

[54] **AIR INJECTING APPARATUS FOR AIR
CONDITIONERS OR THE LIKE**

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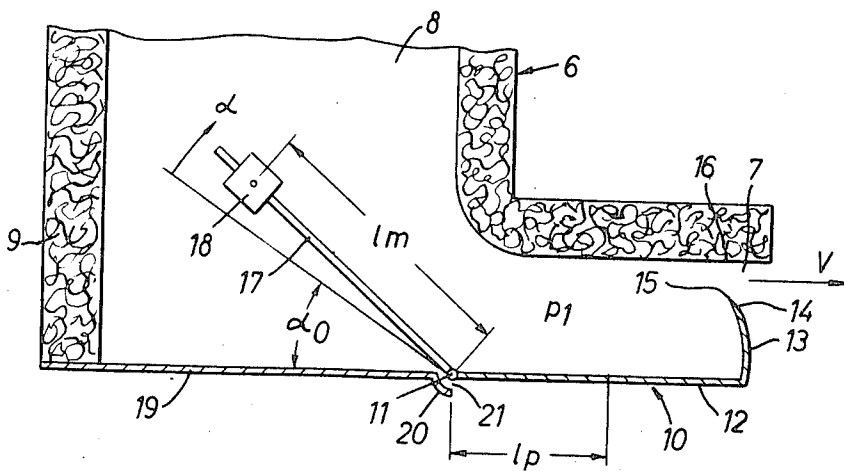
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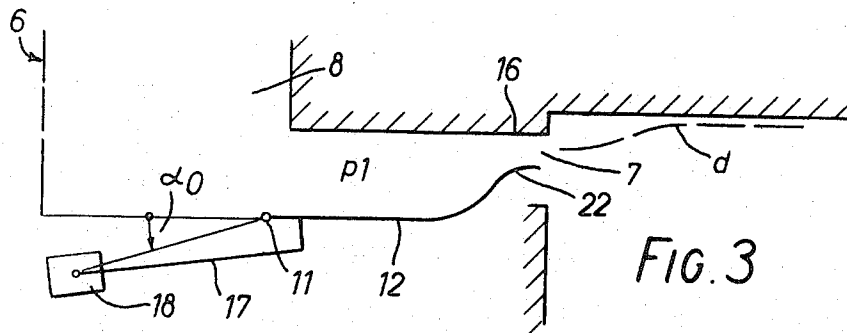
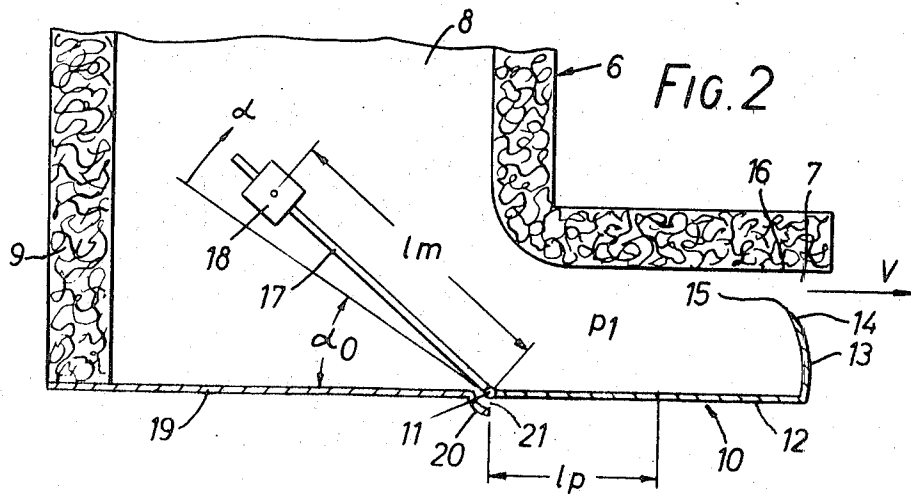
