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[54] REVERSING PNEUMATIC AMPLIFIER

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[58] **Field of Search**.....137/625.66, 625.6, 596.14, 137/596.18

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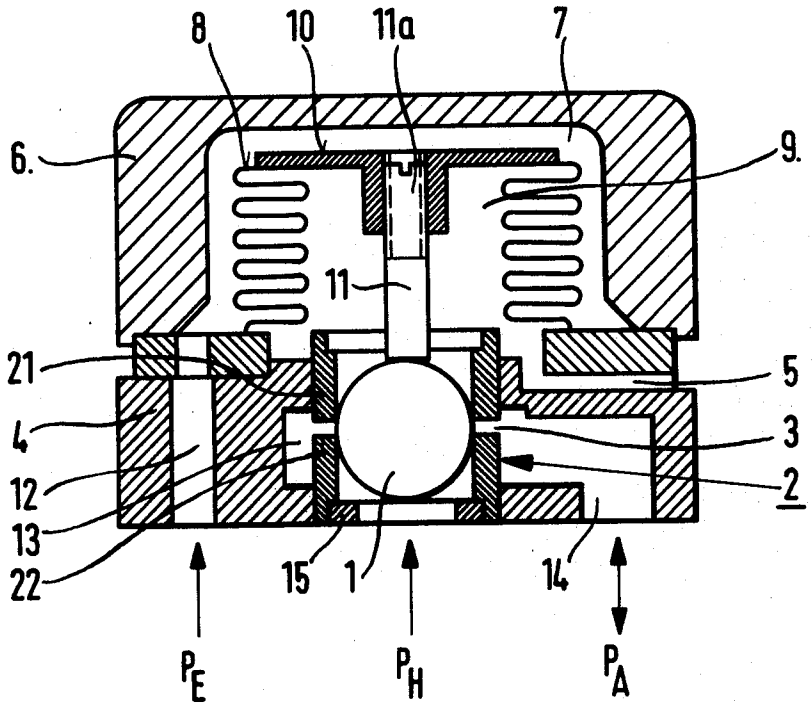
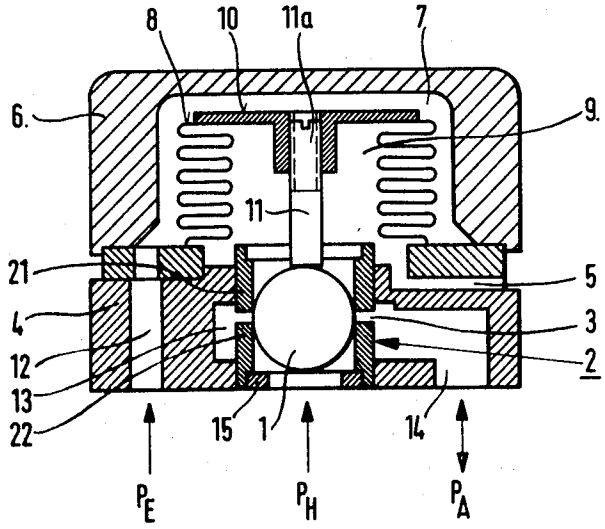
[57] **ABSTRACT**

There is disclosed a reversing pneumatic amplifier including a valve ball movable in a sleeve for opening or closing a control slot provided circumferentially in the sleeve in a radial plane thereof. The valve ball is displaced in one or the other direction when a pilot pressure, indirectly exerting a force to the ball through a bellows and a push rod, exceeds or drops below a predetermined value. Said force is opposed by a supply pressure directly affecting the valve ball. Dependent upon the direction of displacement of the valve ball, the output pressure of the amplifier is either increased or decreased.

4 Claims, 1 Drawing Figure





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REVERSING PNEUMATIC AMPLIFIER

BACKGROUND OF THE INVENTION

This invention relates to a reversing pneumatic amplifier in which a movable control member, guided in a sleeve, opens or closes control openings. One side of the movable control member is exposed indirectly to a pilot pressure, while its other side is affected directly by a supply pressure.

Amplifiers of the aforenoted type find application particularly in pneumatic controllers wherein a force balance controls a nozzle and flapper system which in turn delivers the pilot pressure for the amplifier. By virtue of the forces to which the movable control member is exposed, the control openings are closed for a predetermined pressure value of the input pressure. In case the input pressure exceeds the predetermined value, the output pressure chamber is connected with a discharge opening and if the input pressure decreases, communication is established between an auxiliary energy source and the output pressure chamber.

