March 25, 1947. T. CHESTER 2,418,012

IMPELLER FOR CENTRIFUGAL APPARATUS

Filed Sept. 20, 1943 2 Sheets-Sheet 1

Fig. 1.

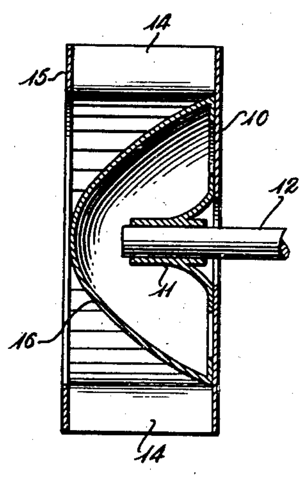


Fig. 2.

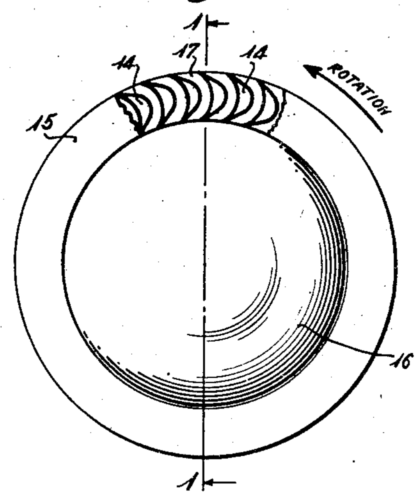
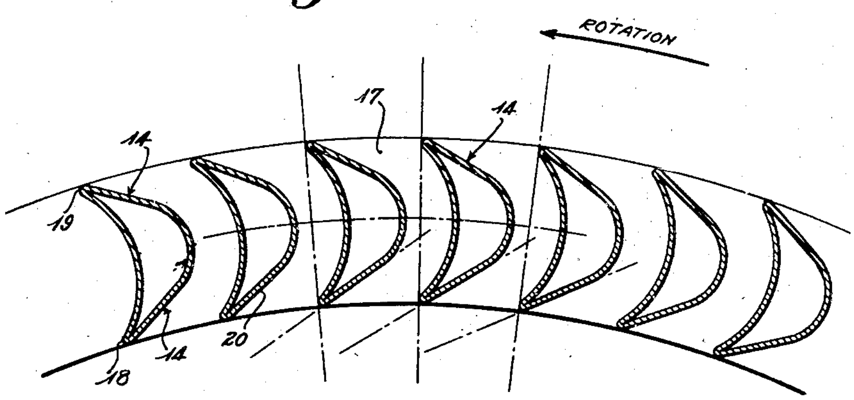


Fig. 3.



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2 Sheets-Sheet 2

Fig. 4.

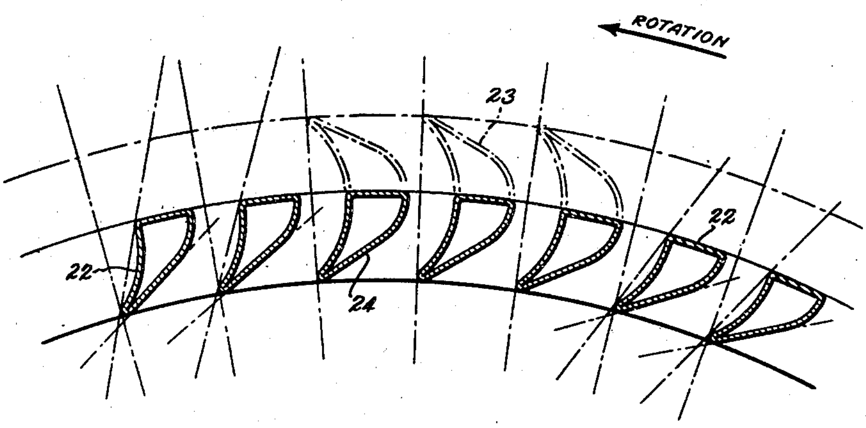
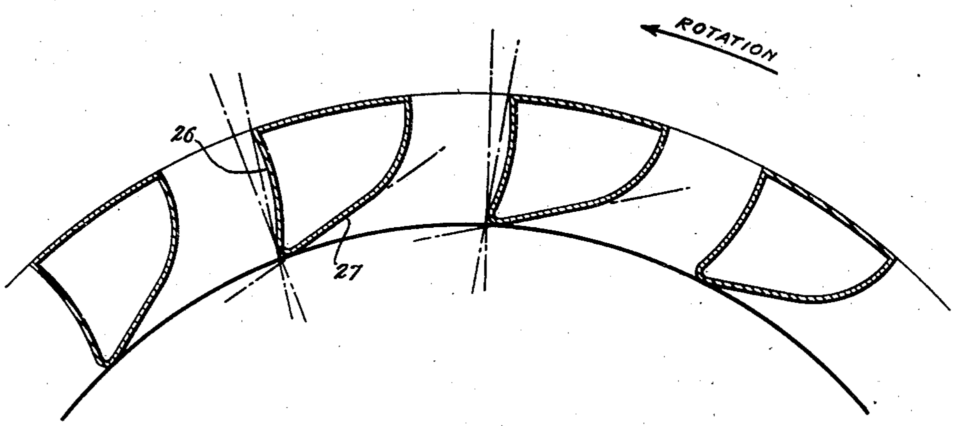


Fig. 5.



