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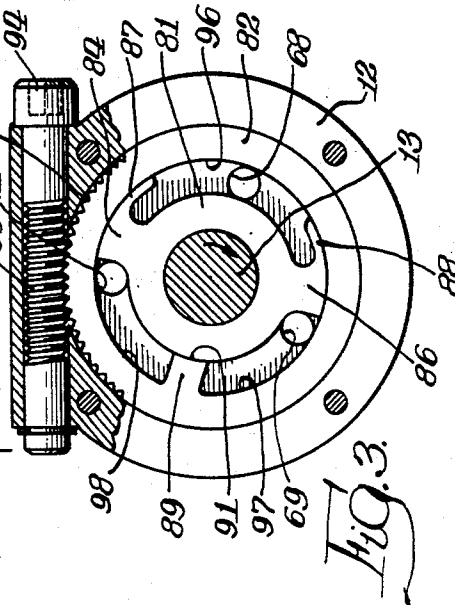
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VARIABLE FLUID DELIVERY OR INTAKE PUMP

Filed Oct. 26, 1960

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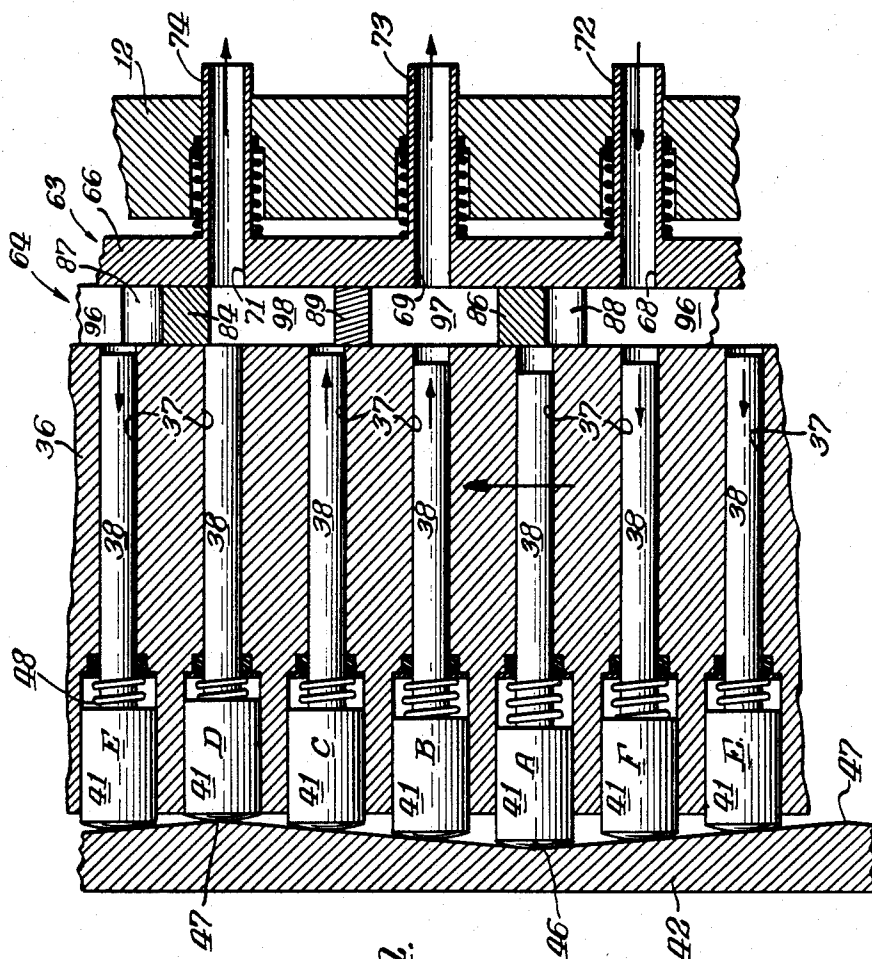


Fig. 4.

