

[54] FLOW CONTROL DEVICE

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[22] Filed: July 21, 1971

[21] Appl. No.: 164,727

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 24,248, March 31, 1970, Pat. No. 3,630,455.

[52] U.S. Cl. 239/535, 137/504, 138/46, 239/570, 239/590.3

[51] Int. Cl. B05b 1/30

[58] Field of Search...239/452, 534, 535, 546, 553.5, 239/562, 569, 570, 575, 590, 590.3, 602; 137/495, 504, 513.5; 138/42, 43, 45, 46

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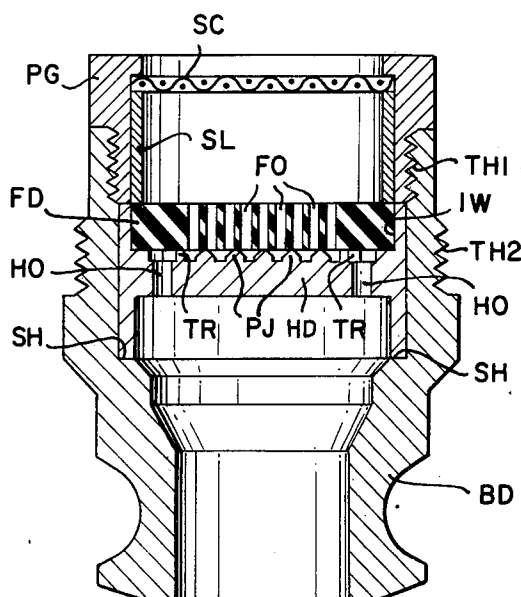
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[57]

ABSTRACT

Covers a fluid flow device or pressure regulator suitable for a spout-end structure for a plumbing fitting or fixture. The equipment includes two tandem arranged disk structures to be inserted in the spout-end to control the flow through the spout-end. The upstream element comprises a substantially flat cylindrical flexible disk having a plurality of substantially identical cylindrical parallel apertures. The downstream element comprises a hard metallic or plastic disk having a plurality of hard substantially non-flexible projections which may be located in the central region of the disk, a plurality of parallel substantially identical apertures which are peripherally arranged about the projections of the disk and a plurality of supports or barriers near the several projections. The two disks are positioned closely adjacent or contiguous to each other so that, in the absence of fluid pressure or under low fluid pressure conditions, the hard or non-flexible projections on the hard or lower disk barely contact the adjacent surface of the upstream or upper flexible disk. As the fluid pressure reaches a predetermined value or exceeds the predetermined value, the projections on the second or hard disk will remain rigid and unchanged in shape, but the upper flexible disk will be compressed so that the overall area of the apertures of the first disk through which fluid flows will be reduced so that the fluid flow through the two disks will remain substantially unchanged, notwithstanding changes in the pressure of the applied fluid however rapid or however slow.

