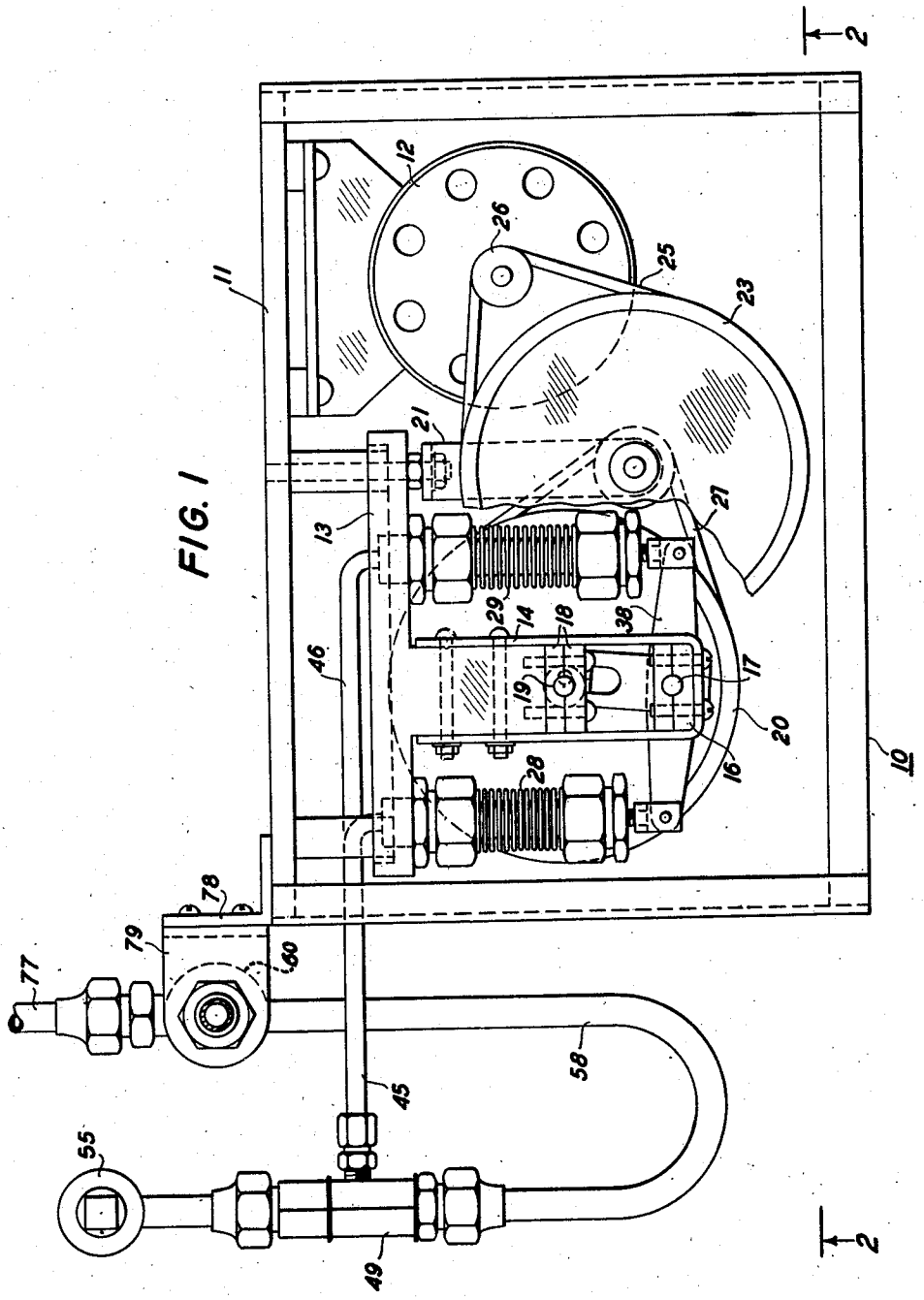
Nov. 21, 1944. E. R. GILL, SR 2,363,410

BELLOWS TYPE PUMP

Filed May 16, 1942 4 Sheets-Sheet 1

FIG. 1



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BELLOWS