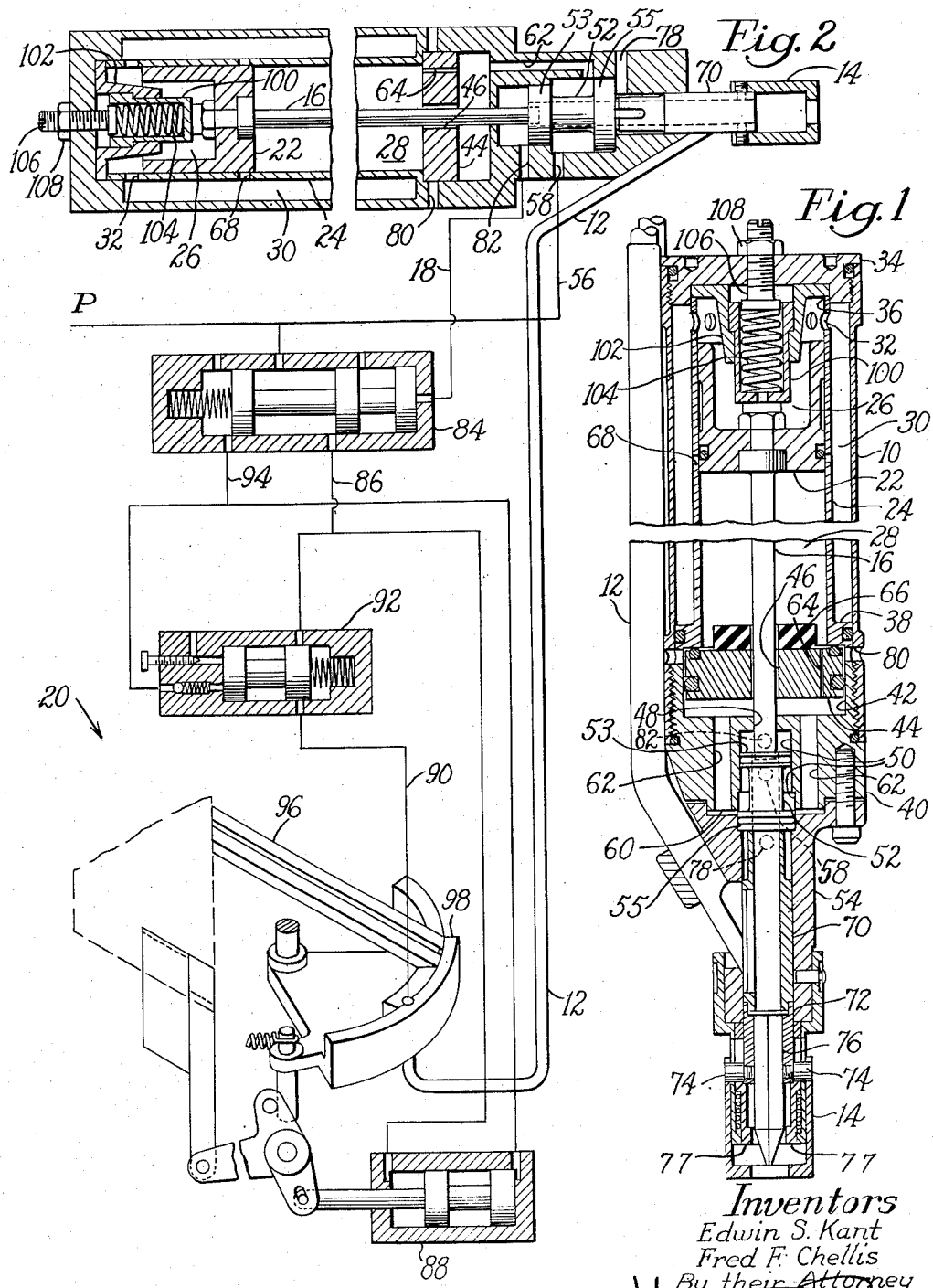
March 11, 1958 F. F. CHELLIS ET AL 2,826,176

FLUID MOTORS FOR FASTENER INSERTING DEVICES

Filed July 26, 1955



Inventors
Edwin S. Kant
Fred F. Chellis
By their Attorney

United States Patent Office 2,826,176 Patented Mar. 11, 1958

2,826,176

FLUID MOTORS FOR FASTENER INSERTING DEVICES

Fred F. Chellis, Manchester, and Edwin S. Kant, Melrose, Mass., assignors to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey

Application July 26, 1955, Serial No. 524,535

11 Claims. (Cl. 121—13)

This invention relates to fluid motors of the percussive type which are particularly adapted for impact driving of fasteners, such as nails, sash pins, etc. However, in its broader aspects the fluid motor of the present invention is not thus limited in its use.

