United States Patent [19]

Ohringer

[11] **3,811,466**

[45] **May 21, 1974**

[54] **SLIT DIAPHRAGM VALVE**

[76] Inventor: **Jack G. Ohringer,** 317 Via Hidalgo No. 24, Greenbrae, Calif. 94904

[22] Filed: **Apr. 6, 1972**

[21] Appl. No.: **241,638**

[52] **U.S. Cl.** **137/493,** 137/525.1

[51] **Int. Cl.** **F16k 15/14**

[58] **Field of Search** 137/493, 512.15, 525.1; 138/45

[56] **References Cited**

UNITED STATES PATENTS

3,151,626	10/1964	Everett	137/493
3,610,279	10/1971	McIntosh	137/525.1 X
2,941,544	6/1960	Peras	137/525.1 X
2,189,084	2/1940	Schank	137/525.1
2,896,661	7/1959	Becker et al	137/525.1 X

FOREIGN PATENTS OR APPLICATIONS

966,137	8/1964	Great Britain	137/493

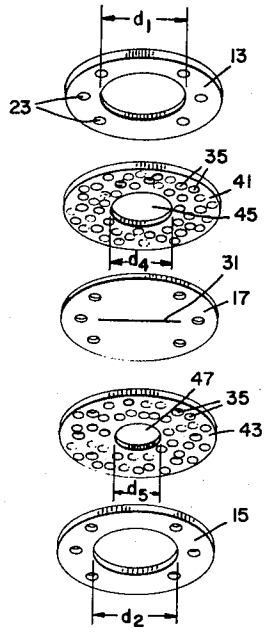
Primary Examiner—Robert G. Nilson

Attorney, Agent, or Firm—R. S. Sciascia; Charles D. B. Curry

[57] **ABSTRACT**

A slit diaphragm valve having a slit diaphragm and a control plate retained in facial contact. The slit diaphragm is a circular sheet of rubber having a centrally positioned elongated slit. The control plate is a flat perforated circular metal plate with a centrally positioned control opening. Fluid flow in one direction is unrestricted whereas flow in the other direction is restricted by the size of the control opening in the control plate. Another embodiment includes a pair of control plates for controlled flow in both directions. Still another embodiment functions as a check valve by employing a perforated control plate having no central opening.

