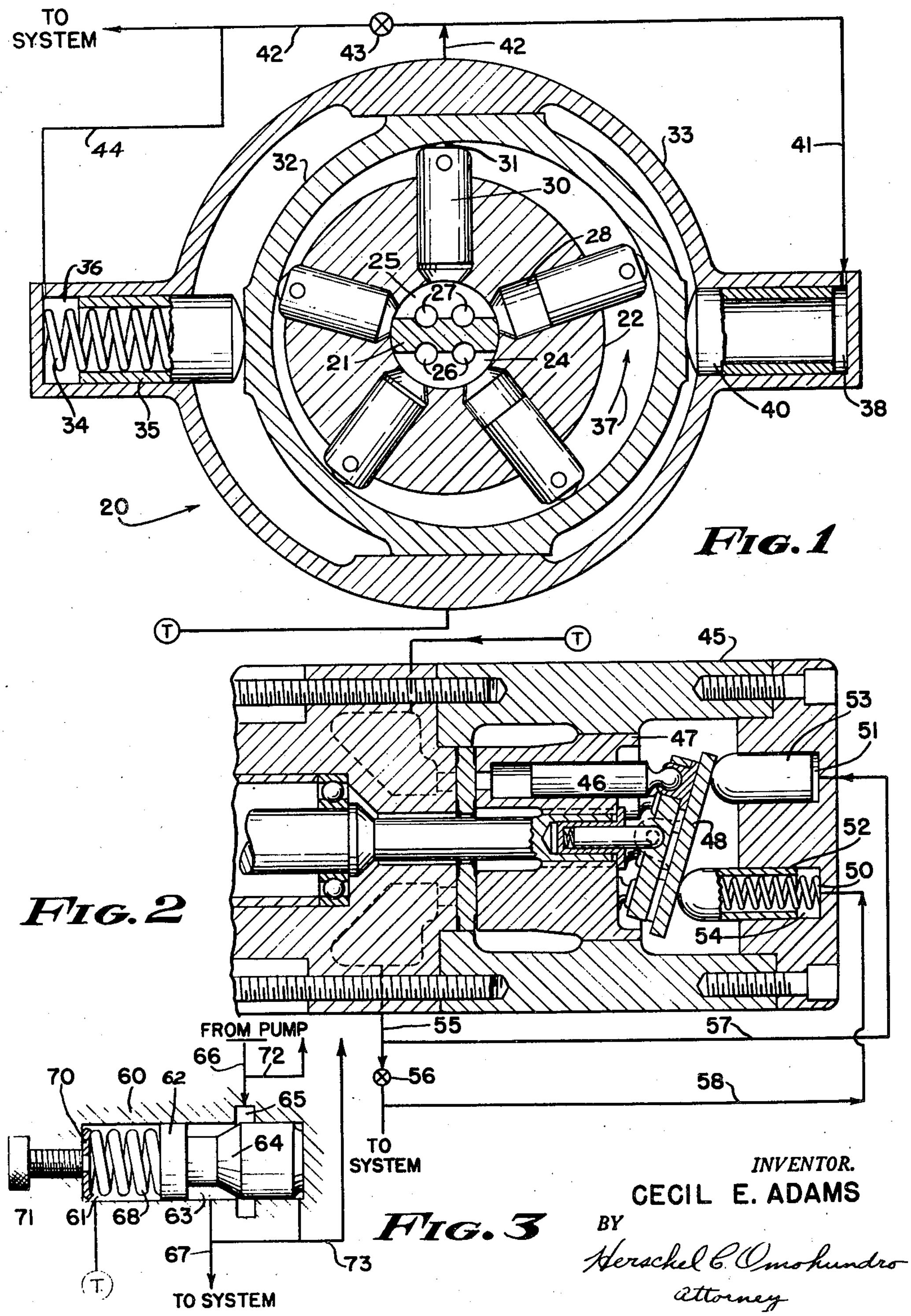
April 4, 1950 C. E. ADAMS 2,502,546

HYDRAULIC APPARATUS

Filed March 28, 1947



INVENTOR.
CECIL E. ADAMS

BY *Herschel C. Omohundro*
Attorney

Patented Apr. 4, 1950

2,502,546

UNITED STATES PATENT OFFICE

2,502,546

HYDRAULIC APPARATUS

Cecil E. Adams, Columbus, Ohio, assignor to The Denison Engineering Company, Columbus, Ohio, a corporation of Ohio

