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(54) **Open bladed impeller, particularly for centrifugal pump.**

(57) The present invention relates to an open bladed impeller (1), particularly for a centrifugal pump, comprising a substantially planar disk-like supporting element (5) having a central hub (7) adapted to be keyed to a drive shaft (3) and a plurality of blades (6) rigidly attached to the front surface of said supporting element at regularly angularly spaced locations thereof, wherein each blade is formed by a longitudinal core (15) extending transversely of the main plane of said supporting element, and has a back longitudinal edge (11) affixed to said supporting element and a front longitudinal edge (12) adapted to cooperate with an adjacent stationary wall (13) of the casing; the front longitudinal edge of each blade has a profile which is substantially parallel to the inner surface of the stationary wall with such a substantially uniform axial clearance (d) to form a free frontal skimming surface providing partial sealing with said stationary wall. At the front longitudinal edge of each blade there is provided a substantially planar, longitudinal flange formation which projects laterally from said longitudinal core to extend parallel to the facing surface of the stationary wall, to thereby increase extension of the front skimming surfaces and improve their sealing action relative to the inner casing wall.

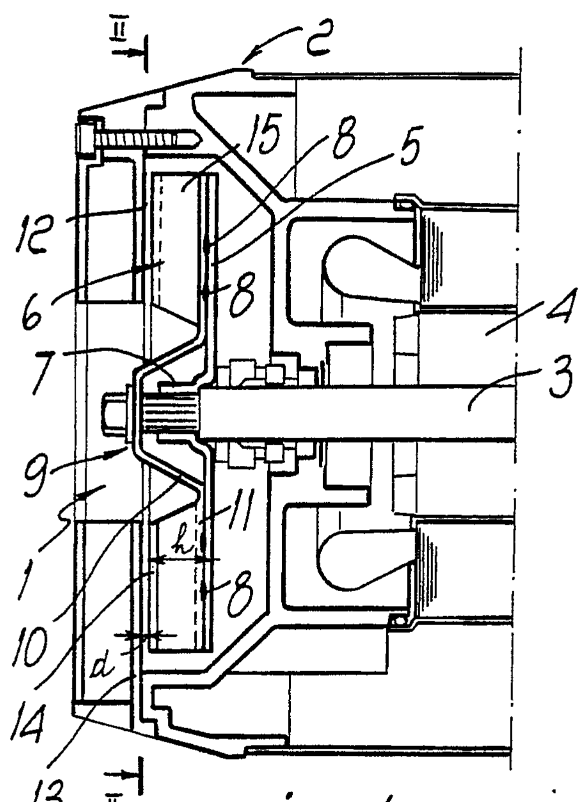

FIG.1

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OPEN BLADED IMPELLER, PARTICULARLY FOR CENTRIFUGAL PUMP

The present invention relates to an open bladed impeller, particularly for a centrifugal pump, comprising a supporting element which substantially has the shape of a planar disk and a plurality of blades rigidly affixed to said supporting element at regularly angularly spaced locations thereof, wherein each blade is formed by a longitudinal core extending transversely of the main plane of the supporting element and having a back longitudinal edge which is affixed to the supporting element and a front longitudinal edge adapted to cooperate with a stationary facing wall of the pump casing; the back longitudinal edge has a profile which is substantially parallel to the inner surface of the stationary wall of the casing with a substantially uniform axial clearance to provide a free frontal skimming surface providing a partial seal against the stationary casing wall.

Bladed impellers of the foregoing type are commonly termed open impellers, since the blading of the impeller is inwardly delimited by the back plate of the hub and outwardly delimited by the stationary wall of the casing, unlike ordinary impellers wherein the blading is closed along the outer edge by the front plate of the hub.

In order to improve the sealing action between the open blading of the impeller and the stationary wall of the scroll casing, an adequate surface roughness is to be provided on this stationary wall, possibly by lapping, to enable small assembly clearances therebetween.

The efficiency of these known impellers obviously depends, to a large extent, on the external profile of the blades, which has to follow as precisely as possible the internal profile of the fixed wall in order to provide the minimum required clearance.

