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(54) **RECIPROCATING HYDRAULIC MOTOR UTILIZING A RAMPED VALVE YOKE WITH A TRIPPING SPRING**

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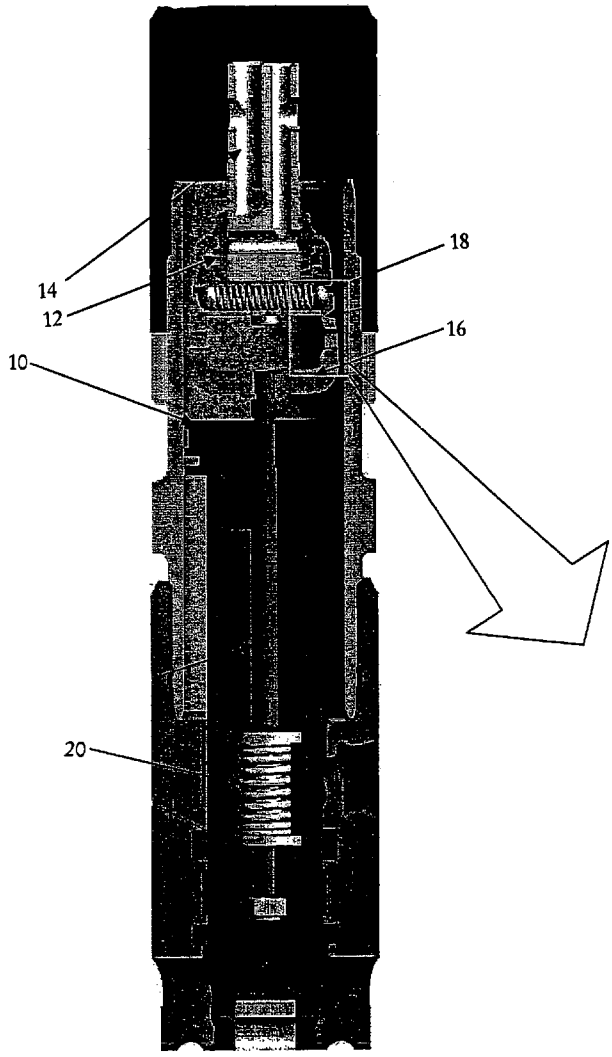
(57) **ABSTRACT**

The ramped valve yoke is utilized in a hydraulic reciprocating motor. The uniqueness of this valve yoke is the profile of the surface on which a ball-detent mechanism rides. The profile ensures the ball-detent will always snap into a position on either end of the profile and prevents the ball-detent from stopping on the profile. This action ensures the switching valve of a hydraulic reciprocating motor will always be fully engaged in either one of two positions and will never stop half way between positions.