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VARIABLE FLUID DELIVERY OR INTAKE PUMP

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This invention relates to improvements in positive displacement pumps of the type having a plurality of pumping chambers rotating in a fixed path of movement. More particularly, the invention relates to an improved device for regulating the fluid delivery of a pump of the aforementioned type whereby the pump is particularly adapted for use in metering controlled quantities of fluid. The invention is also adapted to provide variable fluid intake to a pump for mixing a plurality of inlet fluid streams. The invention is particularly applicable to pumps of the so-called swash plate type but is not limited thereto.

In a pump of the swash plate type, a plurality of pistons or plungers are carried by a rotating cylinder barrel, the pistons being spring-pressed against a stationary cam member or swash plate at one end of the barrel so as to effect reciprocation of the pistons upon rotation of the barrel. The cam member or swash plate has a high point and an oppositely disposed low point so that at any given instant certain of the pistons are executing a suction stroke while other pistons are discharging fluid. Suitable fluid inlet and outlet ports or manifolds are provided at the opposite end of the barrel for the fluid intake and discharge. Instead of a rotating cylinder barrel and a stationary cam, it is also possible to provide a stationary barrel and a rotating cam or swash plate.

One object of the present invention is to provide a novel and improved variable fluid delivery or intake arrangement for a positive displacement pump of the type having a plurality of pumping chambers rotating in a fixed path of movement.

An additional object of the invention is to provide a swash plate type pump having novel and improved means for providing a variable fluid delivery from the pump.

A further object of the invention is to provide novel and improved flow control means for regulating the fluid delivery or intake in a swash plate type pump.

Another object of the invention is to provide a novel and improved adjustable valve mechanism for a swash plate type pump.

Still another object of the invention is to provide a novel and improved swash plate type pump having a pair of fluid outlets and valve mechanism for dividing the fluid delivery from the pump between the outlets in a predetermined ratio.

Other objects and advantages of the invention will become apparent from the subsequent detailed description taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a longitudinal sectional view through a metering pump of the swash plate type comprising one specific embodiment of the invention;

FIG. 2 is a transverse sectional view taken substantially along the line 2-2 of FIG. 1;

FIG. 3 is a transverse sectional view taken substantially along the irregular line 3-3 of FIG. 1; and

FIG. 4 is a development of the cylinder barrel, swash plate, and flow regulating portions of the pump.

Briefly described, the novel flow regulating mechanism of the preferred embodiment of the invention comprises a valve plate having a fluid inlet port and a pair of spaced fluid outlet ports, and an adjustable valve mechanism interposed between the valve plate and the pumping cham-

bers. The valve mechanism provides a single inlet slot of constant area and volume in register with the fluid inlet port and a pair of outlet slots of variable area and volume in register with the respective outlet ports. By suitable manual adjustment, the relative areas and volumes of the two outlet slots are varied while the area and volume of the inlet slot remains constant so that the fluid delivery is thereby divided in a predetermined ratio between the two outlet ports. By means of this arrangement, it is possible to obtain in a simple and inexpensive manner a high degree of control over the fluid delivery from the pump. The invention is particularly suited for low and moderate pressure applications where it is desired to meter a carefully regulated quantity of fluid, e.g. in a fuel pump for an oil burner or the like. In such applications, one of the outlet ports may comprise a by-pass so that only a single fluid stream is discharged from the pump. In other applications, both outlet ports may be utilized to discharge dual streams having a selected output ratio for operating hydraulic devices or servomechanisms, for feeding separate fuel systems, and for any of a multitude of uses requiring the feeding of a pair of adjustably proportioned fluid streams.

The invention also contemplates an alternate form wherein the valve plate has a pair of spaced fluid inlet ports and a single fluid outlet port with the valve mechanism providing a single outlet slot of constant area and volume in register with the fluid outlet port and a pair of inlet slots of variable area and volume in register with the respective inlet ports. In this form of the invention the device functions as a mixing valve for mixing variable proportions of two inlet streams with a constant fluid delivery.

Hereinafter, the invention will be described in connection with a swash plate type pump, but it is to be understood that the invention may also be utilized in connection with a gear pump or a rotary vane pump or other types of pumps having a plurality of pumping chambers rotating in a fixed path of movement.

Referring now to the drawings, the invention is illustrated in connection with a preferred embodiment having a rotating cylinder barrel and a stationary cam member or swash plate. However, it is to be understood that the principles of the invention are also applicable to the type of pump wherein the cylinder barrel is stationary and the cam member or swash plate rotates.

