Aug. 9, 1960 R. W. BRUNDAGE 2,948,229

METHOD AND ARRANGEMENT FOR COOLING VARIABLE VOLUME HYDRAULIC PUMPS AT LOW VOLUMES

Filed April 24, 1957 2 Sheets-Sheet 1

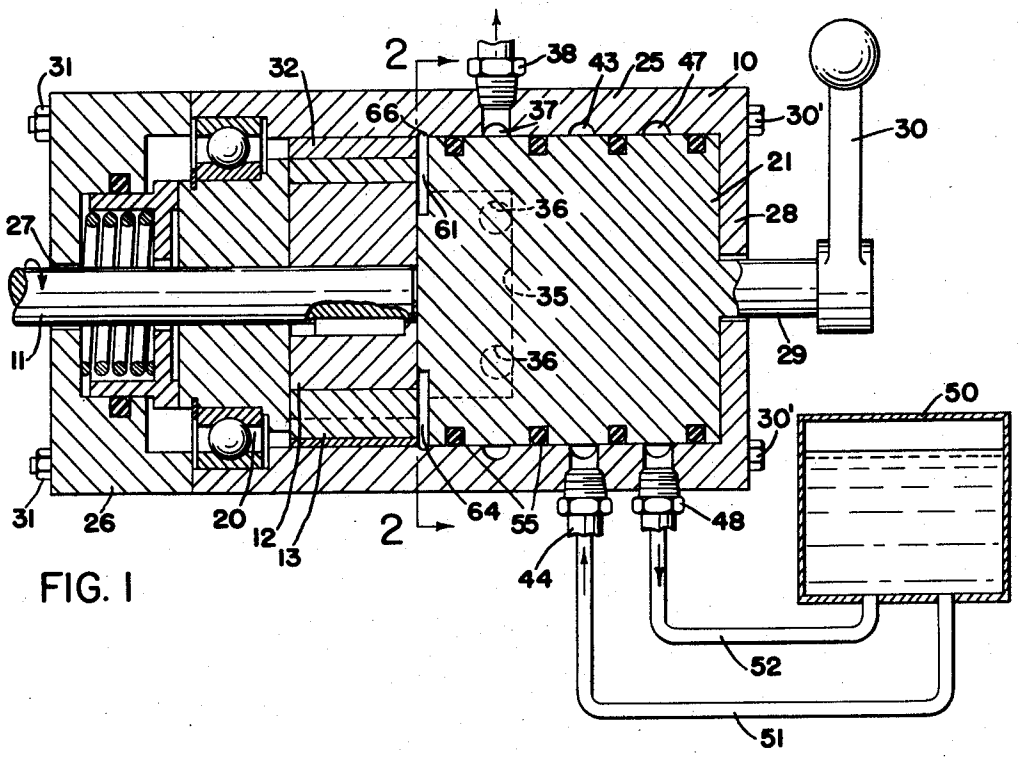


FIG. 1

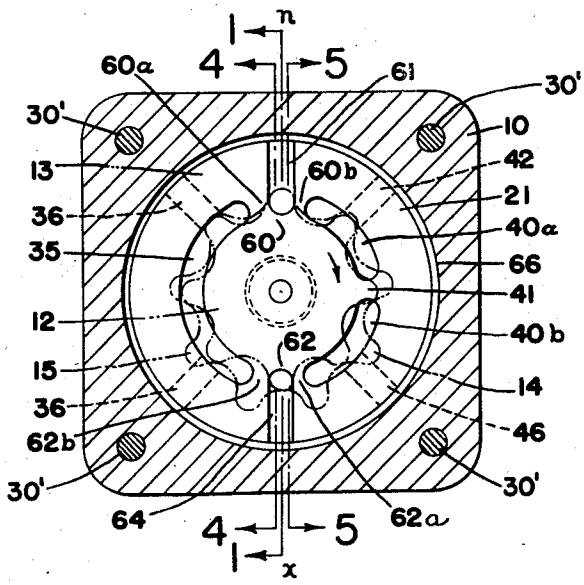


FIG. 2

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FIG. 4

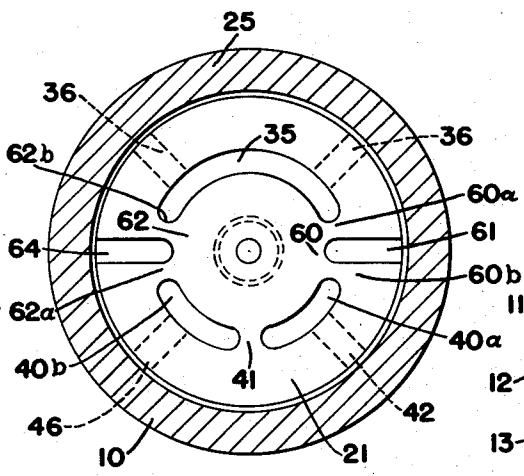
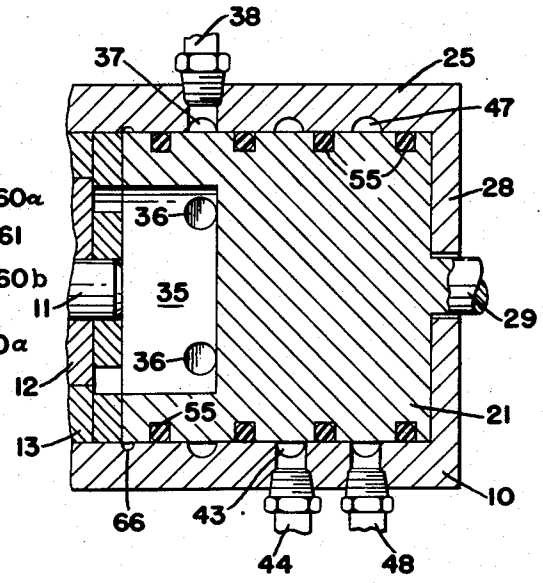


FIG. 3



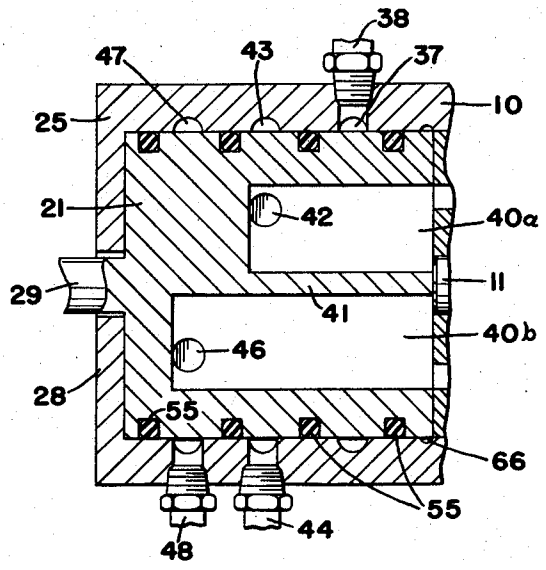


FIG. 5

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METHOD AND ARRANGEMENT FOR COOLING VARIABLE VOLUME HYDRAULIC PUMPS AT LOW VOLUMES

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4 Claims. (Cl. 103—120)

This invention pertains to the art of hydraulic pumps, and more particularly to an arrangement for cooling a variable volume pump when it is adjusted to deliver a small volume output.

The invention is particularly applicable to a hydraulic pump of the internal tooth gear type and will be described with particular reference thereto, although it will be appreciated that the invention is equally applicable to other types of pumps such as, without limitation, vane-type pumps or barrel-cylinder type pumps.