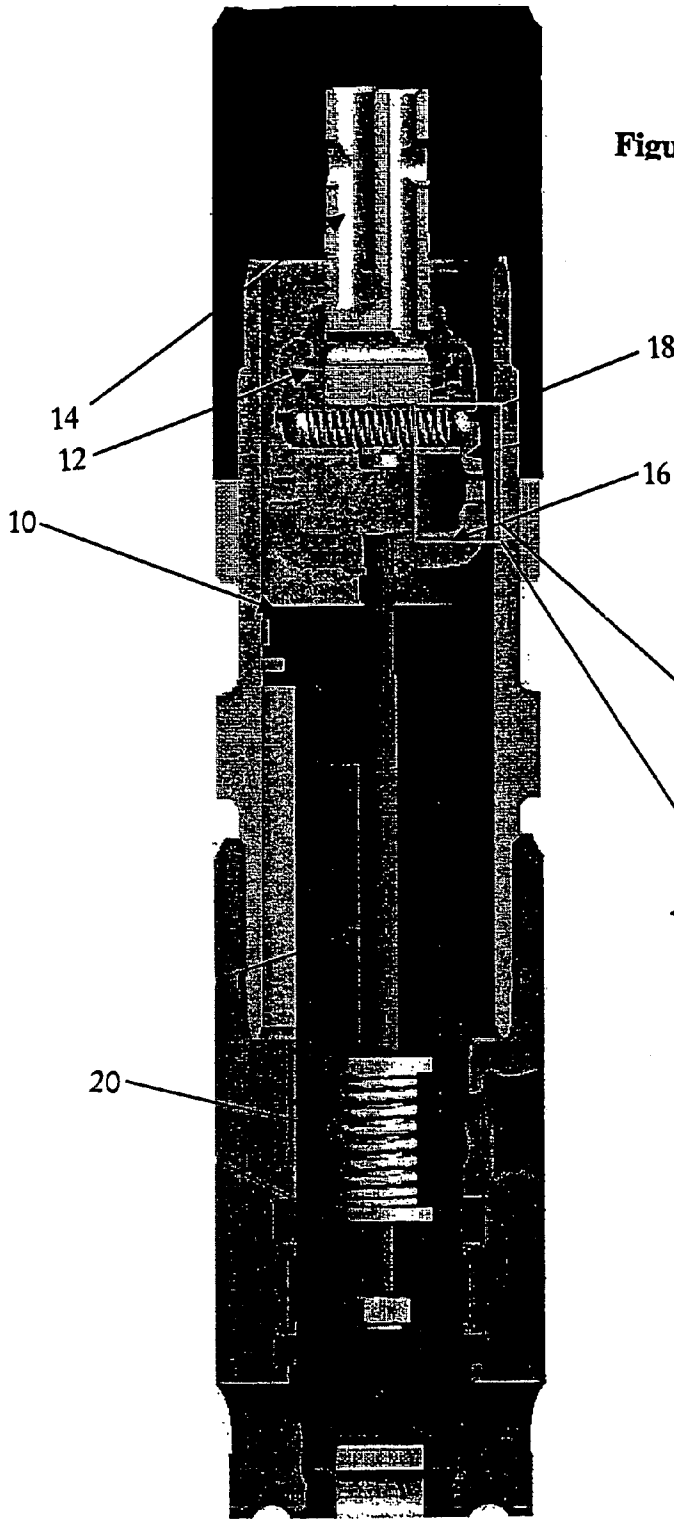


Figure 1

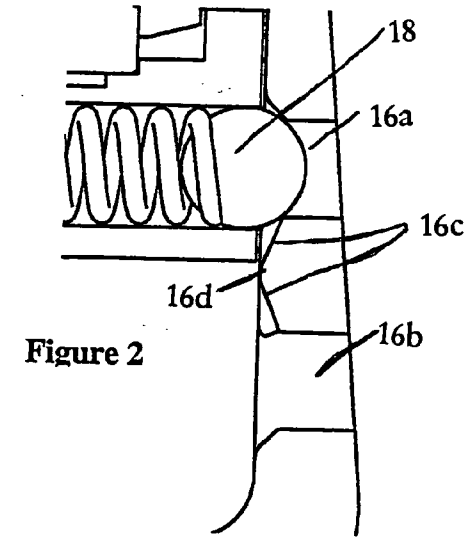


Figure 2

RECIPROCATING HYDRAULIC MOTOR UTILIZING A RAMPED VALVE YOKE WITH A TRIPPING SPRING

RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 60/409,250, filed Sep. 9, 2002.

BACKGROUND OF THE INVENTION

[0002] A typical design for a hydraulic reciprocating motor employs a piston that moves up and down by means of pressurized fluid enacting a greater net force on either side of a piston. By switching fluid flow from one side of the piston to the other and back again, the piston accomplishes the up and down motion. The reciprocating motion of the piston is employed to move any required load, for example in the case of this intended design, to reciprocate a paint pump for use in an airless paint sprayer.

SUMMARY OF THE INVENTION

[0003] The tripping spring is a method of providing energy to propel a valve sleeve from one position to another. The uniqueness of this method is the use of the ramped yoke in conjunction with a tripping spring.

[0004] To redirect the fluid flow, the motor employs a valve that rapidly switches position, closing a fluid port and opening another. The valve itself consists of a cylindrical sleeve that slides axially on the outer surface of a cylindrical spool. The spool contains fluid passages that are open to the surface of the spool by means of holes drilled radially. When the sleeve slides along the surface of the spool and over a radial hole, the passage in the spool is sealed. Therefore, when the sleeve is slid back and forth axially on the spool, passages within the spool are sealed and unsealed, consequently redirecting fluid flow through the spool.