TYPE PUMP

Filed May 16, 1942 4 Sheets-Sheet 2

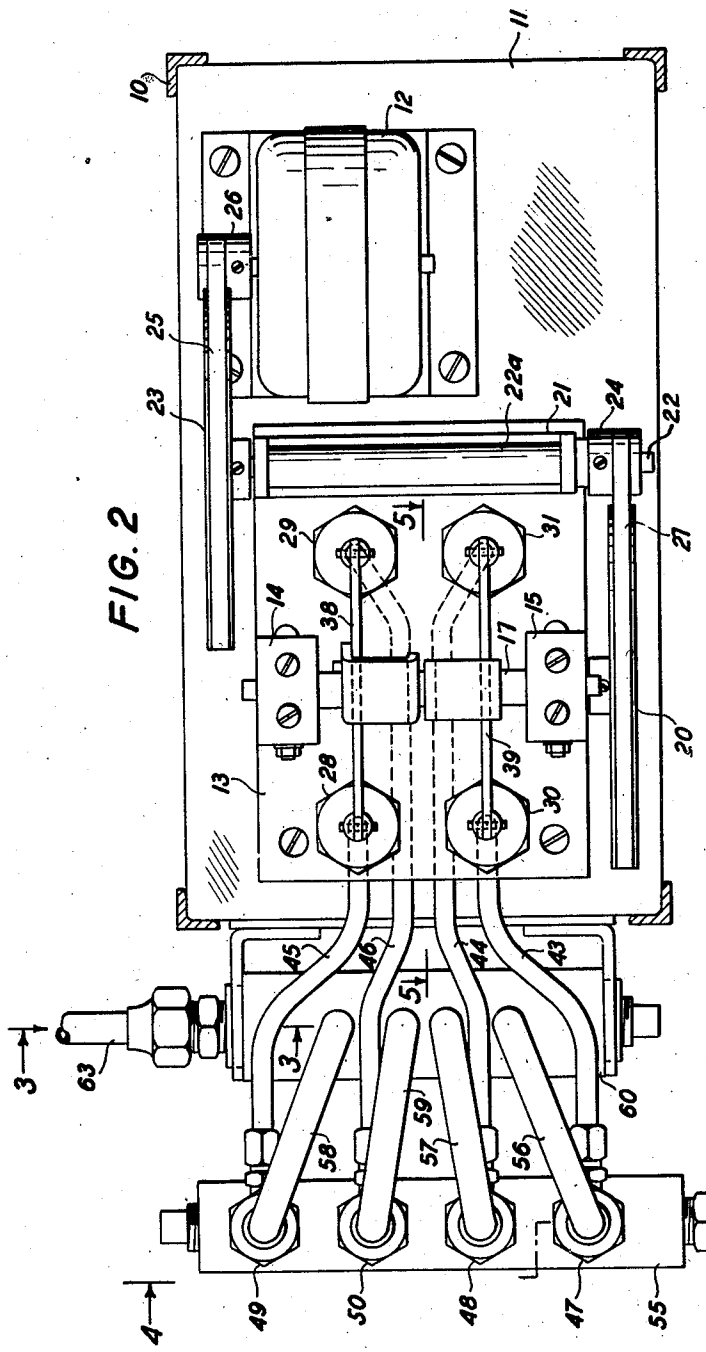


FIG. 2

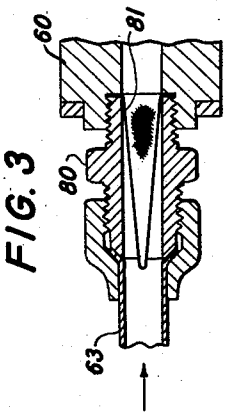


FIG. 3