In the art of internal gear type hydraulic pumps, a pair of gears rotate on spaced axes to define a plurality of increasing and decreasing volume chambers. Inlet and outlet manifolds communicate alternately with pasasges from these chambers to receive therefrom and supply fluid thereto. Stops or lands separate the manifolds and seal the passages one from the other as they move from communication with one manifold to the other. It is known that if the position of the lands and the manifolds are rotated about the gears in relation to the points of minimum and maximum volume of the chambers that the outlet volume of the pump can be readily varied. Thus, if the lands are located respectively opposite the points of minimum and maximum volume, the pump will have full output. If the lands are rotated through an angle of 90° so that they are each opposite the chambers when they are at approximately one-half volume, then one-half of the decreasing volume chambers will be in communication with one-half of the increasing volume chambers through the inlet and outlet manifolds and the pump will have zero volume output. However, with such an arrangement, there is a considerable exchange of fluid from the decreasing volume chambers to the increasing volume chambers. If the pump is left in this zero volume position for a sufficiently long time, the fluid will excessively heat due to internal friction.

The present invention contemplates a variable volume hydraulic pump of the general type described which overcomes all the above-referred to difficulties and others, and enables the pump to operate for long periods of time at zero volume output without overheating.

In accordance with the present invention, a variable volume hydraulic pump is provided including a plurality of members defining a plurality of chambers which progressively increase and decrease in volume as the members rotate, inlet and outlet manifolds alternately in communication with the chambers, a pair of lands sealingly separating the inlet and outlet manifolds and adjustable relative to the points of minimum and maximum volume of said chambers so as to vary the output of the pump from maximum to zero volume, an auxiliary land adjustable with the other lands and separating the inlet manifold into two manifolds, and means intercommunicating both inlet manifolds and including heat-radiating surfaces whereby hydraulic fluid circulates through the means when the lands are adjusted to the zero volume output position and will be cooled thereby.

The principal object of the invention is the provision

of a new and improved hydraulic pump of the general type described which has provisions for cooling same when it is adjusted to the zero volume position.

Another object of the invention is the provision of a new and improved hydraulic pump in combination with a sump therefor, the pump having arrangements such that some of the fluid in the pump will be returned to the sump and back to the pump when the pump is adjusted to zero volume.

Still another object of the invention is the provision of a new and improved hydraulic pump in combination with a sump therefor wherein the pump has a plurality of conduits leading to the sump and is so arranged that when the pump is adjusted to zero output volume, some fluid is pumped from the pump to the sump and thence back to the pump, whereby the pump is continuously receiving a fresh supply of cooled fluid.

The invention may take physical form in a number of different appearing parts and arrangements of parts, a preferred embodiment of which will be described in detail in the specification and illustrated in the accompanying drawing which is a part hereof and wherein:

Figure 1 is a side cross-sectional view of a pump connected to an external sump illustrating a preferred embodiment of the invention, the pump being shown in the maximum volume position and the section being taken on approximately the line 1—1 of Figure 2.

Figure 2 is a cross-sectional view of Figure 1 taken approximately on the line 2—2 thereof with the bears being shown superimposed on the view in phantom relationship and the pump being adjusted to the maximum volume position,

Figure 3 is a view similar to Figure 2, but with the pump adjusted to the zero volume position,

Figure 4 is a cross-sectional view of Figure 2 taken approximately on line 4—4 thereof, and

Figure 5 is a cross-sectional view of Figure 2 taken approximately on line 5—5 thereof.

Referring now to the drawings, wherein the showings are for the purposes of illustrating a preferred embodiment of the invention only, and not for the purposes of limiting same, the various figures show a housing **10**, a drive shaft **11**, inner and outer members **12**, **13** respectively defining therebetween increasing and decreasing volume chambers **14**, **15** respectively, a sealing disc **20** mounted on the shaft **11** and a control plate or manifold member **21**, the adjustment of which will vary the output volume of the pump as will appear hereinafter.

