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[54] **AUTOMATIC DOUBLE ACTING DIFFERENTIAL PUMP**

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[58] **Field of Search** 417/404, 396, 393; 92/181, 182, 183, 184, 185; 91/303, 323, 342, 345, 346, 340

[56] **References Cited**

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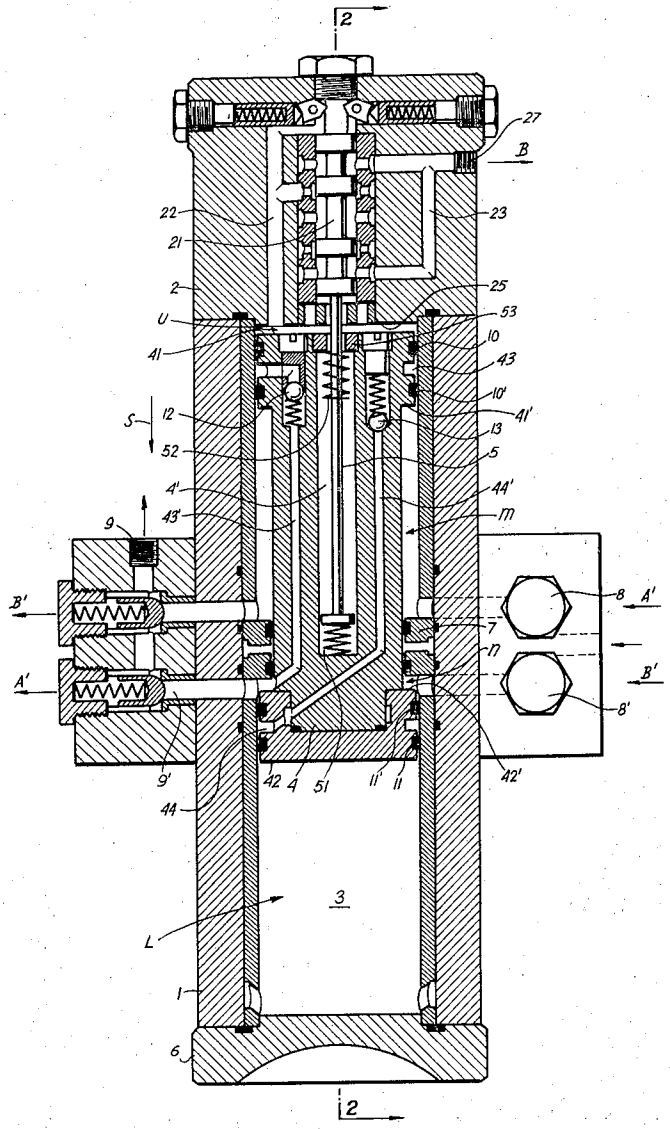
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[57] **ABSTRACT**

