

Jan. 29, 1935.

H. F. HAGEN

1,989,413

CENTRIFUGAL FAN

Filed Oct. 31, 1929

2 Sheets-Sheet 1

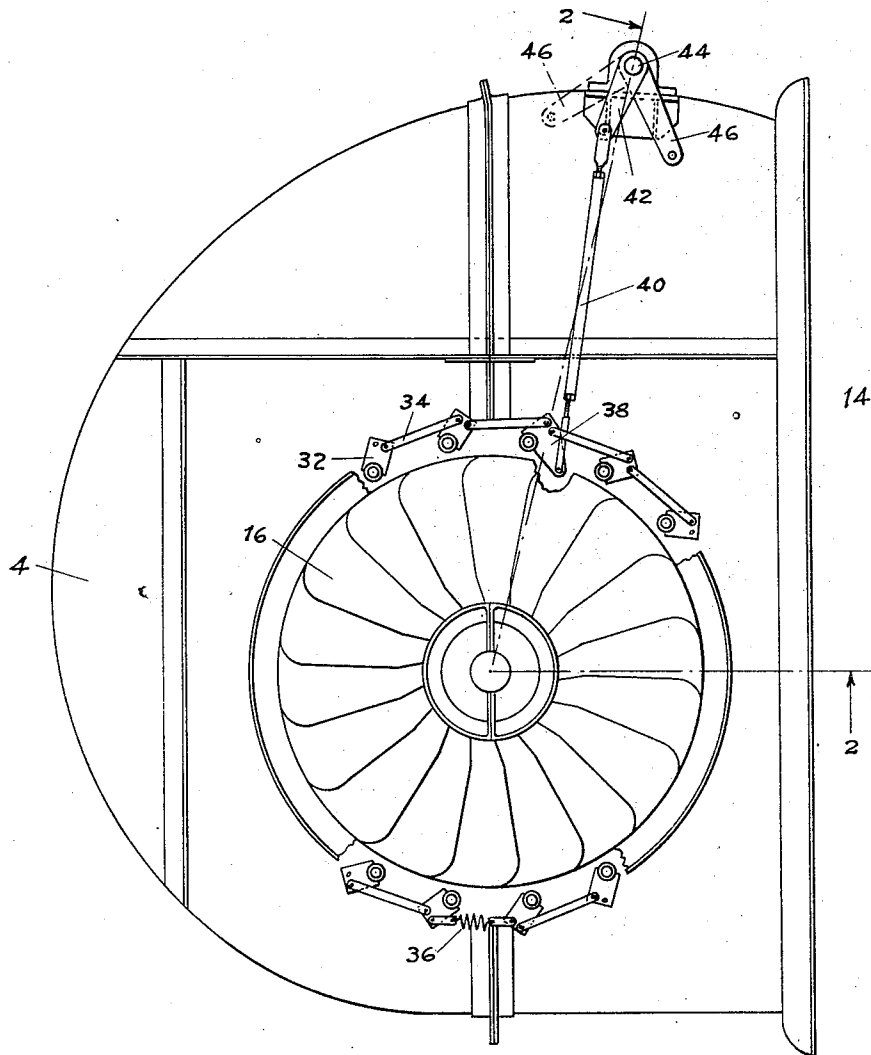


FIG 1

INVENTOR

Harold F. Hagen

By

Van Emmerich & Eldredge
ATTORNEYS

Jan. 29, 1935.

