

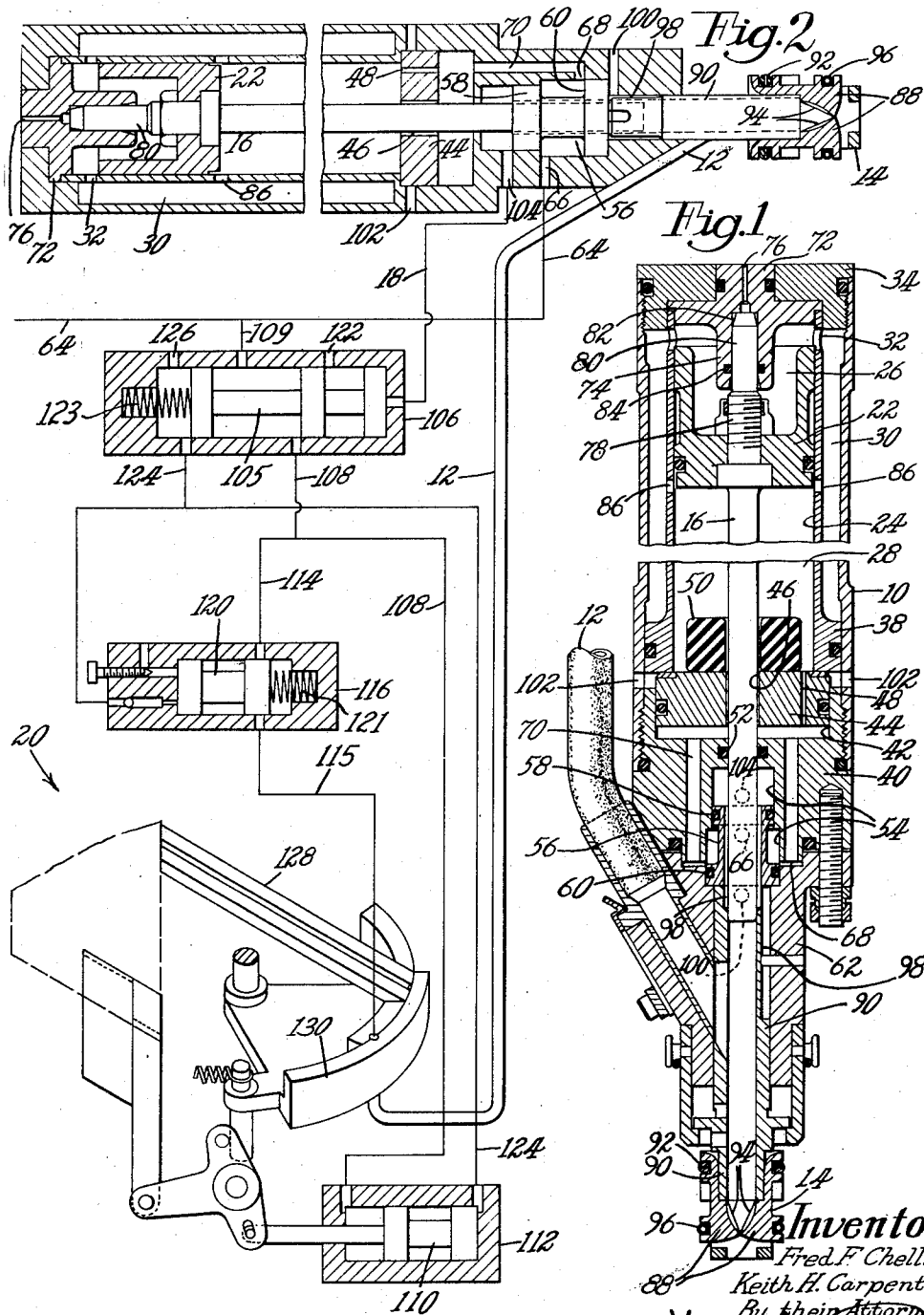
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F. F. CHELLIS ET AL

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FLUID MOTORS FOR FASTENER INSERTING DEVICES

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Inventors
 Fred F. Chellis
 Keith H. Carpenter
 By their Attorney
Wm. S. ...

