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3,129,668

VARIABLE CAPACITY FLUID PUMP

Filed Dec. 19, 1960

2 Sheets-Sheet 1

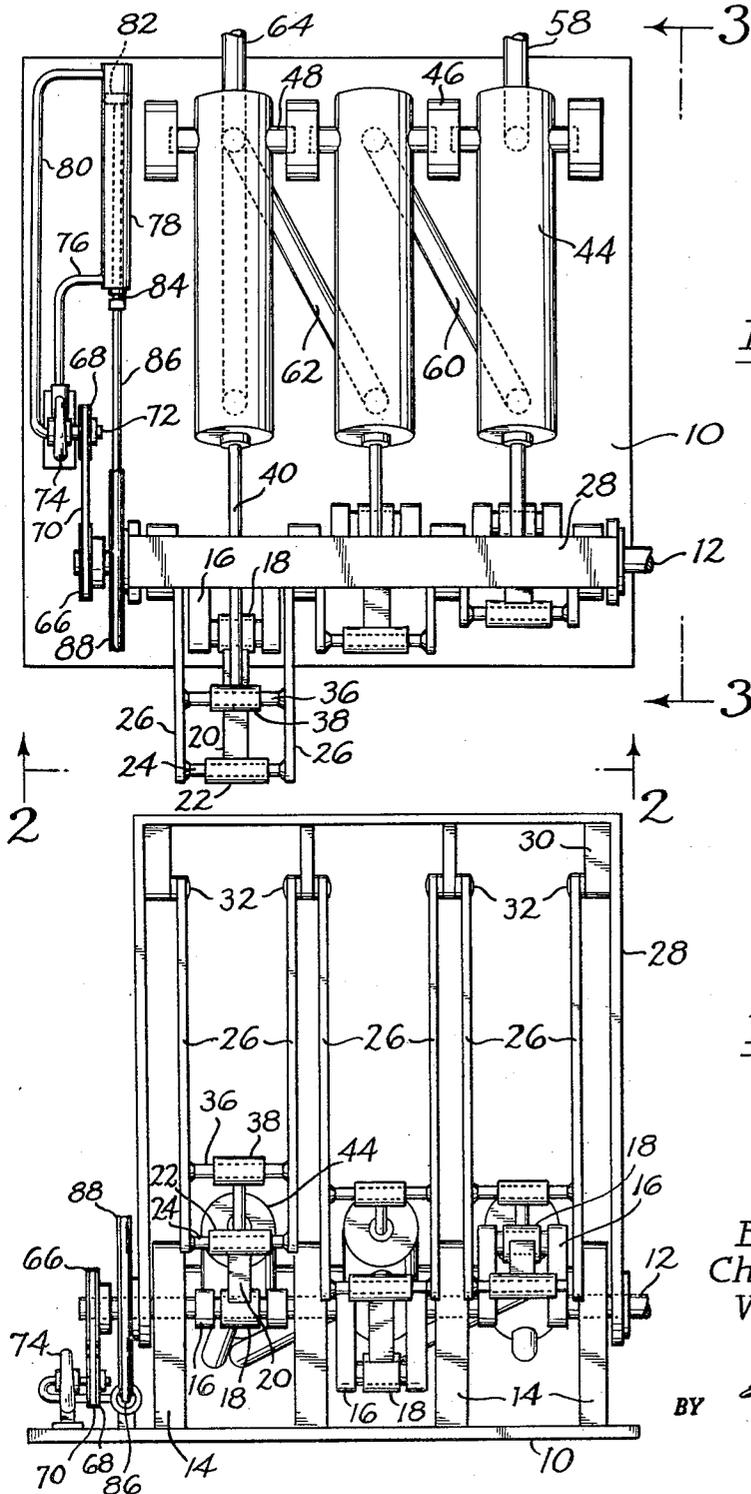


Fig. 1.

Fig. 2.

