Dec. 23, 1941. C. KÜHNEL 2,267,280

DEVICE FOR CONVEYING FLUIDS

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Fig. 1

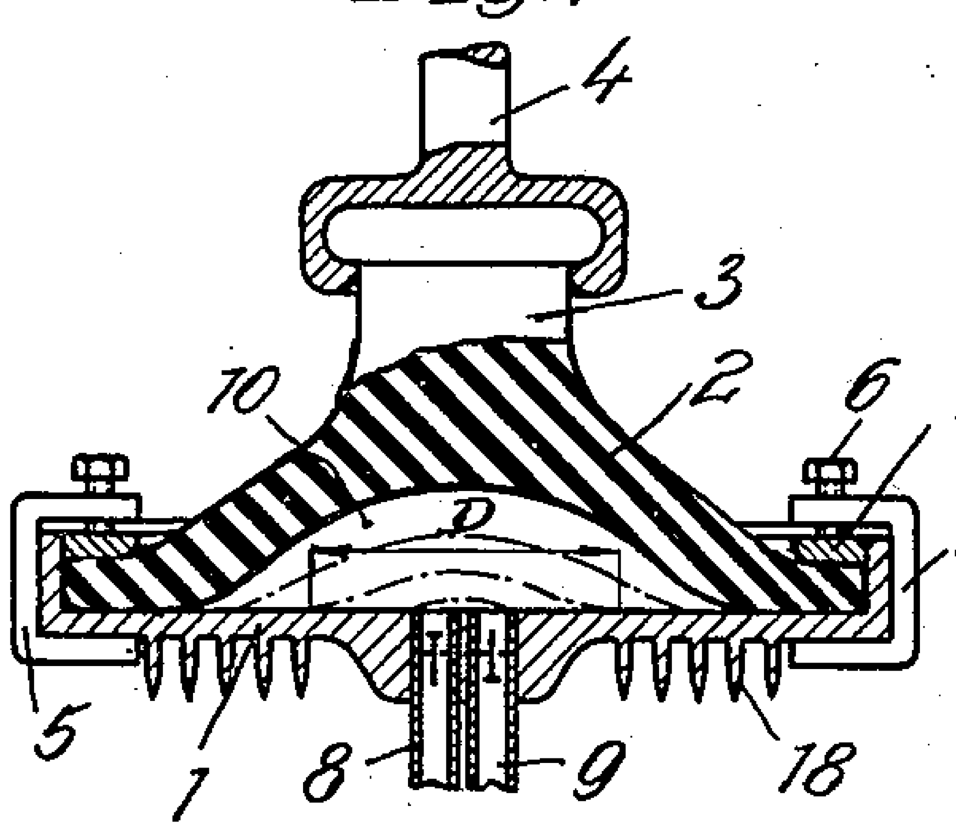


Fig. 2

