July 29, 1958 J. SALLOU 2,845,216

CENTRIFUGAL APPARATUS FOR THE CIRCULATION OF FLUIDS

Filed Oct. 23, 1953

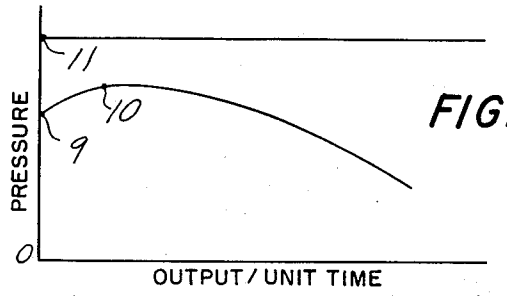


FIG. 1.

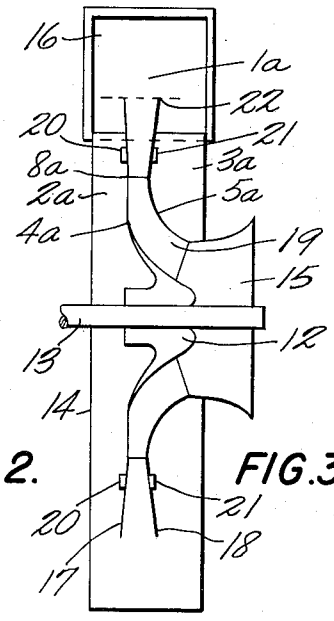


FIG. 3.

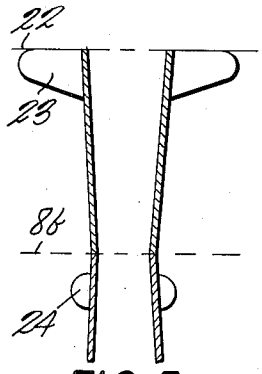


FIG. 5.

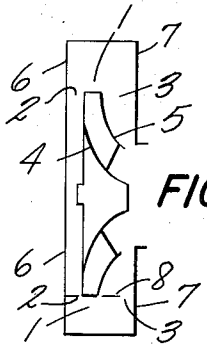


FIG. 2.

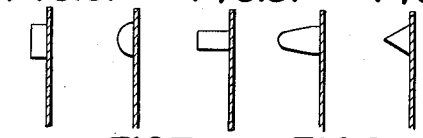


FIG. 6. FIG. 8. FIG. 10

FIG. 7. FIG. 9.

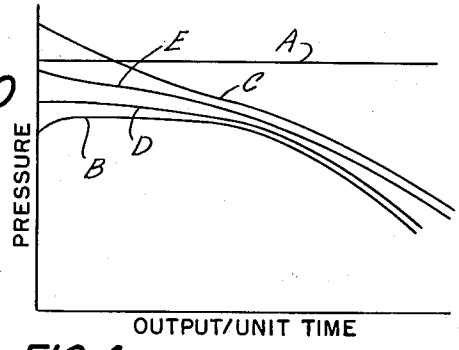


FIG. 4.

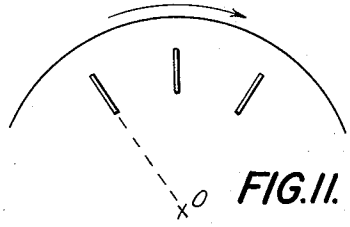


FIG. 11.

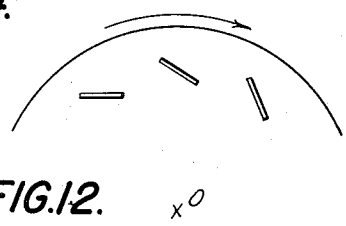


FIG. 12.

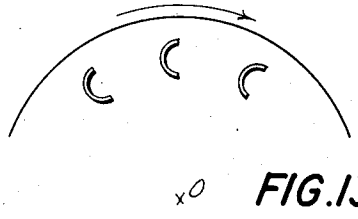


FIG. 13.

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United States Patent Office 2,845,216 Patented July 29, 1958

2,845,216

CENTRIFUGAL APPARATUS FOR THE CIRCULATION OF FLUIDS

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Application October 23, 1953, Serial No. 388,019

Claims priority, application France November 15, 1952

2 Claims. (Cl. 230—127)

This invention relates to centrifugal apparatus for the circulation of fluids.

It is known that in a centrifugal fan, and in general in any apparatus serving to displace a fluid, such as a pump, fan or compressor, the characteristics revealed by tests differ considerably from the theoretical characteristics based on the equation of Euler.

