Jan. 29, 1963 D. L. McINTOSH 3,075,740

DIAPHRAGM VALVE

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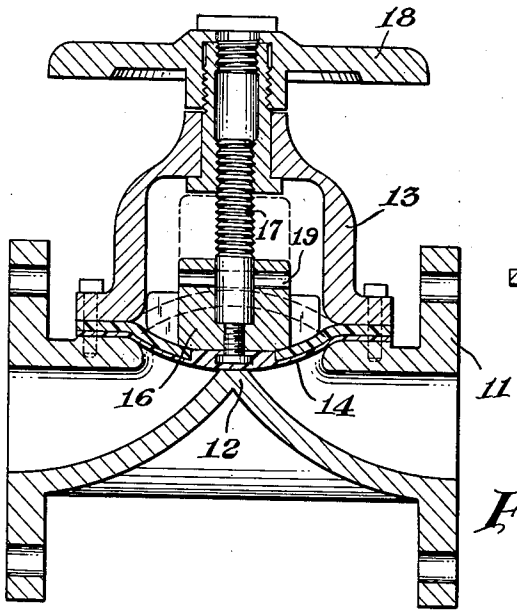

Fig. 1

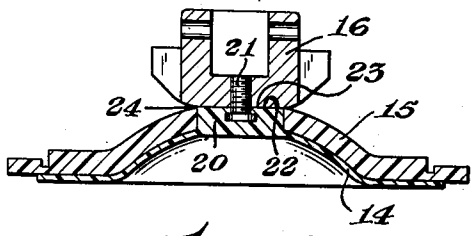

Fig. 2

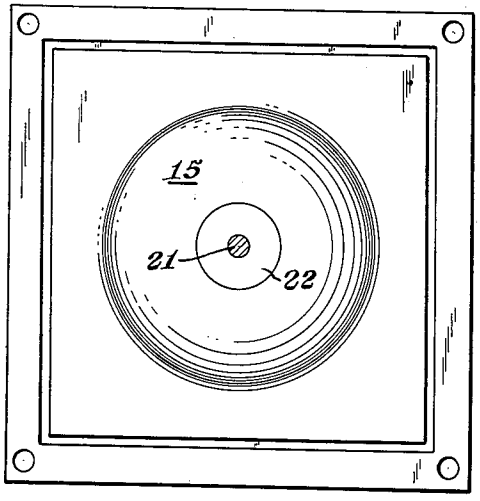

Fig. 3

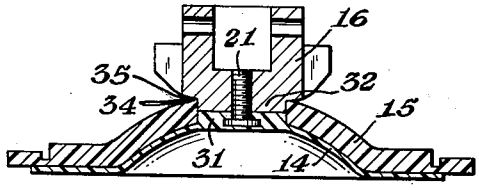

Fig. 4

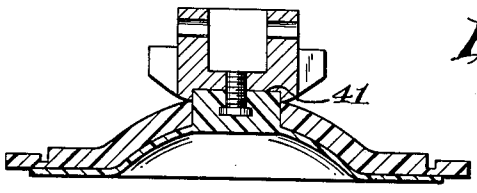

Fig. 5

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DIAPHRAGM VALVE

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This invention relates to improvements in a diaphragm valve. More particularly it pertains to an improved assembly and diaphragm having a thin sheet plastic diaphragm molded from an aliphatic base polymer and a thick flexible backing sheet therefor made of a rubber-like material and an arrangement of securing the diaphragm to the mechanism by which it is actuated.

Valves of the type to which this invention relates have a body with a substantially straight passageway therethrough which is interrupted by a transverse weir whose concaved surface extends across the passageway and forms a seat for the diaphragm. The latter is clamped around its periphery between the body and a bonnet mounted thereon which houses most of the working parts by which the diaphragm is moved toward or away from the weir. At all times the diaphragm seals off the actuating mechanism from the fluid flowing through or standing in the body passage.

One of the elements of the actuating mechanism housed within the bonnet is a so-called compressor located adjacent to the diaphragm on the side thereof remote from the weir. When the valve is to be closed, the other actuating mechanism elements cause the compressor to advance towards the weir and bulge the diaphragm firmly against the top concaved surface thereof, thereby shutting off all communication in the passage from one side of the weir to the other. To open the valve the diaphragm must be withdrawn from its contact with the weir and bulged in the opposite direction. Diaphragms made of either natural or synthetic rubber compounds reinforced with a fabric are fairly thick and strong and are used successfully in the type of valves described above. However, since the diaphragms of either natural or synthetic rubber are not resistant to certain chemicals, such as acids, alkalies or strong solvents, they cannot be used in lines in which these chemicals are present. To overcome this difficulty recently diaphragms have been constructed of aliphatic base polymers such as Saran and polytetrafluoroethylene. The diaphragms constructed wholly of plastic material are not entirely satisfactory. Because if such a plastic diaphragm is made thick enough to provide the necessary strength required it does not have the required flexibility. Thus recently diaphragms are being made of a thin sheet of the plastic material which is backed up with a rubber-like sheeting to strengthen the diaphragm.