The pump comprises an outer casing having a central section 10 and end sections 11 and 12 secured thereto, as by screws or bolts. A drive shaft 13 is mounted for rotation in the pump casing, the shaft being journaled in a tubular bearing portion 14 in the end section 11 and a central bore 16 in the end section 12. A tubular boss 17 projects from the end section 12 for receiving the free end of the shaft 13, and an oil seal 18 is held in place by a gland 19 threadedly secured in the tubular boss 17. At the opposite end of the shaft 13, which is adapted to be connected to suitable drive means (not shown), an O-ring seal 20 surrounds the shaft 13 and is housed in a channel ring 21 so that both the rings 20 and 21 rotate with the shaft 13. The channel ring 21 is held in axial abutment against the tubular journal 14 by means of a sleeve 22 having a flange portion 23. A diaphragm 24 extends across the end section 11 for maintaining a supply of lubricant in an annular cavity 26 within the end section, the diaphragm having a central opening through which the shaft 13 projects and the diaphragm being clamped between the flange 23 of the sleeve 22 and a retainer ring 27 concentric with the sleeve 22. A dished cover or retainer plate 28 overlies the diaphragm 24 and is secured to the end section 11 by screws 29. A

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compression spring 31 surrounds the shaft 13 and coacts between the dished portion of the spring retainer 28 and the retainer ring 27 for maintaining the channel ring 21 in rotary sealing engagement between the shaft journal 14 and the flange 23.

A cylinder barrel or rotor 36 is rotatably disposed in the central casing section 10 and is keyed to the shaft 13, as at 35 (FIG. 2), for rotation therewith. The barrel 36 is provided with a plurality of axially extending cylinders 37 disposed in a circular arrangement around the shaft and on axes parallel with the shaft 13. Each cylinder 37 has a piston or plunger 38 reciprocally mounted therein. At the piston actuating end of the barrel 36, each cylinder 37 has an enlarged counterbore 39 for receiving an enlarged cap portion 41 disposed over the end of the piston 38. An annular cam member or swash plate 42 is fixedly secured, as by a key 43, in an annular recess 44 in the end section 11 for coaction with the pistons 38. The cam member 42 has an angular or slanting cam surface providing a low point 46 and a high point 47 corresponding to the extreme suction and discharge positions, respectively, of the pistons 38.

The pistons 38 and their cap portions 41 are spring-pressed toward the cam member 42 by means of a compression spring 48 encircling each piston 38 in the corresponding counterbore 39, the spring 48 coacting between a retainer ring 49 secured in a groove 51 on the piston 38 and a retaining washer 52 seated against the base of the counterbore 39. An O-ring seal 53 surrounds each piston 38 adjacent the base of the counterbore 39. The outermost end of each cap portion 41 has a curved or arcuate contour, as clearly seen in FIG. 1, for facilitating rotary sliding contact with the angular face of the cam member 42. As will be evident from FIG. 1, the cap portion 41 has only axial engagement with the piston 38, but the cap portion reciprocates in the counterbore 39 so that side thrust forces created by reason of the engagement of the curved end of the cap portion 41 with the slanted cam surface of the cam member 42 are taken by the cylindrical skirt of the cap portion 41 and the cooperating wall of the counterbore 39. Thus, the piston 38 is substantially relieved of all side thrust thereby contributing materially to the effective life of the parts. Each cap portion 41 is also provided with a longitudinally extending flat 54 on its outer surface adjacent the shaft 13 in order to prevent trapping of gas or liquid within the counterbore portions 39 during reciprocating movement of the pistons 38 and cap portions 41. The arrangement of the flats 54 on the respective cap portions 41 is best seen in FIG. 2.

At the pump end of the barrel 36, the end section 12 has an enlarged cavity 60 and three counterbores 61 and communicating end openings 62 spaced circumferentially around the shaft 13. The flow regulating mechanism comprising the principal feature of the invention includes a stationary valve plate (designated generally at 63) and an adjustable valve means (designated generally at 64).