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UNITED STATES PATENT OFFICE

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IMPELLER FOR CENTRIFUGAL APPARATUS

Thomas Chester, Detroit, Mich.

Application September 20, 1943, Serial No. 503,134

11 Claims. (Cl. 103—115)

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This invention relates to impellers for centrifugal apparatus and more particularly to impellers of the radial flow type for imparting motion to fluids such as gases or liquids.

Impellers of the general type to which this invention relates are usually provided with a conventional volute casing such as shown in my copending application Serial No. 430,467 filed February 11, 1942, and impart circumferential and radial motion to a fluid entering through one or more inlets in the casing near the axis of the impeller, the fluid being discharged from a plurality of tangential ports at the periphery of the impeller into the volute of the casing and thence through an outlet opening from the casing.

An object of the present invention is to provide an improved impeller blade which accelerates the fluid entering the ports between the blades with a minimum of turbulence and loss of power.

Another object of the invention is to provide an improved impeller for centrifugal apparatus in which the impeller is provided with a plurality of hollow blades with concave frontal surfaces facing in the direction of impeller rotation and convex back surfaces having ports therebetween which enable acceleration of the fluid from substantial rest with reference to arcuate motion around the axis of the impeller to high velocity without substantial turbulence.

Another object of the invention is to provide an improved impeller for centrifugal apparatus in which the forward surfaces of hollow blades are concave and in which the rear surfaces of the blades adjacent the radially inner tips thereof make a relatively low angle with a line joining the radially inner tips of adjacent blades.

A further object of the invention is to provide an improved impeller for fluid pumps or fans in which a plurality of axially extending blades in the form of portional crescents have concave forward surfaces facing in the direction of impeller rotation and rear surfaces backwardly inclined at an angle in consonance with the neutral path of the fluid which enters the ports of a rotating impeller to provide acceleration of the fluid through the ports between said blades with minimum turbulence.

Other objects and advantages of the invention will appear in the following description of preferred embodiments thereof made in connection with the attached drawing in which

Fig. 1 is a vertical section through an impeller in accordance with the present invention taken on the line 1—1 of Fig. 2;

Fig. 2 is a side elevation of the device of Fig. 1 with parts broken away to show the shape and arrangement of the impeller blades;

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Fig. 3 is a fragmentary detail view on an enlarged scale showing one type of blade;

Fig. 4 is a view similar to Fig. 3 showing a modified type of blade; and

Fig. 5 is another view similar to Fig. 3 showing a still further modified type of blade.

Referring particularly to the drawings, the impeller of the present invention may comprise any suitable type of supporting structure such as a backing ring secured to a hub 11 rigidly mounted upon a shaft 12, which in turn is supported in suitable bearings (not shown) and rotated from a source of power (also not shown). The impeller may also include a plurality of axially extending blades 14 secured to the backing plate 10 in any suitable manner, such as by welding, and the extending ends of the blades may be similarly secured to a shroud ring 15. The impeller is also preferably provided with an internal deflector 16 for directing the fluid radially outward into the ports 17 between the blades 14 to secure uniform non-turbulent flow through the interior of the impeller. The deflector 16 is preferably a parabola or approximate parabola in axial section. While such deflector measurably increases the efficiency of the device, improved results over prior impellers may be obtained even if the deflector 16 be omitted.

A suitable blade in accordance with the present invention is shown by way of example in Fig. 3. The blades 14 of this figure are shown as being substantially crescent shaped with the points of the crescent forming the radially inner and outer tips 18 and 19, respectively, of the blades. In general, the forward face of the blades will be concave although the radially inner portion of the forward face may, in some instances be substantially straight. It will be further observed that the portion 20 of the rearward face of the blades adjacent the radially inner tip makes a rather small angle with a line joining the radially inner tip of such blade and the corresponding tip of the next succeeding blade. In general, it has been found that this angle should not be greater than approximately 40° and that it may be as small as 10° or even smaller depending upon the speed at which the impeller is rotated and upon the required relationship between static pressure and velocity pressure, the smaller angles being employed with higher speed impellers and when the static pressure has a high ratio to the velocity pressure. As shown, the portion of the rearward face adjacent the radially inner tip is preferably substantially straight although it may be slightly curved and in general the rearward surface of any one blade is preferably approximately parallel to the forward face of the next succeeding blade. However, with full crescent shaped blades a port which first converges and then diverges with respect to the direction of fluid flow, as shown in Fig. 3, may be advantageously employed. With the structure shown, fluid entering the ports between the blades is uniformly accelerated without turbulence and delivered at high velocity from the periphery of the impeller.

