

[54] COMPRESSED LIQUID ENGINE OR PUMP

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[56] References Cited

UNITED STATES PATENTS

1,001,821 8/1911 Coffield.....91/342

1,032,689	7/1912	Martens.....	91/222
1,458,383	6/1923	Bassler.....	91/342
2,361,757	10/1944	Fink.....	91/342
3,014,464	12/1961	Barnes et al.	91/303
2,039,570	5/1936	Thornton.....	103/175
3,086,470	4/1963	Skipor et al.....	103/50
3,174,409	3/1965	Hill.....	103/153

FOREIGN PATENTS OR APPLICATIONS

76,804	10/1961	France.....	103/47
1,312,051	11/1962	France.....	103/50

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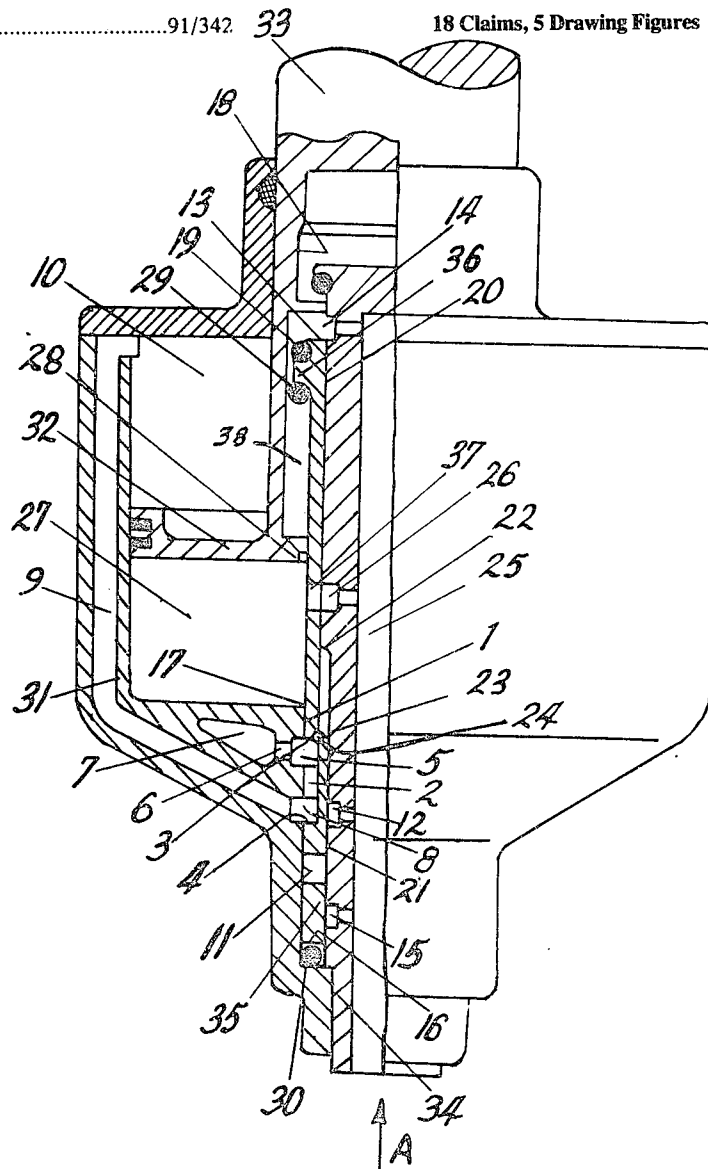
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[57]

ABSTRACT

In a fluid operated device, a novel timing system which is formed by a fixed hollow mandrel mounted in a working cylinder with a timing sleeve and a piston mounted on the mandrel and within the cylinder. Compressed fluid is fed axially through the mandrel and through radial ports therein, which ports are selectively opened and closed by the timing sleeve sliding on the mandrel. The timing sleeve is provided with catches acting on corresponding catches on the piston to move the timing sleeve in response to piston movement.