15 Claims, 10 Drawing Figures



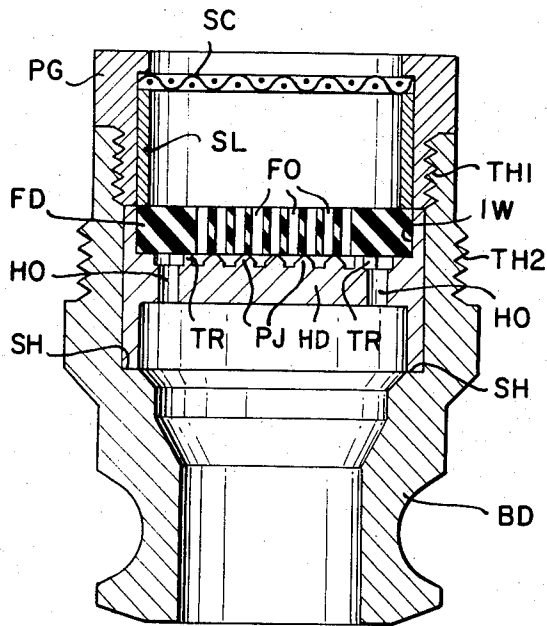


FIG. 1

FIG. 2

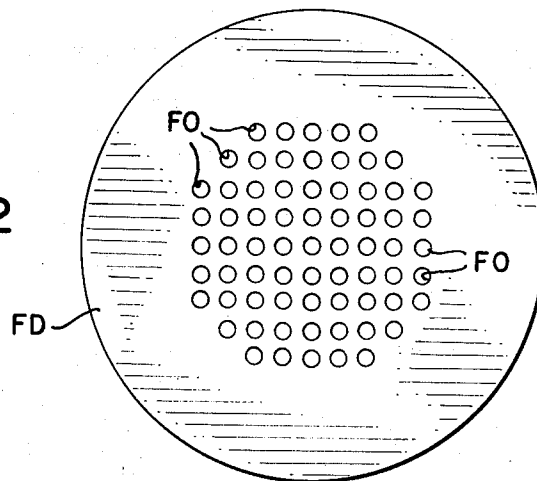
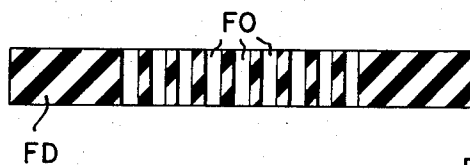


FIG. 3



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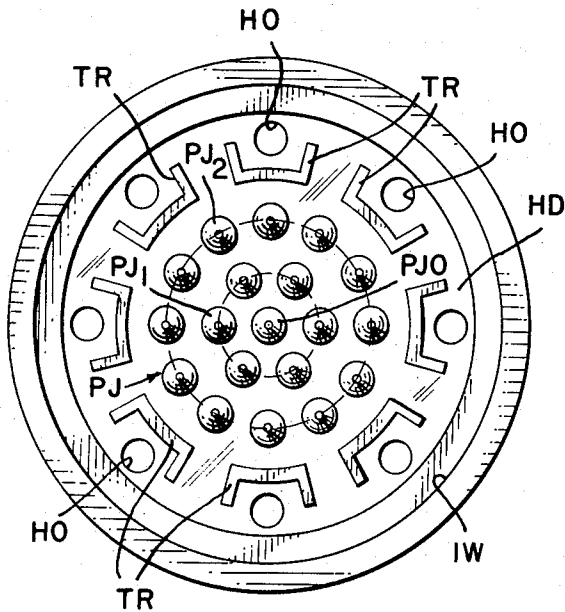