7 Claims, 10 Drawing Figures



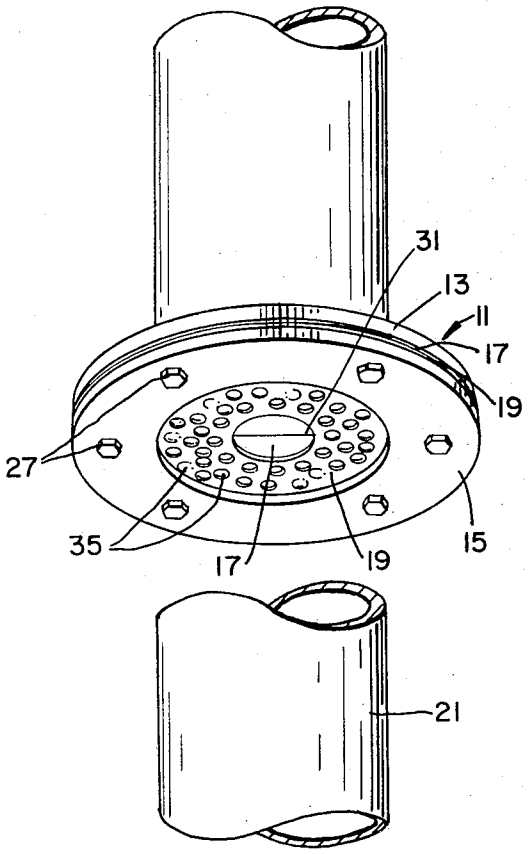


FIG_1

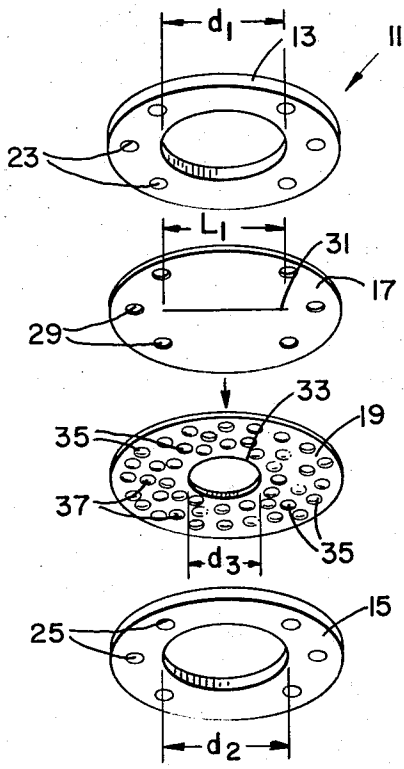


FIG_2

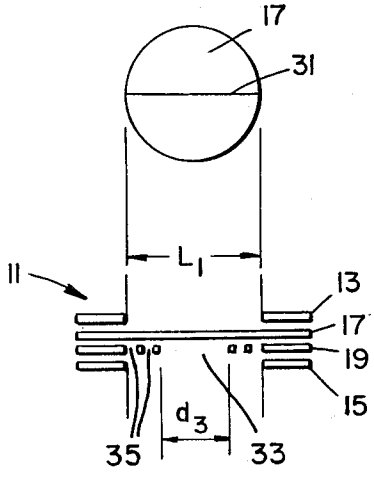


FIG_3A

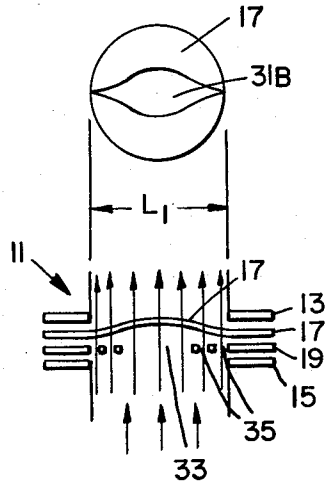


FIG_3B

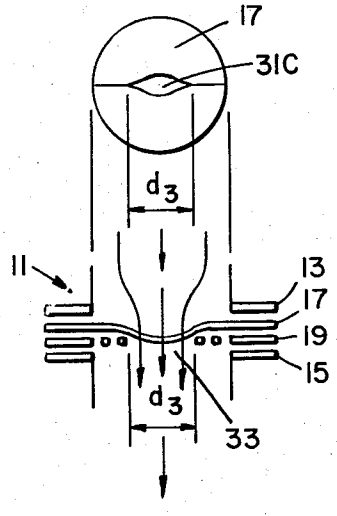


FIG_3C

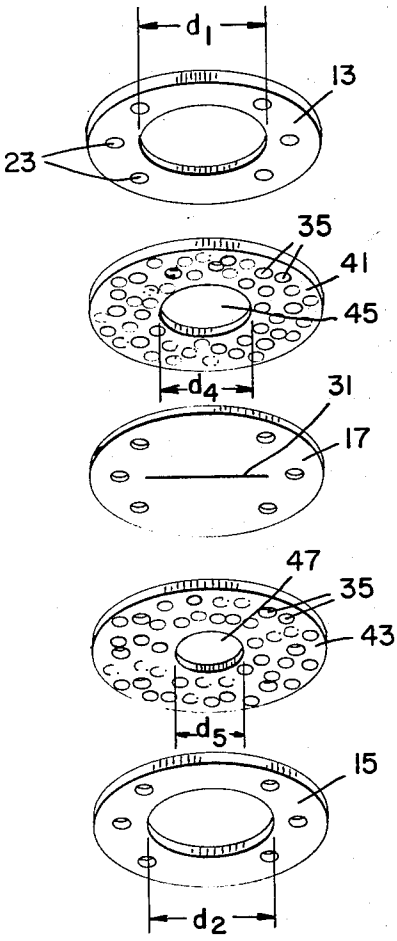


FIG_4

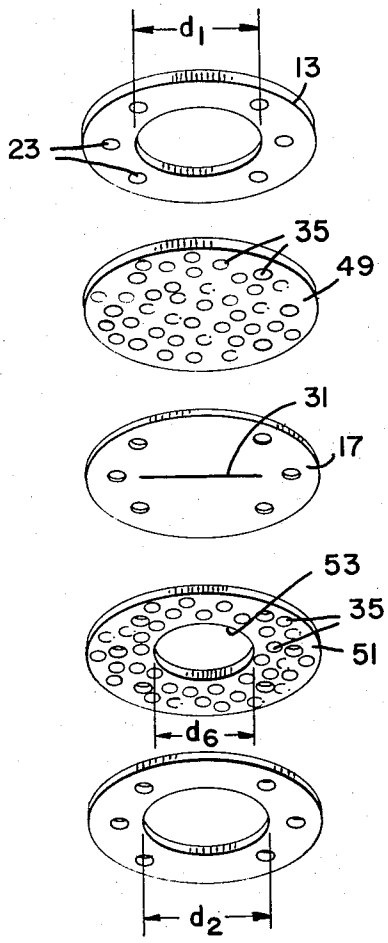


FIG_5

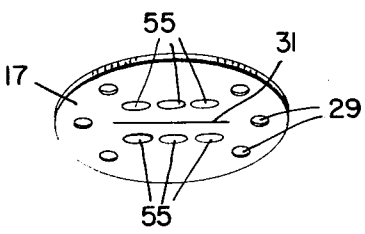


FIG_6

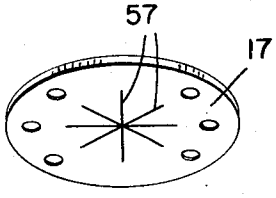


FIG_7

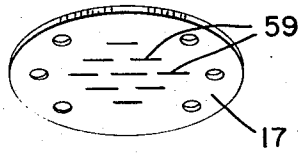


FIG_8

SLIT DIAPHRAGM VALVE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a valve and more particularly to a slit diaphragm valve for controlling fluid flow in one or both directions.

2. Description of the Prior Art

Previously available valves for controlling fluid in one or both directions have included breather valves, relief valves, check valves and recirculation control devices, for example. These valves often include relatively complex mechanical systems such as hinged covers, sliding pistons and other mechanical levers and parts. In addition, these valves are expensive, require maintenance and are subject to frequent failure.

These disadvantages are overcome by the present invention by the use of a very simple and reliable valve that employs a flexible slit diaphragm and has no moving metal parts.

SUMMARY OF THE INVENTION

Briefly, the present invention comprises a slit diaphragm valve having a slit diaphragm and a control plate retained in facial contact. The slit diaphragm is a circular sheet of rubber having a centrally positioned elongated slit. The control plate is a flat perforated circular