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(12) # EUROPEAN PATENT APPLICATION

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(54) **Axial and centrifugal fan.**

(57) Electromechanical fan apparatus operable to provide a new type of ventilation comprises a rotor constituted by a rectangular frame (9, 10, 11) mounted to turn about an axis (6) lying in the plane of the frame and parallel to two opposite sides (9) thereof. These sides (9) of the frame, parallel to the axis of rotation (6), are constituted by blades having cylindrical surfaces, with the concavity directed towards the direction of movement, whilst the other two sides of the frame, orthogonal to the axis of rotation (6) are each constituted by two pairs of oppositely inclined blades (10, 10') also having cylindrically curved surfaces and a concavity facing in the direction of movement or in the opposite direction from this.

The rotation of rotor (9, 10, 11) consequently causes axial displacement of air from both ends of the rotor, preferably drawing such air streams in and causing an intimate mixing thereof before the mixed air is expelled radially.

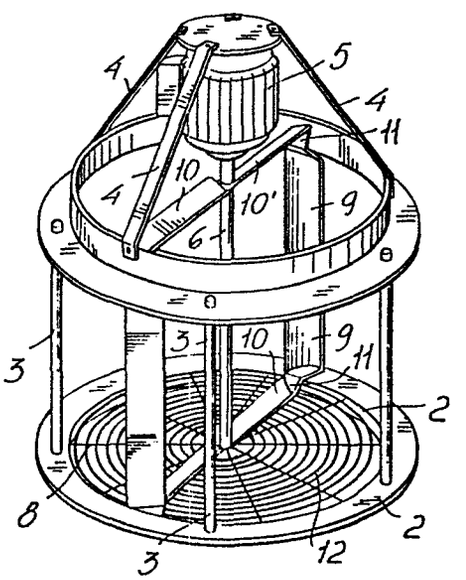

Fig. 1

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Axial and Centrifugal Fan

The present invention relates generally to electro-mechanical fan apparatus and particularly to a composite axial and centrifugal fan operable to provide a new type of ventilation.

As is known, in large buildings, such as factories, sheds, hangars and industrial buildings generally, having interior spaces of significant width and height, a problem which is often encountered, particularly in the higher zones, is that of stagnation of air. This is a great disadvantage as far as the heating of the interior environment is concerned since a substantial stratification of the air takes place, with the warmer and therefore less dense layers becoming localised in the higher parts of the interior environment.

It is known to use fans to cause forced movement of the air, and for this purpose both centrifugal and helical fans have been used. Such fans, however, draw the air from only one side thereof, and expel it radially (in the case of a centrifugal fan) but in a

given determined direction, and axially, parallel to the axis of rotation (in the case of an axial fan). In both cases, therefore, there is a substantial transfer of air from a first region to a second region without there being any substantial mixing of cold air with warm air.

The present invention seeks to overcome the above discussed disadvantage by providing electromechanical fan apparatus which is able to operate both as a double axial fan generating two oppositely directed air streams, and as a centrifugal fan generating a radially directed air stream.

According to one aspect of the present invention, therefore, there is provided electromechanical fan apparatus characterised by the fact that it includes a rotor constituted by a rectangular frame mounted for rotation about an axis parallel to two sides thereof, the sides of the frame parallel to the axis of rotation being constituted by fan blades having curved surfaces the concavity of which faces in the direction of movement and each side of the frame orthogonal to the axis of rotation being constituted by two oppositely inclined blades also having curved surfaces and a concavity facing in the direction of movement.

A particular feature of this aspect of the present invention is that it provides electromechanical fan apparatus which is able to put into effect a new method of ventilation which will be described in more detail below.

Another feature of the present invention is that it provides electromechanical fan apparatus which is structurally simple and of great reliability.

The present invention also comprehends a method of circulating air within a closed environment, such as the interior of a building, which comprises the contemporaneous aspiration of two oppositely directed air streams from opposite sides of the apparatus and parallel to the axis of rotation of the rotor thereof in such a way as to cause mixing of the two opposite incoming air streams which may have different physical characteristics (temperature, humidity, pressure), and the subsequent radial expulsion of the air streams after having been mixed.

One embodiment of the invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of electromechanical fan apparatus formed as an embodiment of the invention;

Figure 2 is an enlarged fragmentary perspective view of a portion of the frame constituting the rotor of the fan apparatus of Figure 1;

Figure 3 is an enlarged fragmentary perspective view of a portion of the frame shown in Figure 2;

Figure 4 is an enlarged fragmentary perspective view of the central portion of the upper part of the frame illustrated in Figures 2 and 3 which is rigidly connected to a drive motor shaft; and

Figure 5 is a view on a reduced scale illustrating the relative positions of the portions shown in

Figures from 2 to 4.