FIG. 4

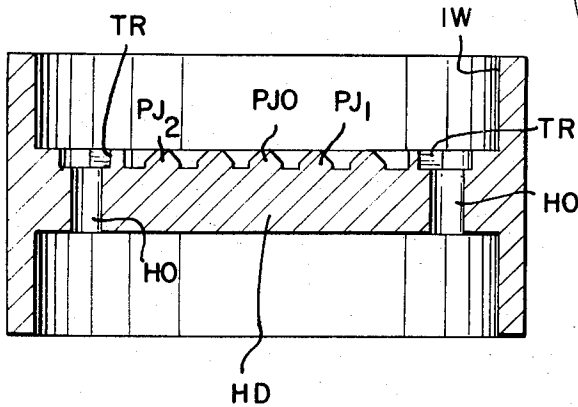


FIG. 5

FIG. 10

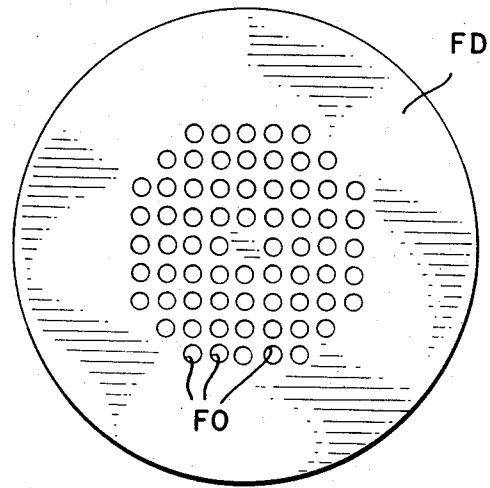
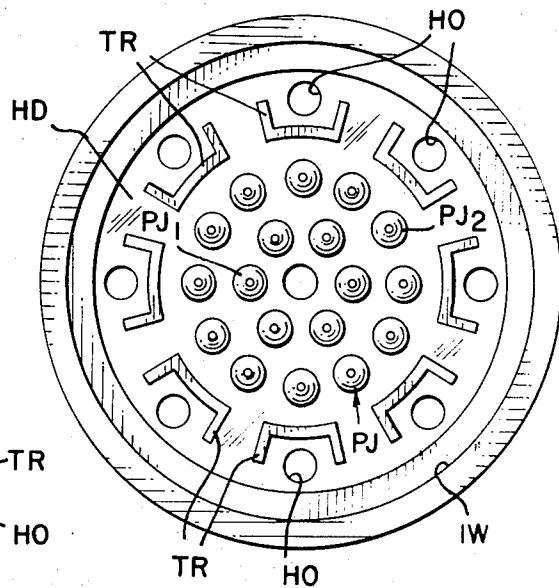


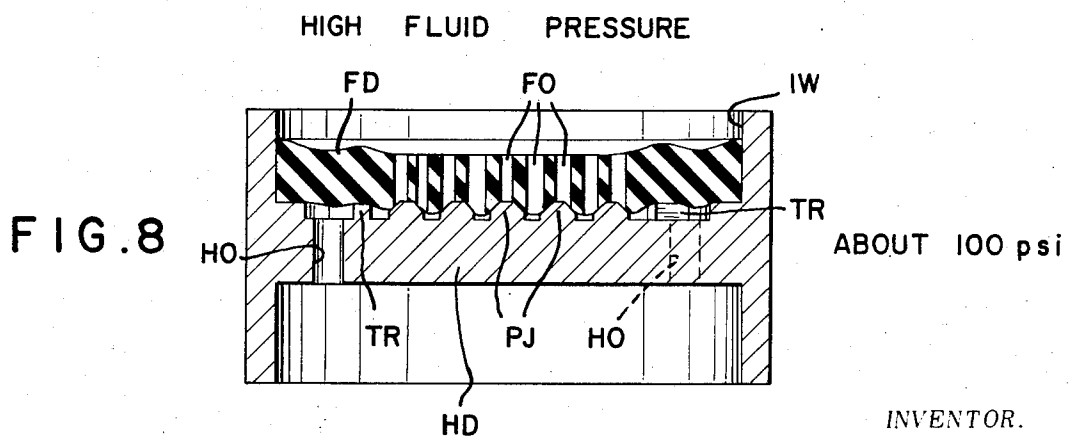
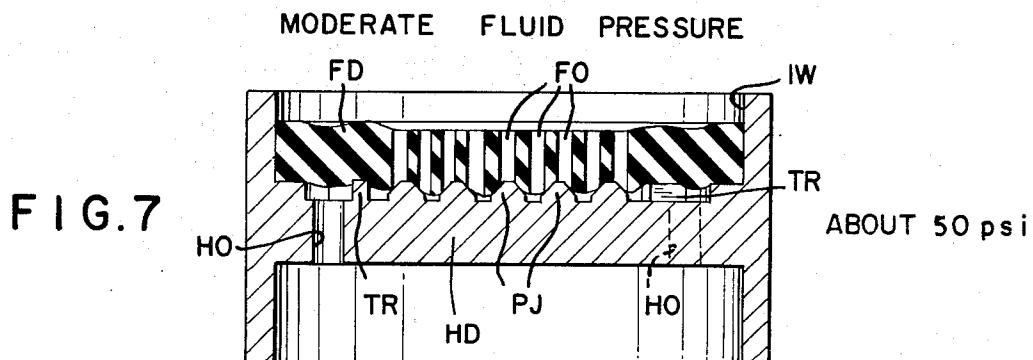
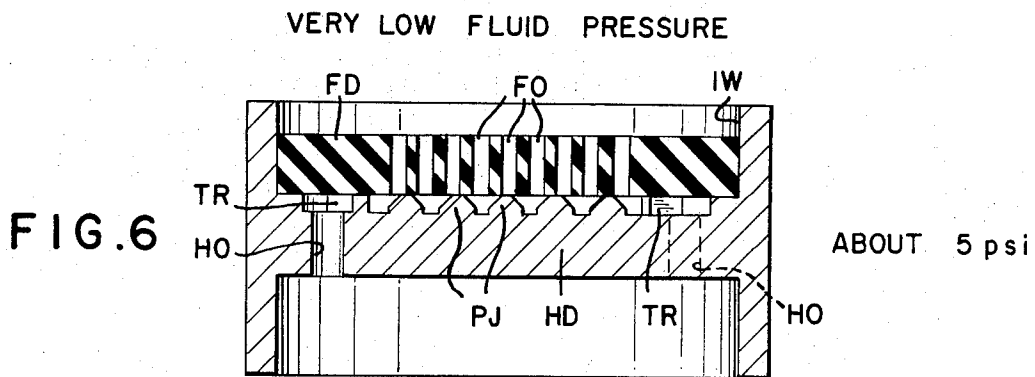
FIG. 9