In a copending application for Letters Patent of the United States Serial No. 487,317, filed February 10, 1955, in the name of Fred F. Chellis, now Patent No. 2,807,021, granted September 24, 1957, there is disclosed a fluid motor which is particularly effective in providing a high impact energy compared to its size and weight. Such a motor is particularly useful when embodied in a hand-held or portable fastener inserting gun of the type disclosed therein.

That gun includes a motor which comprises a cylinder in which rides a driver piston separating the cylinder into upper and lower chambers. A casing surrounds the cylinder forming an accumulator which communicates with the upper chamber. Pressurized fluid, preferably air, is introduced into the lower chamber to maintain the driver piston in a cocked position ready to be fired. This is accomplished by first introducing air against a control valve which seals the lower chamber from atmosphere and which has a driver clearance hole through which air passes to the lower chamber. Pressurized fluid, preferably air, also at line pressure, passes through a pressure-regulating valve to the upper chamber of the gun and into the accumulator. The pressure-regulating valve is opened by the driver piston as it is forced upwardly by the air in the lower chamber. When the pressure in the upper chamber approaches the pressure in the lower chamber, the pressure-regulating valve is closed as the pressure in the upper chamber forces the piston away from the valve. Thus the pressure in the upper chamber is established at a point slightly below the pressure in the lower chamber as the force on the upper side of the piston equals the force on its lower side either due to the area differential created by the driver extending from the lower side or the spring force of the valve which acts on the upper side of the piston.

While the above-described construction functions in an entirely adequate manner, greater simplicity of construction is desired. It is, therefore, an object of this invention to provide an improved fluid motor which operates on a differential air pressure principle of simpler and more economical construction. To this end and in accordance with various features of the invention, the pressure-regulating valve for controlling the admission of pressure fluid into the upper chamber of the motor has been eliminated. The upper end of the air motor is sealed off and pressurized air is supplied to the upper chamber of the motor in the following manner. Bypass ports are provided near the upper end of the cylinder and are so located that when the lower chamber of the motor is pressurized at line pressure, the driver piston moves upwardly and opens these ports to the lower chamber. Air passes through these ports to the upper chamber, preferably by passing through and pressurizing the surrounding accumulator. As pressure force is built up in the upper chamber to equal and slightly exceed the force on the lower side of the piston, it drifts downwardly, sealing off the bypass ports and preventing passage of further air from the lower chamber to the upper chamber. This drifting of the piston occurs until a force balance is established on the two sides of the piston, the upper chamber becoming larger and the lower chamber smaller in the process. The pressure in the upper chamber will be less than that in the lower chamber due to the provision of a driver extending from the lower side of the piston and the consequent decrease in area since the forces on each side of the piston are equal when the piston is in a cocked or inactive position sealing the bypass ports. The fluid motor thus is then ready to drive a fastener held in the positioning means extending from the lower end of the casing. The gun is triggered by pressing it against a workpiece to vent the lower side of the control valve to atmosphere. The driver piston is driven by the pressurized air in the upper chamber and in the accumulator as the lower chamber is vented to atmosphere. The driver piston may then be returned by re-pressurizing the lower chamber without venting the air in the upper chamber to atmosphere.

The present type air motor, as noted, is particularly useful in portable fastener inserting devices and is disclosed herein with means for automatically delivering fasteners to the fastener positioning means mounted on the motor in response to each operation of the motor or inserting gun. In use, such a device must be capable of operation at a rapid rate. It has been found that for this rapid rate of operation the pressure in the upper chamber must be maintained at a point substantially below the pressure in the lower chamber. Otherwise, as the driver piston is returned, its rate of motion will be relatively slow, due to the small pressure differential, as it re-compresses the air in the upper chamber and accumulator.

