HYDRAULIC SPRING DRIVE APPARATUS

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Appl. No.: 12/299,368
PCT Filed: Feb. 6, 2008
PCT No.: PCT/US2008/53195
§ 371 (c)(1), (2), (4) Date: Nov. 3, 2008

Publication Classification

Int. Cl.
F01L 9/02 (2006.01)
F01L 1/04 (2006.01)
F01L 1/10 (2006.01)
F01L 1/18 (2006.01)

U.S. Cl. ................. 123/90.12; 123/90.6; 123/90.39

ABSTRACT

Hydraulic spring drive apparatus comprising: a rotatable cam shaft having fixed thereon a number of cams; a number of rocker arms, one following each cam, each pivotally attached at one end to a pressure bar and at another to an expansible, compressible connecting means in turn connected to a crank portion of a crank shaft. The cams, crank shaft, and expansible compressible connecting means are arranged so that a number of connecting means expand against the compression of one connecting means. The pressure bar is movable to position the rocker arms for a selected degree of connecting means compression.
HYDRAULIC SPRING DRIVE APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application No. 60/899,924 filed on Feb. 6, 2007, the contents of which are incorporated herein fully by reference.

FIELD OF THE INVENTION

[0002] The present invention is related to the field of motors and more specifically, a hydraulically driven spring drive motor.

SUMMARY OF THE INVENTION

[0003] According to the present invention, a hydraulic spring drive apparatus is provided whereby independent spring force for rotation is continuously delivered by a number of expandable, compressible connecting means operating so that at any given time, more connecting means are expanding than are being compressed.

[0004] As embodied in a presently preferred apparatus, a rotatable cam shaft has axially spaced along its length a number of cams fixed to the shaft for rotation therewith. Each cam has an edge varying in distance from a center of rotation of the cam between a maximum distance and minimum distance. A number of rocker arms, one following each cam, are pivotally attached, in a predetermined position, to the apparatus at one end and support at an opposite end expandable, compressible connecting means. A crank shaft having an eccentric crank portion for connection with each connecting means is rotateably driven by rotation of the cam shaft and reciprocal movement of the connecting means. Each cam is shaped so that the maximum distance at its edge extends through a minor portion (about 90°) of its 360° rotation and the minimum distance extends through a larger portion (about 135°) of rotation with a sharp rise from minimum to maximum distance and a gradual decline from maximum to minimum distance as the cam rotates. The arrangement at the edge of the cams provides compression of one connecting means opposed to expansion of a plurality of other connecting means. A hydraulic pump may be connected to the cam shaft for rotation with the cam shaft to aid in the operation of a throttle system. The throttle system may be used to control the rest position of the rocker arms by displacing a pressure bar connected to a rocker arm riding on each cam. Adjustment of the rocker arm controls the degree of compression and expansion of each connecting means.

DESCRIPTION OF THE DRAWING

[0005] FIG. 1 is a side sectional view of an apparatus of the present invention with portions removed for clarity.

[0006] FIG. 2 is an end view of the apparatus of FIG. 1, with portions removed for clarity.

[0007] FIG. 3 is a sectional view of the power unit assembly shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0008] Referring now to FIGS. 1 and 2, the present apparatus is contained in a rectangular housing 4 which supports a crank shaft 6, a cam shaft 8, and a rocker arm assembly 10. A hydraulic pump 12 and throttle assembly 14 are mounted on the housing.

[0009] The crank shaft 6 is mounted axially through an upper portion of the housing 4 through forward bearing 16 and rearward bearing 18 and comprises equally axially spaced eccentric crank portions 20 for each cam and connecting means, there being eight in the presently preferred embodiment. Each crank portion 20 comprises a pair of axially offset members and a cross piece 22 which rotates in a circle of a given diameter Dr about the axis of rotation 24 of the crank shaft.

[0010] The cam shaft 8 is supported on a forward bearing 26 and a rearward bearing 28 and supports eight cams 30 in equally axially spaced relationship along its length, one opposite each crank portion 20. The cam shaft terminates forwardly in a pulley wheel 32 and rearwardly in a flywheel 34. The cam shaft may be journaled to support engagement with the plurality of cams for rotation therewith.

[0011] The cams 30 are mounted in circumferentially offset relationship to each other so that each succeeding cam is offset from its rearwardly adjacent cam by 360° divided by the number of cams, or 45°. Similarly, each crank portion 20 is offset from its rearwardly adjacent crank portion by 45° so that, as shown in FIG. 2, a cam denominated 180 will be oppositely connected to a crank portion having its 180 portion engaging a rocker arm. A cam advanced 45° in the direction of arrow 36 is oppositely connected to a crank portion 225, and so forth. A timing gear 38 engages gears 40, 42 on the crank shaft and cam shaft, respectively, to maintain thecams and crank portion in the above-described predetermined relationship.