The valve plate 63 has a circular plate portion 66 disposed in the cavity 60 with a central opening 67 through which the shaft 13 extends and three circumferentially spaced openings comprising a fluid inlet port 68 and a pair of fluid outlet ports 69 and 71, respectively. Tubular extensions 72, 73, and 74 project axially from the ports 68, 69, and 71, respectively, and extend through the counterbores 61 and the end openings 62 in the end section 12. For convenience, the outlet port 69 and its tubular extension 73 are shown diagrammatically in dash lines in FIG. 1, but it will be appreciated that the exact location of the port 69 is as shown in FIG. 3. Seal rings 76 surround the tubular extensions 72, 73, 74 and are seated in annular grooves adjacent the base of each counterbore 61.

The adjustable valve mechanism 64 is interposed between the valve plate 63 and the adjacent end of the barrel 36 and comprises a pair of concentric inner and outer

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valve elements 81 and 82, respectively, with an annular space therebetween. In the illustrated embodiment, the inner valve element 81 is held stationary, for example, by means of a keyed connection (not shown) with the plate portion 66, and has a central opening 83 (FIG. 1) through which the shaft 13 extends. A pair of radial lands 84 and 86 project rigidly outwardly from the stationary valve element 81 and have extended arcuate outer end portions or feet 87 and 88, respectively, disposed in sealing and bearing engagement with the arcuate inner periphery of the outer valve element 82. The outer valve element 82 is rotatably mounted in the cavity 60 and has a radial land 89 projecting inwardly therefrom for movement therewith. The inner end surface of the land 89 has an arcuate contour, as at 91, for sealing and bearing engagement with the outer periphery of the inner valve element 81. For rotatably adjusting the valve mechanism, a portion of the outer periphery of the valve element 82 is provided with gear teeth 92, and an adjusting screw 93 is journaled in the casing end section 12, the screw 93 having its threads engaging the gear teeth 92 and being formed with a head portion 94 adapted to be manipulated by a suitable tool.

As best seen in FIG. 3, the lands 84, 86, 89 are located so that the annular space between the valve elements 81 and 82 is divided into three segregated arcuate slots 96, 97, and 98. The slot 96 has a constant area, regardless of the rotary position of the adjustable valve element 82 and the movable land 89, and is always in flow communication with the fluid inlet port 68. However, the slots 97 and 98 have variable relative areas dependent upon the adjusted position of the movable land 89 therebetween but are always in flow communication with the outlet ports 69 and 79, respectively. It will be recognized that regardless of the position of the movable land 89, the total or combined areas of the outlet slots 97 and 98 is always the same.

A compression spring 101 encircles each of the tubular extensions 72, 73, 74 within the corresponding counterbore 61 and coacts between the plate portion 66 and a thrust washer 102 disposed at the base of the counterbore. Thus, the combined action of the three springs 101 urges the valve plate 63 and the valve means 64 axially against the pumping end of the cylinder barrel 36 so that the parts are maintained in sealing relation during rotation of the cylinder barrel. As will be evident from FIG. 1, the circumferential spacing of the cylinders 37 is such that the open pumping ends of the cylinders are in register with the arcuate slots 96, 97, 98 which are in turn aligned with the ports 68, 69, and 71. Consequently, as the cylinder barrel 36 rotates with the shaft 13, the pistons 38 are reciprocated by the swash plate action of the cam member 42 and the open pumping ends of the cylinders 37 successively traverse the intake and outlet slots of the valve mechanism 64. Each piston 38 in turn draws fluid into its cylinder 37 through the inlet port 68 and the intake slot 96 and discharges fluid partly through the outlet slot 97 and its port 69 and partly through the outlet slot 98 and its port 71. At any given rotational speed of the barrel 36 it will be understood that the fluid delivery from the pump will be divided between the outlet ports 69 and 71 in proportion to the relative areas of the slots 97 and 98 as determined by the preadjusted position of the movable land 89.