Application March 28, 1947, Serial No. 737,932

1 Claim. (Cl. 103—161)

1

This invention relates generally to the science of hydraulics and is particularly directed to fluid pressure energy translating devices of the type employed in the transmission of motion and power. More specifically this invention is directed to volume control mechanism for a fluid pressure energy translating device of the type having an element which is movable to vary the volume of fluid discharged by the device.

An object of this invention resides in utilizing an intentionally created pressure differential to regulate the volume of fluid delivered by a pump so that the control mechanism for the pump may be remotely located therefrom.

Another object of the invention is to provide a pump with a movable member for varying the volume thereof and a plurality of fluid pressure responsive elements for imparting movement to the member for varying the volume, the pump being further provided with means for restricting fluid flow to create a pressure differential, the contrasting pressures being applied to the fluid pressure responsive elements to move the volume-varying member to and retain the same in a position to cause the pump to deliver a predetermined volume of fluid.

Another object of the invention is to provide a fluid pressure energy translating device which functions as a pump, with a volume-varying member mounted for movement and providing a pair of oppositely acting pressure responsive elements in the form of pistons to move the volume-varying member in opposite directions, one of the pistons being supplemented by a resilient power-transmitting element in the form of a spring which tends to move the volume-varying member toward a predetermined position, the device also being provided with a flow-resisting element to create a pressure differential which is applied to the pistons to move the volume-varying member in opposition to the spring so that the volume produced will be controlled by the pressure differential.

Another object of the invention is to provide the mechanism mentioned in the foregoing paragraph with means for adjusting the flow-resisting element to vary the volume of fluid delivered by the device; when the flow-resisting element is adjusted the setting of the volume-varying member will automatically change to cause the pump to deliver the volume necessary to maintain the pressure differential.

A further object is to dispose the flow-resisting element mentioned in the two preceding paragraphs, in the outlet line of the pump so that

2

the entire output thereof will be exposed to the action of the element and thus a more accurate control of the pump volume will be secured.

A still further object is to provide an automatic throttle or flow-resisting element which includes a metering spool, a device for resiliently urging such spool toward a certain position and means for subjecting the spool to fluid pressure to move the same in opposition to the urging means to maintain a uniform pressure drop or differential which is utilized to effect a pressure adjustment of the volume-varying member of the pump and the development of constant horsepower by motor units supplied with fluid by the pump.

In the drawings:

Fig. 1 is a diagrammatic view of a radial piston pump provided with a volume control formed in accordance with the present invention.

Fig. 2 is a similar view of an axial piston pump provided with a control mechanism formed in accordance with the invention; and,

Fig. 3 is a diagrammatic view of an automatic throttle which may be employed in carrying out the invention.

Referring more particularly to the drawings and especially to Fig. 1, the numeral **20** indicates generally a radial piston pump; this pump is of conventional form and includes a pintle **21** about which a cylinder barrel **22** revolves, the pintle being provided with oppositely disposed recesses **24** and **25**, the former communicating with inlet passages **26** while the latter communicates with outlet passages **27**. The cylinder barrel **22** has a plurality of radially extending chambers **28** which alternately communicate with the slots **24** and **25** as the cylinder barrel is revolved, suitable mechanism, not shown, being provided to cause such movement of the cylinder barrel. The chambers **28** receive, for sliding movement, piston elements **30** which are provided at their outer ends with rollers **31** for engaging the inner surface of an adjustable ring **32**, suitable means, not shown, being provided for maintaining the engagement of the rollers with such ring.