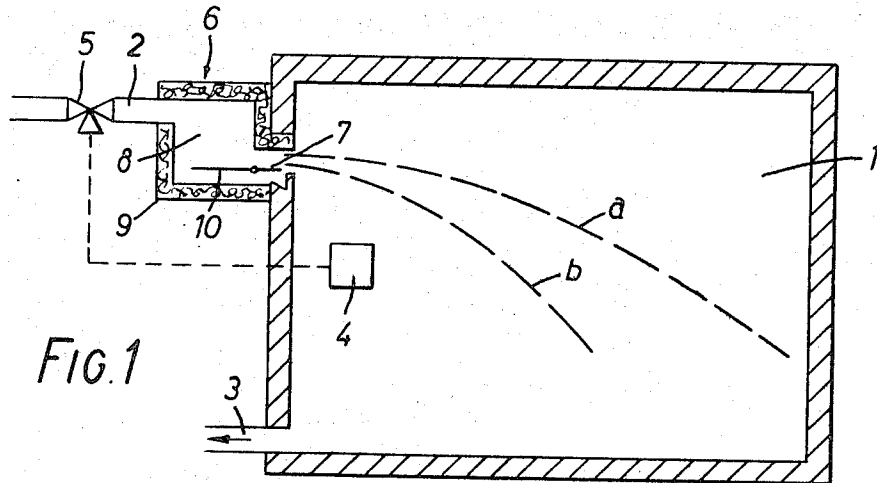
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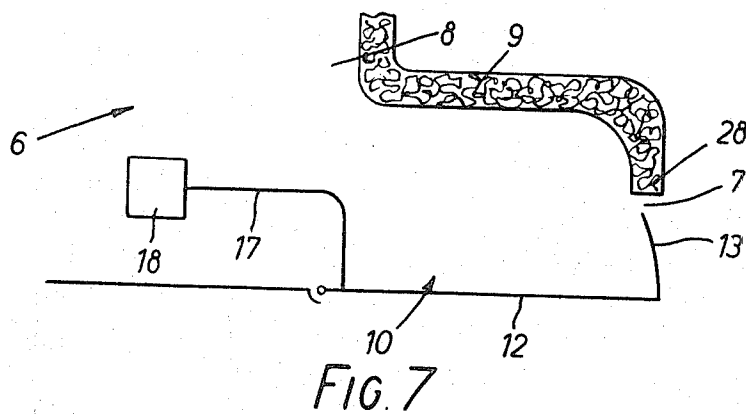
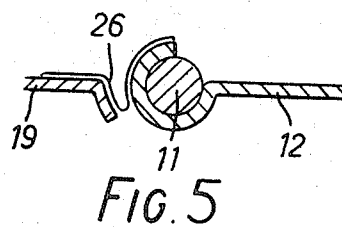
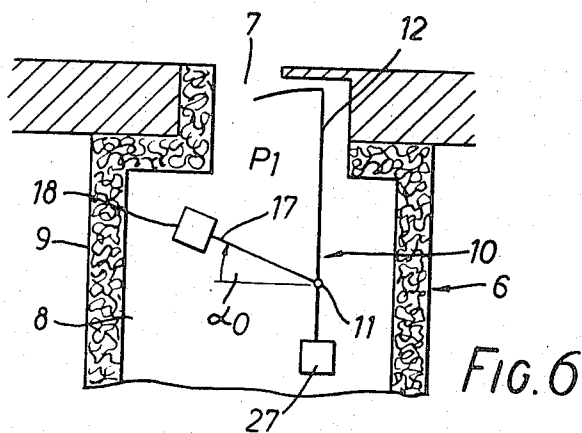
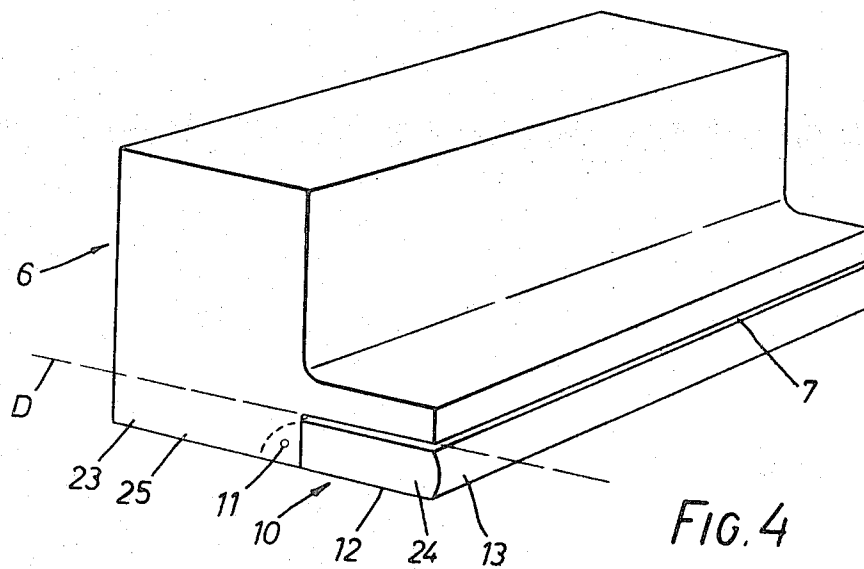
ABSTRACT

