March 28, 1961 C. ALLANDER ET AL 2,976,794

HIGH-VELOCITY PRIMARY AIR NOZZLE

Filed April 25, 1958

FIG.1.

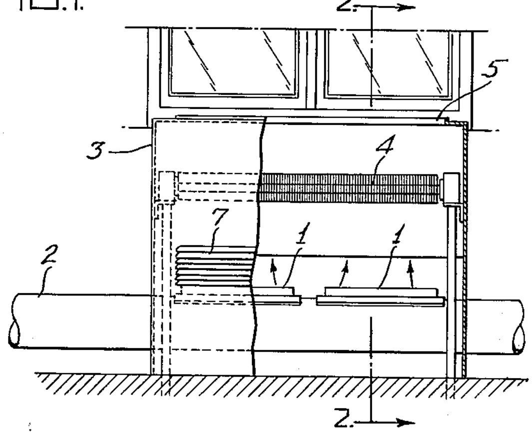


FIG.2.

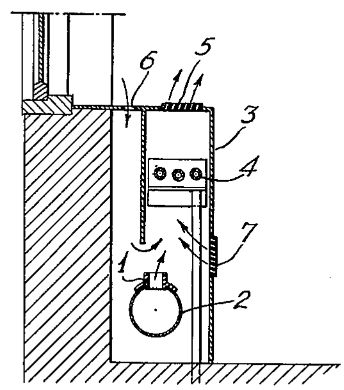


FIG.5.

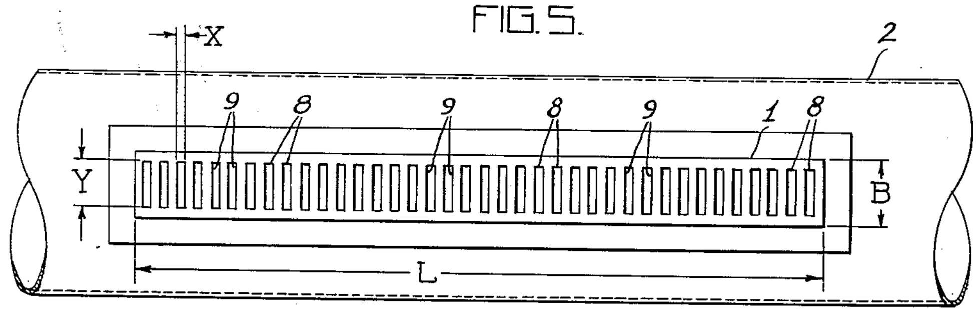


FIG.3.

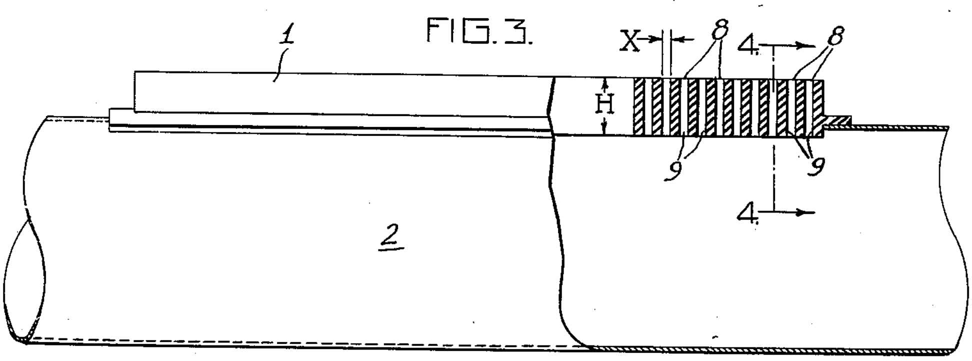
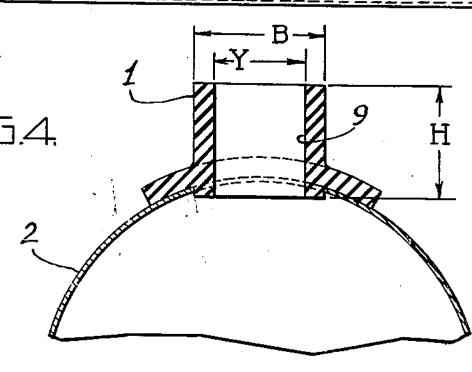


FIG.4.