It is, therefore, another object of the present invention to provide an air motor similar to that disclosed in the above-mentioned application which has a faster return rate of the driver piston. To accomplish this object and in accordance with a further feature of the present invention, we have found it desirable to provide a spring loaded plunger which is arranged to bear against the upper surface of the driver piston when it is in its cocked position. This plunger tends to maintain the driver piston in an inactive position sealing off the bypass ports in the cylinder. Thus, when air is introduced into the lower chamber for the first time, air will pass to the upper chamber and pressurize that chamber, as well as the accumulator, to a point where the pressure in the upper chamber in combination with the spring pressure of the plunger will displace the piston to its cocked or inactive position sealing off the bypass ports. The pressure in the upper chamber may thus be maintained at a point substantially below the pressure in the lower chamber. It has also been found preferable in these types of devices to match the output energy of the fluid motor to the energy needed to drive a particular fastener.

It is still another object therefore to provide an air motor for a fastener inserting gun which may be adjustable to match its output energy to that needed for driving a particular fastener. As a further feature of this invention, means have been provided to vary the spring pressure applied to the plunger whereupon the air pressure in the upper chamber may be regulated.

In obtaining rapid operation of the inserting gun it has been found that the driver piston will at times stick in its lower position or hesitate thereat when air is first introduced into the lower chamber. Normally air is introduced into the lower chamber through a hole in

the control valve which also provides clearance for the driver. This hole provides a relatively small area on the lower side of the piston on which air pressure may act to force the piston upwardly. This condition is aggravated by a rubber-like bumper which is provided to absorb shock when the driver piston hits against the control valve in its lower position. This bumper can effectively seal off passage of air from the hole to the lower chamber. Therefore, in accordance with another feature of the present invention a further hole is provided in the control valve which permits passage of air therethrough to the lower chamber of the inserting gun so that this air may act against the area of the piston extending beyond the bumper.

The above and other features of the invention, including various novel details of construction and combinations of parts, will now be more particularly described by reference to the accompanying drawing and pointed out in the claims.

In the drawing,

Fig. 1 is a longitudinal cross-section of our improved fluid motor shown embodied in a fastener inserting device; and

Fig. 2 is a diagrammatical view of this device showing also diagrammatically, means for delivering a fastener to the inserting device in response to each operation thereof.

Referring to the drawing, our modified fluid motor is illustrated as embodied in a novel fastener inserting gun. This gun in many respects is similar to the inserting gun disclosed in the above-mentioned application. Therefore, certain elements common to both guns are shown herein only in diagrammatical form, reference being made to said application for a detailed showing of the construction of such elements. In the following description, the fluid medium will be described as air and the fasteners which will be discussed are nails. However, these and other terms are used only for the sake of explanation and are in no way intended as limitations of our invention.

Referring to the drawing, Fig. 1 shows the present inserting gun positioned to drive fasteners downwardly vertically into a workpiece. Various parts of the gun and its associated mechanism will hereinafter be referred to as "upper" and "lower" elements. This refers to the gun as oriented in Fig. 1 and is done for the sake of clarity and ease of explanation rather than as a limitation of the invention since the gun operates in other positions equally as well as when vertically oriented.

The present inserting gun comprises an outer casing 10 which is held by an operator to manipulate the inserting gun. Nails are delivered through a flexible tube 12 to a nose piece 14 which is slidably mounted with respect to the casing 10. A driver 16 is maintained in an upper inactive position ready to drive the nail positioned within the nose piece 14. The driver 16 is triggered to drive the positioned nail by pressing the nose piece 14 against a workpiece. As the nail is being driven, a flexible signal line 18 is pressurized to actuate remote nail handling means 20 (Fig. 2) which deliver another nail to the nose piece of the inserting gun.

The power for driving nails is provided by our improved air motor which includes a piston 22 to which the driver 16 is secured. The piston 22 is slidably mounted in a cylinder 24 and separates the cylinder 24 into upper and lower chambers 26, 28 respectively. The cylinder 24 is concentric with and spaced from the casing 10, the space between the cylinder and the casing forming an accumulator 30. Communication between the accumulator 30 and the upper chamber 26 is provided by holes 32. The upper end of the accumulator is sealed off by a cap 34 which is threaded into the casing 10 and which is also provided with a recess 36 for locating the upper end of the cylinder 24. A flange 38 extends from the lower end of the cylinder 24 to seal off the lower end of the accumulator 30. A plug 40 is threaded into the lower

end of the casing 10 and is provided with a bore 42 in which a control valve 44 is slidably mounted. A clearance hole 46 provides free relative movement between the control valve 44 and the driver 16 and is large enough to permit passage of air around the driver. The driver extends through a hole 48 in the plug 40 which provides an air tight seal between the bore 42 and a two-diameter bore 53. A pilot valve 52 comprising an upper spool 53 and a somewhat larger lower spool 55 rides in said two-diameter bore, an extension of which is formed in a nose piece bracket 54 secured to the plug 40. The driver 16 passes freely through a central bore in the pilot valve 52.