Referring now to FIG. 4, the operation of the pump will be clear from the development shown wherein the direction of rotation of the cylinder barrel 36 is illustrated by the arrow. For convenience, the respective pistons 38 have been identified in FIGS. 2 and 4 by the letters A-F. Piston E is beginning its suction stroke to the left with its cap portion 41 having just moved away from the high point 47 of the cam member 42 and with the open end of the cylinder 37 moving into register with the intake slot 96. Piston F is in a further stage of its suction stroke. Piston A is in its extreme suction posi-

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tion with the cap 41 at the low point 46 of the cam member 42 and the cylinder still partially in register with the inlet slot 96. Piston B has just started its discharge stroke to the right with the cylinder in register with the outlet slot 97. Piston C is in a further stage of its discharge stroke with the cylinder moving into register with the outlet slot 98. Piston D is in its extreme discharge position with its cap 41 at the high point 47 of the cam member 42 and its cylinder still in register with the outlet slot 98. Thus, it will be seen that each cylinder 37 traverses the intake slot 96 during its suction stroke, passes over the stationary land 86, discharges partially into the outlet slot 97, passes over the adjustable land 89, completes its discharge stroke into the outlet slot 98, and finally passes over the stationary land 84 into register with the intake slot 96 to repeat the cycle. Dependent upon the position of the adjustable land 89 and the relative areas of the slots 97 and 98, the fluid delivery from the pump is thereby divided in a predetermined ratio between the outlets 69-73 and 71-74. For example, if the movable land 89 is positioned closer to the fixed land 84 than to the fixed land 86, the slot 97 will have a greater area than the slot 98 and, at a given rotational speed of the barrel 36, the slot 97 will therefore have a proportionately greater pumping time or time of exposure to the discharging cylinders 37 so as to provide a greater output of fluid to the outlet port 69 than to the outlet port 71. Conversely, if the movable land 89 is positioned closer to the fixed land 86, the output to the port 71 will be greater than the output to the port 69.

It will be seen that the pump provides controlled delivery of either one or two output streams, as desired. For example, when used as a metering device as in an oil burner pump, the outlet tube 73 may be connected by a by-pass arrangement to a fuel sump or supply source so that only the fluid stream from the outlet tube 74 is fed to the burner. By regulation of the adjustable valve 64 any desired proportion of the fluid output may be bypassed or recirculated so as to control the delivery rate from the outlet tube 74. In other uses of the pump, both fluid streams from the outlet tubes 73 and 74 may be utilized, e.g., as actuating fluids for hydraulic devices or the like, as fuel streams for a dual burner system, as proportioned feed streams for a physical or chemical process, etc.

As heretofore mentioned, although the variable port principle of the invention has been specifically illustrated and described in connection with a constant intake system with variable delivery from two outlets, it will readily be appreciated that by proper correlation of the cam or swash plate action on the pistons it is also possible to utilize the same valve mechanism to accomplish intake of two fluid streams in varying proportions with a constant output so that the device functions as a mixing means for mixing two fluid streams. Thus, the port 68 and the slot 96 would handle outlet fluid while the ports 69, 71 and their respective variable slots 97, 98 would handle the inlet fluid streams, the cam member 42 being modified to effect suction and discharge movement of the pistons 38 at the appropriate points in the operating cycle.

Although the invention has been described with reference to an illustrated specific embodiment thereof, it is to be understood that various alternative and equivalent structures may be resorted to without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In a positive displacement pump of the type having a plurality of pumping chambers revolving in a fixed path of movement, the improvement comprising means defining a fluid inlet port for admitting fluid to the pump and a pair of fluid outlet ports for discharging fluid from the pump, and flow control means providing flow communication between said ports and each of the pumping chambers successively during movement thereof, said flow

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control means including means defining a slot of fixed size in register with said inlet port and a pair of slots of variable size in register respectively with said outlet ports for dividing the fluid delivery from the pump between said outlet ports in a predetermined ratio.

2. In a positive displacement pump of the type having a plurality of pumping chambers revolving in a fixed path of movement, the improvement comprising means defining a fluid inlet port for admitting fluid to the pump and a pair of fluid outlet ports for discharging fluid from the pump, and adjustable valve means providing flow communication between said ports and each of said pumping chambers successively during movement thereof, said valve means comprising a pair of inner and outer concentric elements with an annular space therebetween, partition means dividing said annular space into three segregated arcuate slots, one of said slots having a fixed area and being in flow communication with said inlet port and the other slots being in flow communication respectively with said outlet ports, and adjustment means for rotatably adjusting one of said elements relative to the other for varying the relative areas of said other slots whereby to divide the fluid delivery from the pump between said outlet ports in a predetermined ratio.

