(12) UK Patent (19) GB (11) 2507307 (13) B

(45) Date of B Publication 29.04.2020

(54) Title of the Invention: Impeller

(51) INT CL: **F04D 29/24** (2006.01) **B63H 1/26** (2006.01) **B64C 11/18** (2006.01) **F01D 5/14** (2006.01) **F03B 3/12** (2006.01) **F03D 1/06** (2006.01) **F03D 3/06** (2006.01) **F04D 29/32** (2006.01) **F04D 29/38** (2006.01) **F04D 29/66** (2006.01)

(21) Application No: **1219200.1**

(22) Date of Filing: **25.10.2012**

(43) Date of A Publication **30.04.2014**

(56) Documents Cited:
GB 2466125 A
GB 0942648 A
CN 206668611 U
CN 001061080 A
JP 620162795 A
JP 080159092 A
JP 2010156311 A
US 5244349 A
US 4243357 A
US 3749520 A
US 20060201721 A1
US 20040213661 A1
US 20030039548 A1
JPH10213097

(58) Field of Search:
As for published application 2507307 A viz:
INT CL **F01D, F04D**
Other: **EPODOC, WPI**
updated as appropriate

Additional Fields
INT CL **F03B**
Other: **EPODOC, WPI, Patent Fulltext**

(72) Inventor(s):
Hassan Shirvani
Ahad Ramezanpour
Ayoub Shirvani

(73) Proprietor(s):
Anglia Ruskin University
Bishop Hall Lane, Chelmsford, Essex, CM1 1SQ, United Kingdom

(74) Agent and/or Address for Service:
Mewburn Ellis LLP
City Tower, 40 Basinghall Street, LONDON, Greater London, EC2V 5DE, United Kingdom