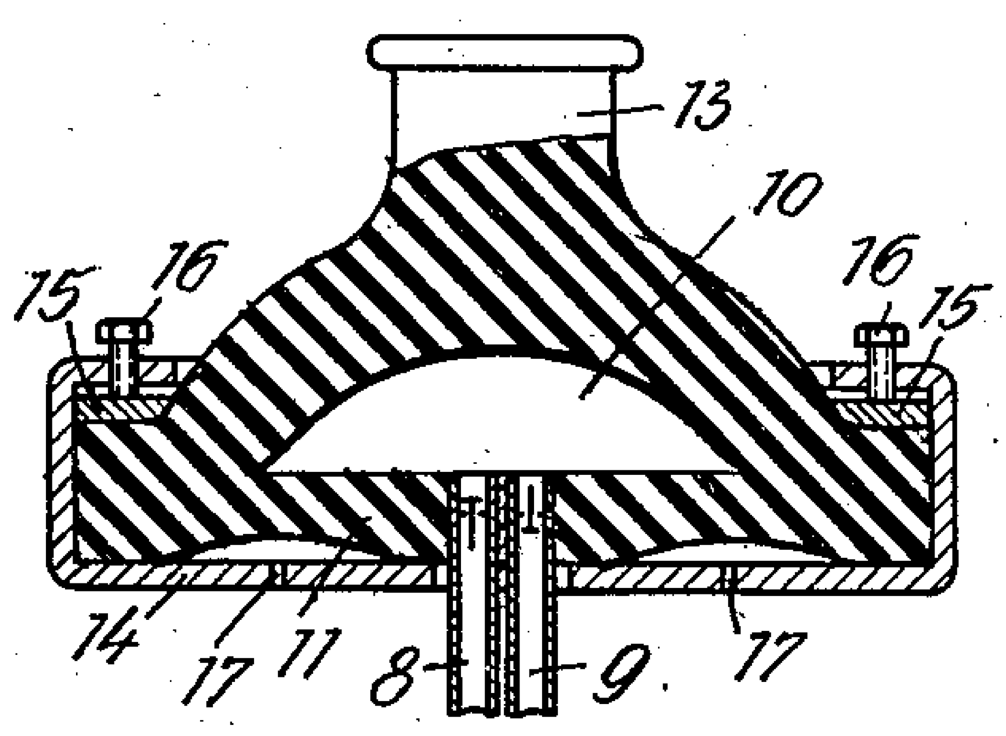


Fig. 3

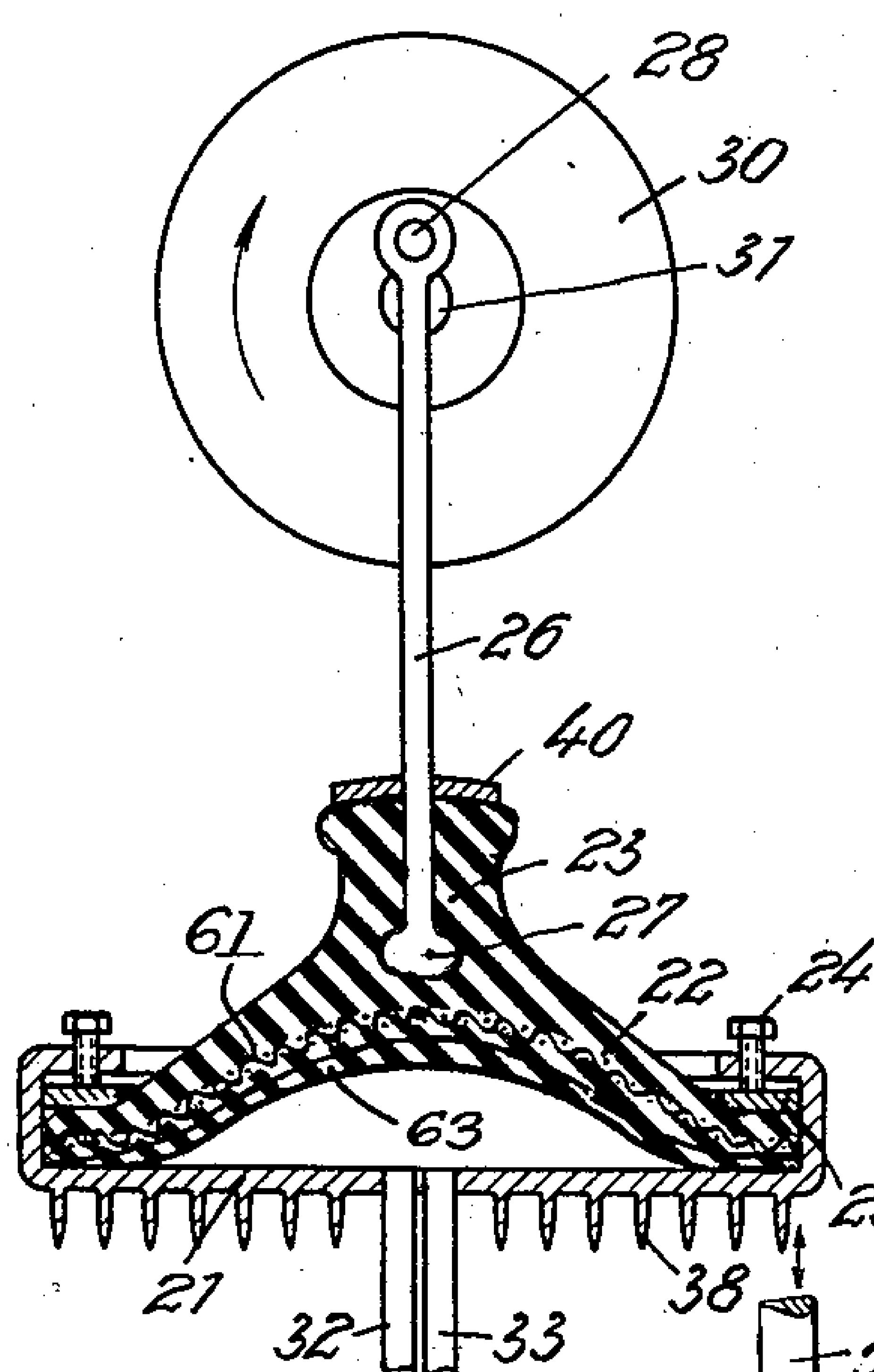


Fig. 4

