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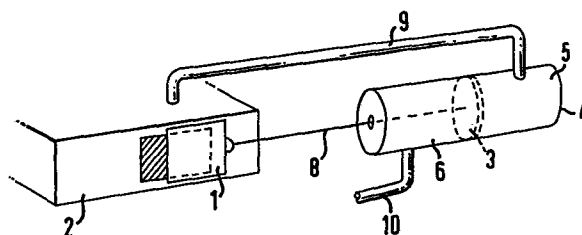
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⑤④ **A burner with an air regulator.**

⑤⑦ A burner having an air regulator upstream of the burner which automatically controls the air pressure at the inlet of the burner at a fixed value. The air regulator comprises a container (2) divided into a zone (6) in communication with the combustion chamber and another zone (5) in communication with the air supply to the burner, the zones (5, 6) being separated by a moveable partition (3) connected to a regulating device (1) for regulating the amount of air supply entering the burner from the atmosphere. When the moveable partition (3) moves in response to a pressure difference between the zones (5, 6) there is change in the amount of air supplied to the burner.



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A BURNER WITH AN AIR REGULATOR

This invention relates to a burner having a regulator for the air supply.

In any burner the air for combustion is regulated by a damper, butterfly valve, one or more gates etc, and this causes a loss of head in the air circuit. Also the air is set in motion either by the natural draught, by a fan or more usually by a combination of the two. Apart from certain highly automated industrial installations, the adjustment is fixed and is set at intervals which may range from for example one week to one year. The adjustment is made for average conditions and therefore is rarely satisfactory if the natural draught of the chimney represents a substantial part of the total motive head.

We have now devised a burner having an air regulator which automatically controls the air pressure at the inlet of the burner at a fixed value which may be that of the base of the chimney or at a value differing from that of the base of the chimney by a fixed amount. In accordance with this invention a burner having an air regulator through which air must flow before entering the air inlet to the burner ^{is one} wherein said regulator comprises a container divided into one zone in communication with the air supply to the burner and another zone in communication with the air flow downstream of the burner. These zones are separated by a *which moves freely with substantially no elastic return forces* moveable partition so that the pressure of each zone is respectively that of the air supply to the burner and the air flow downstream of the burner. A change in pressure in the combustion chamber of the burner causes movement of the partition and by regulating means operatively connected to said moveable partition causes a change in the amount of air entering the regulator from the atmosphere. By this means whilst

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the burner is operating the pressure difference (which is preferably zero) between the air supply to the burner and the air flow downstream of the burner remains substantially constant.

The air regulator is eminently suitable for use with the burner described in French patent specification 75-15854 (equivalent to UK patent application 20532/76). However the air regulator can be attached to any burner, for example burners used for heating premises connected to natural draught chimneys. Furthermore the air regulator can act as a scavenging limiter when the burner is not being used, for as the pressure drops in the combustion zone and chimney of the burner so will the supply of air to the regulator from the atmosphere substantially cease.

It has been found that there is good control on burners fitted with this regulator with a diminution in the variation in the amount of CO₂ produced compared with the same burner not using this regulator.

The container which is divided into zones by the moveable partition can take various forms, and may simply be a cylinder or a rectangular box with a slideable piston as the moveable partition. Alternatively, it may be a cylindrical housing with rotary blades constituting the moveable partition. Other suitable forms of container are any mechanical arrangements producing a displacement when submitted to a differential pressure provided the displacements are sufficient to overcome any elastic return forces. In such cases the moveable partition can for example be a pendulum, a membrane or an aneroid type element.

The separate communications between the zones and the air flow downstream of the burner and the air supply to the burner are usually by way of pipe, conduit or tubing. The communication with the air supply

downstream of the burner is preferably made with the chimney stack of the burner, but it can if desired be made at the combustion chamber itself.

Most burners are provided with a fan or other device which takes in air at atmospheric pressure and delivers it at a higher pressure e.g. a compressor. In such cases the respective zone of the container must communicate with the air supply upstream of the fan or said other device. Most burners also have an adjustment means whereby for a given operation the amount of air entering the burner is fixed at a certain level. Again the respective zone of the container must communicate with the air supply upstream of the adjustment means.