metal plate with a centrally positioned control opening. Fluid flow in one direction is unrestricted whereas flow in the other direction is restricted by the size of the control opening in the control plate. Another embodiment includes a pair of control plates for controlled flow in both directions. Still another embodiment functions as a check valve by employing a perforated control plate having no contral opening.

STATEMENT OF THE OBJECTS OF THE INVENTION

An object of the present invention is to provide a valve that is inexpensive and reliable.

Another object is to provide a valve that has control of fluid flow in one or both directions.

Still another object is to provide a valve wherein the moving element is made of elastomeric material.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a pictorial view of one embodiment of the slit diaphragm valve of the present invention;

FIG. 2 is an exploded view of the slit diaphragm valve of FIG. 1;

FIGS. 3A, 3B and 3C are diagrams illustrating the operation of the slit diaphragm valve of FIGS. 1 and 2;

FIG. 4 is an exploded view of another embodiment of the valve of the present invention in which the flow is variable in both directions;

FIG. 5 is an exploded view of another embodiment of the valve of the present invention in which the valve functions as a check valve;

FIG. 6 is another embodiment of the slit diaphragm that may be used in the different embodiments of the slit diaphragm valves of the present invention;

FIG. 7 is still another embodiment of the slit diaphragm that may be used in the different embodiments of the slit diaphragm valves of the present invention; and