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FLOW CONTROL DEVICE

This application is a continuation-in-part of an application Ser. No. 24,248, filed by the same applicant on Mar. 31, 1970, now U.S. Pat. No. 3,630,455 entitled "Spout End Apparatus", and assigned to the same assignee.

This invention relates generally to fluid flow control devices and to pressure regulators for plumbing fixtures and fittings.

In the earlier application, Ser. No. 24,248, a spout end structure was provided with a pair of disk structures which were contiguous or adjacent to each other, the upper or upstream disk structure being made of a flexible material and having a plurality of flexible projections, together with a central aperture through which fluid could flow, while the downstream disk was made of a hardened material, which may be metallic or plastic, and included a plurality of parallel apertures of substantially the same size.

The structure of the earlier case, as well as the invention of the present application, provide a mechanism which is relatively simple to construct and is low in price and is provided for maintaining substantially constant the flow of fluid, such as water, through a faucet or other plumbing fitting or fixture, the flow remaining substantially constant notwithstanding rather wide changes of the pressure of the applied fluid and notwithstanding the pressure variations over a predetermined magnitude. However, the device of the earlier application is subject to considerable wear due to its flexible projections in contrast to the device of the present invention which comprises solid, inflexible projections. The structures of the two applications have other differences which will be apparent from a comparison of the two inventions.

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

FIG. 1 shows a cross-sectional view of a spout-end taken along a diameter of the device which is exhibited in elevation;

FIG. 2 illustrates a plan view of a form of the upstream flexible element employed in this invention;

FIG. 3 denotes an elevational view, in cross-section, taken along a diameter of the device of FIG. 2;

FIG. 4 shows a plan view of a form of the downstream solid element employed in this invention;

FIG. 5 shows an elevational view, in cross-section, taken along a diameter of the device of FIG. 4;

FIG. 6 shows a cross-sectional view of the normal positions of the disks shown in FIGS. 1 to 5;

FIGS. 7 and 8 show similar cross-sectional views of the disks of FIG. 6 after they have been subjected to respectively different fluid pressures;

FIG. 9 shows a view of another form of rigid disk; and

FIG. 10 shows a view of another form of flexible disk, the disks of FIGS. 9 and 10 being suitable for joint use in the practice of this invention.

The same or similar reference characters will be employed to designate the same or similar parts wherever they may occur in the drawing.

FIG. 1 shows a cross-sectional view taken through a diameter of a spout-end according to one form of the

invention. The spout-end structure of FIG. 1 includes a spout-end body BD having a tapered inner wall positioned downstream beyond its shoulder SH. Seated on its shoulder SH is a hard disk device HD which embodies a plurality of solid pointed or point-like projections PJ which are inflexible and do not change in shape, together with openings HO and surface cavities CV. Within the upper inner wall IW of the U-shaped hard disk structure HD, there is positioned a flexible disk FD, preferably made of rubber or any other suitable flexible material, the flexible disk FD including a plurality of substantially equal cylindrical openings FO. The forms of the hard disk HD and the flexible disk FD will be described in somewhat more detail in connection with FIGS. 2 and 3 of the drawing.

