Sept. 29, 1953 J. E. McDONALD 2,653,754

AXIAL FLOW FAN REGULATOR

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FIG. 1

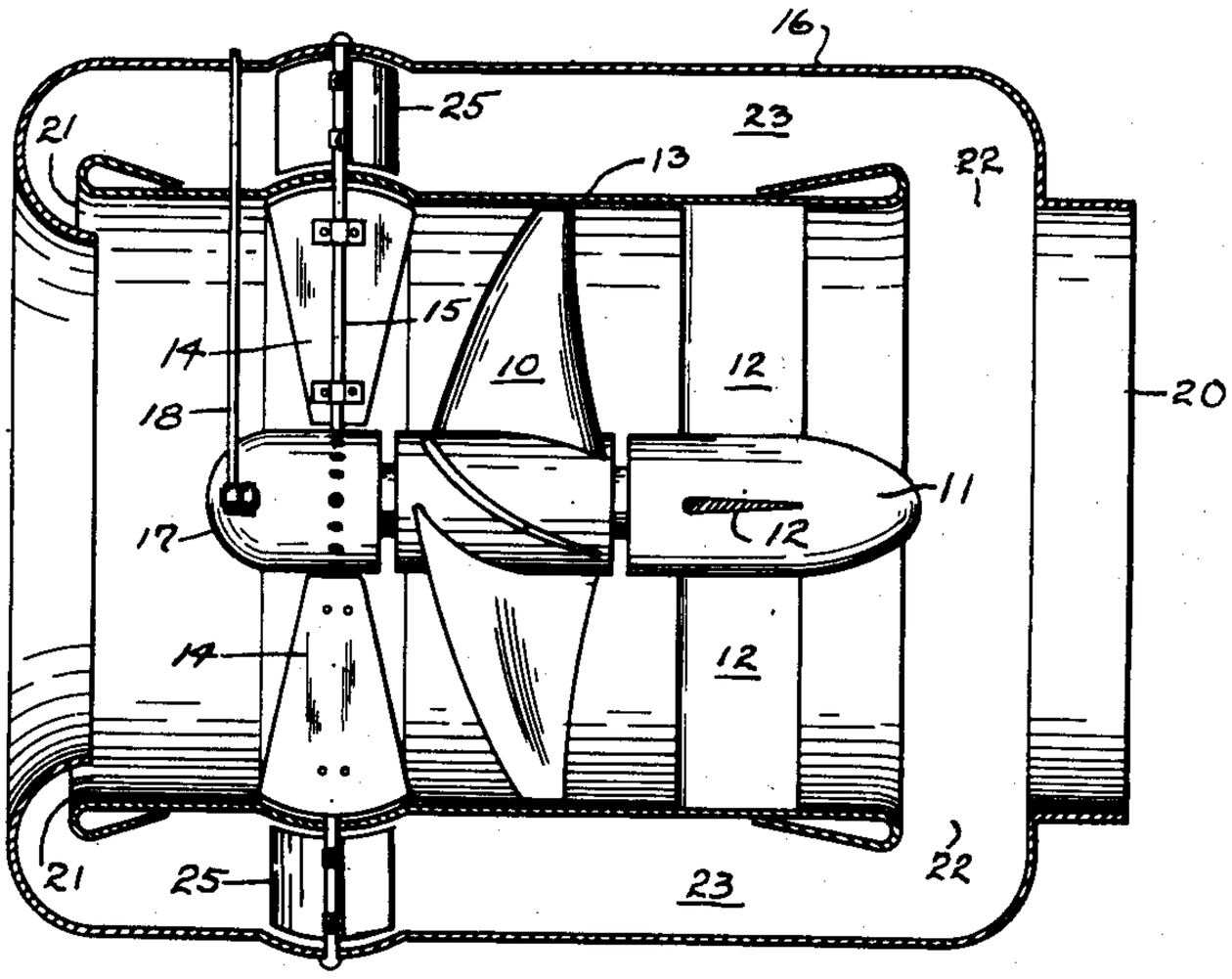

FIG. 2

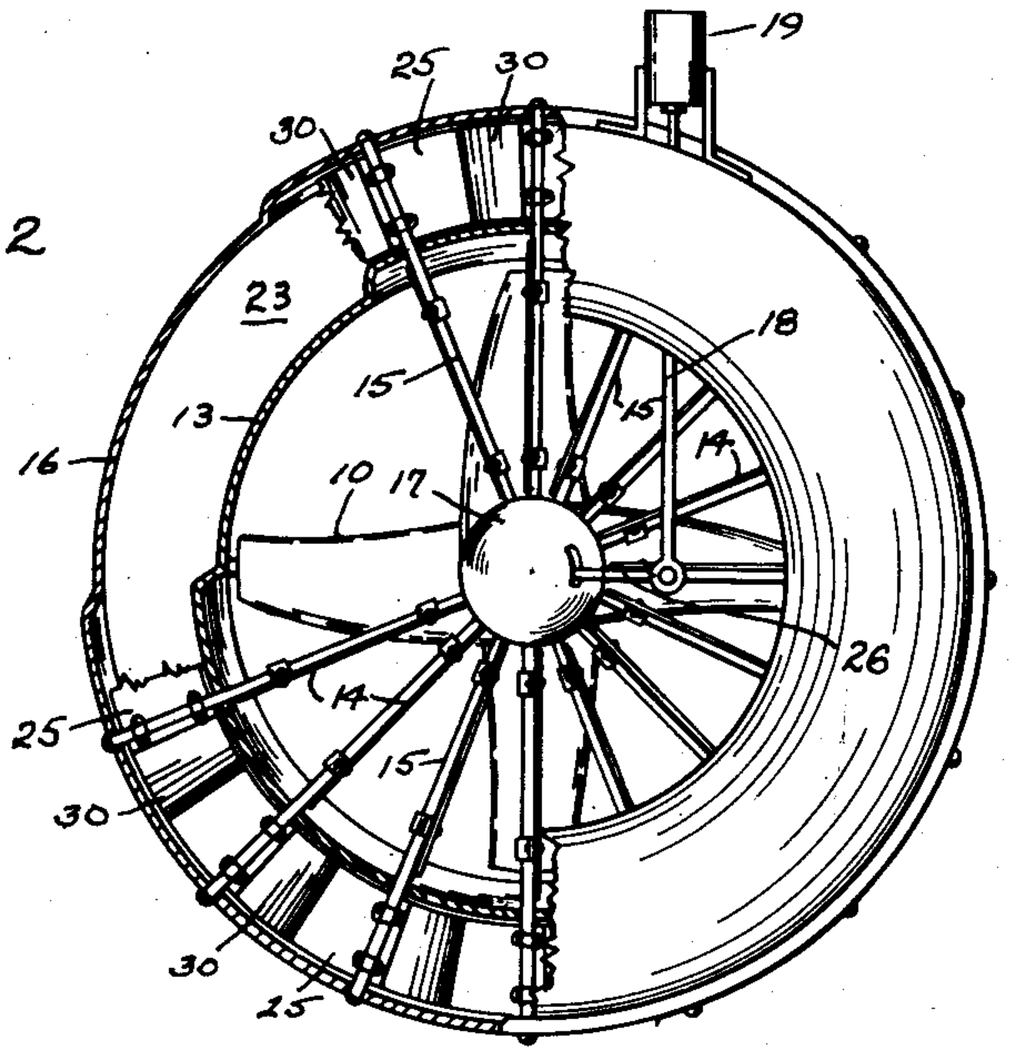

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FIG. 5

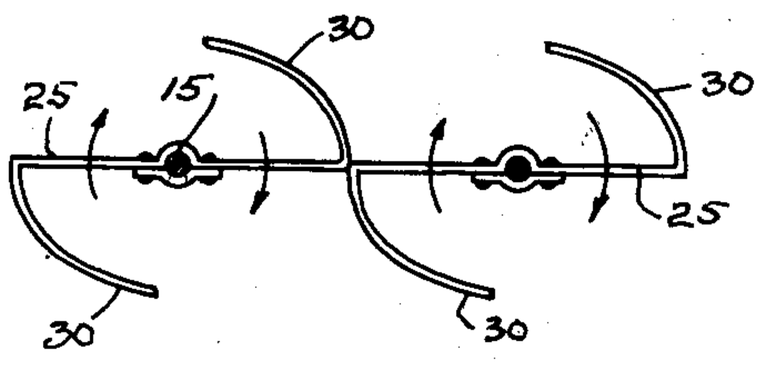


FIG. 3

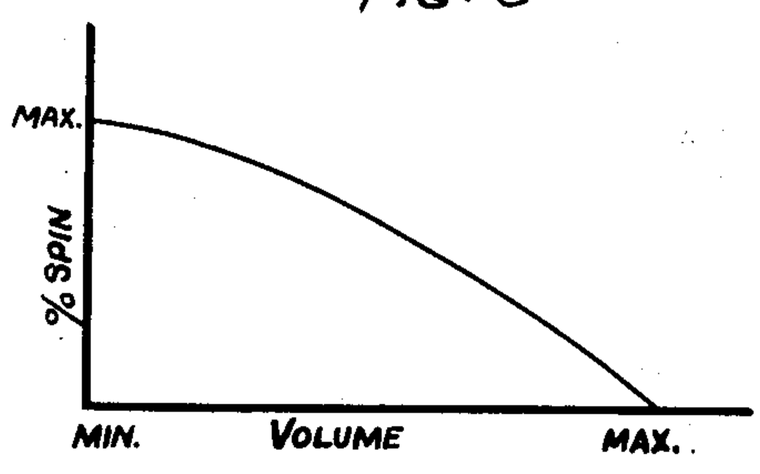
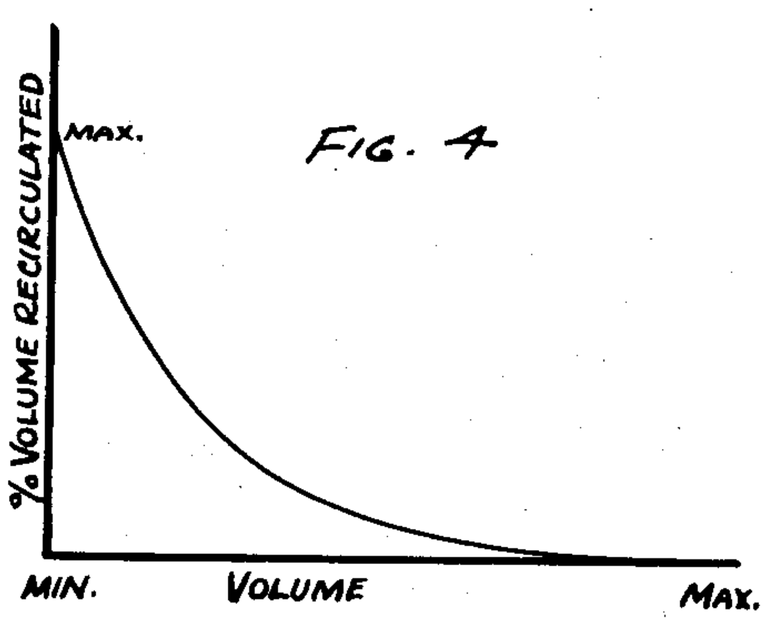


FIG. 4



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UNITED STATES PATENT OFFICE

2,653,754

AXIAL FLOW FAN REGULATOR

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Application November 1, 1949, Serial No. 127,160

4 Claims. (Cl. 230—114)

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This invention relates to axial flow fans, and relates more particularly to controls for enabling such fans to operate at high efficiencies over a wide range of gas volumes delivered to their loads.

The H. F. Hagen Patent No. 2,393,042 which issued January 15, 1946, describes how, for the most efficient operation of an axial flow fan driven by a constant speed motor at reduced loads, larger volumes of gas than are required by the loads must be passed through the fan, and describes coordinated spin vane and damper controls for so adjusting the gas volumes through the fan and supplied to its load that most efficient operation results.

