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2,737,899

AXIAL PISTON PUMP

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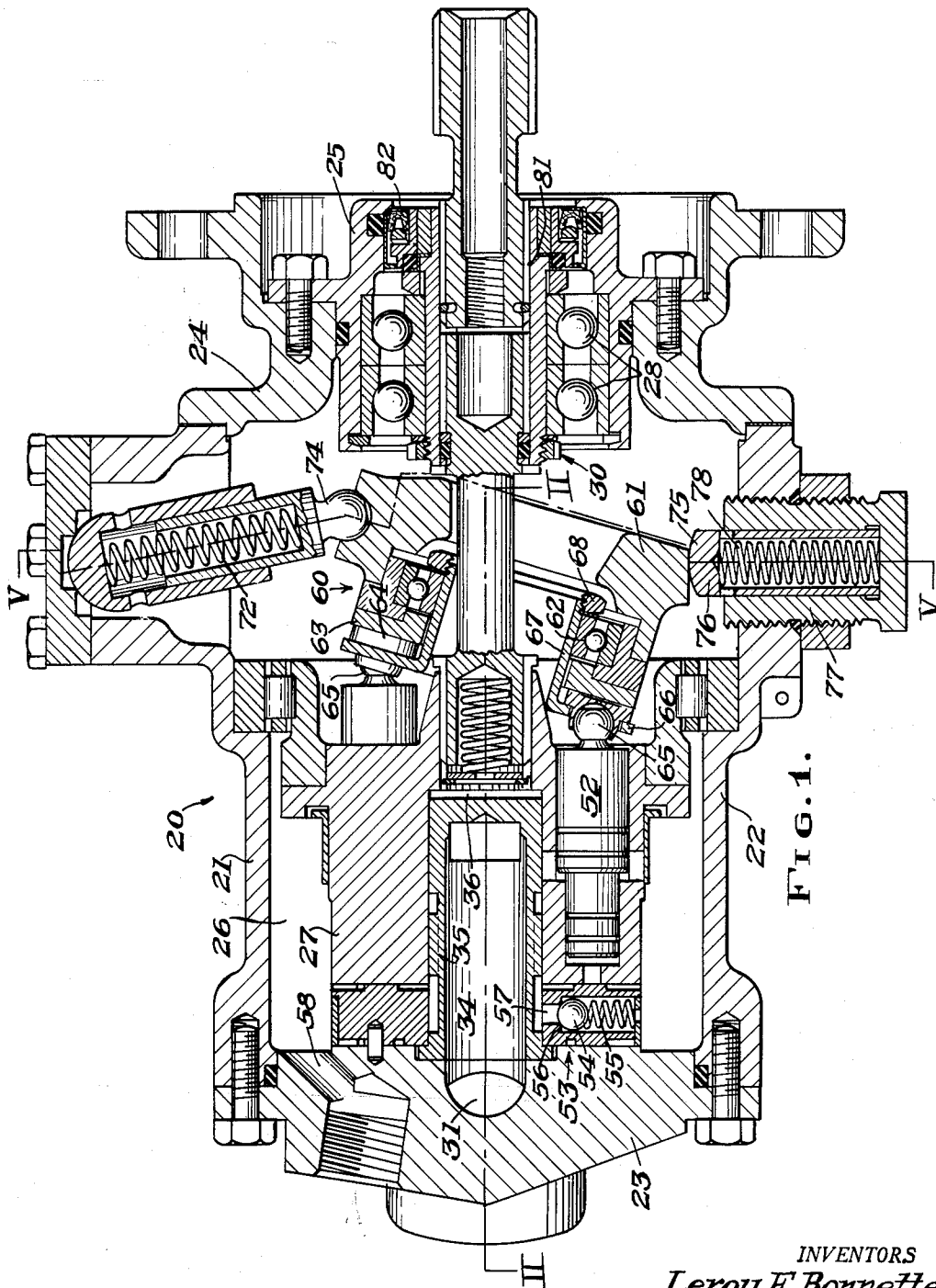


FIG. 1.