The regulating means for causing a change in the amount of air entering the regulator may be of various forms, for example a damper, butterfly valve, a gate or one or more vanes, eg where the moveable partition comprises rotary blades. It must be designed so that aerodynamic forces do not product substantially any force or momentum tending to close or open the regulating means. The regulating means is operatively connected to the moveable partition and this may be by means of a link whereby for example lateral shifting of the moveable partition in a box or cylinder causes lateral shifting of the link which thereby alters the setting of the regulating means according to how much lateral shifting has been undergone by the moveable partition. Where a rotary container is used shifting of the blades due to a difference of pressure will cause a shifting of a vane or vanes whereby the amount of air entering the regulator is altered.

If desired one could use a servo mechanism, for example pneumatic, hydraulic or electric, to replace the bare connection between the moveable partition and the regulating means. This could be suitable for large burners where the regulating means may be hard to move.

The connection between the moveable partition and the regulating means can be adjusted so that negative pressure in the combustion chamber will tend to move the moveable partition in a direction closing the regulating means. If the burner is operating this closure will subject the air supply to a subatmospheric pressure and with no return force the regulating means will continue to close until the air supply pressure is equal to that in the combustion chamber.

If the burner is not working the flow of air is very slight so that the pressure drop through the regulator is negligible and the regulator will close completely, thus limiting the scavenging of the combustion chamber when the burner is not working. This may often be advantageous in that heat losses can be reduced during shut-down periods.

By contrast when the burner starts, a pressure peak generally occurs before the draught (which is due to the difference in temperature between the flue gases and ambient air) is established and for analogous reasons the regulator opens widely, so reducing the smoke during the few seconds or minutes following the start up.

For a natural draught burner there must be a difference in pressure between the air supply and the combustion chamber and the pressure of the air supply must be greater than that of the combustion chamber. It is necessary therefore that the difference in pressure between the zones should not cause the moveable partition to move so much that the regulating means changes the amount of air so that the pressure of the air supply equalises that of the combustion chamber. This can be readily prevented by applying a force to one side of the moveable partition, the force being applied so as to act against the tendency of the moveable partition to close the regulator. A weight connected to the moveable partition by a line passing over a pulley is a convenient way of applying a force. It is desirable that the difference in pressure between the air supply and the combustion chamber should be constant, and the use of the weight as just described provides this constant pressure difference.

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However it is preferred that burners where there is no pressure difference between the air supply and the combustion chamber be used.

The invention is now described with reference to the drawings in which:

Figure 1 shows a perspective view of one form of regulator suitable for use with the burner in accordance with the invention;

Figure 2 shows a view of another regulator;

Figure 3 shows a view of one form of burner with the regulator of Fig 1;

Figure 4 shows an exploded view of a rotary form of the regulator;

Figure 5 shows a section of the regulator of Figure 4;

Figure 6 shows a cross-section of the regulator on the line 6-6 of Figure 5; and

Figure 7 shows a view of a detail of a modified form of the regulator according to Figures 4 to 6.

Referring to Figure 1 of the drawings where it is assumed that the combustion chamber is under negative pressure a damper 1 closes an air box 2 in communication with the air supply. This damper 1 is constructed so as to slide freely so that the difference in pressure between the two faces of the damper does not lead to any forces tending to open or close the damper.

A piston 3 moves in a cylinder 4 which is closed at both ends except for allowing passage of rod 8 which connects the piston 3 to the damper 1. In this example the regulator therefore consists of the box 2, damper 1, cylinder 4, piston 3 and rod 8. The chamber or zones 5 and 6 on each side of the piston 3 are connected respectively via conduits 9 and 10 to the box 2 and the combustion chamber (not shown). The cross-section of conduits 9 and 10 is sufficient to enable the pressure in the zones 5 and 6 to be the same as that in box 2 and combustion chamber respectively.

Since this regulator (Figure 1) has no return force the negative pressure in the combustion chamber will tend to move the piston 3 (to the left in Figure 1) so as to close the damper 1. If the burner is operating, the closing of damper 1 will subject the box 2 to subatmospheric pressure and the damper 1 will continue to close until the pressure in the box 2 is equal to that in the combustion chamber.