18 Claims, 5 Drawing Figures



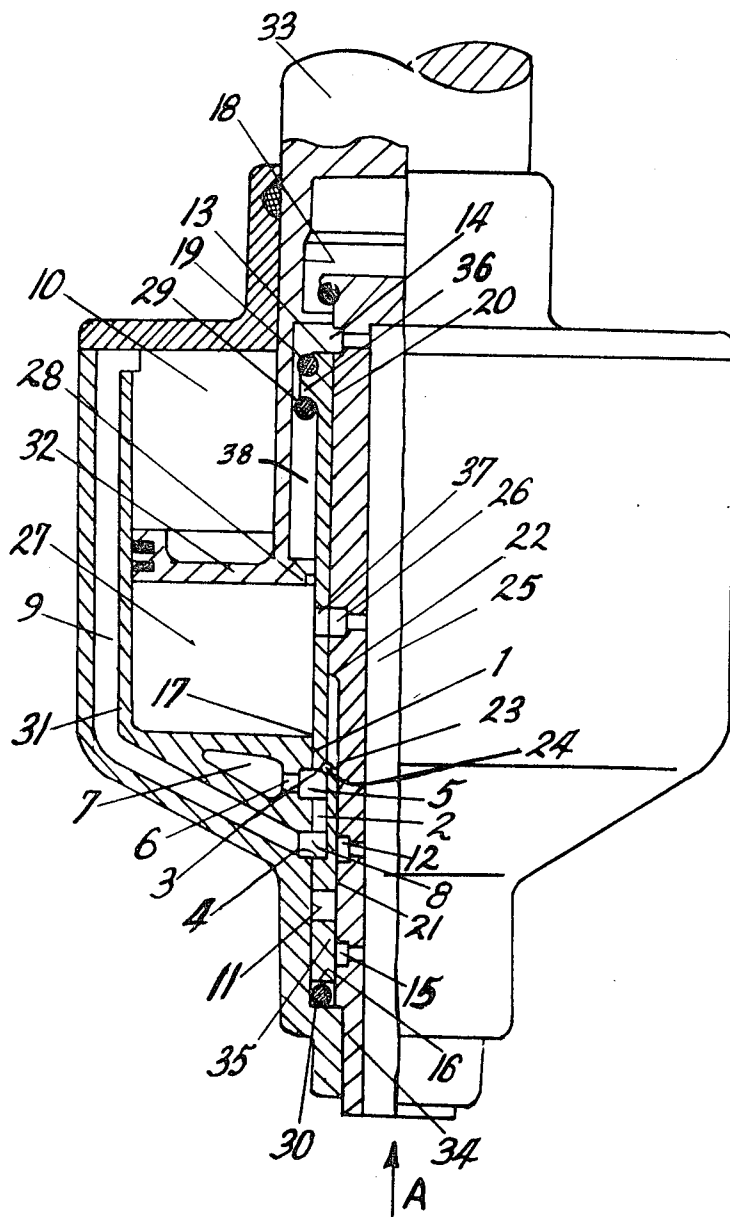


FIG. 1

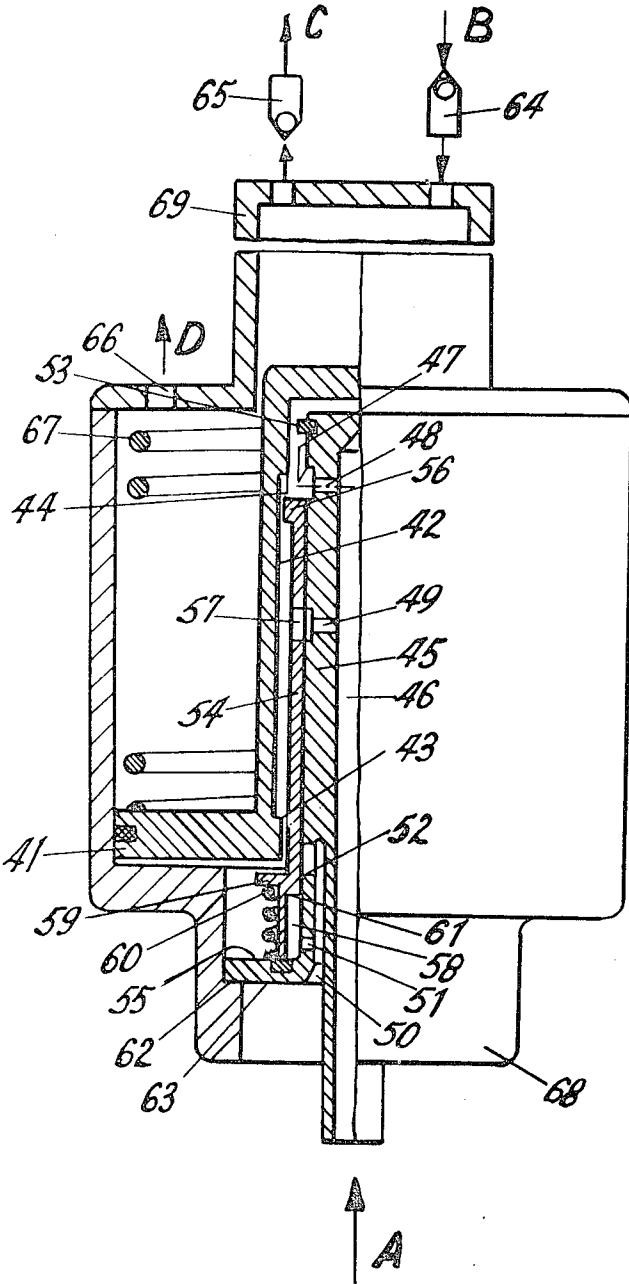
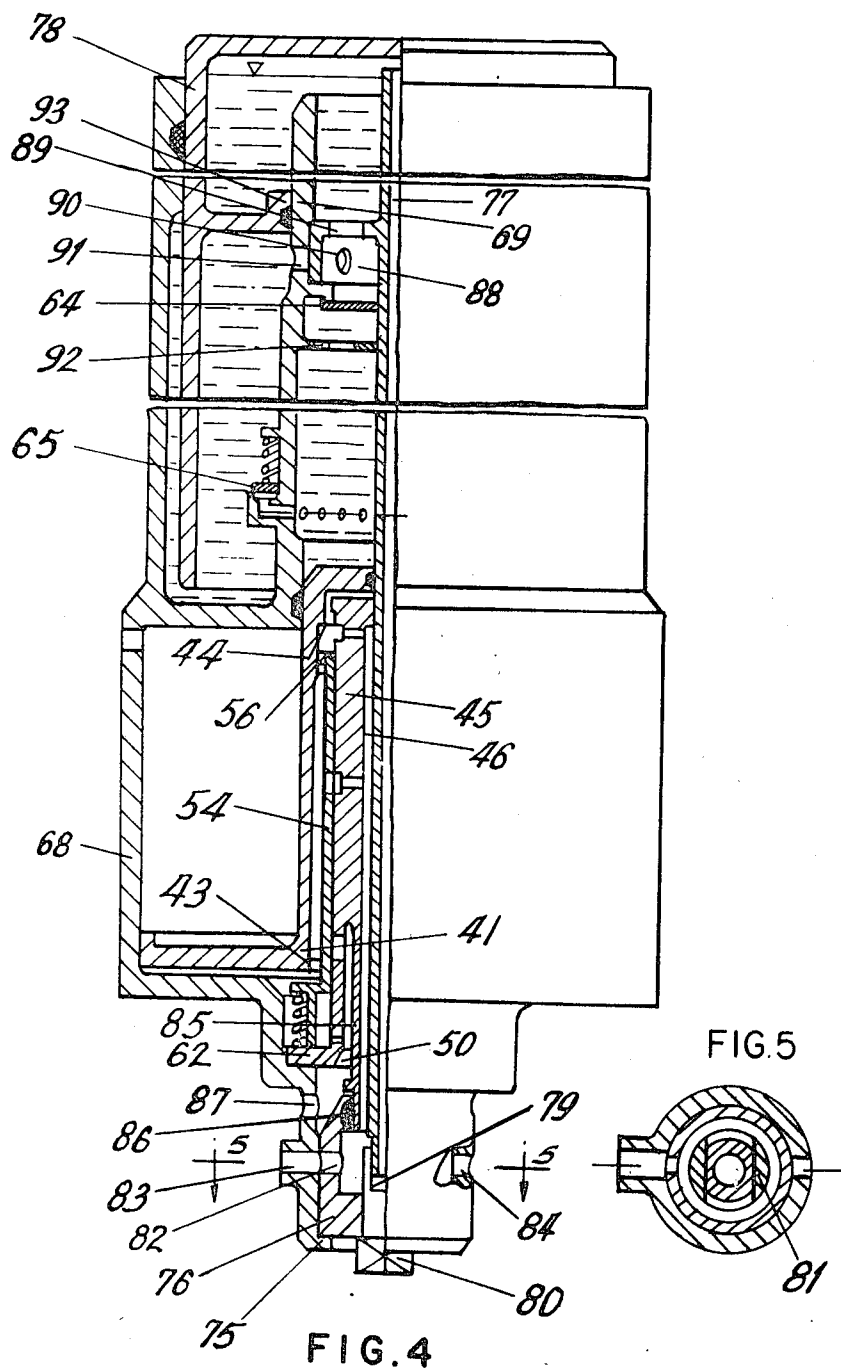