The housing **10** may take a number of different forms, but in the embodiment shown is comprised of a central portion **25**, a left-end plate **26** having an opening **27** through which the shaft **11** extends, and a right-end plate **28** through which extends to the exterior of the housing a control shaft **29** formed integral with the control plate **21**. A handle **30** fixed to the shaft **29** enables the control plate to be rotated by a force applied externally to the housing. The members **25**, **26** and **28** all have abutting surfaces in sealing engagement to define an interior cavity in which the various members of the pump are positioned. Bolts **30'** and nuts **31** hold the members in assembled relationship.

The drive shaft **11** has mounted thereon in side-by-side relationship the sealing disc **20** and the inner member **12**, all of which rotate with the shaft.

The inner and outer member **12**, **13** may take a number of different forms, but in the embodiment shown are respectively externally and internally tooth gear members with the inner member having one or more less teeth than the outer member. The outer member is rotatably supported on an axis spaced from the axis of shaft **11** by an eccentric ring **32** mounted on the inside of the housing **10**. The eccentricity, the shape and dimensions

of the teeth are all so proportioned that one portion of each tooth is always in sliding, sealing contact with a portion of the tooth on the opposite member to define chambers sealed from each other circumferentially. Thus, as the shaft **11** rotates, the inner and outer members **12**, **13** also rotate to cause the chambers **14**, **15** to increase and decrease in volume. With this arrangement, the chambers will have a point of minimum volume indicated generally by the point *"n,"* and a point of maximum volume indicated by the point *"x"* defining a neutral axis. Assuming a clockwise direction of rotation, as viewed in Figure 2, the chambers just past the point *"n"* will be increasing in volume and are indicated by the reference character **14**, while the chambers which have just moved past the point *"x"* are decreasing in volume and are indicated by the reference character **15**. Obviously, if the direction of rotation were reversed, the situation would also be reversed. The sealing disc **20** bears against the left-hand side of the gears **12**, **13** and closes the chambers **14**, **15** on this end. The exact arrangement and mounting for the sealing disc **20** forms no part of the present invention and will, therefore not be described further herein. For a further more detailed description of the functioning of the sealing disc **20**, reference is made to my co-pending application, Serial No. 613,235, filed October 1, 1956. Suffice it to say, as described in that application, the sealing disc **20** is constantly urged towards the gears **12**, **13** by hydraulic pressure so as to be in sealing engagement with the sides of these gears. Also a ported plate to close the right hand end of the chambers **14**, **15**, as is taught in said application, may be employed.

The manifold block, or disc, **21** has formed therein an outlet manifold **35** generally arcuate in shape and spaced from the center of rotation a distance so as to be in communication with passages or openings from the chambers **14**, **15** as they rotate. The radial width of the manifold **35** is generally equal to one-half the maximum radial dimension of the chambers **14** and **15** at the point *"x."* The manifold **35** adjacent its base or right-hand end, communicates outwardly through the manifold block **21** through one or more radial holes or passages **36**, which passages **36** communicate at the outer end with a peripheral groove **37** formed on the inner surface of the cylindrical portion **25** of the housing **10**. This groove **37** in turn communicates with a passage **38** opening to the exterior of the housing **10** and forming the outlet or discharge pasage for the pump.

The manifold block **21** also has an inlet manifold similar in arcuate extent and radial dimension to the outlet manifold **35**, which inlet manifold in accordance with the present invention, is divided into two inlet manifolds **40***a* and **40***b* separated by a wall or auxiliary land **41**. The inlet manifold **40***a* has a passage **42** opening radially outwardly through the manifold block **21** and communicates at its outer end with a groove **43** formed in the inner surface of the cylindrical portion **25**. A passage **44** extends radially outwardly through the housing **10** from the passage **43** and provides an inlet passage for the pump.

