The present invention relates generally to a fluid moving device, and is more particularly concerned with a device for increasing the kinetic energy of the moved fluid.

Conventional devices have herefore been constructed for the pumping of liquids which utilize flexible vanes of resilient material and superficially are somewhat similar in appearance to the device of the present invention. However, in the conventional devices the vanes were in contact with the casing and where mechanically distorted so as to vary the vane shape and cause a decrease in the volume of space between the vanes and thereby raise the pressure of the working fluid. Such structures due to this increased pressure had to be strongly constructed of comparatively heavy materials, and in general were inefficient in operation as a result of their inherent design.

In contrast to the prior art devices, as generally exemplified above, the device of the present invention is arranged to impart energy to the working fluid in a dynamic manner by utilizing flexible non-resilient vanes, and by making use of centrifugal force and differential pressures in the fluid stream to vary the shape and position of the vanes in such a manner that it becomes unnecessary to have the vanes in engaged contact with the casing.

A unique construction of a fluid moving device according to the present invention, as briefly described above, permits the accomplishment of outstanding objects including the following:

One object is to provide an improved fluid moving device in which energy is dynamically imparted to the working fluid, and more specifically wherein shaft horsepower may be changed to kinetic energy in the moved fluid economically.

Another object is to provide a fluid moving device of such construction that the casing will operate at low pressures and permit the use of lightweight material, in which a low weight rotor using flexible non-resilient vane may be utilized so as to produce an extremely light weight device as compared to conventional structures.

A further object is to provide a dynamic fluid moving device wherein extremely low losses prevail with the result that extremely high efficiencies will be obtained.

Another object is to provide a device of the character described herein in which the total pressure of entering fluid will be increased at the outlet, but wherein the static pressures will be approximately the same. That is to say, that the device will increase the velocity of the entering fluid and discharge it at a high velocity having high kinetic energy.

Still another object is to provide a flap arrangement at the outlet to control the momentum increase imparted to the working fluid, the power required to drive the device at any particular speed, and the direction of discharge of the fluid at the outlet.

The above enumerated objects provide a fluid moving device which is admirably adapted for utilization in locations where the weight factor becomes a material consideration. For example the device is extremely well adapted for use in aircraft, and particularly in those types of aircraft designed for vertical take-off and landing.

Further objects of the invention will be brought out in the following part of the specification, wherein detailed description is for the purpose of fully disclosing the invention without placing limitations thereon.

Referring to the accompanying drawings, which are for illustrative purposes only:

FIG. 1 is a fragmentary perspective view of a fluid moving device according to the present invention; and

FIG. 2 is a transverse sectional view through the same showing the cooperative relationship of the component parts, taken substantially on line 2—2 of FIG. 1.

Referring now more specifically to the drawings, the fluid moving device of the present invention is shown as comprising an elongate casing of light material, and which is closed at its ends. The casing is provided along one side with a longitudinally extending elongate inlet opening 11, and along another side in substantially right angled relation with a longitudinally extending elongate outlet opening 12.

Placed within the casing is a cylindrical hub 13 which is carried by a shaft 14 rotatably supported in the casing in appropriate end bearings 15. As shown in FIG. 2, the shaft 14 is offset so that the hub 13 is in general in eccentric relation to the casing and is positioned in relatively close proximity to one side of the casing, as indicated by the numeral 16, so as to cooperatively form therewith a restricted chamber 17 on one side of the hub, one end of this restricted chamber communicating with the outlet opening 12 and the other end with the inlet opening 11. On the diametrically opposite side from the restricted chamber portion 17, it will be observed that the chamber portion as indicated by the numeral 18 is substantially unrestricted, and that in this portion of the chamber the casing wall is in substantially concentric relation throughout its length with respect to the hub surface.

The hub 13 carries a plurality of flexible vanes 19 of flexible non-resilient fabric of suitable material such as may be purchased under the trade name "Dacron."

The flexible vanes 19 are secured along one edge to the hub 13 in any suitable manner, and are of such width that they may extend radially from the hub into the chamber portion 18 without contacting the casing. The flexible vanes as they are successively moved alternately through the restricted chamber portion 17 and the chamber portion 18 will change their shape, and while moving primarily through the chamber portion 15 will transfer kinetic energy to the fluid therein.