FIG. 2



COMPRESSED LIQUID ENGINE OR PUMP

The object of the invention is to provide an engine with a reciprocating motion piston which is driven by means of liquid or gas, and most advantageously by compressed air, or pump of similar construction destined for compressing liquids.

There are various known types of piston engines driven by compressed liquids, and especially by compressed air with reciprocating motion of the piston.

In the majority of cases these engines are equipped with a sliding control gear located outside of the cylinder, most frequently beside this cylinder.

This type of timing is generally directly controlled by the piston or the element connected with it, for instance a piston rod as described in British Pat. No. 635,629.

The slide valve may be controlled by a pneumatic or hydraulic system, as described in German Democratic Republic Pat. No. 40,325.

Although operation of the control systems described above is usually quite correct, they are comparatively complicated, have a great number of parts and enlarge the overall dimensions of the engine.

There are known solutions in which the control system is united in the block with engine cylinder which allows for reduction of overall dimensions of the engine and simultaneously for simplification of the timing gear. In the construction described above the piston drives the slide valve by the push rod, as described for instance in French Pat. No. 1,503,681 or in British Pat. No. 742,419. In such solutions the number of parts of the timing gear is much smaller but still it is comparatively great. Moreover the essential fault of the all above described solutions is the necessity of using springs.

These springs are used for accumulating the energy necessary for moving the timing gear elements, in the case of stopping the piston in the dead center. Instead of springs, the spring catch may be used for switching the slide valve from one terminal point to another as described, for instance, in German Democratic Republic Pat. No. 40,325 or in French Pat. No. 1,503,681. Any increase of resistance during the motion of the slide valve or piston, for instance contamination or cracking of the spring element, causes instantaneous stopping of the engine. In comparison to the above described solutions, progress has been made by the solution introduced in British Pat. No. 663,259. In this solution compressed gas is supplied by the holes in the piston rod on which the timing sleeve and piston is mounted. The terms "timing sleeve" and "piston valve sleeve" are equivalents and the first one has been used in the present specification. In this manner the most compact construction of timing gear is obtained.

Displacing of the timing sleeve into terminal points is effected in this solution by means of buffers located in the cylinder heads. Coil springs are used as the buffers.

Use of the coil springs causes the inconveniences which have been described above, moreover the described timing gear causes useless increase of axial overall dimensions of the engine. An additional disadvantage of the described system is the feed, as well as draining, of a working medium through the piston rod which must be drawn out from both sides of cylinder which practically makes it impossible to directly connect the engine with the machine being driven, for instance pumps as described in the German Democratic Republic Pat. No. 8,227 or in French Pat. No. 1,503,681, considering that the piston of the engine constitutes also the piston of the pump.

Moreover in the engine according to British Pat. No. 663,259 the piston is connected with the piston rod by means of guide pins traveling along the longitudinal cutouts in the piston rod. This construction causes strong impacts of the guide pins in the cutouts and very fast wear of these parts, which instantly causes a decrease in the engine efficiency.

It should be added that solutions are known in which the working medium is fed to the engine from outside the cylinder and the piston is located inside the piston valve sleeve. These solutions, described in German Pat. No. 230,710, cause con-

siderable extension of the engine dimensions in the direction perpendicular to the axis of the piston rod.

There is also known the solution of a single acting pneumatic engine according to German Democratic Republic Pat. No. 37,243.

In this engine a three-stage telescopic piston is used which automatically displaces the timing gear in the position corresponding with the backward motion of the piston. However, this backward motion may happen only after a decrease of the working medium pressure under the action of the external force. In principle this engine may be considered as an engine with a separated timing gear which is different in comparison with the scope of application of the invention in question. It should be added that the described engine, because of the telescopic construction of the piston, causes unequal forces on the piston rod as a function of piston travel.

The faults of the known solutions listed above have been eliminated in the construction of the engine which is the object of the present invention. The solution according to the present invention may be applied in the engines with reciprocating single-acting as well as double-acting pistons which are driven by means of liquid or compressed gas, and most advantageously by compressed air.

The solution according to the present invention may be especially useful as the engine for driving hydraulic pumps, in this case it is most advantageous to use the construction in which the engine piston constitutes the pump piston.

The solution according to the present invention may be used with a good result as the pump for liquids and especially for gases.

