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Schlicker et al.

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[54] **FAN CONSTRUCTION**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.** **F04b 17/00**

[58] **Field of Search** 417/352–354, 417/234; 415/54, 214

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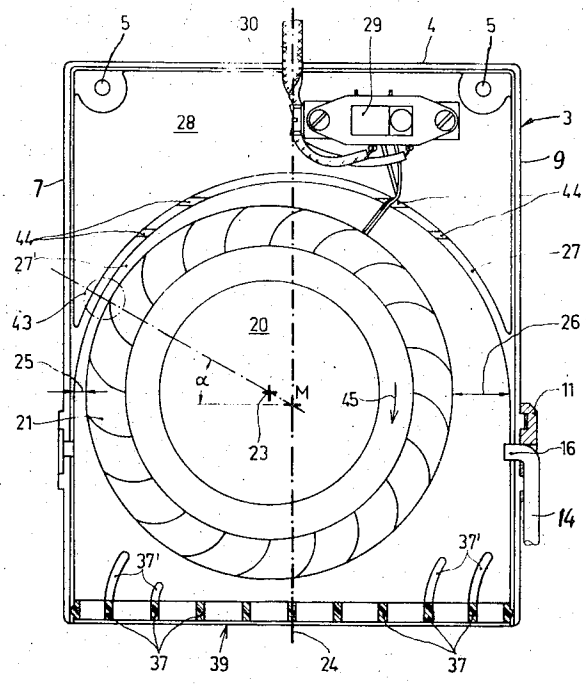
Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

A fan, particularly a portable fan, includes a substantially square flat casing having a top wall with an inlet and substantially parallel side walls and front and rear walls. The front wall is provided with an open front face for the discharge of the air from a radially operating motor driven fan wheel which is positioned within the casing in an eccentric arrangement. The casing is provided with a partition wall on the rear wall side of the fan which is substantially cylindrical and the axis of the fan is located so that the clearance between the periphery of the fan and the adjacent side wall at one side is less than at the opposite side. The fan is also oriented so that its axis is positioned at a greater distance toward the curved partition wall on the closer spacing side than the opposite side so that an inwardly spiralling flow path in the form of a volute is provided from one side toward the other.