The advantage offered by these open impellers resides in the simplified machining operations and results in improved surface smoothness of the rotation blades, which generally leads to improved efficiency due to reduction of losses.

Various attempts have been made to manufacture high-efficiency open impellers in an economical way. In particular, known impellers are obtained from cast-iron castings or from steel or light-alloy forgings which have walls of considerable thickness in order to provide open bladed structures with front skimming surfaces of suitable extension.

Though said known impellers have shown satisfactory operating conditions, they have a first limitation in the fact that the blade vanes have a reduced width due to the intrinsic thickness of the blades.

A further disadvantage of the known impellers made of cast-iron castings or steel forgings resides in their considerable weight, which is a negative factor especially for very large pumps. Though they fulfill optimum requirements from many viewpoints, light-alloy castings are difficult and expensive to produce and machine.

In order to obviate the afore mentioned drawbacks, an attempt has been made to provide impellers made of metal plate which have the features stated in the preamble of the accompanying claim 1 and which involves a number of constructional and economical advantages.

In said prior impellers, a problem arises in the limited front surface of the outer skimming edges of the blades which are adapted to cooperate with the fixed wall of the pump casing, due to the limited thickness of the metal plate forming the blades.

Manufacturers are evidently interested in providing impellers which offer the advantages of metal plate products but have skimming surfaces interacting with the stationary wall of the casing which are larger than is allowed by the limited thickness of the metal plate itself, so as to obtain higher efficiency in spite of the same constructive clearance. As an alternative, larger frontal coupling surfaces could be used which would allow the adoption of smaller constructive clearances involving lower production costs.

Unfortunately, current metal plate impellers have sets of stamped blades exhibiting rather wide tolerances, which when combined with the tolerances for assembly on the supporting frames lead to considerable variations of clearance with respect to the fixed walls of the casing. In order to reduce said variations, subsequent surface finishing operations are to be effected, which reduce the competitiveness of this kind of sheet metal impellers with respect to the conventional ones.

It is an object of the present invention to obviate the foregoing disadvantages by providing an open bladed impeller permitting to obtain high efficiency with low fabrication costs.

A further object of the present invention is to provide an open bladed impeller which has a simplified structure and can be easily obtained starting from commonly commercially available raw materials.

These and other objects which will become apparent hereinafter are achieved by an open bladed impeller, particularly for a centrifugal pump, according to the preamble of claim 1, characterized in that at the front longitudinal edge of each blade there is provided a substantially planar, longitudinal flange formation which projects laterally from said longitudinal core to extend parallel to the facing surface of the stationary wall, to thereby increase extension of the front skimming surfaces and improve their sealing action relative to the inner casing wall.

Further characteristics and advantages will become more apparent from the following description of some preferred but not exclusive embodiments of open bladed impellers, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

figure 1 is a partially sectional side view, taken along an axial plane, of a centrifugal pump with open impeller according to the invention;

figure 2 is a partially sectional front view, taken along the plane II-II, of a first embodiment of the impeller of figure 1;

figure 3 is a partially sectional partial front view, taken along the plane III-III, of a second embodiment of the impeller of figure 1;

figure 4 is a sectional view of a blade of the impeller illustrated in figure 3, taken along the plane IV-IV;

figure 5 is a sectional view of a blade of the impeller illustrated in figure 2, taken along the plane V-V;

figures 6, 7 and 8 are front views respectively of a third, fourth and fifth embodiment of impellers according to the invention.

With reference to the above figures, the open impeller according to the invention, generally indicated by the reference numeral 1, is rotatably mounted inside a stationary case 2 and is drivably connected to a shaft 3 which is rigid with the rotor 4 of the motor.

The impeller 1 is formed by a supporting element 5 which is substantially disk-shaped and whereupon a plurality of blades 6 of the radial centrifugal type are fixed. The supporting element 5 comprises a central portion or hub 7 for rigid connection with the motor shaft 3, optionally keyed by means of per se known elements not illustrated in the drawing, and is generally obtained from blanked and stamped steel plate. Blades 6 are rigidly attached at 8 to element 5 by means of weldings, rivets or other similar connecting elements.