Considering the forces which are utilized to control the vanes, it will be seen that, for example, as a vane enters the inlet opening 11 as it emerges from the restricted chamber portion 17, the vane will be freed so that it may move as shown at position a under the action of centrifugal force into a radially extending position. During this movement it will draw in air at the inlet and carry it through the chamber portion 18. When the vane reaches the position indicated at b, the outermost edge of the vane begins to leave and move away from the casing, and as it moves further toward a position c, the dynamic back pressure at the outlet 12 concomitantly to accelerate the fluid stream sets up differential pressures which act on the vane and cause it to fold back and assume a substantially tangential position as it moves into the restricted chamber portion 17. The chamber portion 17 is tapered from the end which communicates with the outlet 12 towards the end thereof which communicates with the inlet 11 so as to accommodate the substantially tangential position of the vane therein without the vane having to make physical contact with the casing. Since the vanes are at no time in contact with the casing, operational losses are materially reduced.

At the outlet opening 12, the device is provided with one or more flaps, in this case a pair of separately mounted flaps 20 and 21 being shown, which may be moved into the dotted line positions so as to control the
momentum increase imparted to the working fluid, the power required to drive the device at any particular speed, and control the direction of discharge of the outgoing fluid. Adjacent the flaps, the casing outlet is terminated to provide elongated slots or openings shown at 22 and 23. These openings provide passages for induced fluid flow into the discharge from the device for thrust augmentation and mass flow control.

It is contemplated that the fluid moving device of the present invention will be operated at higher speeds than conventional types of devices, and that such speeds may be on the order of 3,000 to 7,000 r.p.m. In operation, the inlet fluid would have a total pressure which is substantially atmospheric, while at the outlet the static pressure will be substantially that of the atmosphere, while the total pressure due to the kinetic energy imparted to the fluid will be raised to the order of 25 to 500 pounds per square foot.

Various modifications may suggest themselves to those skilled in the art without departing from the spirit of our invention, and hence, we do not wish to be restricted to the specific form shown or the claims mentioned, except to the extent indicated in the appended claims.

We claim:

1. In a fluid moving device, a rotatably mounted hub member; a plurality of non-resilient flexible vanes carried by said hub; a casing surrounding a generally eccentric chamber with respect to the axis of rotation of said hub, said casing and hub coating to provide a constricted chamber portion on one side of the hub having communication at the first end thereof in the direction of hub rotation with a fluid outlet and at the other end thereof with a fluid inlet, whereby vanes leaving the constricted chamber portion may assume a substantially radial direction under the action of centrifugal force upon entering the inlet, said vanes being dimensioned with respect to said casing such that the distal edges thereof clear said casing when said vanes are in said substantially radial direction, and a substantially tangential bent position under the action of fluid pressures adjacent the outlet before entering the constricted portion, said vanes being held by fluid pressure away from said casing when in said bent position, whereby said vanes clear said casing during all rotational positions thereof.

2. In a fluid moving device, a rotatably mounted hub member; a plurality of nonresilient flexible vanes carried by said hub; a casing surrounding said hub forming a generally eccentric chamber with respect to the axis of rotation of said hub, said casing and hub coating to provide a constricted chamber portion on one side of the hub having communication at the first end thereof in the direction of hub rotation with a fluid outlet and at the other end thereof with a fluid inlet, whereby vanes leaving the constricted chamber portion may assume a substantially radial direction under the action of centrifugal force upon entering the inlet, said vanes being dimensioned with respect to said casing such that when in said radial position said vanes are spaced from said casing at the distal ends thereof, and a bent position under the action of fluid pressures adjacent the outlet before entering the constricted portion, said vanes being held by fluid pressure away from said casing when in said bent position, whereby said vanes clear said casing during all rotational positions thereof.

3. In a fluid moving device, a rotatably mounted hub member; a plurality of nonresilient flexible vanes of fabric material carried by said hub; a casing surrounding said hub forming a generally eccentric chamber with respect to the axis of rotation of said hub, said casing and hub coating to provide a constricted chamber portion on one side of the hub having communication at the first end thereof in the direction of hub rotation with a fluid outlet and at the other end thereof with a fluid inlet, whereby vanes leaving the constricted chamber portion may assume a substantially radial direction under the action of centrifugal force upon entering the inlet, said vanes being dimensioned with respect to said casing such that the distal edges of said vanes clear said casing when said vanes are in said radial direction, and a bent position under the action of fluid pressures adjacent the outlet before entering the constricted portion, said vanes being held by fluid pressure away from said casing when said vanes are in said bent position, whereby said vanes clear said casing during all rotational positions thereof; and adjustable flaps at said outlet for forming a variable restriction in and controlling the fluid discharge therefrom.

4. In a fluid moving device, a rotatably mounted hub member; a plurality of flexible vanes of non-resilient material carried by said hub, said vanes being free from contact with said casing at all times during rotation of said hub upon operation thereof.