The invention relates to an air conditioning system inlet assembly which has walls which form a chamber having an outlet opening. A pivotally mounted valve plate varies the size of the opening. The valve plate forms one lever arm of a fulcrumed lever and the second lever arm thereof is counterweighted. Weights on the second lever arm balance the biasing forces of pressurized air in the chamber which tend to move the valve plate in closing direction. An increase in the total volume of air supplied per unit time results in a larger valve opening to counter the effects of unpleasant drafts which would otherwise occur.

8 Claims, 7 Drawing Figures







AIR INJECTING APPARATUS FOR AIR CONDITIONERS OR THE LIKE

The invention relates to an air injecting apparatus for air conditioners or the like, comprising an injection orifice through which a variable volume of air passes.

In air conditioning and ventilating installations it is known to take into account a higher cooling load in the room that is being provided with air by supplying the room with a larger volume of air per unit time. The air that is thus controlled is blown into the room through injection orifices having a constant cross-section. In some cases this volume control can be combined with the regulation of other parameters of the injected air, e.g. the temperature. With such air injecting apparatus there are, however, disadvantages. In particular, uncomfortable draughts occur during at least some operating conditions. Also, there are often disturbing noises.

The object of the invention is to provide an air injecting apparatus of the aforementioned kind in which the described disadvantages can be entirely or partially avoided with a mechanically simple construction.

This object is achieved in accordance with the invention in that the size of the injection orifice is adjustable in relation to the angular position of a lever having a pressure plate which is subjected to the pressure of the injected air in a chamber upstream of the injection orifice in one direction of rotation and to a mechanical force in the opposite direction of rotation.

With this construction, the set orifice is controlled in dependence on the pressure of the injected air in the upstream chamber. However, the speed of injection varies in accordance with this pressure and the size of the injection orifice and it is this injection speed that is largely responsible for the disadvantages that have hitherto been observed. In addition, the control of the size of the injection orifice makes it possible to take into account other parameters which influence the flow in the room. The lever subjected to the pressure and the mechanical force gives rise to a condition of equilibrium which determines the size of the injection orifice in a simple manner.

It is particularly advantageous if the pressure plate bounds one side of the upstream chamber and carries at its free end a limiting edge of the injection orifice. The lever here serves to bound directly the upstream chamber and the injection orifice.

For an injection orifice of gap shape, the limiting edge can here be formed by an end wall which adjoins the pressure plate and extends substantially perpendicular thereto. This end wall will then exert no torque on the lever. This will be so if the end wall is part of a cylinder having its axis coincident with the rotary axis of the lever.

It is also recommended that the limiting edge be sharp-edged by means of a chamfer on the side of the end wall remote from the rotary axis of the lever. This to a large extent suppresses disruptive torques emanating from the limiting edge.