Figure 2 is a front view of the impeller of figure 1, wherein the blades 6 are obtained monolithically from an element 9 made of blanked and stamped plate which is subsequently rigidly attached on the supporting element 5. In particular, the bladed element 9 is formed by a frusto-conical shaped, raised central portion 10 having a central hole for the passage of coupling elements for connection with the drive shaft 3, from which central portion blades 6 extend in a radial pattern at regularly spaced locations.

The impeller of figure 3 differs from the one of figure 2 exclusively in that the blades 6 consist of separate members which are individually coupled to the supporting element 5 at predetermined locations. Blades 6 may be obtained from stamped plate or from sections of extruded profiled elements which are subsequently curved.

In both embodiments set forth before, the blades 6 have an elongated core 15 which extends along a suitable profile to provide a centrifugal radial flow. The core 15 has an inner longitudinal edge 11 which is contacting the supporting element 5 and an outer longitudinal edge 12 which is parallel to the inner surface of the fixed wall 13 of the stationary case 2.

When the impeller 1 is assembled in case 2, the outer edges 12 are spaced from the inner surface of the fixed wall 13 by an axial clearance d of relatively small value enabling free rotation of the impeller, to thereby limit the laminar leakage of the fluid between the edges and the fixed wall, in order to convey the fluid to be pumped into the blade vanes.

The clearance d is usually a few percent of the axial height h of the core 15 of the blades. Obviously, the smaller are the values of axial clearance d , the better will be the sealing conditions of the blade skimming and the operating efficiency of the impeller.

According to the invention, the blades 6 have, at the outer edge 12, a substantially planar longitudinal flange 14 extending laterally from the core 15 of the blades so as to increase the front skimming surface, improving sealing conditions thereof with respect to the fixed wall. In the embodiment illustrated in figure 1, the fixed wall 13 of the stationary case 2 is substantially perpendicular to the axis of the pump; however, the wall could have different shapes and inclinations, and consequently the outer edge 12 of the blades should match these orientations and inclinations.

The width b of the longitudinal flange 14 can be comprised between 2 and 10 times the thickness s of the core 15 of the blades.

Advantageously, the transverse cross section of the blades may be C-shaped, as illustrated in figure 4, or X-shaped, as illustrated in figure 5.

These embodiments are particularly advantageous since they can be obtained by stamping or extrusion, in a separate form or as a monolithic assembly, and besides the advantages of greater sealing described above they have high rigidity and stiffness with a very limited increase in weight.

According to a further aspect of the present invention, the free edge of the longitudinal flange 14 can assume various shapes in order to cooperate with the wall of the stator case so as to act like a shredding or jam-preventing blade. Figures 6, 7 and 8 depict three exemplary embodiments of the outer edge of the longitudinal flange 14 having this purpose. In particular, in figure 6 the edge is defined with trapezoidal teeth, in figure 7 the teeth are semicircular protrusions, and in figure 8 the teeth are semicircular recesses alternated with linear portions.

The fact is stressed that both the supporting element 5 and the set of blades 6 are preferably obtained starting from sheet metal, by means of blanking and cold forging process. With particular reference to the blades 6, this embodiment permits axial span of the blades with high precision and repeatable processes, due to the presence of the upper and lower blades which are normal to the central core. As an alternative, by providing wider skimming surfaces it is possible to use larger axial clearances d obtaining the same efficiency.

However, the same components can be obtained with other materials and by means of other processes such as for example light-alloy casting or injection of thermoplastic resins.

From the foregoing description it appears that the invention achieves the proposed aim and objects and in particular the fact is underlined that though the open impeller according to the invention has a simplified and lightweight structure it however implies the same efficiency and performances as prior more complicated and expensive impellers.

The impeller according to the invention is susceptible to numerous modifications and variations, all of which are within the scope of the inventive concept. Furthermore, all the details may be replaced with other technically equivalent elements. By way of example, mention is made of possible flattening operations and/or thermal or surface treatments carried on the flange portions of the blades in order to improve the resistance of said regions.