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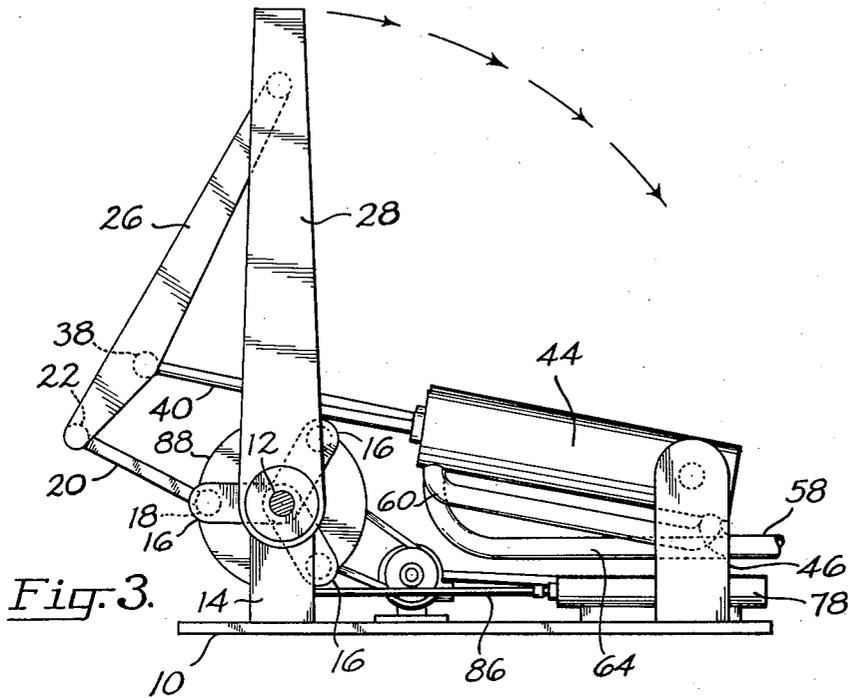


Fig. 3.

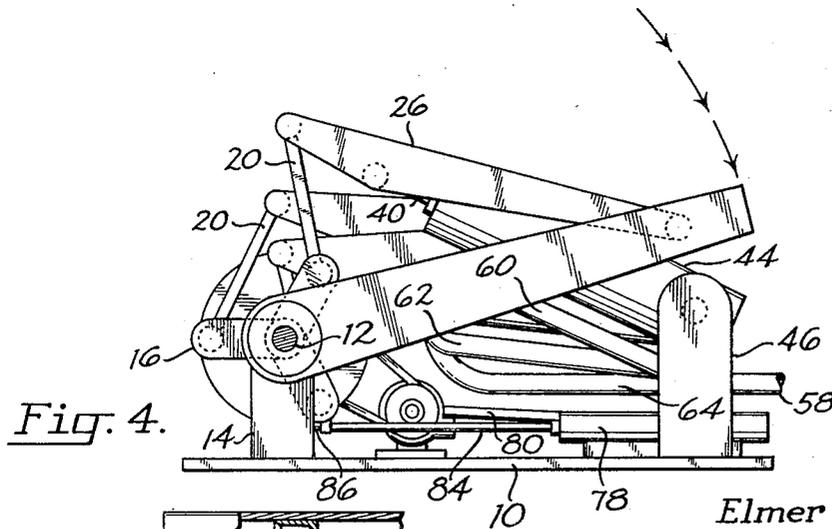


Fig. 4.

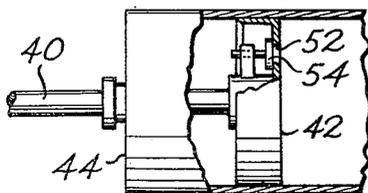


Fig. 5.

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VARIABLE CAPACITY FLUID PUMP

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3 Claims. (Cl. 103—38)

This invention relates to a variable capacity fluid pump mechanism and more particularly relates to a fluid pump for transmitting power from a drive shaft to a fluid operated motor for operating the motor at different speed and drive ratios.

A general object of the present invention is to provide a pump of the type described which is efficient in operation for transmitting power in driving ratios dependent upon load requirements, and more particularly to provide a fluid pump in which the entire input power from a driving member is applied to a driven member in automatically changing ratios dependent upon load requirements.

Another object is to provide a pump employing a plurality of series connected fluid pump elements and reciprocating linkage means for operating the pump elements sequentially at equally spaced intervals for accomplishing a smooth power output.

Another object is to provide a pump employing novel control means.

A further object is to provide a pump of the type described which operates to prevent overloading of a power unit by automatically selecting a proper ratio pump function.

A further object is to provide a pump which is light in weight and is substantially trouble free in operation.

Briefly stated, the pump of the present invention is operated by a crank shaft adapted to impart oscillating motion to a plurality of levers carried on a pivotally mounted carrier frame. The levers are connected to piston pump elements and are adapted upon rotation of the crank shaft to operate such pump elements and produce a fluid driving force. The pump elements are connected in series and operate together to produce a smooth driving function. As will be seen more fully hereinafter operation and control of the pump is accomplished by speed responsive pump means.

The invention will be better understood and other objects thereof will become apparent from the accompanying specification and claims considered together with the accompanying drawings, wherein like numerals of reference indicate like parts, and wherein:

FIG. 1 is a top plan view of the present pump mechanism;

FIG. 2 is an end elevational view of the pump taken on the line 2—2 of FIG. 1;

FIG. 3 is a side elevational view of the pump taken on the line 3—3 of FIG. 1 and showing one position of operation of the pivotally mounted carrier frame;

FIG. 4 is a view similar to FIG. 3 but showing another position of the carrier frame; and

FIG. 5 is a fragmentary elevational view partly broken away showing piston structure for the pump elements.