19 Claims, 7 Drawing Figures



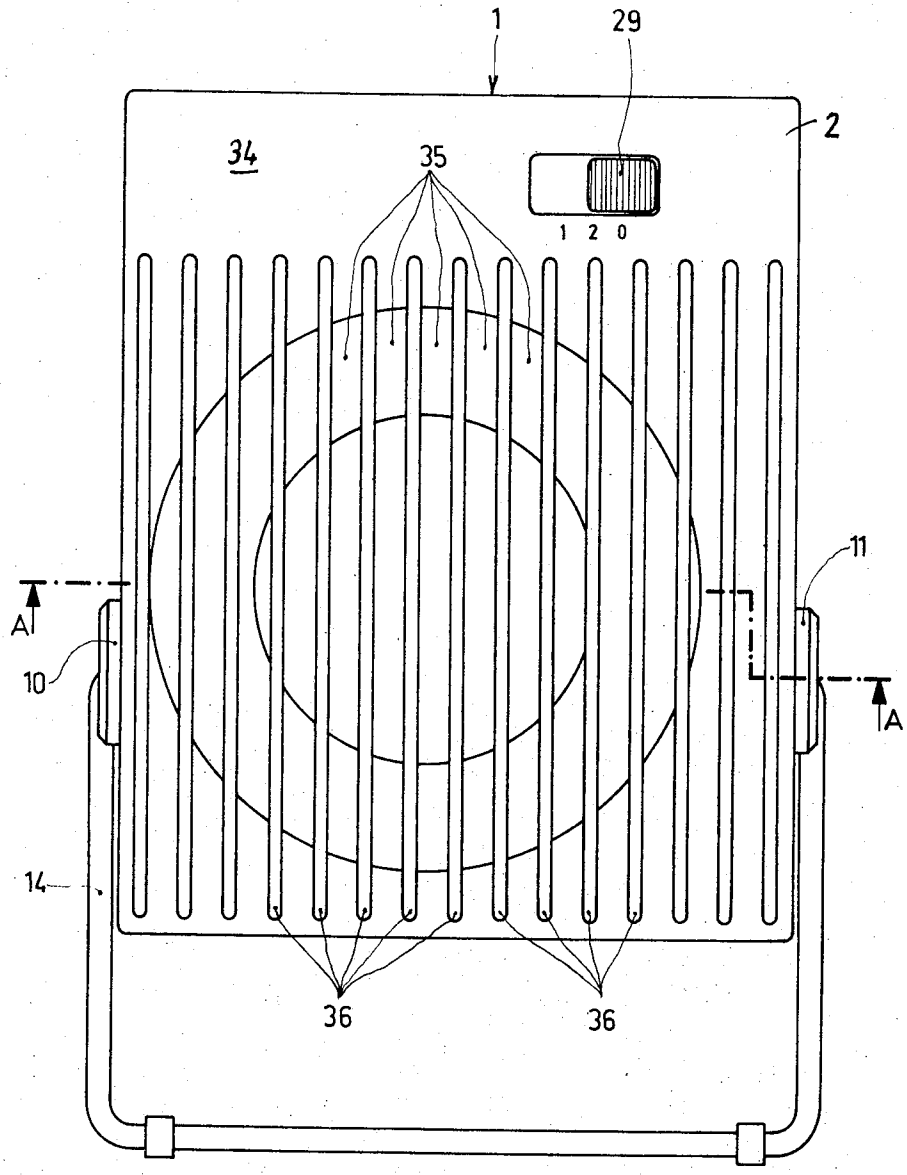


Fig.1

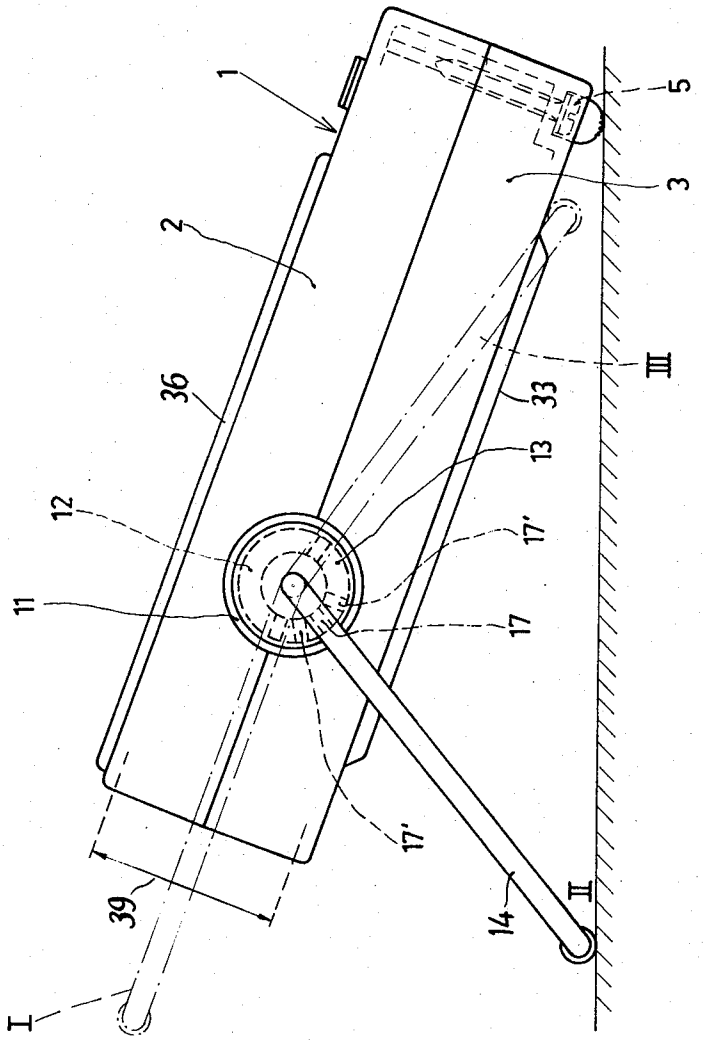


Fig. 2

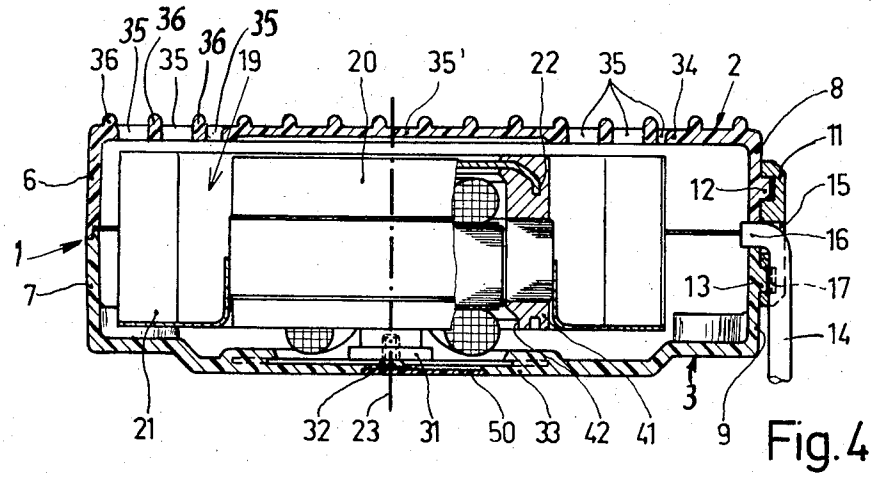

