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W. E. BAARS ETAL

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AUTOMATIC AIR VALVE

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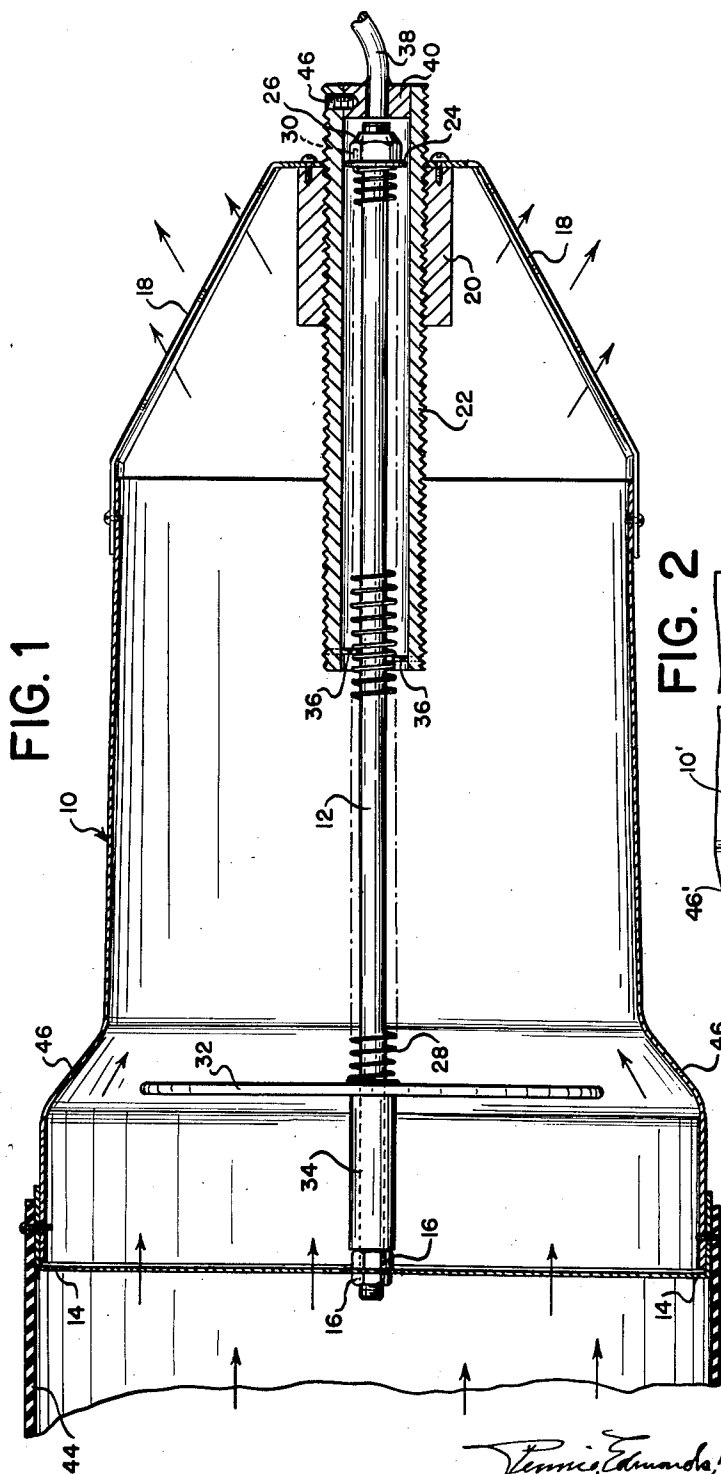
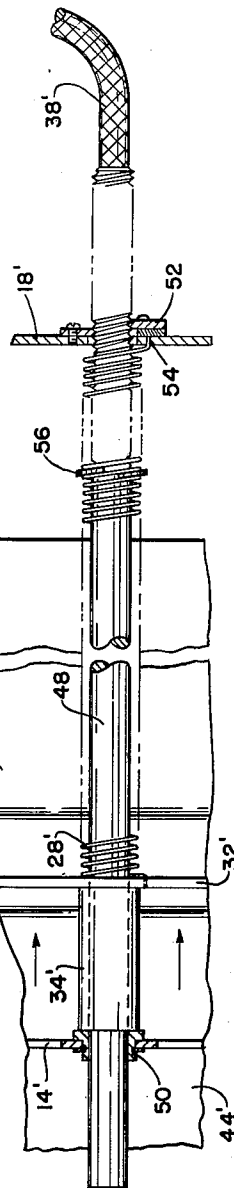


FIG. 2



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AUTOMATIC AIR VALVE

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This invention relates to improvements in air flow control valves, and more particularly to an improved automatic air valve for controlling the flow of air in air ducts and air conditioning systems, or for controlling the flow of air through or its discharge from pipes or ducts.