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FLUID MOTORS FOR FASTENER INSERTING DEVICES

Fred F. Chellis, Manchester, and Keith H. Carpenter, Danvers, Mass., assignors to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey

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6 Claims. (Cl. 121-11)

This invention relates to fluid motors and particularly to fluid motors of the percussive type which are 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, there is disclosed a fluid motor which is 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.

The above-mentioned inserting gun includes a motor which comprises a driver piston slidable in a cylinder and separating the cylinder into upper and lower chambers, a casing surrounding the cylinder forming between them a fluid accumulator which communicates with the upper chamber and a fastener driver being attached to the piston and extending through the lower chamber and out of the cylinder. To "cock" the gun, pressurized fluid, preferably air, is introduced into the lower chamber moving the piston toward the upper chamber making said upper chamber smaller as it moves. At a predetermined time during the stroke of the piston, pressurized air passes into the upper chamber and into the accumulator. When the forces acting on the piston in both directions become equalized due to the pressures in the upper and lower chambers, the motion of the piston stops and it is ready to drive a fastener by means of the driver rod affixed thereto and extending through the first chamber. In order to drive the fastener, the pressure of the air in the lower chamber is rapidly reduced by permitting the air to pass to atmosphere and the air under pressure in the upper chamber expands moving the piston and driver rapidly in a percussive manner against the fastener to drive it into a workpiece.

In another copending application for Letters Patent of the United States, Serial No. 524,535, filed July 26, 1955, in the names of Fred F. Chellis and Edwin S. Kant, there is disclosed a fluid motor embodied in a hand-held fastener inserting gun similar to the type disclosed in the first-mentioned application. Both fluid motors operate in the same manner to drive a fastener. However, in the device of the second-mentioned application, air is introduced into the upper chamber and the accumulator directly from the lower chamber at a predetermined time during the piston stroke. It will be noted that in both devices the air within the upper chamber is compressed as the piston moves to its upper or "cocked" position ready to drive a fastener. This compressing of air naturally retards the rate at which the piston moves and consequently increases the time required to complete the overall operating cycle of the gun.

Present day standards require that the operating cycle of pneumatic fastener inserting devices be extremely fast in order that a large number of fasteners be driven in

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the shortest possible time. Consequently, any means which will increase the rate of the return or gun cocking stroke of the piston and the driver will reduce the time of the overall operating cycle of the inserting device.

- 5 Accordingly, it is an object of this invention to provide an improved fluid motor of the type disclosed in the above-mentioned applications which operates on a differential air pressure principle having a faster return rate of the driver piston. Another object of this invention is to provide an air motor similar to that disclosed in the above-mentioned applications which is more economical to construct and operate.

To accomplish these objects and in accordance with the various features of the present invention there is provided a fluid motor of the type disclosed in the above-mentioned copending applications comprising a cylinder with a piston slidable therein separating the cylinder into first and second chambers, one on either side of the piston, a fastener driver extending from the side of the piston facing the first chamber and extending therethrough and out of the cylinder, means for introducing compressible fluid, preferably air, under pressure to the first chamber to displace the piston and its driver from a lower or force delivering position toward an upper or inactive position and air relief means in the second chamber to permit the air, which would normally be compressed therein, to escape during at least the first portion of the displacement of the piston, the air relief means comprising a vent leading from the second chamber to atmosphere, a sleeve surrounding the vent and extending toward the piston within the upper chamber, a plunger fixed to the piston in axial alinement with the vent, a fluid seal on the inner surface of the sleeve, the plunger on the piston being of such length and diameter that during the initial part of the return stroke of the piston it is spaced from the sleeve permitting air to escape from the upper chamber through the sleeve and out of the vent, while during the latter portion of the return stroke the plunger enters the sleeve contacting the seal and preventing the further escape of air thus permitting air trapped within the second chamber to be compressed.

As in the fluid motor disclosed in application Serial No. 524,535, filed July 26, 1955, in the names of Fred F. Chellis and Edwin S. Kant, pressurized air is introduced to the upper chamber from the lower chamber passing through passageways exposed when the piston nears the end of its return stroke. In this way a supply of pressurized air in addition to that trapped in the upper chamber when the plunger enters the sleeve, is introduced to the upper chamber, the combined quantities of compressed air within the upper chamber then being permitted to expand driving the piston forward in a rapid and percussive manner as the air pressure in the lower chamber is reduced. 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,

- 60 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.