With particular reference now to the accompanying drawings, the electromechanical fan apparatus in question comprises a structure constituted by two main annular support elements 1 and 2 lying in parallel planes and interconnected by means of a plurality of spacer rods 3 positioned around the perimeter of the annular support elements 2 and lying orthogonally with respect to the plane of the annular elements 2.

Above this structure is a generally pyramid-shape motor support frame formed by four upwardly converging struts 4 which are joined at the top by a flat plate for support of an electric motor 5. The motor shaft carries a drive spindle 6 on which there is fixed a rectangular frame generally indicated 7. The lower end of the spindle 6 is housed in a bearing held in place by a plurality of radial arms 8 extending inwardly from the lower annular support element 2. This arrangement for rotary support of the lower end of the spindle 6 ensures that the rotor formed by the said rectangular frame 7 cannot, during operation, cause flexure of the spindle 6.

The rectangular frame 7 constituting the rotor has two sides 9 parallel to the axis of rotation formed by blades having preferably cylindrical surfaces the concavity of which may face in the direction of rotation or opposite this latter. The other two sides of the rectangular frame, orthogonal

to the axis of rotation are, in turn, each constituted by two inclined blades 10 and 10' also having preferably cylindrical surfaces the concavity of which faces in the direction of rotation. The blades parallel to the axis of rotation are connected to the blades orthogonal to the axis of rotation by means of corner portions 11 whilst the lower annular support element 2 carries a grid or grille 12 of circumferential grid bars.

In operation the fan apparatus thus formed contemporaneously produces two positively driven converging axial air streams flowing into the fan and an outward radial air stream, which differs from the air flow pattern of a conventional centrifugal fan which causes a positively driven radial air stream and, as a secondary action, a displacement of air in the direction of the axis of rotation by virtue of the pressure differential caused by the radial air flow.

With the fan apparatus of the present invention it is possible to recirculate enormous volumes of air in a very short time because the displacement of air parallel to the axis of rotation, produced by the two pairs of radial blades, is very much greater than that produced by the induction action of a traditional centrifugal fan. The fan apparatus of the present invention thus acts to create three positively displaced, or primary, air streams, two of which are parallel to the axis of the fan, but oppositely directed with respect to one another, each axial air stream moving towards the fan, and a radial air

stream moving outwardly away from the fan.

One of the more interesting results which can be obtained by means of the use of the fan apparatus of the present invention is that of aspirating volumes of air even spaced from the centre of rotation in the direction of the axis of rotation. Such masses of air, aspirated from above and from below, are mixed vortically within the rotor, subsequently being expelled radially from this latter forming an effective method of counter current mixing of two counterposed air streams having different physical states (temperature, humidity and pressure) with subsequent radial expulsion of the said streams after they have been mixed.

From what has been explained above and from observation of the various figures of the attached drawings the great functionality and practicability in use which characterises the electromechanical fan apparatus constituting the subject of the present patent for invention will be apparent.

Claims:

1. Electromechanical fan apparatus characterised by the fact that it includes a rotor (9, 10,11) constituted by a rectangular frame mounted for rotation about an axis parallel to two sides thereof, the sides (9) of the frame parallel to the axis of rotation being constituted by fan blades (9) having curved surfaces the concavity of which faces in the direction of movement, and each side of the frame orthogonal to the axis of rotation being constituted by two oppositely inclined blades (10,10') also having curved surfaces and a concavity facing in the direction of movement.

2. Fan apparatus according to Claim 1, characterised by the fact that the rotor (9, 10,11) is carried for rotation by a support structure constituted by two annular elements (1,2) lying parallel to one another and interconnected by connector rods (3) fixed to one another at intervals around the annular elements (2) and extending orthogonally with respect thereto, the said support structure also carrying a framework formed by upwardly converging struts (4) forming a frusto-conical pyramid for supporting an electric motor (5).

3. Fan apparatus according to Claim 2, characterised by the fact that the shaft of the said electric motor (5) carries a spindle (6) to which the said rotor (9,10,11) is secured, the spindle (6) being supported at its endremote from the motor (5)

by a bearing held fixedly in position by means of radial arms (8) extending inwardly from one of the said annular support elements (2) .