[0005] An economical and simple method of moving the sleeve on the spool is to employ the piston itself to provide the force. However, the force of the piston diminishes as a port on the spool is closing because the piston force is dependent on the fluid flow through that port. Therefore, a method to allow the piston itself to provide the force required to move the sleeve to the next position is to store the energy provided by the piston while the piston has all the force provided by a full open port. This stored energy is then released just before the end of the stroke is reached to rapidly move the sleeve to the other position.

[0006] The method of storing energy in this claim is by means of a tripping spring and ball-detents. Ball detents hold the sleeve in a position over a port on the spool. At the same time, the piston moves upward and compresses the tripping spring. The ball detents will hold position until the force of the tripping spring builds to the point where its reaction force to the piston become greater than the holding force of the ball detents. At this point the ball detents loose grip and the force required to move the sleeve is greatly diminished. All the energy built up in the tripping spring is now released and rapidly moves the sleeve to the other position on the spool, opening one port and sealing another. Fluid flow is now redirected to the opposite side of the piston and the piston changes direction. Ball detents now hold the sleeve in this new position while the piston moving in its new direction begins to build energy in the tripping spring in the opposite direction. The process is now repeated in this direction. As this system of actions is used to redirect fluid flow back and forth rapidly at either end of the stoke of the piston, the result is the reciprocating motion of the piston.

[0007] The problem of this system alone is its reliance on the sleeve to fully complete a rapid journey from one position on the spool to the other. If the spool does not complete the journey, the result is the partial opening of both ports on the spool. If this happens, fluid pressure on both sides of the piston will cause equivalent net forces acting in opposite directions to stop the piston from traveling. A motor in this position is said to be "stalled".

[0008] In an equivalent design in which ports on the spool are spaces such that only one can be open at a time, there is a position of the sleeve in which both ports can be closed. In this case, if the sleeve fails to make a complete journey from one position to the other, both ports may become closed and the system experiences a fluid lock. Fluid becomes trapped in one cavity above or below the piston and the piston can no longer move.

[0009] The key to preventing a piston from experiencing fluid lock or stalling is to ensure that the sleeve completes the journey from one position on the spool to the other by employing a ramped yoke. The yoke is the link in the mechanism that contains the holes for the ball-detent and provides the connection from the tripping spring to the spool sleeve. The surface between ball-detent holes on the ramped yoke contains a bump that intrinsically causes an unstable position for the ball detents. The result is a back-up mechanism that causes the spool to fall into either of the two intended positions and preventing the spool from stopping somewhere between the two positions. The trip spring therefore, is designed to store sufficient energy to fire the ball-detent mechanism though this inherently unstable position caused by the bump to the intended stable position.

[0010] These and other objects and advantages of the invention will appear more fully from the following description made in conjunction with the accompanying drawings wherein like reference characters refer to the same or similar parts throughout the several views.

A BRIEF DESCRIPTION OF THE DRAWINGS

[0011] **FIG. 1** is a cross section of a hydraulic reciprocating motor utilizing the ramped yoke of the instant invention.

[0012] **FIG. 2** is a detailed view showing the ramped yoke.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] In the instant invention, generally designated **10**, the key to preventing a piston from experiencing fluid lock or stalling is to ensure that the sleeve **12** completes the journey from one position on the spool **14** to the other by employing a ramped yoke **16**. The yoke **16** is the link in the mechanism that contains the holes **16**a and **16**b for the ball-detent **18** and provides the connection from the tripping spring **20** to the spool sleeve **12**. The ramp surface **16**c between ball-detent holes **16**a and **16**b on the ramped yoke

16 contains a bump **16**d that intrinsically causes an unstable position for the ball detents **18**. The result is a back-up mechanism that causes the spool to fall into either of the two intended positions and preventing the spool **14** from stopping somewhere between the two positions. The trip spring **20** therefore, is designed to store sufficient energy to fire the ball-detent mechanism **18** though this inherently unstable position caused by the bump to the intended stable position.

[**0014**] It is contemplated that various changes and modifications may be made to the hydraulic reciprocating motor without departing from the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. In a hydraulic reciprocating motor having a piston, a spool sleeve moveable between first and second positions and at least two ports, the improvement comprising providing a tripping spring in conjunction with a ramped yoke to provide a reliable method of switching direction of said piston such that the tripping spring stores energy while the piston enjoys the full force provided by fully open said ports, and so that said ramped yoke prevents said spool sleeve from stopping half way between positions.

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