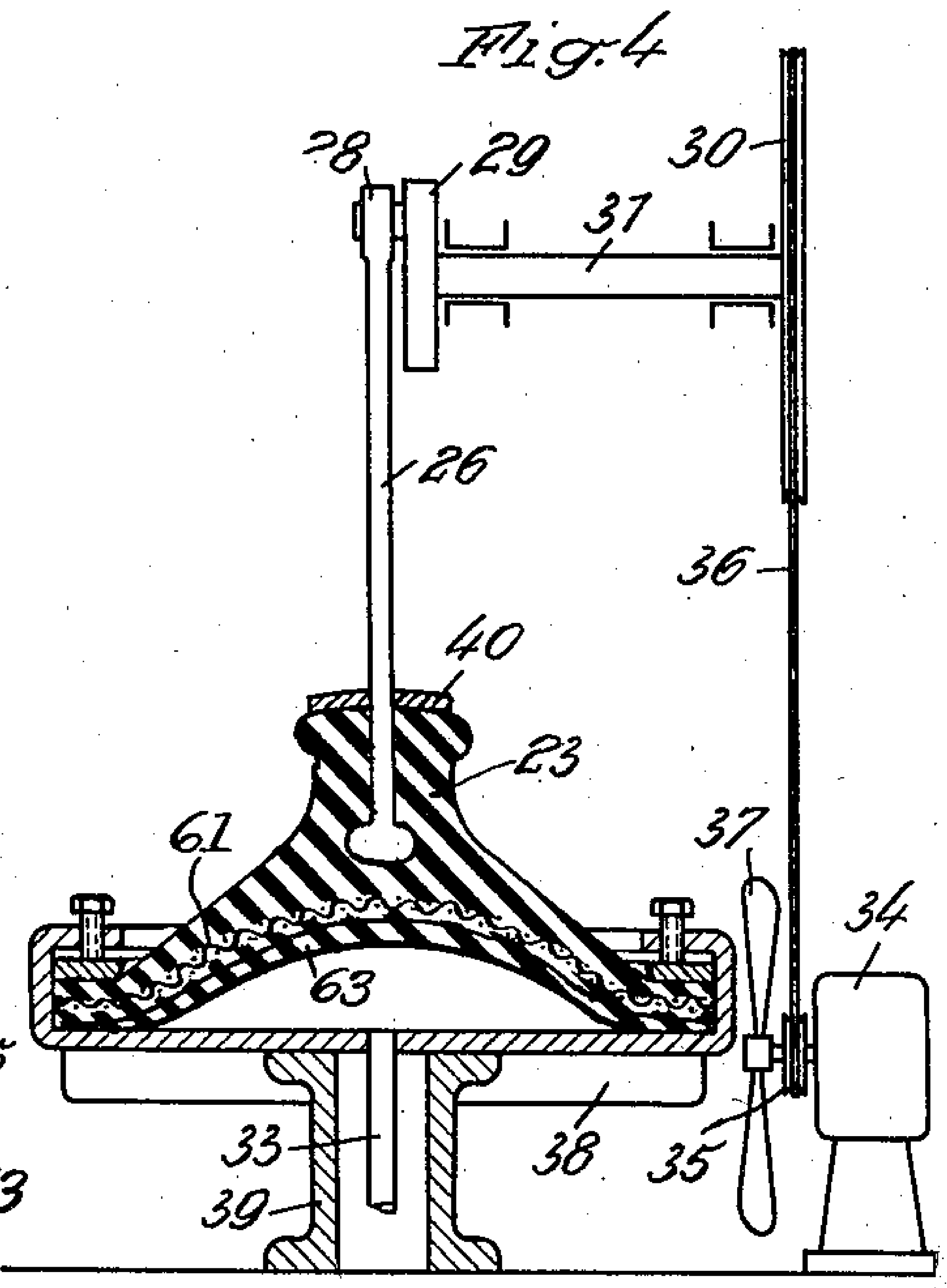
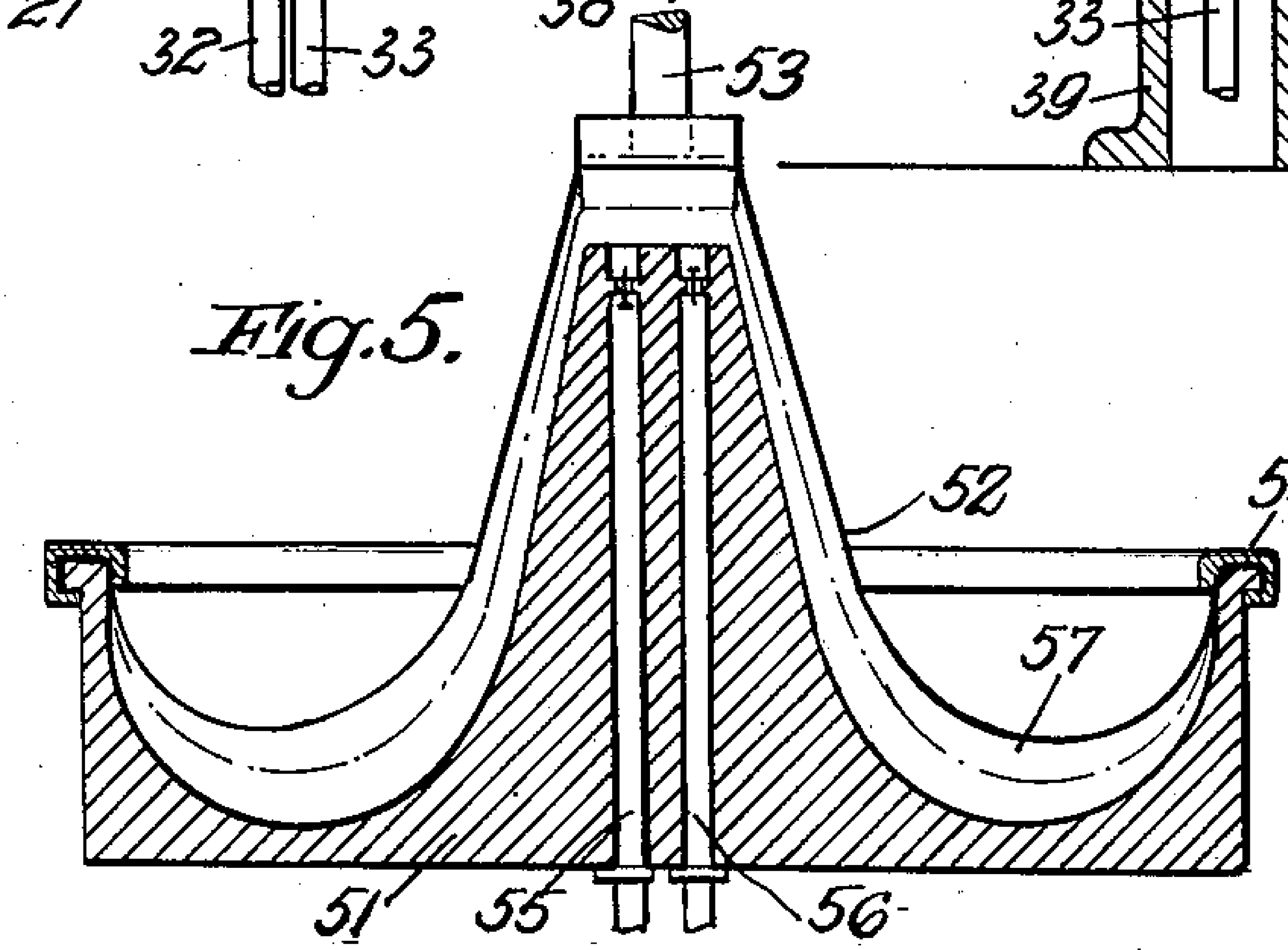


Fig. 5.