4. Fan apparatus according to any preceding Claim, characterised by the fact that blades (9) of the said rotor (9, 10, 11) parallel to the axis of rotation are connected to the said blades (10, 10') orthogonal to the axis itself by means of corner portions (11), whilst the said lower annular support element (2) carries a grille or grid (12).

5. Fan apparatus according to any preceding Claim, characterised by the fact that it contemporaneously generates two converging oppositely directed air streams axially of the rotor (9, 10, 11) and one radially directed air stream.

6. Fan apparatus according to any preceding Claim, characterised by the fact that it can aspirate volumes of air in the direction of the axis of rotation spaced from the centre of rotation, such volumes of air aspirated from above and from below are mixed in a vortex within the rotor and subsequently expelled radially of this latter.

7. Fan apparatus as in one or more of the preceding Claims, characterised by the fact that it is provided that the individual elements constituting the said rotor are made independently and these are driven by one or more motors.

8. A method of recirculating air with fan apparatus according to any preceding Claim, characterised by the fact that it comprises the contemporaneous aspiration of two oppositely directed air streams from opposite sides of the apparatus and parallel to the axis of rotation of the rotor (9, 10, 11) thereof in such a way as to cause mixing of the two opposite incoming air streams which may have different physical characteristics (temperature, humidity, pressure), and the subsequent radial expulsion of air streams after having been mixed.

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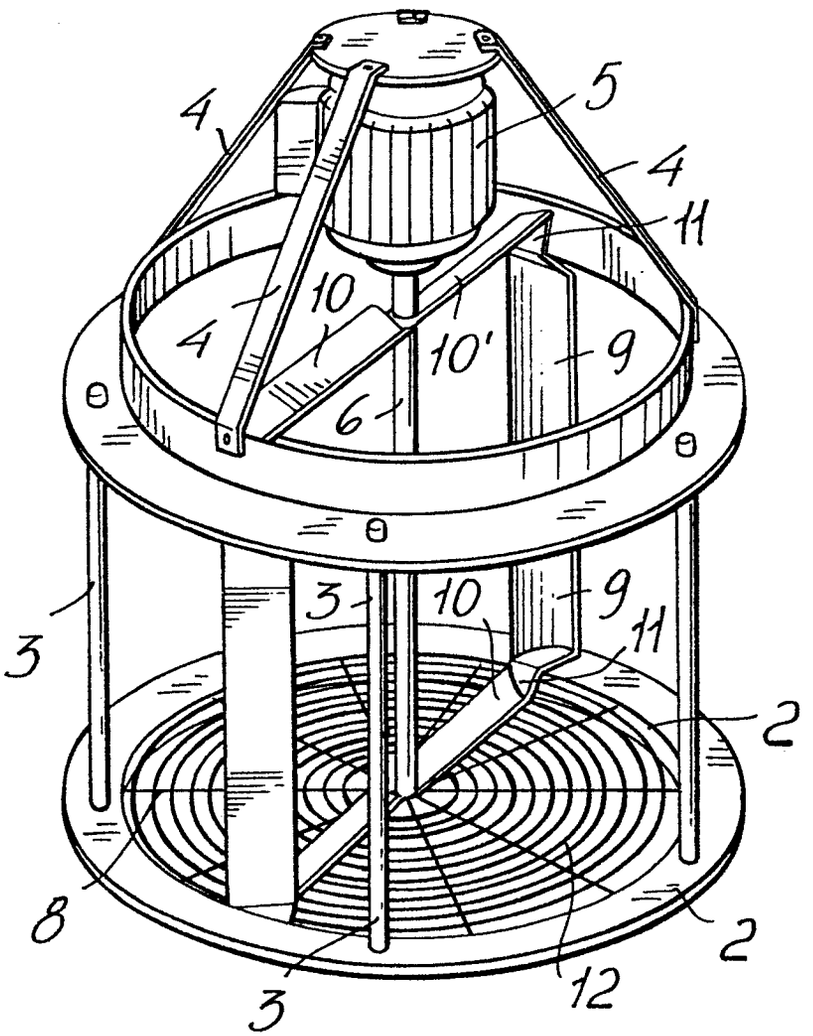