Known amplifiers of the aforenoted type have a plurality of interconnected pistons as movable control members, the edges of which effect the control of the auxiliary energy source as they slide over or uncover the control openings in their cylinder. Such movable piston valves are expensive and are difficult to manufacture and further, there is significant wear because of the substantial area of contact between the pistons and the cylinder.

In another known type of pneumatic amplifiers balls are used as the movable control members. Such balls are easy to manufacture and, unlike the pistons, do not have a tendency to jam. These balls, however, cooperate with control edges rather than with control openings. Consequently, the manufacture of the guide cylinder which has to be provided with steps or extensions forming the control edges is quite complex.

In known amplifiers a plurality of movable control members, such as pistons or balls, are combined with one another or with valve bodies and are interconnected by means of linkages or the like. Such arrangements are prone to substantial switching errors because the valve bodies actuated by the movable control members have to be lifted from the valve seats.

It is further known to use, for the indirect actuation of the movable control members by the pilot pressure, a membrane or a spring bellows which affects the movable control member directly or through a linkage mechanism. Since the supply pressure is usually by one order of magnitude larger than the pilot pressure, the movable control body may be held in a predetermined position by the opposing pressures of the surface ratios between the control body on the one hand and the membrane or the bellows on the other hand are properly chosen.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved reversing pneumatic amplifier which requires small space, is of simple structure, consumes low auxiliary energy with high output and operates with no switching errors.

Briefly stated, according to the invention, the movable control member is constituted by a sole ball which is disposed in a cylindrical sleeve provided, in a radial plane, with at least one slot forming a control opening. The ball is controlled by means of a membrane or bellows and an actuator rod in such a manner that the output pressure chamber communicates with the ambient atmosphere in case of increasing pilot pressure, while it communicates with the supply pressure source in case of decreasing pilot pressure.

The invention will be better understood as well as further objects and advantages of the invention become more apparent from the ensuing detailed specification of a preferred, although exemplary embodiment of the invention taken in conjunction with the sole FIGURE illustrating the invention in longitudinal section.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the FIGURE, a ball **1** constituting a movable control member, is positioned and guided in a bilaterally open-ended sleeve generally indicated at **2**. The latter has, in a radial plane, a circumferential slot **3** constituting a control opening. The sleeve **2** is force fitted into a central opening of a base block **4**. One end of the sleeve **2** communicates with an auxiliary energy source (not shown) delivering a supply pressure P_H, while the other end of the sleeve **2** is connected with the ambient atmosphere through a channel **5**. To the base block **4** there is secured in a fluid-tight manner a cap **6** which defines a chamber **7**. In the latter there is disposed a bellows **8** which separates the chamber **7** from the bellows chamber **9** which, in turn, communicates with the sleeve **2** and with the discharge channel **5**. The bellows **8** has a base plate **10** to which there is centrally secured an axially displaceable push rod **11** by means of an externally threaded screw portion **11***a*. The push rod **11** is in contact with the ball **1** and transmits thereto the force of the pilot pressure P_E which prevails in chamber **7** and which is admitted thereto through an inlet bore **12** provided in the base block **4**. The ratio between the cross-sectional face of the ball **1** and the effective face of the bellows **8** is selected in such a manner that for a predetermined value of the pilot pressure P_E (corresponding to the zero value of the characteristic amplifier curve) and for a predetermined value of the supply pressure P_H, the ball **1** is so positioned in the sleeve **2** that the equator of the ball is situated in the middle of the slot **3**, so that the latter is obturated by the ball **1**. A fine axial adjustment of the push rod **11** may be effected by turning the screw **11***a*.