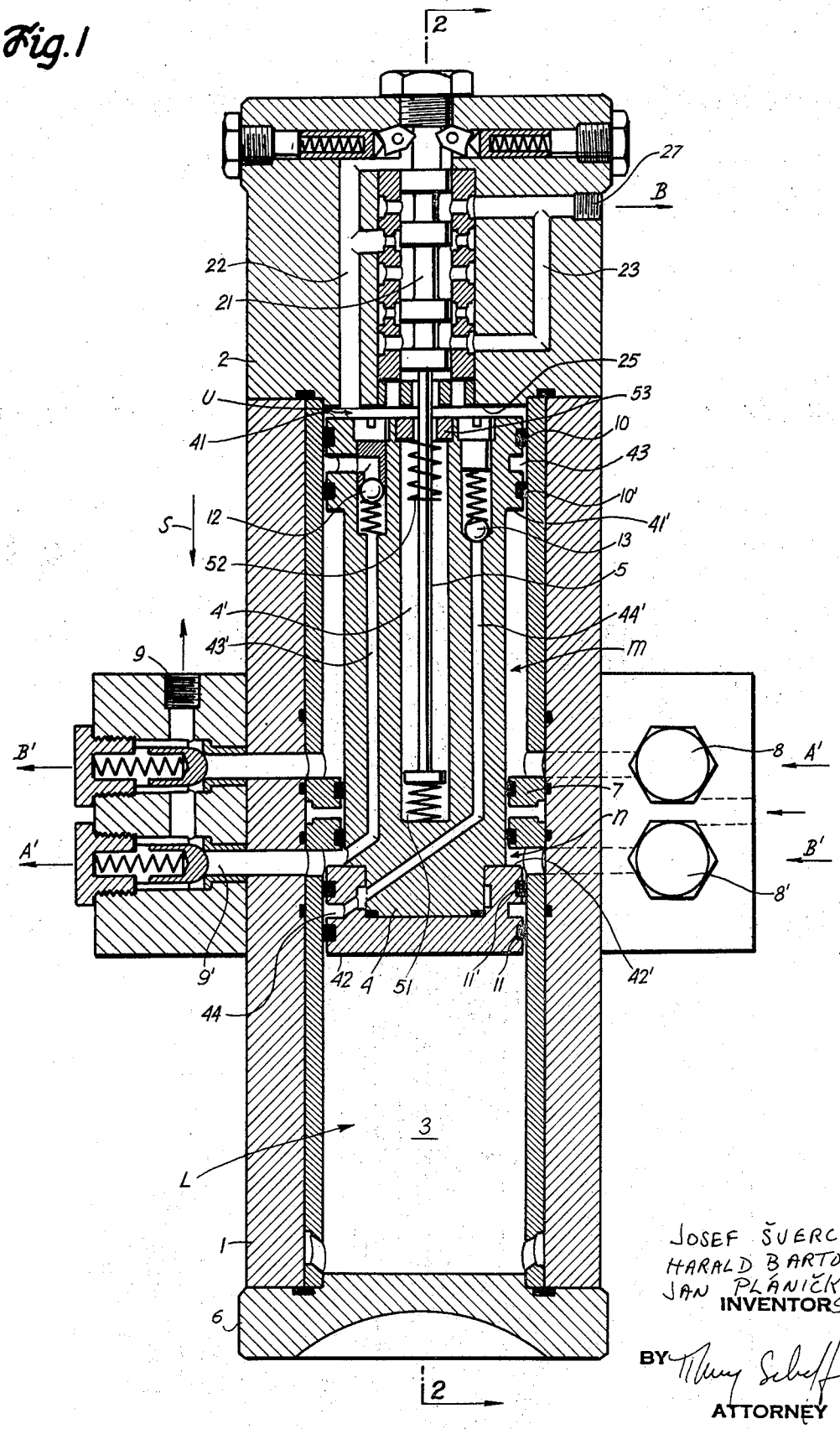
An automatic, double acting, differential pump having a body with a cavity, a reciprocable piston in the cavity which divides it into a first functional pressure space and a pair of second functional pressure spaces straddling the first space, means for interconnecting the second spaces as well as intake and outlet means communicating with them, sealing means dividing the first space into two portions and intake and outlet means communicating with the two portions of the first space when the piston is moved towards either of the second spaces.

