Feb. 21, 1967 N. LAING 3,305,164

FANS OF THE CROSS-FLOW TYPE

Original Filed Nov. 17, 1959

2 Sheets-Sheet 1

FIG.1.

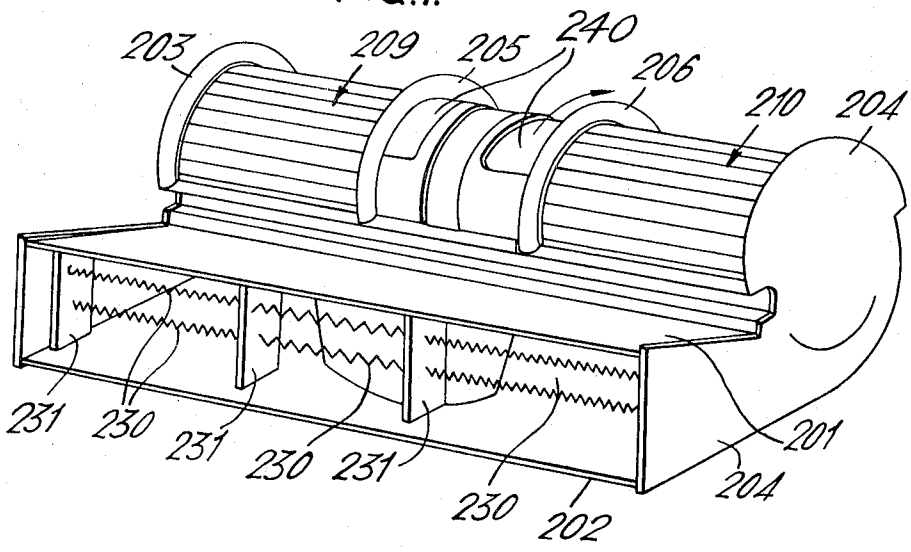
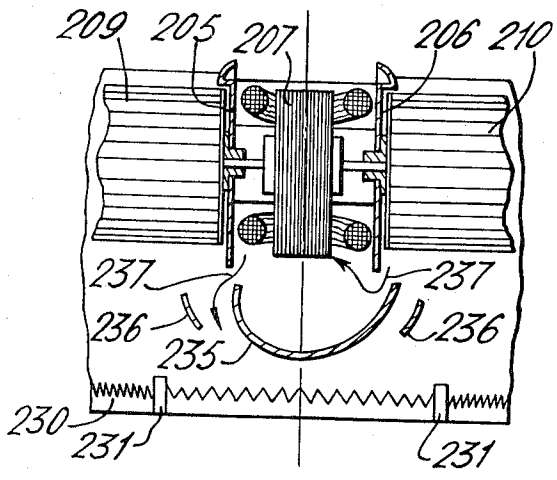


FIG.3.



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2 Sheets-Sheet 2

FIG. 2.

