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SHIELDED TRANSDUCER HAVING MEANS TO REDUCE CORE MOVEMENT

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1

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This invention relates to a position indicating system and more specifically to a combination position signal generating system for an inducer or the like such as an actuator.

For control purposes, especially in industrial and aerospace applications, it is frequently advantageous and necessary to supply a position indicating system for inducers and the like by incorporating in the inducer control system means for indicating the actual position of the inducer and at times, the speed of actuation or movement the inducer is effecting. However, detection of the movement is generally difficult due to limitations of space and the environmental conditions such as high temperatures and pressures, also any electrical signal generating system may be subjected to electrical interference if utilized in radiation generating systems such as nuclear reactors, making the signal generation and detection difficult. Furthermore, such signal indicating devices must be reliable due to their comprising an important control signal generator in the control system which if it malfunctions, can incapacitate the total system. The subject position indicating system is directed to providing a system for use with an inducer or the like which combines the advantages of a reliable, lightweight and simple structure which may be generally employed wherever such means are needed. For the purposes of this invention an inducer may be considered any device such as an actuator, shock absorber or motion affecting device, generally self contained and including two or more relatively movable components. In the described embodiment the example of an actuator will be used.

It is one object of this invention to provide a signal generating device incorporated in an inducer or the like such that the actuator serves to protect, cool and encapsulate the signal generating device for reliable operation.

It is another object of this invention to provide a position indicating system utilizing a signal generating device incorporated in an actuator or the like for positive coupling with the actuator or movable member and providing positive indication of actuator component movement.

In carrying out these and other objects of the invention there is provided a signal generating system incorporated within an actuator and coupled through a motion reducing and translating device directly to the movable member of an actuator such that there is positive indication of actuator movement provided directly to the signal generating device and wherein the signal generating device is encapsulated by a portion of the actuator so as to be shielded both from heat and external signal interference in a manner to provide a small compact mechanism of relatively lightweight construction.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 illustrates a cross-sectional view of an actuator and position indicating device,

FIG. 2 is an enlarged partial cross-sectional view showing the motion reducing and transducing device connecting the signal generating device and the piston of the actuator, and

FIG. 3 is a cross-sectional view taken on 3—3 of FIG.

2

2 of the anti-rotation guide connecting the motion transducer with the signal generating device.

Referring now to FIG. 1, therein is illustrated an actuator 10 comprising a cylinder 11 which includes a cylindrical cavity 12 in which is positioned a piston 13. One end of the cylinder is enclosed by end cap 14 attached to the cylinder by the threaded collar 15, while the other end cap 16 is threaded on the opposite end of the cylinder 11. The piston 13 includes an attached piston rod 17 which extends through the opening 18 in the end cap 16 with the seals 21 and 22 extending between the piston rod 17 and the end cap 16 to seal around and yet allow movement of the piston rod through the end cap. Clevises 19 and 20 are attached to the piston rod 17 and the end cap 14 respectively.

The actuator functions in the normal manner by introduction of pressured fluid through ports 25 and 26 in the end caps such that with the piston in the position of FIG. 1, the introduction of fluid through the port 26 will act on the piston 13 so as to cause it to move from this right hand position as illustrated to the left or towards the end cap 16. This action moves the clevises 19 and 20 apart by the interaction of the piston 13 within the cylinder 11. Similarly, the introduction of pressured fluid through the port 25 will cause the piston to move back to the position of FIG. 1. Naturally any mechanism attached to the clevises 19 and 20 will be moved accordingly.

To generate a signal responsive to the positioning of the piston a signal or generating device 30 is provided within the cavity 31 of the cylinder 11 and piston rod 17 in a manner so as to be substantially inclosed by the cylinder with the exception of one end facing the clevis 20 to which electrical connections may be made. This signal generating device comprises a primary screw 33 having a screw thread interfitted with a primary nut 34 positioned within the piston rod 17 of the piston 13. This primary nut may be retained in this piston rod at any satisfactory manner that prohibits motion of the primary nut with respect to the piston rod and in the embodiment shown, a threaded nut 35 interfits with the threaded portion of the piston rod 17 to retain the primary nut against the shoulder 35a. Attached for rotation with the primary screw 33 is a secondary nut 36 which is retained against longitudinal movement by bearings 37 supported in the housing 38 forming a portion of the end cap 14. The primary screw and with it the secondary nut 36 may freely rotate but is retained from longitudinal movement in a manner such that the translation of the piston 13 with the piston rod 17 will cause translation of the primary nut 34 and interaction between this nut and primary screw 33 will result in a rotation of this screw with the attached secondary nut 36.