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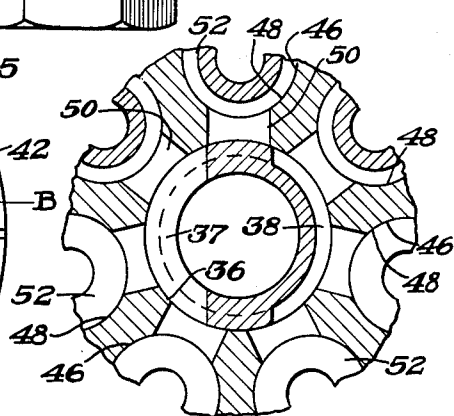
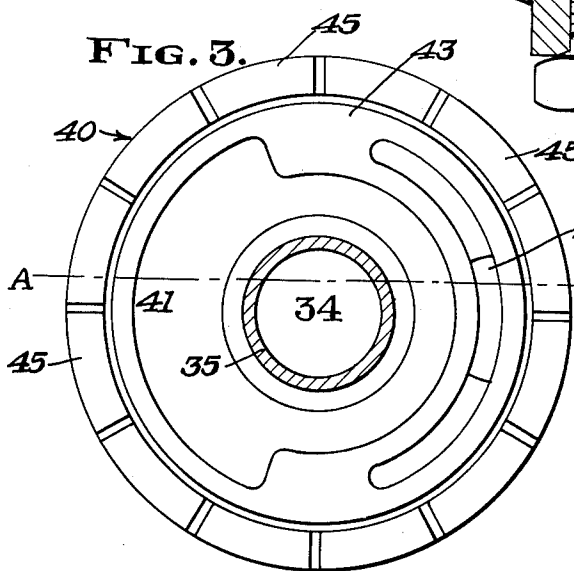
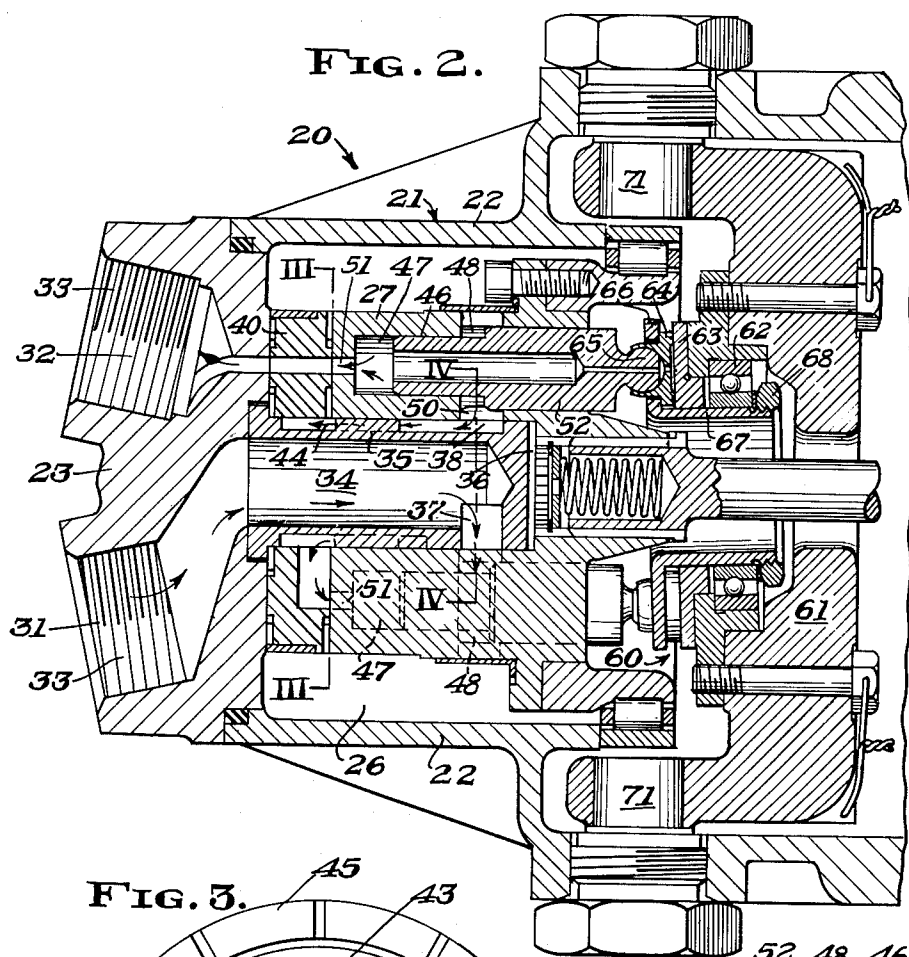
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

