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(71) Applicant: **HALTON OY**
Teollisuustie 2-4
SF-47400 Kausala(FI)

(72) Inventor: **Kyllönen, Pekka**
Riihitarhankatu 3 A 2
SF-15170 Lahti(FI)

(74) Representative: **Tiedtke, Harro, Dipl.-Ing. et al**
Patentanwälte Tiedtke-Bühling- Kinne &
Partner Bavariaring 4 Postfach 20 24 03
W-8000 München 2 (DE)

(54) A suspended ceiling structure and a method for flowing air in connection with the suspended ceiling structure.

(57) The invention relates to a suspended ceiling structure (10) and a method for flowing air in connection therewith. The suspended ceiling structure is especially intended for large-scale kitchen spaces and is formed of modular units, which comprise at least an inlet air unit (11) and an outlet air unit (18) and in an area therebetween a suspended ceiling board (25). The suspended ceiling structure comprises means producing a capture air jet (L_{1a}), whereby the air jet may be brought to flow in the direction of a plane (T) of the suspended ceiling board (25) toward an outlet air opening (20) of the outlet air flow (L_2), whereby the capture air flow (L_{1a}) draws an impure air and/or excess heat or excess moisture risen from the the impurity source of the room space toward the outlet air unit (18). The suspended ceiling structre (10) comprises such means producing the capture air jet (L_{1a}), the air-flow dischage opening (D) of which means is located essentially directly in the vicinity of a surface plane (25') of the suspended ceiling board (25) and that the means producing the capture air jet (L_{1a}) comprise an air guiding surface (27a'), which orientates the air jet such that it flows in the direction of the plane (T) of the suspended ceiling board (25) toward the outlet air chamber (19) of the outlet air unit (18).

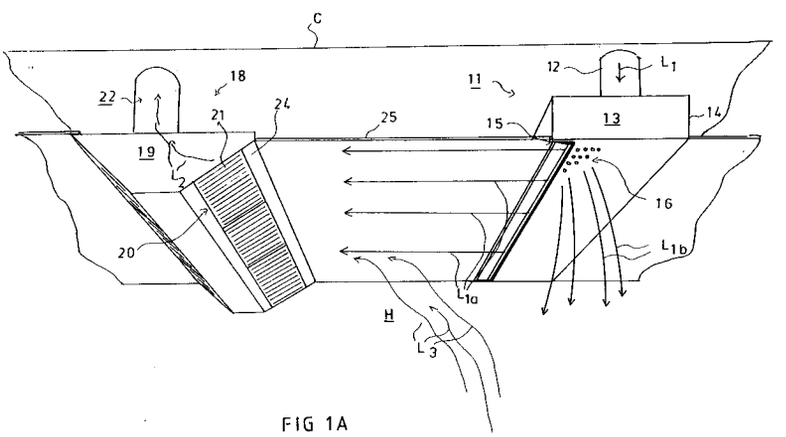

FIG 1A

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The invention relates to a suspended ceiling structure and a method for flowing air in connection with the suspended ceiling structure.

From an earlier FI publication print 84 096 by the applicant is known a suspended ceiling structure, in which structure impurities produced in cooking objects are prevented by means of a capture air jet from collecting in connection with a suspended ceiling structure and said imputities are passed to an outlet air unit of the ceiling module. In the structure, the suspended ceiling structure comprises such an inlet air unit related to the suspended ceiling structure, via channel opening of which inlet air unit a carrier air and capture air jet is produced toward grease filters of the outlet air unit.

In this application, attempts have been made to improve said orientatation of the capture air jet to the outlet air unit. It has been observed in the invention to use such a carrier air jet, which has been flown along with the plane surface of the ceiling module towards the outlet air unit. Thus, it has been realized in the invention to use a so-called Coanda-effect, in which an air jet produced in connection with the ceiling module surface flows, when adhered to the surface of the ceiling module, tightly along with the surface towards the outlet air unit and flows along therewith impurities and/or overheated air produced by lower cooking equipment. In accordance with the invention, such a device producing a capture air jet is used, from which air is released from the plane of the ceiling surface and flown thereafter in the direction of the plane of the ceiling surface. According to the invention, the speed of the carrier air jet directed towards the outlet air unit and the form of its distribution figure may be adjusted by an adjusting device.

The inventive adjusting device comprises an air chamber, which is limited by curved surfaces limited to the air chamber. The air is preferably brought to the air chamber from an air chamber of the inlet air device, from which inlet air chamber the air is flown also via a separate hole surface into the room space.

The air is flown from the air chamber of the adjusting device out from between the curved air control surface and the curved air control surface of an adjusting piece such that the curved surface of the chamber plate controls air to flow immediately from the ceiling surface plane of the ceiling module in the direction of the ceiling-surface plane towards the outlet air unit. In accordance with the invention, the adjusting piece to be moved in the air chamber is comprised of a nose portion, the tip of which is fitted to move along with the curved inner surface of the chamber plate limiting the chamber. The tip of the nose portion comprises a curved air flowing surface. The adjusting piece is fitted to be manually rotated on a rotational bearing around a central point O of the bearing and the air chamber. The adjusting piece is fitted to be located in a counterpiece of the rotational bearing such that it is located in an area between the central point O of the rotational bearing and a surface bounded to the chamber plate of the rotational bearing, as the nose portion of the adjusting piece is tangent to the curved inner air control surface of the chamber plate.