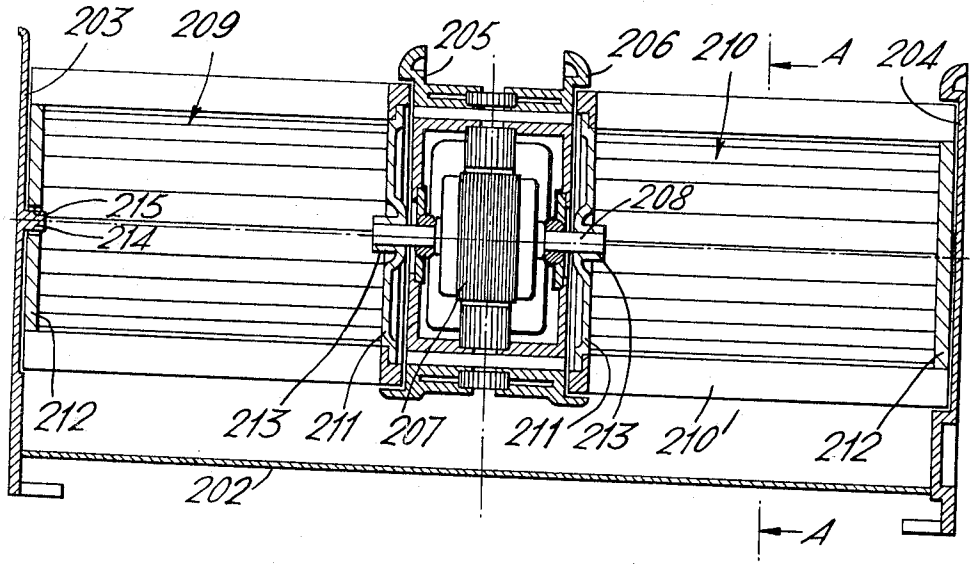
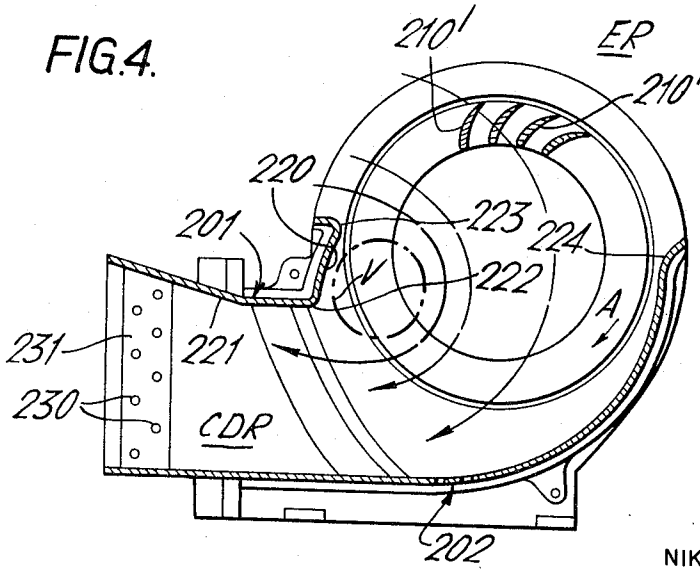


FIG. 4.



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FANS OF THE CROSS-FLOW TYPE

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Original application Nov. 17, 1959, Ser. No. 853,596. Divided and this application Aug. 17, 1965, Ser. No. 480,321

16 Claims. (Cl. 230—117)

This invention relates to fans of the cross-flow type. The application is a division of my copending application Serial No. 853,596, filed Nov. 17, 1959.

The invention more particularly concerns fans of the cross-flow type, that is, machines comprising a cylindrical bladed rotor mounted for rotation about its axis in a predetermined direction and defining an interior space, and guide means defining with the rotor an entry region and a discharge region, the guide means and rotor co-operating on rotation of the latter in said predetermined direction to induce a flow of air from the entry region through the path of the rotating blades of the rotor to said interior space and thence again through the path of said rotating blades to the discharge region. More especially but not exclusively, the invention concerns fans of the cross-flow type wherein the guide means and rotor co-operate to set up a vortex of Rankin character having a core region eccentric of the rotor axis and a field region which guides the air so that flow through the rotor is strongly curved about the vortex core: such fans are sometimes known as "tangential" fans and the preferred from of fan to be described in detail later is of this type.

Cross-flow fans have in recent years become of great and increasing technical and commercial importance, and it is being appreciated that such fans can advantageously be used in a wide range of apparatus.

One main object of the invention is to provide a cross-flow fan unit which can be simply and cheaply produced in quantity and which is compact and can readily be built into different forms of apparatus.

With this object in view the invention provides a fan unit comprising a motor having a drive shaft and a pair of bladed cylindrical rotors one on either side of the motor and each having one end mounted on the corresponding end of the motor drive shaft. If the unit has only to be relatively short the rotors can be overhung on the shaft ends; longer rotors could be supported at their ends opposite the motor. Guide means are provided to co-operate with the rotors in the manner described above. These guide means comprise at least one guide wall secured to the motor and extending parallel to the axis of the rotors over the whole distance between the extreme ends of the rotors. This guide wall forms a main structural member for the unit and avoids the need for a separate frame or structure to interconnect the guide means for the two rotors and to position such means relative to the rotors.

Preferably, the guide means for the two rotors comprises two guide walls both extending the whole distance between the extreme ends of the rotors and interconnected by outer end walls in general alignment with such extreme ends of the rotor. This provides a box-sinder-like construction which will have the required rigidity even if constructed out of, say, relatively thin sheet metal. Inner end walls, substantially aligned with the ends of the rotors adjacent the motor, may provide the means for securing the guide walls to the motor: such inner end walls have a further rigidifying effect on the guide structure.