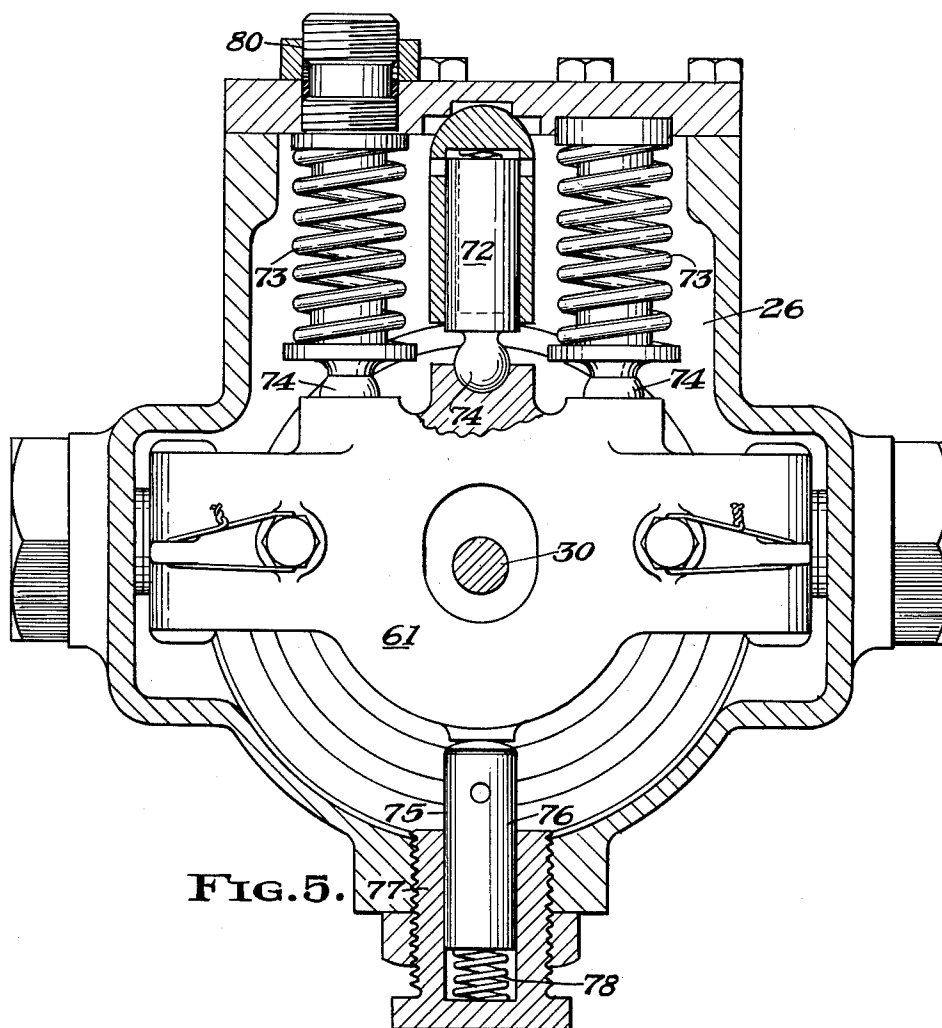


FIG. 5.

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## AXIAL PISTON PUMP

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10 Claims. (Cl. 103—162)

This invention relates generally to hydraulics and more particularly to fluid pressure energy translating devices commonly known as fluid pumps and motors.

This invention relates still more specifically to fluid pumps and motors of the axial piston type.

An object of this invention is to provide a fluid pressure energy translating device particularly suitable for use in aircraft and having means for supercharging the device so that it may be operated at high speeds and altitudes and at a high rate of efficiency.