The inventive suspended ceiling structure is mainly characterized in that the suspended ceiling comprises such means producing a capture air jet, the air-flow outlet opening of which means is essentially located directly in the vicinity of the surface plane of the suspended-ceiling board and that the means produced by the capture air jet comprise an air control surface, which directs the air jet such that it flows in the direction of the suspended-ceiling board towards an outlet air chamber of the outlet air device.

The inventive method for flowing air in connection with a suspended ceiling structure is mainly characterized in that air is flown from a flowing gap placed in the vicinity of the surface plane of the suspended ceiling board bounded to the room, which flowing gap is located by its plane essentially in the direction of the board surface of the suspended ceiling board, and in which method air is led, directed by the inner surface of the curved chamber plate, to be discharged from the gap such that the air flow is given the direction of the board plane of the suspended ceiling board already at a step when air exits via the gap.

The invention is next described with reference to certain preferred embodiments of the invention, to which the invention is not solely intended to be limited.

Fig. 1A shows a general represantation of the inventive method and the device solution.

Fig. 1B shows an adjusting device as a side view and as a cross-sectional view.

Fig. 2 shows the adjusting device as an axonometric view before the assembly of the parts.

Fig. 3A shows the adjusting device when assembled, and in a certain embodiment of the adjustment, Fig. 3B shows the carrier air jet figure related to the embodiment of Fig. 3A.

Fig. 4A shows another adjusting position of the adjusting piece of the adjusting device.

Fig. 4B shows a flow diagram of the carrier air jet related to the position of the adjusting piece of Fig. 4A.

According to Fig. 1A, fresh inlet air L_1 is brought to a room space H via an inlet air device 11. The air coming from an inlet air channel 12 is flown to an inlet air chamber 13 of the inlet air unit 11, which inlet air chamber 13 is bounded by a box body 14. Air is flown from the inlet air chamber 13

via a channel opening 15 as a carrier air jet L_{1a} towards grease filters 21 of an outlet air device 18.

The outlet air unit 18 comprises an outlet air chamber 19, which is bounded by a case 23 of the outlet air chamber. The case 23 comprises for an outlet air flow L_2 an opening 20, which opens into an internal outlet air chamber 19 of the case structure. In connection with the opening 20 is located a grease filter 21. The outlet air opening 20 is located on a slanting surface 24 of the case 23. The air flow is further led, according to the figure, to an outlet air chamber 22 of the case-like outlet air chamber. The air flow is further led via the outlet air chamber 22 out of the connection of the structure.

According to Fig. 1A, both the inlet air unit 11 and the outlet air unit 18 are supported on the actual ceiling structure C. In an area L between the inlet air unit 11 and the outlet air unit 18 is located below the actual ceiling structure C a suspended ceiling board 25. The suspended ceiling board 25 rests on the inlet air unit 11 and the outlet air unit 18. On top of the suspended ceiling board 25 are fitted devices for other technical equipment, such as electrical lead-ins. The air flow as the carrier air jet L_{1a} occurs in the vicinity of the suspended ceiling board 25. By means of the capture air jet L_{1a}, the impurities risen from the cooking equipment of the kitchen are led directly to the filters 21. The accumulation of the impurities is thus prevented by means of the capture air jet L_{1a} in the area between the inlet air unit 11 and the outlet air unit 18 to the vicinity of the suspended ceiling structure 25.

According to Fig. 1A, air is flown to a room space H via one channel opening 16 of the inlet air unit 11 directly downwards, as shown by an arrow L_{1b}. By means of a perforated plate 17, a sufficiently low flow rate is achieved for the air flow L_{1b}. In this way, the feeling of draught is prevented in the working zone of the kitchen personnel working in the kitchen space H. From the kitchen space H, the outlet air flow is removed via the outlet air channels 22 of the outlet air device 18, as shown by the arrow L_2, which flow is formed of the carrier air jet L_{1a} as well as of an impure air flow L_3 drawn along therewith.

The inventive structure is modular comprising several constant widths for the suspended ceiling board 25. Thus, a different suspended ceiling structure arrangement may be formed according to the need of each space. Thereby, it is possible to select the distance between the inlet air units and the outlet air units as desired and according to the requirements of the space.

According to Fig. 1B, the equipment comprises an adjusting device 26, by means of which the capture air jet L_{1a} may be adjusted. The adjusting device 26 is fitted to the inlet air chamber 13 of the inlet air unit 11 such that the air flows from the inlet air chamber 13 to an air chamber E of the adjusting device. The air chamber E is bounded by curved chamber plates 27a and 27 b. An adjusting piece 28 is fitted to the air chamber E. It is fitted to turn in the air chamber E to the desired position such that it is caused to enter into different covering positions relative to a gap D. The adjusting piece 28 is moved by means of bearing means 29 (Fig. 2). The adjusting piece is connected to the bearings means 29 such that the adjusting piece 28 is located in the air distribution chamber E eccentrically relative to a central point O of the chamber. The adjusting piece 28 is thus located in an area between the central point O of the chamber and a curved inner surface F of the chamber plate 27a, 27b limiting the chamber E.

A nose portion 30 of the adjusting piece 28 is located in the vicinity of the inner surface F of the chamber plate 27a, 27b.

A curved air-flow guiding surface 31 is connected to the nose portion 30, whereby the air flow out from the chamber E occurs along with the curved guiding surface 31 of the air flow of the adjusting piece 28 as well as along with the curved inner surface of the chamber plate 27a.