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Fig. 4

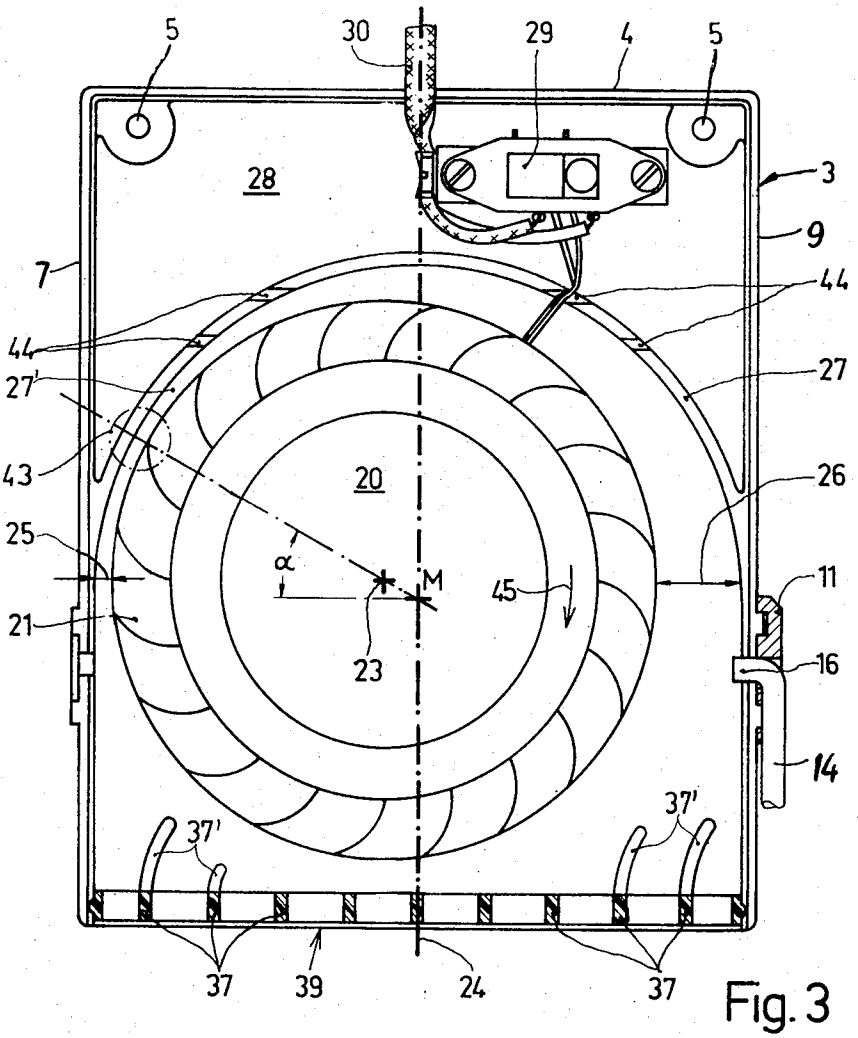
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Fig. 3

