REVOLVING YOKE LOAD-SENSITIVE DISPLACEMENT-VARYING MECHANISM FOR AXIAL PISTON HYDRAULIC PUMP

Inventor: Aleksandr Michael Brailovskiy, Lumberton, MS (US)

Correspondence Address: ALEKSANDR M. BRAILOVSKY 613 MAGNOLIA ROAD LUMBERTON, MS 39455 (US)

ABSTRACT

A revolving yoke load-sensitive displacement-varying mechanism for axial piston hydraulic pump, the mechanism including a housing and a pump shaft with a first transverse opening approximately in a central portion of the pump shaft and a fluid passageway within the pump shaft approximately parallel to a longitudinal axis of the pump shaft. The pump shaft includes means to receive rotary motion from an energy source. The fluid passageway connects a front end of the pump shaft with the first transverse opening and continues beyond the transverse opening into a rear portion of the pump shaft. A swash plate and a yoke are formed as a single member and have a second transverse opening that is substantially coaxial with the first transverse opening. A yoke axis is oriented such that the yoke is stabbed over the pump shaft and the yoke axis is inserted into the first and second transverse openings to enable a partial rotation of the yoke about the yoke shaft. The yoke and yoke axis allow for unobstructed flow of a working fluid in both directions while preventing a loss of the working fluid into an internal space of the housing. The rear portion of the pump shaft includes means to utilize changes of a pressure of the working fluid towards automatic change of an angle of the yoke with respect to a longitudinal axis of the pump shaft.
REVOLVING YOKE LOAD-SENSITIVE DISPLACEMENT-VARYING MECHANISM FOR AXIAL PISTON HYDRAULIC PUMP

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Patent Application No. 60/565,345, filed on Apr. 26, 2004, which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention primarily relates to a field of load-sensitive variable displacement hydraulic pumps, more specifically to those where slim and compact size, layout simplicity and low precision and material requirements, along with light weight and low cost of manufacturing are being of greater importance then high flow and continuous duty cycle capabilities. Examples include various hand-held tools, robotic arms, mid- and light duty winches and hoists, forklift claws and so on.

A vast quantity of prior art exists in the related field. The invention of U.S. Pat. No. 2,190,812 to Wahlmark, Feb. 20, 1940 presents a good approach to swash plate angle changing (and subsequent changes of delivery parameters of the pump). But it lacks means to adjust the angle automatically according to the pump’s workload and appears to be rather sensitive to a precision with which its components must be machined.

Since the time the above mentioned invention was made, load sensitive means of changing the swash plate angle were introduced in a lot of ways and various embodiments. Widely known load sensitive variable displacement axial piston pump is shown on FIG. 1. However, for the purposes that this invention pursues, such layout is not being suitable due to still fairly high requirements to a material of which the pump is made and to a precision of its parts, plus the large overall size of the pump that this layout inevitably results into.

A great number of ways to adjust the fluid delivery parameters according to the workload are found throughout the field of pumps and compressors. However, none of these ways appear to involve as few parts, as low precision of the parts and as low requirements to the parts material as the present invention.

SUMMARY OF THE INVENTION

The present invention relates to a load-sensitive variable displacement hydraulic pump that substantially obviates one or more of the disadvantages of the related art.

Additional features and advantages of the invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

FIG. 1 shows plane view of vertical cross-section of axial piston variable displacement swash plate hydraulic pump of prior art.

FIG. 2 shows plane view of vertical cross-section of variable displacement hydraulic pump featuring revolving yoke mechanism of the present invention.

FIG. 3 shows isometric view of a grooved yoke axis and a revolving yoke of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to embodiments of the present invention, example of which is illustrated in the accompanying drawings.

The present invention, in a broad sense, is a substantial improvement over existing methods of automatic adjustment of hydraulic pump’s delivery characteristics according to workload variations regardless of the speed with which the workload increases or decreases. In one embodiment, it introduces the following elements:

a) a swash plate, functionally aggregated into one piece with revolving yoke, whereas both of these members are stabbed onto pump’s drive shaft and rotationally fixed to this shaft by a yoke axis inserted into transverse openings of both the yoke and the shaft,

b) a control body, functionally aggregated into one piece with the pump drive shaft and incorporating a yoke angle control piston and a yoke return spring, both being bias against the rear side of the yoke in such manner that control piston’s stroke strives to rotate the yoke about the yoke axis while overcoming a resistance of the return spring,

c) a fluid passageway arranged within the pump shaft, leading from high pressure discharge outlet of the pump via yoke axis groove and one-way check valve into a control piston’s bore, from which the fluid can return back into the passageway through second one-way check valve.

A primary object of the present invention is to provide inexpensive to make, low maintenance and simple yet sufficiently reliable hydraulic pump for those applications that do not require prolonged or volatile duty cycles, but can rather benefit from a slim profile of the layout, relatively short time of the pump’s reaction to the change of workload and far greater selection of suitable fluids then that of most existing art.

The invention described herein can be helpful for:

1. Significantly reducing manufacturing costs due to minimal complexity of every part and the whole assembly.
A preferred embodiment of the present invention comprises elongated pump housing, or housing 3. Rear portion of housing 3 incorporates pump drive compartment, or compartment 4. Rear end 5 of pump drive shaft assembly, or assembly 6, protrudes through a rear wall of housing 3 so that any rotational motion source can be added. Assembly 6 extends throughout an entire length of compartment 4 and its front end 7 is inserted moveably into pump discharge cavity, or cavity 8. Seal 9 is provided therein to prevent pressurized fluid from escaping into compartment 4.