Between the chamber plate 27a and the chamber plate 27b there is an outflow gap D, which is located on the plane T of the sucpended ceiling board 25. The air exits from the chamber E along with a surface portion 27a' bounded to the gap D of the chamber plate 27a and flows thus to the vicinity of a surface plane 25' of the suspended ceiling board 25 and further in the direction of the plane T of the suspended ceiling board.

Fig. 2 shows the adjusting device 26 as a partial viwe, as an axonometric representation and before the assembly of the parts related to the adjusting device 26. The adjusting device 26 comprises an end piece 32, in which a counter-bearing 29a of the bearing means is located. The counterbearing part 29a is formed of a flange 33 extending from a surface plane S of the part 32, which flange is preferably a circular flange. Around a side surface G of the flange 33 is placed a counterbearing part 29b of the bearing means 29. The counterbearing part 29a may be rotated, guided by the surface G, around a central point O into a desired angular position. The centre of the bearing is located in the point O (Fig. 1B). The counterbearing part 29b comprises a flange portion 34 extending from a surface plane S', which is also preferably a circular flange. Around the flange portion 34 is placed the adjusting piece 28 from its end. The circular flange 34 comprises guiding slots P_1, P_2, P_3, into which guiding notches P_1', P_2', P_3' of the adjusting piece 28 are placed and thus keep the

adjusting piece 28 in an accurate position with respect to the counterbearing part 29b of the bearing means 29.

In accordance with the figure, the adjusting device 26 additionally comprises the curved chamber plates 27a, 27b, which may be fixed with screws R to a frame plate 35 of the counterbearing part 29a of the bearing means 29.

Fig. 2 shows only one end of the adjusting device 26. The other end of the adjusting device 26 is mounted with corresponding means, and the adjusting piece 28 is fixed by corresponding means to the bearing means 29 as the first end.

Thus, when controlling the capture air jet L_{1a} the adjusting piece 28, when fixing to the bearing portion 29b of the bearing means 29, may be rotated by rotating said bearing means (arrow N) to a desired position in the air chamber E of the chamber plates 27a, 27b.

Fig. 3 shows the adjusting piece 28 in a position realizing the thin capture air jet L_{1a}. The air comes according to arrows M to the inlet chamber E into a space between the chamber plates 27a, 27b and flows further from a gap D' between the adjusting piece 28 and the chamber plate 27a, guided by an end surface 27a' of the chamber plate 27a to a surface plane 25' of the suspended ceiling board 25, and flows in the direction of the plane T of the suspended ceiling board 25 toward the outler air unit.

Fig. 3B shows a flowing figure of the capture air jet L_{1a} of Fig. 3A corresponding to the position of the adjusting piece 28. By means of the adjusting device 26, it has been possible to achieve a thin air flow just to the vicinity of the surface plane 25' of the suspended ceiling structure 25.

Fig. 4A shows another adjusting position of the adjusting piece 28, in which the adjusting piece 28 has been turned according to the figure in a clockwise direction and in which the flowing gap D' from between the air guiding surface of the adjusting piece 28 and the inner surface of the chamber plate 27a is larger than in the adjusting position of Fig. 4A. According to Fig. 4B, a thicker air flow jet is produced toward the grease filters 21 of the outlet air device 18.

In the inventive method, the air is first flown into the space E between the chamber plates 27a, 27b, and from said space E from the flow route D' between the curved guiding surface 31 of the air of the adjusting piece 28 as well as the inner surface F of the chamber plate 27a or 27b via the gap D to the vicinity of the surface plane 25' of the suspended ceiling board 25 and further in the direction of the plane T of the suspended ceiling board 25 toward the outlet air unit 18. The air thus flows smoothly in the flowing route D' between the curved guiding surface 31 of the adjusting piece 28 and the curved guiding surface F of the chamber plate 27a or 27b. The air is directed via the curved end portion 27a' of the chamber plate 27a into the gap D and further to the vicinity of the surface plane 25' of the suspended ceiling board 25. The flow opening of the gap D is located by its plane S essentially in the direction of the plane T of the suspended ceiling board 25. In the inventive method, the flow of the carrier air jet L_{1a} iscontrolled by adjusting the distance between the curved guiding surface 31 of the adjusting piece 28 and the chamber plate 27a or 27b by rotating the adjusting piece 28. The invention relates to a suspended ceiling structure (10) and a method for flowing air in connection therewith. The suspended ceiling structure is especially intended for large-scale kitchen spaces and is formed of modular units, which comprise at least an inlet air unit (11) and an outlet air unit (18) and in an area therebetween a suspended ceiling board (25). The suspended ceiling structure comprises means producing a capture air jet (L_{1a}), whereby the air jet may be brought to flow in the direction of a plane (T) of the suspended ceiling board (25) toward an outlet air opening (20) of the outlet air flow (L_2), whereby the capture air flow (L_{1a}) draws an impure air and/or excess heat or excess moisture risen from the the impurity source of the room space toward the outlet air unit (18). The suspended ceiling structre (10) comprises such means producing the capture air jet (L_{1a}), the air-flow dischage opening (D) of which means is located essentially directly in the vicinity of a surface plane (25') of the suspended ceiling board (25) and that the means producing the capture air jet (L_{1a}) comprise an air guiding surface (27a'), which orientates the air jet such that it flows in the direction of the plane (T) of the suspended ceiling board (25) toward the outlet air chamber (19) of the outlet air unit (18).