For a natural draught burner there must obviously be a difference in pressure between the system upstream of the burner and the combustion chamber. Figure 2 shows a regulator which provides this difference in pressure and a difference which is constant. Parts shown with numerals 1, 3, 4, 5, 6 and 8 are as previously described. In the zone 5 there is a rod 11 connected to the piston 3. This rod passes out of zone 5 and is connected to cable 12 which passes over pulley 13 and is connected to weight 14. The (constant) difference in pressure between zones 5 and 6, will be $\Delta P = \frac{mg}{S}$ where m is the mass of weight 14 and S the cross-sectional area of piston 3. It is necessary that the piston 3 should have sufficient power to overcome friction and displace the damper 1.

The area of cross-section S must therefore be large and friction as low as possible. If S is large the variation of volume of zones 5 and 6 will be large and conduits 9 and 10 (not shown) of large cross-sectional area are used to avoid excessive time for achieving desired changes to the damper opening.

Normally combustion chambers which are under superatmospheric pressure are not of interest as far as this invention is concerned because they are usually completely insensitive to variations of natural draught. However where combustion chambers are occasionally subjected

to superatmospheric pressure the regulator and burner of this invention can be used provided that upstream of the damper there is a fan which for the normal air supply produces a head at least equal to the highest superatmospheric pressure recorded. A suitable regulator is shown in Figure 3 where the same numerals indicate identical parts as those shown in Figure 1 and the fan is shown at 15.

A regulator having more sensitivity is described with reference to Figures 4 to 7 which is a rotary regulator. There is a fixed housing 16 and a rotary bell 17. Both housing 16 and bell have blades 18 and 19 respectively. In this case there are two zones 5 and two zones 6, each zone being bounded by the blades 18 and 19. As can be seen from Figure 6 zones 6 are in communication with conduits 11 leading to the combustion chamber and zones 5 communicate with ports or conduit 10 leading to the air supply.

The fixed housing 16 carries circumferential vanes 20 as does the rotary bell 17 i.e. vanes 21. The rotary bell 17 is mounted co-axially inside the housing 16 so that the relative overlap of the vanes 20 on the one hand and the vanes 21 on the other hand act as a damper for air passing through the regulator. Pressure differences between zones 5 on the one hand and zones 6 on the other hand will cause slight rotation of bell 17 thereby altering the damper setting until the pressure is equalised.

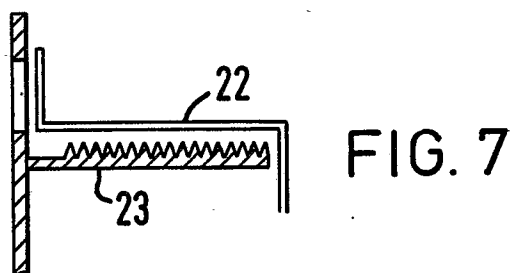
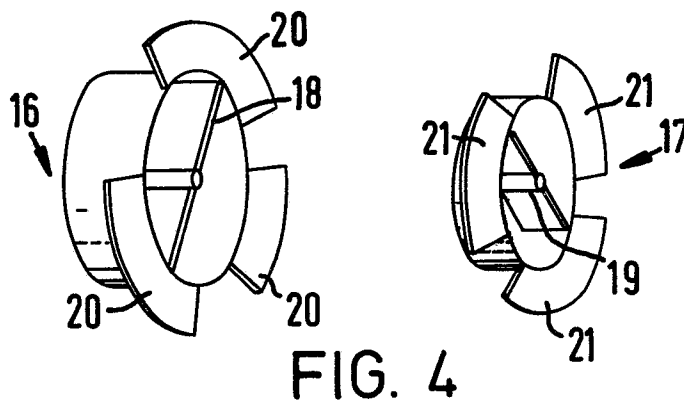
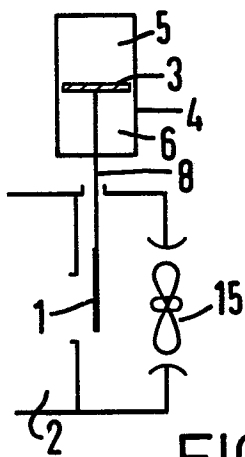
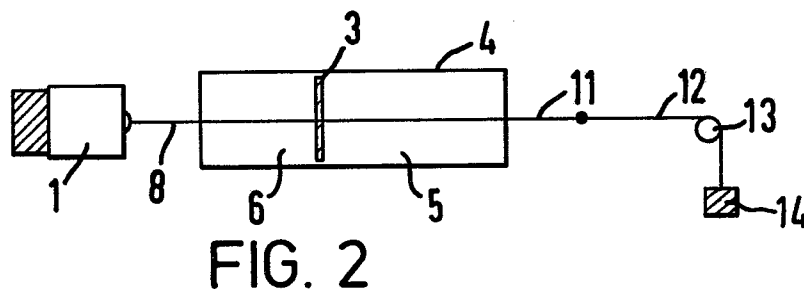
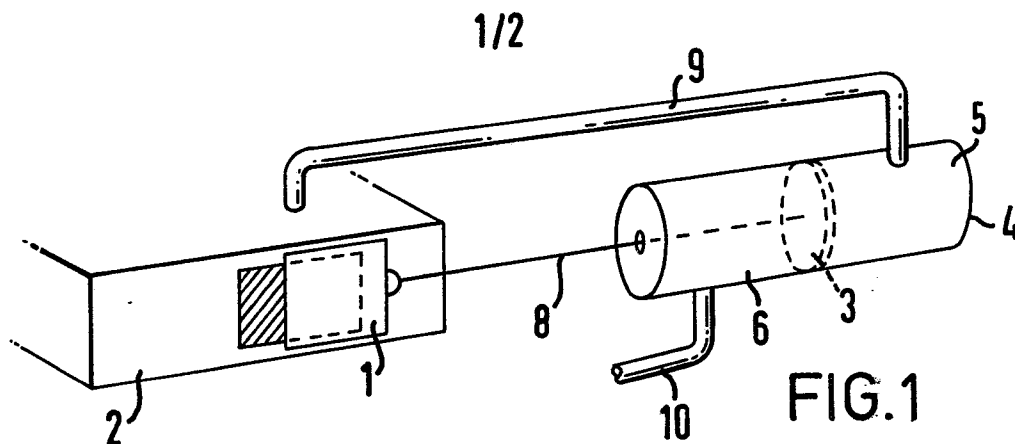
One difficulty of a rotary regulator is to achieve tightness between the rotary bell 17 and the housing 16, that is between the zones 5 and 6 and the outside. This can be achieved if the depth of the housing amounts to a few cm, if diametrical play is minimum (less than 0.5 mm) and if one of the two walls is of the labyrinth type. This is shown in Figure 7 where the hub 23 of the housing 16 has an undulating surface about which rotates the hub 22 of the rotary bell 17.