The spout-end structure also includes an upstream cylindrical metallic or plastic sleeve SL which is seated on the upper surface of the flexible disk FD and a flat screen SC is seated on the sleeve SL as shown. A plug PG is threaded at TH1 into the inner wall IW of the body BD and serves to hold all of the parts in their assigned positions. The outer wall of the body BD is also threaded at TH2 so as to be connectable to any spout or other plumbing fitting or fixture through which fluid, such as water, may flow under varying pressure conditions.

FIGS. 2 and 3 show respective plan and cross-sectional views of one form of a cylindrical flexible disk FD which may be used in the practice of this invention. It is shown as embodying a plurality of substantially equal cylindrical openings FO which are located in the central region of the cylindrical disk FD.

FIGS. 4 and 5 show respective plan and cross-sectional views of one form of a solid or hardened disk HD according to this invention. The device HD includes a plurality of solid or inflexible projections, as is shown in the cross-sections of FIGS. 1 and 5. These pointed projections are shown coaxially arranged. One of the projections is located at the axial region of device HD and is designated PJO. Six other inflexible projections designated PJ1 are located in a coaxial circle shown in dotted lines in FIG. 4, and twelve other inflexible projections PJ2 are arranged in a still larger coaxial circle, as also shown in FIG. 4. These are the projections which, made of metallic or plastic inflexible materials, are normally contiguous with the under-surface of the flexible disk FD. When the pressure of the fluid exceeds a predetermined value, the flexible disk FD will be deflected, as will be later explained, to correspondingly reduce the overall area of transmission of fluid through the device, but whether the fluid pressure is high or low, the solid disk HD and its projections retain the same shape and are not flexed.

The solid disk HD also includes a plurality of peripheral openings HO, eight of which are shown in the plan view of FIG. 4. These are the openings through which the fluid flows after it has traversed the openings FO of the flexible disk FD. Each opening HO has adjacent to it a segment TR which is both a support and a barrier. Each segment TR may be U-shaped, somewhat as shown in FIG. 4, and is positioned at or near the upper surface of the solid disk HD and is arranged so that water flowing through the openings FO of the flexible disk FD will necessarily travel around the segment TR and then exit through the adjacent holes HO of the

solid or rigid disk HD. Each segment TR acts as a peripheral support for the flexible disk FD.

The segment TR may be made smaller if its sole or primary function is to maintain a spacing between the two disks FD and HD to prevent any blockage of the water flow through openings HO. It may be necessary to prevent a direct linear path through the openings of both disks FD and HD to bar a burst of fluid through any such direct linear path.

FIGS. 6, 7 and 8 are intended to illustrate the operation of the structure when it is composed of a flexible disk FD of the kind shown in FIGS. 2 and 3 and a solid disk HD of the kind shown in FIGS. 4 and 5, the composite structure being illustrated in FIG. 1 of the drawing. As shown in FIG. 6, for example, the flexible disk FD is shown resting lightly within the collar of the rigid disk HD for the condition when either no water is flowing through the spout-end device or for the condition in which the pressure of the water is below a predetermined magnitude such as 30 psi. In the absence of water pressure or in the absence of any pressure exceeding the predetermined or assigned pressure, the flexible disk FD will be undeflected or substantially undeflected. All of the many openings FO in the flexible disk FD are fully and freely available for transmitting fluid such as water.

As noted in FIG. 6, all of the openings FO in the flexible disk FD are normally of substantially the same cross-sectional dimensions and they are not distended due to any excessive fluid pressure. In this stage of operation, the solid projections PJ of the solid disk HD just barely touch the under surface of the disk FD.

