Dec. 7, 1948.

H. F. HADLEY

2,455,480

DIAPHRAGM PUMP

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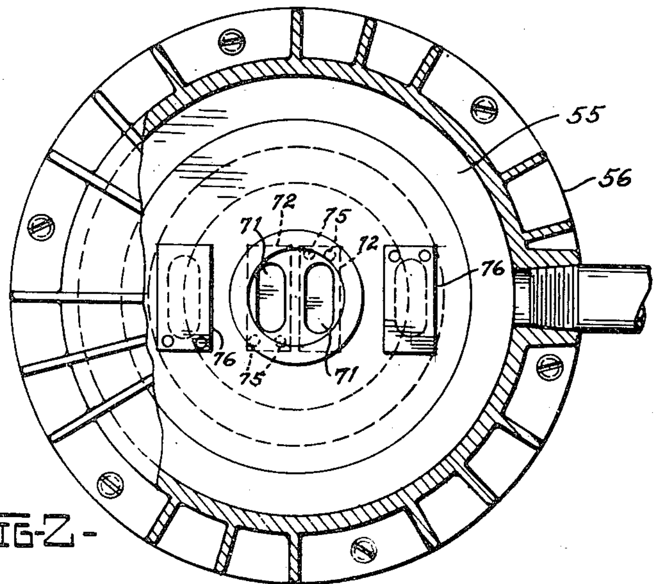

FIG-2-

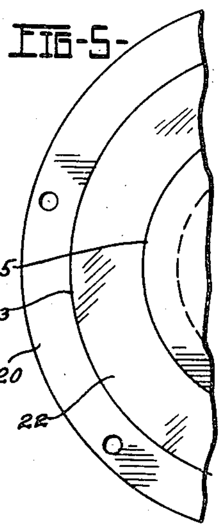

FIG-5-

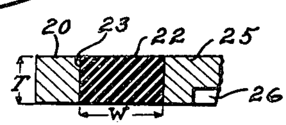

FIG-6-

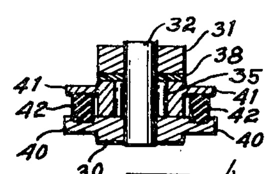

FIG-4-

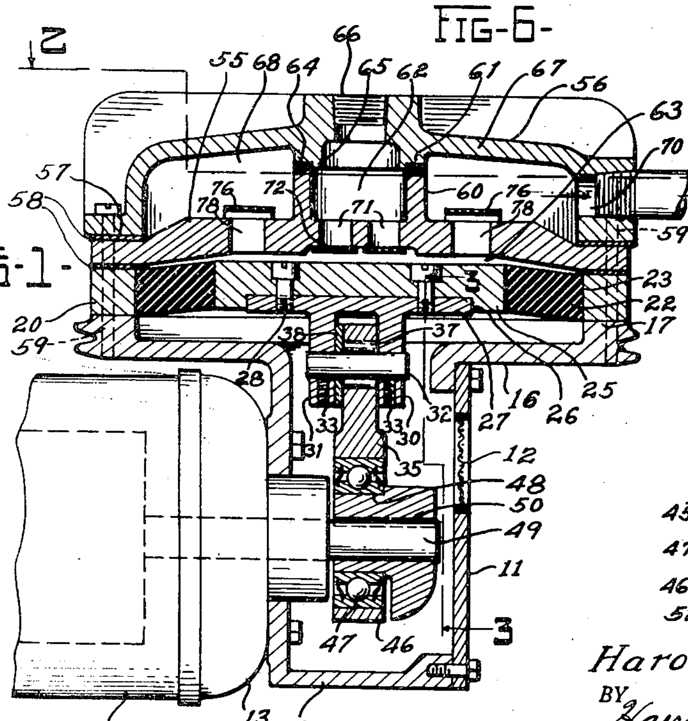

FIG-1-

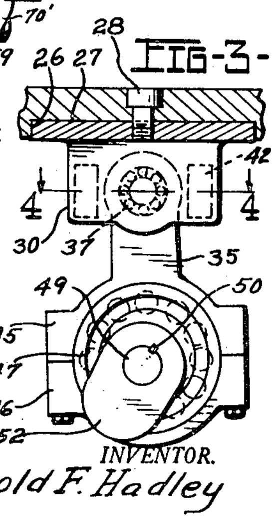

FIG-3-

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DIAPHRAGM PUMP

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4 Claims. (Cl. 253—170)

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This invention relates to fluid pumps and more particularly to pumps or compressors of the diaphragm type especially adapted for compressing gases.

Pumps and compressors of the diaphragm type have been constructed for comparatively low, pressure and small volume operation especially for compressing air and other gases, and have proven fairly satisfactory for this character of work. When attempts have been made to use a compressor of the usual diaphragm type for high pressures or large volume operations, diaphragm rupture and other attendant difficulties have been encountered which in the past have resulted in failures.

The present invention has for a principal object the provision of a fluid pump or compressor of the diaphragm type capable of operation at high pressures and of compressing comparatively large volumes of gas for long periods of time without diaphragm failure.

