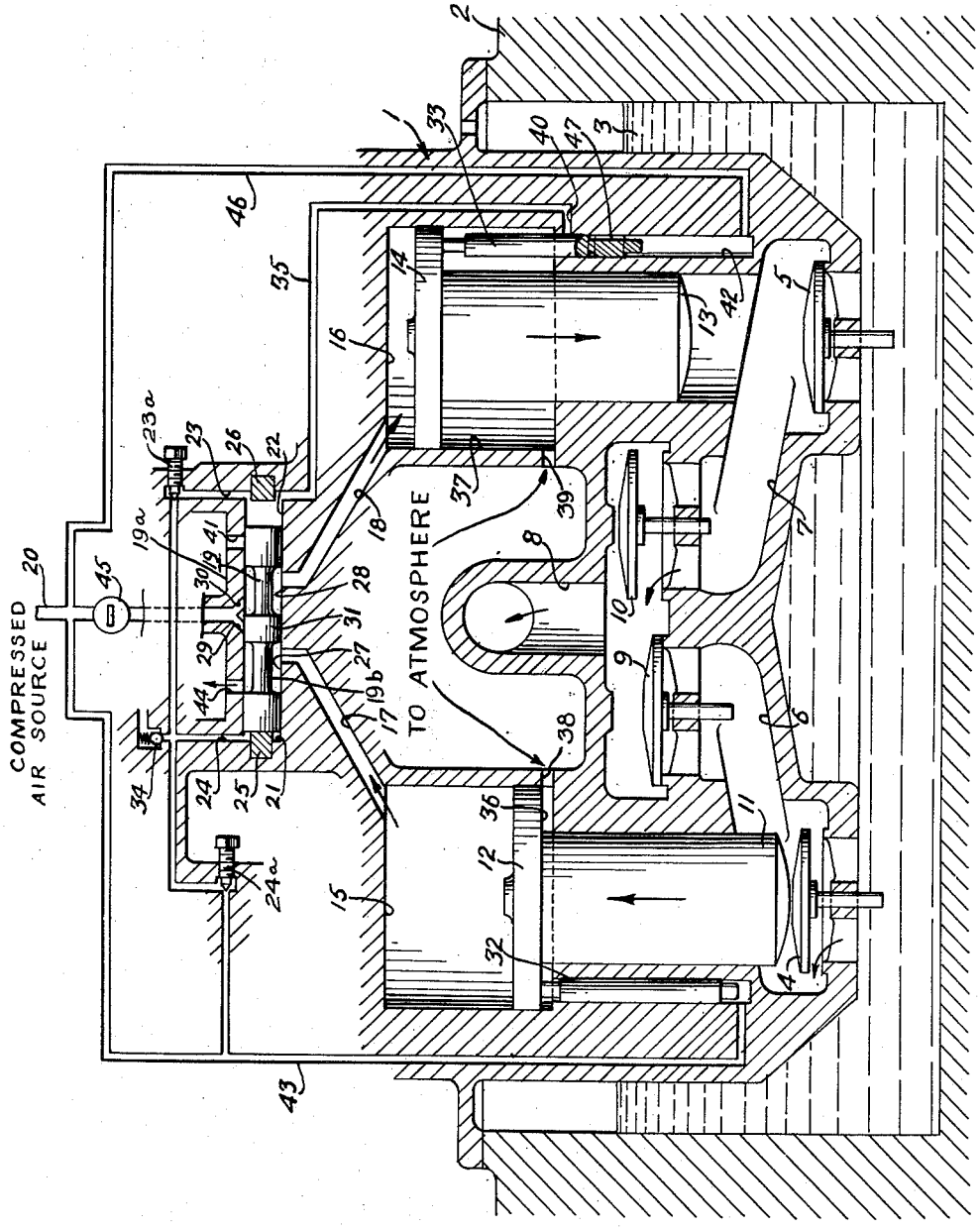
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PNEUMATIC LIQUID PRESSURE PUMP

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Inventor:
Eric Georg Hjärpe
by Howson & Howson
Attys.