This invention is an improvement on the apparatus illustrated and described in said patent in that the dampers for adjusting the volume of gas recirculated through a fan, are mounted on the ends of the spin vanes which adjust the volume of gas handled by the fan, and in that the pressure energy of the recirculated gas is converted into velocity energy as it enters the fan inlet.

An object of this invention is to simplify spin vane and damper controls for an axial flow fan through which gas is recirculated at reduced loads.

Another object of the invention is to improve the performance of an axial flow fan through which gas is recirculated at reduced loads, by converting the pressure energy in the recirculated gas into velocity energy.

The invention will now be described with reference to the drawing, of which:

Fig. 1 is a side elevation partly in section, of an axial flow fan embodying this invention;

Fig. 2 is a front elevation, partially in section, of the fan;

Fig. 3 is a chart showing the percentage of spin added to the gas entering the fan for different gas volumes supplied to its load;

Fig. 4 is a chart showing the percentage of recirculation through the fan for different gas volumes supplied to its load, and

Fig. 5 is a developed plan view looking downwardly upon two of the dampers used.

The fan illustrated has the fan wheel 10 driven by the electric motor 11, the wheel and the motor being supported by the spaced diffusion vanes 12 from the cylindrical inner casing wall 13.

The spin vanes 14 are supported on the pivot rods 15 which are journalled for rotation in the outer casing wall 16, the inner casing wall 13 and the hub 17. The hub contains mechanism for rotating the rods 15 and the vanes 14 attached thereto, when the lever 18 actuated by a piston

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in the cylinder 19 is moved vertically up and down. The spin vane adjusting mechanism in the hub 17 may be of the type described in the A. C. Bartlett et al. Patent No. 2,113,391 and since forming no part of the present invention, will not be described in detail herein.

The outer casing wall 16 is connected to the inner casing wall 13 adjacent the outlet 20 of the fan, and has a cylindrical central portion extending centrally around and spaced from the inner wall 13, and has an upstream portion which curves inwardly into the inlet of the fan and forms with the upstream edge of the inner casing wall 13, a constricted nozzle 21.

