

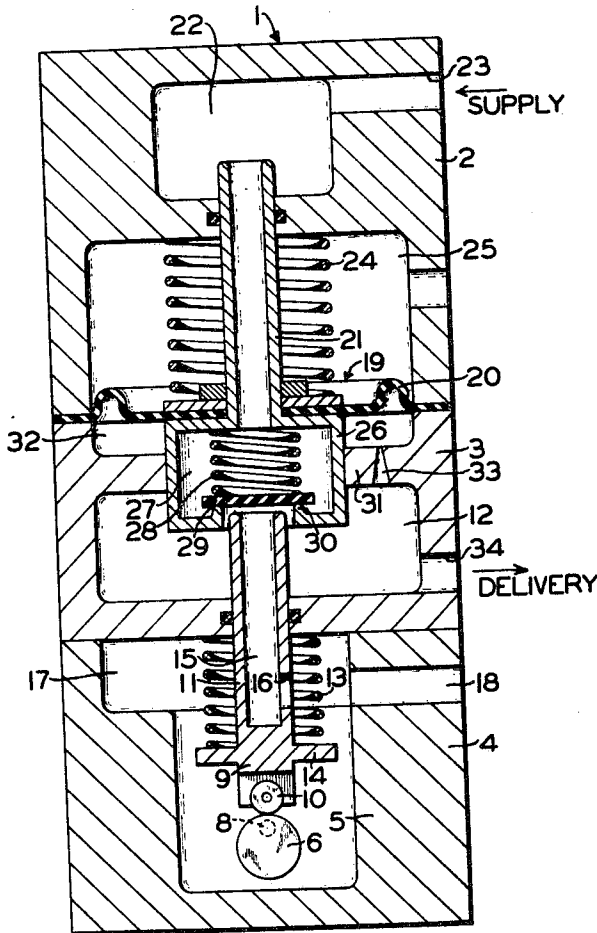
[72] Inventor **Ronald A. Sarbach**
Pittsburgh, Pennsylvania
[21] Appl. No. **638,968**
[22] Filed **May 16, 1967**
[45] Patented **Oct. 27, 1970**
[73] Assignee **Westinghouse Air Brake Company**
Wilmerding, Pennsylvania
a corporation of Pennsylvania

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Primary Examiner—William F. O'Dea
Assistant Examiner—David J. Zobkiw
Attorneys—Adelbert A. Steinmiller and Ralph W. McIntire, Jr.

[54] **ELECTRIC TO FLUID PRESSURE TRANSDUCER**
3 Claims, 3 Drawing Figs.
[52] U.S. Cl. 137/116.3,
91/429, 137/627.5, 303/52, 303/54, 303/56
[51] Int. Cl. B60t 15/06
[50] Field of Search 137/116.3,
627.5, 596.2, 85, 596.18; 91/429; 303/52, 54;
137/116.5; 137/495; 73(Prince)

ABSTRACT: An electric to fluid pressure transducer comprising a self-lapping valve means actuatively controlled by an electric torque motor to deliver a supply of fluid at a pressure in accordance with the degree of electrical energization of the torque motor.