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UNITED STATES PATENT OFFICE

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DEVICE FOR CONVEYING FLUIDS

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7 Claims. (Cl. 230—160)

The present invention relates to a device for conveying fluids.

In conveying fluids, devices are often employed which have one or more flexible walls or diaphragms. In this case these walls are reciprocated by a driving device; for instance, by a crank mechanism, an electric oscillating armature drive or the like, whereby the working chamber volume of the device is alternately increased and decreased. A suction conduit and a pressure conduit are connected to a suitable point of the working chamber. In the case of a direct drive cooperating with such flexible walls difficulties are encountered if a considerable super-atmospheric pressure is to be overcome during the pressure stroke. In this case it may happen that the portion of the flexible wall lying between the hub, arranged in most cases in its central portion, and the firmly clamped wall edge warps out of the desired shape owing to the super-atmospheric pressure. To avoid this, devices have hitherto been employed in which the desired motion is imparted to the operating portions of the flexible wall by reinforcing plates and corresponding articulated rods connected with the affected portions of the wall. The device according to the invention avoids such additional guide rods for the portions of the flexible wall lying between the hub and the edge of the wall.

According to the invention the preferably circular flexible wall has such a shape that the forces acting during the pressure stroke on the wall between the point of application of the driving force and the peripheral support of the edge cause a deflection of the wall only toward the working chamber. In this manner the material of the wall supports itself during the pressure stroke, so that no strengthening means are necessary to prevent the wall from warping away from the opposite wall of the working chamber. The particular shape of the flexible wall is determined by the forces (inner pressure and outer driving force) acting on the wall.

The invention may be used in connection with metallic diaphragms as well as with arrangements whose flexible walls are made of rubber or of a similar resilient material. The use of rubber diaphragms presents the advantage that the ring stresses occurring in the material upon the reciprocating motion may be easily absorbed owing to the elasticity of the material so that the risk of fracture is considerably reduced. According to the invention the rubber wall and the wall of the working chamber opposite thereto are given such a shape that during the pressure stroke the volume of the working chamber is gradually reduced towards a given point, preferably towards the portion of the working chamber in which are arranged the suction conduit and the pressure conduit. Since strengthening plates need not be at all arranged on the side of the rubber portion facing the working chamber, the working chamber of the device may be utilized to such an extent that the clearance or dead volume is practically reduced to zero. The device is preferably so designed that the side of the rubber portion facing the working chamber is cambered in the position of rest of the device. During the pressure stroke the rubber is stressed in compression, whereas the known rubber diaphragms are stressed in tension both during the pressure stroke and suction stroke. According to the invention the rubber member is so shaped that a warping of the rubber toward the outside cannot occur in operation. In case reinforcements are necessary in some points elements made of less resilient material, such as sheet iron, metal wires, fibrous material or the like may be vulcanized in the rubber diaphragm, care being preferably taken in this case to maintain its surface defining the working chamber elastic so that it may snugly fit against the opposite wall of the working chamber at the end of the compression stroke. The device according to the invention may, for instance, be so designed that the working chamber is enclosed by the rubber wall and a stationary wall opposite thereto, in the central portion of which are arranged the suction conduit and the pressure conduit. However, it is also possible to design the gas-compressor or pump according to the invention with two opposite walls of rubber or of a similar resilient material.

In many cases homogeneous rubber may be employed for the driving parts. Under certain conditions, it may, however, also be advantageous to arrange in the construction of the rubber walls layers differing in elasticity; for instance, in such a manner that the parts of the rubber wall adjacent to the working chamber consist of a more elastic material than the parts lying further away or vice versa.

In the accompanying drawing are shown various embodiments of the invention.

In this drawing—

Figs. 1 and 2 show in sectional elevation two modifications of the compressor according to the invention,

Fig. 3 shows partly in sectional elevation a third form of the invention,

Fig. 4 shows a sectional elevation of Fig. 3 at right angles to that in Fig. 3, and

Fig. 5 represents a fourth embodiment also in a sectional elevation.