The primary object of the invention is to provide an automatic air flow control valve adapted to deliver air at a constant rate or to supply a constant quantity of air in a given period of time.

A further object of the invention is to provide an automatic air flow control valve adapted to deliver air at a constant rate even though the air supplied to the valve varies in pressure from time to time.

In accordance with the invention the improved automatic air flow control valve comprises means defining a flow passageway, means for controlling the air flow through the passageway and means responsive to changes in the pressure of the inlet air entering the passageway for actuating the flow control means in such a manner as to maintain a constant rate of air flow through the passageway.

In a preferred construction, the means forming the passageway comprises a shell having a circular cross section in which is mounted an axially movable valve control member in the form of a disc, the shell being reduced in diameter in the direction of air flow in the zone of movement of the flow control disc, and means responsive to the changes in air pressure on the air inlet side of the disc for moving the disc axially to change the flow area. In this construction the means responsive to changes in air pressure is adapted to decrease the flow passageway with increasing air inlet pressure and to increase the flow passageway with decreasing air pressure at the inlet of the shell.

The improved automatic valve includes means for adjusting the rate of air flow, and other features, objects and advantages described in detail hereinafter in connection with the accompanying drawing, in which:

FIG. 1 is a longitudinal sectional view through one embodiment of an automatic air control valve embodying the features of the present invention, and

FIG. 2 is a view similar to that of FIG. 1, with parts broken away, showing another embodiment according to the invention, but on a slightly larger scale.

Referring to the drawings, the improved valve as shown in FIG. 1, comprises an outer shell 10 of circular cross section which may be made of sheet metal, such as aluminum, for example, from a cylindrical section of sheet aluminum formed to the shape shown in the drawing by spinning. A rod 12 extends axially through the shell 10, supported at the air inlet end at the left by a diametral strip bracket 14 attached to the periphery of the shell 10 and through which the rod 12, threaded at the end, extends and to which the rod is secured in fixed axial position against rotation by nuts 16. At its opposite end the rod 12 is supported by strip brackets 18 attached at one end to the shell 10 and at their other ends to the outer face of a fixed internally threaded bushing 20. The bushing 20 is mounted axially with respect to the shell 10, and a considerably longer externally-threaded bushing or sleeve 22 is threaded through the bushing 20 so that it projects beyond the brackets 18.

The rod 12 extends axially into the sleeve 22 in spaced relation thereto, is threaded at the end located in the sleeve

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22 where it carries a flat washer 24, fitting in the bore of the sleeve 22 with a sliding fit and adapted to center the rod in the sleeve. The washer is secured in place by a nut 26. A helical compression spring 28 is mounted on the rod 12 and fixed against rotation at the position of the washer 24, for example by locking the bent end 30 of the spring in a hole extending through the washer 24 and nut 26 as indicated. A circular valve plate or flow control disc 32 fixed to one end of a sleeve 34 is mounted together with the sleeve on the other end portion of the rod 12. The sleeve 34 is provided with internal bearings, for example of Teflon or similar material, which slide on the rod 12 and provide for easy axial movement of the sleeve 34 and valve disc member 32. The spring 28 extends from the washer 24 to the valve disc member 32 and is under a predetermined degree of compression for opposing the force of the stream of air flowing into the shell 10 from the left.

The externally-threaded bushing or sleeve 22 which turns inside the fixed bushing 20 is provided at its inner end with a stop means in the form of three radially-mounted pins 36, fixed in the wall of the bushing and extending into the helical convolutions of the spring 28 in the manner shown. When the bushing 22 is turned, the pins 36 follow the spring helix. This has the effect of changing the working length of the spring, since, because of the pins, only the length of the spring between the valve disc 32 and the pins 36 will be active with respect to opposing the forward movement of the valve disc.