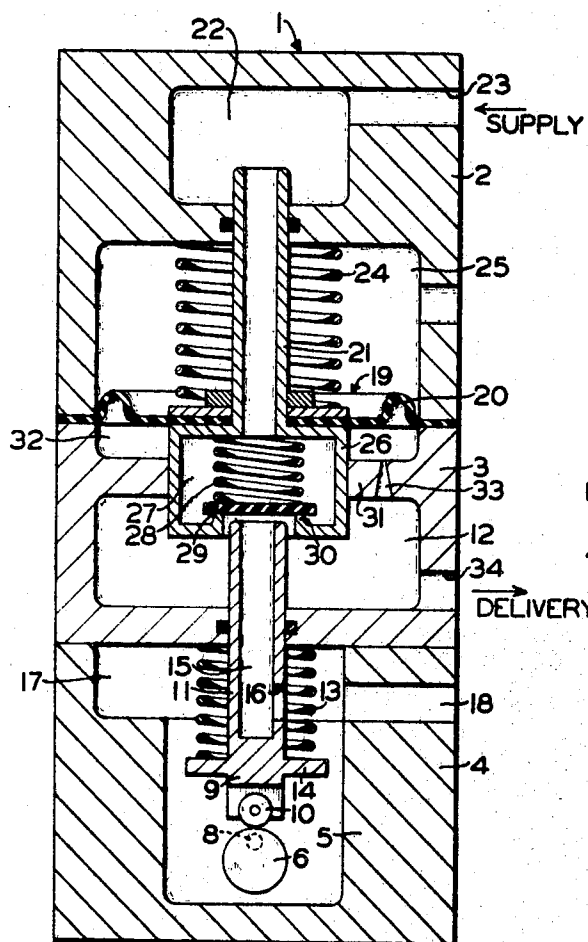


FIG. 1

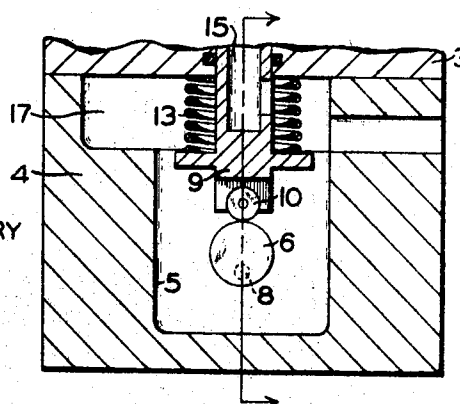


FIG. 2

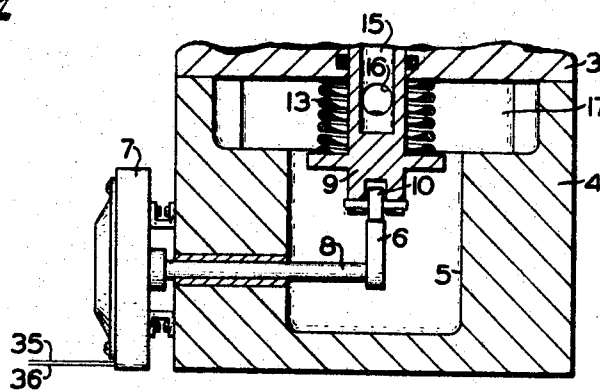


FIG. 3

INVENTOR
RONALD A. SARBACH

BY
A. A. Steinmiller
ATTORNEY

ELECTRIC TO FLUID PRESSURE TRANSDUCER

BACKGROUND OF THE INVENTION

Transducer means have long been known in electro-pneumatic control art. However, it has been a problem in electric to pneumatic transducer means to overcome the effect of hysteresis and frictional forces such that the supply of pneumatic fluid pressure is not immediately responsively controlled with small incremental changes in the electric energization supplied thereto. It has also been a problem in past designs of electric to pneumatic transducers where the electric portion operates against a variable force load depending on the supply of pneumatic pressure desired thereby giving a lagging characteristic of the supply of fluid pressure therefrom. It is desirable to have a transducer which is operable with a minimum of hysteresis effect for both increasing and decreasing delivered fluid pressures, and operable with a minimum frictional force at all times and more especially at time of reversing a control fluid pressure by means of reversing the increments of electrical energy supplied to the transducer. It is also desirable to provide a fluid pressure transducer in which the electric portion operates against a uniform low force load thus minimizing the size of the electric control unit and also minimizing the frictional characteristics of said transducer thus enabling a control in small increments in which the hysteresis effect and frictional effect is held to a minimum when changing from an increasing to a decreasing fluid pressure control and vice versa.

SUMMARY OF THE INVENTION

This invention relates to a transducer for providing a pneumatic analog supply of fluid pressure responsive to variations in electrical energy supplied thereto, said analog pressure being directly proportional to the voltage impressed upon the transducer. A cam positioned by an electric rotary torque motor actuates a self-lapping valve device within the transducer to supply fluid at a pressure in accordance with the positioning of the cam with a minimum of hysteresis or frictional effects.

In the accompanying drawing, FIG. 1 is a sectionalized view of the transducer shown with a zero electrical energy input and consequent zero fluid pressure delivered by said transducer.

FIG. 2 is a fragmental sectionalized view of the control portion of the transducer showing the condition for a maximum of electrical energy input to the transducer and consequent maximum pressure output.

FIG. 3 is a fragmental sectionalized view of the transducer showing the drive connection of the torque motor to the cam.

DESCRIPTION

Referring to FIG. 1 of the drawing, the transducer comprises a valve body 1 having three portions, a supply portion 2, a delivery portion 3, and a control portion 4, held together by a suitable conventional securing means (not shown). Within the control portion 4 in a bore 5 is a cam 6, rotation of which is controlled by an external torque motor 7, (FIG. 3) through a shaft 8 extending through the wall of portion 4. The cam 6 rides against a cam follower 9 in engagement with an antifriction bearing 10. The follower 9 has a hollow stem 11 extending through a wall of the delivery portion 3 with suitable sealing means, into a chamber 12 in said delivery portion of the body 1. The follower 9 is biased downward against the cam 6 by a spring 13 compressed between the aforesaid wall of the delivery portion 3 and a flange 14 on the stem. A chamber 15 in the hollow stem 11 is connected by a port 16 to a chamber 17 in the control portion of the body which in turn is connected by a passage 18 to atmosphere. One end (the upper end as shown in the drawing) of the chamber 15 is open, while the other end is closed.