According to a further important feature of the invention the guide walls and outer ends walls preferably define a common discharge region receiving flow from

both rotors and delivering an air flow which is continuous over the length of the unit. This feature avoids the drawback of single-rotor constructions, that if the motor and rotor occupy a given length, air flow only occurs over the part of the total length occupied by the rotor and not over the length of the motor. The invention provides means to promote flow over the central zone of the common discharge region, so as to help even out the flow over the total length.

Further features of the invention, together with objects and advantages thereof, will become apparent from the following description of one embodiment thereof, including certain varients of this embodiment, which description is given purely by way of example, and with reference to the accompanying diagrammatic drawings, in which:

FIGURE 1 is a perspective view of a sub-unit for a fan heater;

FIGURE 2 is a vertical longitudinal section of the sub-unit shown in FIGURE 1;

FIGURE 3 is a horizontal longitudinal section of the central part of sub-unit of FIGURE 1 showing variant motor cooling arrangements; and

FIGURE 4 is a vertical transverse section of the sub-unit of FIGURES 1 and 2 taken on the line *a—a* of FIGURE 2;

FIGURES 1 to 4 show a sub-unit incorporating a casing, for example to form a fan heater, the casing having appropriately located inlet and outlet for the air flow.

The sub-unit comprises first and second guide walls **201, 202** secured between substantially plane parallel outer end walls **203, 204**. A pair of intermediate or inner walls **205, 206** are arranged symmetrically between and parallel to the end walls **203, 204** and secured to the guide walls. The intermediate walls **205, 206** mount between them a motor **207**, the shaft **208** of which projects to either side to mount a pair of similar bladed cylindrical rotors **209, 210**. The rotors **209, 210** each comprise a series of blades **210'** mounted parallel to the axis of rotation and in a ring thereabout between end support discs **211, 212**, the discs **211** adjacent the intermediate walls **205, 206** being received in recesses in those walls and formed with integral bosses **213** push-fitted on the end portions of the motor shaft **208**.

The left and right hand sides of FIGURE 2 show variant constructions of the end walls **203, 204**. In each case, the corresponding rotor end disc **212** closely overlies the end wall, but at the right hand side of the figure the disc **212** is shown received in a recess in the end wall **204**, which may be formed as a sheet metal pressing. At the left hand side of the figure the end wall **203** is shown without a recess, but with a central projection **214** received with clearance in a central hole **215** in the end disc **212** of the rotor **209**. In normal operation the projection **214** has no effect, but if the sub-unit is dropped, for example, it engages the side of the hole **215** so as to prevent the rotor end disc **211** from being stressed beyond its elastic limit, as would permanently damage the sub-unit. The variant constructions are combined in FIGURE 2 for economy of illustration. An actual construction would have similar end walls.

The guide wall **201** consists of a main guide portion **220** (see FIGURE 4) and an outlet portion **221**: the main guide portion **220** converges with the rotors **209, 210** in the direction of rotor rotation (shown by the arrow A) from a rounded nose **222**, where it joins the outlet portion **221** at an angle of somewhat over 90°, to a line **223** of nearest approach to the rotor. The guide wall **202** diverges from the rotors **209, 210** with steadily increasing radius of curvature from a line of nearest approach **224** diametrically opposite the line **223**. Both these lines of nearest ap-

proach are well spaced from the rotors **209, 210**, and at both the respective guide wall is rounded away from the rotors on the side of air entry thereto. The guide walls **201, 202** terminate adjacent their lines of nearest approach to the rotors **209, 210**, and define for each rotor an entry region ER (FIGURE 4) on one side of the unit. The rotors **209, 210** have an approximately 180° arc projecting free beyond the plane containing the edges of the guide walls **201, 202** on the inlet side.

The innner end walls **205, 206** terminate adjacent the motor **207** on the downstream side thereof. The outer end walls **203, 204** extend further on this side than the inner end walls, and they define with the guide walls **201, 202** a common discharge region CDR receiving the air from both rotors **209, 210**. The guide walls **201, 202** diverges in the direction of flow so that this common discharge region acts as a diffuser.