While the thin plastic diaphragm and the backing are normally made of resilient material preformed with a bulge extending away from the weir, the resiliency of the material cannot be relied upon to cause it to return to the opened position when the compressor is withdrawn. Thus, an attachment between the diaphragm and the actuating mechanism whereby the diaphragm would be positively withdrawn from engagement with the weir upon opening of the valve must be provided. This attachment has heretofore taken the form of a stud with its head embedded in the center of the plastic diaphragm and its shank extending outwardly therefrom on the side remote from the weir to engage into the compressor. Generally a hole was provided through the rubber-like backing through which the shank of the stud extends and engages the compressor. No contact of the plastic diaphragm with the compressor is provided other than through the stud embedded into the plastic material. With the shank

of the stud engaged in the compressor, undue pressure is applied to the portion of the thin plastic gasket at the head of the stud. At times appreciable pressure is applied to the compressor to insure proper seating of the diaphragm on the weir. When this is done the plastic material between the stud-head and the weir is severely squeezed and also stressed so that after a number of operations of opening and closing the valve the plastic diaphragm will rupture at the stud-head.

To overcome the above difficulty it has been suggested that the diaphragm be mounted non-rigidly to the compressor. While a non-rigid attachment may overcome the difficulty of rupturing the plastic diaphragm at the stud-head, it is undesirable due to the "floating" action obtained. At times it is desirable to control the flow rates by use of the valve and thus it is desirable to have a valve with positive action knowing that if the valve is turned a certain amount it can be expected that the diaphragm will be raised or lowered a given amount. A further disadvantage is that the method of attachment becomes complex and can only be used on large valves. Even in fairly large valves, the mechanism cannot be built very sturdily due to its complexity. While at times it is not necessary to have a sturdy method of attaching the diaphragm to the rise, it does become critical when the valve is to be used in a vacuum system. In a vacuum system the differential pressure obtained gives rise to a force on the diaphragm tending to close it. Under these conditions a strong method of attaching the diaphragm to the compressor is necessary to keep from pulling the diaphragm from the compressor or rupturing its method of attachment.

It is therefore an object of this invention to provide a diaphragm valve wherein undue stress is not placed upon the head of the stud embedded in the diaphragm upon closing of the valve. A further object is to provide a diaphragm valve wherein the diaphragm is attached firmly to the compressor so it can be actuated without any floating action. A still further object is to provide an improved assembly of a diaphragm, backing and compressor wherein the diaphragm is firmly attached to the compressor without placing undue stress on the diaphragm when the diaphragm is closed or actuated.

The above and other objects are accomplished, according to the invention, by the improved assembly comprising a thin plastic diaphragm having a stud with its head embedded in a boss on the plastic diaphragm with the thread stem projecting from the boss. The boss extends into a center opening in the rubber-like backing with the threaded stem of the stud engaging the compressor seating the boss of the plastic diaphragm and the area of the backing adjacent to the central opening against the compressor surface. By the above assembly the diaphragm may be actuated and closed without producing undue stress on the plastic diaphragm at the head of the embedded stud. The diaphragm which is of a plastic material is less resilient than the backing. By having the boss of this less resilient material contacting the compressor, the pressure applied to the compressor is transmitted to the boss on the plastic diaphragm and distributed over the diaphragm uniformly without localizing the stress at the stud. Also by having the boss of the less resilient material contacting the compressor, positive action is obtained and no floating action is experienced as when the backing sheet is between the compressor and the diaphragm as heretofore used. The resilient backing material used in support of the diaphragm engages the compressor surface at the area adjacent to the boss and thus the advantages of a resilient rubber-like material backing is fully realized.

The invention may be more easily understood by con-

sidering the specification in conjunction with the drawings, in which

FIGURE 1 illustrates a diaphragm valve to which the invention is related,

FIGURE 2 is a detailed illustration of the diaphragm backing and compressor assembly,

FIGURE 3 is a top view of diaphragm of FIGURE 2, and

FIGURES 4 and 5 illustrate modifications of the assembly shown in FIGURE 2.

The valve shown in FIGURE 1 comprises a body **11** having a passageway therethrough which is intersected by a transverse weir **12**. A bonnet **13** bolted to the body in which the actuating mechanism for the movement up and down of diaphragm **14** is housed. As shown in the drawing the actuating mechanism comprises a compressor **16** which is attached to a threaded stud **17** and engaging the threaded portion of the handle **18** which raises and lowers the stud by turning of the handle.