[0012] Each cam 30 is of the same modified disk shape having modified edge surface 41 as shown in FIG. 2. Each cam may be divided into eight sectors, 0-360. The edge surface of sectors comprising angles 135-225 are at a minimum distance from the axis 44 of rotation of the cams. Sectors 270 and 225 comprises a rate of 90° and the edge 41 of cam 30, is curved slightly outwardly. From 270° the edge continues at a maximum distance from axis to sector 0, along which it describes a circle of a diameter approximately Dr. From sector 0, the cam gradually returns to a minimum distance in the vicinity of sector 90.

[0013] With reference to FIG. 2, the rocker arm assembly 10 comprises an axially elongated pressure bar 46 supported through three axially spaced, upwardly extending rod portions 48-52 (FIG. 2). The rod portions 48, 50, 52 are slidably fitted into tube portions 49, 51, 53 in the housing 4. Eight rocker arms 54 are pivotally connected to the pressure bar 46 to extend generally horizontally laterally to move in parallel pivotal directions as shown by arrow 56. Each rocker arm 54 moves in cooperation with a cam 30 operational engaged with the cam, and are connected to a power rod assembly 58. Each rocker arm 54 is of the same shape and may comprise a lower surface having a curved projection 60 which rides on the cam 30 and follows the cam through the edge variations described above. The outward portion 61 of the rocker arm is curved slightly downwardly so that the power rod assembly 58 joins the rocker arm at a portion thereof which is downwardly offset from the projection 60. A cavity portion 62 extends through the outward portion 61 of the rocker arm 54 to slidably receive a shaft 64 of the power rod assembly 58. A pin 66 pivotally supports and driveably engages a spring cup pivot 68 of the power rod assembly.
The power rod assembly 58 transmits reciprocal movement of its associated rocker arm 54 to a corresponding crank portion 22 (FIG. 1) of the crank shaft 20 and supplements this motion through expansion of a spring member 72.

Turning to FIG. 3, each power unit assembly 58 comprises an upper nose piece 70, a coil spring 72, the shaft 64, and a spring cup pivot 68. The upper nose piece 70 is rotatably fixed to its associated cross piece 22 on the crank shaft 20 and terminates downwardly in rim portion comprising a spring receiving aperture 69 and a coil connecting rod aperture 71 to receive connecting rods 73. The coil spring 72 surrounds the shaft 64 and downwardly engages the spring cup 68. The shaft 64 is fixed to the nose piece 70 and extends to the spring cup 68 supported on the rocker arm 54. The spring cup 68 is pivotally supported on an upper surface of the rocker arm 54 and comprises an aperture to receive a lower coil of the coil spring 72. The power unit assembly 58 thus provides compressible, expansible connecting means translating the reciprocal pivotal movement of the rocker arm 54 brought about by the cam 30 into rotation of the crank shaft 20 accompanied by compression and expansion of the coil 72. Compression and expansion of the coil spring 72 takes place as the spring cup 68 rides on the rocker arm 54 and slides along the shaft 64 towards the nose piece 70.

The relationship between the various crank portions, cams, and springs is shown in the following table:

<table>
<thead>
<tr>
<th>Composition</th>
<th>Crank Shaft</th>
<th>Cam</th>
<th>Spring Tension</th>
<th>Connecting Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Farthest</td>
<td>Maximum</td>
<td>Idle</td>
<td>1</td>
</tr>
<tr>
<td>180</td>
<td>Farthest</td>
<td>Intermediate</td>
<td>Idle</td>
<td>2</td>
</tr>
<tr>
<td>270</td>
<td>Closest</td>
<td>0</td>
<td>Compressed</td>
<td>3</td>
</tr>
<tr>
<td>360</td>
<td>Farthest</td>
<td>Idle</td>
<td>Compressed</td>
<td>4</td>
</tr>
<tr>
<td>315</td>
<td>Closest</td>
<td>Minimum</td>
<td>5/6 Compressed</td>
<td>5</td>
</tr>
<tr>
<td>135</td>
<td>Farthest</td>
<td>Intermediate</td>
<td>Idle</td>
<td>6</td>
</tr>
<tr>
<td>45</td>
<td>0</td>
<td>Maximum</td>
<td>Idle</td>
<td>7</td>
</tr>
<tr>
<td>225</td>
<td>0</td>
<td>0</td>
<td>50% Compressed</td>
<td>8</td>
</tr>
</tbody>
</table>

The above crank shaft positions are those which each individual crank portion goes through during a complete revolution and also those of each member at a given moment.