Another object of this invention is to provide an axial piston pump having, in effect, two stages of operation.

Still another object of this invention is to provide an axial piston pump having pistons with sections of different diameters operating in piston chambers of corresponding shape and size, the larger pistons supplying fluid at pre-charged pressure to the smaller pistons whereby high pressure operation will be secured easily and without cavitation or other deleterious effects which occur with other mechanisms and under similar circumstances.

Still a further object of the invention is to provide an axial piston type of pump having two sets of valves, one set controlling the ingress and egress of fluid to the pre-charging cylinders and the other performing a similar function for the main cylinders, the exhaust valve of one set communicating with the inlet valve of the other set to secure the two stage operation.

Another object of the invention is to provide a variable volume axial piston pump having a rotary sliding valve mechanism and a cylinder barrel with piston reciprocated therein by an inclined cam plate, the latter being supported for rocking movement about an axis so arranged that the reaction to the pressure generated will be effective on the cam plate to cause it to tend to swing toward a no volume position, resilient means being provided to yieldably oppose the movement of the cam plate by the fluid pressure so that the degree of inclination assumed by the cam plate will be dependent upon the pressure existing in the system with which the pump is connected, for example, when the pressure is low, the resilient means will cause the volume control to move toward a maximum volume position, when the pressure increases, the volume control will be moved toward a no-volume position, all movements taking place automatically without the attention of an operator.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the drawings:

Fig. 1 is a detail longitudinal view taken through a hydraulic pump, or motor, formed in accordance with the present invention.

Fig. 2 is a horizontal sectional view taken through the pump, or motor shown in Fig. 1, on the plane indicated by the line II—II of Fig. 1.

2

Fig. 3 is a detail sectional view taken through the device on the plane indicated by the line III—III of Fig. 2.

Fig. 4 is a vertical transverse sectional view taken through the pump or motor on the plane indicated by the line IV—IV of Fig. 2.

Fig. 5 is a similar view taken on the plane indicated by the line V—V of Fig. 1 and shows more in detail the supporting means for the piston actuating cam and the means for causing such supporting means to vary the inclination of the cam and the volume of the pump.

Referring more particularly to the drawings the pump is indicated in its entirety by the numeral 20. This pump includes a casing 21 having a body section 22, a head section 23, mounting flange section 24 and an end section 25. These sections are suitably joined together to complete the casing. The casing provides a chamber 26 for the reception of the cylinder barrel 27 of the pump. The section 25 is provided with a plurality of anti-friction bearings 28 which rotatably support a shaft assembly 30 employed to transmit rotary motion to the cylinder barrel when the device is used as a pump and from the cylinder barrel to any suitable mechanism when the device is used as a motor.

The head 23 has inlet and outlet ports 31 and 32 formed therein, these ports being threaded as at 33 to receive fittings which connect the device in a hydraulic circuit. The inlet port 31 extends to the center of the head 23 where it communicates with the interior 34 of a hollow pintle-like member 35 projecting from the head into the chamber 26. This projection extends into a recess 36 formed axially of the cylinder barrel 27 and has a relatively close slip fit therein to provide a first set of valving ports including inlet and outlet ports 37 and 38 (Figs. 2 and 4). The head 23 is also provided with a valve plate 40 suitably secured thereto and disposed at one end of the chamber 26. This valve plate 40 is shown in front elevation in Fig. 3 of the drawings. It is provided with arcuate inlet and outlet ports 41 and 42 which are arranged in a sealing pad 43. The inlet port 41 directly communicates with grooves 44 which extend longitudinally along the exterior of the pintle 35. These grooves are closed on the outer sides by the interior wall of the recess 36 formed in the cylinder barrel so that a passage is provided which extends from the outlet port 38 of the first set of ports to the inlet port 41 in the valve plate, the ports 41 and 42 forming a second set of valving ports. Suitable bearing pads 45 are provided on the surface of the valve plate around the sealing surface 43 for engagement by the end of the cylinder barrel 27. The outlet port 42 directly communicates with the outlet opening 32 formed in the head 23.