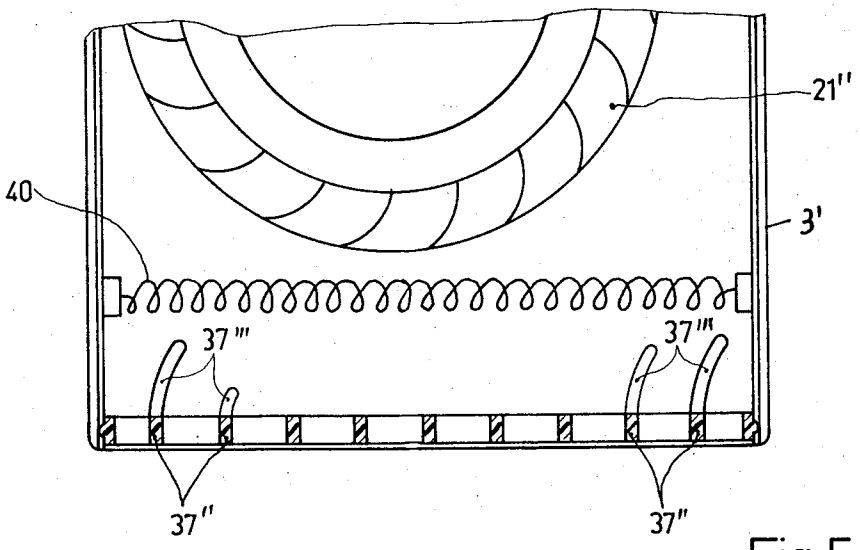

Fig.5

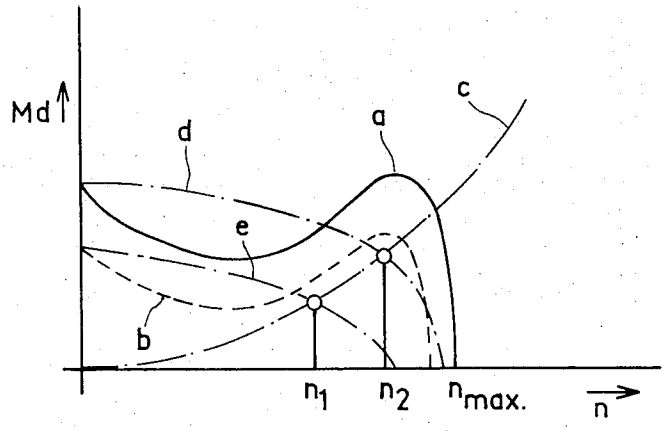

Fig.6

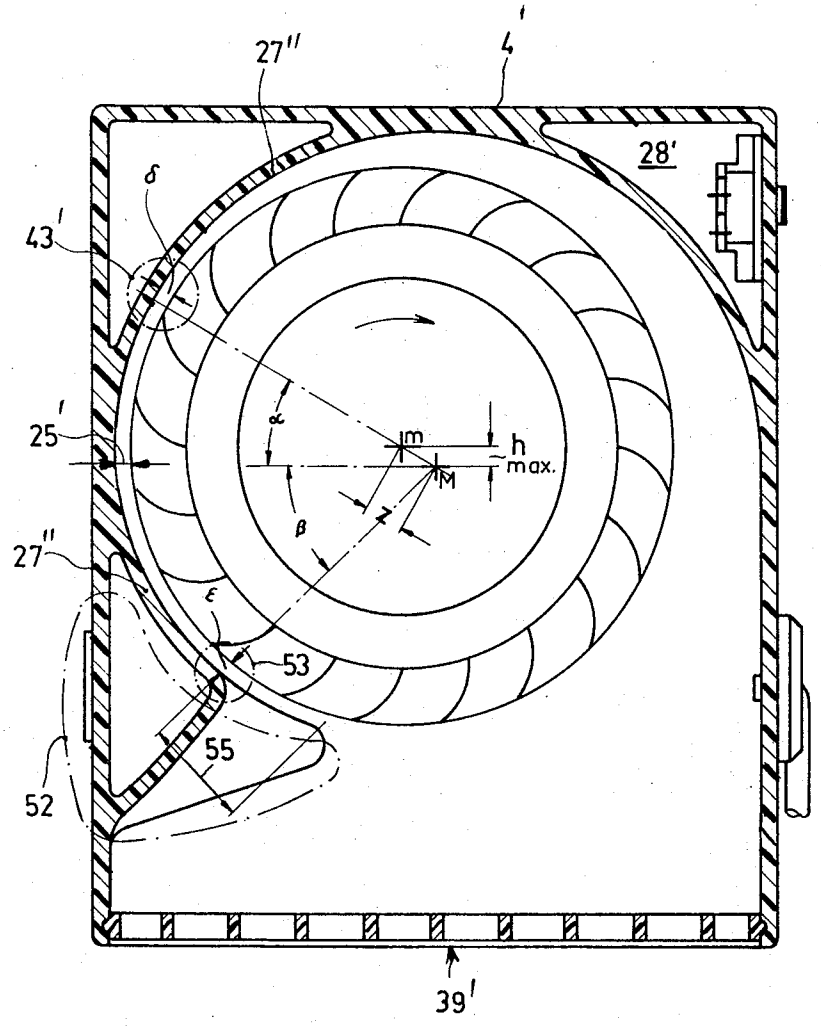

Fig.7

FAN CONSTRUCTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to the construction of fans and, in particular, to a new and useful fan, particularly a portable fan, which is to be used, for example, for the production of a pleasant air current at a desk in an office or at a table in a room.

2. Description of the Prior Art

For small blowers, particularly portable fans, only transverse flow blower wheels and axial flow fans or helical blowers are generally provided. Transverse blowers, if they have a certain range, that is a certain minimum velocity of flow, have the disadvantage that running noises are caused by the turbulences of the air. These disadvantages make transverse flow blowers usable only to a limited extent as portable fans. The other known commercial axial flow blowers are relatively noiseless but as portable fans, for example, they have the disadvantage that they are not capable of producing a far reaching focused air current. The air current produced by axial flow fans has a great conical scatter which covers practically the entire range in the blowing direction ahead of the fan; for example, on a table surface, and thus has the unpleasant property of blowing away loose papers, etc., from the table. In order to reduce this effect, the known fans are sometimes secured on frames to achieve a greater vertical distance from the base. This makes the axial flow fans very bulky and unhandy, and they require much packing space.