GB 2507307 B

29 10 13

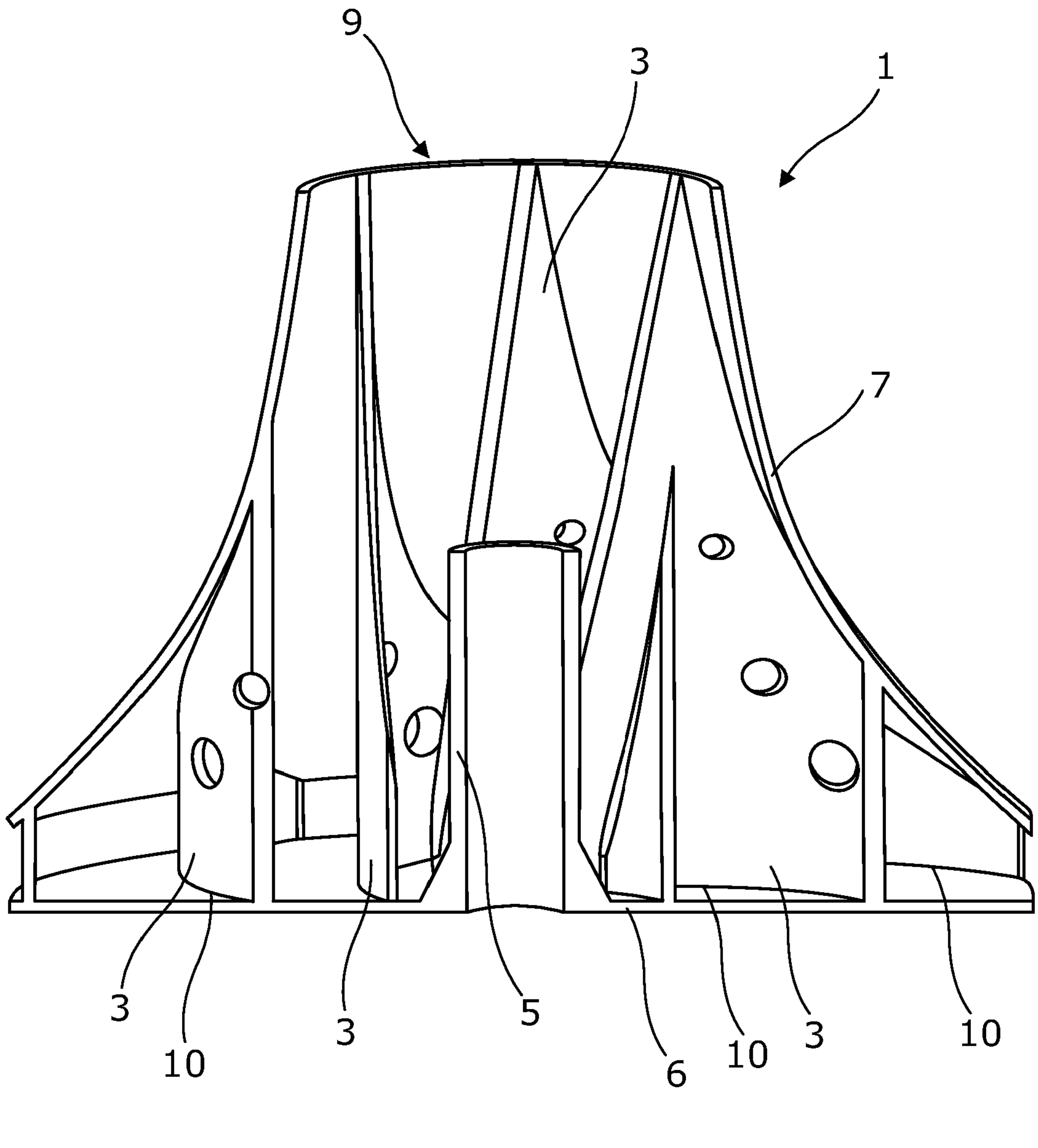

Fig. 1