Claims

1. A suspended ceiling structure (10), which is especially intended for large-scale kitchen spaces and is formed of modular units, which comprise at least an inlet air unit (11) and an outlet air unit (18) and in an area therebetween a suspended ceiling board (25), and which suspended ceiling structure is formed below an actual ceiling structure (C) of the room, whereby a free space (E) remains between the suspended ceiling structure (10) and the actual ceiling (C) of the room, and which suspended ceiling structure (10) comprises an inlet air chamber (12) for a fresh-air flow (L_1) to be brought to the room, which inlet air chamber (12) is connected to a body frame (14) limiting the inlet air chamber, from which inlet air

chamber (11) opens at least one flow opening for the air flow coming to the room, and which suspended ceiling structure comprises an outlet air unit (18), which comprises a case-like frame (23), which limits inside it an outlet air chamber (19), whereby an opening for the outlet air flow (L_2) opens into the outlet air chamber (19) from the room space, which opening comprises in its connection grease filters (21), and whereby the outlet air chamber (19) is fitted to be located in the suspended ceiling structure above the cooking means located in the room space, and which suspended ceiling structure (10) comprises a modularily mountable suspended ceiling board (25), whereby at least one suspended ceiling board (25) is fitted in an area between the inlet air unit (11) and the outlet air unit (18), and that the suspended ceiling structure (10) comprises means producing a capture air jet (L_{1a}), whereby the air jet may be brought to flow in the direction of a plane (T) of the suspended ceiling board (25) toward an outlet air opening (20) of the outler air flow (L_2), whereby the capture air flow (L_{1a}) draws an impure air and/or excess heat or excess moisture risen from the the impurity source of the room space toward the outlet air unit (18), which prevents the accumulation of the impurities and/or excess heat and/or excess moisture in an area between the inlet air unit (11) and the outler air unit (18) in the vicinity of the suspended ceiling board (25) of the suspended ceiling structure, **characterized** in that the suspended ceiling structure (10) comprises such means producing the capture air jet (L_{1a}), the air-flow dischage opening (D) of which means is located essentially directly in the vicinity of a surface plane (25') of the suspended ceiling board (25) and that the means producing the capture air jet (L_{1a}) comprise an air guiding surface (27a'), which orientates the air jet such that it flows in the direction of the plane (T) of the suspended ceiling board (25) toward the outlet air chamber (19) of the outlet air unit (18).

2. A suspended ceiling structure according to Claim 1, **characterized** in that the surface portion (27a') directing the air flow relates to the curved chamber plate (27a), which limits together with the adjusting piece (28) of the adjusting device (28) therebetween a flow gap, from which the air flows to the vicinity of the suspended ceiling board (25).

3. A suspended ceiling structure according to Claim 1 or 2, **characterized** in that there is an adjusting device (26), by means of which it is possible to adjust the location of the adjusting piece (28) of the adjusting device in the air chamber (E) limited by the curved chamber plates (27a, 27b), into which chamber (E) the air is first flown and from which the air is further flown from between the adjusting piece (28) and the curved chamber plate (27a or 27b) to the vicinity of the surface plane (T) of the suspended ceiling board (25).

4. A suspended ceiling structure according to any of the preceding Claims, **characterized** in that the adjusting piece (28) comprises at its end bearing means (29), on which the adjusting piece (28) may be turned into different adjusting positions for producing a desired air flow profile (L_{1a}) via the gap (D) below the suspended ceiling board (25).

5. A suspended ceiling structure according to any of the preceding Claims, **characterized** in that the adjusting piece (28) is fitted into the air chamber (E) into an an air space (E) bounded by the chamber plates (27a, 27b) such that the adjusting piece (28) is located in an area between the central point (O) of the chamber (E) and an inner surface (F) of the the chamber plate (27a, 27b) and such that a nose portion (30) of the adjusting piece (28) is located in the vicinity of the inner surface (F) of the chamber plate (27a or 27b).

6. A suspended ceiling structure according to any of the preceding Claims, **characterized** in that the nose portion (30) of the adjusting device (26) comprises a curved air-flow guiding surface (31), whereby the guiding surface (31) of the adjusting piece (28) together with the curved inner surface of either of the chamber plates (27a or 27b) forms therebetween an air flow route (D'), via which the air is flown from the gap (D) to the vicinity of the surface plane 25') of the suspended ceiling board (25) and flown in the direction of the plane (T) of the suspended ceiling board (25).

7. A suspended ceiling structure according to any of the preceding Claims, **characterized** in that the adjusting device (26) comprises an end piece (32), in which a counterbearing part (29a) of the bearing means (29) is located, which counterbearing part (29a) is formed of a circular flange (33) extending from the surface plane (S) of the part (32), around a side surface (G) of which circular flange (33) is placed a counterbearing part (29b) of the bearing means (29), which will be located around the side surface (G) of the flange (33).

8. A suspended ceiling structure according to the preceding Claim, **characterized** in that the counter-bearing part (29b) may be turned, guided by the side surface (G) of the flange (33), around the central point (O) of the chamber and the bearing into a desired angular position, whereby the adjusting piece (28) fixed to the counter-bearing part (29a) obtains the desired adjusting positions.

9. A suspended ceiling structure according to the preceding Claim, **characterized** in that the counter-bearing part (29a) comprises a flange portion (34) extending from the surface plane (S), which flange portion (34) is preferably a circular flange, and around the flange portion (34) is placed from its end the adjusting piece (28).

10. A suspended ceiling structure according to any of the preceding Claims, **characterized** in that the chamber plates (27a, 27b) open from their both ends, whereby the adjusting device (26) is placed in the inlet air unit (11) such that the air chamber (E) of the adjusting device opens into the inlet air chamber (13) of the inlet air unit (11), whereby via the inlet air unit (11) are produced both the capture air jet (L_{1a}) and the normal fresh-air inlet air jet (L_{1b}), preferably via a perforated surface.

