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(54) IMPROVEMENTS IN OR RELATING TO ELECTRO-HYDRAULIC SYSTEMS

(71) We, HAWKER SIDDELEY DYNAMICS ENGINEERING LIMITED, a British Company of Manor Road, Hatfield, Hertfordshire AL10 9LL, England, do hereby declare the

invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the control of fluid flow in a hydraulic control system and in particular the invention is concerned with providing means enabling reliable control of the movement of a valve to be achieved in a contaminated environment.

The invention further seeks to provide a reliable interface between an electric/electronic controller and a hydrualic system. In the following discussion and description emphasis is placed upon the application of the invention to mining equipment. It is to be understood, however, that the invention is not so limited in application and could be applied to other uses.

With the increasing emphasis on automation in the mining industry and the increasing usage of computers and microprocessors to provide proportional and remote control of mining machines and equipment, a requirement exists for a reliable interface between the electric/electronic controllers and the machine hydraulic systems.

It is an object of the present invention to achieve an improved electro-hydraulic servo valve for this purpose, incorporating the feature of automatic centring of the valve spool.

According to the present invention, there is provided an electro-hydraulic servo valve assembly for regulating the amount or pressure of hydraulic fluid supplied to a hydraulically-operated machine system, comprising a ported valve sleeve, a progressively rectilinearly movable valve spool controlling ports in said valve sleeve, a rotary motive power unit, coupling means including a leadscrew and nut mechanism coupling the drive of the motive power unit to the valve spool, a valve spool position transducer supplying a feedback signal representative of the instantaneous position of the valve spool, electrical control means controlling the energisation of the motive power unit in accordance with input command signals and the feedback signal, means for centring the valve spool in the absence of hydraulic pressure, and hydraulically-operated means locking the leadscrew against rotation when hydraulic pressure is present and unlocking to allow the leadscrew to rotate in the absence of hydraulic pressure to permit the valve spool to be centred.

Forces equivalent to those available on manual control valves used in systems liable to fluid contamination, e.g. mining and similar machines, will be used

An arrangement embodying the invention will now be described by way of example, with reference to the accompanying drawing. The drawing shows in diagrammatic longitudinal cross section a motor-driven valve spool the movement of which will control the direction of fluid flow in a machine system.

The drawing shows an arrangement wherein the valve spool can be automatically centred or nulled. This may be done as a dirct control action or so arranged that it results from a control power failure, i.e. the arrangement is such that the application of hydraulic pressure frees the spool for movement by the motor, while power failure results in the spool being returned to and locked in a centred position.

The valve spool 11 has a coupling rod 48 extending from one end thereof into centring cylinder 49 where a head 50 on the rod 48 is located between a pair of spring-urged centring pistons 51. When hydraulic pressure enters the cylinder 49 through a port 52 mid-way along the cylinder, the pistons 51 are forced back against the action of their springs 53 thereby allowing freedom of movement to the head 50 on the rod 48. In the absence of fluid pressure the pistons 51 are urged by their springs against opposite sides of a centre stop 54 thereby centring and trapping the head 50 and likewise the spool 11.

The spool 11 is operated by the drive motor (not shown) through a leadscrew 55 and nut 56. A pair of leadscrew guide rollers 57 are urged against opposite sides of the leadscrew shank which has a plain turned surface. The guide rollers 57 are mounted on spindles 58 which can be angularly adjusted by piston-and-cylinder units 59 acting through cranks 60. When hydraulic pressure is applied to the cylinders 59 the guide rollers 57 are turned into line with the leadscrew axis thereby frictionally preventing rotation of the leadscrew. Rotation of the nut 56 will therefore cause solely linear movement of the leadscrew 55. In the absence of fluid pressure, springs in the cylinder units 59 cause the guide rollers 57 to turn to match the helix angle of the threads on the leadscrew, thereby allowing the leadscrew to rotate. This enables the centring pistons 51 to move the spool and leadscrew to the centred position.

The leadscrew guide roll arrangement can also be arranged to provide spool operation in a combined linear and rotary motion. The angle at which the guide rolls are set to the axis of the leadscrew will determine the ratio of linear to rotary motion. Control of the angle can be used to control the amount of linear movement with respect to motor rotation and hence control the effective gain. The rotary motion will also tend to reduce the force required to move the spool in contaminated fluid and reduce the risk of linear scoring of spool and sleeve.

In the usual arrangement, the spool valve will provide the means of directly controlling the direction and flow of fluid in a hydraulic system where the flow is generated by means of a flow and pressure generating pump such as a gear pump, eccentric vane pump, piston pump etc. and where the hydraulic fluid flow is the means of transmitting power and causing and controlling the movement and position of machines or parts of machines.

However, such a valve may also be applied to control the generation, as well as the direction, of flow in a hydraulic or hydrostatic system where the means of generating the flow and determining the amount and direction of flow is a swash plate pump. In this case the movement and position of the swash plate can be controlled by operation of the type of valve arrangement shown, to direct the flow of a charge pump to the piston which governs the angle of the swash plate and hence controls the amount and direction of fluid flow in the main machine system.

The electro-hydraulic servo valve may be used to control position or speed of movement, or both speed and position, of machines or parts of machines, feedback transducers appropriate to the requirements being incorporated.

A system designed to control a valve driven by a stepper motor can be arranged so that when a command/feedback error exists it will output a number of drive pulses which will be related to the magnitude of the error and switched so that the direction of rotation which results will cause movement of the valve spool such that it takes up a predetermined position directly related to the error, e.g. at zero error the spool will take up a null position.

The spool position feedback information may be derived either directly from a spool position feedback transducer, or indirectly from a stepper drive output pulse count system.

WHAT WE CLAIM IS:—

1. An electro-hydraulic servo valve assembly for regulating the amount or pressure of hydraulic fluid supplied to a hydraulically-operated machine system, comprising a ported valve sleeve, a progressively rectilinearly movable valve spool controlling ports in said valve sleeve, a rotary motive power unit, coupling means including a leadscrew and nut mechanism coupling the drive of the motive power unit to the valve spool, a valve spool position transducer supplying a feedback signal representative of the instantaneous position of the valve spool, electrical control means controlling the energisation of the motive power unit in accordance with input command signals and the feedback signal, means for centring the valve spool in the absence of hydraulic pressure, and hydraulically-operated means locking the leadscrew against rotation when hydraulic pressure is present and unlocking to allow the leadscrew to rotate in the absence of hydraulic pressure to permit the valve spool to be centred.

2. A valve assembly according to claim 1, wherein the centring means comprises a pair of spring-loaded pistons that are held apart by the hydraulic pressure, and move toward one another in the absence of hydraulic pressure thereby trapping between them a head on a member coupled to the valve spool.

3. A valve assembly according to claim 1 or claim 2, wherein the leadscrew locking means comprises guide rollers that engage a plain surface of the leadscrew and are angularly adjustable between a position in which they are in line with the leadscrew axis and a position in which they are set at the leadscrew helix angle.

4. A valve assembly according to any one of the preceding claims, arranged to

control the position of the swash plate of a swash plate pump or motor in a hydraulic machine system.

5. An electro-hydraulic valve assembly substantially as described with reference to the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*