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PNEUMATIC LIQUID PRESSURE PUMP

Eric Georg Hjärpe, Goteborg, Sweden, assignor to Aktiebolaget Svenska Kullagerfabriken, Goteborg, Sweden, a corporation of Sweden

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The present invention relates to a liquid pressure pump in which liquid pressure is obtained by permitting air pressure to act alternately on two pistons which each actuate a pump piston in such a manner that pressure liquid is obtained at a constant pressure and temperature and in which the capacity will always adjust itself automatically at each moment in accordance with the consumption of pressure fluid for the time being.

The device according to the invention is provided with a plurality of differential pistons arranged to operate mechanically independent of each other in separate cylinders, the said pistons being subjected at one outer end surface to pressure from a gaseous pressure medium and acting with their other outer end surfaces upon a liquid. The purpose of the invention is to provide a device of this kind which operates satisfactorily even when such great quantities of liquid are consumed that the working stroke of the pump takes place during a shorter period than the return stroke and is characterized mainly thereby that the pistons are governed by a distributing valve or valve system common to all of the pistons, the said valve system being in communication with the cylinder chambers in such a manner that at least one of the pistons always carries out complete working strokes of constant length while the other pistons carry out only such part of a complete working stroke as is required to maintain the pressure or pumping action during the period required for the first-mentioned piston to carry out its return stroke and begin a new working stroke.

The accompanying drawing shows diagrammatically and in partial section, a form of a device according to the invention.

The device comprises a cylinder and valve casing or pump body **1** submerged in a liquid container **2** containing liquid **3** which by way of valves **4** and **5** can flow into two lower chambers **6** and **7** in the valve casing or pump body **1**. From the chambers **6** and **7** the liquid can flow to an upper chamber **8** through valves **9** and **10** respectively. The chamber **8** is, for example, connected through one or more pipes to the manoeuvre members which control the movements of a machine (not shown) which is to be actuated by hydraulic pressure.

The smaller pistons of two differential reciprocating pistons **11—12** and **13—14** are, respectively, in direct communication with the chambers **6** and **7**. The larger pistons **12—14** of the differential pistons move in cylinders **15** and **16**, respectively, which through channels **17** and **18** leading to the chamber of a piston valve **19**, are alternately put into communication with an air pressure line **20** and with the atmosphere. Piston valve **19** reciprocates in said chamber and has two reduced portions **19a** and **19b** intermediate the central piston portion **31** and its ends. The fluid pressure in the valve chamber thus operates the piston valve, in a manner to be explained.

Two end chambers **21** and **22** of the piston valve **19** are in communication with the air pressure line **20** through narrow channels **24** and **23**, respectively. An

adjustable needle valve **24a** restricts flow of air from air pressure line **20** to end chamber **21**, and a like adjustable needle valve **23a** regulates the volume of air passing to and from end chamber **22** by way of channel **23**. A by-pass valve **34** is so adjusted relative to needle valves **23a** and **24a** that a reduced pressure only is available in the chamber **21**. The piston valve **19** is of magnetic material, hence is subjected to the influence of two permanent magnets **25** and **26** located in end chambers **21** and **22**, respectively, and can thus be retained in either of its end positions until the air pressure on the piston valve overcomes the magnetic pull. The air pressure line **20** to both valve chambers **27** and **28** of the piston valve divides into two branches **29** and **30** which open into the piston valve at a greater distance from each other than the length of the central piston **31** of the piston valve. For this reason, both cylinder chambers **15** and **16** can never be cut off simultaneously from the air pressure line **20**.

The differential pistons **11—12** and **13—14** are lifted by air pressure admitted through chambers **43** and **46** to small auxiliary pistons **32—33** (of which several, for example 3, are provided for each differential piston) as soon as the respective cylinder chambers **15** or **16** are put into communication with the atmosphere through the piston valve **19**. When the piston **14** approaches its lower position, the valve chamber **22** is put into communication with the atmosphere through channels **35—40**, the cylinder chamber **37** and a channel **39**, of which the latter leads to the atmosphere. The cylinder chambers **36** and **37** are continuously in communication with the atmosphere through the channels **38** and **39**. These chambers are therefore always pressureless, whereby all risk that air can leak between the pistons **11** and **13** and their cylinder walls is eliminated.