11. A method for flowing air in connection with a suspended ceiling structure (10) comprises an inlet air unit (11) and an outlet air unit (18) as well as a suspended ceiling board (25) therebetween, and which units (11, 18) are mounted below the actual ceiling (C) of the room space, whereby a free space (E) remains between the suspended ceiling structure (10) and the actual ceiling (C) of the room space, and which suspended ceiling structure (10) is supported on the actual ceiling (C) of the room space, and in which method air is flown via the inlet air unit (11) to the room space (H) such that it is directed from the inlet air unit (11) at a fairly high speed in the direction of the plate plane (T) of the suspended sealing board (25), **characterized** in that the air flown to the vicinity of the surface plane limiting to the room of the suspended ceiling board (25) from the flowing gap (D), which is located by its plane essentially in the direction of the plate plane (T) of the suspended ceiling board (25) and in which method the air is guided, directed by the inner surface (F) of the curved chamber plate (27a or 27b), from the gap (D) such that an orientation of the plate plane (T) of the suspended ceiling board (25) is given to the air flow already at a step when the air exits via the gap (D).

12. A method according to the preceding Claim, **characterized** in that air is flown form between the curved air guiding surface (31) of the adjusting piece (28) and the curved inner surface (F) of the chamber plate (27a or 27b) via the gap (D) to the room space (H).

13. A method according to Claim 11 or 12, **characterized** in that the flow of the carrier air jet is controlled by adjusting the distance between the inner surface (F) of the chamber plate (27a, 27b) and the air guiding surface (31) of the adjusting piece (28).

14. A method according to any the preceding Claims 11-13, **characterized** in that the distance between the inner surface (F) of the chamber plate (27a or 27b) and the adjusting piece (28) is changed by turning the adjusting piece (28) on the bearing means (29).

15. A method according to any the preceding Claims 11-14, **characterized** in that the air is flown (arrow M) first to a space (E) between the chamber plates (27a, 27b) and from the space (E) via the gap (D) to the vicinity of the inner surface of the suspended ceiling board and to flow in the direction of the plane (T) of the suspended ceiling board (25) toward the outlet.

