this invention;

FIG. 2 illustrates a cross-sectional view taken through the horizontal centerline of the flexible disk of FIG. 1;

FIG. 3 illustrates a plan view of the rigid disk structure that may be employed in this invention;

FIG. 4 illustrates a horizontal cross-sectional view taken along the centerline of the rigid disk of FIG. 3; and

FIG. 5 shows a cross-sectional view of a spout end to which the invention may be applied to illustrate a complete and operative structure.

Referring to the drawing, particularly FIG. 5, the flexible disk and the rigid disk, designated FD and SD, respectively, are shown assembled in a spout end. FIG. 5 shows the housing, or spout end body H for supporting the flexible disk FD and the rigid disk SD adjacent to each other so that the flexible disk FD will be located upstream of the rigid disk SD. If desired, a screen SC may be added and it may be positioned upstream of the flexible disk FD. The screen SC may be physically positioned against a sleeve SL which spaces the screen SC by a predetermined distance from the rear surface of the flexible disk FD.

It will be observed from the exemplary device of FIGS. 1 and 2 that the flexible disk FD embodies a plurality of apertures which are substantially cylindrical in shape and parallel

to each other. The central aperture is designated A1 and the six peripheral apertures are each designated A11. The peripheral apertures A11 are equally spaced from each other and from the central aperture A1, as shown. In addition to the several apertures A1 and A11, the flexible disk FD includes a multiplicity of projections which, as shown in the FIGS. 1 and FIG. 2 illustrations, may be divided into three tiers or levels. The projections of the outer tier are designated P1, the projections of the intermediate tier are designated P11, and the projections of the innermost tier are designated P21.

The central aperture A1 provides an axial flow path for the flexible disk FD and apertures A11 the peripheral flow paths.

The projections P21 may be regarded as satellites of the central aperture A1. Each other aperture, such as A11, is surrounded by a group of satellite projections, six in number as shown. Two of the projections for each aperture are in the outer tier P1, two more in the intermediate tier P11 and the remaining two in the innermost tier P21. Each other aperture A11 is surrounded by a similar group of satellite projections having the same general configuration and arrangement.

FIG. 2 shows a side view of the projections which are generally semispherical in shape. An enlarged cross-sectional view of a singular projection is shown in FIG. 6.

The rigid disk SD is shown in FIGS. 3 and 4 as embodying a large number of apertures designated A50. Each of these apertures is cylindrical in shape. The diameter of each of these apertures is smaller than the diameter of the apertures A1 and A11 of the flexible disk FD. The rigid disk SD also includes a so-called retaining seat RS which is designed to receive the circumferential aperture AP of the flexible disk FD shown in FIGS. 1 and 2. The rigid disk SD also embodies a skirt SK which, in the longitudinal direction or flow path, may be of any desired length.

FIG. 5 shows the assembly of the flexible disk FD and the rigid disk SD in a spout end, the body of which is designated H. The spout body H has a shoulder SH for supporting the rigid disk SD and the flexible disk FD in juxtaposition. A plug PG, which is threadedly engaged to body H, houses sleeve SL and a screen SC.

It will be observed from FIG. 5 that the ends of the projections P of the flexible disk FD are adjacent to and barely touch the adjacent back or upstream surface of the rigid disk SD. However, as the pressure of water traversing screen SC is applied to the flexible disk FD, the several projections P will be depressed and will exert an influence upon flexible disk FD and the holes in the rigid disk SD and also upon the sizes and number of openings in the rigid disk SD, with the net result that the area of the fluid passageways will be restricted and reduced in size in proportion to the amount of fluid pressure exerted against the flexible disk FD.

Under normal conditions, the flow of fluid, such as water, through the structure of FIG. 5 in the direction indicated by the arrow will cause the water to traverse the outer screen SC quite uniformly and press against the flexible disk FD. The fluid will traverse both the flexible disk FD and the rigid disk SD and will then be emitted through the main or central opening of the holder H. If the fluid pressure is somewhat below a predetermined value, such as 30 p.s.i., the amount of deflection of the flexible disk FD will be relatively small, perhaps even completely negligible. Hence the volume of water traversing the two disks FD and SD will be relatively undiminished and the undiminished flow will be emitted through the main opening in the holder H. The water flow through the structure will be at substantially the same rate even with a quick change in the water pressure from a low or negligible value to a relatively high value.