FIG. 8 is still another embodiment of the slit diaphragm that may be used in the different embodiment of the slit diaphragm valves of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 is illustrated a pictorial view and in FIG. 2 is illustrated an exploded view of one embodiment of the slit diaphragm valve **11** of the present invention. Slit diaphragm valve **11** includes flanges **13** and **15**, slit diaphragm **17** and control plate **19**. The piping **21** of a system, in which the slit diaphragm valve **11** may be used, is illustrated by broken lines in FIG. **1**. The piping may be connected to the flanges by means of bolts, welding or the like. Flanges **13** and **15** normally have inside diameters d_1 and d_2 that are about the same as the inside diameter of the piping to which they are connected. However, these openings may be larger or smaller depending upon special design considerations. Flanges **13** and **15**, respectively, include openings **23** and **25** through which bolts **27** of FIG. **1** may be inserted. Slit diaphragm **17** is made of an elastomeric material, preferably neoprene, and includes openings **29** through which bolts **27** of FIG. **1** may be inserted. Slit diaphragm **17** also includes a slit **31** that is preferably straight, is center positioned and has a length L_1. The length L_1 is preferably the same as, or longer than, the inside diameter d_1 of flange **13**. This is because if L_1 is lesser than d_1, the slit has a tendency of tearing at the ends after a certain duration use. However, if this limited use is a permissible condition, then L_1 may be made of lesser length and will provide a more restricted flow than if L_1 were the same as or greater than diameter d_1. Control plate **19** includes a center opening **33** having a diameter d_3, a plurality of openings or perforations **35**, and openings **37** through which bolts **27** of FIG. **1** may be inserted. Depending upon the desired flow control the diameter d_3 may be varied. Openings **35** are made throughout the exposed region of control plate **19** and provide for relatively unrestricted and uniform flow when fluid flow is in the uncontrolled or upward direction. The size and spacing of openings **35** are based upon providing adequate flow and strength. If high strength is not essential, then a greater total area of openings **35** is preferred. In certain situations, depending upon the size of the opening **35**, it may be desirable that openings not be provided directly behind the slit of slit diaphragm **17**. That is, adjacent to slit **31** should be provided a solid backing except where opening **33** is provided. This will provide a somewhat better seal and control of flow in the downward direction and control will be determined only by opening **33**. When assembled, flanges **11** and **15**, slit diaphragm **17** and control plate **19** lie flat against each other and are

clamped in place by bolts **27** to provide structural integrity and an effective seal at the periphery of the valve.

In FIGS. **3A**, **3B** and **3C** is shown the schematic sequential operation of the slit diaphragm valve **11** of the present invention. The elements of the valve are shown in spaced relation for illustrative purposes. Above each figure is illustrated the configuration of the slit for that particular condition.

FIG. **3A** illustrates the components of the valve when there is no flow in either direction through the valve. From this diagram it can be seen that slit **31** of slit diaphragm **17** is closed and provides a tight seal in both directions.

FIG. **3B** illustrates the components of the valve when there is fluid flow through the valve in the upward or unrestricted direction. From this figure it can be seen that slit **31** has separated to provide a relatively large opening **31B**. It can also be seen that there is a free flow of fluid through openings **33** and **35** of control plate **19**. Therefore, when the flow is in the upward direction, control plate **19** does not control or restrict the fluid flow.

FIG. **3C** illustrates the components of the valve when there is fluid flow in the downward or restricted direction. From this figure it can be seen that slit **31** has separated to provide a relatively small opening **31C**. This is because control plate **19** prevents all parts of slit **31** from separating except that part of slit **31** that is adjacent opening **33**. Therefore, only restricted flow is allowed to pass through openings **31C** and **33** in the downward direction.

From this it can be seen that a variable flow valve of FIGS. **1** and **2** is provided that is simple and very effective. This valve may be used in many applications where variable flow in opposite directions is desired. That is, it may be used in piping systems as either a breather valve, relief valve or a circulation control device, for example.