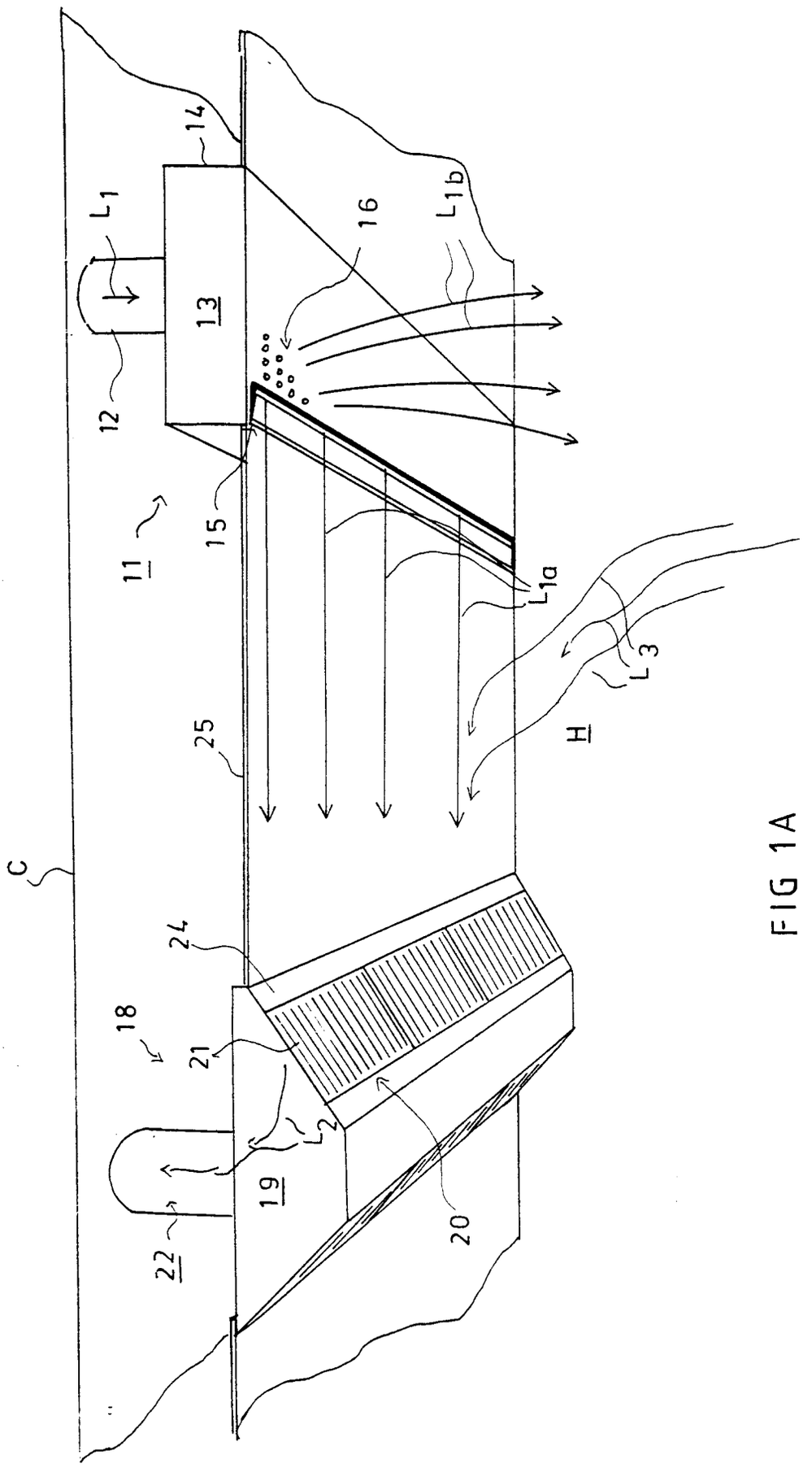

FIG 1A

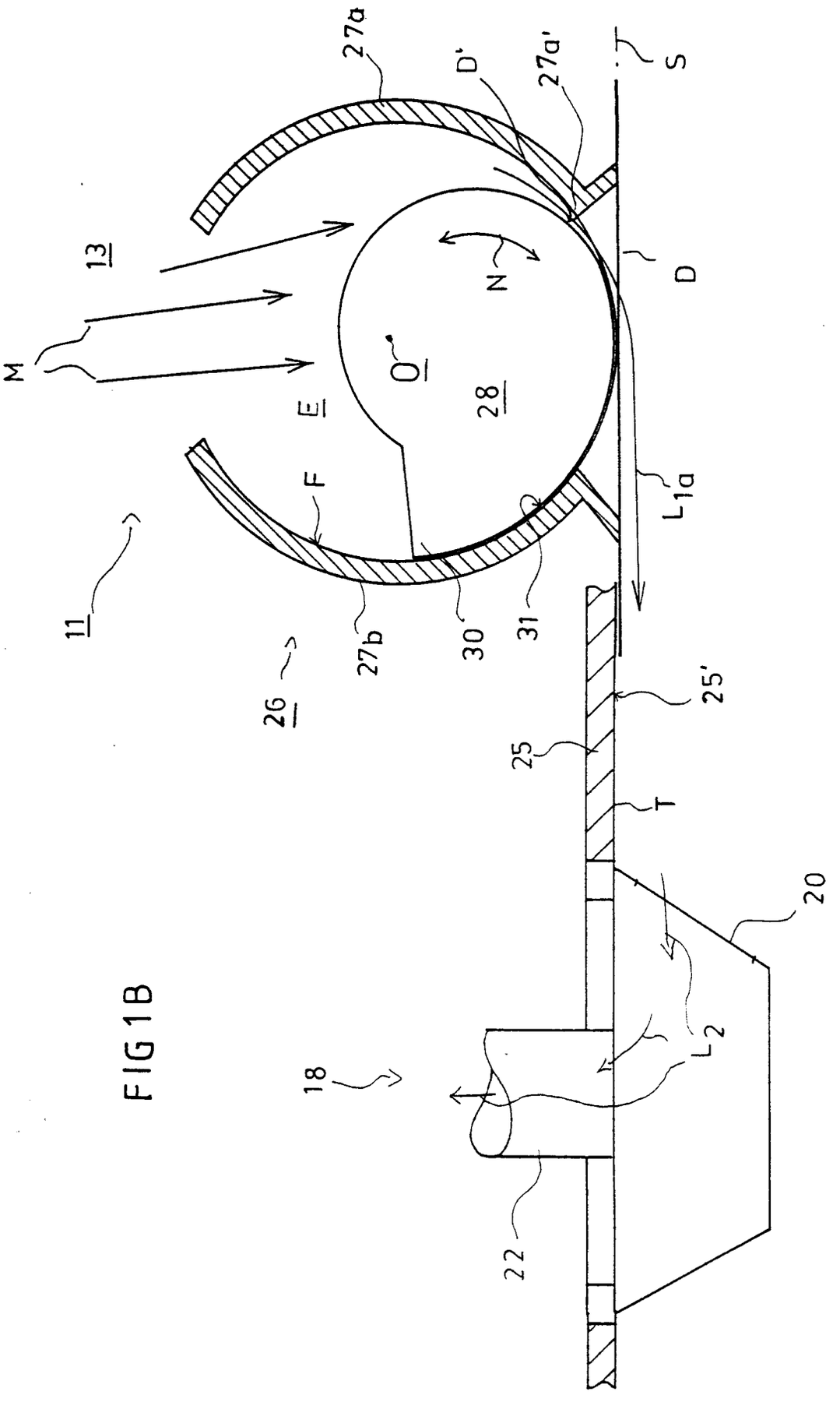

FIG 1B