According to the invention, the engine consists of a cylinder with a stationary mandrel mounted inside. The mandrel has a central bore by which the working medium, most advantageously air, is fed. The slidable timing sleeve is mounted on the mandrel. This sleeve may be partly inside the hollow cylinder body and in such case the outside surface of the sleeve collaborates with the cylinder. The timing sleeve has holes and ducts which, in the dead center position of the sleeve, connects the corresponding sides of the cylinder, divided by the piston, with the bore in the mandrel by which the working medium is fed. On the external surface of the timing sleeve there is a piston connected with a piston rod which passes through the end of the cylinder opposite to the end in which the mandrel for feeding the working medium is mounted. The piston rod may be shaped as the plunger of the hydraulic pump combined with the engine. The timing sleeve has various bosses collaborating with the corresponding bosses on the piston, which causes displacing of the timing sleeve to dead center in which the cylinder is fed by working medium from one or the other side of the piston. The timing sleeve has a special surface in a plane perpendicular to its oblong axle, which surface is under the pressure of working medium fed to the engine. After displacing of the timing sleeve in one dead center, independently to the following piston motion the sleeve is kept in its position by means of pressure of the working medium.

Thanks to this, spring elements in form of catches or spring buffers, which were mentioned in the description of the known solutions, are not necessary.

According to the invention, the engine may be built not only as the double-acting type, in which working medium presses alternately against one or the other side of the piston, but also as the single-acting type in which motion of the piston is forced by the working medium only in one direction and backward motion is effected by a spring element pressing the piston.

In some cases, as will be described below, it is advisable to use spring elements in the timing gear of the engine which is the object of the invention, but it is not indispensable in the basic embodiments of the invention. Coil springs, which are the most simple and reliable, are used. The invention may be also used in the construction of pumps for liquids and specially for gases by using any engine for transferring the reciprocating

motion to the piston rod of the engine made according to the invention. However, the most advisable use of the invention is for the construction of piston engines.

The detailed description of the invention and examples of its construction are given below.

The examples of applications of the invention given below do not limit the scope of the invention and its application is also possible in different not described alterations. The examples of application of the invention are illustrated in the accompanying drawings.

FIG. 1 is a partial vertical sectional view of a double-acting engine embodying the invention;

FIG. 2 is a partial vertical sectional view of a single-acting engine connected to a hydraulic pump;

FIG. 3 is a view like FIG. 2 of a modification of the engine shown in FIG. 2;

FIG. 4 is a partial vertical sectional view of a further modification of a single-acting engine connected to a hydraulic pump and having a special valve for feeding compressed air over the liquid level in the feeding tank of the pump; and

FIG. 5 is a horizontal section on line 5—5 of FIG. 4.

In the cylinder 31, there is a piston 32 having a piston rod 33, the piston rod being connected with any equipment to be driven. In the bottom end of the cylinder 31 is an opening 1 in which the mandrel 34 is mounted. The mandrel has an axial bore 25 which is closed on one end. On the mandrel 34 a slidable timing sleeve 35 is mounted. The bottom part of the timing sleeve 35 collaborates in a slidable manner with the opening 1 located in the bottom end of cylinder 31. Below the bottom end of cylinder 31, the timing sleeve has an annular groove 2 with upper edge 3 and bottom edge 4 which enclose duct 5 connected by the aperture 6 with the outlet to atmosphere 7 and duct 8 of the air conduit 9 which is connected with the chamber 10 above the piston 32.

Below the annular groove 2 the timing sleeve 35 has radial holes 11. The distance between upper edge of each of the holes 11 and bottom edge of duct 8 and duct 12 (in mandrel 34 and of the same height) is greater than the distance between upper face 13 of the timing sleeve 35 and the upper edge of the inlet duct 14, the last distance being less than or equal to the distance between bottom edge 4 of the annular groove 2 in the timing sleeve 35 and the upper edge of duct 8. The duct 12 is located on the surface of the mandrel 34 and is connected with its axial bore 25.

The mandrel 34 has a ring-shaped duct 15 connected with the axial bore 25 by means of the holes bored above bottom face 16 of the timing sleeve 35 at a distance greater than the distance between bottom edge 4 of the annular groove 2 of the timing sleeve 35 and upper edge of the duct 8, but less than the distance between upper edge 3 of the annular groove 2 of the timing sleeve 35 and upper edge 17 of the opening 1 bored in the bottom of the cylinder 31. The upper part of the timing sleeve 35 has a collar 36 which constitutes a catch cooperating with a catch in the form of an annular recess 18 in a bore which is formed in the piston rod 33 and which encloses the mandrel 34 and the timing sleeve 35.

For diminishing the results of impacts which occur between the collar 36 and recess 18, an elastic ring 19 is placed on the collar 36 of the timing sleeve 35.

The inside diameter 20 of the bore in the upper part of the sleeve 35 and the equal outside diameter of the upper part of mandrel 34 are greater than the inside diameter 21 of the bottom part of the bore in the timing sleeve 35 and equal to outside diameter of bottom part of mandrel 34. In this way a free closed space formed between step 22 of the mandrel 34 and step 23 of the timing sleeve 35 is connected by means of holes 24 in the timing sleeve 35 with the annular groove 2 in timing sleeve 35.

A chamber 27 under the piston 32 is connected, by means of a bore provided in piston rod 33, to the chamber 38 formed between the piston rod 33 and the timing sleeve 35. The bottom edge of the bore in the piston rod 33 is equipped with a catch in form of a boss 28 cooperable with the mentioned

catch in the form of a collar 36 formed on the timing sleeve 35.

Recess 18, boss 28 and collar 36 are used for controlling motion of the timing sleeve 35 directly by the piston 32. For the purpose of diminishing the effects of impacts which occur during interaction of the boss 28 and collar 36, the bottom surface of the collar 36 of timing sleeve 35 is equipped with a ring 29 made of elastic material similar to the ring 19.