In FIGURE 2 the improved assembly used in the valve in FIGURE 1 comprising the compressor **16**, diaphragm **14**, and the backing **15** is shown in detail. In the improved assembly the diaphragm which is constructed of relatively thin material has a boss **20** located at its center in which the stud **21** which engages the compressor is embedded. In the assembly, the boss of the diaphragm extends through the backing **15** and the top surface **22** of the boss seats against the surface **23** of the compressor. In addition to the top surface of the boss seating against the compressor the top surface **24** of the backing sheet **15** adjacent to the opening through which the boss extends also is seated against the surface of the compressor. In FIGURE 3 a top view of the diaphragm is shown.

A modification of the improved assembly of FIGURE 2 is shown in FIGURE 4. The boss **31** on the diaphragm shown in FIGURE 3 does not extend all the way through the backing **15** as in FIGURE 2. The compressor used in this assembly is made with a boss-like reduced section at the end **32** which fits into the center opening of the backing sheet and is seated against the boss of the diaphragm when the diaphragm is attached to the compressor. The top surface of the backing sheet **34** adjacent to the opening in the backing is in contact with the flared portion **35** of the compressor.

In FIGURE 5 a further modification of the assembly of FIGURE 2 is shown wherein the boss in which the stud used for attaching the diaphragm to the compressor is appreciably thicker than the thickness of the backing and extends in a recess **41** in the compressor when the diaphragm is attached.

A method of attaching the compressor to the mechanism used to raise and lower the compressor is immaterial. The compressor may be screwed onto stud **17**, however it is preferred to have the attachment made as shown in FIGURE 1 by insertion of a pin **19** in an aligning passageway in stud **17** and the compressor.

It will be apparent from the specification and drawing that the improved assembly herein claimed enables the diaphragm to be actuated and tightly closed without producing undue stress on the plastic diaphragm at the point the stud is embedded. By using a boss on the plastic diaphragm and having this boss in contact with the compressor the diaphragm may be firmly seated without localizing the stress at the head of the stud. Since the backing is also in contact with the surface of the compressor the advantages of the backing are fully utilized. This assembly is simple and thus may be constructed and used in small valves as well as large valves. Also due to the simplicity, the stud used may be of sufficient size and strength to hold the diaphragm opened even in vacuum operation. In vacuum operation a force is applied intending to close the diaphragm and if the attachment of the diaphragm to the compressor is not strong enough the diaphragm is torn loose from the compressor. In addition to the above advantages by having the boss in contact of the relatively non-resilient material of the plastic diaphragm in contact with the compressor, floating action that is normally obtained in the valve heretofore used is not present. Thus, when the rate of flow has to be controlled by use of the valve, this is a distinct advantage. A turn of the handle will actuate the diaphragm a corresponding amount. In valves heretofore used, the backing malerial was inserted completely between the diaphragm and the compressor. Since the backing is of resilient material a floating action was obtained. When the valve was closed tight the backing would be compressed. Thus, it was difficult to know whether the movement of the compressor obtained by turning of the valve moved the plastic diaphragm or was compressing or releasing the compression on the backing sheet.

What is claimed is:

1. In a diaphragm valve comprising a body having substantially straight passageway therethrough intersected by a weir extending thereacross with an inwardly curved surface forming a seat for a diaphragm, and a bonnet assembly secured to said body housing having a compressor capable of being moved toward and away from the weir, a thin plastic diaphragm sufficiently thin that in use a backing is required, and a rubber-like resilient backing sheet therefor with the edges clamped between the bonnet and the body, said plastic diaphragm being substantially less resilient than the backing sheet, said backing being interposed between the diaphragm and the compressor, the improvement of said bonnet assembly comprising said thin plastic diaphragm having a stud with its head embedded in a boss on the diaphragm with a threaded stem projecting from the boss and said rubber-like resilient backing sheet having a central opening therethrough, said boss on said plastic diaphragm extending into the central opening of the backing sheet with the threaded stem of the stud engaging the compressor, seating the boss on the plastic diaphragm and the area of the backing sheet adjacent to the boss against the compressor surface.

2. A diaphragm valve according to claim 1 wherein the boss on the diaphragm is substantially the same height as the thickness of the backing sheet.

3. A diaphragm valve according to claim 1 wherein the boss on the diaphragm extends only part way into the central opening in the backing sheet and a boss, provided on the lower end of the compressor, extends into the central opening in the backing sheet to contact the boss of the plastic diaphragm.

4. A diaphragm valve according to claim 1 wherein the boss on the diaphragm extends through the central opening in the backing sheet and is seated in a recess provided on the lower end of the compressor.

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