A further disadvantage of the known axial flow fans is that their fan blades must be protected by wire grills against contact or made of a material such as an elastic plastic which will not injure a person if contact takes place. The wire grills impart to the fan a less attractive appearance, and fan blades made of an elastic plastic have the disadvantage that they are deformed even in normal operations by the air resistance and thus, the blowing effect is reduced.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a small compact fan, particularly, a portable fan having a noiseless relatively great blowing power and capable of producing a relatively focused current of air at the discharge and which does not have the disadvantages of the known axial fan constructions. With the invention, a radial flow fan wheel is employed which is eccentrically arranged within a flat substantially square casing which has substantially parallel side walls and front and rear walls with an open front face for the discharge of the air and a top wall or bottom wall with an intake opening. The front end discharge opening is substantially parallel to the axis of the fan wheel and the intake openings are transverse to the axis of the radial flow fan wheel. The fan wheel is positioned in respect to a circularly curved partition wall on the rear wall side of the fan so that it is eccentrically located within the remaining space and has a smaller clearance with one side wall than with the opposite side.

The known blowers for the radial flow fan wheel require a so-called blow lip for good aerodynamic operation. This blow lip, however, causes the most noise. Surprisingly, the flow conditions are so changed in the design, according to the invention, that this blow lip can be omitted without reducing the output of the free blowing operation and the noise is thus reduced at the same time. In addition, a far-reaching focused air current, with very little scatter, is achieved. The invention also results in a very compact design and it is of particular advantage that the fan wheel itself is arranged in the casing completely protected against contact.

The excellent operation of the fan, according to the invention is enhanced by the fact that a partition parallel to the axis of the radial flow fan wheel is provided in the casing and located in respect to the fan wheel so that the flow space or clearance between the periphery of the fan wheel and the curved partition wall in the direction of rotation of the fan wheel increases constantly from a point of a minimum clearance up to the maxiumum clearance at the opposite side wall. The partition in the casing also imparts additional stability to the casing for the fan wheel and the motor. With the inventive arrangement, the casing is preferably square and the walls parallel but the parallel conditions need not be realized exactly, but only approximately, and without changing the advantageous effects of the flow conditions mentioned above. The partition wall advantageously has a semicircular form extending from one side wall to the other and this makes manufacture of this partition wall relatively simple. In addition, the turbulence of the air inside the casing and thus the noise are further and almost completely reduced by the semicircular design of the partition, and a relatively great part of the circumference of the fan wheel thus takes part in the formation of the air current to be produced.

Another important feature of the invention is that the axis of the radial flow fan wheel is staggered with regard to the curvature center of the semicircular partition both in the direction toward one side wall and in the direction toward the rear wall of the casing so that the point of the least distance between the circumference of the fan wheel and the partition in the direction of rotation of the fan wheel is staggered by an angle of 20° to 40° relative to the head of the partition adjacent the respective side wall. This feature contributes considerably to the prevention of noise and to an increase of the blowing power.

The front face of the casing is advantageously provided with replaceable current guide ribs or elements which also define a protective grill or grid across the front face and which ensure a good alignment of the air currents over the entire outlet area. A selector switch is arranged in the space between the back wall of the casing and the partition along with a series resistance for starting the various speed stages of the driving motor or other electrical or electronic switching aids. One or more openings are provided in the partition and the adjoining casing walls in order to cool the switch. The series resistance in particular, and there could be several which are used in the connection with the selector switch, requires a certain amount of cooling so that it does not form a heat nest.

Shaded pole motors have been used for such portable fans, particularly axial flow fans. When it is required that the fan have at least two different power stages or speed stages, the use of a shaded pole motor becomes particularly problematical for a radial flow fan because the speed-torque characteristic (n/Md) of a shaded pole motor has a saddle-shaped course, while the

torque consumption characteristic of a radial flow fan is less progressive in the low speed range than in the high speed range. This could have the result, under certain circumstances, in several intersections of these two characteristics or in a substantial parallellism in certain speed ranges. Thus, the motor will deviate sharply from the set nominal speed even with minor torque differences which may be caused, for example, by temperature changes, different friction conditions, or stress variations. This means that the reduced speed of the shaded pole motor achieved, for example, by means of a series-resistance or a voltage divider, etc., or its working point are too close together in terms of speed. In order to be able to use a radial flow fan with a shaded pole motor that can be set to at least two different nominal speeds, it is necessary to stabilize the adjustable speed stages. This is achieved, in accordance with the invention, in a simple manner by providing the rotor of the shaded pole motor with a higher electric short-circuiting ring resistance. The shaded pole motor thus receives a different altogether digressive speed torque characteristic which has no saddle and which can have only one intersection with the torque consumption characteristic of the radial fan wheel. This intersection represents then the respective stable working point which corresponds to a certain speed. The increase of the short-circuiting ring resistance can be achieved by making the short-circuiting ring of a silicone-aluminum alloy (silumin) instead of pure aluminum, and by providing it with a reduced cross-section compared to the maximum cross-section.