In its preferred form, the invention is embodied in a variable capacity fluid pump which is intended to take the place of clutch operated sliding gear transmissions. The present pump may have general application where a ratio connection is desired between drive and driven means and finds particular application in equipment such as Caterpillar tractors. This pump may be employed, and is described herein, as a drive connection between the power unit and the track wheels of a tractor for driving the latter, but of course the pump may be used with fa-

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cility for the operation of other power operated elements such as the bulldozer blade.

Referring now in particular to the drawings, the numeral 10 designates a base for supporting the present pump and may comprise a part of the vehicle to be driven or a plate attached thereto. The pump is operated by a crank shaft 12 suitably journaled in end support standards 14.

Shaft 12 is shown in the present embodiment as having three crank or offset portions 16, although it is to be understood that a greater number of such crank portions may be utilized depending upon the number of pump elements desired to be driven. With the use of three elements in the pump the crank portions 16 are disposed at 120 degree intervals around the crank shaft so that upon rotation of the latter uniformly timed driving thrusts are produced. Rotatably supported on the crank portions 16 are sleeves 18 comprising an integral part of links 20. These links also have integral sleeves 22 at their opposite ends which are rotatably supported on cross pins or shafts 24.

Pins 24 are secured to pairs of lever arms 26 pivotally connected to a U-shaped carrier frame 28 by means of suitable inwardly projecting lugs 30 and pivot pins 32 engageable with the lever arms and the lugs. Carrier frame 28 is in turn pivotally supported on the crank shaft 12 by suitable bearings.

Each pair of lever arms 26 carries therebetween an integral pin 36 on which is rotatably supported sleeve members 38 forming an integral part of piston rods 40. Piston rods 40 terminate in piston heads 42 operable in cylinders 44. Each of the cylinders 44 is pivotally supported at its rearward end on upright support means 46 by pairs of lateral stub shafts 48. By the arrangement provided, the cylinders are capable of vertical pivotal movement for operation of the piston rods 40 therein at different angular positions.

Piston heads 42, FIG. 5, are equipped with suitable ports 52 and valves 54 which permit one-way pumping of said piston heads. The arrangement is such that the outwardly moving or pulled stroke of the piston head comprises its working stroke. It is desirable that a plurality of valves 52 be provided in the piston heads in order to permit free flow of the fluid in the return movement of the piston heads to prevent frictional heat from developing therein.

Cylinders 44 are fluid connected in series to produce a common fluid flow. Such series connection comprises a conduit 58 communicating with a fluid supply tank, not shown, leading into the rearward end of one of the end cylinders 44. A conduit 60 leads from the forward end of this cylinder to the rearward end of the next or middle cylinder, and a conduit 62 leads from the forward end of the middle cylinder to the rearward end of the remaining cylinder. A conduit 64 leads from the forward end of the last mentioned cylinder to the means to be driven such as a hydraulic motor which as stated before may be used for driving the tractor or any movable working unit thereon.

Since the crank portions 16 of the crank shaft 12 are disposed 120 degrees apart around the shaft it will be apparent that upon rotation of the latter to produce oscillating movement of the links 20 and levers 26 and reciprocating movement of piston rods 40, the latter will be operated in sequence and the pump will produce a substantially smooth fluid flow, and consequent smooth operation of the driven unit.

Keyed to one end of the drive shaft 12 is a pulley 66 driving a second pulley 68 through the medium of a belt 70. Pulley 68 is keyed to a shaft 72 of a pump 74 having a fluid pressure line 76 leading into the forward end

of a fluid cylinder 78 and having a return line 80 leading into the rearward end of the cylinder 78. Cylinder 73 encloses a piston head 82 having a piston rod 84 connected to a flexible link 86 which in turn is attached to and partially wrapped around a pulley 88. Pulley 88 forms an integral part of the carrier frame 28 whereby upon rotation of the pulley the carrier pivots therewith.

Pump 74 is a slippage type pump but is adapted to develop considerable pressure at increased speeds. That is, it may be an impeller type pump, whereby at slow speeds it develops little or no pressure, but as the speed is increased, the pressure developed therein also increases.

Thus, at slow speeds little or no pressure is applied against piston head 82 and therefore pivotal positioning of the carrier frame 28 is not influenced by operation of the pump. However, as the speed of crankshaft 12 increases pressure builds up in the pump to urge the piston head 82 rearwardly and thus rotate the pulley 88 counterclockwise, as viewed in FIG. 3, by means of flexible link 86. Such rotation of the pulley 88 pivots the carrier frame 28, in a counterclockwise direction, in a function of operation now to be described.