Suitably secured between the delivery portion 3 and the supply portion 2 is a diaphragm piston 19 comprising a

diaphragm 20 and a hollow piston stem 21 secured thereto and extending through a wall in the supply portion 2 with suitable sealing means into a supply chamber 22 connected by passage 23 to a suitable source of supply of fluid under pressure (not shown herein). The diaphragm piston 19 is maintained in position by a spring 24 enclosed in a vent chamber 25 and abutting the aforesaid wall in the supply portion 2 and the diaphragm 20. The hollow piston stem 21 extends from the chamber 22 and chamber 25 down through the diaphragm 20 to a supply valve 26 secured to the diaphragm 20 on the opposite (under) side thereof. Supply valve 26 comprises a hollow piston means having a chamber 27 in which is enclosed a spring 28 and valve 29, said valve 29 being biased by said spring 28 to a valve seat 30 within said chamber 27. The supply valve 26 is slidably movable through a wall 31 within the delivery portion of the valve body.

A control chamber 32 is defined between the wall 31 and the diaphragm 20, within the supply portion 2, said chamber 32 being connected by a choke means 33 to the chamber 12, said chamber 12 being connected by passage 34 to the desired control means to be controlled by the fluid pressure output from said transducer.

The torque motor 7 as shown in FIG. 3 is of the conventional type torque motor designed for high torque "stand still" operation, for positioning systems whereby the torque supplied directly to the shaft 8 is proportional to the voltage supplied by the leads 35 and 36. By the elimination of gears there is no backlash error with this directly coupled shaft 8 and cam 6.

OPERATION

In operation, electrical energy is supplied to the leads 35 and 36 (FIG. 3). The torque motor 7 will turn the shaft 8 to position the cam 6 in accordance with the voltage supplied by said leads. The cam 6 will act against the antifriction bearing 10 (shown herein as a type of roller bearing) to cause the stem 11 to be positioned in accordance with the degree of rotation of the cam 6.

Initially, with no torque applied to the cam, the transducer is positioned such that the valve 29 is against the valve seat 30 thereby shutting off supply of fluid from the supply chamber 20 to the chamber 12 and the hollow stem 11 is slightly removed from said valve 29 to permit venting of chamber 12 around the open end of said hollow stem 11 through the chamber 15 and port 16 to chamber 17 and the atmospheric vent 18. With the initial turning of the cam responsive to a slight voltage on the torque motor the hollow stem 11 is moved upward as shown in the drawing whereby the open end of the hollow stem engages the valve 29 to cut off exhaust of chamber 12 through said hollow stem as just described. Further movement of the hollow stem 11 in an upward direction resulting from further movement of the cam 6 will cause the hollow stem 11 to open the valve 29 away from the valve seat 30 and thereby initiate a supply of fluid under pressure from the source of supply to passage 23 and chamber 22, through the hollow piston stem 21, to the chamber 27 of the supply valve 26, by the valve seat 30 to chamber 12 and thence via passage 34 to the operating unit (not shown) desired to be supplied with fluid under pressure. Simultaneously with a supply of fluid under pressure to passage 34, the fluid under pressure in chamber 12 is supplied to the control chamber 32 by way of choke means 33, to build up a pressure therein. The fluid pressure in control chamber 32 acts upon the diaphragm 20 until the spring 24 is compressed to permit the diaphragm piston 19 to move to a position to permit the valve seat 30 to move against the valve 29 to stop the supply of fluid under pressure to chamber 12 and thereby define a lap condition of the transducer. Further increasing voltage supplied to the torque motor will cause further rotation of the cam 6 to again cause the hollow stem 11 to effect movement of the valve 29 away from the seat 30 to again supply fluid under pressure to the chamber 12 until the simultaneous

build-up of fluid pressure in the control chamber 32 again causes a lap condition of the transducer as just described.