The ring is disposed for adjustment within a casing **33** to vary the relation of the ring and pintle members to one another, the ring being movable from a position in concentric relation to one of eccentric relation to the pintle member. When the ring is concentric with the pintle the cylinder barrel may be revolved without effect, the pump then being said to be operating at zero volume. When the ring is moved to the maximum degree of eccentricity relative to the pintle the pump will be operating at a maximum volume; it is urged toward this position by a spring **34** disposed in the casing between a piston **35** and the end of a chamber **36** in which such piston is arranged for sliding movement, this chamber **36** being located at one side of the casing **33**. By locating the ring **32** in eccentric relation to the pintle and rotating the cylinder barrel **22** in the direction of the arrow **37** in Fig. 1, pistons **30** will be moved into and out of the cylinders **28** causing a transfer of fluid from recess **24** to recess **25**. The amount of fluid transferred and consequently the volume of fluid delivered by the pump will be varied by changing the degree of eccentricity of the ring **32**.

To effect movement of the ring toward a concentric position the casing **33** is provided on the side opposite the chamber **36** with a second chamber **38** in which a second piston **40** is disposed for sliding movement. Pistons **35** and **40** are suitably engaged or connected with the ring **32**. To cause the piston **40** to move the ring **32**, fluid under pressure is introduced into the outer end of the chamber **38**. This fluid is conducted to the chamber through a line **41** which is connected with the outlet line, indicated by the numeral **42**, of the pump. This line **42** communicates with the passages **27** and at a point beyond the connection of the line **41** therewith, it is provided with an orifice or adjustable restriction **43**, this restriction serving to resist the flow of fluid through the line **42** to cause a pressure drop therein at opposite sides of the restriction.

A second line **44** extends between the line **42** at the down-stream side of the orifice **43** and the outer end of the chamber **36**. This arrangement subjects pistons **35** and **40** to the contrasting pressures of the pressure differential created in the outlet of the pump by the orifice **43**. When the orifice is adjusted to provide a minimum restriction, a large volume will be necessary to create the pressure drop, spring **34** will consequently move the ring **32** to cause the pump to deliver a greater volume of fluid. If it is desired to reduce the volume the orifice **43** is adjusted to offer more restriction. Since a smaller volume will produce the pressure drop the pressure in line **42** will increase and be supplied to chamber **38** through line **41**. The ring will then be moved in opposition to the spring **34** until the force of the spring **34**, plus the fluid pressure in back of piston **35** equals the fluid pressure in the chamber **38**. With this arrangement the orifice **43** and the means for adjusting the same may be located remotely from the pump at any suitable point of control.

In Fig. 2 the invention has been applied to an axial piston pump **45**. In this type of pump the pistons **46** are moved into and out of the cylinder barrel **47** by an inclined cam or swash plate **48**. To vary the volume of fluid delivered by such pump, the swash plate **48** is made adjustable about an axis extending at right angles to the axis of rotation of the cylinder barrel **47**. To effect the movement of the cam plate **48** the casing of the pump **45** is formed with a pair of chambers **50** and **51** on opposite sides of the pivotal axis of the plate **48**. The chambers **50** and **51** receive, for sliding movement, piston elements **52** and **53**, the chamber **50** also receiving a coil spring **54**. This spring tends to urge the cam plate **48** toward a maximum inclined position whereby the highest volume of fluid will be delivered by the pump.

To vary the position of the cam plate **48**, chamber **51** is supplied with fluid under pressure. This fluid is taken from the outlet line **55** of the pump immediately in advance of an adjustable orifice **56** disposed in such line. The fluid is transmitted from line **55** to chamber **51** through a branch line **57**, the pressure of this fluid acting upon piston **53** to effect the movement of the plate **48**. Spring **54** is supplemented by fluid pressure introduced into chamber **50** through a line **58** which is connected with line **55** on the low-pressure side of the orifice **56**.