In practice, the materials employed, so long as compatible with the specific use, as well as the contingent shapes and dimensions, may be any according to the requirements. Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the scope of each element identified by way of example by such reference signs.

Claims

1. Open bladed impeller (1), particularly for a centrifugal pump, comprising a substantially planar disk-like supporting element (5) having a central hub (7) adapted to be keyed to a drive shaft (3) and a plurality of blades (6) which are rigidly attached to the front surface of said supporting element (5) in regularly angularly spaced locations thereof, each of said blades (6) being formed by a longitudinal core (15) extending transversely of the main plane of said supporting element, said blades having a back longitudinal edge (11) affixed to said supporting element (5) and a front longitudinal edge (12) adapted to cooperate with an adjacent stationary wall (13) of the pump casing (2), said front longitudinal edge (12) having a profile which is substantially parallel to the inner surface of said stationary wall (13) with such a substantially uniform axial clearance (d) to provide a free frontal skimming surface providing partial sealing with said stationary wall, characterized in that said blades (6) have, at said front longitudinal edge (12), a longitudinal flange formation (14) which is substantially planar and projects laterally from said longitudinal core (15) to extend parallel to the facing surface of said stationary wall (13), to thereby increase extension of the front skimming surfaces and improve their sealing action relative to said wall.

2. Open bladed impeller according to claim 1, characterized in that said blades (6) consist of longitudinal members, made of stamped plate or extruded elements, which have a substantially constant transverse cross section along their longitudinal extension.

3. Open bladed impeller according to claim 2, characterized in that said transverse cross section is substantially C-shaped.

4. Open bladed impeller according to claim 2, characterized in that said transverse cross section is substantially X-shaped.

5. Open bladed impeller according to any one of the preceding claims 3 and 4, characterized in that said longitudinal flange (14) is defined by one of the end wings of said transverse cross section, whereas the other end wing of said cross section defines an attachment portion for connection with said first supporting element (5).

6. Open bladed impeller according to claim 1, characterized in that said plurality of blades (6) are monolithically formed in a second metal plate element (9) adapted to be coupled to said first supporting element (5).

7. Open bladed impeller according to one or more of the preceding claims, characterized in that the average width (b) of said longitudinal flange (14) is comprised between 2 and 10 times the average thickness (s) of the core (15) of the blades.

8. Open bladed impeller according to claim 1, characterized in that the free edge of said longitudinal flange formation (14) is substantially continuous and parallel to the curved profile of the longitudinal core (15) of the blades.

9. Open bladed impeller according to claim 1, characterized in that the free edge of said longitudinal flange (14) has a ragged profile suitable for shredding debris or other solid materials possibly present in the fluid to be pumped.

10. Open bladed impeller according to claim 9, characterized in that said ragged shape is substantially saw-toothed.

11. Open bladed impeller according to claim 9, characterized in that said ragged shape comprises semicircular protrusions or recesses alternated with substantially continuous portions.