The device functions as follows.

In the position in which the piston valve **19** is shown in the drawing, air pressure is communicated from the line **20** through the channel **30**, valve chamber **28** and channel **18** to the cylinder chamber **16** and forces the piston **14** downwards.

The liquid under the piston **13** is thus subjected to a pressure, the magnitude of which depends upon the pressure of the air in line **20** and the ratio of the areas of the pistons **14** and **13**. As pressure liquid is withdrawn from the pipes (not shown) connected to the chamber **8**, other liquid flows from the chamber **7** through the valve **10** to the chamber **8**. When the differential piston **13—14** has been forced down so far that the upper reduced end of the auxiliary piston **33** opens a channel **40** from the valve chamber **22**, the latter will be put into communication with the atmosphere through the cylinder chamber **37** and the opening **39** and will thus become practically pressureless by reason of the needle valve **23a** which limits flow of air to chamber **22** from compressed air line **20**. The piston valve **19** will then be moved to its right hand end position against the permanent magnet **26** by the air pressure in the valve chamber **21**, whereby the cylinder chamber **16** will be put into communication with the atmosphere through the channel **18**, valve chamber **28** and a port **41** in the walls of the piston valve chamber.

Under the influence of the pressure of the air in the cylinder chambers **42**, the differential piston **13—14** will now be moved upwards by the auxiliary pistons **33** and the valve **10** will close of its own weight. Hereby the valve **5** will be opened partly by the static pressure of the liquid **3** in the container **2** and partly by the suction created in the chamber **7** as the piston **13** moves upwards.

During the above described movement towards the right of the piston valve **19**, the cylinder chamber **15**

was put into communication with the air pressure line 20 through the channel 29, valve chamber 27 and the channel 17. Before the channel 30 was closed by the central portion 31 of the piston valve 19, both cylinder chambers 15 and 16 were momentarily in communication with the air pressure line 20. Thus a drop in pressure of the liquid in the chamber 8 upon movement of the piston valve 19 from one end position to the other is prevented, even if liquid is simultaneously being withdrawn. Through the action of air pressure in the cylinder chamber 15 the piston 11—12 is forced downwards. The liquid under the piston 11 is then subjected to the same pressure already existing in the chamber 8 and as long as liquid is being withdrawn therefrom to the machine cylinders, the differential piston 11—12 will sink, thereby forcing liquid from the valve chamber 6 through the valve 9 to the chamber 8.

The downward movement of the differential piston 11—12, or if no liquid is being withdrawn from the chamber 8, static pressure on the liquid in the chamber 6, is maintained only for the length of time required for the differential piston 13—14 to reach its upper end position and begin its new work stroke. This will occur when the auxiliary pistons 33 have attained a position in which a longitudinal groove 47 in each piston 33 opens a channel 40 and the pressure air from the cylinder 42 passes through the groove 47 and the channels 40 and 35 to the valve chamber 22, where it forces the piston valve 19 towards the left to its other end position. This is possible because of the reduced pressure in the end chamber 21, governed by the relief or by-pass valve 34, and the restricting action of needle valve 23^a which limits flow of air from end chamber 22 by way of passage 23. The differential piston 13—14 thus always makes a complete stroke no matter whether small or large quantities of liquid are being withdrawn from the chamber 8. The differential piston 11—12 on the other hand serves mainly to maintain the pressure in the chamber 8 during the time required for the return stroke of the differential piston 13—14.

If no liquid is being withdrawn during the return stroke of the differential piston 13—14, the differential piston 11—12 will be practically immovable during this time. The only movement required will be to compensate for leakage.

The piston valve 19 has now assumed the position above described and the differential piston 13—14 is again moving downwards or is maintaining the pressure in the chambers 7 and 8.