Operation

Upon starting the vehicle engine and operation of the crank shaft 12 at idling speed, it will be apparent that there will be a slight load resistance on the operation of the piston heads in cylinders 44 whereby the thrust of the links 20 on the lower ends of levers 26 will tend to pivot the carrier 28 clockwise in the direction of the arrows in FIG. 3. In the idling speeds of the engine, therefore, the carrier 28 is held in a position approaching that of horizontal, such a position of the parts being shown in FIG. 4.

In such FIG. 4 position, the levers 26 are almost parallel with the cylinders 44 and the oscillating movement of the one end of the levers 26 caused by oscillating of links 20, will cause merely a combined up and down movement of such levers and cylinders whereby there will be no appreciable movement of the piston heads relative to the cylinders. Therefore, no effective fluid driving thrust is produced by the cylinders 44.

Upon increasing the speed of the crank shaft 12 there will of course be, because of the initial force necessary to produce motion and to accelerate the driven parts, a resistance to the operation of the pistons 42 in the cylinders, and the carrier 28 will therefore tend to remain in its lying down position. However, with the increased speed of the drive shaft 12, pressure is increased in the pump 74 and the cylinder 73 to move the piston head 82 rearwardly and pull on the link 86 and thus pivot the carrier frame upwardly by means of pulley 88. Such upward movement of the carrier 28 in turn carries the levers 26 therewith and pivots them on their pins 36 to increase the angle between the levers and the piston rods, and it will be apparent that as such angle increases the stroke length of the piston rods increases.

Therefore, as the initial load is overcome and with the drive shaft operating at a constant speed, less load resistance is present in the cylinders and the pressure of the pump 74 causes the carrier 28 to move upwardly. As the load lessens, as when the tractor nears running speed, the pressure of pump 74 is sufficient to pivot the carrier to its vertical position whereby the stroke length of the pistons is at maximum and the driving ratio may be equivalent to that of a one-to-one gear ratio.

When the load increases, as when the tractor encounters a grade or is working with its blade, the load resistance in the cylinders 44 also increases and the thrust of the links 20 tends to rotate the carrier 28 clockwise. Any such clockwise rotation of the carrier decreases the stroke length of the piston rods 40 and thus produces a higher drive ratio and consequently greater power. Thus, the carrier moves automatically to establish the most efficient ratio drive as regards the requirements of the load.

The operation of the device is of course dependent upon the speed of operation of drive shaft 12 as well as the efficiency of the pump 74. Such factors are readily determined empirically for the accomplishment of the best operation of the unit. For such purpose, the vehicle engine may be equipped with a governor to maintain a constant engine speed.

It thus will be apparent that the present pump will shift automatically to the ratio drive for overcoming the load at constant engine speed. In operation, the carrier frame will move between its upright position which causes the pump to accomplish greater speed at lessened torque and lowered positions which result in progressively greater torque at lessened speed.

If the load should suddenly become insurmountable, the driving thrust imparted by links 20 against the lower end of levers 26 will cause the carrier 28 immediately to swing to its inoperative, FIG. 4 position. Thus, damage to the vehicle or working parts is avoided.

In accordance with the present invention there is thus provided a variable capacity pump which is automatic in operation and shifts to a preferred drive ratio for the load encountered. Such accomplishes maximum work without overloading the power unit of the vehicle. The mechanism, due to the multiple pump arrangement, produces a smooth power output, and is also light in weight and of simplified structure.

It is to be understood that the form of our invention herein shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of our invention or the scope of the subjoined claims.

Having thus described our invention, we claim:

1. A variable capacity pump comprising, a plurality of pivotally supported fluid cylinders fluid connected in series, piston means operative in each of the cylinders for producing a pumping function, a piston rod extending from each piston, a crank shaft, a plurality of lever means one connected pivotally to each piston rod, link means pivotally connecting each lever means to the crank shaft, each lever means being driven in oscillating motion by the crank shaft to operate the piston rods reciprocally in the cylinders, a rotatable carrier, means pivotally interconnecting the carrier and said plurality of lever means, and means operatively connected to the carrier for rotating the latter to pivot the lever means and the fluid cylinders selectively and adjust the angular relation between the piston rods and the lever means whereby to change the stroke length of the piston rods and vary the volume of fluid delivered by the cylinders at a constant speed of the drive shaft.

2. The pump of claim 1 wherein the means for rotating the carrier comprises drive means having a rotary input shaft connected to the crank shaft for rotation thereby, and a movable output shaft connected to the carrier.

3. The pump of claim 1 wherein the means for rotating the carrier comprises a rotary impeller type fluid pump having an input shaft connected to the crank shaft, a reciprocating extensible fluid motor connected to the carrier, and conduit means interconnecting said pump and motor for operating the reciprocating motor by the impeller pump.

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