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BELLOWS TYPE PUMP

Filed May 16, 1942 4 Sheets-Sheet 3

FIG. 4

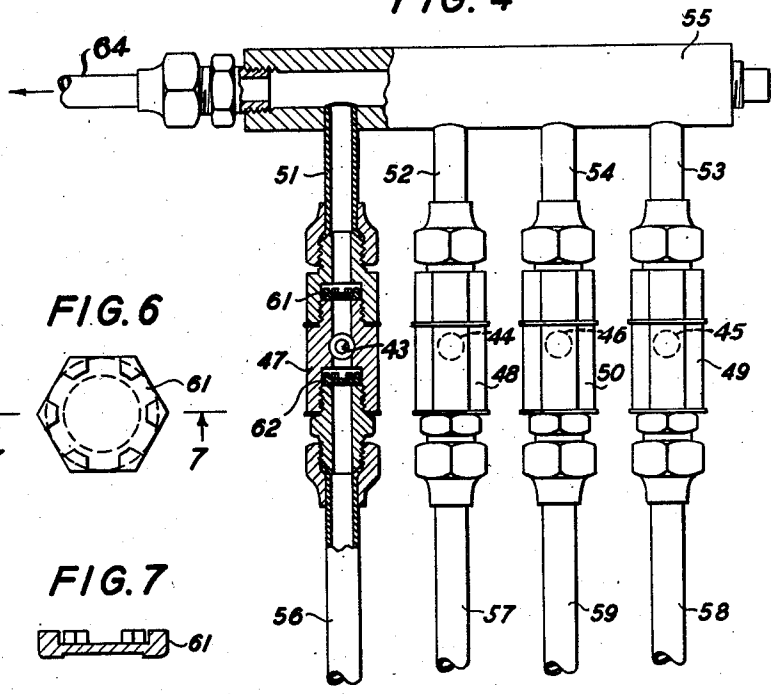
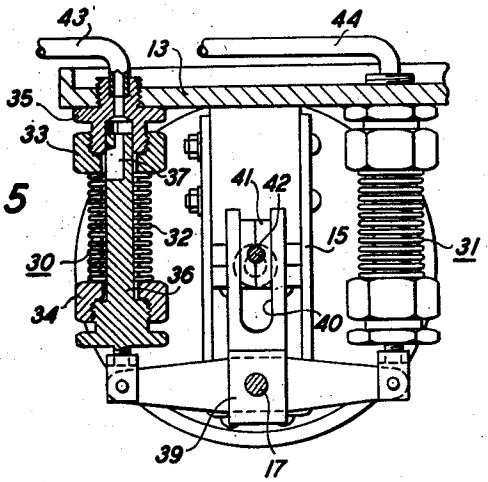