The invention has for its object improvements in centrifugal apparatus for the circulation of fluids, wherein, for the purpose of increasing the pressure, particularly around a point of operation with an output equal to zero, there are provided on the outer faces of the centrifugal wheel auxiliary vanes which are adapted to actuate the air located between the wheel and the fixed surrounding or volute portion of the apparatus.

The invention also provides for disposal of these vanes on the peripheral portion of the wheel, and if the latter comprises a rotary diffuser the vanes may be arranged to be carried by this diffuser, so that they are situated in the immediate proximity of the air outlet from the wheel.

The invention will now be described by way of example, both as regards its principle as well as its reduction to practice, with reference to the accompanying drawing, in which:

Fig. 1 is a diagram illustrating the theoretical curves and experimental pressure and output of centrifugal apparatus of the usual kind;

Fig. 2 is a diagrammatical sectional view in elevation through a normal centrifugal fan;

Fig. 3 shows diagrammatically a sectional view in elevation through a centrifugal fan in accordance with the invention;

Fig. 4 is a diagram of comparison showing the pressure and output curves obtained by centrifugal apparatus according to the invention;

Figs. 5 to 10 are front views of different forms of vanes in accordance with the invention;

Figs. 11 to 13 illustrate different forms of profile in respect of vanes according to the invention.

Fig. 1 permits by way of example a comparison of the theoretical and experimental output and pressure characteristics, at a constant speed, of a centrifugal apparatus having radial blades of the usual kind.

Among the different causes which serve to produce the divergence ascertained between the curves there is one which, although it may preponderate in the zone situated substantially at zero output, exists none the less over the entire zone of action of the fan.

This cause resides in the friction which is produced on each side of the stream of fluid **1** (Fig. 2) leaving the wheel against the layers of fluid **2** and **3** contained in the lateral spaces between the flanks **4** and **5** of the wheel and the flanks **6** and **7** of the volute portion.

When the stream of fluid **1** leaving the wheel contains an appreciable amount of energy, which is the case when the output is high, the friction in question causes rotation of the layers **2** and **3** about the axis of the fan, and

there are produced more or less perfectly formed tubular eddies, the tangential speed of which, at right angles to the outlet cylinder **8** of the blades, is almost equal to the tangential speed of the fluid at the outlet from the blades of the wheel. In this case, therefore, the effect of friction will be small and the drop in pressure due to this cause will be reduced.

On the other hand when the energy contained in the stream of fluid is small, which is the case in the region of zero output, the friction slows down the tangential speed of the stream of fluid leaving the wheel, and this speed, instead of tending to be equal to the peripheral speed of the ends of the blades, will be lower. In consequence, the pressure, which theoretically should then be approximately double the dynamic pressure of the peripheral speed, assumes a very much lower value.

It is, therefore, primarily this cause to which there must be attributed the change in direction **9—10** in the experimental curve (Fig. 1), a change in direction which is the reason for the frequently very troublesome condition known as surging.

The object sought by the present invention is to render the tangential speed of the tubular eddies in the lateral spaces **2** and **3** independent of that of the stream of fluid **1** leaving the wheel.

It will in fact be appreciated that if by any suitable means there is imparted to the tangential speed of the tubular eddies a value, which is equal, for example, to the peripheral speed of the blades, all friction will be eliminated in the assumed instance of zero output, and there will be set up at this moment a pressure equal to the theoretical pressure of the point **11** in Fig. 1.

It will also be apparent that if the wheel comprises radial blades, a tubular eddy of this nature will also not create friction in the case of high output, as in a wheel of this character the tangential speed of the stream leaving the wheel is theoretically always equal to the peripheral speed of the end of the blades. Friction tending to slow down somewhat the stream of fluid no longer occurs, and in consequence there will also take place in this case a slight increase in pressure.

It will finally be appreciated that if the wheel comprises blades which slope off towards the rear, assuming that the tubular eddy has a tangential speed which is always equal to the peripheral speed, and in the range of high output, where theoretically the tangential speed of the stream leaving the wheel is less than the peripheral speed, friction will again occur, but this time in the opposite direction. This friction, being motive instead of resistant, will assist to relieve the pressure.

The means employed to achieve this object and forming the subject matter of the present invention consists in providing on each side of the wheel a series of auxiliary vanes, the number, form, dimensions and position of which will be selected according to the value which it is desired to impart to the tangential speed of the lateral tubular eddies.

Preferably, auxiliary vanes will be employed in combination with wheels furnished with a peripheral mobile diffuser. An arrangement of this nature is illustrated in section in Fig. 3.