For the same purpose the ring 30 made of elastic material is located on the bottom of the opening 1 bored in the cylinder 31. Moreover, the mandrel 34 has a duct 26 located between the ducts 12 and 14 which is connected with the axial bore 25 and when the timing sleeve 35 is in the bottom dead center position the port 37 bored in the timing sleeve 35 connect the duct 26 with the chamber 27 under the piston 32.

The working medium, preferably compressed air, is fed according to the arrow A into the axial bore 25 of the mandrel 34. FIG. 1 presents the position of the movable parts of the engine according to the invention at the moment when working medium flows from the axial bore 25 in the mandrel 34 through ducts 14 and 26 to the chamber 27 under the piston 32 driving the piston 32 upward.

In the extreme upward end of the piston 32 motion, the boss 28 located on the piston 32 and piston rod 33 comes into contact with the collar 36 of the timing sleeve 35 and pulls it up, as a result the timing sleeve 35 covers the ducts 14 and 26 and with its bottom edge 4 cuts annular groove 2 off from the duct 8. This stops the feed of the working medium to the chamber 27 under the piston 32 as well as exhaust of the working medium from the chamber 10 above the piston 32 through the conduit 9, the duct 8, annular groove 2, the duct 5 and the aperture 6 to the outlet 7 to atmosphere. In this manner the upward motion of the piston 32 is stopped, however, because of the simultaneous upward motion of the timing sleeve 35, its bottom face 16 opens the duct 15 allowing the working medium to flow under the timing sleeve 35 and push on its bottom face 16 thus causing farther upward motion independently of the stopping of the piston 32. Displacement of the timing sleeve 35 under the pressure of the working medium on its bottom face 16 is sufficient for pushing out the upper edge 3 of its annular groove 2 over the upper edge 17 of the opening 1 in the bottom of the cylinder 32 which connects the chamber 27 under the piston 32 by the annular groove 2, the duct 5 and the aperture 6 with the outlet 7 to atmosphere, so that the working medium may freely leave out the chamber 27 under the piston 32. At that moment the holes 11 in the timing sleeve 35, the duct 8 in the opening 1 of the cylinder 31 and the duct 12 on the mandrel are on the same height thus opening a path for the flow of the working medium to the chamber 10 above the piston 32 through the conduit 9.

As a result of inflow of the working medium to the chamber 10 above the piston 32 it starts a downward motion. In the final phase of the downward motion of the piston 32 the annular recess 18 in the bore of the piston rod 33 comes into contact with the collar 36 of the timing sleeve 35 causing the downward motion of the timing sleeve 35. The upper edge 3 of annular groove 2 of the timing sleeve 35 moves below the edge 17 of the opening 1 in cylinder 31 thereby cutting off the connection between chamber 27 under the piston 32 and atmosphere. Afterwards the displacement of the bottom face 16 of the timing sleeve 35 below the duct 15 causes cutting off of the inflow of working medium under the bottom face 16 of the timing sleeve 35 and opening of the duct 8 by the bottom edge 4 of the annular groove 2 of the timing sleeve 35. The farther downward motion of the timing sleeve 35 opens the inlet ducts 14 and 26, this will bring back the condition in which the working medium inflows into the chamber 27 under the piston 32, while the chamber 10 above the piston 32 is connected with atmosphere. Motion of the piston 32 is stopped, while the timing sleeve 35, under pressure on the upper face 13 from the working medium flowing through the duct 14 is displaced downwardly until reaching its initial position. In this way the working cycle of the engine according to the invention is

finished and the next one of the analogical course to the above described may start. Production possibility of the engine according to the invention is not limited to the double-acting engine described above.

A different example of using the invention is the single-acting engine illustrated in FIG. 2. The piston 41 of this engine constitutes also a plunger of a hydraulic pump coupled with the engine.

In the described example the piston 41, biased by a spring 67, is located inside a cylinder 68 which is integral with the cylinder 69 of the hydraulic pump and its plunger, which is formed by the upper part of a piston 41.

The piston 41 has an axial bore 42 with a ringlike lip 43 protruding inwards from the lower open end and a step 44 formed near the upper closed end. The lip 43 and step 44 serve to control the motion of the timing sleeve 54. The timing sleeve 54 is mounted in a sliding manner on the mandrel 45 which has inside an axial bore 46. The mandrel 45, with the timing sleeve 54 mounted thereon, is located inside the axial bore 42 of a piston 41. On the outer surface of mandrel 45 there are two annular recesses 47 connected through ducts 48 and 49 with the axial bore 46 inside the mandrel 45. In the bottom part of the mandrel 45 there is a duct 50 opening to atmosphere and in the lateral surface of the mandrel 45 are bored holes 51 and 52 connected with this duct 50. On the upper part of the mandrel, a retainer ring 53 is mounted. The bottom end of the timing sleeve 54, which is mounted on the mandrel 45, rests on the surface of flange 55 of the mandrel which closes the air cylinder 68. The upper part of the timing sleeve 54 has a collar 56 which constitutes a catch collaborating with the step 44 and lip 43 which are on the piston 41. In the middle part of the timing sleeve 54 there are the holes 57 which selectively exposes the annular recess 47 connected to the duct 49, and in the bottom part of an axial bore 58 of a diameter bigger than the diameter of the mandrel 45.

Outside the timing sleeve 54 there is a collar step 59 on which rests a spring 60 biasing the timing sleeve 54. The bottom end of spring 60 rests on the flange 55. The holes 51 have a diameter smaller than the holes 52 and the distance between the flat end surface 61 of axial bore 58 in the timing sleeve 54 and the bottom edge of the holes 52 is smaller than the distance between the upper surface of the collar 56 and the retainer ring 53.

Inside the flange 55, opposite to the bottom surface of the timing sleeve 54, there is mounted a ring 63. The bottom of the flange 55 rests on step 62 formed in cylinder 68. The upper part of the cylinder 68, above the piston 41, is directly connected with atmosphere through the port 66. Through this port the air which is above the piston 41 may escape outside cylinder 68 in the direction according to the arrow D.