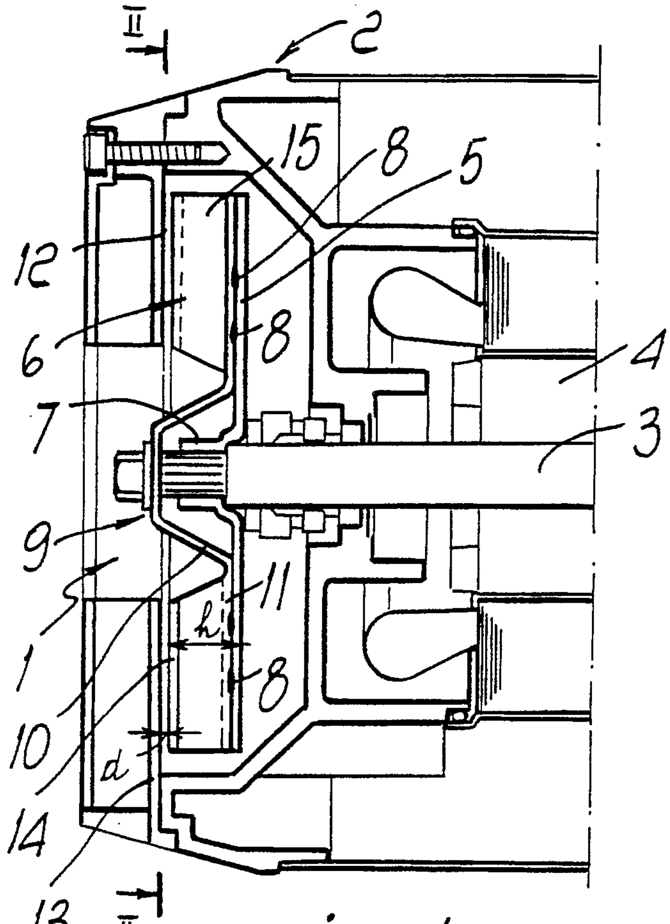

Fig.1

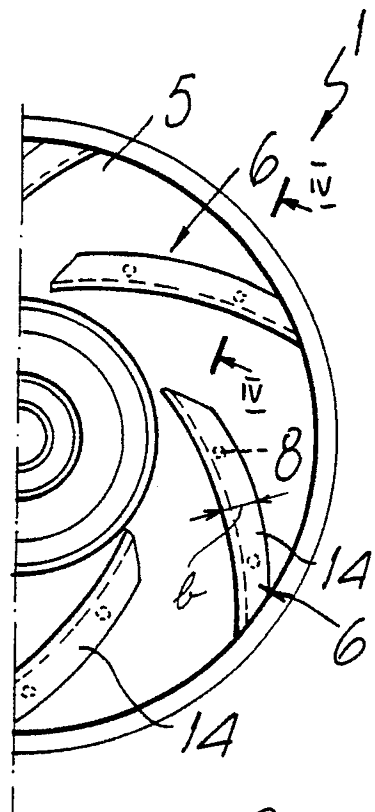

Fig.3

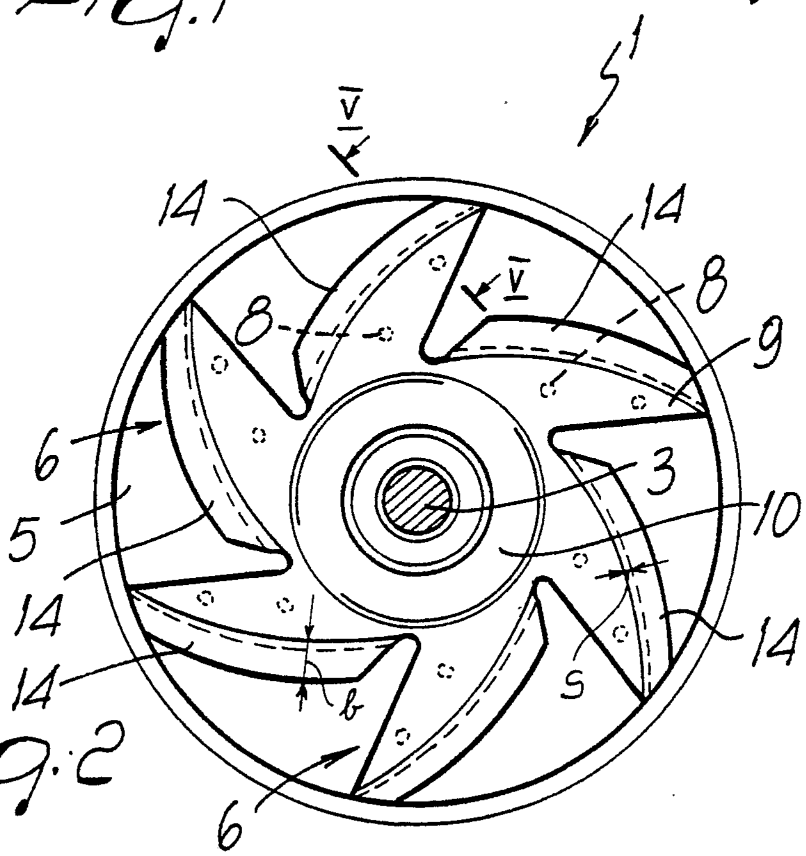

Fig.2

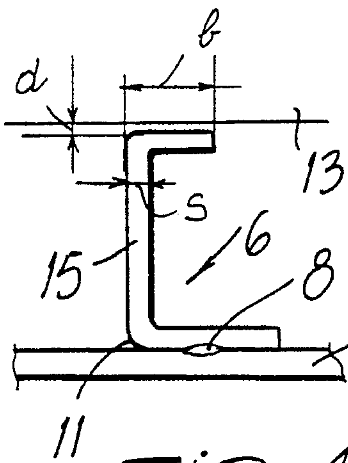

Fig. 4