FIG. 6

FIG. 7

FIG. 5



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BELLOWS TYPE PUMP

Filed May 16, 1942 4 Sheets-Sheet 4

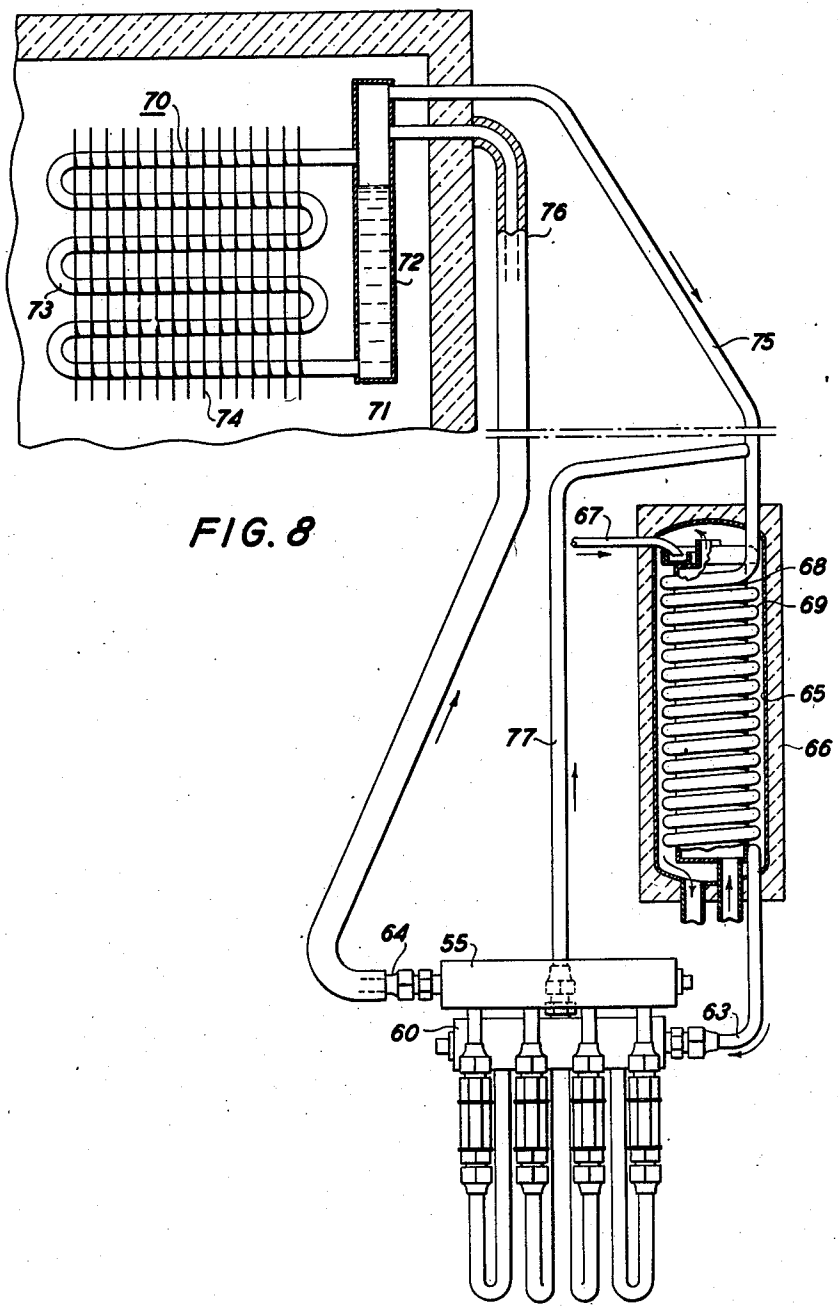


FIG. 8

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UNITED STATES PATENT OFFICE

2,363,410

BELLOWS TYPE PUMP

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Application May 16, 1942, Serial No. 443,190

4 Claims. (Cl. 103—148)

My invention relates to diaphragm or bellows type pumps and it is an object of the invention to provide an improved pump of this type for pumping a continuous stream and in which internal pressures are equalized so that the pump can be used for high pressure work with small energy input, and which is constructed so as to have no gas trapping space, making this pump particularly useful for pumping low boiling point liquids, and which has a new and improved valve structure and arrangement which eliminates flashing of liquid being pumped.

A pump embodying this invention is described and explained in the following description in connection with the accompanying drawings forming a part of this specification and of which:

Fig. 1 is a side elevation of a pump embodying the invention.

Fig. 2 is a view taken on line 2—2 in Fig. 1.

Fig. 3 is a detailed sectional view on line 3—3 of Fig. 2.

Fig. 4 is a detailed view partly in section on line 4—4 in Fig. 2.

Fig. 5 is a detailed view partly in section on line 5—5 in Fig. 2.

Fig. 6 is a plan view of a valve member shown in Fig. 4.

Fig. 7 is a sectional view on line 7—7 in Fig. 6; and

Fig. 8 more or less diagrammatically shows a circulating fluid type heat transfer system embodying a pump like that shown in Figs. 1 to 7.