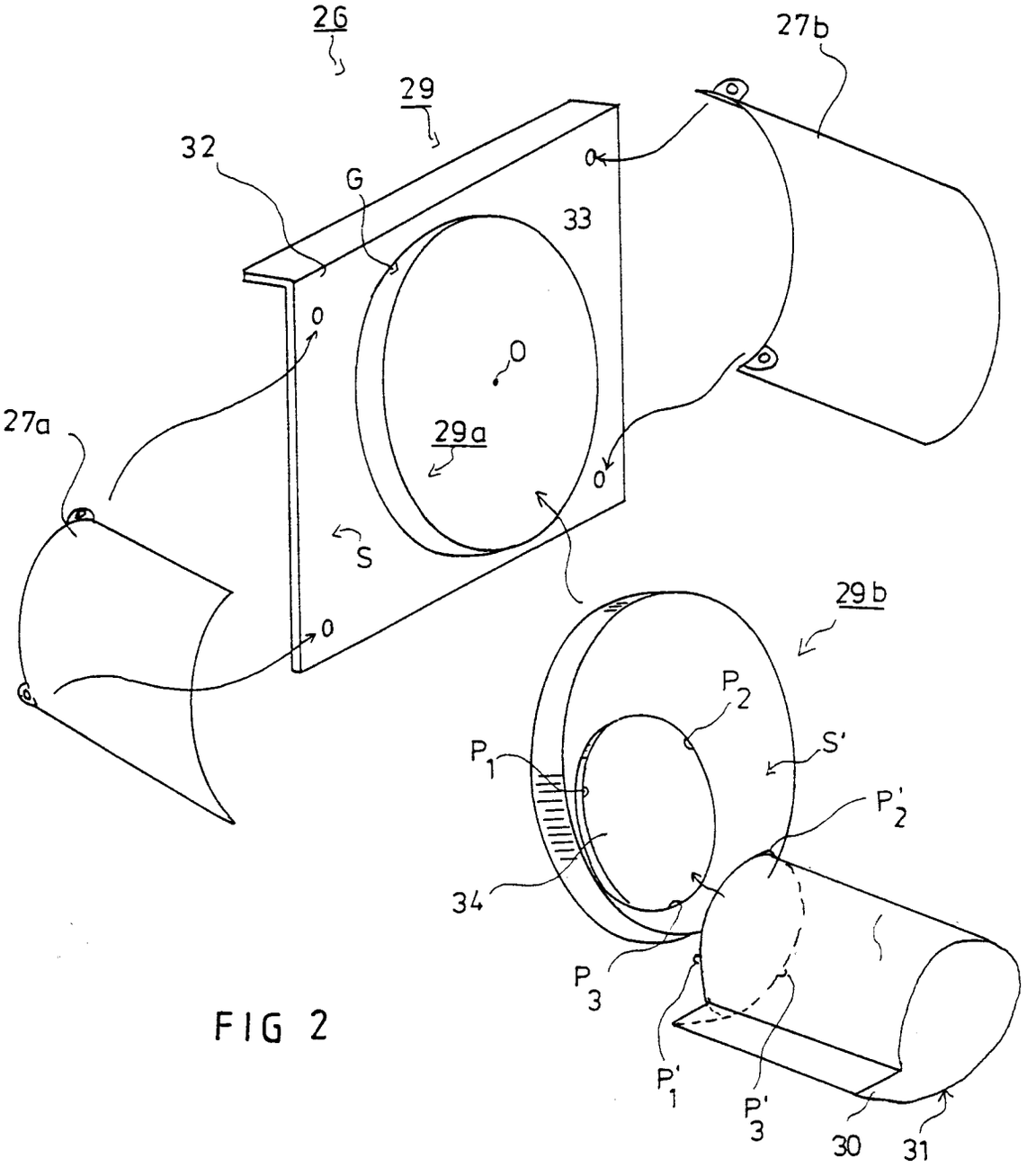

FIG 2

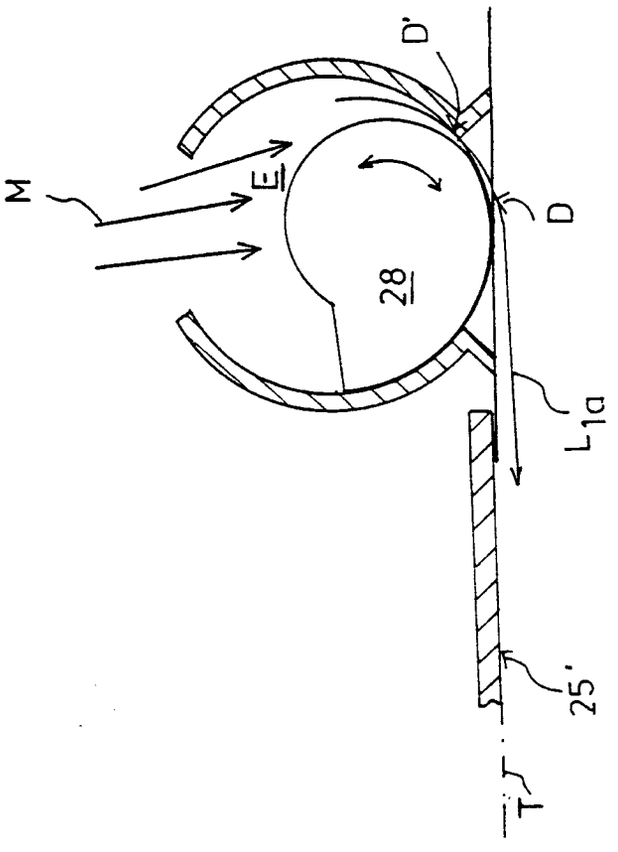

FIG. 3A

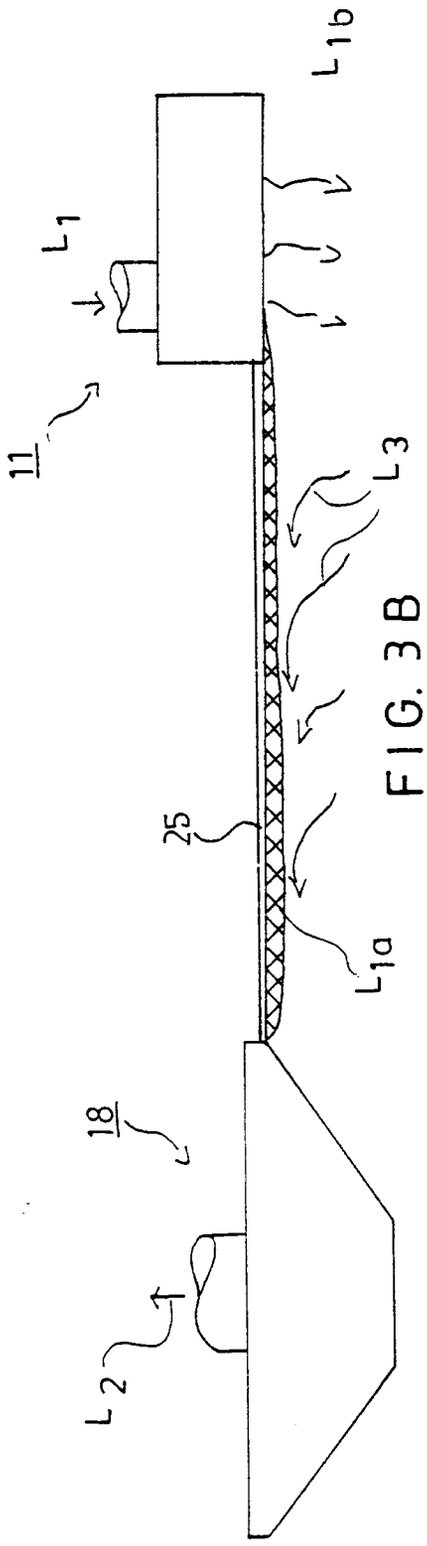