3 Claims, 2 Drawing Figures



2 Sheets-Sheet 1

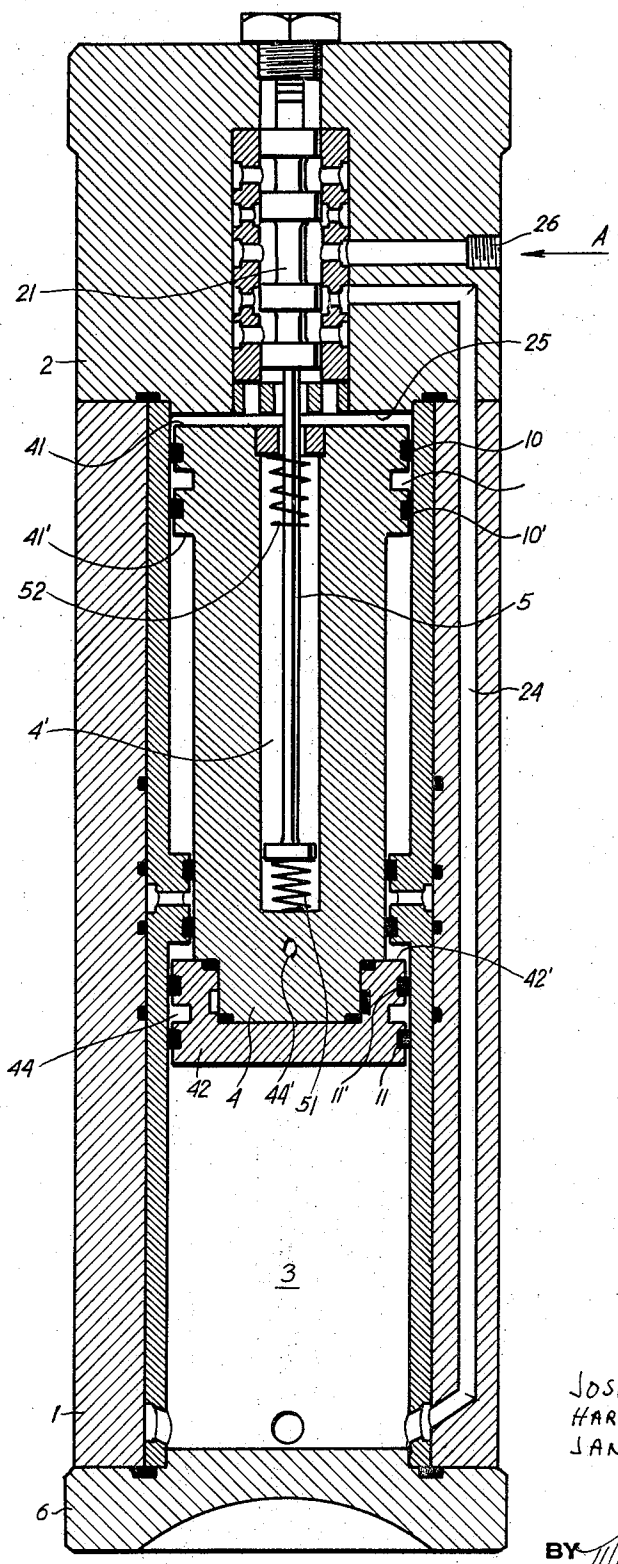
Fig. 1



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Fig.2



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AUTOMATIC DOUBLE ACTING DIFFERENTIAL PUMP

This invention relates to an automatic double acting differential pump having a low-pressure distribution which co-acts with a reciprocating piston which limits high and low-pressure functional spaces inside the cavity of the body and in which suction and discharge valves are connected to high-pressure spaces of the pump.

Many presently known automatic differential pumps of the double acting type which permit the regulation of high pressures are designed so that the body of the pump consists of three parts. The first or upper part is usually a low pressure space equipped with a slide valve. The center or second part is usually a high pressure space. The third or lower part is usually a low pressure space.

The above arrangement of the differential pump is relatively intricate and its assembly is complicated.

An object of the invention is to improve and to simplify, while at the same time meeting the requirements of operational reliability, the overall design of an automatic, double acting differential pump.

It is a further object of the present invention to improve sealing effects between the low and high pressure spaces of the pump.

The present invention overcomes the above problems and eliminates the disadvantages and drawbacks of known devices, such as failure of the seals and consequent leakage from one space to another.

Generally an automatic, double acting differential pump in accordance with the invention comprises a body with a cavity that is equipped with a reciprocable piston which divides the cavity into a first functional pressure space that is a high pressure space and a pair of second functional pressure spaces that are low pressure spaces and which straddle the first functional pressure space. Means for interconnecting the second functional pressure spaces as well as intake and outlet means therefor are also provided. In addition sealing means located between the inner wall of the body and the piston divide the first functional pressure space into two portions which communicate with intake and outlet means interconnected with them when the piston is selectively caused to move toward either of the second functional pressure spaces.