Means is provided for rotating the externally-threaded sleeve for in turn changing the working length of the spring 28, such means including a flexible cable 38 extending from a conveniently positioned remote control means, not shown. The other end of the flexible cable is soldered or otherwise fixed in a central opening in a plug 40 fitted in the projecting end of the sleeve 22 and secured thereto in a non-rotatable manner by a set screw 42.

In the operation of the automatic air valve, air enters the large end of the valve, for example from a duct or pipe 44, to which the valve is attached, and passes through the annular area around the flow control disc 32. As the air passes through the annular area, a pressure drop occurs which results in a lower pressure on the right side of the flow control disc 32 than that on the left side. The resulting pressure difference exerts a force on the flow control disc 32 which tends to move it to the right against the action of the spring 28 which in turn tends to move the plate to the left. When the force of the inlet air pressure is equal to the force of the spring, the flow control disc 32 will be in equilibrium, and a specific quantity of air will be flowing through the valve in a given time, that is, the rate of air flow will be constant. If the pressure on the entering side of the valve is increased, the rate of air flow will tend to increase, but the higher pressure will move the control disc 32 to the right and reduce the annular area to the extent that for the higher pressure, the rate of air flow through the valve will be the same as previously passed through the larger area at the lower pressure.

The diameter of the flow control plate or disc 32 is correlated with the diameter and shape of the shell 10 so that the annular area between the member 32 and the smaller diameter of the shell 10 will provide an annular flow area for fixed flow rate at maximum pressure, while the larger annular area provided by the enlarged inlet portion of the shell opposite the illustrated portion of the member 32 will provide for fixed flow rate at the minimum anticipated pressure. The shell 10 is flared outwardly along the section 46 from the smaller diameter portion of the shell to the larger diameter portion at the air inlet end. This flaring area of the shell 10 corresponds to a considerable part of the range of movement of the member 32. In the drawing the member 32 is shown in the position of

minimum pressure with the sleeve 34 bearing against the inner nut 16.

It will be noted that in response to changes in the inlet air pressure, a decrease in air pressure, for example, will permit the spring to force the plate 32 to the left and increase the annular area to maintain the fixed preset rate of flow. If the air pressure at the inlet increases the force of the spring will be overcome and the plate 32 will move toward the right to correspondingly decrease the annular flow area to maintain the fixed flow rate.

The force applied by the spring 28 or its resistance to the movement of the plate 32 may be changed and adjusted by rotating the sleeve 22, so that it is moved either to the right or left by the threaded connection with the bushing 20. It will be understood that since the active length of the spring extends from the stop pins 36 to the plate 32, the changing of this active length by the movement of the sleeve 22 changes the rate of the spring and the spring forces acting against the pressure behind the plate 32. The spring adjustment, therefore, is for the purpose of changing the rate of air flow through the valve. In this connection it will also be understood that if the active spring length is increased from that shown (the minimum active length), the plate will move farther to the right for a given air pressure, since the spring rate is reduced, and the air flow rate will be less at this given air pressure because of the reduction in the annular flow area as the plate 32 moves to the right.

In the embodiment of the invention illustrated in FIG. 1, it will be seen that the active length of the spring 28 may be approximately doubled by movement of the sleeve 22 to the right from the position illustrated. The helical convolutions of the spring 28 when fully extended preferably correspond approximately to the convolutions of the threads of the bushing 20 and sleeve 22. For example, these members may be provided with nine threads to the inch and the spring chosen to approximate this, since the spring is fixed against rotation by the washer 24, the nut 26 and the nuts 16.

In the construction of FIG. 2, the elements which are the same as those of FIG. 1 are referred to by the same reference characters to which a prime has been added. The construction in FIG. 2 operates on the same principle as that of FIG. 1, although the mechanism for adjusting the spring is different and somewhat more simple. The shell 10' in FIG. 2 is the same as that shown in FIG. 1, but is broken away, and the same is true of the movable valve member 32'.

In FIG. 2 a longitudinally-movable circular rod 48 extends axially through the shell 10', its end at the left being slidably mounted in a bearing 50 supported by the bracket 14'. At the opposite end of the shell, the rod 48 extends through a helically-shaped washer 52 fixed to the brackets 18'. A helical spring 28' is mounted on the rod 48 between the valve plate 32' and the brackets 18' at the position of the washer 52. The end of the spring 28' at the right is preferably fixed to one of the brackets 18' at the point 54.