Referring to Figs. 1 and 2 of the drawings, a rectangular angle iron frame 10 supports at its top a plate 11. A motor 12 is suspended from plate 11. A pump baseplate 13 is also suspended from plate 11. U-straps 14 and 15 are secured to the underside of baseplate 13. These U-straps form bearing posts. At the lower end of bearing post 14 are secured a pair of blocks 16. One end of a shaft 17 is held by blocks 16. The other end of shaft 17 is held by a similar pair of blocks in post 15. Above blocks 16 are secured a pair of bearing blocks 18 in which is journaled one end of a shaft 19. The other end of shaft 19 is journaled in a similar pair of bearing blocks in post 15. One end of shaft 19 projects beyond post 15 and on this end of the shaft there is secured a grooved pulley 20. An inverted U-shaped bracket 21 is suspended from baseplate 13. A jackshaft 22 is journaled in the ends of bracket 21. On one end of jackshaft 22 there is secured a grooved pulley 23. On the other end of shaft 22 there is secured a small pulley 24. Pulley 23 is connected by a belt 25 to a small pulley 26 on motor 12. Pulley 24 is connected by a belt 27 to pulley 20 on shaft 19. Bracket 21 is mounted on baseplate 13 so that it pivots slightly. This permits tension on the belts 25 and 27 to be simply and evenly adjusted by movement of motor 12. Around the jackshaft 22 within the legs of bracket 21 is a sleeve 22a which forms a bearing for the jackshaft 22. The part of shaft 19 between the bearing posts 14 and 15 is of a larger diameter than the journaled ends of the shaft so that endwise play thereof is limited.

On the under side of baseplate 13 are suspended four similar bellows assemblies indicated generally by the reference characters 28, 29, 30 and 31. The bellows assembly 30 is shown in section in Fig. 5. One end of a cylindrical bellows 32 is secured to a gland nut 33, and the other end is secured to a similar gland nut 34. One end of a fitting 35 is threaded through baseplate 13. The gland nut 33 is threaded on the other end of fitting 35. Thus, the upper end of bellows 32 is fixed to the baseplate 13. The lower gland nut 34 is threaded on a post 36. This post projects upward through bellows 32 and its upper end is slidably journaled in fitting 35. A passage 37 in post 36 affords communication from the interior of bellows 32 with the passage through fitting 35. Each of the four bellows assemblies are like that described.

Two inverted T-shaped rocker arms 38 and 39 are journaled on shaft 17. The ends of the head of the rocker arm 38 are connected each to one of the bellows assemblies 28 and 29 by a sliding pivot connection. The ends of the head of rocker arm 39 are similarly connected each to one of the bellows assemblies 30 and 31. As best seen in Fig. 5, the leg of rocker arm 39 is provided with a slot 40 forming a yoke in which slides a crosshead 41. The leg of rocker arm 38 is similarly formed to provide a yoke in which there slides a crosshead. Shaft 19 has an eccentric portion or crank 42 which is journaled in the crosshead 41 in the leg of rocker arm 39. Shaft 19 has a second eccentric portion or crank which is journaled in the crosshead in the leg portion of rocker arm 38.

When motor 12 is operated it causes shaft 19 to be revolved by the previously described belt and pulley connections. Turning shaft 19 causes the crank or eccentric portion 42 to revolve in a circle of the radius of its eccentricity. Revolution of the crank 42 causes the crosshead 41 to reciprocate in groove 40 and this combined motion results in oscillation of rocker arm 39. As rocker arm 39 oscillates, the bellows assemblies

30 and 31 expand and contract in alternation. The movement of the bellows is limited to movement in the direction of their lengths or axis by the posts, such as post 36 in bellows 30. The extent of this movement is entirely limited by the throw of crank 42. The bellows may be made of beryllium copper which has a high degree of resiliency and has been found desirable for this purpose. The eccentrics or cranks associated with rocker arms 38 and 39 are arranged substantially at 90° to each other, so that the several bellows are compressed one at a time in sequence.

Referring to Fig. 5, the upper end of fitting 35 is connected to one end of a conduit 43. Referring to Fig. 2, bellows assembly 31 is similarly connected to one end of a conduit 44. Bellows 28 and 29 are similarly connected to conduits 45 and 46. Referring to Figs. 1, 2 and 4, the other ends of conduits 43 to 46 inclusive are connected respectively to valve casings 47, 48, 49 and 50. The upper ends of valve casings 47 to 50 inclusive are connected respectively by conduits 51, 52, 53 and 54 to a header 55. The lower ends of valve casings 47 to 50 inclusive are connected respectively to conduits 56, 57, 58 and 59 to a header 60. The header 60 is located at an elevation higher than that of the valve casings 47 to 50 inclusive. The conduits 56 to 59 inclusive are each formed as downward loops which may be referred to as U-bends.