In order to understand the present invention more completely, reference is directed to the following specification which is to be taken in conjunction with the accompanying drawing wherein:

FIG. 1 is an elevational view, partially in section, of a pump in accordance with the invention showing the internal arrangement in detail and the piston in top dead center position; and

FIG. 2 is an elevational view in section taken across line 2—2 of FIG. 1.

Referring now more particularly to FIG. 1, a pump in accordance with the invention comprises a body 1, which is prefereably cylindrical, as illustrated, although it can have any other convenient shape, having a head part 2 at its upper end and an internal cavity 3 closed at its lower end by a cap 6. The upper part 2 accomodates both a slide valve 21 and ducts 22, 23, and 24 referred to in greater detail below and which form a low pressure distribution system. A reciprocable piston 4 is contained in the cavity 3. The piston 4 itself contains

a cavity 4' accomodating a pull-rod 5, the lower part of which bears against a spring 51 seated at the lower end of cavity 4'. Another spring 52 is located in fixed position attached to a plug 53 seated in the end of the upper part of the cavity 4' and surrouns pull-rod 5. The pull-rod 5 is connected to a slide valve 21 located in the upper head part 2. Piston 4 is provided with upper and lower radial enlarged end faces 41 and 42. Between the upper face 41 of the piston and the face 25 of the upper part 2 of the body and between the lower face 42 of the piston and the cover 6 there are respectively defined low pressure annular spaces U and L respectively. A high pressure space is formed axial between the inner faces 41' and 42' of the piston, the piston being undercut to form the annular space. A seal 7 secured to the body divides the high pressure space *m* and *n* respectively into two parts, making the automatic differential pump operate as a double acting device.

Suction intake non-return valves 8 and 8' and discharge non-return valves 9 and 9' are attached externally to the body of the pump at the point of location of seal 7. Valves 8 and 9 communicate with the upper high pressure part m while valves 8' and 9' communicate with the lower high pressure part *n*. Between the faces 41, and 41', and 42 and 42' of the piston are seals 10, 10' and 11 and 11' respectively. Between each pair of these seals at each of the respective ends of the piston there are radial grooves 43 and 44. The radial groove 43 between seals 10 and 10' on the upper part of the piston is connected to a discharge duct 43' which, when the piston is in its top dead centre position, communicates with the discharge valve 9'. Between the radial groove 43 and the discharge duct 43' there is a non return valve 12 formed by a spring biased ball. At the lower part of the piston 4 between the seals 11 and 11' a radial groove 44 is formed which communicates with a discharge duct 44' which passes through the piston 4 and leads via spring biased ball valve 13 into the upper high pressure space u of the pump cavity 3.

Referring now more particularly to the upper head part 2 of the body 1,; that part of the body is provided with inlet means 26 (FIG.2) which communicates with a duct 22 leading to the upper face 41 of the piston. The inlet 26 is opened and closed by means of the slide valve 21 mentioned above. The slide valve 21 comprises a spool member movable between a series of radially extending ports by movement of the rod 5. Leading from the slide valve 21 to the lower low pressure space L is a duct 24 which connects with the bottom low pressure space L through the body 1. Communicating with the slide valve 21 is an outlet 27, the outlet being opened and closed likewise by the slide valve 21. In addition a duct 23 located in upper part 2 of the body leads into outlet 27 and communicates with the upper lower pressure distributing space u, carrying ing discharged from that low pressure space U.

The piston is, as previously described provided on both its ends with a double seal 10 and 10', and 11 and 11' and the gap between them is connected through the annular grooves 43 and 44 to the discharge valves 9 and 9'via discharge ducts 43' and 44' over the respective high pressure spaces. The above arrangement provides perfect sealing between the high and low pressure spaces in case of leaking of high pressure medium through the seal 10' or 11' when applying high pressures.