FIG. 3B

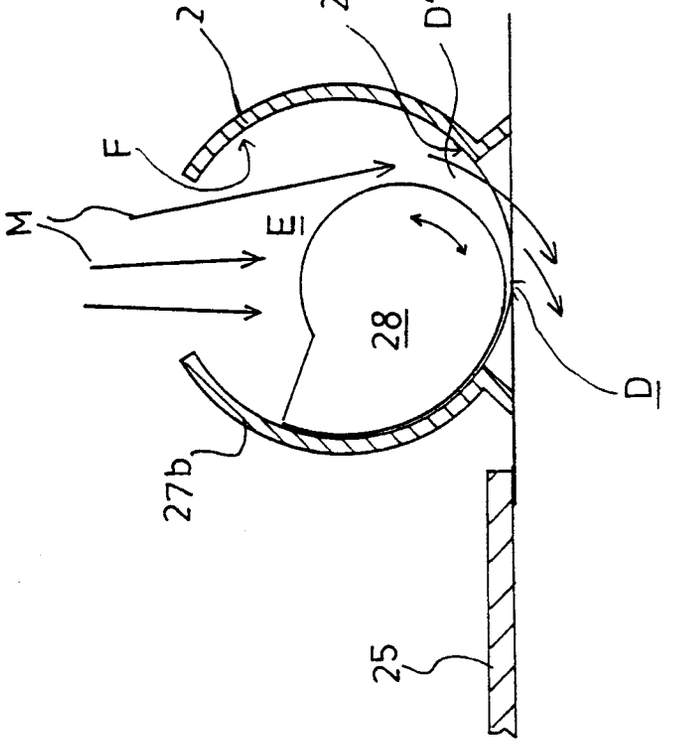

FIG. 4A

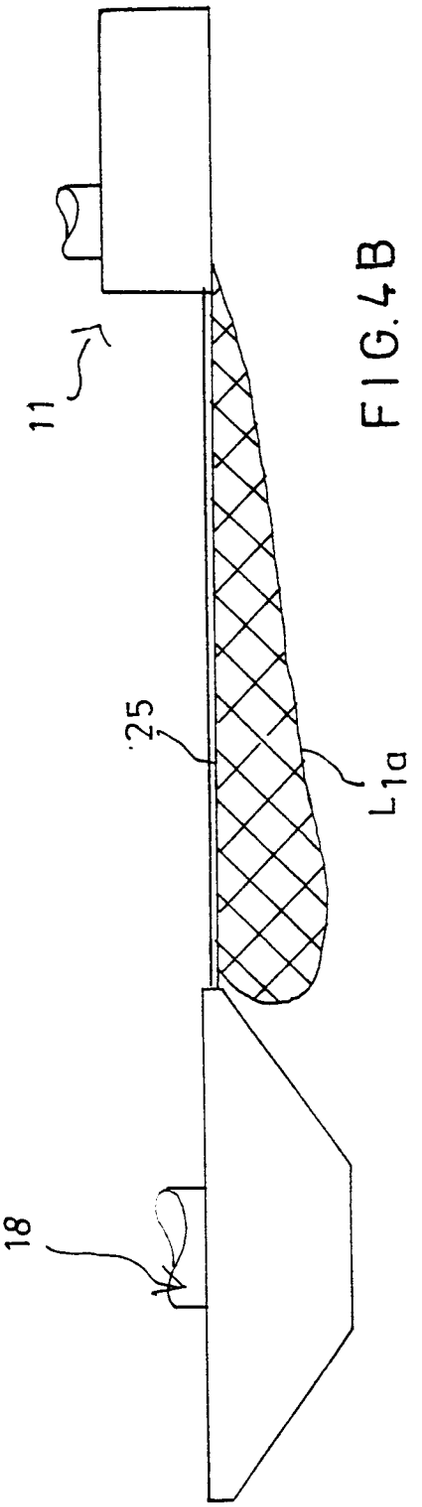

FIG.4B