3. The structure of claim 2 further characterized in that said partition means comprises three circumferentially spaced lands extending radially between said elements and interposed between said ports for defining said slots, one of said lands being disposed between said outlet ports and being rigid with said outer element and the other lands being rigid with said inner element, and said adjustment means comprises means for rotatably adjusting said outer element relative to said inner element whereby to vary the position of said one land between said outlet ports for regulating the relative areas of said other slots.

4. In a pump of the swash plate type, the combination of a barrel member, a plurality of pistons slidably supported in said barrel member, a cam member operatively engaging said pistons at one end of the barrel member for effecting reciprocation of said pistons in response to relative rotation between said members, port means at the opposite end of said barrel member defining a fluid inlet port for admitting fluid to the pump and a pair of fluid outlet ports for discharging fluid from the pump, and flow control means providing flow communication between said ports and each of said pistons successively upon relative rotation between said barrel member and said flow control means, said flow control means including means defining a slot of fixed size in register with said inlet port and a pair of slots of variable size in register respectively with said outlet ports for dividing the fluid delivery from the pump between said outlet ports in a predetermined ratio.

5. In a positive displacement pump of the swash plate type having a pair of relatively rotatable barrel and cam members, a plurality of pistons slidably supported in the barrel member and operatively engaged by the cam member at one end of the barrel member for effecting reciprocating movement of the pistons in response to relative rotation between said members, and means at the opposite end of the barrel member for admitting fluid to and discharging fluid from the pistons; an improved control for regulating the fluid delivery from the pump which comprises means at the opposite end of the barrel member defining a fluid inlet passage and a pair of fluid outlet passages, valve means interposed between said passages and the pistons and defining three fluid recesses adapted to be disposed in flow communication successively with each of said pistons upon relative rotation between said valve means and the barrel member, one of said recesses having a fixed area and being in flow communication with said inlet passage and the other recesses being in flow communication respectively with said outlet passages, and adjustable means for varying the relative areas of said

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other recesses whereby to divide the fluid delivery from the pump between said outlet passages in a predetermined ratio.

6. The structure of claim 5 further characterized in that said valve means comprises a pair of inner and outer concentric elements with an annular space therebetween, means dividing said annular space into three segregated arcuate slots comprising said fluid recesses, and means for rotatably adjusting one of said elements relative to the other for varying the relative areas of the slots communicating with said outlet passages.

7. The structure of claim 6 further characterized in that said inner element is stationary and said outer element is rotatably adjustable relative to said inner element.

8. The structure of claim 5 further characterized in that said valve means comprises a pair of inner and outer concentric elements with an annular space therebetween, three lands extending radially between said elements in circumferentially spaced relation and interposed between said passages for dividing said annular space into three segregated arcuate slots comprising said fluid recesses, and means for varying the relative position of said outlet passages with respect to the land interposed therebetween for varying the relative areas of the slots communicating with said outlet passages.

9. In a positive displacement pump of the swash plate type having a pair of relatively rotatable barrel and cam members, a plurality of pistons slidably supported in the barrel member and operatively engaged by the cam member at one end of the barrel member for effecting reciprocating movement of the pistons in response to relative rotation between said members, and means at the opposite end of the barrel member for admitting fluid to and discharging fluid from the pistons; an improved control for regulating the fluid delivery from the pump which comprises means at the opposite end of the barrel member defining in circumferentially spaced relation a fluid inlet passage and a pair of fluid outlet passages, and adjustable valve means interposed between said passages and the pistons, said valve means comprising a pair of inner and outer concentric elements with an annular space therebetween, a plurality of circumferentially spaced lands extending radially between said elements and interposed between said passages for dividing said annular space into three segregated arcuate slots in register with said passages and adapted for successive fluid communication with the pistons upon relative rotation between said valve means and the barrel member, one of said lands being disposed between said outlet passages and being rigid with said outer element and the other lands being rigid with said inner element, and means for rotatably adjusting said outer element relative to said inner element whereby to vary the position of said one land between said outlet passages for regulating the relative areas of the slots communicating with said outlet passages and thereby dividing the fluid delivery from the pump between said outlet passages in a predetermined ratio.