Reduction of the voltage supply to the torque motor 7 will cause the cam 6 to rotate in a reverse direction, thereby permitting the spring 13 to move the cam follower 9 and the hollow stem 11 downward such that the open end thereof is moved away from the valve member 29. With movement of the open end of the hollow stem 11 away from the valve member 29 fluid under pressure from the operating unit (not shown) and the chamber 12 flows through the hollow stem chamber 15 to the passage 16 and thence to chamber 17 and passage 18 to atmosphere to vent the chamber 12 and the fluid at the operating unit. The fluid pressure in the control chamber 32 is simultaneously vented through the choke 33 to chamber 12 to cause the diaphragm piston 19 to move downward to permit the valve 29 to again seat on the open end of the hollow stem 11 and thereby define a lap condition of the transducer during a voltage and pressure reduction. Continued reduction of the voltage supply to the torque motor will effect further downward motion of the cam follower 9 and the hollow stem 11 to permit further reduction of the fluid pressure from the operating unit, chamber 12, and control chamber 32 until complete venting is accomplished to render the operating unit completely vented as initially described.

I claim:

1. An electric to fluid pressure transducer comprising:
 - a. a casing;
 - b. self-lapping valve means in said casing having an operating stem the axial position of which determines the fluid pressure output of the valve means, said self-lapping valve means including:
 - i. a disc valve element;
 - ii. a first annular valve seat to which said disc valve element is biased in seated relation to close communication between a fluid pressure inlet and a fluid pressure outlet which communication is opened upon unseating of said disc valve element from said first valve seat;
 - iii. a second annular valve seat formed on the said operating stem and engageable with said disc valve element coaxially within said first annular valve seat to close an exhaust communication from said outlet to atmosphere which exhaust communication is opened upon unseating of said second annular valve seat from said disc valve element;
 - iv. a diaphragm subject opposingly to atmospheric pressure and the pressure in said outlet for moving said first annular valve seat to different positions; and
 - v. said operating stem being effective to shift said second annular valve seat into and out of seated relation with said disc valve element, and to shift said disc valve element with respect to said first annular valve seat;
 - c. cam means in said casting for controlling the axial position of the operating stem; and
 - d. a torque motor secured to said casing for variously positioning said cam means according to the degree of electrical input to said torque motor.
2. An electric to fluid pressure transducer comprising:
 - a. a casing including:
 - i. a first chamber having an inlet through which a supply of fluid under pressure is communicated thereto;
 - ii. a second chamber having a delivery port opening thereout of;

- iii. a third chamber communicating with said second chamber via a restricted orifice in a wall therebetween;
 - iv. a fourth chamber and a fifth chamber each constantly open to atmosphere; and
 - b. a self-lapping valve means including:
 - i. a diaphragm separating said third and said fourth chambers;
 - ii. a stem member coaxially extending through said diaphragm and sealingly fixed thereto, one portion of said stem member at one side of said diaphragm extending slidably through an opening in said wall between said second and third chambers and terminating in said second chamber, the opposite end portion of said stem member extending in slidably sealed relation through an opening in a wall between said fourth and said first chambers and terminating in said first chamber, said stem member having a passage therein open to said first chamber, and having a first annular valve seat in the said passage;
 - iii. a valve member biased into seated relation on said first annular valve seat;
 - iv. a second annular valve seat formed at one end of said operating stem and coaxially disposed within said first annular valve seat for seated and unseated relation with said valve member;
 - v. the said operating stem extending in slidably sealed relation through a wall of the casing separating said second and said fifth chambers and having a passage opening within said second annular valve seat and also constantly open to said fifth chamber; and
 - c. a cam means being operating to shift said operating stem to a position in which it causes seating of said second annular valve seat on said valve member to close communication between said second and said fifth chambers and unseating of the valve member from said first annular valve seat to effect supply of fluid under pressure from said first chamber to said second chamber, the pressure of fluid supplied from said second chamber to said third chamber via said restricted orifice being effective on said diaphragm to cause said first annular valve seat to be moved correspondingly to effect reseating of the valve member thereon to lap off further supply of fluid under pressure from said first to said second chamber; and
 - d. a torque motor secured to said casing for variously positioning said cam means according to the degree of electrical input to said torque motor.
3. An electric to fluid pressure transducer as defined in claim 2, further characterized in that said cam means is movable to another position thereof in consequence of a decreasing electrical input to said torque motor to cause unseating of said second annular valve seat on said operating stem from said valve member while said valve member remains seated on said first annular valve seat to establish communication between said second chamber and said fifth chamber thereby to vent fluid under pressure from said second chamber, said third chamber being simultaneously vented via said restricted orifice to said second chamber and said fifth chamber to cause said diaphragm, said stem member, and said first annular valve seat to be moved correspondingly to effect reseating of the valve member on said second annular valve seat to lap off further venting of fluid under pressure from said second chamber.