The hydraulic pump coupled with the engine is built of cylinder 69 which is connected with the engine cylinder 68, a plunger formed by the upper part of piston 41 and one way inlet valve 64 and one way exhaust valve 65. Medium compressed by the hydraulic pump is supplied by a pipe in the direction according to an arrow B and discharged by a pipe in the direction according to an arrow "C."

The principle of operation of the described alternative of the invention is as follows: the working medium is fed through the axial bore 46 in the direction according to arrow A and through the duct 48 and recess 47 into the space above the collar 56 of the timing sleeve 54, causing a downward displacement of the timing sleeve 54 to the position in which its bottom surface contacts the ring 63 on flange 55.

In this position of the timing sleeve 54 the axial bore 58 is connected through the holes 51 with the duct 50 and through this duct with atmosphere. Simultaneously the working medium flows through the duct 49 and the recess 47 to the space under the collar 56 of the timing sleeve 54 and then to the space under the piston 41 causing its upwards motion. While the piston 41 moves upwards, its control lip 43 hitches the controlling collar 56 of the timing sleeve 54. From this moment the movement of the piston 41 causes lifting of the tim-

ing sleeve 54 and consequently its bottom surface separates from the flange 55 and the working medium flows to the axial bore 58. It causes the compensation of the downward pressure induced by the working medium on the collar 56 of the timing sleeve 54 and upward pressure on the surface 61 of the timing sleeve 54.

The force of the spring 60 is large enough to press the timing sleeve 54 up into the contact with the retainer ring 53. The holes 51 have diameters small enough to keep in the axial bore 58 a pressure of the working medium sufficient for compensation of the thrusts pressing against the timing sleeve 54. However, the diameter of the holes 51 is big enough so that the working medium which could flow to the space of the axial bore 58, owing to leakage between the bottom surface of the timing sleeve 54 and the flange 55 which closes the air cylinder 68, may flow to the atmosphere making it impossible to increase the pressure in the axial bore 58.

Any increase of the working medium pressure which may occur in the axial bore 58 at that moment may cause an early connection of the space under the piston 41 with atmosphere.

In response to the upward motion of the timing sleeve 54 under the force of the spring 60, the surface 61 of the bore 58 opens the holes 52, in this manner connecting the space under the piston 41 through the bore 58, holes 51, 52 and the duct 50 with the atmosphere.

This causes a decrease of the working medium pressure in the space under the piston 41 to the level of atmospheric pressure. Under the pressure of the spring 67 and the compressed liquid which is fed to the hydraulic pump cylinder 69 through the valve 64 under a preliminary pressure, the piston 41 moves downward until the step 44, which serves as the controlling catch, comes into contact with the collar 56, which controls the motion of the timing sleeve 54, and from that moment the timing sleeve 54 moves downwards together with the piston 41. At the moment when the upper edge of the timing sleeve 54 opens the recess 47 connected through the duct 48 with the axial bore 46 of the mandrel 45, the working medium flows over the collar 56 of the timing sleeve 54 inducing a pressure sufficient for pressing the spring 60 and displacing the timing sleeve 54 to its bottom position with its bottom surface contacting the flange 55. At that moment the bottom edge of the hole 57 opens the duct 49 connected through the recess 47 with the axial bore 46 of the mandrel 45 with the effect that the working medium flows under the piston 41 causing the repetition of the described working cycle.

According to the above given description, it is clear that also in this solution the basic features of the invention are retained, namely the direct control of the timing sleeve by the piston and appropriate catches of the piston and the sleeve.

FIG. 3 shows an example using the invention, in which its fundamental features are kept, which concerns also a single-acting piston operating according to the invention and connected with a hydraulic pump.

The hydraulic pump, as in the previous example, is composed of the cylinder 69 which constitutes one unit with the engine cylinder 68.

The pumped medium is fed according to the direction of the arrow B and is discharged according to the direction of the arrow C through check valves, not shown in the drawing. As in the example described above, the piston 41 moves in the cylinder 68 and has a recess in which a mandrel 45 with an axial bore 46 and a slidable timing sleeve 54 mounted on the mandrel 45 are located. A step 44 is formed in the recess of the piston 41.

The timing sleeve 54 has in its bottom part an axial bore 58 and the mandrel 45 has below the flat surface 61 of the axial bore 58 a step 73 of an accordingly enlarged diameter.

At the same time the flat surface 61 of bore 58 in the timing sleeve 54, in the bottommost position of the timing sleeve 54, covers the bottom edge of the hole 52 which is connected with the outlet duct 50 to the atmosphere according to the arrow E. The collar 56 of the timing sleeve 54 rests on the spring 71, the other end of which rests on the ring-shaped lip 43 of the piston

41. Two rings 70 and 72, made of the elastic material, are mounted on the mandrel 45. The upper ring 70 adheres to the retaining ring 53 which limits the travel of the timing sleeve 54, and the bottom ring 72 adheres to the flange 55 which closes the air cylinder 68. The end 74 of the timing sleeve 54 rests on the bottom ring 72. The upper part of the cylinder 68 above the piston 41 is connected with atmosphere through the port 66 according to the arrow D.

The working medium is fed to the axial bore 46 of the mandrel 45 according to the arrow A. The mandrel 45 has ducts 48 and 49 connected with the bore 46 and the timing sleeve 54 has the holes 57.

In the FIG. 3 the position is shown when the working medium flows from the bore 46 of the mandrel 45 through the duct 49 and hole 57 to the space under the piston 41 causing its upward movement. The piston, by means of its ring-shaped lip 43 which serves as the controlling step, causes compressing of the spring 71 until the moment when the force of the spring 71 is large enough for lifting the timing sleeve 54. The timing sleeve 54 covers the duct 49 through which the working medium flows to the space under the piston 41. After that, because of lifting up of the end 74 of the timing sleeve 54, over the edge of the step 73 in the mandrel 45, through the hole 52 and outlet duct 51, the space under the piston 41 is connected with atmosphere.