Another object of the invention is the provision of a diaphragm compressor especially adapted for compressing gases to high pressures in conjunction with a valve arrangement which permits gas to be compressed uncontaminated with oil or other lubricant.

Another object is the provision of a unitary diaphragm construction wherein a metallic flexible element is bonded to a metal member in such a manner that the diaphragm is capable of operation over long periods of time at high pressures without failure.

Another object is the provision of a unitary diaphragm construction which may be readily replaced in a comparatively short time without the use of special tools.

Still another object is the provision of a diaphragm compressor adapted for high pressure operation wherein there is afforded a large metallic area enhancing the radiation of excess heat from the compression and plenum chambers.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

Figure 1 is a vertical sectional view illustrating a compressor embodying a form of my invention;

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Figure 2 is a horizontal view taken substantially on the line 2—2 of Figure 1;

Figure 3 is a fragmentary vertical sectional view taken substantially on the line 3—3 of Figure 1;

Figure 4 is a horizontal sectional view taken substantially on the line 4—4 of Figure 3;

Figure 5 is a plan view showing a portion of the diaphragm arrangement per se;

Figure 6 is a sectional view showing a portion of the diaphragm construction.

While I have illustrated the arrangement of my invention as particularly adapted for use in compressing gases, such as air to comparatively high pressure, it is to be understood that my invention may be utilized for pumping liquids, or as a vacuum producing means, or for any other purpose where it may be found to have utility.

Referring to the drawings in detail, the apparatus is inclusive of a housing 10 formed with an opening in the front thereof normally closed by a cover 11, the latter having a screened breather opening 12 to facilitate equalization of air pressure in the housing. The housing 10 is adapted to be secured to the frame structure or end plate 13 of a motor 14 adapted to actuate the compressor. The upper portion of the compressor housing 10 is enlarged or flared outwardly as at 16 the enlarged portion having a peripheral flange 17.

The diaphragm construction of my invention is inclusive of an annulus or ring 20 preferably formed of metal, as for example, brass to which is bonded or vulcanized a flexible element or diaphragm 22 as at 23. The flexible element 22 is of annular configuration, the inner wall of which is bonded or vulcanized to a circular member or metal disc 25. As the diaphragm construction forms an important part of the present invention, it will be hereinafter described in further detail. The member 25 is formed with a circular recess 26 adapted to receive a disc-like member 27 fixedly secured to member 25 by means of screws 28. Integrally formed with member 27 are shaped depending bosses 30 and 31 having aligned openings adapted to accommodate a journal pin 32 retained in place by screws 33. A connecting rod 35 has its upper end bored to accommodate a needle bearing 37 which surrounds the journal pin 32. Positioned between boss 31 and the connecting rod is a thrust bearing 38 preferably of the self-lubricating type. Boss 30 and the upper end of the connecting rod 35 are formed with laterally extending projections designated 40 and 41 respectively. Positioned between each set of projections are resilient elements 42 as shown in Figure 4, these elements being preferably blocks or rubber, synthetic rubber or the like. The resilient element 42 are subjected to initial compression for the purpose of exerting continuous lateral pressure upon the thrust bearing 38 and thus function as a vibration damping means for minimizing the shocks due to reciprocatory movements of the connecting rod 35, members 25, 27, diaphragm 22 and associated parts as well as to eliminate lateral lost motion between bosses 30, 31 and the connecting rod.

The connecting rod 35 is formed with an enlarged portion 45 to which is secured a bearing cap 46, the latter securing a ball bearing 47 in the end of the connecting rod. The inner race of the bearing 47 fits the exterior surface of a cylindrical member 48 which is bored to fit the motor shaft 49, the member 48 being fixed to the shaft by means of a key 50. The axis of the exterior cylindrical surface of member 48 is eccentric with respect to the axis of the motor shaft 49, which eccentricity causes reciprocation of the connecting rod 35, members 25 and 27, and diaphragm 22 during rotation of the motor shaft. Member 48 is formed with a projection 52 for the purpose of counterbalancing the "pull" of the reciprocating parts of the compressor structure.

Positioned above the diaphragm construction is a valve carrying member or plate 55. A head 56 of the compressor having heat radiating fins is formed with an annular surface 57 arranged to secure the plate 55 in position on the housing 10, there being annular gaskets 58 interposed between the head 56 and plate 55 and between the plate 55 and member 20 to effect sealed joints. The head 56 and plate 55 are secured in position by means of screws 59 threaded into openings formed in the peripheral portion 17 of the housing 10. The plate 55 is provided with a concentrically arranged upwardly extending wall 60 which with a depending annular wall 61 on the head 56 forms an air inlet passage 62 for the compressor chamber 63. Interposed between the adjacent edges of walls 60 and 61 is a resilient gasket 64 of compressible material, as for example, rubber or the like arranged to seal the joint between the walls. The wall 61 is provided with an annular abutment 65 so that the high pressure of the compressed air or fluid will not dislodge the sealing member 63. The head 56 has a threaded opening 66 to accommodate an air filter (not shown).