In a like manner, the inlet manifold **40***b* extends somewhat further into the manifold block **21** and has an opening **46** at its base extending radially outwardly to communicate with a circumferential groove **47** formed in the surface of the portion **25**. A passage **48** communicates with the groove **47** externally of the housing. The passage **44** is communicated with a sump **50** by means of a fluid conduit **51** and the passage **48** is communicated with a sump **50** through a passage **52**. Preferably, but not necessarily, the conduit **51**, **52** communicate with the sump at the bottom thereof.

O-rings **55** axially spaced along the external surface of the manifold block **21** seal the grooves **37**, **43** and **47** one from the other.

The outlet manifold **35** and the inlet manifold **40***a* are separated from each other by a land **60**, in effect, divided into two auxiliary stops **60***a* and **60***b* by a trapping port **61** in the form of a groove extending inwardly from the outer edge of the manifold housing **21**. The opposite end of the outlet manifold **35** is separated from the inlet manifold **40***b* by a stop **62**, in effect, divided into two auxiliary stops **62***a* and **62***b* by a trapping port **64** also in the form of a groove in the left-hand surface of the manifold housing **21**, and extending radially to the outer surface thereof. The inner edge of the groove **61**, **64** correspond generally with the inner surfaces of the inlet and outlet manifolds **35**, **40***a* and **40***b*.

The circumferential width of each auxiliary land **60***a*, **60***b*, **62***a* and **62***b* is preferably approximately equal to the circumferential width of each chamber **14**, **15**, and in a like manner, the circumferential width of the trapping port **61**, **64** is preferably approximately equal to the circumferential width of the chambers **14**, **15**.

For a more detailed construction of the lands **60***a*, **60***b*, **62***a* and **62***b* and the trapping ports **61** and **64**, reference is made to my co-pending application, Serial No. 548,022. The particular dimensions of these lands and ports form no part of the present invention except insofar as they must seal the inlet and outlet manifolds one from the other. The outer edges of the trapping ports **61**, **64** are intercommunicated by a groove **66** formed in the inner surface of the member **25**.

The wall, or partition, **41** serves as an auxiliary land and is a particular contribution of the invention of this application. This land **41**, in effect, divides the inlet manifold into two separate manifolds sealed one from the other, but in communication with each other through the sump.

In operation, and in the position shown in Figure 2, the gears **12**, **13** rotate with the shaft **11** and the chambers located opposite the inlet manifold **40***a*, **40***b* increase in volume and thus suck fluid in from the manifolds. After the chambers pass the land **62**, they decrease in volume and discharge fluid into the outlet manifold **35**. With the manifold housing **21** in the position shown in Figure 2, the pump will have full discharge volume. The inlet manifolds **40***a* and **40***b* are each supplied from the sump, that is to say, fluid flows from the sump through both conduits **51** and **52**.

If it is desired to adjust the pump to zero output volume while the shaft **11** continues to rotate, the manifold member **21** is rotated through an angle of 90°. The lands **60**, **62** are thus both located midway between the points *"n," "x."* Figure 3 shows the manifold mem-**21** adjusted to this position. Obviously, the member could be adjusted 180° from that shown.

With the adjustment as shown in Figure 3, the fluid flowing from the upper half of the decreasing volume chambers will flow into the outlet manifolds **35** through this manifold into the upper half of the increasing volume chambers. There will be no discharge as the rate of increasing volume is exactly equal to the rate of decreasing volume.

The lower half of the decreasing volume chambers will, however, discharge fluid into the inlet manifold **40***b* and this fluid is prevented from communicating with the lower half of the increasing volume chambers by the auxiliary land **41**. This fluid instead flows outwardly through the conduit **52** to the sump **50**. In a like manner, the lower half of the increasing volume chambers will create a suction and draws an equal amount of fluid from the sump **50** through the conduit **51**.

It will be appreciated that the conduits **51** and **52**, and the sump **50** all have a substantial surface exposed to the air and any heat generated by friction in the hydraulic fluid can be readily dissipated by this radiation. In effect, they form means for radiating heat. Obviously, other forms of heat radiating means can be employed for the fluid flowing between the two inlet manifolds.