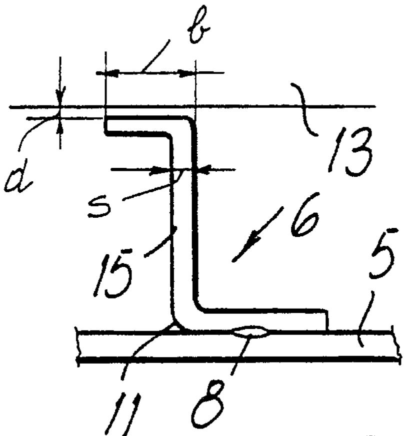

Fig. 5

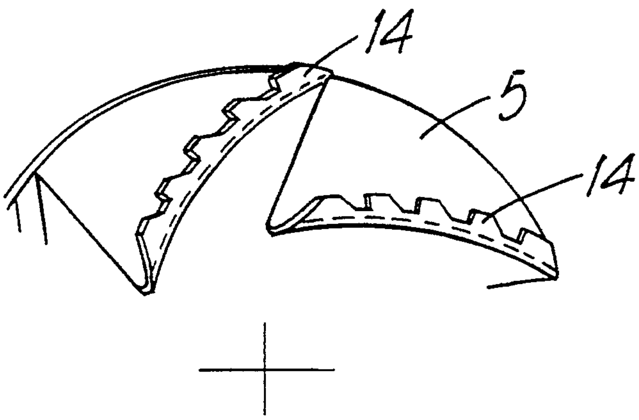

Fig. 6

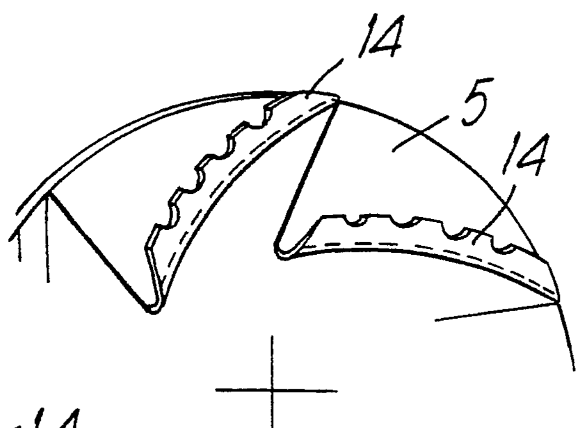

Fig. 7

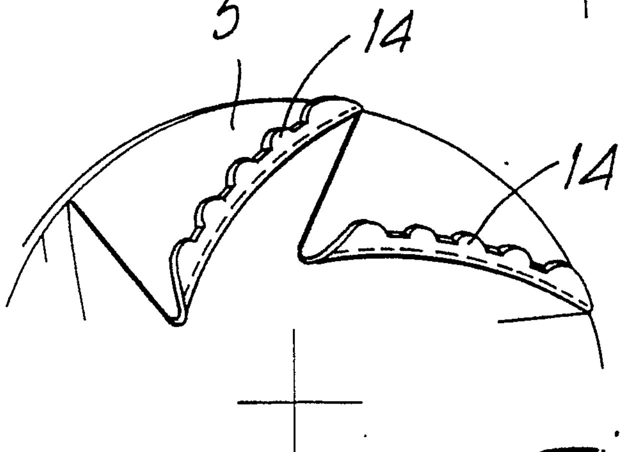

Fig. 8