In Fig. 4, the valve casing 47 is shown in vertical section. In the upper part of the valve casing 47, above the connection thereto of conduit 43, there is a valve member 61. Valve member 61 is a small flat hexagonally shaped member shaped as shown in the detail plan view of Fig. 6 and the vertical section in Fig. 7. The casing 47 is formed to provide an annular recess in which the valve member 61 is located. The valve member 61 is free. Its movement is confined to the recess in which it is located. The height of this recess is such that the valve member 61 cannot be tipped up on its edge. The valve member 61 is formed so as to seat on the lower surface of its recess by gravity, in which position the passage in valve casing 47 is closed to shut off communication between conduits 43 and 51. A similar check valve 62 is provided in the valve casing 47 below the connection thereto of conduit 43. The valve assemblies 48, 49 and 50 are identical with the valve assembly 47 just described.

In Fig. 8, the pump structure previously described is shown connected in a heat transfer system like that shown and described in Patent No. 2,182,934 of A. R. Thomas. In this system there is a cooling unit or evaporator 65 of refrigeration apparatus of the diffusion type like that shown and described in Patent No. 2,207,838 of A. R. Thomas. The looking unit 65 constitutes a source of refrigeration and comprises an outer shell which is embedded in heat insulating material 66. Liquid refrigerant is introduced into the upper part of the cooling element 65 through a conduit 67. Inert gas enters the upper part of the cooling element from the upper end of a cylinder 68 located within the shell. A cylindrical pipe coil 69 is located in the annular space around the cylinder 68. The liquid refrigerant flows downward over the exterior surface of the pipe coil 69. The descending liquid evaporates and diffuses into the hydrogen, providing a refrigerating effect to cool the pipe coil 69.

A second evaporator 70 is arranged to cool a thermally insulated refrigerator storage compartment 71 which is located on an upper floor, or at some higher elevation than the refrigerating apparatus. The evaporator 70 comprises a pipe coil 73 provided with heat transfer fins 74, and a header 72 to which the ends of the pipe coil 73 are connected.

The upper part of evaporator header 72 is connected by a conduit 75 to the upper end of the pipe coil 69, which may be referred to as a condenser or a condensing coil. The upper part of the evaporator header 72 is also connected by a pipe 64 to the header 55 of the previously described pump. The pipe 64 is shown provided with a thermal insulation covering 76. The lower end of condenser coil 69 is connected by a pipe 63 to the header 60 of the pump. The pump header 60 is also connected by a vent pipe 77 and a part of pipe 75 so as to be in communication with the upper end of condenser coil 69.

The system comprising the evaporator 70 and the condenser coil 69 and the pump and the described interconnecting conduits form a circuit which is charged with a suitable volatile heat transfer fluid. This fluid may be methyl chloride or it may be one of the refrigerant fluids known in the trade as "Freon". The liquid refrigerant is cooled by evaporation in the evaporator 70 to provide a cold element for cooling the refrigerator compartment 71. The resulting vapor flows through pipe 75 to the condenser coil 69. The refrigerant vapor is liquefied by condensation in coil 69. In this manner heat is transferred from the elavated refrigerator compartment 71 to the downstairs refrigerating apparatus represented by the cooling element 65. The pump is provided to raise the condensed refrigerant from the condenser coil 69 back up to the evaporator header 72.