Our modified fluid motor is illustrated as embodied in a fastener inserting gun which in many respects is similar to the inserting gun disclosed in the above-mentioned applications. Certain elements common to the guns are shown only in a diagrammatical form, reference being made to United States application Serial No.

487,317, filed February 10, 1955, in the name of Fred F. Chellis 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 as nails. However, these and other terms are used only for the sake of illustration, and are in no way intended to limit the invention.

Fig. 1 shows the present inserting gun positioned to drive fasteners vertically in a downward direction. 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 the position shown 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 gun comprises an outer casing 10 which may be gripped by an operator while inserting fasteners. Nails are delivered through a flexible tube 12 to a nosepiece 14 wherein they are held point downwardly until they are engaged by a driver 16 which drives them from the nosepiece into the work. The gun is triggered to drive the positioned nail by pressing the nosepiece against the work piece, and as the nail is driven, a flexible signal line 18 (Fig. 2) is pressurized to actuate a remotely located nail handling means 20 which delivers another nail to the inserting gun.

The power for driving nails is provided by our improved air motor which includes a piston 22 which slides within a cylinder 24. The piston 22 divides the cylinder into upper and lower chambers 26 and 28, respectively. For the purpose of this invention the lower chamber 28 may also be referred to as the first chamber and the upper chamber 26 as the second chamber. The cylinder 24 is concentric with and spaced from the casing 10, the space between the cylinder and the casing forming an air accumulator 30. Communication between the accumulator and the upper chamber 26 is provided by holes 32 radially spaced in the cylinder 24. The upper end of the accumulator is sealed by means of a cap 34 which is threaded in the casing 10 and which engages the outer wall of the cylinder 24. On the lower end of the cylinder 24 there is provided a flange 38 engaging the casing 10 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 cylindrical recess 42 in which a control valve 44 is slidably mounted. The driver 16 passes through a bore 46 in the control valve, the bore being large enough to permit the passage of air around the driver. Spaced radially from the bore 46 is an air passageway 48 in the control valve 44 to permit the passage of air around a shock absorber 50 surrounding the driver 16 on the upper side of the control valve. The driver extends through an airtight seal 52 into a two diameter cylinder 54 in the plug 40. Slidable in the cylinder 54 is a pilot valve 56 in the form of a spool having an upper flange 58 fitting the smaller diameter and a lower flange 60 fitting the larger diameter. The driver 16 passes through the interior of the pilot valve which is large enough to permit air to pass around the driver 16 and through said valve. A lower extension of the cylinder 54 is received in a nosepiece bracket 62 which is secured to the plug 40.

The inserting gun at all times is connected to a source of compressed air by means of a flexible line 64 which leads to a passageway 66 formed in the plug 40 whereby pressurized air may flow to the annular chamber formed between the flanges 58 and 60 of the pilot valve 56 and then to an annular chamber 68 formed in the bracket 62 and from there through holes 70 to the lower side of the control valve 44. The pilot valve 56 is normally maintained in its lower position (as seen in Fig. 1), the force on flange 60 being greater than the force on flange 58 due to its larger area. The air pressure moves the valve 44 upwardly as seen in Fig. 1, sealing it

against the lower end of the cylinder 24, the air then passing through the holes 46 and 48 into the first chamber 28, moving the piston 22 upwardly.

When the piston 22 begins its upward movement the air in the accumulator 30 and the second or upper chamber 26 is at atmospheric pressure and would, if not permitted to escape, begin to be compressed. This, naturally, would tend to retard the speed of the upward movement of the piston and the driver which is undesirable since it would reduce the operating speed of the gun. In order to facilitate the rapid upward movement of the piston there is provided a temporary air relief mechanism comprising an airtight plug 72 fitted within the cap 34 and abutting the end of the cylinder 24. Formed on the plug 72 is a sleeve 74 in axial alignment with the piston 22 and the driver 16. The upper end of the plug 72 has a small air passageway 76 formed therein whereby air within the second or upper chamber 26 may escape through the sleeve 74 and out the passageway 76 as the piston moves upwardly. Formed on the upper side of the piston is a plunger 78 which fits within the sleeve 74. The plunger has a constant diameter portion 80 terminating in a bevel 82. An airtight seal 84 is fitted in the sleeve 74 which prevents the flow of air through the sleeve and passageway 76 when the constant diameter portion 80 of the plunger 78 enters the sleeve 74 near the end of the upward travel of the piston. Thus it will be seen that the air in the accumulator and in the upper chamber 26 is compressed, but only during a limited time near the end of the upstroke of the piston when the portion 80 of the plunger passes the seal 84 to seal the passageway 76, thus permitting an initial rapid movement and a later retarded movement reducing the total time necessary to move the piston upwardly.