In practice, a lever has proved particularly suitable which has two arms, one of which comprises the pressure plate and the other of which is subjected to the mechanical load. A construction which is particularly less prone to disturbance is one where the mechanical force is formed by a weight. This weight can be adjust-

able along the second arm, whereby an accurate adjustment of the apparatus is made possible on site.

There are various possibilities of control that can be used depending on the nature of the disturbing influence that is to be removed. There are also possibilities of combination, e.g. such that in one limiting range a first control function predominates and in another limiting range a second control function predominates.

Thus, it is desirable to make the torque exerted on the lever by the mechanical force substantially independent of the angular position of the lever. This will then ensure that the presence in the upstream chamber remains substantially constant. This results in a substantially constant injecting speed despite a variable volume. In this way it is possible to keep the injection speed so low under all operating conditions that no disturbing noise will be set up.

When using a weight this control function is achieved if the second arm carrying the weight extends substantially horizontally because changes in the angular position of the lever have little influence on the torque occasioned by the weight.

In another manner of control, provision is made that the torque exerted on the lever by the mechanical force is dependent on the angular position of the lever in such a way that the size of the injection orifice is substantially proportional to the pressure in the upstream chamber. In this way the archimedian number of the injected air can be kept substantially constant if its temperature remains unchanged. If the flow of air extends partially along the ceiling of the room utilising the Coanda effect during normal operation, one can in this way prevent the flow from leaving the ceiling when the archimedian number exceeds a critical value.

This can be achieved with the use of a weight in that the second arm carrying the weight is inclined obliquely downwardly in the rest position of the lever.

Another possibility of control consists in that the torque exerted on the lever by the mechanical force is dependent on the angular position of the lever in such a way that the size of the injection orifice changes substantially inversely proportionally to the square of the pressure in the upstream chamber. As will be derived from the theory concerning geometrically similar chambers in the theory of flow, with this control function the air flow maintains a particular course even if the volume of injection changes. This is particularly so for injection orifices in the form of a horizontal gap lying substantially in a vertical plane.

This can be achieved with the use of a weight in that the second arm carrying the weight is inclined obliquely upwardly in the rest position of the lever. This construction also has the advantage that the second arm and the weight can be conveniently accommodated in the interior of the air injecting apparatus.

Generally, the pressure plate will extend substantially horizontally. But there are also constructions, e.g. for injection orifices from which the air flows upwardly, in which an upwardly directed pressure plate must be provided. In this case a counterweight balancing out the weight of the pressure plate should be provided on the lever below the rotary axis.

In a preferred construction, the rotary axis is provided at the end of a wall of the housing upstream of the pressure plate and an extension of this way surrounding the rotary axis forms between itself and the axis a gap which is directed so that leakage air leaves

it substantially parallel to the pressure plate. This leakage air will in that case create no more than a negligible disruptive torque. If there is to be even less leakage air, it is recommended that the gap between the rotary axis and the adjoining wall of the housing be covered by a thin sealing diaphragm.

Further, the pressure plate may comprise two side walls extending up to the end wall and overlapped in the region of the rotary axis by side walls of the housing.

To reduce the air speed in the upstream chamber without enlarging the downwardly projecting structural components, it is recommended that the fixed limiting edge of the injection orifice be bounded by a fixed end wall extending substantially parallel to the movable end wall.

The invention will be described in more detail by way of preferred examples shown in the drawings wherein:

FIG. 1 is a diagrammatic representation through a room equipped with an air injecting apparatus according to the invention;

FIG. 2 is a diagrammatic representation of a modified example;

FIG. 3 is a diagrammatic representation of a third example;

FIG. 4 shows the outside of an air injecting apparatus to be mounted near the ceiling;

FIG. 5 is an enlarged view of a seal between the housing and the lever axis;

FIG. 6 is a diagrammatic representation of a further embodiment having an upwardly directed injection orifice, and

FIG. 7 is a further modification.