For example, during the motion of the piston in direction of the arrow S which results in the discharge of high pressure medium from the upper high pressure space via the discharge valve **9** as explained more fully below the high pressure medium tends to leak between the body **1** of the pump and the piston **4** through the seal **10'**. Medium which may pass through the seal **10'** enters the radial groove **43** and because of interconnection of said groove **43** and non-return ball valve **12** is released due to underpressure formed and medium is sucked into the lower high pressure space *n* between the face **42'** and the seal **7** together with the sucking of medium in through the suction valve **8'**. A similar effect results from the upward motion of piston **4**, i.e., contra to arrow S, via annular groove **44** and duct **43.**

The device operates as follows. Pressure fluid, such as oil is supplied through the inlet means **26** in direction of the arrow A (FIG.2) being distributed by the slide valve **21** into the duct **22** on to the face **41** of the piston, pressuring the upper low pressure space U. The piston then moves in the direction of the arrow S into the bottom dead centre position creating a vacuum in the lower high pressure space *n*, sucking pressure fluid medium through the valve **8'** into the lower high pressure space *n*, while simultaneously compressing the volume of the lower low pressure space L to cause the discharging of medium from the bottom low pressure space L via duct **24** and slide **21** into the outlet means **27.** During the downward motion of piston mentioned there also occurs simultaneous discharge of high pressure medium from the upper high pressure space *m* of the pump through the discharge valve **9** and simultaneous sucking of pressure fluid medium through the suction non-return valve **8'** into the lower high pressure space between the lower face **42** and the seal **7** generally indicated by the arrows B'. The piston moves into the bottom dead centre position until the spring **52** contacts the end of the pull rod **5** which is connected to the slide valve **21.** At that moment the slide valve **21** changes its position and the pressure fluid such as oil or any other medium is reversed to be led through the duct **24** into the bottom low pressure space L, so that the pressurized fluid impinges on the lower face **42** of the piston causing the piston to move upward into its top dead centre position as seen in the Figures. The medium is discharged from the upper low-pressure space through the duct **23** into piping **27** wherefrom it is led away in the direction of the arrow B. High pressure medium is discharged from the annular space *n* through the discharge non-return valve **9'**, accompanied by simultaneous suction of medium, into the upper high pressure space *m* through the suction valve **8** between the face **41'** and the seal **7** as seen by arrows A'. After reaching the top dead centre position the function is repeated.

The automatic differential pump of the invention, because of its simple design, is easy to assemble from the individual components into a functional unit and insures, because of the arrangement and design of the piston and its components, separation of low-pressure spaces from the high pressure spaces and prevents the pump from accidental leakage of medium from the high-pressure space into the low-pressure one which is of great importance in cases where different media are employed.

What is claimed:

1. An automatic,double acting fluid operated differential pump comprising a body having an inner cavity, a reciprocating piston located in said cavity, said piston having a pair of radially enlarged ends dividing said cavity into an inner first functional pressure space and a pair of second functional pressure spaces straddling said first functional pressure space, valve means operable for alternatively distributing a pressurized fluid medium to said second functional pressure spaces, inlet and outlet means communicating with said valve means for delivering and discharging said pressurized fluid medium to and from said second functional pressure spaces,sealing means located between the inner wall of said body and about said piston, said sealing means dividing said first functional pressure space into a first and second portion in which the ends of said piston are located and inlet and outlet means communicating with each of said first and second portions for delivering and discharging a second fluid medium to and from each of said first and second portions, each end of said piston being provided with two spaced circum-ferential seals defining a groove located between them, a discharge duct extending through said piston from each of said grooves to an outlet port located adjacent the end of the piston opposite to said groove to communicate with the outlet means in the respective first and second portion of the first functional pressure space, and a unidirectional valve located in each duct to permit fluid to flow from said groove only when said piston is selectively caused to move towards the opposite one of the pair of second functional pressure spaces.

2. A pump as defined in claim **1,** wherein said body includes a hollow member extending from one of its ends and said valve means comprises a slide valve located in the cavity of said hollow member and includes a pull rod having one end disposed in a cavity in the piston, said cavity in said piston having a pair of opposed ends selectively engaging said pull rod on movement of said piston, said slide cooperating with a plurality of ducts forming a distribution system for said second functional pressure spaces.

3. A pump as defined in claim **2** including spring means arranged at each end of said cavity in said piston interposed between said pull rod and the ends of said cavity.

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