Also supported in the housing 38 is an electrical transformer coil 39 having an elongated core cavity 40 in which fits a movable core 41. This transformer is commonly referred to as a linear variable differential transformer comprising multiple electrical coils through which an iron core is moved with the position of the iron core being detected by the electrical field sensed by the secondary coil or coils of the transformer. Varying the position of the core varies the magnetic coupling between the primary and secondary coils of the transformer and by detection of the electrical signals generated in the secondary coils, the position of the core may be determined.

The movable core 41 is attached by shaft 42 to the guide member 43 and a secondary screw 45. The secondary screw interfits with internal screw threads 46 in the secondary nut 36 in a manner such that rotation of the secondary nut will effect longitudinal movement of the core member 41. To prevent the rotation of the core 41 and shaft 42 a guide 43 is provided which in this em-

bodiment is square shaped for a sliding fit within the anti-rotation guide 44 such that the guide may move longitudinally however is prevented from rotating.

In operation, translation of piston 13 and piston rod 17 translates primary nut 34 causing rotation of primary screw 33 which in turn rotates the secondary nut 36, causing axial movement of the secondary screw 45, the shaft 42 and the attached core 41. The reason for providing this motion transducer connecting the piston and core is to reduce the overall longitudinal movement of the core 41 since generally a linear variable differential transformer must have a coil length of $2\frac{1}{2}$ times the longitudinal movement of the core. The ratio of the motion of the piston 13 to the motion of the core being the ratio of the lead of the primary screw thread to the lead of the secondary screw thread, the motion transducer therefore provides motion to the core through the shaft that is directly proportional to the motion of the piston to allow limitation of the size of the coil thereby allowing the coil to be interfitted within the cylinder 11.

It is therefore obvious that the position of the movable core 41 may be detected by proper detection of the magnetic coupling between the primary and secondary coils of the linear variable differential transformer 30, and since the movement of the core 41 corresponds directly with the movement of the piston 13 the movement and position of the piston 13 may therefore be determined. The signal generating system is fully enclosed within the cylinder cavity to be shielded by the cylinder and cooled by the fluid within the actuator, and since the linear variable differential transformer coils may be encapsulated in a manner to allow immersion within and containment of the fluid of the actuator, no dynamic sealing is necessary in the motion transducing or signal generating system.

While particular embodiments of the invention have been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention. For instance while the position indicating system has been disclosed for use in a hydraulic actuator it is equally applicable to other types of inducers, also while a particular signal generating device is utilized other types may function equally well in various other applications. It is therefore intended to cover in the appended claims all such changes and modifications that come within the true spirit and scope of the invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An actuator comprising,
 - a cylinder having closed ends,
 - a piston reciprocable in said cylinder and having a rod projecting through one end thereof said piston

defining in combination with the closed ended cylinder, expansible pressurization chambers on opposite sides of the piston,

said cylinder having ports for the alternate introduction of pressurized fluid into the pressurization chambers at the opposite end portions of the piston to reciprocate said piston and rod,

a transducer disposed in the pressurization chamber at the end portion of said cylinder opposite said rod, and exposed to the fluid introduced therein,

said transducer comprising a coil having electrical leads extending from said actuator and a core displaceable within said coil to produce an output signal therefrom which is a function of the relative position of said core within said coil, and

positive coupling means for connecting said core and piston and positively displacing said core in response to piston movement at a fixed lesser rate than said piston movement,

whereby a relatively small transducer may provide an output signal reflecting the full range of a relatively long piston stroke.

2. An actuator as in claim 1 wherein, said coil and said core are disposed coaxially of said cylinder, and

said connecting and displacing means comprise threaded means.

3. An actuator as in claim 2 wherein, said piston and rod are centrally recessed and telescoped over said transducer when the piston is fully reciprocated toward the other end of said cylinder.

4. An actuator as in claim 3 wherein said threaded means comprise,

a primary screw member having threads of a relatively large pitch, said primary screw member also being disposed coaxially of said cylinder and journaled in fixed relation on said other end of said cylinder, a nut telescoped over said primary screw member and held in fixed relation within said recessed rod, said primary screw member having a nut portion receiving a threaded end portion of said core, and means preventing rotation of said core whereby the core will reciprocate with said piston but at a fixed lesser rate.

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