As the result of the pressure drop of the working medium in the space under the piston 41, and the force of the working medium fed under preliminary pressure on the upper part of the piston 41 which is located in the hydraulic cylinder 69, the piston 41 moves downward.

As in the example shown in the FIG. 2, for increasing this effect the pressure of the spring on the piston 41 may be used. This spring is not shown in the FIG. 3.

During the downward motion of the piston 41, its step 44 contacts the collar 56 of the timing sleeve 54 causing its displacement to the position in which its upper edge opens the duct 48. The pressure of the working medium against the collar 56 of the timing sleeve 54 causing its displacement downwardly, closing the connection of the space under the piston 41 with the atmosphere and reconnecting the inflow of the working medium to cause repetition of the described working cycle.

In the example of the invention shown in FIG. 3, the collar 56 is used as the controlling step for the timing sleeve 54 and a step 44 with the lip 43 are used for controlling the piston 41. The lip 43 collaborates with the collar 56 of the timing sleeve 54 through the intermediary of the spring 71; however, the fundamental above-described feature of the invention, which is controlling the motion of the timing sleeve by means of motion of the piston is still kept.

Finally, in the FIGS. 4 and 5 there is introduced the variation of application of the invention, which was already shown in the FIG. 2, in which the engine is united in the block not only with a hydraulic pump, but also with the container for the pumped medium which is fed to the pumps. For obtaining the preliminary pressure of the feeding medium, the working medium which also is used for driving the engine is utilized. The construction and operation of the engine in this variation of invention are identical with the example shown in the FIG. 2 with the difference that the return downward motion of the piston 41 takes place only under the pressure of the pumped medium which presses the part of the piston 41 which constitutes the plunger of the hydraulic pump. Because of that, the spring 67 of FIG. 2 is not shown in FIG. 4. The remaining parts of the engine which are similar to the example shown in the FIG. 2, have the same reference numerals and operate in the similar way to that described above. The main differences in the constructions of both embodiments of the FIGS. 2 and 4 are the bottom part of the mandrel 45 is connected with cylinder 68 and body 75 of the valve 76 to which also is connected the conduit 77 located inside the axial bore 46 of the mandrel 45. This conduit projects from the other side over the level of the pumped medium which is fed to the hydraulic

pump from the container 78 which encloses from outside the cylinder 69 of the hydraulic pump. The container 78 has a partition 93 which divides it into two parts.

The bottom part of the conduit 77 which is connected to the valve 76 does not touch the bottom of the cavity 79 in the pin 80 of the valve 76. To make possible rotation of the conduit 77 by means of the pin 80 of the valve 76, the conduit 77 has lateral scarfs 81 (FIG. 5) which contact the lateral walls of the cavity in the pin 80 of the valve 76. In the lateral surface of the valve 76 there is an inlet 82 the axis of which is located at the same height as the axis of inlet 83 and outlet 84 in the bottom part of the body 75 of the valve 76. Extension 85 of the mandrel 45 is connected to the valve 76 through a seal ring 86. Over the valve 76 in the body 75 is located a hole 87 which connects the space above the valve 76 with atmosphere. The outlet 50 of the mandrel 45 is connected to this space. In the pump cylinder 69 there is a rotating valve 88 which is connected with the conduit 77. The valve 88 has, in its upper horizontal plane, holes 89 and in the lateral plane holes 90 which are located on the same level as the holes 91 in the upper part of the pump cylinder 69. Moreover, the hydraulic pump is equipped with a one-way inlet valve 64 and one-way outlet valve 65 which are of the plate valve type. The chamber of the inlet valve 64 is connected with the interior of the cylinder 69 through the holes 92. Rotation of the pin 80 of the valve 76 causes simultaneous rotation of the conduit 77 and the valve 88 which is connected with it, with the effect that the holes 90 of the valve 88 are moved away from alignment with holes 91 in the pump cylinder 69. The working medium flows through the inlets 83 and 82 inside valve 76 then to the axial bore 46 in the mandrel 45 to the space over the bottom of the cavity 79 in the pin 80 of the valve 76 and to the conduit 77. From the conduit 77 the working medium flows inside the container 78 over the level of the pumped medium.

As the consequence of the pressure of the working medium on the pumped medium, the working medium flows through the inlet valve 64 and holes 92 inside the cylinder of the pump 69 causing downward dislocation of the piston 41.

As the effect of the operation of the timing gear described above, the upward stroke of the piston 41 causes the flow of the liquid through the valve 65 to the space of the container 78 under its partition 93.

Filling up of this space by the farther operation of the engine which is connected with the pump, causes farther lifting of the container 78, which may be used for instance as a plunger of a hydraulic jack. Upward lifting of the container 78 lasts as long as the engine which is connected with the pump operates.

Upward lifting is stopped upon stopping of the engine. For pushing the container 78 down, the pin 80 of the valve 76 should be turned until the inlet hole 82 is aligned with the outlet hole 84, through which the working medium flows out of container 78 to the atmosphere.

At the same time, the rotation of the pin 80 of the valve 76 causes rotation of the conduit 77 and with it the hydraulic valve 88 so that the holes 90 in the valve 88 are aligned with the holes 91 in the cylinder 69. The result is the pumped medium, which is in the space under the partition 93 of the container 78, is pumped through the holes 90 and 91 under the pressure effected by the weight of the container 78. Then the medium is pressed into the space over the partition 93 which causes lowering of the container 78.

The examples described above, which concern specific applications of the invention, do not exhaust all possibilities of its application and do not limit its use in different solutions, especially in pumps of a construction similar to the construction of the engine. In this case the piston rod 33 of the piston 28 of the engine (FIG. 1) is connected with the driving gear for reciprocating motion.