Accordingly, it is an object of the invention to provide an improved fan construction, which includes a flat, generally square, casing with a front wall discharge opening and with a top wall inlet opening for an axial flow fan which is positioned eccentrically within the casing.

A further object of the invention is to provide an improved portable fan, including a radial discharge fan wheel, which is operated from a shaded pole motor and which is arranged in a casing such that the discharge air focusing characteristics are enhanced and the noise level and operational characteristics are improved.

A further object of the invention is to provide a fan, particularly a portable fan, which is simple in design, rugged in construction and economical to manufacture.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a top plan view of a portable fan constructed in accordance with the invention;

FIG. 2 is a side elevational view of the fan;

FIG. 3 is a top plan view of the interior of the fan with the top part of the casing removed;

FIG. 4 is a section taken along the line A—A of FIG. 1;

FIG. 5 is a view similar to FIG. 3 but of another embodiment of the invention;

FIG. 6 is a diagram indicating the fan operating characteristics; and

FIG. 7 is a view similar to FIG. 3 but illustrating a further embodiment of the invention.

GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings in particular, the invention embodied therein in FIGS. 1 through 4, comprises a small compact fan including a substantially square flat casing 1, which is made up of an upper half shell portion 2 and a lower half shell portion 3. The casing portions 2 and 3 are joined together by means of screws 5 at the corners of a rear end wall 4 and, at parallel side walls 6, 7 and 8, 9, they are held together by discs 10 and 11. The discs 10 and 11 extend beyond projections 12 and 13 of the sidewalls 8 and 9. (See FIG. 4) The discs 10 and 11 are non-rotatably connected with a standing and carrying stirrup 14 of generally U-shape configuration, having respective ends 16, which engage into central bores 15 of discs 10 and 11 and which are introduced with an initial spring stress into the bores. The areas of the stirrup 14 adjacent each of the ends 16 may engage into notches 17 of beaded projections 12 and 13 and may be locked in a selected position, such as one of three different end positions indicated by I, II and III. When the stirrup 14 is in position I, the stirrup is held as a handle to carry the fan. In position II, it may be oriented in an inclined manner on a table, and in position III, it may be oriented backwardly against the casing in a position for packing. In position II, adjoining notches 17' permit a more accurate adjusting of the blowing direction. Instead of the stirrup 14, projections of the disc 11 can also engage in notches 17 and 17', respectively, in order to lock the fan in different positions.

As can be seen from FIGS. 3 and 4, the fan 19 includes a motor 20 which advantageously comprises a shaded pole motor of the external rotor type and which is connected to drive a radial flow fan wheel 21 which is secured to the external rotor 22 of the motor 20. The arrangement of the fan 19 in the casing 1 is such that its axis 23 is vertical but staggered with regard to the longitudinal center axis 24 of the casing 1, that is, the fan 19 is arranged eccentrically in the casing 1. The circumference of the fan wheel 21 has thus a substantially smaller distance as indicated at 25 from the side walls 6, 7 of the casing 1, than from the opposite parallel side walls 8, 9. The spacing from the periphery of the fan to the opposite side wall is indicated by the dimension 26 in FIG. 3.

In order to provide a noise-free fan space with optimum flow conditions inside the casing 1, a semicircular partition 27 is arranged in the casing whose center M lies on the longitudinal center axis 24 of the casing and whose radius of curvature corresponds at least approximately to the half inner distance of the opposite parallel side walls 6, 7 and 8, 9.

The construction includes the circular curved partition wall 27 on the side of the fan toward the rear wall 4 which leaves a space 28 in which is arranged a selector switch 29 for operating the shaded pole motor 20 at various speed stages 1 and 2 and to shut the motor off. The switch is connected to an electrical utility cord 30 for supplying power to the motor.

The shaded pole motor 20 is mounted by a flange 31 by means of two screws 32 on the bottom 33 of the lower half shell of the casing 1. The upper half shell 2 includes a cover portion 34 which is provided with intake openings 35 which are substantially concentrically arranged with respect to the radial flow fan wheel 21

and which are defined between stiffening and/or decorative ribs **36,** which advantageously influence the air flow through the openings. As best seen in FIG. **4,** the intake openings **35** are arranged at least partly directly above the fan wheel blades which have a radial spacing from the outer circumference of the fan **22.** The blades do not have an upper front cover ring in contrast to the known radial blowers. This results in a much better intake blowing power. The ribs **36,** whose lateral surfaces are arranged substantially in planes parallel to the fan wheel axis between the intake openings **35,** also contribute to the improvement of the blowing effect by preventing, to a great extent, the formation of twist currents of air on the inlet side of the fan wheel **21.** In this additional improved construction is the arrangement of the intake openings **35** so that they extend in a circle. A closed plate **35'** of the upper end face of the motor **20** is centered between the intake openings **35** of the cover **34.**