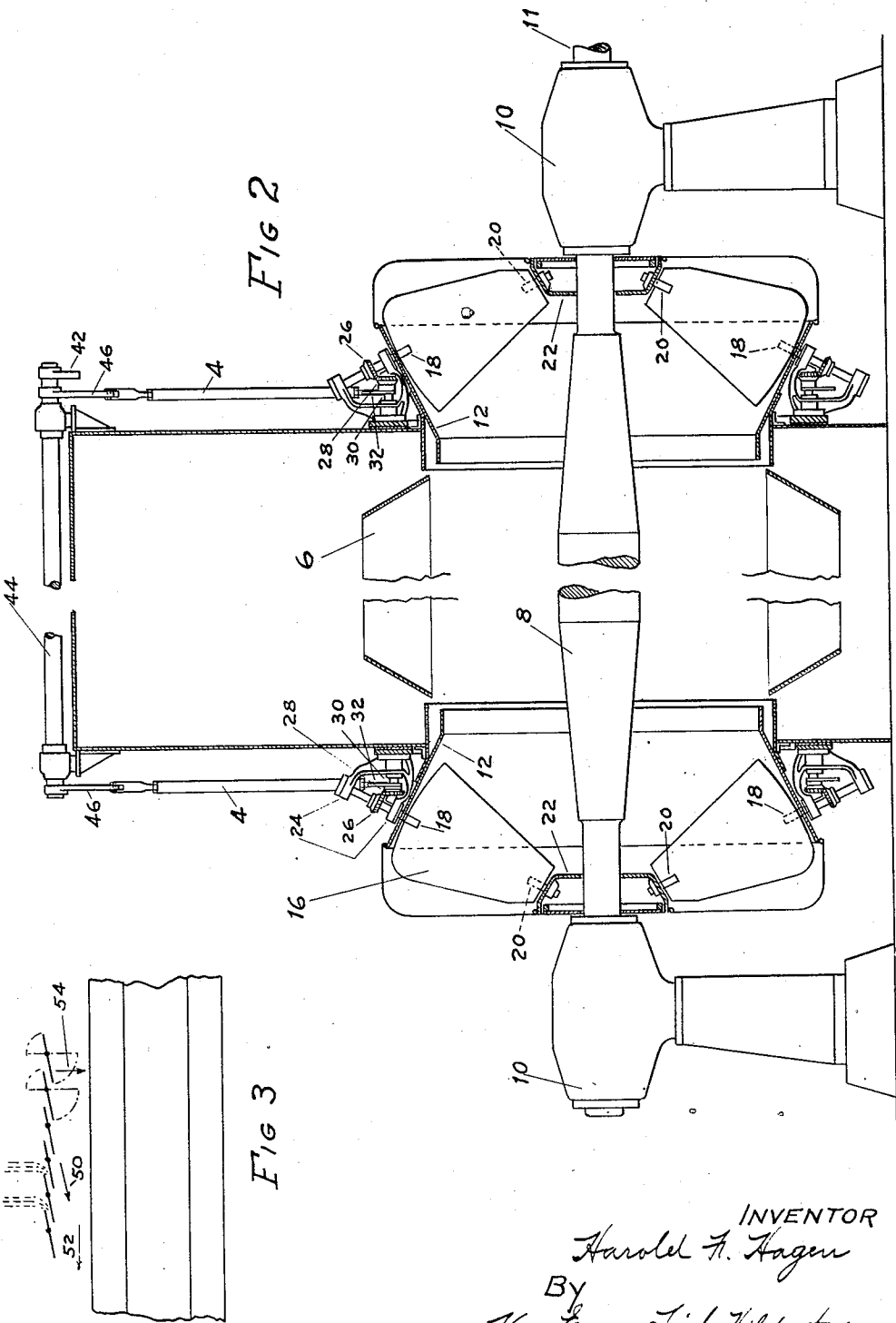
H. F. HAGEN

1,989,413

CENTRIFUGAL FAN

Filed Oct. 31, 1929

2 Sheets-Sheet 2



INVENTOR
Harold F. Hagen
By
Van Curen, Fish, Hildreth & Carr
ATTORNEYS

UNITED STATES PATENT OFFICE

1,989,413

CENTRIFUGAL FAN

Harold F. Hagen, Dedham, Mass., assignor to
B. F. Sturtevant Company, Hyde Park, Mass.,
a corporation of Massachusetts

Application October 31, 1929, Serial No. 403,753

4 Claims. (Cl. 230—114)

The present invention relates to centrifugal fans and more particularly to fans having provision for efficient variation of output independently of the speed. A fan of this general type disclosed in my Patent No. 1,846,863, dated February 23, 1932, employs vanes constructed and arranged to impart a controllable spin velocity to the fluid in the direction of rotation of the rotor. The illustrated embodiment of the invention of said application is a fan provided with inlet scrolls and having curved vanes which may be adjusted to impart any desired degree of spin velocity to the entering fluid. Such a fan is particularly adapted for induced draft.

The principal object of the present invention is to provide a fan in which the fluid may be admitted directly from the atmosphere and which has provision for imparting a controllable spin velocity to regulate the output of the fan.