Liquid refrigerant flows from the lower end of condenser coil 69 through conduit 63 into the pump header 60. The liquid flows from header 60 through conduits 43 to 46 inclusive to the pump inlet check valves 62. The fact that header 60 is located above the valve assemblies 47 to 50 inclusive insures a head of liquid for flow through the check valve 62 into the pump bellows. The pump is started by energizing the motor 12. Control of the motor 12 may be provided in any of various known manners as, for instance, by a thermostatic device responsive to a temperature condition in a suitable part of the system, or by a pressurestat device responsive to a pressure condition in a suitable part of the system. During operation of the pump, the bellows 28 to 31 inclusive expand and contract in a certain sequence. The cranks such as crank 42 which oscillate the walking beams 38 and 39 are displaced 90°. Thus, for instance, while bellows 30 is being compressed, its companion or associated bellows 31 is being expanded. Bellows 30 reaches maximum compression at the same instant that bellows 31 reaches maximum expansion. Likewise, bellows 28 reaches maximum compression at the same time that its associated bellows 29 reaches maximum expansion. The 90° displacement of the eccentrics results in an operation whereby one of the four bellows reaches maximum compression at each quarter revolution of the shaft 19. Also, another bellows reaches maximum expansion each quarter revolution of the shaft 19. As shown in Fig. 5, the bellows 30 is half compressed and the bellows 31 is half expanded. At the same instant, as shown in Fig. 1, bellows 28 is fully com-

pressed and bellows 29 is fully expanded. After the next quarter turn, the bellows 28 will be half way expanded and bellows 29 will be half way compressed, while bellows 30 will be fully compressed and bellows 31 fully expanded. Thus, the sequence of compression of the bellows is in the order 28—30—29—31.

Thus, individually the operation of bellows 30, make a reference to Figs. 2, 4 and 5. As bellows 30 expands, liquid flows from the elevated header 60 through the conduit 56 and past the inlet check valve 62 into conduit 43 and thence into the bellows 30 through passage 37 in its guide rod or post 36. In this manner the increased internal volume of bellows 30 is occupied by liquid. As the bellows 30 is compressed, its internal volume is decreased so that liquid is forced from the bellows through the passage 37, conduit 43, and past the exit check valve 61 into pipe 51 and header 55. Displacement of liquid takes place while the pump is in operation in the previously described sequence. Thus, there is continuous flow of liquid into the header 55. Liquid starts to enter header 55 from pipe 51 before liquid flow into the header from pipe 53 has stopped. Liquid starts to flow into header 55 from pipe 54 before flow into the header from pipe 51 has stopped. Liquid starts to enter header 55 from conduit 52 before flow into the header from conduit 54 has stopped.

The little flat hexagonal valve buttons 61 and 62 with their upward peripheral projections provide for smooth flow of liquid past these valve members. These members, due to their flat construction, lift fully upon liquid flow in the proper direction. Thus, there is no throttling or spraying of the liquid as in the case of ball checks. A ball check tends to fall back onto its seat and rides in the liquid stream, especially upon opening of the valve, causing the liquid to spray out and around the ball member. This throttling or spraying results in vaporization or flashing of liquid in the case of low boiling point liquids.

At the joint where pipe 63 is connected to the inlet header 60, see Fig. 8, there is inserted in the line a strainer providing an extensive surface without requiring enlargement of the line. This joint and the strainer are shown in detail in Fig. 3. One end of a nipple 80 is threaded into the header 60. The other end of the nipple 80 is connected to the end of pipe 63 by a flare nut joint. The strainer 81 is in the form of a long narrow cone made of suitable screening material. The rim of the cone is flared outward and secured between the end of the nipple 80 and a shoulder in the header 60. With this construction, the strainer 80 is quickly accessible for cleaning or replacement.

Liquid which continuously flows into header 55 during operation of the pump as previously described, fills the header 55 and pipe 64 until the liquid overflows at the upper end of pipe 64 into the evaporator header 72. If desired, a known liquid flow restricter or metering valve may be placed at the upper end of pipe 64. This may be a well known expansion valve. With such known provision, liquid is maintained in the pump header 55 and pipe 64 at a higher pressure, making for lower thermal loss in these parts.