5. A device for moving a fluid and nonresilient imparting kinetic energy thereto, comprising: an elongate tubular casing having a longitudinally extending inlet opening and a longitudinally extending outlet opening; a cylindrical hub extending lengthwise within said casing and supported for rotation therein, with a portion of its periphery positioned in relatively close proximity to an adjacent portion of the casing lying between said outlet and inlet openings, and cooperating therewith to form a substantially sealed chamber portion; said hub and hub portion being axially movable under the action of centrifugal force tele, said hub portion being dimensioned to clear said casing when in said substantially radial position, and caused by fluid back pressure to clear said casing during all other rotational positions during operation of said device.

6. A device for moving a fluid and imparting kinetic energy thereto, comprising: an elongate tubular casing having a longitudinally extending inlet opening and a longitudinally extending outlet opening; a cylindrical hub extending lengthwise within said casing and supported for rotation therein, with a portion of its periphery positioned in relatively close proximity to an adjacent portion of the casing lying between said outlet and inlet openings, and cooperating therewith to form a substantially sealed chamber portion; said hub and hub portion being axially movable under the action of centrifugal force tele, said hub portion being dimensioned to clear said casing when in said substantially radial position, and caused by fluid back pressure to clear said casing during all other rotational positions during operation of said device.

7. A device for moving a fluid and imparting kinetic
energy thereto, comprising: an elongate tubular casing having a longitudinally extending inlet opening and a longitudinally extending outlet opening in substantially 90 degree relation with respect to the longitudinal axis of said casing; a cylindrical hub extending lengthwise within said casing and supported for rotation therein, with a portion of its periphery positioned in relatively close proximity to an adjacent portion of the casing lying between said outlet and inlet openings, and cooperating therewith to form a restricted chamber portion in the casing at one side of said hub; and flexible vanes carried by said hub movable under the action of centrifugal force to a substantially radial position after leaving said restricted chamber portion, said vanes being dimensioned to clear said casing when in said radial position and being bent rotationally rearward under the action of differential pressures in said fluid to a substantially tangential position upon entering said restricted chamber portion, said vanes being held away from the wall of said casing by fluid pressure in said restricted chamber portion, whereby said vanes clear said casing during all rotational positions thereof.

8. A device for moving a fluid and imparting kinetic energy thereto, comprising: an elongate tubular casing having a longitudinally extending inlet opening and a longitudinally extending outlet opening; a cylindrical hub extending lengthwise within said casing and supported for rotation therein with its axis substantially parallel to said openings, with a portion of its periphery positioned in relatively close proximity to an adjacent portion of the casing lying between said outlet and inlet openings, and cooperating therewith to form a restricted chamber portion in the casing on one side of said hub and an unrestricted chamber portion on the opposite side of said hub; and a plurality of spaced flexible vanes of non-resilient material carried by said hub with the connection of each vane to said hub being substantially parallel to the axis of said hub, said vanes being successively movable alternately through said chambers, and acting in the unrestricted chamber portion to impart the velocity of the hub rotation to the moved fluid therein, said vanes being moved by centrifugal force to a substantially radial position when in said unrestricted chamber portion and being dimensioned to clear the wall of said unrestricted chamber portion when in said substantially radial position, said vanes being bent rearwardly by fluid pressure when in said restricted chamber portion so as to clear the wall of said restricted chamber portion, whereby said vanes clear said casing during all rotational positions of said vanes.

References Cited in the file of this patent

UNITED STATES PATENTS

Re 23,015 Yingling .......................... July 6, 1948
346,471 Falcon et al. .......................... Aug. 3, 1886
1,053,321 Schrock .......................... Feb. 18, 1913
1,086,488 Wachter .......................... Feb. 10, 1914
1,116,851 Schneible .......................... Nov. 10, 1914
1,402,719 Bartlett et al. .......................... Jan. 3, 1922
1,616,992 Ruckstuhl .......................... Feb. 8, 1927
1,904,056 Kjaer .......................... Apr. 18, 1933
2,258,961 Saathoff .......................... Oct. 14, 1941
2,332,411 Swanson et al. .......................... Oct. 19, 1943
2,465,987 Larsh .......................... Mar. 29, 1949
2,634,805 Bills et al. .......................... Apr. 14, 1953
2,664,050 Abresch .......................... Dec. 29, 1953
2,669,188 McIntyre .......................... Feb. 16, 1954
2,905,091 Lippisch .......................... Sept. 22, 1959
2,911,920 Thompson .......................... Nov. 10, 1959

FOREIGN PATENTS

275,132 Germany .......................... June 9, 1914
531,206 Great Britain .......................... Dec. 31, 1940

OTHER REFERENCES

German application KL. 59e 2, 1,002,630, Feb. 14, 1957.