The inserting gun at all times is connected to a source of pressurized air through a flexible line 56 (Fig. 2) which leads to a passageway 58 formed in the plug 40. Pressurized air thus may flow to an annular chamber between the two spools 53 and 55 of the pilot valve 52 and then to an annular chamber 60 formed in the bracket 54 and from there through holes 62 to the lower side of the control valve 44. Air then may pass through the hole 46 or through a hole 64 which is also formed in the control valve 44 to pressurize the lower chamber 28. It will be noted that if the piston 22 were firmly seated against a shock absorbing bumper 66 associated with the valve 44, there would be very little area affected by pressure introduced through the hole 46. For that reason, the hole 64 is provided radially outward of the hole 46 to allow air to pass through the control valve and act against a relatively larger surface on the piston 22 which lies outwardly of the bumper 66 to effect upward displacement of the piston as the lower chamber 28 is pressurized.

When the line 56 is first connected to a source of compressed air there is no pressurized air in either the accumulator 30 or the upper chamber 26, the air therein being substantially at atmospheric pressure. The piston 22 will therefore be displaced upwardly, the lower chamber 28 becoming larger and the upper chamber 26 becoming smaller. At a point near the end of the upward movement of the piston 22, holes 68 formed in the cylinder 24 will be uncovered thereby providing communication between the lower chamber 28 and the upper chamber 26 by way of the accumulator 30 and the holes 32. In this manner pressurized air flows from the lower chamber 28 into the upper chamber 26 adding to the pressure caused by the compression of the atmospheric air originally in the upper chamber. Shortly after the holes 68 are uncovered the upward movement of the piston stops. Thereupon the piston drifts downwardly a slight amount the upper chamber becoming somewhat larger and the lower chamber smaller. Then the piston comes to rest in the position shown in Fig. 1 to seal off the holes 68 and prevent further passage of air from the lower chamber to the upper chamber. This downward movement is augmented by a spring 104, hereinafter to be described more fully. In the position shown in Fig. 1 which is called the cocked or inactive position, the piston is in a state of equilibrium with the force urging it upwardly balanced by the force urging it downwardly.

The gun is triggered to allow the pressure in the upper chamber and in the accumulator to drive the piston downwardly to a force delivering position by pressing the nose piece 14 against a workpiece. In so doing the pilot valve 52 is displaced upwardly with respect to the plug 40 by a hollow shaft 70 which extends between said pilot valve and a quill mounting means 72 which is secured to the nose piece 14 by screws 74. A quill 76 provides the nail positioning means within the nose piece 14. Quill locking means 77 shown within the nose piece 14 prevent inadvertent discharge of a nail therefrom. These means are fully described in the above-mentioned application and form no part of the present invention.

It will be understood that as the gun is initially pressed toward the workpiece to drive a nail the entire gun including the casing 10 and nose piece 14 moves. Thereupon the nose piece 14 strikes the workpiece and its for-

ward motion ceases but the casing 10 and its associated mechanism continue toward the workpiece a short distance. At this point the gun is actually moving relative to the stationary nose piece. It is obvious that the gun also may be held in a fixed position relative to the workpiece, as for example, clamped in a frame and the workpiece moved against it, whereupon the nose piece 14 would then be moved relative to the stationary gun. For the sake of a simpler description of operation as will become more apparent hereinafter the nose piece and the mechanism fixed thereto will be described as moving upwardly relative to the gun as would be the case when the tool is mounted so as to be stationary.