Fig. 1, more particularly, shows a gas compressor which may, for instance, be employed in a domestic refrigerator. The compressor consists substantially of a stationary wall 1 and a flexible wall 2 which may be raised and lowered with respect to wall 1 and consists of rubber or a similar substance and is provided with a neck or hub portion 3. In engagement with the latter is a rod 4 which may be reciprocated, for instance, by a crank mechanism or the like (not shown). The walls 1 and 2 are held together at their outer rims by clamps 5 provided with screws 6 exerting a pressure on clamping elements 7. In the central portion of the wall 1 are arranged a suction conduit 8 and a pressure conduit 9. 18 denotes cooling ribs by means of which the waste heat of the gas compressor is dissipated to the atmosphere. The other parts of the refrigerator are not shown in Fig. 1.

The working chamber 10 of the compressor enclosed by the walls 1 and 2 has the greatest volume in the position of rest shown. During the pressure stroke the average diameter D of the working chamber 10 decreases gradually—owing to the particular shape of the walls 1 and 2—towards the central portion of wall 1 where the conduits 8 and 9 are arranged, as is shown by the various positions of the rubber wall 2 indicated in dotted lines. The shape of walls 1 and 2 just referred to and as apparent from Fig. 1 is as follows. The hub portion 3, the clamped marginal portion, and the intermediate portion of the movable wall, formed of an integral body of rubber or the like, has a continuous inner surface. The wall body 2 is cup-shaped when in the relaxed position shown in Fig. 1, so that its inner surface is concavely curved away from the opposite inner surface of the rigid and stationary wall 1. The inner surface of wall 1 is also substantially continuous and has a flat shape. Consequently, the inner wall of the wall body 2, having no projections or the like, is flattened out during the pressure strokes of the crank-operated rod 4 and at the end of the stroke is contiguous with the inner surface of the stationary wall 1 substantially throughout the entire extent of both walls. The entire wall body 2 is self-supporting and its thickness increases from the clamped and stationary marginal portion towards the reinforced hub portion 3, as is apparent from Fig. 1. It will be noted from Fig. 1 and any of the other figures that the entire intermediate portion of the body 2 lies within an angle or triangle having its apex at the point of attack of rod 4 and determined by any two opposite points at the clamped periphery of the marginal portion, this angle being directed from its apex towards the stationary wall. Due to this design, the intermediate portion of the material of the body is stressed by a compressive force directed mainly from the hub portion 3 towards the clamped marginal portion and towards the surface of wall 1. As a result, the working chamber is constrainedly reduced in diameter towards its center as shown by the dotted lines already mentioned.

In Fig. 2, 10 denotes the working chamber, 11 and 12 the rubber walls enclosing the working chamber and 13 the neck of another gas compressor. 8 denotes the suction conduit and 9 the pressure conduit which pass through the wall 11. In this case the compressor is secured to a stationary plate 14 with the aid of a pressure rim 15 and clamping screws 16. Also in this case the diameter of the working chamber 10 decreases during the pressure stroke owing to the special shape of the walls 11 and 12 gradually towards the central portion of the container where the suction conduit and pressure conduit are arranged so that the clearance space of the compressor is practically eliminated. In this embodiment the valves and the suction conduit 8 and pressure conduit 9 are preferaby associated with the rubber member by vulcanization. 17 denotes the ventilation holes arraged in the plate 14.

In the embodiment shown in Figs. 3 and 4 the compressor consists, as shown in Fig. 1, substantially of a stationary wall 21 and a movable rubber wall 22 provided with a neck 23. The walls 21 and 22 are held together by means of clamping screws 24 and clamping plates 25. 26 denotes a connecting rod whose lower part 27 is attached to the rubber body 22, 23 by vulcanization. The upper end of rod 26 is pivoted on crank pin 28 fixed on the disk 29 which is driven with the aid of a shaft 31 and pulley 30 by an electric motor 34. In this embodiment the rubber body is caused to oscillate in the plane of the drawing upon the rotation of the disk 29. In the end positions, both of the suction stroke and pressure stroke the driving rod 26 is, however, perpendicular to the stationary plate 21. 32 denotes the pressure conduit and 33 the suction conduit. 40 is a support plate secured to the rod 26 and in engagement with the neck 23.