This pneumatic amplifier is advantageously used in compensating regulator systems; it becomes effective only when the pilot pressure P_E deviates from the predetermined value (zero point on the amplification curve). The drawing shows the ball **1** in its stable position; thus, the amplifier is in the zero point on its characteristic curve. Apart from a very small idling consumption caused by leakage losses, no energy conversion takes place. If the pilot pressure P_E exceeds the predetermined value, then the ball **1** is displaced downwardly by the push rod **11** and, as a result, the slot **3** is partially or entirely exposed. Since the slot **3** provided in the control sleeve **2** communicates through an annular chamber **13** with the output opening **14** of the amplifier, the output pressure P_A will drop since the annular chamber **13** will now communicate through the slot **2** with the discharge channel **5**. This condition will

last in a compensating system until the pilot pressure P_E again reaches its predetermined value. If, on the other hand, the pilot pressure P_E drops below the predetermined value, then the supply pressure P_H displaces the ball **1** upwardly. In this case, communication will be established between the auxiliary energy source delivering the supply pressure P_H and the output opening **14** of the amplifier. As a result, the output pressure P_A will increase. It is thus seen that during operation of the amplifier, consumption of auxiliary energy (utilization of pressure P_H) takes place only when the output pressure P_A is to be increased.

The sleeve **2** is preferably formed of two similar cylindrical parts **21** and **22** force fitted in a fluid-tight manner in the base block **4** and arranged slightly spaced and in axial alignment with respect to one another. The width of the circumferential slot **3** is thus determined by the spacing between the two parts **21**, **22** and the slot itself is defined by adjoining radial edge faces of these two parts which, in their arrangement, are mirror images of one another. In this manner it is possible to obtain a very narrow slot which has significant advantages in enhancing a compact structure and a minimum consumption of energy in the stable position of the ball **1**. On the other hand, the uninterrupted circumferential configuration of the slot **3** permits a relatively large flow rate and thus results in a large amplifier output. In order to reduce the idling consumption of energy to 10 percent or less of the maximum flow rate, the diameter of the ball **1** should preferably be 20 – 30 times larger than the width of the slot **3**. For example, the slot width may be 0.25 millimeter and the ball diameter 5.5 millimeter. In case of a maximum amplifier output of approximately 50 lit./min., the idling consumption will be about 5 lit./min. The external dimensions of this amplifier which, as it may be observed from the drawing, comprises very few parts and is of very simple structure, are comparatively very small and may be, for example, 24 × 24 × 20 millimeters.

In order to protect the amplifier from damages in case of overloading into one end of the sleeve **2**, there is inserted a ring **15**, the internal diameter of which is smaller than that of ball **1**, so that in case of an interruption in the delivery of the supply pressure P_H, the ball **1** will be seated thereon. On the other hand, the cap **6** is arranged at such a distance from the base plate **10** of the bellows **8** that the base plate **10**, in case of an overload, will come into a face-to-face engagement with the inner face of the cap **6**.

It is further noted that from the amplifier according to the invention switching errors are substantially eliminated, since the ball **1**, which in its zero position blocks the control slot **3**, is, when displaced, entirely surrounded and carried by a leakage air flow, so that a friction (i.e., the source of said switching error) between the ball **3** and the inner wall of the sleeve **2** can generally not occur.

What is claimed is:

1. A reversing pneumatic amplifier comprising:

A. a first input means through which a pilot pressure is introduced into said amplifier,

B. a second input means through which a supply pressure is introduced into said amplifier,

C. discharge channel means in communication with the ambient atmosphere,

D. an output opening,

E. a hollow cylindrical control sleeve having a first open end communicating with said discharge channel means and a second open end communicating with said second input means,

F. a slot provided in said sleeve and extending in a radial plane thereof; said slot connecting the inside of said sleeve with said output opening,

G. a valve ball movably disposed in said sleeve and adapted to assume first, second and third positions, in said first position said valve ball closes said slot, in said second position communication is established between said second input means and said output opening, in said third position communication is established between said discharge channel means and said output opening, and

H. means in engagement with said valve ball and in communication with said first input means for transmitting said pilot pressure indirectly to said valve ball, said pilot pressure being opposed by said supply pressure directly affecting said valve ball through said second input means.

2. A reversing pneumatic amplifier as defined in claim **1**, wherein said means defined in (H) includes

A. a bellows pneumatically separating said valve ball from said pilot pressure, and

B. a push rod secured to said bellows and in contact with said valve ball.

3. A reversing pneumatic amplifier as defined in claim **1**, including a base block; said sleeve is formed of two spaced and axially aligned sleeve parts fitted into said base block; said slot is constituted by the clearance between said two sleeve parts.

4. A reversing pneumatic amplifier as defined in claim **1**, wherein the diameter of said valve ball is 20 – 30 times larger than the width of said slot.

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