The modified blades 22 shown in Fig. 4 are illustratively substantially similar to the radially inner halves of the blades of Fig. 3 and, to illustrate this, the remaining halves of certain of the crescents are dotted at 23 in Fig. 4. The blade form shown in Fig. 4 may be considered to be a portional crescent without limitation to half a crescent illustratively shown thereby and the angle which the portion 24 of the rear surface of the blade adjacent the radially inner tip makes with a line joining the said radially inner tip with the corresponding tip of the next succeeding blade may be substantially that described with reference to Fig. 3. It will be noted that the forward face of the blades of Fig. 4 are rearwardly inclined and in general such rearward inclination is desirable, although the forward faces may have other inclinations as is old in the art. Again, the forward faces are preferably concave as shown in Fig. 4 but may be substantially straight. In the impeller of Fig. 4 fluid entering the ports between the blades is also uniformly accelerated and discharged outwardly from the ports of the impeller with relatively high velocity and with minimum turbulence in the impeller.

The blades of Fig. 5 are a still further modification of the blades of Figs. 3 and 4 in that a portion of a crescent elongated in the circumferential direction of the impeller periphery is employed. Substantially the same considerations as to the inclination of the forward faces of the blades and also rearward faces of the blades as discussed with reference to Fig. 4 are also contemplated for the blades of Fig. 5. Thus, the portions 27 of the rear surfaces of each of the blades adjacent the radially inner tip thereof make a relatively small angle with a line joining the radially inner tip of the blade and that of the next succeeding blade. It will be noted that the hollow blades have increased arcuate width in relation to radial depth as compared with the preceding figures, although the arrangement shown is illustrative and the circumferential spacing or pitch and also the radial depth can be different from that shown. Again the fluid is uniformly accelerated in its flow through the ports between the blades and discharged from the impeller with minimum turbulence in the impeller.

From the above description it will be apparent that the blades of Figs. 4 and 5 may be termed portional crescents derived from the full crescent blades of Fig. 3 and that in all of the blade constructions described, the radially inner portion of the blade may be considered to be a portional crescent. While all of the blades illustrated are shown as having a hollow structure, it is apparent that solid blades may be employed, particularly for impellers having blades of small size. From Figs. 4 and 5 it will also be apparent that the blades are substantially portional crescents in cross section, formed by the truncation or omission of the radially outer portion of the blades shown by Fig. 3. This truncation is important because it eliminates the necessity of the fluid moving forward along the removed blade portion, with an angular or rotational velocity in excess of the impeller peripheral speed and thereby prevents instability of performance.

One of the important factors providing the increased efficiency of the present invention is the low back angle of the blades, i. e., the angle which the portion of the rearward surface of the blade adjacent the radially inner tip makes with a line joining the radially inner tip of said blade and the corresponding tip of the next succeeding blade. Also, the portions of the blade surfaces forming the port walls which face each other are preferably approximately parallel, i. e., the ports have substantially uniform width measured normally of the rearward surfaces of the blades. The arcuate pitch or distance from blade to blade shown in the drawings is merely illustrative and the spacing can be greater than that shown. However, the port width measured at approximately half the radial depth of the full crescent, that is, at the radially outer portion of the substantially triangular blades of Figures 4 and 5, is preferably not greater than approximately half of the arcuate pitch or spacing of the blades, and this port width should not be less than approximately 35% or greater than approximately 65% of the distance between corresponding points on adjacent blades measured on the circle at half the radial depth of the full crescents. The ratio of blade radial depth to impeller diameter shown as indicated in Fig. 1 is merely by way of example and this ratio can be varied within wide limits. Also, the impeller can have a greater or lesser axial length than that shown in Fig. 1 for the same diameter. Preferably all of the corners or tips of the blades shown in Figs. 3, 4 and 5 are somewhat rounded although these corners may be relatively sharp without material decrease in efficiency of the device. In Figs. 4 and 5 the portional crescent shaped blades are approximately triangular in outline, the radially inner tip of each blade constituting the apex and the radially outer side constituting the base. When considered desirable these outer sides can be omitted or eliminated, in order to reduce centrifugal stresses or for other reasons.

While I have disclosed the preferred embodiments of my invention it is understood that the details thereof may be varied with considerable amplitude without departing from the spirit and essence of the invention.

I claim:

1. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being approximately in the form of a portional crescent and positioned to have the point of said portional crescent form the radially inner tip of said blade and to provide a convex rearward surface with respect to the direction of rotation of said impeller, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is between approximately 10° and 40°.

2. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being substantially in the form of approximately a half crescent positioned to have the point of said half

crescent form the radially inner tip of said blade and to provide a convex rearward surface with respect to the direction of rotation of said impeller, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is between approximately 10° and 40°.

3. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades having substantially the form of a portional crescent positioned to have the point of said portional crescent form the radially inner tip of said blade and to provide a convex rearward surface with respect to the direction of rotation of said impeller, said rearward surface being rearwardly inclined, the forward surface of said blades being so positioned that a line joining said radially inner tip and the radially outer extremity of said forward surface is rearwardly inclined and the rearward surface of said blades being positioned with respect to said forward surface to provide ports between said blades which have substantially uniform width throughout each port when measured normally of said rearward surface.

4. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being substantially in the form of a portional crescent positioned to have the point of said portional crescent form the radially inner tip of said blade and provide a convex rearward surface with respect to the direction of rotation of said impeller, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is between approximately 10° and 40°, the forward surface of said blades being so positioned that a line joining said radially inner tip and the radially outer extremity of said surface is approximately radial.

5. In a rotary impeller for imparting motion to a fluid, a plurality of hollow blades each having the form of a portional crescent truncated by the omission of the radially outer tip, said portional crescent being elongated in the circumferential direction of the impeller periphery and disposed about the circumference of said impeller, the frontal face of each of said blades with reference to the direction of impeller rotation being approximately radial and the back face of each of said blades being substantially convex with its radially inner portion inclined at an angle not greater than approximately 40° to a line joining the radially inner tip of said blade to the radially inner tip of the next following blade, the circumferential width of the port between successive blades measured at half the radial depth of the full crescent being not greater than approximately half of the arcuate pitch of the blades.

6. In a rotary impeller for imparting motion to a fluid, a plurality of hollow blades each having in cross section the shape of a truncated crescent and disposed about the circumference of said impeller, the frontal face of each of said blades being concave and inclined with reference to the direction of impeller rotation in accordance with the required relationship between total pressure and the peripheral velocity and the back face of each of said blades being substantially convex with its radially inner portion inclined at an angle not greater than approximately 40° to a line joining the radially inner tip of said blade to the radially inner tip of the next following blade, the circumferential width of the port between successive blades measured at half the radial depth of the full crescent being not greater than approximately half of the arcuate pitch of the blades.

7. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being substantially in the form of a portional crescent positioned to have the point of said portional crescent form the radially inner tip of said blade and to provide a convex rearward surface with respect to the direction of rotation of said impeller, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is between approximately 10° and 40°, and the forward and rear surfaces of said blades being positioned to provide a port therebetween which has substantially uniform width throughout said port when measured normally of the said rearward surface.

8. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being substantially triangular in cross section with one corner directed inwardly to form a radially inner tip of said blade, each of said blades having a concave forward surface and a convex rearward surface with respect to the direction of rotation of said impeller, said forward and rearward surfaces being positioned to provide ports between the blades having substantially uniform width throughout said ports when measured normally of said rearward surface.

9. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades having substantially the form of a portional crescent positioned to have the point of said portional crescent form the radially inner tip of said blade and to provide a convex rearward surface with respect to the direction of rotation of said impeller, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is not greater than approximately 40°, the circumferential width of the port between successive blades measured at approximately half the radial depth of the full crescent being not greater than approximately half of the arcuate pitch of the blades.

10. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades having the shape of a fractional crescent and being positioned to have the point of said fractional crescent form the radially inner tip thereof and to provide a convex rearward surface with respect to the direction of rotation of said impeller, said rearward surface being inclined backwardly and the forward and rearward surface of adjacent blades being positioned to provide a port therebetween which has substantially uniform width

throughout said port when measured normally of said rearward surface, the circumferential width of the port between successive blades measured at half the radial depth of the full crescent being not greater than approximately half of the arcuate pitch of the blades.

11. In a rotary impeller for imparting motion to a fluid, a plurality of axially extending blades circumferentially spaced adjacent the periphery of said impeller, each of said blades being substantially triangular in cross section with one corner directed inwardly to form a radially inner tip of said blade, each of said blades having a concave forward surface and a convex rearward surface with respect to the direction of rotation of said impeller, said forward and rearward surfaces being positioned to provide ports between the blades having substantially uniform width throughout said ports when measured normally of said rearward surface, the portion of said rearward surface adjacent said radially inner tip forming an angle with a line joining said radially inner tip with the corresponding tip of the next succeeding blade which is between approximately 10 and 40 degrees, said ports having a circumferential width measured at the radially outer portion of said blades which is not greater than approximately half of the arcuate pitch of the blades.

THOMAS CHESTER.

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Certificate of Correction

Patent No. 2,418,012.

March 25, 1947.

THOMAS CHESTER

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 1, line 43, for "neutral" read *natural*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of August, A. D. 1947.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.