On operation of the motor **207** to rotate the rotors **209, 210** in the direction of the arrow A (FIGURE 4) the rotors and the guide walls **201, 202** co-operate to set up a vortex of Rankine character having a core approximately indicated at V in FIGURE 4 which is eccentric of the axis and consists of a region of circulatory flow interpenetrating the rotor blades **210'** adjacent the portion **220** of the guide wall **201**. The vortex further comprises a field region wherein air is induced to flow through each rotor **209, 210** from its entry region ER through the path of the rotating blades of the rotor to the interior thereof and thence again through the path of the rotating blades to the common discharge region CDR. The flow pattern is here shown purely diagrammatically: it is more fully discussed in British Patent 876,611 in which I am co-inventor. In passing from the entry region ER to the common discharge region CDR the bulk of the throughput is caused to turn around the vortex core V through an angle exceeding 90°, but without the losses which would be associated with bent ducting designed to effect a similar turn.

An electric heater element is located in the common discharge region CDR and comprises coiled resistor wire **230** supported on insulating support plates **231** secured between the guide walls **201, 202** parallel to the end walls **203, 204**, so as to minimise resistance to air flow. The plates **231** are located approximately opposite the rotor end discs **211, 212** and the resistor wire **230** is arranged to provide greater heating (i.e. dissipation of watts per unit of length parallel to the rotor axis) opposite the rotors **209, 210** than between them, where the air flow is less.

As shown in FIGURE 3 a baffle plate or fairing **235** is secured between the guide walls **201, 202** in the central zone of the common discharge region CDR, downstream of the motor **207**. The baffle **235** has the approximate outline in horizontal section of a semicircle with its upstream ends, in general alignment with, but spaced from, the inner end walls **205, 206**. For economy of illustration in FIGURE 3 variant constructions of the baffle plate or fairing **235** are shown on opposite sides of the centre line. Thus to the left of the centre line the end of the baffle plate or fairing **235** is shown bent slightly to the motor side of the plane of the end wall **205**, while the end on the right hand side of the line is shown bent slightly to the rotor side of the end wall **206**. The purpose of the baffle plate or fairing **235** is two-fold, firstly to guide air flow from the two rotors **209, 210** towards the central zone of the common discharge region CDR, and secondly to set up a small flow of cooling air through the motor **207**. In the variant construction shown on the left hand side, a flow of cooling air is sucked through the motor, while on the right hand side air which has passed the rotor **210** is diverted back through the rotor by the baffle plate or fairing. In a given construction the baffle plate or fairing **235** would normally be symmetrical, adopting for both sides either one or the other of the variants described. However, an asymmetrical arrangement, substantially as shown, would be a possibility. Auxiliary baffles **236** are mounted symmetrically between the guide walls **201, 202** adjacent the baffle plate or fairing **235** and outside it. In operation air is helped to flow around the outside of the baffle plate or fairing **235** by the auxiliary baffles **236**. The curved baffle plate or fairing **235** and auxiliary baffles **236** help to deflect air longitudinally into the central zone of the common discharge region between the downstream rotors **209, 210**, and thus tend to even out flow through this region as considered over its whole length between the end walls **203, 204**. The central insulating support plates **231** are shown in FIGURE 3 as spaced somewhat outwardly of the intermediate walls **205, 206**.

Where the construction of the baffle plate takes the form as shown in the left-hand side of FIGURE 3 for both rotors or for a single rotor in a fan unit having only one rotor, air will flow over the motor through slots **240** as shown in FIGURE 1. It is thus seen that the baffle construction shown on the left side of FIGURE 3 provides a passageway which extends from the motor compartment to an area adjacent the rotor **209** where the pressure is less than ambient such that cooling air is caused to flow over the motor, into the motor compartment and thence to an area adjacent the rotor.

I claim:

1. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said guide walls forming a frame for said fan unit, said walls defining an entry region for each rotor at one side of the unit and a common discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to the common discharge region.

2. A fan unit as claimed in claim **1**, including a fairing extending between the guide walls on the downstream side of the motor to guide air from each rotor towards the central zone of said common discharge region.

3. A fan unit as claimed in claim **1**, wherein the rotors are overhung on the ends of the drive shaft.

4. A fan unit as claimed in claim **3**, wherein said end walls extend over the extreme ends of the rotors and carry projections extending into oversize holes in the rotor ends to limit bending of the rotors in case of abuse of the unit.

5. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of inner end walls fixed to the motor and in substantial alignment with the ends of the rotors adjacent thereto, a pair of spaced guide walls secured to said inner end walls and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends with said guide walls forming a frame for said fan unit, said walls defining for each rotor an entry region at one side of the unit and a discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior

space and thence again through the path of the rotating blades to said discharge region.

6. A fan unit comprising an electric motor having a drive shaft, a bladed cylindrical rotor defining an interior space and having one end mounted on the motor shaft, guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotor, and walls joining the guide walls, said guide walls and end walls defining an entry region for said rotor and a discharge region for said rotor, said guide means cooperating with the rotor on operation of the motor to induce flow of air from the entry region of said rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to the discharge region, and baffle means in said discharge region to divert a proportion of the outlet flow through the motor for cooling thereof.

7. A fan unit comprising an electric motor positioned in a motor compartment and having a drive shaft, a bladed cylindrical rotor defining an interior space and having one end mounted on the motor drive shaft, guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotor; a pair of end walls joining the guide walls, said guide walls and said end walls defining an entry region for said rotor at one side of said unit and a discharge region for said rotor at another side of said unit, said guide means cooperating with the rotor on operation of the motor to induce a flow of air from the entry region of the rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to the discharge region, and at least one passageway extending from the motor compartment to a region adjacent the rotor of lower pressure than ambient whereby cooling air will flow from said compartment through said passageway and into the region of lower pressure.

8. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said walls defining an entry region for each rotor at one side of the unit and a common discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to the common discharge region, and a baffle extending between the guide walls adjacent the inner end of each rotor in said common discharge region to guide air from each rotor to the central zone of said region.

9. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said walls defining an entry region for each rotor at one side of the unit and a common discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior

space and thence again through the path of the rotating blades to the common discharge region, and a baffle means in said common discharge region to divert a proportion of the flow from at least one rotor through the motor for cooling thereof.

10. A fan unit as claimed in claim 9, wherein said baffle means extends between the guide walls and forms a fairing around the downstream side of the motor to guide air from the rotors to the central zone of the common discharge region.

11. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of spaced guide walls secured to the motor and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said walls defining an entry region for each rotor at one side of the unit and a common discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to the common discharge region, and a baffle means in said common discharge region whereby flow therein induces into said region a flow of cooling air through the motor.

12. A fan unit as claimed in claim 11, wherein said baffle means extends between the guide walls and forms a fairing around the downstream side of the motor to guide air from the rotors to the central zone of the common discharge region.

13. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising a pair of inner end walls fixed to the motor and in substantial alignment with the ends of the rotors adjacent thereto, a pair of spaced guide walls secured to said inner end walls and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said walls defining for each rotor an entry region at one side of the unit and a discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to said discharge region, said inner end walls terminating short of the other walls so that said discharge regions for the two rotors merge and discharge takes place over the whole length between the outer end walls.

14. A fan unit as claimed in claim 13 including a baffle extending between the guide walls around the downstream side of the motor to guide air from each rotor to discharge in the central zone between said outer end walls, the baffle having its ends in general alignment with the inner end walls.

15. A fan unit as claimed in claim 14 wherein the upstream ends of the baffle are spaced from the downstream ends of the inner end walls and formed in relation thereto to induce through said spaces a flow of cooling air over the motor.

16. A fan unit comprising an electric motor having a drive shaft, a pair of bladed cylindrical rotors one on either side of the motor and each defining an interior space and having one end mounted on the corresponding end of the motor drive shaft, and guide means comprising

a pair of inner end walls fixed to the motor and in substantial alignment with the ends of the rotors adjacent thereto, a pair of spaced guide walls secured to said inner end walls and extending generally parallel to the axis of the rotors over the whole length between the extreme ends of the rotors and a pair of outer end walls joining the guide walls and in substantial alignment with said extreme ends, said walls defining for each rotor an entry region at one side of the unit and a discharge region at another side of the unit, said guide means co-operating with the rotors, whereby on operation of the motor to induce a flow of air from the entry region of each rotor through the path of the rotating blades thereof to said interior space and thence again through the path of the rotating blades to said discharge region, said end walls being recessed to receive the ends of the rotors.

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