In FIG. **4** is illustrated another embodiment of the present invention. This embodiment differs from the previously described embodiment in that it includes a pair of control plates **41** and **43** positioned on opposite sides of slit diaphragm **17**. Control plate **41** includes an opening **45** that has a diameter d_4. Control plate **43** has an opening **47** that has a diameter d_5. From this it can be seen that flow in the upward direction is controlled by the diameter d_4 of opening **45** and flow in the downward direction is controlled by the diameter d_5 of opening **47**. As illustrated in FIG. **4**, opening **45**, having a diameter d_4, is larger than opening **45**, having a diameter d_5. Therefore, flow in the upward direction is less restricted than flow in the downward direction. It should be particularly noted that the simplicity of removing and then inserting different control plates having different sized openings is one of the unique features of the present invention.

In FIG. **5** is illustrated another embodiment of the present invention. This embodiment differs from the previously described two way flow valves in that it allows flow in only one direction, that is, it functions as a check valve. This embodiment includes a pair of control plates **49** and **51**. It should be particularly noted that control plate **49** has no central opening and therefore prevents slit **31** from opening when there is a pressure differential that would otherwise cause fluid flow in the upward direction. Control plate **51** has an opening **53**, having a diameter d_6, which controls the flow in the downward direction in the same manner as described in the previous embodiments. The perforated openings **35** in control plate **49** allow flow in the downward direction but are spaced and sized in such a manner as to prevent slit **31** from opening for what would otherwise be flow in the upward direction. It should be noted that control plate **51** need not include perforations **35**. Moreover, the valve in this embodiment would still function as a check valve if control plate **51** were removed.

In FIG. **6** is illustrated another embodiment of the slit diaphragm **17** that may be used in the previously described embodiments of the slit diaphragm valve of the present invention. This slit diaphragm includes a plurality of magnets **55** that are imbedded in each side of the elastomeric material. This may be used when a more positive closure is required. Also, springs may be used in place of the magnets, or in conjunction with them, to provide a more positive closure.

In FIG. **7** is illustrated still another embodiment of the slit diaphragm **17** that may be used in the previously described embodiment of the slit diaphragm valve of the present invention. This slit diaphragm includes a plurality of slits **57** in the elastomeric material. These plurality of slits allow a larger flow than the previously described single slit.

FIG. **8** illustrates still another embodiment of the slit diaphragm **17** that may be used in the previously described embodiment of the slit diaphragm valve of the present invention. This slit diaphragm includes a plurality of short and or long parallel or nonparallel unconnected slits **59** in the elastomeric material. This plurality of slits allows a larger flow due to a larger cross sectional area of elastomeric material which can be used.

What is claimed is:

1. A valve comprising:

a. a flat diaphragm made of elastomeric material and having at least one slit formed therein;

b. a flat first control plate having a center opening positioned in the center region thereof;

c. means holding one side of said flat diaphragm in facial contact with one side of said flat first control plate;

d. said flat first control plate has a plurality of fluid transfer openings formed therein that surround said center opening;

e. said slit is elongated, is centrally positioned and has a predetermined length that is greater than the diameter of said center opening; and

f. whereby said flat first control plate restricts said slit from opening more than the diameter of said center opening.

2. The valve of claim **1**, wherein:

a. the diameters of said plurality of openings are substantially smaller than the diameter of said center opening.

3. The valve of claim **1**, including:

a. a flat second control plate having a center opening positioned in the center region thereof;

b. means holding the other side of said flat diaphragm in facial contact with one side of said second flat control plate; and

c. said predetermined length of said slit is equal to or greater than the diameter of the opening in said second control plate and the diameter of the open-

ing in said second control plate is greater than the diameter of the opening in said first control plate.

4. The valve of claim 3 wherein:
a. said second control plate has a plurality of openings formed therein that surround said center opening; and
b. the diameters of said plurality of openings are substantially smaller than the diameter of said center opening in said second control plate.

5. The valve of claim 1 including:
a. a flat plate having a plurality of openings formed therein;
b. the diameters of said plurality of openings are substantially smaller than the diameter of said center opening in said first control plate; and
c. whereby said flat plate completely restricts the slit from opening.

6. The valve of claim 1 wherein:
a. said flat diaphragm has a plurality of magnets embedded adjacent said slit and in said elastomeric material.

7. The valve of claim 1 wherein:
a. said flat diaphragm has a plurality of slits formed therein.

* * * * *