With these objects in view, the principal feature of the present invention comprises a fan having vanes adapted to be placed in the inlet and constructed and arranged to pivot on generally radial axes. A fan of this type is especially useful for forced draft wherein the air is admitted to the rotor directly from the atmosphere rather than through inlet connections such as are employed in induced draft fans.

Other features of the invention consist of certain novel features of construction, combinations and arrangement of parts hereinafter described and particularly defined in the claims.

In the accompanying drawings illustrating the preferred form of the invention, Fig. 1 is a side elevation of the improved forced draft fan; Fig. 2 is a section on line 2—2 of Fig. 1; and Fig. 3 is a diagrammatic plan view of a portion of the rotor and vanes to illustrate the theory of operation.

The fan illustrated in the drawings comprises a casing 4 and a rotor or wheel 6 mounted on a shaft 8 which is journaled in suitable bearings 10. The shaft is driven by a constant speed motor such as a squirrel cage induction motor, preferably directly connected to the end 11 of shaft 8. On each side of the casing is an inlet cone or eye 12 through which the air passes from the atmosphere into the rotor 6. The casing is provided with the usual outlet connection 14.

In order to control the output of the fan independently of the speed, each inlet cone is provided with a plurality of overlapping vanes 16. As shown in Fig. 2, each vane is in the general shape of a sector and is provided with pivot pins 18 and 20 at opposite ends. The outer pin 18 is journaled in the inlet cone 12 and the inner pin 20 is jour-

naled in a cone-shaped hub 22 secured to the bearing.

The vanes in each set are adapted to be simultaneously adjusted to any desired inclination from closed position, as shown in Fig. 1, to open position, as shown in Fig. 2. To this end, each pin 18 is journaled in a yoke 24 secured to the casing and each pin carries a bevel gear 26 which meshes with a bevel gear 28 mounted in a horizontal shaft 30 also journaled in the yoke. Secured to each gear 28 is a plate 32, the several plates on each side of the fan being connected by links 34 to form a closed ring about the inlet.

A coil spring 36 is provided connecting two of the plates at one point in the periphery to take up lost motion in the mechanism.

To one of the gears is attached a plate 38 which, as shown in Fig. 1, is adapted to be similarly connected to the links 34 but which has an extension to which one end of an operating link 40 is attached. This link is connected at its other end to a lever 42. The levers 42 on opposite sides of the fan are connected by a rock shaft 44. An arm 46 which is adapted to be actuated to vary the position of the plate 38 and thereby to adjust the positions of the vanes is secured to the rock shaft. The arm 46 is shown in two positions in Fig. 1. In the full-line position, the vanes are completely closed. In the dot-and-dash line position, the vanes are wide open. The arm 46 may be adjusted manually, but in power plant operation is preferably operated by any suitable mechanism which functions on variations in the load.

It will be seen from Fig. 2, that the axes about which the vanes turn, although extending in a general radial direction from the shaft, are inclined somewhat from the vertical and therefore lie on the surface of a cone. The purpose of this construction is to afford sufficient space near the inner end of the vanes for the inner end mounting without unduly restricting the effective area of the inlet.

As shown in Fig. 2 and in the diagram of Fig. 3, the portion of each vane on the inner or down stream side of its axis, that is, the side nearer the fan, is of greater area than the outer or up stream portion. The ratio of areas is preferably about 60 to 40, although the figure is not critical. The purpose of thus unbalancing the areas is to permit opening and closing of the vanes with a minimum of effort.

In Fig. 3, there are shown two stream lines of

air passing adjacent to one of the vanes at a time when the vanes are nearly closed. It will be seen that because of the convergence of the stream lines as the air enters between the vanes, the velocity of air past the side of each vane down stream from the pivot is much greater than its velocity past the up stream side. The static pressure on the down stream side is therefore less than the pressure on the upstream side, and the tendency is for the vane to move towards closed position. If the vanes are symmetrically pivoted, therefore, a considerable force is required to hold the vanes open in any desired position or to move them from closed to open position. By mounting the vanes as shown in Fig. 2, with a preponderance of area on the down stream side, the forces due to air pressure may be approximately balanced so that only a small force is required to move or to hold the vanes.