The cylinder barrel is provided with a plurality of axially extending piston chambers 46 which are each composed of two sections 47 and 48 of different diameters. The larger sections 48 have laterally directed ports 50 extending therefrom to the chamber 36 these ports being so located that, as the cylinder barrel revolves, they will alternately communicate with the inlet and outlet ports 37 and 38 of the first set of valving ports. The smaller sections 47 have ports 51 extending therefrom to the end surface of the cylinder barrel in engagement with the valve plate 40, these ports 51 alternately communicating with the inlet and outlet ports 41 and 42 of the second set of valving ports. The piston chambers 46 receive piston members 52 for reciprocation therein, these piston members also including two sections of diameters corresponding to the sections of the piston chambers.

When the piston members are reciprocated in the piston chambers the larger sections of the pistons will draw fluid through the inlet port 37 into the larger sections of the piston chambers; then when the ports 50 communicate with the port 38, as the cylinder barrel revolves, fluid will be expelled from the larger sections

of the piston chambers, this fluid flowing along the groove or passage 44 to the inlet port 41. Also during the rotation of the cylinder barrel and the reciprocation of the pistons therein fluid discharged from the larger sections of the piston chambers will flow from the inlet port 41 through ports 51 of the smaller sections of the piston chambers. When these piston chambers communicate with the outlet port 42 through the ports 51 fluid will be expelled from the smaller sections of the piston chambers into the outlet port 42 from which it will flow through the outlet opening 32 in the head 23.

During the operation of the pump, the super-charging portion, provided by the larger sections of the pistons and piston chambers, pumps more fluid than the main portion of the pump, comprising the smaller sections of the pistons and their chambers can use. The excess fluid is vented through a relief valve 53 (Fig. 1) which is disposed in the valve plate 42. The valve 53, in this instance, constitutes a ball 54 which is urged by a spring 55 into engagement with a seat 56 formed at the outer end of a port 57 directly communicating with the passage 44. Fluid escaping around valve 53 will flow to the chamber 26 in the casing and be exhausted to the lower pressure section of the hydraulic system through an outlet 58 formed, in this instance, in the head 23. This fluid will be conducted to the reservoir of the hydraulic system.

To impart reciprocatory movement to the pistons the device is provided with a cam assembly designated generally by the numeral 60. This assembly includes a pivoted support 61, an anti-friction bearing 62 carried by the support, a cam plate 63 also carried by the support and suitably secured thereto for engagement by bearing shoes 64 which have a universal connection with the pistons 52. In the form of the invention shown the bearing shoes 64 are clinched on to spherical heads 65 formed with the piston. The bearing shoes have flanges which are engaged by a retaining ring 66 to hold the bearing shoes in sliding engagement with the cam plate 64. The retaining ring 66 has a sleeve 67 formed therewith which is connected with the inner race of the anti-friction bearing 62, being held in connection therewith by a clamp nut 68. By this construction the cylinder barrel is permitted to rotate and cause the bearing shoes 64 to slide over the cam plate, the inclination of the latter causing the pistons to be reciprocated in the cylinder barrel. This inclination is shown in Fig. 1. The mounting of the support 61 is such that it will permit the member 61 to rock and vary the inclination of the cam plate with respect to the axis of rotation of the shaft and cylinder barrel which changes the volume delivered by the pump. The support 61 is mounted on pivot members 71 which extend into the casing 22 from either side thereof. These pivots may include any suitable type of bearings to facilitate the rocking movement of the support. As shown in Figs. 3 and 5 the axis about which the support 61 rocks is located above and parallel to the plane in which the axis of rotation of the cylinder barrel is disposed. The axis of rocking movement of the support 61 is indicated in Fig. 3 by the line A—B. It will be noted from Fig. 3 that this line intersects the ports 42 a considerable distance above the mid-point of such ports. The purpose of this location will be apparent from the description which follows.