A room 1 is provided with air at a predetermined temperature through a supply conduit 2. The air is withdrawn again through a conduit 3. A thermostat 4 in the room 1 controls a throttle element 5 so that a control of the injected volume is achieved in dependence on the required cooling load. Between the supply conduit 2 and the room 1 there is an air injecting apparatus 6 which is in this case in the form of a wall mounting unit.

This apparatus 6 comprises an injection orifice 7 and a chamber 8 upstream thereof which also acts as a sound suppresser by reason of being clad with an insulating layer 9. An important component of the air injecting apparatus is a lever 10 with the air of which the size of the injection orifice 7 can be varied.

This will be explained in more detail in conjunction with FIG. 2.

The lever 10 is pivotable about an axis 11. One lever arm is in the form of a pressure plate 12 at the free end of which there is provided an end wall 13. This has the shape of a cylinder of which the axis coincides with the rotary axis 11. The upper edge of the end wall 13 is provided with a chamfer 14 at the outside and forms a sharp limiting edge 15 of the injection orifice 7. The upper fixed limit is formed by a wall surface 16. A second lever arm 17 is in the form of a rod which carries a weight 18 that is adjustable along the rod. The lower wall 19 of the apparatus 6 has an extension 20 which surrounds the rotary axis 11 and, together with it, forms a gap 21 through which leakage air can flow out substantially only parallel to the pressure plate 12.

If a certain volume of air is to be injected per unit time, a pressure p_1 depending on the size of the injection orifice 7 will obtain in the upstream chamber 8.

This pressure acts on the pressure plate 12 and gives rise to a clockwise torque which is proportional to this pressure p_1 , the area of the pressure plate 12 and the length l_p up to the middle of the plate 12. Since the lastmentioned quantities are constant, the torque is proportional to p_1 . The weight 18 gives rise to a torque in the opposite direction. This torque is proportional to the weight 18, the length l_m and to $\cos(\alpha_0 + \alpha)$. Since the two firstmentioned quantities are constant, this torque is proportional to the angular function but it is possible to provide a certain basic position by adjusting the weight 18 along the rod 17. The angle α_0 is determined by the rest position of the lever 10. FIG. 2 illustrates an operating condition at which the injected air enters the room 1 with an injection speed v . By changing the size of the injection orifice 7 and a corresponding change in the pressure p_1 , the injection speed v will also change. It can be shown that the following condition will to a large extent apply:

$$p_1 \sim v^2 \sim \cos(\alpha_0 + \alpha).$$

In FIG. 1 use is made of a lever 10 for which $\alpha_0 = 0$. This ensures that on a change in the injected volume the injection orifice 7 will be enlarged to such an extent that the pressure p_1 and thus also the speed v remain substantially constant. This speed can be set by adjusting the weight 18 along the rod 17. There is no difficulty in keeping it below the critical value that leads to disturbing noises.

In the FIG. 2 embodiment the angle α_0 is positive. A higher pressure p_1 and thus a higher speed v is therefore associated with a smaller size of the injection orifice 7. By appropriately choosing the angle α_0 , it is possible in the operating range of the lever 10 substantially to fulfil the condition $v^2 \cdot l = \text{constant}$, where l is the height of the injection orifice 7 in the form of a gap. From the theory of geometrically similar chambers in the theory of flow it can be shown that for this condition a selected course of flow will be maintained even when the injected volume changes. A very favourable course of flow is indicated by the line a in FIG. 1. The flow from the injection orifice 7 is the side wall is so directed that it will impinge on the opposite side wall somewhat above the floor. If the injection speed drops on a decrease in the injected volume but if the injection orifice 7 were to remain constant, a course of flow according to the line b would occur. By means of the described control of the injection orifice 7 the course of flow according to the line a can be substantially maintained.