Fig. 1

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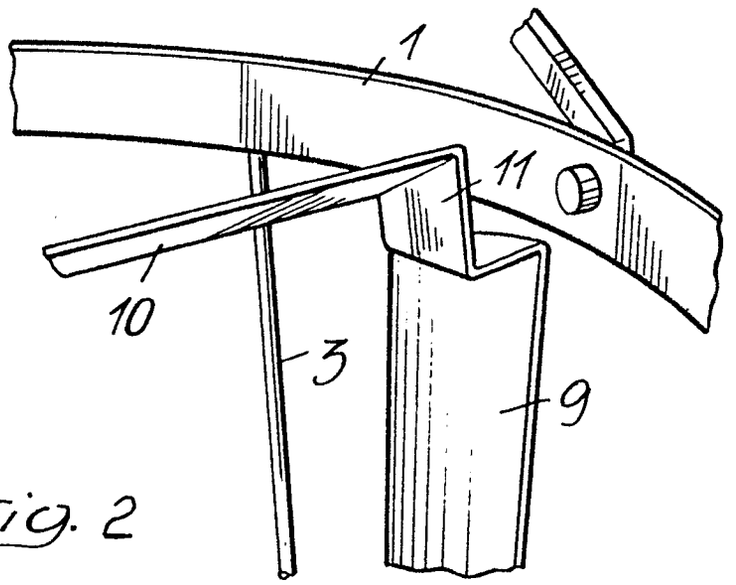

Fig. 2

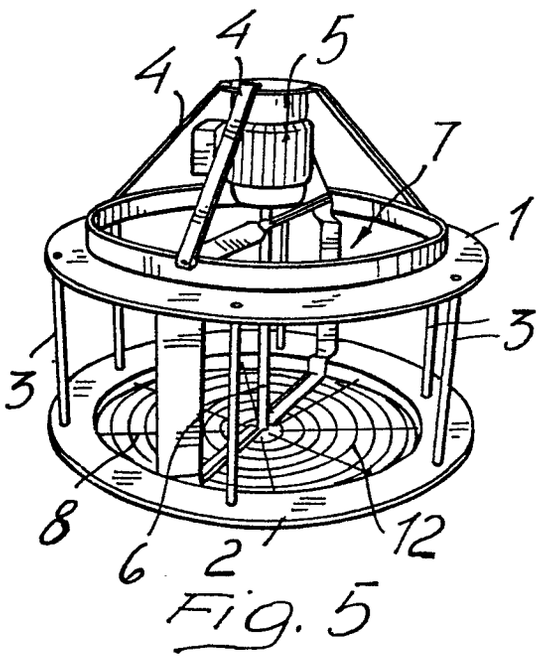

Fig. 5

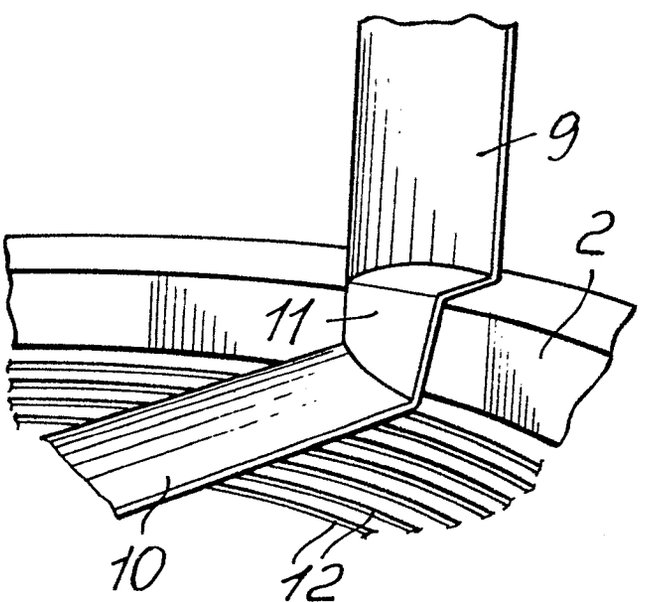

Fig. 3

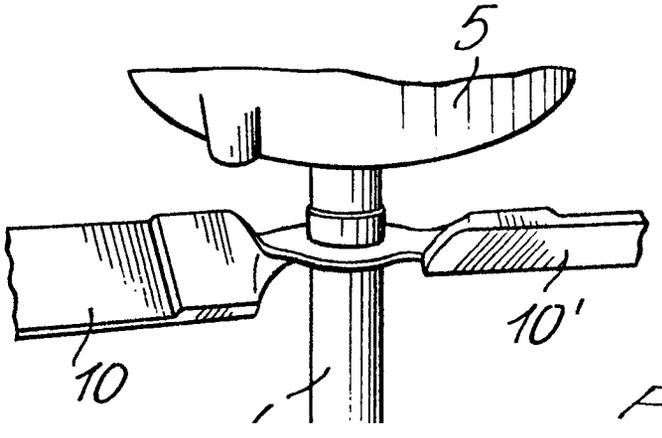

Fig. 4