The support 61 is urged in a downward direction when the device is viewed as in Fig. 1, by a plurality of spring pusher assemblies 72 and 73; these springs have their upper ends in engagement with a portion of the casing and the lower ends in engagement with adapter members 74 having spherical portions which are seated in spherical sockets formed in the support 61. These spring assemblies normally urge the support 61 toward a position determined by a stop member 75, this member being mounted in the lower portion of the casing. Stop 75 includes a plunger 76, a receiver 77 which is

threaded into the casing and a coil spring 78 which is disposed in a socket formed in the plunger, the spring having one end in engagement with the inner end of the socket and the other in contact with the receiver. This spring causes the plunger 76 to follow the support 61 in its rocking movement. When the plunger 76 engages the inner end of the opening therefor in the receiver 77 the support 61 will be stopped in its movement in a downward direction. This position of the plunger 76 determines the maximum inclination of the cam plate. In addition to serving as a stop for the support 61, the assembly 75 acts as a dash pot to cushion the movement of the support in a downward direction. It will be noted that the plunger 76 has small openings adjacent its outer end; these openings restrict the flow of fluid from the socket in the receiver 77 as the support moves downward and in that manner reduce the shock which sudden movement might cause.

Upward movement of the support 61 is also cushioned by the member 72 which has a construction similar to the stop 75 except the receiver for the plunger is supported for universal movement in a recess in a cover secured to the casing 21. The openings are formed in the receiver near the inner end of the socket for the plunger. As the support moves in an upward direction the restricted flow of oil will limit the rate at which the support may move. Through the provision of the cushioning members or dash pot device too rapid movement of the support is prevented.

Referring again to Figs. 2 and 3 it will be apparent that the ports 51 in the cylinder barrel will communicate with the port 42 and that at all times there will be exposed to the port 42 below the line A—B an area of pistons 52 greater than the area of such pistons exposed to the pressure above the line A—B. Since port 42 will contain fluid under pressure when the pump is in operation more force tending to oppose inward movement of the pistons will be exerted on the area thereof exposed to port 42 below line A—B than is exposed to the force above such line. This increased area of exposure provides a greater total force on the pistons below the line A—B which force will be transmitted by the pistons to the support 61 and will tend to rock this support about the axis of the pivots 71 against the force of the springs 72 and 73. As the pressure generated by the pump increases, the force tending to swing support 61 will also increase until the force of the springs is overcome and the support 61 moved upwardly. If the pressure should build up sufficiently the support may swing upwardly until the inclination of the cam plate disappears, however, at this time pressure would cease to be generated and the support would start to swing in the opposite direction.

It should be obvious from the foregoing that the support 61 will in effect hunt its position of equilibrium wherein the pressure generated will be just sufficient to maintain the cam plate at the proper angle to generate such pressure. This angle of course will vary depending upon the setting of the relief valve in the hydraulic system in which the pump is incorporated. At least one of the spring pusher assemblies is provided with an adjuster indicated by the numeral 80, for the purpose of varying the force tending to swing the support 61 to increase the volume.

The shaft assembly includes sections which are coupled together as at 81 so that the pump need not be accurately aligned with the driving member. This shaft assembly forms no part of the patentable subject matter of the invention and further description thereof is believed to be unnecessary. The end member 25 is provided with a seal 82 around the shaft assembly to prevent leakage at this point. Other seals are provided at suitable locations also for the purpose of preventing leakage.

While the form of embodiment of the present inven-

tion as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

We claim:

1. A fluid pressure energy translating device comprising a hollow casing with inlet and outlet ports formed in one end; a pintle member having an internal bore projecting from said one end into the interior of the casing, the bore in said pintle member communicating with said inlet port, said pintle member having a port extending laterally from said bore and external grooves extending along said pintle; a valve plate adjacent said one end of said casing, said valve plate having an annular valving surface with arcuate inlet and outlet ports opening thereto, said arcuate inlet port communicating with the grooves in said pintle, said arcuate outlet port communicating with the outlet port in said one end of said casing; a cylindrical barrel surrounding said pintle and having one end in sliding engagement with said valve plate, said cylinder barrel having a plurality of differential piston chambers, the smaller sections of said piston chambers having ports alternately communicating with the inlet and outlet ports in said valve plate, the larger sections of the piston chambers having ports alternately communicating with the lateral port and the external grooves in said pintle; differential pistons disposed for movement in said chambers; and cam means for reciprocating said pistons in said chambers.