At a point in the upward displacement of the piston, holes 86 formed in the cylinder 24 will be uncovered, thereby providing communication between the first or lower chamber 28 and the second or upper chamber 26 by way of the accumulator 30 and the holes 32. In this manner the air in the upper chamber, as well as in the accumulator, approaches line pressure until the force on the upper side of the piston 22 balances the force on the lower side. The effective area of the upper side of the piston, i. e., the side facing the upper chamber 26, is slightly greater than the effective area on the lower side of the piston since the constant diameter portion 80 of the plunger 78 is slightly less than the diameter of the driver 16. The effect of this area differential is that a lower pressure in the second chamber 26 will balance a higher pressure in the first chamber 28 and to reach a force equilibrium the piston 22 will drift downwardly slightly and assume an inactive position. However, the downward drifting is not sufficient for the constant diameter portion 80 of the plunger 78 to become disengaged from the seal 84. In this manner the driver piston 22 is held in an inactive or "cocked" position ready to drive a nail from the nosepiece of the gun.

The gun is triggered to allow the pressure in the upper chamber and in the accumulator to drive the piston downwardly, it first being necessary to reduce the pressure in the lower chamber 28. This is done by causing relative movement between the pilot valve 56 and the cylinder 54 which movement results from relative movement between the nosepiece 14 and the gun casing 10. The nosepiece comprises a pair of jaws 88 which are pivotally secured in slots formed in the end of a hollow shaft 90 and are held therein by means of an annular ring 92. The forward end of the jaws have converging camming surfaces 94 formed thereon, which surfaces contact and retain a nail as it is delivered through the flexible tube 12. The camming surfaces 94 are held together by means of a garter spring 96 fitting around the jaws. The hollow shaft 90 is slidable within the nosepiece bracket 62 and abuts the lower end of the flange 60 of the pilot valve 56. Relative movement between the nosepiece 14 and

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the gun casing 10 may be obtained in two ways, either by moving the entire gun against a stationary work piece whereupon the nosepiece 14 upon contact with the work piece is prevented from further movement while the casing moves relative thereto, or by maintaining the entire gun stationary, as for example, clamped in a frame or on a bench and moving the work piece toward the gun to displace the nosepiece 14. The operation of the device will be described, by way of illustration only, with reference to the gun maintained in a stationary vertical position with the work piece moved thereagainst. When the work piece contacts the nosepiece 14, it moves the nosepiece upwardly relative to the casing urging the shaft 90 and the pilot valve 56 upwardly relative to the plug 40. The pressurized air on the lower side of the control valve 44 is then vented to atmosphere through the holes 70, the annular chamber 68, around reduced portions 98 of the shaft 90 and through a passageway 100 formed in the nosepiece bracket 62. Thereupon, the control valve 44 is unseated from the cylinder 24 and displaced downwardly in a rapid and positive manner by the air pressure in the lower chamber 28. The first or lower chamber 28 is then vented to atmosphere through a number of holes 102 circumferentially spaced in the casing 10 which are exposed when the valve 44 moves downwardly. The holes 102 are of sufficient size and number to permit the pressurized air in the lower chamber 28 to escape very rapidly. Thereupon, the pressurized air in the second chamber 26 and in the accumulator 30 causes the piston 22 and the driver 16 to be driven downwardly in a percussive manner to a force delivering position to drive the nail positioned within the jaws 88. It will be noted that during the initial part of the down stroke of the piston the air passageway 76 remains sealed until the constant diameter portion 80 of the plunger 78 is withdrawn past the seal 84 in the collar 74. After the plunger has been withdrawn some of the air within the second or upper chamber 26 may escape through the passageway 76, but this is not until the piston has obtained a substantial momentum, and the rate with which the air escapes from the passage 76 is negligible compared with the rate at which the air on the lower side of the piston escapes through the numerous larger holes 102. The piston continues downwardly in its nail driving stroke until it strikes the shock-absorbing bumper 50 whereupon the nail will be driven and the cycle may be repeated in a manner now to be described.