10. In a positive displacement pump of the swash plate type having a rotatable barrel with a plurality of pistons slidably supported therein and operatively engaged by stationary cam means at one end of the barrel for effecting reciprocating movement of the pistons in response to rotation of the barrel, an improved control for regulating the fluid delivery from the pump which comprises a stationary valve plate at the opposite end of the barrel, said valve plate having a fluid inlet port for supplying fluid to the pistons and a pair of fluid outlet ports for discharging fluid from the pistons, valve means interposed between said valve plate and said opposite end of the barrel, said valve means defining three fluid recesses adapted to be disposed in flow communication successively with each of said pistons upon rotation of the barrel, one of said recesses having a fixed area and being in flow communication with said inlet port and each of the other recesses being in respective flow communication with one of said outlet ports, and said

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valve means including adjustable means for varying the relative areas of said other recesses whereby to divide the fluid delivery from the pump between said outlet ports in a predetermined ratio.

11. The structure of claim 10 further characterized in that said valve means comprises a pair of inner and outer concentric elements with an annular space therebetween, means dividing said annular space into three segregated arcuate slots comprising said fluid recesses, and means for rotatably adjusting one of said elements relative to the other for varying the relative areas of the slots communicating with said outlet ports.

12. The structure of claim 11 further characterized in that said inner element is stationary and said outer element is rotatably adjustable relative to said inner element.

13. The structure of claim 10 further characterized in that said valve means comprises a pair of inner and outer concentric elements with an annular space therebetween, three lands extending radially between said elements in circumferentially spaced relation and interposed between said ports for dividing said annular space into three segregated arcuate slots comprising said fluid recesses, and means for varying the relative position of said outlet ports with respect to the land interposed therebetween for varying the relative areas of the slots communicating with said outlet ports.

14. In a positive displacement pump of the swash plate type having a rotatable barrel with a plurality of pistons slidably supported therein and operatively engaged by stationary cam means at one end of the barrel for effecting reciprocating movement of the pistons in response to rotation of the barrel, an improved control for regulating the fluid delivery from the pump which comprises a stationary valve plate at the opposite end of the barrel, said valve plate having in circumferentially spaced relation a fluid inlet port for supplying fluid to the pistons and a pair of fluid outlet ports for discharging fluid from the pistons, and adjustable valve means interposed between said valve plate and said opposite end of the barrel, said valve means comprising a pair of inner and outer concentric elements with an annular space therebetween, a plurality of circumferentially spaced lands extending radially between said elements and interposed between said ports for dividing said annular space into three segregated arcuate slots in register with said ports and adapted for successive fluid communication with the pistons upon rotation of the barrel, one of said lands being disposed between said outlet ports and being rigid with said outer element and the other lands being rigid with said inner element, and adjustment means for rotatably adjusting said outer element relative to said inner element whereby to vary the position of said one land between said outlet ports for regulating the relative areas of the slots communicating with said outlet ports and thereby dividing the fluid delivery from the pump between said outlet ports in a predetermined ratio.

15. The structure of claim 14 further characterized in that said inner element is keyed to said valve plate for holding the inner element stationary, said one land having a sealing and bearing surface at its inner end engaging said inner element, and said other lands having sealing and bearing surfaces at their outer ends engaging said outer element, whereby said outer element is supported by said surfaces for rotative adjustment thereof.

16. The structure of claim 14 further characterized in that said adjustment means comprises gear means on at least a portion of said outer element and a movable adjusting member engaged with said gear means for effecting rotary adjustment of the outer element.