2. A fluid pressure energy translating device comprising a casing forming a chamber and inlet and outlet ports; a pintle member provided with an internal bore carried by said casing and projecting into said chamber, said pintle member having a port extending laterally from said bore and a longitudinally extending external passage; a valve plate at one end of said chamber, said valve plate having an annular sealing surface with arcuate inlet and outlet ports opening thereto, said arcuate inlet port communicating with the external passage in said pintle members, said arcuate outlet port communicating with the outlet port in said casing; a cylinder barrel surrounding said pintle member and having one end in rotary sliding engagement with said valve plate, said cylinder barrel having a plurality of piston chambers with sections of different diameters, the sections of smaller diameter having ports alternately communicating with the inlet and outlet ports in said valve plate, the sections of larger diameter having ports alternately communicating with the lateral port and the external passage in said pintle; pistons with sections of two diameters disposed for movement in said chambers; and cam means for reciprocating said pistons in said chambers.

3. A fluid pressure energy translating device comprising a casing with an internal chamber and inlet and outlet ports; a cylinder barrel supported for rotation in said chamber, said cylinder barrel having piston chambers with sections of different diameters; means in said casing forming a set of inlet and outlet ports for the smaller diameter sections of said chambers; additional means forming a set of inlet and outlet ports for the larger diameter sections of said chambers; a passage formed in said casing and establishing communication between the inlet port of said casing and the inlet port for said larger diameter sections; a second passage in said casing connecting the outlet port of said larger diameter sections and the inlet port of said smaller diameter sections, the outlet port of said smaller diameter sections communicating with the outlet port of said casing; pistons with sections of two diameters disposed for movement in said piston chambers; and cam means for imparting reciprocatory movement to said pistons upon rotation of said cylinder barrel.

4. A fluid pressure energy translating device comprising a casing with an internal chamber and inlet and outlet ports; a cylinder barrel supported for rotation in said chamber, said cylinder barrel having piston chambers

with sections of different diameters; stationary elements in said casing having rotary sliding engagement with said cylinder barrel to form two sets of valves having inlet and outlet ports, the inlet and outlet ports of one set of valves alternately communicating with the larger sections of said piston chambers and the inlet and outlet ports of the other set alternately communicating with the smaller sections of said piston chambers upon rotation of said cylinder barrel; means forming passageways establishing communication between the casing inlet and the inlet port of the valve set communicating with the larger sections of said piston chambers, and between the outlet port of such valve set and the inlet port of the other valve set, the outlet port of the latter set communicating with the outlet port of said casing; piston members with sections of different diameters disposed for movement in said piston chambers; and cam means for imparting reciprocatory movement to said pistons upon rotation of said cylinder barrel.

5. A fluid pressure energy translating device comprising a casing with an internal chamber and inlet and outlet ports; a valve plate at one end of said chamber, said plate having arcuate inlet and outlet ports, the latter communicating directly with the outlet port of said casing; a tubular member projecting from the center of said valve plate, said tubular member having a lateral port and an external groove extending longitudinal thereof, said groove communicating with the inlet port in said valve plate; a cylinder barrel disposed in said chamber in rotary sliding engagement with said valve plate and tubular member, said cylinder barrel having a plurality of piston chambers with sections of different diameters, the larger diameter sections having ports alternately communicating with the lateral port and groove in said tubular member, the smaller diameter sections alternately communicating with the inlet and outlet ports in said valve plate upon rotary movement of said cylinder barrel; pistons with sections of different diameters disposed for reciprocation in said piston chambers and cam means for imparting reciprocatory movement to said pistons upon rotation of said cylinder barrel.