It should be noted at this point that the lower spool 55 of the pilot valve 52 is larger than the upper spool 53. Thus a force differential is obtained which normally maintains the pilot valve in its lower or rest position. When the pilot valve 52 is displaced upwardly relatively to the gun by the pressure of the nose piece against the work, the pressurized air on the lower side of the control valve 44 is vented to atmosphere through the holes 62, the annular chamber 60 around a reduced portion of the hollow shaft 70 and through a passageway 78 formed in the bracket 54. Thereupon, the control valve 44 is displaced downwardly in a rapid and positive manner by the air pressure in the lower chamber 28. The lower chamber 28 is then vented to atmosphere through holes 80 formed in the plug 40 and the casing 10. Upon venting of the lower chamber 28 to atmosphere the piston 22 and the driver 16 are driven downwardly in a percussive manner to the force delivering position by the air pressure in the upper chamber 26 and the accumulator 30 to drive a nail positioned within the quill 76.

When the pilot valve 52 is in its upper position, the signal line 18 is pressurized, the passageway 58 being placed in communication with a passageway 82 (Fig. 2). Upon pressurization of the signal line 18 a remote, control valve 84 (Fig. 2) is displaced from a first to a second position. In the first position of the control valve 84 a line 86 is placed in communication with the source of compressed air which maintains the piston of a fluid motor 88 in its right-hand position as seen in Fig. 2. The line 86 leads to a line 90 which communicates with the nail delivery tube 12. A time delay valve 92 is interposed in the line 90 so that normally no air flows through the line 90 and the delivery tube 12. When the control valve 84 is displaced to its second position by the pressure in the line 18, the line 86 is vented to atmosphere and a line 94, which is normally vented to atmosphere, is placed in communication with the source of compressed air. The line 94 leads to the fluid motor 88 and upon pressurization thereof the motor piston is displaced toward the left thereby causing further nails to be delivered to a raceway 96 by means not herein described and a separating segment 98 to be moved into a position for receiving a single nail at the end of the raceway 96. The line 94 also extends to the time delay valve 92 which is now opened to provide free communication between the lines 86 and 90.

After a nail has been driven, the inserting gun and the workpiece are separated by moving one or the other and the pilot valve 52 returns to its lower position. Immediately, the signal line 18 is vented to atmosphere through the interior of the pilot valve 52 as said pilot valve returns to its lower position due to the differential areas of its spools. The control valve 84 returns to its first position, the line 94 is immediately depressurized, and the line 86 is pressurized. The piston of the fluid motor 88 is displaced toward the right allowing the separating segment 98 to deliver a nail to the delivery tube 12. The time delay valve 92 remains open a predetermined time so that air may flow through the line 90 and then through the tube 12 to carry the nail to the inserting gun where it is positioned in the quill 76.

The nail handling means 20 above described form no part of the present invention but are described only to emphasize the rapid automatic operation for which the present type of inserting gun is intended. The nail handling means are described in detail in a copending application for Letters Patent of the United States Serial No. 427,022, filed May 3, 1954, in the name of Donald B. McIlvin.

When the pilot valve 52 returns to its lower position, pressurized air is again introduced against the lower side of the control valve 44 moving it upwardly and sealing the lower chamber 28 from the venting holes 80. Air passes either through the hole 46 or the hole 64 to displace the piston 22 upwardly as the lower chamber 28 is pressurized at full line pressure. In moving upwardly, the piston 22 recompresses the air in the upper chamber 26 and the accumulator 30.

It will be appreciated that if there is only a slight pressure differential between the upper and lower chambers, the upward movement of the piston 22 will be relatively slow as the air in the upper chamber is recompressed. It is desirable especially in nail inserting devices of the present type that this return stroke be relatively rapid to permit rapid operation of the device itself. To obtain such ends a spring loaded plunger 100 is provided. The plunger 100 shown in contact with the piston 22 is slidably mounted in a bushing 102 which is secured between the upper end of the cylinder 24 and the end cap 34. A compression spring 104 extends between the plunger 100 and a screw 106 which is threaded into the end cap 34. By this mechanism an auxiliary force is provided which tends to maintain the piston 22 in the inactive position in which the holes 68 are sealed from the lower chamber 28. Therefore, when air is first introduced into the lower chamber 28, the piston 22 will be displaced upwardly, its inertia compressing the spring 104. Then the piston uncovers the holes 68 so that air will flow to the upper chamber 26. This flow of air will continue until the air force upon the upper surface of the piston 22 in combination with the spring force exerted by the spring 104 causes the piston 22 to drift downwardly as above described and seal off the holes 68 whereupon the piston assumes its inactive position in a state of equilibrium. The resulting air pressure in the upper chamber 26 will therefore be substantially lower than the pressure in the lower chamber 28. Thus upon subsequent operation of the inserting gun, the piston 22 can move upwardly at a relatively rapid rate due to the substantial pressure differential between the two chambers.