The outer wall 67 of the head 56 together with the walls 60 and 61 define an annular plenum chamber 68 surrounding the air inlet passage 62 the wall 67 having an air outlet passage 70 arranged to accommodate a tube 70' or other means for conveying the compressed air or other fluid to the place where it is used.

The valve mechanism of the compressor is carried by the plate 55. In the form of the invention illustrated, the plate 55 is provided with a pair of inlet passages or ports 71 communicating between the walled passage 62 and the compression chamber 63. The inlet ports 71 are of elongated configuration, and are normally closed by flexible, reed-like valves or plates 72. One end of each valve is fixedly secured to the plate 55 by rivets 75, the valves being arranged in opposed relation as shown in Figure 2, i. e. the free or movable extremities of the valves extending in parallel but opposite directions so as to facilitate rapid passage of air or other fluid through the passage 62 into the compression chamber 63.

Similarly constructed valves 76 are arranged to normally close the outlet ports 78 and are also arranged with the free or movable extremities extending in parallel and opposite directions. This valve arrangement enhances the passage of gas from the compression chamber 63 into the plenum chamber 68.

The diaphragm or flexible element 22 is preferably made of rubber, synthetic rubber of the neoprene type or the like and is so bonded to the members 20 and 25 that continued flexure during compression operations does not dislodge the bonds. The arrangement of my invention is particularly adaptable for compressing gases to comparatively high pressures as well as having utility in pumping liquids. I have found a comparatively thick diaphragm with respect to its width must be employed in order to secure satisfactory results under high pressures without encountering diaphragm failure. One example of a practical construction which I have employed in developing compression pressures exceeding 150 lbs. per square inch is as follows: a compressor in which the outside diameter of the flexible element 22 is seven inches, and the diameter of metal member 25 is four and one half inches, a thickness of approximately three quarters of an inch for the flexible element has been found to be satisfactory. I have found that the following approximate proportions of flexible diaphragm dimensions will give satisfactory results. The thickness T (see Figure 6) of diaphragm or flexible element 22 should be at least equal to or greater than one half the width W of the element when the ratios of the diameter of member 25 to the diameter of the element are substantially in the proportion of four and one half to seven. If the width of the flexible element 22 is increased, the thickness should be proportionately increased.

While other proportions of width and thickness of flexible element 22 may be employed without departing from the spirit of the invention, I have found that by utilizing the above mentioned general proportions, very little bulging or flexure of the flexible element is encountered under pressure. It is not sufficient to materially affect the compression stroke so that a high compression and volumetric efficiency is maintained even at comparatively high pressures.

In the operation of the compressor, the motor 14 is started (that shown being electrically operated) rotating the shaft 49 and the eccentric member 48. The eccentric 48 causes reciprocatory movement of the connecting rod and diaphragm structure of the compressor. Each downward stroke of the connecting rod and diaphragm structure, as viewed in Figures 1 and 3, sets up a differential in pressure between the compression chamber and passages 62 which causes the inlet valves 72 and 73 to open, permitting air or other fluid to flow through the ports 71 into the compression chamber 63. On the upward stroke of the diaphragm construction, the valves 72 are closed, causing the air or fluid to be compressed in chamber 63. When the pressure within the chamber 63 exceeds that in the plenum chamber 68, the valves 76 are opened by reason of the higher pressure in chamber 63, causing the air or other fluid under pressure to flow through the outlet ports 78 into the annular plenum chamber or reservoir 68. The fluid under pressure is thereafter conveyed to the point of use through the duct 70.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

1. In combination, a compressor including a housing, a plate in said housing, valved ports in said plate; a compressor head; a diaphragm construction in said housing and forming with said plate a compression chamber; said diaphragm construction including a metal ring removably secured to said housing; a disc-like member in said housing; an imperforate stretchable diaphragm of uniform thickness bonded to said ring and said disc; and mechanical means associated with said disc-like member for positively effecting successive suction and pumping strokes of said member and stretchable diaphragm, said metal ring, diaphragm and disc being of substantially the same thickness.

2. A removable pumping element for a compressor including a metal annulus; a metal disc arranged within said annulus and spaced therefrom; an imperforate stretchable element of rubber or the like vulcanized to said annulus and said disc; said element being of uniform thickness and substantially the thickness of said metal annulus at the point of juncture therewith and of a width in cross section substantially twice the thickness thereof.

3. In combination, a pump including a housing; a plate in said housing; valved ports in said plate; a diaphragm construction in said housing; said diaphragm construction and said plate forming a pumping chamber; said diaphragm construction including an annulus of non-resilient material removably secured to said housing; a disc-like member in said housing; an imperforate stretchable element of uniform thickness permanently bonded to said annulus and said member; and mechanical means associated with said disc-like member for effecting successive pumping strokes of said member and stretchable element; said annulus, stretchable element and disc-like member being of substantially the same thickness.

4. A removable pumping element for a compressor including an annulus of non-resilient material; a disc-like member of non-resilient material arranged within said annulus and spaced therefrom; an imperforate stretchable element of rubber or the like bonded to said annulus and said member; said element being of uniform thickness and substantially the thickness of said annulus at the point of juncture therewith and of a width in cross-section substantially greater than the thickness thereof.

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