In the normal condition set forth in FIG. 6, water flowing through the two-disk flow device will pass through the various openings FO of the flexible disk FD and will travel around the associated barriers TR in the adjacent rigid disk HD and then pass through the peripheral openings HO of disk HD and then out through the tapered wall of the body BD of the spout-end to exit therefrom. The two-disk flow control device under these conditions will hardly, if at all, affect the fluid flow. That is, the fluid exiting from the housing BD (FIG. 4) will be exiting at a pressure substantially equal to the pressure of fluid entering the upstream end of the housing BD of the spout-end.

As the pressure of the fluid rises and exceeds the predetermined level of pressure (30 psi) on the upstream side of the flexible disk FD, the flexible disk FD will be compressed and deflected, somewhat as shown in FIG. 7 of the drawing. FIG. 7 may, for example, illustrate the conditions when the entering fluid pressure is about 50 psi. So pressurized, the projections PJ of the rigid disk HD will themselves remain unchanged and undeflected in shape because of their hard metallic or plastic structure, but, upon the deflection of the disk FD in response to the relatively higher pressure, the projections PJ will become embedded into the flexible disk FD. The openings FO will be somewhat changed in shape in accordance with the instantaneous magnitude of the fluid pressure and hence the aggregate size of the openings FO will be correspondingly reduced. The number of openings FO which are so affected, and the amount of the distortion in the several openings FO, will depend upon the relative magnitude of the applied fluid pressure, the spacing between the holes FO and

the projections PJ, etc. However, notwithstanding these changes in the shape of the flexible device FD and its openings FO, the overall fluid flow rate will remain substantially unchanged in the face of pressure changes. In other words, the fluid flow exiting from the spout-end BD will remain substantially the same in volume notwithstanding changes in the fluid pressure over and above the predetermined value. The fluid traversing the overall structure under varying pressure conditions may not be identical in magnitude, but the magnitude differentials will be relatively small and the magnitudes will be reasonably safe and remain sufficiently uniform to avoid surges and overshoots.

As previously noted, fluid will flow through all of the openings FO of the flexible device FD and then continue along the upper surface of the rigid device HD, then around the barriers TR in its upper surface, then through the openings HO of the rigid device HD, and then out through the tapered mouth of the spout-end of the housing BD of the mechanism. The barriers may be shaped to control the directions of flow.

In FIG. 8, the flexible disk FD is shown still further compressed and deflected due to a still higher applied fluid pressure, such as about 100 psi. The projections PJ are still further embedded into the flexible disk openings FO, the magnitude of the entry of the projections PJ corresponding to the instantaneous magnitude of the increased applied fluid pressure. The space which is available for fluid flow through the openings FO under this higher pressure is thus further restricted by the projections PJ. But, notwithstanding this elevation in the pressure, the fluid will still pass over the same path through the openings FO of the flexible disk FD and around the barriers TR and out through the openings HO of the rigid device HD. The overall transmission through the exit port of the spout-end will remain substantially constant, notwithstanding this even greater applied fluid pressure or any variations of this high pressure.

The flexible device FD is shown as disk-shaped and cylindrical and provides a rather large area over which the pressure of the fluid is physically applied, notwithstanding the relatively small mass of the flexible device FD. This same small mass of flexible material is considerably distorted as the pressure reaches and exceeds a predetermined value of, for example, 30 psi. Because of the relatively small mass of the flexible device FD, it reacts promptly and virtually instantaneously to the changes in the applied pressure. The change in shape of device FD is so rapid in response to pressure changes that it compares uniquely and advantageously with conventional flow washers which are available in the market and have very different structures and configurations. Some conventional flow washers embody a rather large mass of rubber that is required to change shape to control the flow rate. Because of the relatively large mass, the rubber element is slow to react to pressure changes. Because of the slowness of response in conventional flow washers, undesirable surges and overshoots of fluid frequently occur. This undesirable condition is manifested when a faucet, for example, is opened. The large and extraordinary surges and overshoots often require the user to reduce the flow of fluid to avoid mechanical difficulties and excessive noise. Moreover, such surges introduce

considerable wear in the washers and other components of the plumbing fitting and such wear requires replacement and maintenance of parts of the mechanism at rather frequent intervals.