17. In a positive displacement pump of the swash plate type having a pair of relatively rotatable barrel and cam members, a plurality of spring pressed pistons slidably supported in the barrel member and operatively engaged by the cam member at one end of the barrel member for effecting reciprocating movement of the pistons in re-

sponse to relative rotation between said members, and means at the opposite end of the barrel member for admitting fluid to and discharging fluid from the pistons; an improved control for regulating the fluid delivery from the pump which comprises a valve plate at the opposite end of the barrel member defining a fluid inlet port and a pair of fluid outlet ports, spring means urging said valve plate toward the opposite end of the barrel member, and valve means interposed between said valve plate and the pistons and defining three fluid recesses adapted to be disposed in flow communication successively with each of said pistons upon relative rotation between said valve means and the barrel member, one of said recesses having a constant area and being in flow communication with said inlet port and each of the other recesses being in respective flow communication with one of said outlet ports, and adjustable means for varying the relative areas of said other recesses whereby to divide the fluid delivery from the pump between said outlet ports in a predetermined ratio.

18. The structure of claim 17 further characterized by the provision of a casing containing the operating parts of the pump and including an end section containing said valve plate and said valve means, a plurality of tubular extensions projecting from the ports in said valve plate through said end section, and said spring means comprising a plurality of springs encircling said tubular extensions and coacting between said end section and said valve plate for urging the latter toward the opposite end of the barrel member.

19. A positive displacement pump of the swash plate type comprising a housing including a center section and a pair of end sections at opposite ends of the center section, a shaft extending through said housing and journaled in said end sections, a rotor mounted on said shaft for rotation therewith in said center section, said rotor having a plurality of axially extending cylinders spaced circumferentially around said shaft and parallel thereto, a plurality of pistons slidably supported in said cylinders, stationary cam means mounted in one of said end sections at one end of said rotor, spring means urging said pistons into engagement with said cam means whereby said pistons are reciprocated upon rotation of said rotor, the other of said end sections having a cavity facing the opposite end of said rotor, a stationary valve plate mounted in said cavity and having an inlet port for supplying fluid to the pump and a pair of outlet ports for discharging fluid from the pump, adjustable valve means comprising a pair of inner and outer concentric elements disposed in said cavity and interposed between said valve plate and said opposite end of said rotor, spring means in said cavity coacting between said other end section and said valve plate for sealingly urging said valve plate and said valve means against said opposite end of said rotor, a plurality of lands extending radially between said concentric elements and dividing the annular space between said elements into three segregated arcuate slots in register with the respective ports and adapted for successive fluid communication with said cylinders upon rotation of said rotor, one of said lands being rigid with said outer element and being interposed between said outlet ports and the other lands being stationary, and adjustment means for rotatably adjusting said outer element relative to said inner element whereby to vary the relative position of said one land between said outlet ports for varying the relative areas of the slots communicating with said outlet ports and thereby dividing the fluid de-

livery from the pump between said outlet ports in a predetermined ratio.

20. The structure of claim 19 further characterized in that said adjustment means comprises peripheral teeth on said outer element and an adjusting screw rotatably supported in said other end section and engaging said teeth.

21. In a positive displacement pump of the type having a plurality of pumping chambers revolving in a fixed path of movement, the improvement comprising means defining three fluid ports, and flow control means providing flow communication between said ports and each of the pumping chambers successively during movement thereof, said flow control means including means defining a slot of fixed size in register with one of said ports and a pair of slots of variable size in register respectively with the other two ports for dividing the fluid delivery or intake of the pump between said other two ports in a predetermined ratio.

22. The structure of claim 21 further characterized in that said flow control means comprises adjustable valve means including a pair of inner and outer concentric elements with an annular space therebetween, partition means dividing said annular space into three segregated arcuate slots, one of said slots shaving a fixed area and being in flow communication with said one port and the other slots being in flow communication respectively with said other two ports, and adjustment means for rotatably adjusting one of said elements relative to the other for varying the relative areas of said other slots whereby to divide the fluid delivery or intake of the pump between said other two ports in a predetermined ratio.

23. In a pump of the swash plate type, the combination of a barrel member, a plurality of pistons slidably supported in said barrel member, a cam member operatively engaging said pistons at one end of the barrel member for effecting reciprocation of said pistons in response to relative rotation between said members, port means at the opposite end of said barrel member defining three fluid ports, and flow control means providing flow communication between said ports and each of said pistons successively upon relative rotation between said barrel member and said flow control means, said flow control means including means defining a slot of fixed size in register with one of said ports and a pair of slots of variable size in register respectively with the other two ports for dividing the fluid delivery or intake of the pump between said other two ports in a predetermined ratio.

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