Referring to Fig. 2, there is disclosed a nail handling means and control mechanism for delivering nails to the gun upon receiving a signal therefrom. The nail handling means form no part of the present invention but are described 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.

The nail handling means and control mechanism comprise a piston 105 slidable in a remotely located control valve 106 which is connected by means of the signal line 18 to the inserting gun and by means of a line 109 to the constantly pressurized air supply line 64. A line 108 connected to the valve 106 supplies compressed air for effecting movement of a piston 110 of a fluid motor 112. A line 114 communicates with the line 108 and leads to a time delay valve 116. A piston 120 within the time delay valve normally prevents the passage of air from the line 114 to a line 115 communicating with the nail delivering tube 12, a spring 121 maintaining the piston 120 in the position shown in Fig. 2. The piston 105 of the valve 106 is normally maintained in its right-hand position within the valve by means of a spring 123. A line 124 places the left-hand end of the time delay valve 116 in communication with the right-hand end of the

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fluid motor 112. Passageways 122 and 126 are formed in the valve 106 to vent to atmosphere, respectively, its right-hand and left-hand portions. The piston 110 of the fluid motor 112 is connected to mechanism, not here-
 5 described in detail, for supplying nails to be delivered to a raceway 128, as well as for causing a separating segment 130 to be moved into a position for receiving a single nail at the end of the raceway 128.

In the inactive or cocked position when the inserting
 10 gun is ready to be fired, the plunger 80 is within the sleeve 74 and the chambers 26 and 28, in addition to the fluid accumulator 30, are pressurized. The signal line 18 is at atmospheric pressure. The line 108 is at full line pressure, being connected through the valve 106 and the line 109 to the line 64 which leads to a source of compressed air. The piston 105 of the control valve 106
 15 is in its right-hand position under the action of the spring 123. The line 124 is at atmospheric pressure, being in communication with the passageway 126 in the valve 106. The line 114 is at full line pressure but the line 115 from the time delay valve 116 to the fastener delivery conduit 12 is at atmospheric pressure, the piston 120 of the time valve blocking the passageway from line 114 to line 115 since the piston is in its left-hand position under
 20 the influence of spring 121.

When the gun is fired to insert a fastener by effecting relative movement between the nosepiece and the casing of the gun as described above, the pressurized line 64 is placed in communication with the signal line 18 by way of the necked area between the spools 58 and 60 of the valve 56. This causes the signal line 18 to become pressurized, effecting substantially immediate displacement of the piston 105 from right to left within the valve 106 as viewed in Fig. 2. The displacement of the piston 105 places the line 124 in communication with the pressurized line 109, the line 108 then being placed
 30 in communication with atmosphere through the passageway 122. Pressurization of the line 124 moves the piston 110 of the fluid motor 112 from right to left as viewed in Fig. 2 and the piston 120 of the time delay valve 116 from left to right. The movement of the piston 110 of the fluid motor 112 causes nails to be delivered to the raceway 128 by means not forming a part of this invention nor herein described in detail. This movement also causes the separating segment 130 to be
 40 moved into a position adjacent the end of the raceway 128 for receiving the single nail therefrom.

After the nail has been driven from the inserting gun, the gun and the work piece are separated whereupon the pilot valve 56, the sleeve 90 and the nosepiece 14 move
 50 relative to the gun casing 10 by the force of the pressurized air within the two-diameter cylinder 54 acting on the larger spool 60 of the valve 56. The movement of the pilot valve relative to its cylinder 54 permits the signal line 18 to be vented to atmosphere through the interior of the pilot valve, the sleeve 90 and the nosepiece 14. Depressurization of the signal line 18 permits the piston 105 of the control valve 106 to return to its right-hand position under the force of the spring 123.