In both forms of the invention, the pressure from the high pressure side of an orifice is applied to a piston to shift the volume control mechanism in a direction to reduce the volume. This movement of the control mechanism is opposed by another piston which tends to move the control mechanism in the opposite direction, this second piston being exposed to the pressure from the low-pressure side of the orifice. The second piston is assisted by a spring and the pressure drop caused by the orifice is such that the total force of the spring and the pressure applied to the second piston will balance the force of the pressure applied to the first piston so that the volume control mechanism will be held in a selected position to deliver a predetermined volume. When the orifice is adjusted, the balance of the forces acting upon the volume control mechanism is temporarily disturbed and the volume control mechanism will be operated to tend to restore such balance. If the orifice is reduced, the volume control mechanism is operated to lower the volume delivered by the pump; if the orifice is enlarged, the volume must be increased to restore the balance.

From the foregoing discussion of the two forms of the invention shown in the drawing it will be obvious that the position of the volume-varying member of a pump provided with the control mechanism will be dependent upon an orifice in the outlet line, the volume bearing a direct relation to the size of the orifice.

Fig. 3, in the drawings, discloses an automatic throttle which may be used in the volume control system as a constant-horsepower control for a fluid pump. In prior apparatus for automatically controlling fluid pumps, use has been made of so-called pressure centering controls which operated to maintain the volumetric delivery of the pump controlled thereby until a given pressure was reached and then suddenly reduced the volume until only sufficient fluid was delivered to maintain the pressure. With such a mechanism the horsepower developed by the motor driving the pump fluctuated according to the pressure variations and a motor having the maximum capacity required at any time was necessary. With the automatic control shown by applicant in Fig. 3, a uniform horsepower will be developed regardless of the change in pressure, the volume being automatically varied to maintain the horsepower required.

The device shown diagrammatically in Fig. 3 includes a body **60** having a chamber **61** for the slidable reception of a metering spool **62**. This spool is formed with an external groove **63** having a tapered shoulder **64** at one end; this tapered shoulder moves when the spool is adjusted, relative to an annular groove **65** formed in the body **60**. This groove is connected with the outlet line **66** leading from a suitable pump the volume of which is to be controlled. Another line **67** leads from the chamber **61** in spaced relation from the groove 65, the line 67 being in registration with the groove 63.

The spool 62 is normally urged toward a position to provide open communication between the groove 65 and the line 67, by a coil spring 68 positioned between the spool 62 and an adjustable spring abutment 70, this member being operated by a manual control 71. A branch line 72 leading from the line 66, extends to the volume-reducing piston 40 or 53 of a pump of the types shown in Figs. 1 or 2, while a second branch line 73 extends from the line 67 to the volume-increasing piston of such a pump. Line 73 is also connected with the chamber 61 of the automatic throttle mechanism at the end of spool 62 opposite that engaged by spring 68. The spool 62 will thus be moved in response to pressure existing on the outlet side of the automatic throttle. If the pressure tends to increase, spool 62 will be moved to restrict fluid flow from groove 65 to passage 67; if such pressure tends to fall, spool 62 will move to facilitate fluid flow between groove 65 and line 67.

When the pressure varies, due to conditions in the system supplied by the pump the balance of pressures on the pistons of the volume control mechanism is temporarily disturbed and the volume is changed in a manner tending to restore the balance. The volume changes gradually and the horsepower developed by the driving motor remains constant.

I claim:

In a variable volume fluid pump, an inlet; an outlet; piston and cylinder means for transferring fluid from said inlet to said outlet; a movable volume varying member; means tending to yieldably urge said volume varying member toward a maximum volume position; throttle means in the outlet of said device, said throttle means having an inlet connected with the outlet of said pump and an outlet; a metering valve between said inlet and outlet; means yieldably urging said valve toward an open position; means for applying outlet pressure of said throttle to said metering valve to move the same in opposition to said second-mentioned urging means; opposed pressure responsive elements operative to impart movement to said volume varying member, one of said elements moving said member in opposition to the first-mentioned urging means; and means for applying the outlet pressure of the pump to said one element and the outlet pressure of said throttle means to the other of said elements.

CECIL E. ADAMS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 21,758	Foisy	Apr. 1, 1941
2,256,459	Kendrick	Sept. 16, 1941
2,418,532	Waldie	Apr. 8, 1947
2,427,224	Morton	Sept. 9, 1947
2,429,005	Watson et al.	Oct. 14, 1947
2,431,094	Tucker	Nov. 18, 1947