In the regulator described with reference to Figures 4 to 7 the nozzle pipe 24 passes through the regulator and the bearing is important in size and difficult to realise. When the burner is of the pneumatic atomisation type, the atomisation compressor facility may be used to provide an air bearing which is frictionless. The bearing hence rotates about a fixed axis, floating on an air film. In other cases good results can be obtained using a thin axle for example 1 mm diameter for a domestic burner, rotating in fixed bearings.

CLAIMS:

1. A burner having an air regulator upstream of the burner so that air must flow therethrough before entering the air inlet to the burner, wherein said regulator comprises a container divided into one zone in communication with the air supply to the burner and another zone in communication with the air flow downstream of the burner, the zones *which moves freely with substantially no elastic return forces* being separated by a moveable partition ~~so~~ that the pressure of each zone is respectively that of air supply and that of the air flow downstream of the burner and wherein a change in pressure in the combustion chamber of the burner causes movement of the partition and by regulating means operatively connected to said moveable partition causes a change in the amount of air entering the regulator from the atmosphere so that the pressure difference, which may be zero, between the air supply to the burner and the air flow downstream of the burner remains substantially constant.
2. A burner according to claim 1 wherein the container is a cylinder and the moveable partition a slideable piston.
3. A burner according to claim 2 wherein the regulating means is a damper and the slideable piston is connected to the damper by a link whereby lateral shifting of the piston alters the setting of the damper.
4. A burner according to claim 1 wherein the container is a cylindrical housing and the moveable partition comprises rotary blades.
5. A burner according to claim 4 wherein the regulating means comprises one or more vanes.
6. A burner according to any one of the preceding claims wherein a force is applied to one side of the moveable partition so as to act against the tendency of the moveable partition to close the regulator.

7. A burner according to any one of claims 1 to 5 wherein the pressure difference between the air supply to the burner and the air flow downstream of the burner is substantially zero.
8. A burner according to any one of the preceding claims wherein said another zone of the container communicates with the chimney stack of the burner.
9. A burner according to any one of the preceding claims which is provided with a fan upstream of which is the air supply to the burner.



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