6. A fluid pressure energy translating device comprising a casing with an internal chamber and inlet and outlet ports; a valve plate at one end of said chamber, said plate having arcuate inlet and outlet ports, the latter communicating directly with the outlet port of said casing; a tubular member projecting from the center of said valve plate, said tubular member having a lateral port and an external groove extending longitudinally thereof, said groove communicating with the inlet port in said valve plate; a passage connecting the inlet port in said valve plate with the chamber in said casing; a resiliently closed valve in said passage, said valve opening in response to predetermined pressure in said inlet port; a cylinder barrel disposed in said chamber in rotary sliding engagement with said valve plate and tubular member, said cylinder barrel having a plurality of piston chambers with sections of different diameters, the larger diameter sections having ports alternately communicating with the lateral port and groove in said tubular member, the smaller diameter sections alternately communicating with the inlet and outlet ports in said valve plate upon rotary movement of said cylinder barrel; piston with sections of different diameters disposed for reciprocation in said piston chambers and cam means for imparting reciprocatory movement to said pistons upon rotation of said cylinder barrel.

7. A fluid pressure energy translating device comprising a casing having an inlet port, an outlet port, and an internal chamber; a valve means at one end of said chamber, said valve means having arcuate supercharging and high pressure ports formed therein, the high pressure port communicating with said outlet port; a cylinder barrel disposed for rotation in said chamber, said barrel having co-axial supercharging and high pressure piston chambers and having one end in rotary sliding engage-

7

ment with said valve means, the high pressure piston chambers alternately communicating with the supercharging and high pressure ports in said valve means upon rotation of said cylinder barrel; a second valve means alternately establishing communication between said supercharging piston chambers and said inlet and the supercharging port in the first mentioned valve means; co-axial high pressure and supercharging pistons disposed for reciprocation in said chambers; and a cam means for imparting simultaneous movement to said high pressure and supercharging pistons.

8. A fluid pressure energy translating device comprising a casing with inlet and outlet ports and a chamber; a valving surface at one end of said chamber, said surface having arcuate supercharging and high pressure ports formed therein, the high pressure port communicating with said outlet port; a cylinder barrel disposed for rotation in said chamber with one end in sliding engagement with said valving surface, said cylinder barrel having supercharger and high pressure piston chambers formed therein, the high pressure piston chambers alternately communicating with supercharging and high pressure ports in said valving surface upon rotation of said cylinder barrel; a second valve means between said cylinder barrel and casing, said second valve means establishing communication alternately between said inlet port and said supercharger piston chambers and the latter and the supercharging port in said valving surface upon rotation of said cylinder barrel; supercharger and high pressure pistons disposed for reciprocation in the respective chambers in said cylinder barrel; and a single cam means for simultaneously reciprocating said pistons.

9. In a fluid pressure energy translating device, a casing with an internal chamber and inlet and outlet ports at one end of said casing; valve means at said one end of said casing, said valve means having first and second sets of ports, each set including an inlet and an outlet, the inlet port of the first set communicating with the inlet port of said casing and the outlet port of the second set communicating with the outlet port of said casing; a cylinder barrel supported for rotation in said casing in sliding engagement with said valve means, said cylinder

8

barrel having co-axial supercharging and high pressure piston chambers formed therein, the supercharging piston chambers alternately communicating with the inlet and outlet ports of the first set and the high pressure piston chambers alternately communicating with the inlet and outlet ports of the second set, the outlet port of the first set and the inlet port of the second set being in communication; supercharger and high pressure pistons disposed for reciprocation in the respective chambers in said cylinder barrel; and a single cam means for simultaneously reciprocating said pistons.

10. In a fluid pressure energy translating device, a casing with an internal chamber and inlet and outlet ports at one end of said casing, said inlet port leading to the axial center of said casing; valve means at said one end of said casing, said valve means having two sets of ports, each set having an inlet and an outlet, the inlet of the first set of ports communicating with the inlet of said casing, the outlet of the first set of ports communicating with the inlet port of said second set of ports and the outlet port of the latter set communicating with the outlet port of said casing; a cylinder barrel disposed for rotary movement in sliding engagement with said valve means, said cylinder barrel having supercharging and high pressure piston chambers formed therein, the supercharging piston chambers alternately communicating with the ports of the first set in said valve means and the high pressure piston chambers alternately communicating with the ports of the second set in said valve means; supercharger and high pressure pistons disposed for reciprocation in the respective cylinders in said cylinder barrel; and cam means common to both sets of pistons to impart simultaneous movement thereto.

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