FIGS. 9 and 10 illustrate a variation in the flexible disk FD and the rigid disk HD which may also be used in the practice of this invention. In this case, the flexible disk FD employs no axial opening. That is, an opening FO is not present at the center or axis of the flexible device FD. Moreover, the axial projection of the rigid device HD of FIG. 4 is replaced by an added opening or hole HO.

When the disk devices FD and HD of FIGS. 9 and 10 are joined together in a spout-end, none of the openings of the flexible disk FD will be in alignment with any of the openings HO of the rigid disk HD. Were any of these openings in alignment, there would be relatively little resistance or impedance to fluid flow through such aligned openings, whereupon the fluid would reach an excessive velocity in the aligned openings. Such an alignment introduces an undesirable condition and should be avoided. The structures shown in the several figures of the drawing, in each case, particular embodiments merely for illustration and explanation, it will be apparent that the arrangements of this invention may be embodied in many forms within the scope of this invention.

What is claimed is:

1. A pressure regulator for a plumbing fitting comprising a first cylindrical disk made of flexible material and having a plurality of substantially identical apertures through which fluid may flow, a second cylindrical disk made of inflexible material and having a plurality of point-like inflexible projections which abut the apertures of the first disk, said second disk also having a plurality of apertures, the first disk being compressed in response to fluid pressure exceeding a predetermined magnitude and its apertures receiving the projections of the second disk to maintain a substantially constant fluid flow through the pressure regulator as the fluid pressure exceeds the predetermined magnitude.

2. A pressure regulator according to claim 1, in which the flexible material is formed of rubber.

3. A pressure regulator according to claim 2 in which the apertures of the first disk are non-aligned with the apertures of the second disk.

4. A pressure regulator according to claim 2, including a screen positioned upstream of said first and second disks.

5. A pressure regulator according to claim 2, in which the second disk has a collar for receiving and

retaining the first disk.

6. A pressure regulator for a plumbing structure, comprising means responding to fluid pressures exceeding a predetermined magnitude to maintain substantially uniform fluid flow through the regulator, said means comprising a first flexible and deformable disk and a second rigid disk, the first disk having a plurality of parallel openings, the second disk also having a plurality of parallel openings and a plurality of projections abutting one of the surfaces of the first disk, each of the projections being adjacent to an opening of the first disk and being partially insertable into said opening in the first disk in response to deformations of the first disk.

7. A pressure regulator for a plumbing structure according to claim 6, in which the first disk is formed as a slab of rubber.

8. A pressure regulator according to claim 7 in which the apertures of the first disk are unaligned with the apertures of the second disk.

9. A pressure regulator according to claim 8 including means for holding said first and second disks in juxtaposition with each other.

10. A pressure regulator according to claim 7, including a screen upstream of said first and second disks.

11. A fluid flow control apparatus comprising a flexible slab of rubber having a plurality of apertures, means for maintaining the flow through said slab substantially unchanged when the applied fluid pressure exceeds a predetermined value, said means comprising a rigid disk having apertures and having a plurality of inflexible projections which may be adjacent the apertures of the rubber slab, the rubber slab being compressed against said projections when the fluid pressure exceeds a predetermined value so that said projections may partially enter the apertures of the rubber slab.

12. A fluid flow control apparatus according to claim 11 in which the rigid disk has a collar for receiving and supporting the rubber slab.

13. A fluid flow control apparatus according to claim 12 which includes a screen upstream of the rubber slab and the rigid disk.

14. A fluid flow control apparatus according to claim 11 in which the rigid disk has a plurality of barriers interposed between the apertures of the slab of rubber and the apertures of the rigid disk.

15. A fluid flow control apparatus according to claim 11 having a plurality of barriers for supporting the slab of rubber on the rigid disk and also for forming obstacles between the apertures of the slab of rubber and the apertures of the rigid disk.

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