INVENTORS:
CLAES ALLANDER
BIRGER LÄRKFELDT

BY *Howson & Howson*

ATTYS.

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HIGH-VELOCITY PRIMARY AIR NOZZLE

Claes Allander, Sodra Angby, and Birger Lärkfeldt, Jonkoping, Sweden, assignors to Aktiebolaget Svenska Flaktfabriken, Kungsgatan, Stockholm, Sweden

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3 Claims. (Cl. 98—38)

The present invention relates to a device for inducing and mixing by ejecting action secondary air into a current of primary air discharged from a duct or pressure chamber, said device consisting of nozzle means connected to said duct or chamber.

Devices of this kind are nowadays used for ventilating plants in order to create a circulation of the room air by means of a limited preferably pre-treated quantity of air supplied to said room. It can be made evident both theoretically and experimentally, that when a resistance is present for the flow of the mixture, the quantity of secondary air increases with increasing velocity of the discharged primary air and with an increased value of the total boundary lines of the primary-air jets. Since in actual practice it is desired to have a heavy ejection of room air and an intimate mixing between primary and secondary air, it will be necessary to work with as high a discharge velocity as possible and with as large a value of the total boundary lines of the primary air jets as possible.

A problem which arises when air is given high velocities is that noise occurs. In apparatus of the kind used within the ventilating technique—to which the present invention relates—there is an extraordinary requirement for freedom from noise. The noise occurs usually because of whirling currents and increases with the extent of whirls and these usually arise in the nozzles or flow passages constituting the discharge means for the primary air.

The deciding factor for the degree of the occurrence of whirls in a flow passage for a medium is the actual Reynold's number for the flow. This number is defined as the product of the flow velocity of the medium and the hydraulic diameter of said flow passage divided by the kinetic viscosity of the flowing medium. In a long channel a shifting from laminar to turbulent flow occurs at a value of the Reynold's number of about 2000. As the length of the flow passage decreases said value decreases depending upon disturbances in the inlet of said passage. When the flow is laminar hardly any noise occurs, and thus the most silient pressure reduction can be obtained in this kind of flow. The rule may thus be so formulated that for a constant pressure reduction, the noise increases with increasing Reynold's number, and thus a method to satisfy the requirement for noise elimination is to work with small Reynold's numbers. In order to obtain the necessary throttling or pressure reduction, the length of the passage must increase with a decrease in the Reynold's number and thus the length of said flow passage in accordance with the invention should considerably exceed the hydraulic diameter of same.

The device according to the invention is constructed in accordance with the above mentioned principles, and is characterized in that the primary air nozzle means is provided with a great number of narrow slots arranged mutually parallel and adjacent each other. The slots constitute throats of a corresponding number of passages having substantially the same cross-section area as

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said slots and being so dimensioned with respect to their length as well as their cross-section area that the flow through said passages takes place without any obvious occurrence of whirls. The nozzle means should preferably be made with a relatively small width in relation to the length of same and the flow passages should be arranged substantially perpendicular to the longitudinal direction of the nozzle means. With respect to the actual medium velocity, the flow passages should be given such a hydraulic diameter that the Reynold's number does not exceed 2000. In order to eliminate as much as possible disturbing noises, the nozzle means should be made of a soft, sound-deadening material for instance of rubber, plastic material or the like.

The invention will now be described more in detail with reference to the accompanying drawing, wherein

Fig. 1 is an elevational view with portions broken away of a ventilating unit provided with nozzle means according to the invention.

Fig. 2 is a cross-section along the line 2—2 of Fig. 1.

Fig. 3 is an elevational view in a larger scale with portions broken away illustrating the nozzle means applied to a duct.