We claim:

1. A fluid operated device comprising a cylinder having a chamber therein, a reciprocable piston mounted in said chamber and having a cavity therein and at least one catch

thereon, a mandrel fixedly mounted in a bottom part of the cylinder extending into said chamber and said cavity, an axial bore formed in said mandrel, a plurality of radial ports in said mandrel leading to said bore, a timing sleeve slidably mounted on said mandrel and having radial ports therein, one end of said timing sleeve extending into said piston cavity, means to feed a working medium through the bore of said mandrel, said timing sleeve having at least one step which cooperates with said at least one catch on said piston, whereby said timing sleeve is displaced depending upon changes in the location of the piston in response to the pressure of the working medium to thereby control the flow of the working medium by selective opening and closing of said ports.

2. A fluid operated device defined by claim 1, further comprising a bore in said cylinder below the chamber having a diameter corresponding to the diameter of the timing sleeve, a first duct in said cylinder communicating with an outlet to the atmosphere, a second duct communicating with the portion of said chamber above said piston, an annular recess in a portion of said sleeve below said chamber and covering said first and second ducts, and ports provided in said portion below said annular recess, the distance between an upper edge of each port and the bottom edge of said second duct, which is coincident with a radial port provided in said mandrel, being greater than the distance between an upper surface of said timing sleeve and an upper edge of an inflow duct in said mandrel which latter distance is less than the distance from the bottom edge of the annular recess to the upper edge of said second duct, said mandrel having a further duct provided with openings located above the bottom surface of said timing sleeve by a distance greater than the distance between the bottom edge of said annular recess and the upper edge of said bore in the cylinder and, at the same time, said catch constituting the means for controlling the motion of said timing sleeve.

3. The fluid operated device defined by claim 2, wherein the inner diameter of the upper portion of said timing sleeve and corresponding outer diameter of the upper portion of said mandrel are greater than the inner diameter of the bottom portion of said timing sleeve and the corresponding outer diameter of the bottom portion of said mandrel with a step formed on each said sleeve and said mandrel connecting said portions of different diameters, a free closed space formed between said steps, openings provided in said timing sleeve connecting said space to the annular recess in said timing sleeve.

4. The fluid operated device defined by claim 3, further comprising a collar on an upper surface of said timing sleeve, a ring of elastic material provided on said collar.

5. The fluid operated device defined by claim 4, further comprising a second outside collar disposed on said timing sleeve, said ring resting on said second collar.

6. A fluid actuated device according to claim 1, further comprising two spaced steps protruding inside the cavity in said piston and serving as the control catches, an annular duct in the bottom part of the mandrel coaxial with said axial bore and forming an outlet to atmosphere, at least two spaced radial holes in said mandrel leading into said annular duct, a retainer ring fixedly mounted adjacent the free end of the mandrel, a radial flange at the bottom end of the mandrel, the bottom end of said timing sleeve engaging with said flange a collar on the upper end of said timing sleeve forming said at least one step, at least one radial port of said timing sleeve being located at the same height as a port in the mandrel, an axial recess in the bottom end of said timing sleeve having a larger diameter than the diameter of the mandrel, a collar-shaped step spaced from the bottom end of said timing sleeve, a spring mounted between said collar-shaped step and the radial flange of the mandrel, the distance between the closed

end of the recess in the timing sleeve and the bottom edge of the uppermost of said two spaced holes in the mandrel being less than the distance between the collar on the upper end of the timing sleeve and the retainer ring on the mandrel and the diameter of the lower of said two spaced holes being smaller than the diameter of the uppermost of said holes, and the distance between the uppermost step in said piston cavity to the end of the cavity being greater than the distance between the uppermost radial bore in the mandrel and the end thereof.

7. A fluid actuated device according to claim 6, wherein said radial flange of the mandrel engages with the bottom of said cylinder.

8. A fluid actuated device according to claim 6 further comprising a wear ring mounted in the radial flange of said mandrel and receiving the bottom end of said timing sleeve.

9. A fluid actuated device according to claim 6, further comprising spring means mounted between an upper face of said piston and the top of said cylinder.

10. A fluid actuated device according to claim 6, wherein the mandrel has at its bottom end a portion with a diameter equal to the inside diameter of an axial recess in the bottom end of said timing sleeve, the inner end of said axial recess being above the bottom edge of a hole in said mandrel leading to the atmosphere.

11. A fluid actuated device according to claim 10, further comprising a spring mounted between one of said at least one step on the timing sleeve and one of said at least one catch on the piston.

12. A fluid actuated device according to claim 10, further comprising upper and lower rings made of elastic material mounted on said mandrel, the upper ring adhering to the bottom surface of said retainer ring limiting the stroke of the timing sleeve, and the lower ring adhering to the radial flange receiving the bottom end of said timing sleeve.

13. A fluid actuated device according to claim 1, further comprising a container means containing a pumping medium and connected to one end of said device to be responsive to pumping action by said piston, an air valve means connected to the other end of said device, a conduit having a diameter smaller than the diameter of the axial bore in the mandrel and mounted to pass through said axial bore and the mandrel with its upper end projecting over the level of the pumped medium in said container and its bottom end connected to said air valve.

14. A fluid actuated device according to claim 13, wherein said air valve comprises a valve housing having a chamber therein, a coaxially mounted valve body means extending into said valve chamber, inlet holes and outlet holes in said valve housing, and a hole in said valve body at the height of said inlet and outlet holes.

15. A fluid actuated device according to claim 13, further comprising an extension of the mandrel extending into the chamber of the air valve, a hole in said housing connecting the portion of the air valve chamber between said valve body and the cylinder with the atmosphere.

16. A fluid actuated device according to claim 15, further comprising a hollow pin in said valve coaxial with said valve body, a lateral scarf on the bottom end of said conduit contacting the lateral walls of the hollow pin, and a rotating valve means connected to an upper part of conduit in said container.

17. A fluid actuated device according to claim 16, wherein the rotating valve has an upper horizontal plane with inlet holes therein and a lateral surface with holes therein located at the height of intake holes in the container.

18. A fluid actuated device according to claim 17, further comprising a second container slidably mounted in the container and having a partition therein, the intake holes of said container being below said partition.

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