If the spring 104 and plunger 100 were not employed, an air pressure differential, although substantially less, would nevertheless exist between the upper and lower chambers when the piston is in its cocked or inactive position sealing off the holes 68. In the inactive position the force tending to urge the piston downwardly is balanced by the force tending to urge it upwardly. A pressure differential results from the presence of the driver 16 which reduces the effective area of the lower side of the piston 22. Thus a lower air pressure in the upper chamber having the undiminished area of the piston to act upon will produce a force which will balance the force produced by a greater air pressure in the lower chamber which has less area to act upon, the total force produced in each direction being the product of the air pressure times the effective area.

It has further been found desirable to match the driving energy of the piston 22 with the type of nail being driven so that the bumper 66 will need to absorb a minimum of shock energy. Therefore, means have been provided for adjusting the spring force of the spring 104. These means include the screw 106 which upon turning is moved inwardly or outwardly with respect to the end cap 34 and locked in adjusted position by the check nut 108.

In the present disclosure various packings in the form of O-rings are disclosed. These O-rings are made of rubber-like material and serve no purpose other than that

of a packing or static seal in the present invention and therefore are not described in any detail.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on said piston to displace it toward one end of said cylinder, means for maintaining a supply of fluid in said second chamber at a pressure below the pressure in said first chamber, said means comprising a passageway connecting said chambers and through which fluid may flow from said first to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, means for causing the piston to be maintained in an inactive position covering said passageway when a predetermined pressure differential exists between said chambers, and means for releasing pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

2. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, the side of said piston facing said first chamber being formed with a smaller effective surface area than the corresponding surface area of the side of the piston facing said second chamber, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted against the side of said piston having the smaller effective area to displace said piston toward one end of said cylinder, a passageway permitting flow of fluid from said first chamber to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, whereby pressurized fluid is introduced into said second chamber and a force is exerted against the side of said piston having the larger effective area to displace said piston to an inactive position covering said passageway, and means for releasing pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

3. A fluid motor comprising a single diameter cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, a rod extending through said first chamber and fixed to one side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on the side of the piston having the rod fixed thereto to displace said piston toward one end of said cylinder, a passageway for permitting flow of fluid from said first chamber to said second chamber, whereby when said piston is displaced beyond said passageway by the fluid pressure in said first chamber fluid flows to said second chamber until a force is built up on the side of said piston opposite the side having the rod fixed thereto which displaces said piston to an inactive position covering said passageway and thereby prevents flow of further fluid to said second chamber, and means for releasing pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

4. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on said piston to displace it toward one end of said cylinder, a passageway permitting flow of fluid from said first chamber to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, means acting on said piston to displace it to an inactive position covering said passageway when said piston is displaced therebeyond by the pressurized fluid in the first chamber, and means for releasing the pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

5. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on said piston to displace it toward one end of said cylinder, a passageway permitting flow of fluid from said first chamber to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, force exerting means to displace said piston to an inactive position covering said passageway comprising a spring loaded plunger which is effective against said piston at all times when said piston is displaced beyond said passageway by the pressurized fluid in said first chamber, and means for releasing the pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

6. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on said piston to displace it toward one end of said cylinder, a passageway permitting flow of fluid from said first chamber to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, force exerting means to displace said piston to an inactive position covering said passageway comprising a spring loaded plunger which is effective against said piston at all times when said piston is displaced beyond said passageway by the pressurized fluid in said first chamber, means for varying the force which is exerted by said spring loaded plunger, and means for releasing the pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

7. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, the side of the piston facing the first chamber having a smaller effective surface area than the side facing the second chamber, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted against the side of the piston having the smaller effective area to displace said piston toward one end of said cylinder, a passageway permitting flow of fluid from said first chamber to said second chamber only when said piston is displaced beyond said passageway by the fluid pressure in said first chamber whereby pressurized fluid is introduced into said second chamber and a force is exerted against the larger side of said piston, auxiliary means for exerting a force against the larger side of the piston to displace said piston to an inactive position covering said passageway, and means for releasing pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