As the fluid pressure rises above the predetermined value of, for example, 30 p.s.i., the flow of the fluid develops a substantially uniform but increased pressure against the adjacent upstream side of the flexible disk FD. If the pressure increase is sufficient to substantially deflect projections P of the flexible disk FD, the projections P will then be depressed into somewhat different shapes, the changed shapes or distortions

depending on the magnitude of the increased pressure. The net result of the fluid pressure will be to reduce not only the spacing between the two disks FD and SD, but also the exposed area or "openings" of the apertures A50 of the rigid disk SD. Hence, the fluid flow through the opening of the holder H will be substantially constant, notwithstanding the increased fluid pressure. It has been found that, as the fluid pressure rises to higher and higher levels, or falls from a very high level to a lower level (above the predetermined level), the fluid flow through the main opening of the holder H will remain substantially constant. Whatever deflections in the flow volume occur through the nozzle of the holder H will be relatively small compared with the rather large changes that may be made in the pressure of the fluid entering the structure of body H.

As the pressure of the inflowing water increases further, the flexible member FD will be depressed more and more against disk SD in the direction of the flow path as well as outwardly toward the periphery of the inner wall of holder H. Pressure toward the inner wall of holder H will also increase the area of the flexible disk FD and thus increase the seal between the flexible member FD and the inner wall of holder H so that the increased water pressure will not precipitate a leak through or around the disks FD and SD. Hence, the fluid must traverse the openings of both disks to reach the downstream nozzle of holder H.

As stated, FIG. 6 shows a cross-sectional detail of a single projection of the flexible member FD. The flexible member FD has a plurality of such projections as shown in FIGS. 1 and 2, each of which may be semispherical in shape as shown. As pressure is applied to the flat side of the disk FD, each projection P will be caused to "spread out" and assume a different shape in proportion to the amount of fluid pressure exerted against disk FD.

The shape of the projection P is important only in regard to a specific configuration of the remainder of the device. The following are the main attributes that contribute to the resultant performance characteristics other than the shape of the projections P:

1. The modulus of elasticity of the elastomer of which disk FD is made;
2. The spacing and size of the projections P;
3. The proximity of the projections P to the holes A in the flexible disk FD;
4. The area of the holes A in the flexible disk; and
5. The spacing and size and number of holes A50 in the rigid disk SD.

Although a multitude of combinations of these several variations in the above attributes may be arranged as desired to provide a constant flow device, the significant characteristic of this device is the relatively small mass of the projections P which respond almost instantaneously to a change in the applied pressure. The small mass of the projections necessarily involves a relatively small inertia and therefore a quick response is obtained however great or small, or whatever the direction of the pressure change may be.

The disks FD and SD, as herein disclosed, need not be embodied in a spout end as shown in FIG. 5. They may be embodied in any conduit, perhaps seated or positioned on a shoulder, such as SH, or positioned between two such shoulders. The presence of the disk in the conduit may serve to maintain a substantially constant flow of fluid, whether liquid or gaseous, through the conduit.

The nozzle arrangement, as shown in FIG. 5, yields a controlled flow rate at all times whether the nozzle structure is pointed downwardly in a substantially vertical direction or is pointed at a predetermined angle for yielding a trajectory flow path. If an angular flow path is used, for example, in a drinking fountain, the flow path will remain substantially unchanged in its assigned course notwithstanding substantial changes in the pressure of the fluid supplied to the nozzle structure. By initially fixing the angle of the nozzle to maintain a flow path which is within the limit of the drinking fountain, i.e., within

the basin, the emitted fluid will not travel beyond the rim of the basin or fountain even during large significant fluid pressure changes.

Notwithstanding the necessity to confine the stream at all times within the confines of the basin, it is important also to so position the fluid stream not only to accommodate the average user, but also to minimize splash against the basin or its walls due to the stream striking the surface or surfaces of the basin. By the employment of this invention, the path of the stream may be initially determined and fixed in practice and the path will remain substantially unchanged even during substantially wide variations in the pressure of the fluid entering the nozzle structure. This factor is especially significant wherever trajectory flow paths are desired. Thus, in accordance with this invention, the structure can be set so as to prevent the stream from striking the front rim of the basin wherever the objectionable splash would occur.

The combination of the flexible disk FD and the rigid disk SD operates as a fixed pressure regulator to maintain substantially constant flow emission despite large variations in the pressure of the incoming fluid. This is an economical arrangement. It is low in cost, easily assembled or disassembled and relatively trouble-free and maintenance-free. Available pressure regulators are relatively complicated and troublesome and costly and the operative results are not very satisfactory.

In one installation according to this invention, the flexible disk FD was molded to have an overall diameter of 0.81 inch and a thickness of 0.09 inch. Each projection P was rounded to a diameter of 0.06 inch approximately. The rigid disk SD had a like overall diameter. Each aperture of the disk and a diameter of 0.028 inch. A rigid disk SD was easily manufactured in brass or delrin.

It will be apparent that the dimensions of the structures and their shapes and arrangements were given hereinabove merely for illustration and explanation and that they may be changed considerably to carry out the principles and features of this invention.