In this position of the piston valve 19, the cylinder chamber 15 is in communication with the atmosphere through the channel 17, the valve chamber 27 and the port 44. The air-driven auxiliary pistons 32 force the differential piston 11—12 upwards to its upper end position where it will remain until the differential piston 13—14 has completed its working stroke and the piston valve 19 is thereby moved in the manner described. As long as liquid is being withdrawn from the chamber 8 the device will continue to function at the speed required to maintain a pressure in the chamber 8 which corresponds to the pressure of the compressed air source 20 and the ratio of the areas of the differential pistons. As soon as liquid is no longer being withdrawn from the chamber 8 the device will stop with at least one piston acting upon the contained liquid to maintain the constant pressure for which the device has been adjusted. At each withdrawal from the chamber 8 one of the pistons 13—14 or 11—12 will carry out the corresponding movement. By adjusting a reducing valve 45 in the air pressure line 20 to a pressure corresponding to a certain pressure on the liquid this latter can be adjusted as required.

I claim:

1. A pneumatically operated liquid pressure pump including, in combination, a connection to a source of compressed air; a valve body carrying said connection; a pair of cylinders; a pair of differential pistons reciprocable in said cylinders, each differential piston consisting of a large piston and a small piston united together; a pressure-responsive piston valve reciprocable in a valve chamber provided in said valve body; means connecting said valve chamber with said source of compressed air; said valve body having air channels leading from said valve chamber to said cylinders at such points that the compressed air flowing through said channels acts only on the large piston of each differential piston; the piston valve being so shaped, positioned and proportioned relative to said air channels and said means connecting the valve chamber with said source that both cylinders can never be cut off simultaneously from said source; said cylinders and said valve chamber all having exhaust ports to the atmosphere; a plurality of reciprocable auxiliary pistons movable in chambers adjacent said cylinders and connected to said source, said auxiliary pistons being operatively associated with said differential pistons to move the same in their suction strokes; means providing channels for flow of air from the auxiliary piston chambers associated with one differential piston to one end of the piston valve chamber; a pair of separate liquid chambers, one connected with each of said cylinders and into each of which liquid chambers the small piston of one of the differential pistons moves as the differential piston makes its working or liquid-displacing stroke; automatic inlet valves controlling inflow of liquid to said liquid chambers; automatic outlet valves controlling egress of liquid from said liquid chambers to a discharge outlet; the parts being so constructed and arranged that one of said differential pistons always makes complete working strokes of constant length while the other differential piston moves through only such part of a complete working stroke as is required to maintain the pressure on the liquid being pumped during the period of the return or suction stroke and the initiation of the working stroke of the first-mentioned differential piston.

2. The invention defined in claim 1, wherein the piston valve chamber has a permanent magnet fixed in each end, and the piston valve is made of magnetic material, so that when the piston valve approaches close to either end of its chamber it will be magnetically attracted and will move into contact with the magnet at that end and will remain in that position until pulled away by a superior force exerted by air pressure.

3. The invention defined in claim 1, wherein the ends of the piston valve chamber have narrow channels communicating with said source, an adjustable needle valve restricting flow through each such channel, and an adjustable relief valve being provided in a channel connecting said needle valves.

4. The invention defined in claim 1, wherein the connection to the source of compressed air has a reducing valve which is adjustable so that the pressure on the liquid delivered by the pump can be controlled.

5. A pneumatic liquid pressure pump comprising a plurality of separate cylinders; a plurality of differential pistons working mechanically independent of each other in said cylinders, each of said pistons acting at an outer end surface upon a body of liquid to withdraw liquid from said body of liquid by suction on one stroke and to displace the withdrawn liquid under pressure on the other stroke; a source of pneumatic pressure; means connected to said source and exerting continuous pressure separately on both differential pistons tending to move said pistons in their suction strokes; a distributing valve and pneumatic channels for connecting the cylinders alternately to said source so as to move the pistons in their working strokes against said continuous pressure and to evacuate the cylinder not so connected preparatory to and during the suction stroke of its piston; and means responsive to the

movements of one of said pistons for actuating the distributing valve so that the pneumatic pressure reciprocates the last named piston continuously through a full working stroke and the other of said pistons through only such part of a complete working stroke as is required to maintain pressure displacement of the first one of said pistons and initiation of the succeeding pressure displacement stroke of the last named piston.

References Cited in the file of this patent

UNITED STATES PATENTS

2,579,670	Hjarpe	Dec. 25, 1951
2,660,955	Kent et al.	Dec. 1, 1953