The portion of the rod 48 at the outlet end is threaded as indicated and threadably engages in the helical washer 52 which serves as a nut, the thread on the rod having the same pitch as the helical convolutions of the spring 28'. Adjacent the inner end portion of the rod 48, a helical washer 56 is welded or otherwise fixed to the rod, so that it engages in the convolutions of the spring. A flexible cable 38' is welded or otherwise fixed to the threaded end of the rod 48, as shown, so that the rod may be rotated and moved longitudinally to shift the position of the helical washer 56 with respect to the spring. The helical washer 56 acts as a stop means and serves the same purpose as the pins 36 in FIG. 1.

The automatic air valve arrangement as shown in FIG. 2 operates in the same manner as that shown in FIG. 1 and the principle of operation is the same. For most installations, the form of the invention shown in FIG. 2

is preferred because it includes fewer parts and is less expensive to manufacture.

While the invention has been described in connection with specific embodiments in which the shell of the valve is cylindrical and the valve plate is circular, it is to be understood that the shell may be rectangular in cross section and the valve plate shaped and mounted so as to provide the conditions, functions and results described above. The automatic valve may be used to supply air from a duct such as the duct 44 or 44' to a room or other space or it may be incorporated in a duct or system so that the air at the outlet flows from the shell directly into a connecting duct. If the outlet end of the duct 10 or 10' is connected into a discharge duct, the shell may extend to or beyond the position at which the brackets at the outlet support the rod. It is also to be understood that the valve may be used for various purposes where it is desirable to supply air at a constant rate.

What we claim is:

1. An automatic air flow control valve comprising a shell defining a passageway for the flow of air, said shell having an air inlet end section and an air discharge end section of smaller diameter than the air inlet section, said sections being connected by a tapered section, a rod extending axially in the shell, a disc like flow control member mounted on said rod and slidable bodily thereon in the tapered section of the shell, one side face of said flow control member facing the air inlet end of the shell and being subjected to the air pressure at the inlet end of the shell, a compression spring one end of which bears against said control member and the other end of which is located toward the air outlet end of the shell, said spring biasing the flow control member toward the air inlet end of the shell and being subject to the pressure of the air flowing against the flow control member, and means for varying the resistance of the spring.

2. An automatic air flow control valve as claimed in claim 1, in which the spring is a helical spring mounted on the rod and through which the rod extends, and means for changing the active length of the helical spring comprising a stop means extending into the helix of the spring at one location, and means for moving the stop means along the spring.

3. An automatic air flow control valve as claimed in claim 1, in which the compression spring is a helical spring mounted on the rod and through which the rod extends, and means for changing the active length of the helical spring comprising a stop means fixed to the rod and extending into the helix of the spring at one location, and means for moving the rod longitudinally with respect to the spring to thereby move the stop means along the spring for changing its active length.

4. An automatic air flow control valve as claimed in claim 3, in which the means for moving the rod comprises a threaded connection including a thread on the rod, and means for rotating the rod.

5. An automatic air flow control valve comprising a shell defining a passageway for the flow of air, said shell having air inlet and discharge end sections and a cross sectional flow area at the inlet end section greater than that of the air outlet end section, said end sections being connected by a tapered section, a rod extending centrally in the shell and lengthwise thereof, a disc like flow control member mounted in said shell on said rod and slideable bodily thereon longitudinally of the shell, said flow control member being located at the position of the tapered section of the shell and providing with the shell an annular flow area, one face of said control member facing toward the air inlet end of the shell and being subject to the pressure of the air flowing into the inlet end of the shell, said flow control member being movable bodily on the rod lengthwise of the shell in the tapered section of the shell for changing the annular flow area between the control member and the shell, resilient means on the downstream side of the flow con-

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trol member for resisting the air pressure thereon and for biasing the flow control member toward the inlet end of the shell, said resilient means being responsive to the pressure of the air applied to the flow control member, and means for varying the resistance of the resilient means. 5

6. An automatic air flow control valve as claimed in claim 5, in which said resilient means comprises a helical compression spring through which the rod extends.

7. An automatic air control valve as claimed in claim 10 6, in which the spring is fixed against rotation on the

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rod, and in which the means for varying the resistance of the spring comprises means for engaging in the convolution of the spring and is movable longitudinally with respect to the spring.

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