While this invention has been shown and described in certain particular arrangements to meet the requirements of the patent law, it will be apparent that other and widely varied organizations may be readily employed to practice this invention.

What is claimed is:

1. A flow control apparatus for a conduit including a first disk having a plurality of apertures and a plurality of flexible projections on one face of said disk, and a second disk having a plurality of apertures, said second disk being positioned adjacent to the first disk so that fluid pressure above a predetermined value applied to the first disk will distort its projections and restrict the flow of fluid through the apertures of the second disk.

2. A flow control apparatus according to claim 1 in which the projections are made of rubber.

3. A flow control apparatus according to claim 1 in which the first disk is made of rubber.

4. A flow control apparatus according to claim 1 in which the first disk is made of rubber and the second disk is made of inflexible material.

5. A flow control apparatus according to claim 4 in which the apertures of the second disk are smaller in cross section and greater in number than the apertures of the first disk.

6. A flow control apparatus according to claim 1 including a screen upstream of the first disk.

7. Apparatus for controlling the flow through a spout which receives fluid under changing pressure comprising a pair of contiguous disks each having a plurality of apertures, one of the disks bearing a plurality of flexible projections which abut the adjacent face of the other disk and which are changed in shape in accordance with the pressure magnitude to correspondingly control the effective area of fluid flow through the apertures of said other disk.

8. Apparatus according to claim 7 in which the disk bearing the projections is made of a rubberlike material and the other disk is made of inflexible material.

9. Apparatus according to claim 8 in which each of the apertures of the disk made of inflexible material are smaller in cross-sectional area and the apertures are greater in number than the apertures of the flexible disk.

10. Apparatus according to claim 9 including a screen upstream of the disks.

11. Flow control apparatus for a spout end, comprising two disks positioned closely adjacent to each other, the first disk being made of a flexible material and having a plurality of apertures and a plurality of projections on its downstream surface, the second disk being made of a rigid material and having a plurality of smaller apertures, the upstream surface of the second disk normally having superficial contact with the downstream projections of the first disk, whereby changes in pressure of the fluid flowing against the first disk will effectively reduce the areas of transmission of the fluid through the second disk to maintain a substantially constant flow through the second disk.

12. Flow control apparatus for a spout end according to claim 11, in which the projections on the downstream end of the first disk are semispherical in shape.

13. Flow control apparatus for a spout end according to claim 11, in which each aperture of the first disk is positioned within a group of projections.

14. Flow control apparatus for a spout end according to claim 11, including means for maintaining the two disks adjacent and substantially parallel to each other when the pressure of the applied fluid is below a predetermined level.

15. A spout end comprising a body having a nozzle, a rigid disk within the nozzle and having a plurality of substantially identical apertures which are parallel to the flow path through the nozzle, a flexible disk having a plurality of apertures which are substantially parallel to each other and larger than the apertures of the rigid disk and substantially parallel to the fluid path through the nozzle and also having a plurality of projections which are closely adjacent to the upstream surface of the rigid disk, whereby varying fluid pressure above a predetermined level applied to the flexible disk will drive the flexible disk against the rigid disk so that the projections of the flexible disk will be distorted and effectively reduce the flow paths through the rigid disk so as to maintain a substantially constant flow of fluid through the nozzle.

16. A spout end according to claim 15, including also a screen spaced from and upstream of the flexible disk and maintained at a substantially constant distance from the flexible disk.

17. A pressure regulator for a spout end comprising a hardened rigid disk having a plurality of parallel substantially identical apertures through which fluid will be continuously discharged, and a member having a plurality of flexible substantially identical projections which abut one of the faces of the rigid disk and which are continually responsive to changes in the fluid pressure exceeding a predetermined value applied to the input of the spout end to substantially change the total of the effective areas of the parallel apertures of the rigid disk substantially in accordance with the amounts of the pressure changes to maintain a substantially constant volume of fluid flow through the spout end under the varying fluid pressures.

18. A pressure regulator for a spout end comprising a hardened rigid disk having a plurality of parallel substantially identical apertures through which fluid will be continuously discharged, and means continually responsive to changes in the pressure of the fluid applied to the spout end to substantially change the total of the effective areas of the parallel apertures of the rigid disk substantially in accordance with the amounts of the pressure changes to maintain a substantially constant volume of fluid flow through the spout end under varying fluid pressures, said responsive means including a diaphragm having a plurality of flexible projections contiguous to the upstream-surface of the rigid disk so that the diaphragm will be pressed against the rigid disk as the incoming fluid pressure rises above a predetermined level to deflect the projections and effectively reduce the area of the fluid passageways to maintain a constant volume of fluid flow through the spout end.

19. A pressure regulator for a spout end according to claim
18 including a screen upstream of the rigid disk.

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