The front wall includes an air discharge opening **39** which extends over its entire height and width. Guide bars **37** extend downwardly from the top to the bottom wall in the opening **39** and provide current flow guides for the air which is discharged. For this purpose, the guides closest to the side walls **6,7** and **8, 9** are equipped with inwardly projecting tongues **37'** which are curved from the widening or volute discharge side of the fan at the dimension **26** to provide a gradual directing of the air flow which issues on this side of the fan in an outward direction for discharge. The guide tongues serve to equalize and align the air current produced by the radial flow fan wheel **21** so that it becomes parallel to the longitudinal center axis **24** of the casing **1.** The air current guide bars **37** can also be arranged in a separate insert part, for example, as shown in the embodiment of FIG. **5,** in which similar parts are similiarly designated, but with additional primes. This permits additional galvanic treatment to the guard and also makes the grill part replaceable.

Advantageously, the half shell portions **2** and **3** of the casing **1,** as well as the current guide bars **37,** and guide tongues **37',** and any additional grill parts of the casing side **39** are made of plastic. The required full insulation protection is achieved in a simple manner by means of a thin plastic plate **50** covering the flange **31** and its screws **32.**

In the embodiment of FIG. **5,** a filament coil **40** is provided between the air current guide bars **37''** and the radial flow fan wheel **21''** and this is adjustable by means of a switch (not shown) so that the portable fan can also be used as a heater.

As can best be seen in FIG. **3,** the axis **23** of the radial flow fan wheel **21** and of the shade pole motor **20** is staggered or offset toward the left side walls **6, 7** of the casing and relative to the longitudinal center axis **24.** In addition, it is offset by a small amount in a direction toward the rear wall **4** from the center M of the concentrically curved partition wall **27.** Consequently, the point of least distance between the circumference of the fan wheel and the casing wall is not at **25,** which corresponds to the level of the center M, but is staggered by an angle α of about 30° in the direction of rotation **45** of the fan wheel **21.** Starting from the point **25** at the level of the axis **23,** the distance between the circumference of the radial flow fan wheel **21** and the partition wall **27'** diminishes only slightly up to the point by the area indicated by the dot and dash line **43.** This spacing increases constantly from the area **43** to the discharge side at the location of the dimension **26.** This construction results in an improved fan characteristic and produces a maximum blowing effect with a minimum of noise.

The selector switch **29,** arranged in the space **28,** includes a series resistance (not shown), and it is cooled by openings **44** provided in the partition **27.** These openings can also be provided in the casing walls surrounding the space **28.**

In FIG. **6,** there is shown an operating characteristic diagram, in which curves *a*, and *b* represent the speed-torque characteristic of an optimally designed shaded pole motor. Curve *c* indicates the torque consumption characteristic as a function of speed of a radial flow fan. It can be seen that the two characteristics curve *a* and curve *b* have a saddle-shaped course and extend in certain speed ranges substantially parallel to the characteristic shown by the curve *c*. While the characteristic shown by the curve *a* represents the torque course of the shaded pole motor at a maximum voltage, characteristic *b* shows the torque course at a reduced voltage as corresponds, for example, to a position I of a speed selector switch **29.** It can be seen that the characteristics shown by curves *b* and *c* would no longer yield a clear intersection in the at least substantially parallel range at relatively low voltage fluctuations downward or at relatively slightly increased torque consumption and this means that there is a nondefined working point.

In order to avoid this, it is provided, according to the invention, to give the shaded pole motor **20** a different speed-torque characteristic corresponding to the characteristics shown by the curves *d* and *e* which do not show a saddle-shaped course but show an exclusively degressive course. The characteristic shown by the curve *d* corresponds to the torque behavior with full voltage, and the characteristic of the curve *e* corresponds to the torque behavior with reduced motor voltage. It can be seen that only an exactly defined intersection can appear between characteristic *d* and *e*, respectively, and the characteristic of the curve *c* at the respective applied motor voltage, and this means that exactly defined speed stages can be set with such a motor. The characteristic curves *d* and *e* are obtained either by making the short-circuiting ring of the outer rotor **22,** shown in FIG. **4,** of an aluminum silicon-alloy (silumin) instead of pure aluminum, or by reducing the cross-section of a short-circuit ring **41** of the outer rotor **22,** for example, by providing a recess **42.** The embodiment of the invention illustrated in FIG. **7** differs from that shown in FIG. **3** in that the semicircular partition **27''** is integral with the back wall **4',** and the control switch is mounted on a side wall. Additionally, the distance between partition **27''** and the periphery of the fan wheel is substantially constant through an angle of about 45° extending from the dimension line **25'** to the dotted area **53.**