The gas compressor is driven by the electric motor 34 with the aid of the belt drive 30, 35, 36. On the motor shaft is mounted a ventilator 37 serving to cool the compressor and other parts of the refrigerating apparatus. 38 are cooling ribs arranged at the lower part of the stationary wall 21. 39 is a support for the compressor. The rubber parts shown in the various embodiments may be so dimensioned that when slackened they just fit in their supporting plates 1 (Fig. 1) and 14 (Fig. 2). The rubber parts may also have a larger outer diameter than their supporting plate and be inserted into the plate rim with a corresponding initial tension. In the embodiment according to the invention the suction stroke may under given conditions be extended beyond the normal position of the rubber piston shown so that the rubber parts become stressed in tension in the last portion of the suction stroke.

The flexible rubber wall of the above-described compressors may be composed of various rubber layers of different elasticity. The embodiment shown in Figs. 3 and 4, for instance, contains a second layer 63 forming an integral part of the wall 22 and having an elasticity different from that of the main portion of the wall. It may further be of advantage to reinforce the flexible wall by strengthening means, such as the reinforcement 61 in Figs. 3 and 4, which are vulcanized in the rubber body.

Fig. 5 shows an embodiment of the invention in which a metallic diaphragm is employed in the construction of the compressor for a refrigerating apparatus. The compressor consists substantially of a stationary body 51 provided with an annular recess the bottom 58 of which forms the stationary wall of the pump. From this recess rises a central cone 59, the outer surface of which forms the continuation of this stationary wall. Over this cone and recess 58 is placed a metal diaphragm 52 forming the movable wall and shaped similarly but not the same as recess 58 and cone 59, so that when the diaphragm is fixed at its rim by a clamp 54 to the rim of body 51, a chamber 57 is normally formed between the diaphragm and the bottom 58 of the recess, as shown. Since this chamber extends to and over the top of cone 59, wall or diaphragm 52 may be raised and lowered with respect to body 51. A driving rod 53 which may be set in motion by a crank mechanism, oscillating armature drive or the like (not shown) is attached to the central portion of the movable wall 52. A suction conduit 55 and a pressure conduit 56 extending centrally through cone 59 and terminating in the upper portion of chamber 57 lead to parts of the refrigerating apparatus not shown. The movable wall 52 is shown by a heavy line in the position of rest corresponding to the end of the suction stroke. An intermediate position of the movable wall is shown in dot and dash lines, from which it will be apparent that the wall is convexly bent on the side facing the working chamber 57 on the suction stroke so that, at the end of the latter, wall or diaphragm 52 lays itself entirely against the contoured surface 58 of body 51.

Owing to the particular shape of diaphragm 52 warping of portions of it lying between the driving rod 53 and the clamping device 54 is rendered impossible even without the employment of additional strengthening means. The forces acting on the movable wall 52 during the pressure stroke merely cause the wall to assume such a shape as to snugly fit into the annular recessed portion of the stationary body 51 and to thus expel the contents of chamber 57. The invention may also be employed in compressors and pumps in which are employed two movable diaphragms lying opposite to each other. The invention is not limited to the use of a particular material. The movable wall may consist of any of the suitable materials hitherto employed.

What is claimed is:

1. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a stationary wall having an inner surface of substantially invarible shape, and a reciprocatory flexible wall of variable shape, said flexible wall having a reinforced hub portion connected with said drive, a marginal portion firmly connected around its periphery to said stationary wall, and an intermediate portion, said three portions consisting of an integral elastic body having a continuous inner surface which is in contact with said inner surface of said stationary wall substantially throughout the extent of said three wall portions at the end of the pressure stroke of said drive so as to reduce the minimum volume of said chamber substantially to zero, said intermediate portion of said reciprocatory wall lying substantially within the angle directed towards said stationary wall and determined by the point of attack of said drive at said hub portion and any two opposite points of the periphery of said marginal portion.

2. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a stationary wall having an inner surface of substantially invariable shape, and a reciprocatory flexible wall of variable shape, said flexible wall having a reinforced hub portion connected with said drive, a marginal portion firmly connected around its periphery to said stationary wall, and an intermediate portion, said three portions consisting of an integral elastic body having a continuous inner surface and being shaped to have said hub portion and said marginal portions stand away from said inner surface of said stationary wall when said body is in relaxed position, said inner surface of said stationary wall and said inner surface of said body being shaped relative to each other to be substantially in contact with each other throughout the extent of said three wall portions at the end of the pressure stroke of said drive so as to reduce the minimum volume of said chamber substantially to zero, said intermediate portion of said reciprocatory wall lying substantially within the angle directed towards said stationary wall and determined by the point of attack of said drive at said hub portion and any two opposite points of the periphery of said marginal portion.

3. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a stationary wall having a substantially invariable inner surface of flat shape and another wall of variable shape, said other wall having a reinforced hub portion connected with said drive so as to reciprocate therewith, a stationary marginal portion firmly connected around its periphery to said stationary wall, and an intermediate portion, said three portions consisting of an integral body of compressibly elastic material having a continuous inner surface and being shaped so as to have said latter surface curved away from said flat inner surface of said stationary wall when said body is in relaxed condition, said inner surface of said stationary wall and said inner surface of said body being contiguous with each other substantially over their entire extent at the end of the pressure stroke of said drive.

4. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a movable wall of variable shape and a stationary wall of rigid material having a flat inner wall surface, said movable wall comprising an integral body of compressibly elastic material cup-shaped so as to have a hollow inner surface when in relaxed condition, said body having a reinforced hub portion connected with said drive to reciprocate therewith, a marginal portion firmly secured around its periphery to said stationary wall, and an intermediate portion of a wall thickness increasing in the radial direction from said marginal portion towards said hub portion so as to cause said drive to maintain said material in said intermediate portion under a compressive force during the pressure stroke of said drive.

5. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a movable wall of variable shape and a stationary wall of rigid material having a flat inner wall surface, said movable wall comprising an integral body of compressibly elastic material cup-shaped so as to have a hollow inner surface when in relaxed condition, said inner surfaces of said stationary wall and of said body respectively being shaped relative to each other to be substantially in contact with each

other throughout their entire extent at the end of the pressure stroke of said drive so as to gradually reduce during said pressure stroke the diameter of said chamber towards its center substantially to zero volume, said body having a reinforced hub portion connected with said drive to reciprocate therewith, a marginal portion firmly secured around its periphery to said stationary wall, and an intermediate portion of a wall thickness increasing in the radial direction from said marginal portion towards said hub portion so as to cause said drive to maintain said material in said intermediate portion under a compressive force during the pressure stroke of said drive.

6. In a device for conveying fluids, comprising a crank mechanism and a container forming a working chamber of variable volume, said container having a stationary wall and a reciprocatory flexible wall, said flexible wall consisting of a body of compressibly resilient substance and having a reinforced central hub portion, an intermediate portion surrounding said hub portion and a marginal portion, said marginal portion being firmly connected along its periphery with said stationary wall, a rigid member having one end connected with said hub portion and its other end engaging said crank mechanism so as to move said hub portion towards said stationary wall during the pressure stroke of said mechanism and to place said hub portion substantially in contact wtih said stationary wall at the end of said stroke, said body when in relaxed position being shaped to curve away from said stationary wall so as to gradually decrease the diameter of said chamber towards its center during said pressure stroke, and said intermediate portion having a wall thickness increasing in the radial direction from said marginal portion towards said hub portion so as to be prevented from warping away from said stationary wall during said pressure stroke.

7. In a device for conveying fluids, comprising a reciprocatory drive and a container forming a working chamber of variable volume, said container being formed of a rigid stationary wall and a movable wall, said stationary wall having an inner surface of a shape composed of a cone and an annular groove surrounding the base of said cone, and said movable wall consisting of metal and having a cone-and-groove shape following approximately the shape of the inner surface of said stationary wall, said movable wall being firmly and tightly connected around its periphery with said stationary wall and having a reinforced hub connected with said drive for pressing the groove-shaped portion of said movable wall into the groove-shaped surface portion of said stationary wall, said groove-shaped portion of said movable wall lying within an acute angle directed towards said stationary wall and having its vertex at said hub and its legs passing through any two opposite points of the periphery of said movable wall.

CARL KÜHNEL.