The casing wall 13 adjacent the downstream side of the vanes 12 is spaced from the wall 16 for forming a circumferentially extending, recirculation opening 22 through which gas from the downstream side of the fan passes into the recirculation passage 23 between the walls 13 and 16, and through the nozzle 21 into the inlet of the fan. The nozzle 21 converts the pressure energy in the recirculated gas into velocity energy, the high velocity, recirculated gas at the blade tips increasing the efficiency of the fan at reduced loads.

The dampers 25 are attached to the outer ends of the pivot rods 15, between the walls 13 and 16 so as to be rotated when the spin vanes 14 are rotated. When the spin vanes are wide open so that they add no spin to the gas entering the fan, the dampers 25 are in their fully closed positions as illustrated by Fig. 5 of the drawing. As explained in said Hagen patent, the characteristics of an axial flow fan are such that when it is adjusted to supply a reduced volume of gas to its load, for most efficient operation, a larger volume of gas must be passed through the fan than is supplied to the load. The motor 11 is driven at constant speed and as the load on the fan is reduced below maximum, the load responsive cylinder 19 causes, through the movements of the levers 18 and 26, the vane control mechanism in the hub 17 to adjust the vanes from their wide open position towards closed position for adding sufficient spin to the gas entering the fan, that the required reduced gas volume will be supplied to the load. When the vanes are so adjusted through rotation of the pivot rods 15, the dampers 25 are simultaneously adjusted to open the recirculation passage whereby sufficient gas will be recirculated through the fan for maintaining its efficiency at the reduced load.

Figs. 3 and 4 illustrate curves showing typical spin and recirculation percentages for the differ-

ent gas volumes for maximum efficiency, although the shapes of the curves may vary for different fans and different loads. Generally speaking, for small load reduction below maximum, little or no recirculation is required. As the load reduction increases the percentage of recirculation increases.

When the load is reduced below maximum, the spin vanes are adjusted to add sufficient spin to the gas so that the volume of gas delivered to the load is that required by the reduced load. The dampers **25** will be rotated by the adjustment of the spin vanes and for preventing them from passing but a small volume of recirculated gas upon slight load reductions below maximum, the curved segments **30** are attached to their edges, the segments on one damper extending oppositely to the corresponding segments on the adjacent damper. If the segments were formed in circular arcs about the centers of the rods **15**, then throughout their range of adjustment no appreciable recirculation would occur since the adjacent segments would remain almost in contact throughout the adjustment.

As illustrated by Fig. 5 of the drawing, the segments **30** are so shaped that adjacent segments remain almost in contact during slight load reductions below maximum, and then are moved increasingly further apart as the load is reduced towards minimum, whereby the volume of recirculated gas is correspondingly increased. Thus, the segments may be shaped to cause the recirculation characteristic to follow the curve of Fig. 4 of the drawing or any other desired characteristic curve.

The casing walls **13** and **16** adjacent the inner and outer edges of the dampers 25 are formed as surfaces of spheres, and the adjacent edges of the dampers and of the spin vanes **14** are curved to conform therewith whereby no appreciable leakage can occur throughout their ranges of adjustment.

While one embodiment of the invention has been described for the purpose of illustration, it should be understood that the invention is not limited to the exact apparatus and arrangement of apparatus illustrated, as modifications thereof may be suggested by those skilled in the art, without departure from the essence of the invention.

What is claimed, is:

1. A fan comprising a rotor having fan blades thereon, an inner casing wall extending around said blades and forming an axial gas passage around said rotor, an outer casing wall radially spaced from said inner wall and forming therewith an annular gas passage, a plurality of spin vanes rotatably supported in said axial gas passage upstream of said rotor about axes which extend perpendicular to the rotary axis of said rotor, said vanes being fixed to pivot rods which extend through said inner casing wall into both of said passages, and dampers in said annular passage attached to said rods for rotation therewith.

2. A fan as claimed in claim 1 in which the surfaces of said inner and outer walls at said dampers, are spherical segments, and the inner and outer surfaces of said dampers are curved to conform to the curvature of said segments to provide close cooperation with said segments during rotation of said dampers.

3. A fan comprising a rotor having fan blades thereon, an inner casing wall around said blades and forming an axial inlet passage around said rotor, an outer casing wall around and radially spaced from said inner wall and forming therewith a circumferentially extending gas passage, a plurality of spin vanes rotatably supported in said axial passage upstream of said rotor about axes which extend perpendicular to the rotary axis of said fan, said vanes being fixed to rotary pivot rods which extend through said inner wall into both of said passages, means connected to the inner ends of said rods for rotating said rods for adjusting said vanes between wide open and closed positions, and dampers in said circumferentially extending passage attached to said rods for rotation therewith, said dampers having radially extending edges which contact each other to close said circumferentially extending passage when said spin vanes are in wide open positions.

4. A fan as claimed in claim 3 in which the surface of said inner and outer walls at said dampers are formed as spherical segments, and the inner and outer edges of said dampers are curved to conform to the curvature of said segments.

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