Fig. 4 is an enlarged cross-section along the line 4—4 of Fig. 3 and

Fig. 5 is a horizontal plan view of the duct of Fig. 3.

In the drawing, a nozzle means **1** in accordance with the invention is mounted in a ventilating unit **3** and is connected to a duct **2**, supplying said unit with ventilating air (primary air). The unit in the illustrated embodiment of the invention is provided with a conventional heat exchanger **4** for finally heating the air, inlet openings **6**, **7** for secondary air and a discharge opening **5** for the mixture of primary and secondary air. The location of said openings **6** and **7** may be varied in accordance with the placing of the unit. It is essential that the room air introduced through said openings is conducted in such a way that the room air will be supplied adjacent the nozzle means as shown by the arrows in Fig. 2. The nozzle means **1**, according to the invention, comprises a generally rectangular hollow frame with a relatively small width B in relation to its length L and provided with a great number of spaced parallel narrow partitions disposed transversely of said frame across its full width and defining a like number of narrow mutually parallel slots **8** arranged adjacent each other. Said slots constitute the throats of a corresponding number of flow passages **9** having substantially the same cross-sectional area as said slots. The flow passages are connected at their inner ends to the conduit or duct **2** and are of uniform cross section throughout. At their outer ends, the flow passages terminate in spaced parallel outlet openings or slots which create a like number of flat streams of primary air flowing into the unit **3**. The partitions between the openings **8** create cavities of sub-atmospheric pressure between the streams into which the secondary air is drawn and mixed with the primary air in the flat streams. The flow passages are with respect to their depth H as well as their cross-section area XY dimensioned in such a manner that the flow through said passages takes place without any obvious occurrence of whirls. To prevent the turbulence or whirls, the flow passages **9** should be given such a hydraulic diameter that the Reynold's number does not exceed 2,000, i.e., the hydraulic diameter multiplied by the velocity of the primary air and divided by the kinetic viscosity of the air, produces a Reynold's number below 2,000. In addition, the depth of the frame and partitions should be substantially greater than the hydraulic diameter of the flow passages to reduce the effect of disturbances at the inlet to the flow passages. The discharge slots **8** should, as in the illustrated embodiment be arranged substantially perpendicular to the length direction of the nozzle means in order to secure as large an area of introduction for the secondary air as possible. For the same reason the flow passages **9** are located—as shown in Fig. 5—with a suitable spacing with respect to their width X.

What we claim is:

1. In an air conditioning room unit having a conduit for the supply of high-velocity primary air, means to admit secondary room air into said unit, and means to exhaust a mixture of primary and secondary air from said unit; an elongated nozzle element within said unit comprising a generally rectangular hollow frame connected at its inner end to the conduit and having a substantially plane outer surface, and a plurality of spaced parallel narrow partitions disposed transversely of said frame across its full width and coextensive in depth with said frame, said partitions defining a plurality of transverse spaced parallel narrow flow passages connected at their inner ends to said conduit, extending through said frame with uniform cross section throughout and terminating at their outer end in a like number of spaced parallel outlet openings creating a like number of flat streams of primary air flowing into said unit, said partitions creating cavities of sub-atmospheric pressure between said streams into which the secondary air is drawn and mixed with said primary air, the partitions being spaced apart relative to the width of said hollow frame to produce in said passages a hydraulic diameter considerably less than the depth of the frame, and when multiplied by the velocity of the primary air flowing therethrough and divided by the kinetic viscosity of the air producing

a Reynold's number below 2,000, whereby the flow through said passage is laminar without reducing the velocity of primary and thereby the quantity of secondary air drawn into and mixed with said primary air in said unit.

2. A device according to claim 1 wherein the nozzle element is relatively small in width in relation to its length and that the flow passages are arranged substanperpendicular to the longitudinal direction of said nozzle means.

3. A device according to claim 1 wherein said primary air conduit extends through said unit and said nozzle element is disposed longitudinally of said conduit whereby said narrow flow passages are disposed transversely of the primary air flow in said conduit.

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