FIG. 3 shows an embodiment in which the injection orifice 7 extends at a very small spacing below the ceiling of the room. This results in a flow according to the line d because the injected air will adhere to the ceiling as a result of the Coanda effect. This, however, will only apply as long as a critical limiting value of the archimedian number A_r for the Coanda effect is not exceeded. This archimedian number is defined as follows:

$$A_r = g \cdot \beta(t_2 - t_1) / v^2,$$

wherein, apart from the aforementioned injection speed v and the height l of the gap, g is the gravitational constant, β is the coefficient of volumetric expansion of the air, t_2 is the room temperature, and t_1 is the injection temperature. This archimedian number is kept substantially constant if the height l of the gap is changed in proportion to v^2 .

This can be substantially achieved by prescribing a negative angle α_0 of rest. With an increase in pressure p_1 and thus an increased injection speed v , the lever will be set to a new condition of equilibrium at which the injection orifice 7 is larger. In this embodiment the pressure plate 12 is integrally bent to a bounding surface 22 for the orifice 7.

FIG. 4 illustrates an air injecting apparatus 6 to be accommodated in the ceiling and of which only the lower portion 23 is disposed below the level D of the ceiling. The limiting surfaces of the apparatus 6 are again bounded by sound-proofing walls 9. In the vicinity of the pressure plate 12, the lever 10 is not only provided with an end wall 13 but also with side walls 24 which are overlapped by the side walls 25 of the housing.

FIG. 5 shows a different kind of seal between the rotary axis 11 and the adjacent wall 19 of the housing. Here, a thin diaphragm 26 covers the gap between the said parts.

FIG. 6 shows what measures must be taken if the pressure plate 12 extends vertically upwardly because an upwardly directed flow is to pass through the outlet 7. Apart from the arm with the pressure plate 12 and the arm 17 with the weight 18 there is a further lever arm provided with a weight 27. This weight balances out the weight of the pressure plate 12 so that stable operating conditions will obtain and the weight 18 will, as in previous cases, give rise to a torque which acts against the torque produced by the pressure p_1 . In the FIGS. 1 to 3 embodiments, the torque produced by the pressure plate 12 can be taken into account by a portion of the weight 18.

In the embodiment of FIG. 7 the chamber 8 upstream of the injection orifice 7 is enlarged in that the wall 9 in the region of the orifice 7 comprises a downwardly projecting end surface 28. This ensures that the speed in the upstream chamber 8 is in any case considerably lower than the injection speed v without the apparatus requiring an excessively large constructional height beneath the orifice 7.

There are possibilities alternative to the weight 18 to bring about a certain functional relationship between the counter-torque and the angular position of the lever

10 with the aid of a mechanical force. For example, the mechanical force can be produced by a spring. For this purpose springs having a non-linear characteristic will be particularly applicable.

I claim:

1. An air conditioning system air inlet assembly comprising an air flow duct, a damper forming a variable outlet orifice for said duct, said damper being mounted for pivotal movement relative to a horizontally extending axis, said damper being movable in an opening direction by pressurized upstream air in said duct, mechanical means biasing said damper in a closing direction, said mechanical means having an angular relationship with said damper to vary the size of said orifice in accordance with the pressure of said pressurized air to maintain a constant air velocity at said orifice, said duct extending horizontally, and said damper having a flat portion below and in generally parallel relation to a portion of said duct.

2. An air inlet assembly according to claim 1 wherein a vertically upward extending lip portion extends vertically from the outer end of said damper.

3. An air inlet assembly according to claim 2 wherein said lip portion is cylindrically shaped relative to said horizontally extending axis.

4. An air inlet assembly according to claim 2 wherein said lip portion has a sharp edge chamfer.

5. An air inlet assembly according to claim 1 wherein said damper constitutes a first lever arm relative to said axis, said mechanical means including a second lever arm.

6. An air inlet assembly according to claim 5 wherein said second lever arm has weight means associated therewith.

7. An air inlet assembly according to claim 1 wherein said mechanical means exerts forces relative to different pivotal positions of said damper so that the size of said orifice is inversely proportional to the square of the pressure of said upstream air.

8. An air inlet assembly according to claim 6 wherein said second lever arm is inclined obliquely upwardly in its at-rest position.

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