As stated above, the best ratio has been found to be about 60—40, although it has been found that it may range from 70—30 to 55—45. In this range, the force required to move the vanes may be as little as one-fiftieth of the force required when the vanes are symmetrically mounted. When the down stream area is less than 55% of the whole, the unbalance of forces increases very rapidly.

The fan of the present invention is particularly adapted for use as a forced draft fan which is operated by a constant speed motor. The action of the spin velocity in permitting control of output without changing the speed has been fully described in the patent referred to, but will be briefly reviewed here.

Referring to Fig. 3, wherein the vanes are shown in nearly closed position in solid lines, the air is admitted to the rotor in the direction indicated by the arrow 50. The velocity of the rotor is represented by the arrow 52. It will be understood that for any useful work to be done on the fluid, there must be a relative velocity between the fan and the entering fluid in the direction of rotation of the rotor. When the vanes are nearly closed, the spin velocity represented by the vector 50 is not greatly different from the velocity of the rotor and little work is therefore done by the rotor. When the vanes are in wide open position, as shown in dotted lines, the fluid enters in an axial direction represented by the vector 54. The relative velocity between the wheel and the entering air is therefore considerable and the maximum output is then obtainable. For intermediate outputs, the vanes are inclined to intermediate positions.

In any case, the speed may be and preferably is maintained constant, thus permitting the fan to be driven by a squirrel cage induction motor, which has been found to be the most economical and satisfactory driving means. The efficiency of this type of motor changes only a small amount with reduced outputs.

It will be noted that just as in the fan of my above-mentioned patent there is no appreciable throttling of the fluid even when the vanes are nearly closed. In any position of the vanes, the predominant controlling factor is the spin velocity.

Having thus described the invention, what is claimed is:

1. A centrifugal fan comprising a rotor, a casing having an eye and a substantially conical inlet passage leading to the eye, and a plurality of vanes in the inlet pivoted on axes which are oblique to the rotor axis and substantially at right angles to the conical inlet, the vanes being adjustable about their axes from substantially wide open position in which they do not appreciably obstruct the flow of gas to the rotor through an angle of nearly 90 degrees to a closed position, throughout which adjustment they direct the entering gas to the rotor with an appreciable spin, the work done by the fan on the gas being variable in accordance with the adjustable spin introduced by the vanes at different positions.

2. A centrifugal fan comprising a rotor, a casing having an eye and a substantially conical inlet passage leading to the eye, a hub disposed on the rotor axis, and a plurality of vanes pivoted on the hub and the conical inlet on axes which are oblique to the rotor axis and substantially at right angles to the conical inlet, the vanes being adjustable about their axes from substantially wide open position in which they do not appreciably obstruct the flow of gas to the rotor through an angle of nearly 90 degrees to a closed position, throughout which adjustment they direct the entering gas to the rotor with an appreciable spin, the work done by the fan on the gas being variable in accordance with the adjustable spin introduced by the vanes at different positions.

3. A centrifugal fan comprising a rotor, a casing having an eye and a substantially conical inlet passage leading to the eye, and a plurality of vanes in the inlet pivoted on axes which are oblique to the rotor axis and substantially at right angles to the conical inlet, the vanes being adjustable about their axes from substantially wide open position in which they do not appreciably obstruct the flow of gas to the rotor through an angle of nearly 90 degrees to a closed position, throughout which adjustment they direct the entering gas to the rotor with an appreciable spin, the work done by the fan on the gas being variable in accordance with the adjustable spin introduced by the vanes at different positions, and means for simultaneously and uniformly adjusting the vanes about their axes.

4. A centrifugal fan comprising a rotor, a casing having an eye and a substantially conical inlet passage leading to the eye, a hub disposed on the rotor axis, and a plurality of vanes pivoted on the hub and the conical inlet on axes which are oblique to the rotor axis and substantially at right angles to the conical inlet, the vanes being adjustable about their axes from substantially wide open position in which they do not appreciably obstruct the flow of gas to the rotor through an angle of nearly 90 degrees to a closed position, throughout which adjustment they direct the entering gas to the rotor with an appreciable spin, the work done by the fan on the gas being variable in accordance with the adjustable spin introduced by the vanes at different positions, and means for simultaneously and uniformly adjusting the vanes about their axes.

HAROLD F. HAGEN.