Returning to FIG. 1, the hydraulic a pump 12 is used to assist the throttle assembly 14. The throttle assembly 14 comprises two hydraulic fluid reservoirs, a power assist reservoir 80 and a master reservoir 82. The master reservoir 82 is the main reservoir and controls the amount of hydraulic pressure from pump 78 delivered through lines 84 to the tube portions 49, 51 and 53 of the rocker arm assembly 58. A source of electric energy 74 controlled by a switch 76 drives an electric pump 78 which develops pressure in the master reservoir. 82. Pressure in the tube portions 49, 51 and 53 forces the rocker arm rods 48, 50 and 52 downward, pivoting the rest position of the rocker arms toward the crank shaft 20. Springs 86 in each tube 49, 51 and 53 help to force the rods 48, 50 and 52 downward to a rest position. Pressure in the tubes 49, 51 and 53 is increased through a sliding piston 87 in the master reservoir 82. The force from the pump 78 initiates and facilitates movement of the piston 87 to decrease reservoir area and increase pressure in the tubes 49, 51 and 53. The piston 87 is reciprocally movable through a shaft 88 connected to a second piston 90 in the power assist reservoir 80. The second piston 90 also moves forward to displace the first piston 87 to increase pressure in the tubes 49, 51 and 53. Pressure from the hydraulic pump 12 is delivered through lines 92, 94 to a first chamber portion 96 of the power assist reservoir 80 and a second chamber portion 98, containing the piston 90, of the power assist reservoir. Flow through the first chamber portion is controlled by a sliding plate 102. The sliding plate 102 is connected to a piston 104 in the first chamber portion 96 and controlled by a rod 106. Movement of rod 106 increases pressurized fluid flow to the second chamber portion 98 to move the piston 90 forward. The pump 12 is driven by a belt 108 from the cam shaft 8 so that increased motor rpm provides increased pressure for moving the pressure bar. The amount of this pressure delivered to the piston 90 is controlled by the plate 102. For maximum power output from the present apparatus, increased pressure is delivered to the pressure bar as cam shaft rpm increases. This pressure may be throttled back by movement of the plate 104 to cut off pressure to the piston 90.

The present apparatus may further comprise an oiling system. An oil hose 112 is connected to each one of the connecting shafts 64. Each shaft 64 has an oil channel running through the center of the shaft full length to two holes 114, 116, at the top of the nose piece 70. The hose 112 which is attached to the end of the connecting shaft 64 is also connected to a main oil line that is connected to an oil pump 118 driven by the cam shaft 8 through the use of a gear.

When oil is pumped up through the connecting shaft it oils bearings on each one of the crank shaft throws. It also oils and keeps the coil springs from getting hot and losing their tension. This is done by forcing the oil out through the two oil holes 114, 116 at the top of the nose piece 70 into a reservoir. This reservoir is created by the use of a rubber shelf in the nose piece 70 that is clipped to the nose piece of the connecting rod and also clipped to a conventional spring cup and by forming a reservoir.

The rubber shelf has holes in it about 1/2 of the way up from the bottom of the shelf, allowing the oil to be forced out when the coil spring is being compressed and by doing this it stops the rubber shelf from ballooning. On the power stroke the cooled oil is forced back into the reservoir because the coil spring is being expanded allowing the oil to fill up the reservoir and cooling off the coil spring. The main bearings are oiled similarly. There are oil ports drilled in each one of the supports and an oil hose is connected to each one.

Various modifications can be made in the design and operation of the present invention without departing from the spirit thereof. Thus, while the principal preferred construction and modes of operation of the invention have been explained in what is now considered to represent its best embodiments, which have been illustrated and described, it should be understood that the invention may be practiced otherwise than as specifically illustrated and described.

What is claimed is:

1. An energy efficient motor system comprising:
   a rotatable cam shaft;
   a plurality of cam members axially spaced along a length of the cam shaft and fixed to the cam shaft for rotation therewith;
   wherein each of the cam members comprises an edge varying in distance from a center of rotation of the cam member between a maximum distance and a minimum distance;
   a plurality of rocker arms, one following each of said cams, pivotally attached at a first end to a hydraulic energy
input and connected at a second end to an expandable, compressible power unit assembly; and a crank shaft having a crank portion for connection with each power unit assembly, rotatably drivable application of a force on the first and of at least one rocker arm by rotation of said cam shaft and reciprocal movement of said power unit assembly.

2. The motor system of claim 1 wherein said edge of each cam member is at a maximum distance from the cam shaft through approximately 90° of rotation and at a minimum distance from the cam shaft through approximately 135° of rotation.

3. The motor system of claim 2 wherein each of the power unit assemblies are connected to the crankshaft at a degree of rotation of the crankshaft whereas a crank portion rotates away from the cam member while the cam member is at the maximum distance from the cam shaft.

4. The motor system of claim 1 further comprising: a pressure bar operatively connected to each of the first ends of the rocker arms and variably positionable relative to the cam members for controlling compression applied to said power unit assembly.

5. The motor system of claim 4 wherein the hydraulic energy input comprises a hydraulic pump operably connected to the crank shaft for applying hydraulic pump operably connected to the crank shaft for applying hydraulic pressure to position the pressure bar.

6. The motor system of claim 5 further comprising: a throttle means for controlling a flow of hydraulic fluid to variably position the pressure bar.

7. The motor system of claim 5 further comprising: an electric pump for applying hydraulic pressure to position the pressure bar.

8. The motor system of claim 1 wherein the power unit assembly comprises a spring cup pivot operably connected to the cam shaft, a nose piece operably connected to the crank shaft, a central shaft connected to the nose piece and slidably receivable by the spring cup pivot, and a spring supported within the spring cup pivot and adapted to encourage separation of the nose piece and the spring cup pivot during operation of the motor.