A wheel **12** mounted on a shaft **13** rotates within a volute portion **14** provided with a suction aperture **15** and a discharge aperture **16**. The wheel comprises two flanks **4***a* and **5***a* extended by two side plates **17** and **18** forming a rotary diffuser beyond the cylinder **8***a* constituting the periphery of the ends of the blades **19**.

On the outside of the wheel auxiliary vanes **20** and **21** are secured in desired number, form, dimensions and location.

Upon rotation, these vanes cause actuation of the layers of fluid occupying the lateral spaces **2***a* and **3***a* and

bring about in these lateral spaces the formation of tubular eddies, the tangential speed of which at right angles to the cylinder **22** bounding the outlet from the diffuser will be independent of the stream **1***a* leaving the wheel and will depend only on the vanes **20** and **21**.

In effect, it will be apparent that if an appreciable number of large vanes **23** (Fig. 5)—for example, twenty on each face of the wheel—are provided in the vicinity of the periphery **22** of the rotary diffuser, there will be imparted to the tubular eddies a tangential speed which is much greater than if a small number of small-sized vanes **24**—for example, five on each face of the wheel—were located below the periphery **8***b* of the blades of the wheel.

It will also be obvious that if the position of the vanes is restricted to a point below the periphery **8***b*, which is the case in a wheel of the usual kind without rotary diffuser, the extreme limit which can be imparted to the tubular eddies at this point will be the peripheral speed of the blades, whereas this value can be exceeded if the auxiliary vanes are located above this periphery. The combination with a wheel having a rotary diffuser will, therefore, be much more efficient than the combination with an ordinary wheel without rotary diffuser. It is then even possible to obtain around the point of zero output pressures which exceed the theoretical pressure.

Fig. 4, in which there are shown by way of example three experimental curves corresponding to three positions of the vanes, permits a comparison of the relationship of pressure to output per unit time of the theoretical curve and the curve obtained without vanes.

The curve A is the theoretical line of a wheel having radial blades, the curve B is the experimental curve of a wheel having a rotary diffuser without auxiliary vanes. The curve C is that obtained by disposing small vanes in the vicinity of the periphery **22**, the curve D is that obtained when the vanes are situated just below the periphery **8***a*, and the curve E corresponds to an intermediate position.

These curves also show that the arrangement is very effective in eliminating pumping.

As regards the form of the vanes, there may be employed one of the forms shown in Figs. 6 to 10, set according to one of the profiles in Figs. 11 to 13, dependent on whether experience will show an increased or decreased efficiency in the solution of a given problem.

I claim:

1. A centrifugal apparatus for the circulation of fluids comprising, in combination, a rotatably mounted centrifugal wheel, a fixed casing surrounding said wheel, said casing having a discharge aperture for removing the fluid impelled by said wheel, a rotary diffuser extending radially from the periphery of said wheel in said casing, said diffuser being integral with said wheel and thereby

rotatable therewith at the same angular velocity and said diffuser having two axially-spaced-apart axially-outer surfaces spaced from the axially-inner surfaces of said diffuser and auxiliary vanes extending axially from both axially-outer surfaces of said diffuser at a plurality of circumferentially spaced-apart points, said vanes lying in the space between said axially-outer surfaces of said diffuser and the axially-inner surfaces of said casing but being spaced substantially from said last-named surfaces and said vanes having radial dimensions substantially less than the radial dimensions of said wheel, said auxiliary vanes being radially spaced from the axis of said wheel a distance greater than the radius of the periphery of said wheel.

2. A centrifugal apparatus for the circulation of fluids comprising, in combination, a rotatably mounted centrifugal wheel, a fixed casing surrounding said wheel, said casing having a discharge aperture for removing the fluid impelled by said wheel, means defining a suction aperture surrounding the axis of said wheel, a rotary diffuser extending radially from the periphery of said wheel in said casing, said diffuser being integral with said wheel and thereby rotatable therewith at the same angular velocity and said diffuser having two axially-spaced-apart axially-outer surfaces spaced from the axially-inner surfaces of said diffuser and auxiliary vanes extending axially from both axially-outer surfaces of said diffuser at a plurality of circumferentially spaced-apart points, said vanes lying in the space between said axially-outer surfaces of said diffuser and the axially-inner surfaces of said casing but being spaced substantially from said last-named surfaces and said vanes having radial dimensions substantially less than the radial dimensions of said wheel, said auxiliary vanes being radially spaced from the axis of said wheel a distance greater than the radius of the periphery of said wheel, the radially outer edges of said blades being nearer to the periphery of said diffuser than to the periphery of said wheel.

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