With the arrangement shown, it will be appreciated that only the fluid in the lower half of the pump is actually

being cooled. The fluid in the upper half continues to recirculate and can be cooled. The fluid in the upper half continues to recirculate and can be heated. However, this heat is conducted to the rotating gears **12, 13** and, in turn, is conducted to the hydraulic fluid being circulated through the sump **50.**

It will thus be seen that an embodiment of the invention has been described wherein the output volume may be varied from full volume to zero volume by positioning the lands of the pump relative to the increasing and decreasing volume chambers. As pointed out, the positioning of these lands effects a recirculation of the fluid within the pump itself.

It will also be seen that an arrangement has been provided whereby some of the fluid being pumped will be circulated externally of the pump to external cooling means and thence back into the pump whereby the dangers of the pump overheating when it is adjusted to zero volume can be entirely obviated.

It is believed that I am the first to ever have provided a variable volume hydraulic pump wherein the output volume may be maintained at zero while the pump is continuing to operate and yet the dangers of overheating of the pump when adjusted to this position are entirely prevented.

The invention has been described with reference to an internal gear-type pump. The invention is obviously applicable to vane-type pumps, rotating-cylinder type pumps wherein the pistons reciprocate on elements of the cylinder, or the like.

The invention has been described with reference to a preferred embodiment. Obviously, modifications and alterations will occur to others upon a reading and understanding of this specification, which modifications and alterations differ materially in appearance from the preferred embodiment described. It is my intention to include all such modifications and alterations insofar as they come within the scope of the appended claims.

In the embodiment shown, the chambers open directly into the manifolds and the lands must have a line of movement width equal to, or greater than, the maximum circumferential or line of movement width of each chamber so as to prevent communication from one manifold to another through a chamber and around a land. Obviously, a ported plate such as described in my co-pending application, Serial No. 613,235, could be employed with the desirable results thereof, as set forth in that application.

Such a plate provides a specific passage between the chambers of the manifolds. In the absence of a plate, the end of the chamber adjacent the manifold may be considered a passage.

Having thus described my invention, I claim:

1. A variable volume hydraulic pump comprised of a plurality of members movable relatively to each other and defining a plurality of pumping chambers revolving in a fixed closed path of movement, said chambers gradually increasing in volume after they pass a fixed point of minimum volume on said path of movement until they

reach a fixed point of maximum volume on said path of movement and then gradually decreasing in volume until they reach said fixed point of minimum volume; means defining an arcuate inlet and an arcuate outlet manifold including a pair of lands one at each arcuate end of said manifolds and sealingly separating said manifolds one from the other, said manifolds having approximately the same arcuate length, an opening for each chamber revolving therewith, each of said openings moving past said lands to alternately communicate its associated chamber with either said inlet or said outlet manifold, both of said lands being adjustable in the path of movement of said chambers so as to change the point in the path of movement in which each opening moves past each land and shifts communication of its chamber from one of the manifolds to the other whereby the output volume of the pump may be varied; the improvement which comprises, a third land sealingly separating said inlet manifold into a pair of minor inlet manifolds, said openings also moving past said third land to shift the communication of its associated chamber from one of said minor inlet manifolds to the other of said minor inlet manifolds, a passage from each of said minor manifolds and means externally of said pump for inter-communicating both of said passages whereby when said lands are adjusted to a position where the pump has zero volume output, hydraulic fluid flows through said external communicating means and dissipates heat generated in said fluid.

2. Improvement of claim 1 wherein said means include surfaces which can radiate heat.

3. The improvement of claim 1 wherein said means include a sump and separate conduits connecting each of said passages to said sump.

4. The improvement of claim 1 wherein said means include conduits external to said pump for inter-communicating said passages, said means including heat radiating surfaces.

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