8. A fluid motor comprising a single diameter cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, a piston rod extending through said first chamber

and fixed to one side of said piston, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on the side of said piston having the rod fixed thereto to displace it toward one end of said cylinder, a passageway for permitting flow of fluid from said first chamber to said second chamber, whereby when said piston is displaced beyond said passageway by the fluid pressure in said first chamber, fluid flows to said second chamber permitting a force to build up on the side of said piston opposite the side having the rod fixed thereto tending to displace said piston toward the opposite end of said cylinder, auxiliary means for exerting a force against the side of said piston opposite the side having the rod fixed thereto which in combination with the fluid force in said second chamber displaces said piston to an inactive position covering said passageway, said auxiliary means including a spring loaded plunger which is effective against said piston at all times when said piston is displaced beyond said passageway by the pressurized fluid in said first chamber, and means for releasing the pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston toward a force delivering position at said opposite end of the cylinder.

9. A fluid motor comprising a single diameter cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, a casing surrounding said cylinder and spaced therefrom, the space between the cylinder and casing forming an accumulator, a passageway connecting said accumulator to said second chamber, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on the side of the piston facing the first chamber to displace said piston toward one end of said cylinder, a second passageway formed in said cylinder and communicating with said accumulator whereby when said piston is displaced beyond said second passageway by the fluid pressure in the first chamber fluid flows to said accumulator and said second chamber until a force is built up on the side of the piston facing the second chamber to displace said piston to an inactive position covering said second passageway and thereby prevent further flow of fluid to said accumulator and second chamber, and means for releasing pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at the opposite end of said cylinder.

10. A fluid motor comprising a cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, a plurality of passageways for venting said first chamber, a piston rod fixed to said piston and extending through said first chamber, a valve for sealing off said first chamber from said passageways, a shock absorber mounted between said piston and said valve, the valve and shock absorber each having an opening through which the piston rod passes, the opening in the valve permitting the flow of fluid therethrough to said first chamber, said valve also having an auxiliary passageway for permitting the passage of fluid to said first chamber, said auxiliary passageway being spaced from said shock absorber and the opening in the valve, means for introducing fluid under pressure against the valve to maintain it in sealing position when fluid enters said first chamber to maintain said piston in an inactive position near one end of said cylinder, means within said second chamber for exerting a force against said piston tending to urge it toward the opposite end of said cylinder, and means for releasing the fluid pressure acting against said valve whereby said valve is displaced from its sealing position by the fluid pressure in said first chamber and the fluid in said first chamber is vented through said passageways to allow said piston and its piston rod to be driven rapidly toward a force delivering position at said opposite end of the cylinder by the force within said second chamber.

11. A fluid motor comprising a single diameter cylinder, a piston slidable therein and separating said cylinder into first and second chambers on either side of said piston, a casing surrounding said cylinder and spaced therefrom, the space between the cylinder and casing forming an accumulator, a passageway connecting said accumulator to said second chamber, means for introducing compressible fluid under pressure into said first chamber whereby a force will be exerted on the side of the piston facing the first chamber to displace the piston toward one end of said cylinder, a second passageway formed in said cylinder and communicating with said accumulator whereby when said piston is displaced beyond said second passageway by the fluid pressure in said first chamber fluid flows to said accumulator and said second chamber permitting a force to be built up on the side of said piston facing the second chamber tending to displace said piston toward the opposite end of said cylinder, auxiliary means for exerting a force against the side of said piston facing the second chamber which in combination with the fluid force in said second chamber displaces said piston to an inactive position covering said second passageway, said auxiliary means including a spring loaded plunger which is effective against said piston at all times when said piston is displaced beyond said second passageway by the pressurized fluid in the first chamber, and means for releasing the pressurized fluid from said first chamber to allow the fluid in said second chamber to expand and thereby drive said piston rapidly toward a force delivering position at said opposite end of the cylinder.

References Cited in the file of this patent

UNITED STATES PATENTS

562,518	Ferguson	June 23, 1896
1,014,639	Colwell	Jan. 16, 1912
1,703,458	Huff	Feb. 26, 1929
1,980,967	De Moody	Nov. 13, 1934
2,548,439	Moffett	Apr. 10, 1951