Any one wishing to practice this invention in connection with pumping of low boiling point fluids is advised to have the header 60 at an appreciable distance above the pipes 43 to 46 inclusive, and to have the pipes 56 to 59 inclusive connected to the bottom of the header 60. With this construction, there is no sucking of liquid on the expansion strokes of the bellows. It is in effect only gravity flow of liquid into the bellows while they expand. This is another important feature in eliminating flashing of the liquid. It is also advised that the described arrangement of the parts be followed so that there are no gas traps which diminish the volumetric efficiency of the pump. There are no unvented upward loops or dead ends in this structure. Observe that there is a full upward path of flow for vapor bubbles that may form from the very lower ends of the bellows, upward through the bellows, through passage 37 (see Fig. 5), through pipe 43, and (see Fig. 4) upward through outlet valve 61 and pipe 51 into header 55. Header 55 may also be referred to as a manifold. It is probably more properly referred to as a manifold than a header although it serves both purposes. The same is true of the part which has been referred to herein as header 60. The headers 55 and 60, as may be seen in Figs. 3 and 4, do not have any large liquid storage capacity but merely constitute a passage for distribution and collection of liquid to and from the several pump bellows. The liquid is wanted in the evaporator and not in the pump. This is true of any pump installation. The purpose of the pump is usually to get a fluid from one point to another and not to store it.

Referring to Figs. 1 and 4, it will be seen that vapor bubbles that may be formed in any of the right hand legs of the U-loops 56 to 59 inclusive have free upward flow to the inlet header 60 which is vented to the condenser by conduit 77. Any vapor which is formed in the left hand legs of these loops has a free upward path through the upwardly unidirectional valves and the conduits 51 to 54 inclusive to the manifold 55.

Referring to Figs. 1 and 5, the internal pressure in bellows 30 acts in opposite direction to and thereby opposes the internal pressure in bellows 31 due to the association of these bellows through the walking beam 39. The same is true of the bellows 28 and 29 which are associated through the walking beam 38. In this manner the internal pressure in the system nullifies itself as far as concerns the requirement of external energy for operating the pump. Thus, the motor 12 need supply only the amount of energy necessary for displacement of the liquid or to exert the required pressure on the liquid above that existing in the system.

Various changes and modifications may be made within the scope of the invention as set forth in the following claims.

I claim:

1. A bellows type pump comprising a cylindrical bellows fixed at one end and movable at the other end, the movable end of said bellows being closed, a shaft inside of said bellows having one end rigidly secured to the closed end of said bellows, the other end of said shaft being slidably journaled in a passage in the fixed end of said bellows to restrict movement of said bellows to the direction of its axis, and a passage in said shaft for permitting flow of fluid into and from said bellows.

2. A pump comprising a support structure, a pair of vertical bellows of substantially the same cross-sectional area each having an upper end fixed to said structure and a lower end free to be reciprocated, a post in each of said bellows,

each post being secured to the lower end of the bellows and having its upper end slidably journaled in said structure to restrict reciprocation of the bellows to the direction of its axis, a conduit for conducting fluid to and from each of said bellows, a passage through each of said posts for the communication between the interior of said bellows and said conduit, a walking beam mounted on said structure and having equal length arms operatively connected to the lower ends of said bellows, the lower ends of said bellows being closed, and motor driven mechanism for oscillating said walking beam to compress and expand respectively said bellows in alternation.

3. A pump comprising two assemblies as set forth in claim 2 and in which said motor driven mechanism includes a pair of cranks displaced from each other through 90°, each crank having associated therewith a yoke and cross head drive for oscillating one of the walking beams, whereby the four bellows are compressed and expanded respectively in overlapping sequence.

4. A pump including a plurality of valve casings each providing an upright passage for flow of fluid, a pair of upward directional check valves arranged one above the other in each of said passages, a corresponding plurality of expansible and contractible elements each connected to a respective one of said passages at a point intermediate said valves, each connection being made from the top of the respective element and having no descent from said element to said passage, an inlet conduit connected to the lower end of each of said passages and projecting to an elevation above that of the connection to said passage of one of said elements, an inlet manifold located at said upper elevation and connected to said inlet conduits, and an outlet manifold located above said valve casings and connected to the upper ends of said passages.

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