The line 124 is immediately depressurized, air escaping through the passageway 126 and the line 108 is again pressurized. The piston 110 of the fluid motor 112 is displaced toward the right allowing the separating segment 130 to deliver the nail it received from the raceway 128 to the delivery tube 12. The time delay valve 116 remains open a predetermined time so that the air may flow from the line 114 to the line 115 then through the delivery tube 12 to propel the nail to the inserting gun where it is positioned within the jaws 88.

When the pilot valve 56 returns to its lower position, pressurized air again is introduced against the lower side of the control valve 44 moving it upwardly and sealing the lower chamber 28 from the venting holes 102. The air passes through the holes 46 and 48 into the chamber 28 to displace the piston 22 upwardly. Upon reach-

ing the end of its upward stroke as described above the piston is then in the inactive or cocked position ready to drive another nail into a work piece.

In the present disclosure various air type seals and packings in the form of O rings are disclosed. These O rings are made of rubber or similar material and serve no purpose other than that of a packing or 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 to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, means for venting compressible fluid from said second chamber during the initial portion of the displacement of said piston, means movable with said piston for rendering said venting means ineffective during and after the latter portion of the displacement of said piston in order to retain compressed fluid in said second chamber when the piston is in said inactive position and means for rapidly releasing the pressurized fluid from said first chamber to allow the then pressurized fluid in said second chamber to expand and thereby drive said piston away from said inactive position and 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, means for introducing compressible fluid under pressure to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, means for venting compressible fluid from said second chamber during the initial portion of the displacement of said piston, a passageway permitting flow of fluid under pressure from said first chamber to said second chamber only during the latter portion of the displacement of said piston, means movable with said piston for rendering said venting means ineffective during and after the latter portion of said displacement in order to retain compressed fluid in said second chamber when the piston is in said inactive position, whereby said displacement begins rapidly and terminates more slowly, and means for rapidly releasing the pressurized fluid from said first chamber to allow the then pressurized fluid in said second chamber to expand and thereby drive said piston away from the inactive position and toward a force delivering position at the opposite end of said cylinder.

3. 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 to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, a fluid relief passageway within said second chamber for venting fluid from within said second chamber during the initial portion of the displacement of said piston, means movable with said piston for closing said fluid relief passageway during the latter portion of said displacement in order that said displacement begins rapidly and terminates more slowly, and means for rapidly releasing the pressurized fluid from said first chamber to allow the then pressurized fluid in said second chamber to expand and thereby drive said piston away from the inactive position and 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 to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, a fluid relief passageway within said second chamber for venting fluid from within said second chamber during the initial portion of the displacement of said piston, means movable with said piston for closing said fluid relief passageway during the latter portion of said displacement, a passageway permitting flow of fluid from said first chamber to said second chamber during the latter portion of said displacement whereby said displacement begins rapidly and terminates more slowly with pressurized fluid being retained in said second chamber, and means for rapidly releasing the pressurized fluid from the first chamber to allow the then pressurized fluid in the second chamber to expand and thereby drive said piston away from the inactive position and 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 to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, a sleeve extending within said second chamber toward said piston, a fluid relief passageway in said second chamber at the end of the sleeve remote from the piston, a plunger on the piston extending in axial alignment with said sleeve, the plunger being formed to enter the sleeve and create a fluid-tight seal therewith during the latter portion of the displacement of said piston, and means for rapidly releasing the pressurized fluid from said first chamber to allow the then pressurized fluid in said second chamber to expand and thereby drive said piston away from said inactive position and 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 to said first chamber whereby a force will be exerted on said piston to displace it toward an inactive position adjacent one end of said cylinder, a sleeve within said second chamber extending toward said piston, a fluid relief passageway in said second chamber at the end of the sleeve remote from the piston, a plunger on the piston extending in axial alignment with said sleeve, the plunger being formed to enter the sleeve and create a fluid-tight seal therewith during the latter portion of the displacement of said piston, a passageway permitting the flow of fluid under pressure from said first chamber to said second chamber after the plunger has entered the sleeve whereby the displacement of the piston begins rapidly and terminates more slowly, and means for rapidly releasing the pressurized fluid from said first chamber to allow the then pressurized fluid in said second chamber to expand and thereby drive said piston away from said inactive position and toward a force delivery position at the opposite end of said cylinder.

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