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A fan construction comprising a substantially square flat casing having a top wall with an air inlet opening, substantially parallel and rectilinear front and

rear walls and substantially parallel and rectilinear side walls interconnecting said front and rear walls, a motor-driven fan wheel in said casing having an axial air intake, radially extending fan blades for radial air discharge and an axis of rotation transverse to said top wall and substantially parallel to said front wall; the axis of rotation of said fan wheel being positioned eccentrically in said casing so that the periphery of said fan wheel is substantially closer to one side wall than to the other; said front wall being substantially fully open to constitute an air discharge opening.

2. A fan construction, according to claim **1,** wherein the lateral dimensions of said top wall are a multiple of the height of said front, rear and side walls.

3. A fan construction, according to claim **1,** including a partition in said casing defining a substantially circularly curved air flow wall on the back wall side of said fan wheel, the spacing between the periphery of said fan wheel and said partition wall increasing constantly in the direction of rotation of said fan wheel.

4. A fan construction, according to claim **3,** wherein said partition is in the form of a semi-circular wall having an axis of curvature substantially parallel to said axis of rotation, said semi-circular wall extending from one side wall to the other side wall of said casing.

5. A fan construction, according to claim **1,** which is a small lightweight fan construction, including a flat electric motor arranged in said casing, said fan wheel being an annular fan wheel and being driven by said flat electric motor.

6. A small lightweight fan construction, according to claim **5,** in which said motor has an external rotor constituting the rotor of said annular fan wheel, and means supporting said radially extending blades on said rotor with their radially inner edges in radially spaced relation to the external periphery of said rotor to define an annular axial air intake for said fan wheel.

7. A small lightweight fan construction, according to claim **5,** in which said casing has a partition wall defining a substantially circularly curved air flow wall on the side of said fan wheel adjacent said back wall, the axis of said fan wheel further being positioned eccentrically with respect to said partition wall.

8. A small lightweight fan construction, according to claim **7,** wherein an imaginary line drawn from a center point of the curvature of the partition wall on the longitudinal axis of the casing through the axis of the fan rotor makes an angle of from 20° to 40° with a line drawn normal to the longitudinal axis of the casing and intersecting the center of curvature of the partition wall.

9. A small lightweight fan construction, according to claim **7,** including an air guide grid located in said discharge opening of said front wall and including rib members extending between said top and bottom wall and curved from the discharge side of said fan wheel on the side thereof with the greatest spacing to the associated side wall outwardly of said casing, said grid being exchangeable.

10. A small lightweight fan construction, according to claim **7,** wherein said casing has an electrical component space defined between said partition wall and said rear wall, and electrical switch means located in said component space, said space being ventilated by openings in said partition wall.

11. A small lightweight fan construction, according to claim **7,** wherein said motor comprises a shaded pole motor having a rotor with a higher electrical short-circuiting ring resistance.

12. A small lightweight fan construction, according to claim **11,** wherein said short-circuiting ring resistance is made of aluminum-silicon alloy and has a reduced cross-section relative to its maximum dimensional cross-section.

13. A small lightweight fan construction, according to claim **7,** including an electrical heater arranged between said fan and said discharge opening.

14. A small lightweight fan construction, according to claim **7,** wherein said casing is made of two half shell parts of generally pot-shape configuration which are joined together, and means for clamping said parts together including a threaded bolt adjacent at least one end of said casing interengaging said top and bottom parts and a disc on each side wall overlying the juncture of said top and bottom parts, and a U-shaped stirrup having leg portions on each side engaged in the respective discs on each side.

15. A small lightweight fan construction, according to claim **7,** including selector switch means in the space between said partition wall and said rear wall of a size in which it is clamped between top and bottom shell portions without additional securement.

16. A small lightweight fan construction, according to claim **14,** wherein each of said discs includes a plurality of angularly spaced notches around its periphery, said stirrup being selectively engageable in respective notches for positioning said stirrup at a desired angle in respect to said casing.

17. A small lightweight fan construction, according to claim **7,** wherein said casing is made of an insulating material, and including an insulating plate covering said motor.

18. A small lightweight fan construction, according to claim **7,** wherein said inlet opening of said top wall comprises a plurality of openings arranged at least partly directly above said fan wheel, said fan wheel being at least partly opened on the side facing said openings, said openings being arranged within a circular area, and sub-dividing ribs extending over said top wall dividing said openings of said circular area and having parallel guide faces extending parallel to the axis of said fan wheel.

19. A small lightweight fan construction, according to claim **18,** including a separate top plate on said top wall carrying said intake openings.

* * * * *