Assembly 6 further comprises yoke axis section, or section 10, and yoke angle-control piston/spring/valves group body, or control body 11. Yoke angle control group’s fluid passageway, or control passageway 12 runs throughout the entire length of both section 10 and control body 11. Section 10 is being of a barrel-shaped reinforced thickness featuring flat sides through which a yoke axis hole, or hole 13 is drilled precisely across a longitudinal axis of assembly 6 so that control passageway 12 and hole 13 are becoming openly interconnected.

Control body 11 accommodates spring-loaded yoke return rod, or rod 14, return spring 15 and system pressure-actuated yoke angle control piston, or control piston 16. Rod 14 and control piston 16 are located so that they diametrically oppose each other, as shown on FIG. 2.

Control passageway 12 loops through control piston’s cylinder via loading one-way check valve, or loading valve 17, and unloading one-way check valve, or unloading valve 18.

FIG. 3 shows the grooved yoke axle, or axle 19, and the revolving yoke, or yoke 20. Axle 19 features seal grooves 21 and control passageway groove, or groove 22. Yoke 20 has two side openings, or side openings 23, tubular body 24 and swash plate support collar, or collar 25. Yoke 20 is stabbed over section 10 so that side openings 23 coincide with hole 13. This causes predetermined partial compression of return spring 15. Seals are placed into seal grooves 21 and axle 19 is then inserted into hole 13 thus affixing yoke 20 to section 10 as to allow predetermined partial rotation of yoke 20 about axle 19. Swash plate ring 26 is thereafter stabbed onto tubular body 24 and seated snugly against collar 25, as shown on FIG. 2.

Hydraulic pump of the present invention also comprises pump piston group, valves and other parts that fall beyond the scope of the present invention. One skilled in the art can easily design these as he/she pleases. However, FIG. 2 shows volume acting pump pistons 27, intake fitting 28, discharge fitting 29 and discharge passageways 30, all of which are well suited for the purpose. Pump pistons 27 are kept bias against swash plate ring 26 via ball joint slide caps 31 by suction spring.

Operation of the Preferred Embodiment

When hydraulic fluid is supplied to intake fitting 28 and rotary motion is imparted to rear end 5 of assembly 6, yoke 20 wobbles causing pump pistons 27 to reciprocate within their cylinders and pumping action thereby occurs. As long as pump’s work can be accomplished at predetermined highest flow/pressure rate, yoke remains at its highest angle with theoretical transverse axis of the pump, typically about 15 degrees.

As the work load increases, growing pressure causes fluid in control passageway 12 to overcome preset resistance of loading valve 17 and to enter into the cylinder of control piston 16. Resulting force urges yoke 20 to rotate around axle 19 thus compressing return spring 15 and assuming a position of a lesser angle with aforementioned transverse axis. This, in turn, makes pump pistons 27 to travel lesser distance so decreasing the pump’s flow, while at the same time increasing pressure up to a point of equalizing output of the pump with greater work load. If the workload rises beyond predetermined capacity of the pump, yoke’s angle reaches zero degrees and pumping action ceases.

When the workload diminishes, fluid pressure in discharge cavity 8 falls. At this point higher remaining
pressure inside the cylinder of control piston 18 opens unloading valve 18 thus allowing return spring 15 via rod 14 to push yoke 20 back towards its original angle, thereby once again adjusting flow/pressure rate accordingly. The mechanism of the present invention can theoretically operate even without valves 17 and 18, but they serve as means to delay reaction of yoke 20 so that’s volatile tensions of mechanism’s structure can be substantially reduced. Beside that, these valves assist in elimination of air from the system.

Alternative Embodiments

Instead of swash plate ring 26 that slides by ball joint caps 31, the alternative embodiment features flat thrust bearing. In this case, supporting surface of each ball joint cap is bias against a front ring of this thrust bearing. Ball joint caps 31 protrude by their narrower ends through oval-shaped openings that are made in ring-shaped pump piston retainer. A circular enclosure is placed around outer rims of collar 25, the thrust bearing and the piston retainer so that any need for suction springs 32 is eliminated since such arrangement provides for a positive suction movement of pump pistons 27 created solely by revolving yoke.

It will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined in the appended claims. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A revolving yoke load-sensitive displacement-varying mechanism for axial piston hydraulic pump, the mechanism comprising:

   a housing;
   a pump shaft with a first transverse opening approximately in a central portion of the pump shaft and a fluid passageway within the pump shaft approximately parallel to a longitudinal axis of the pump shaft, the pump shaft further comprising means to receive rotary motion from an energy source,
   wherein the fluid passageway openly connects a front end of the pump shaft with the first transverse opening and continues beyond the transverse opening into a rear portion of the pump shaft;
   a swash plate and a yoke formed as a single member and having a second transverse opening that is substantially coaxial with the first transverse opening;
   a yoke axis, wherein the yoke is stabbed over the pump shaft and the yoke axis is inserted into the first and second transverse openings to enable a partial rotation of the yoke about the yoke axis,
   wherein the yoke and yoke axis allow for unobstructed flow of a working fluid in both directions from a pressurized discharge cavity of a pump through the fluid passageway via the first transverse opening and further into the rear portion of the pump shaft while preventing a loss of the working fluid into an internal space of the housing,
   wherein the rear portion of the pump shaft comprises a sequence of means to utilize changes of a pressure of the working fluid towards automatic change of an angle of the yoke with respect to a longitudinal axis of the pump shaft;
   means to prevent the loss of the working fluid from the pressurized discharge cavity of the pump into the internal space of the housing and from the internal space of the housing.