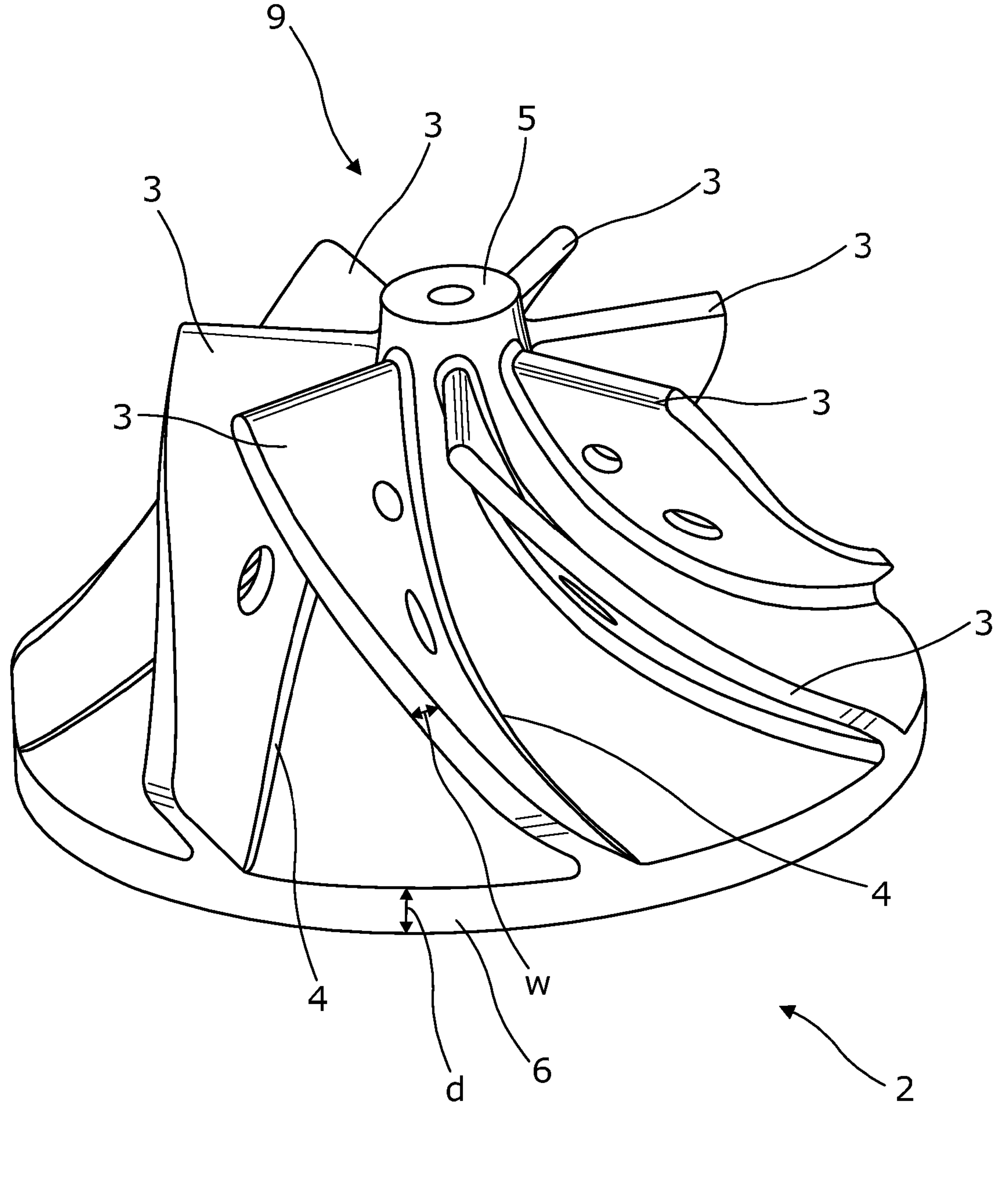

Fig. 2

29 10 13

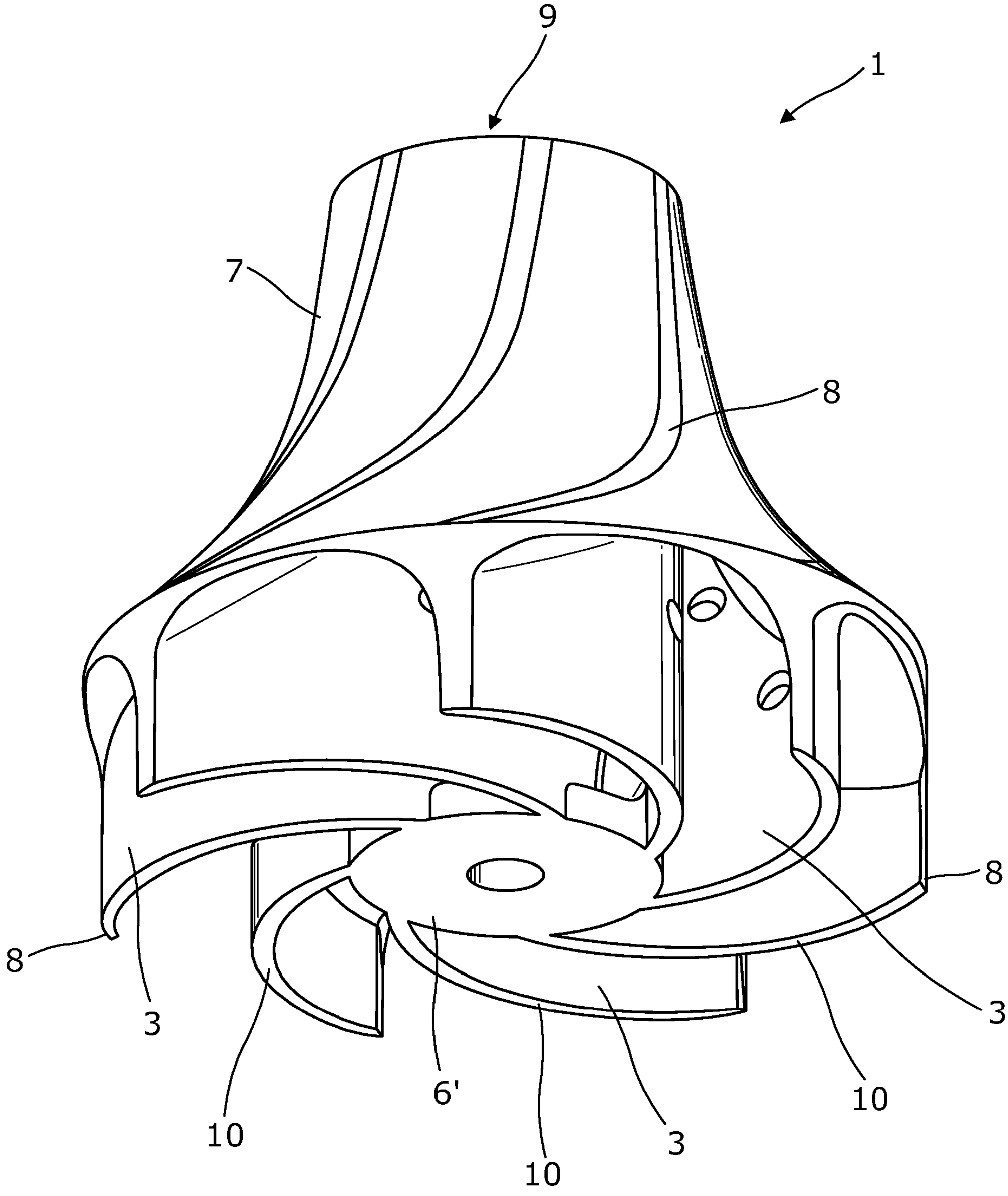

Fig. 3

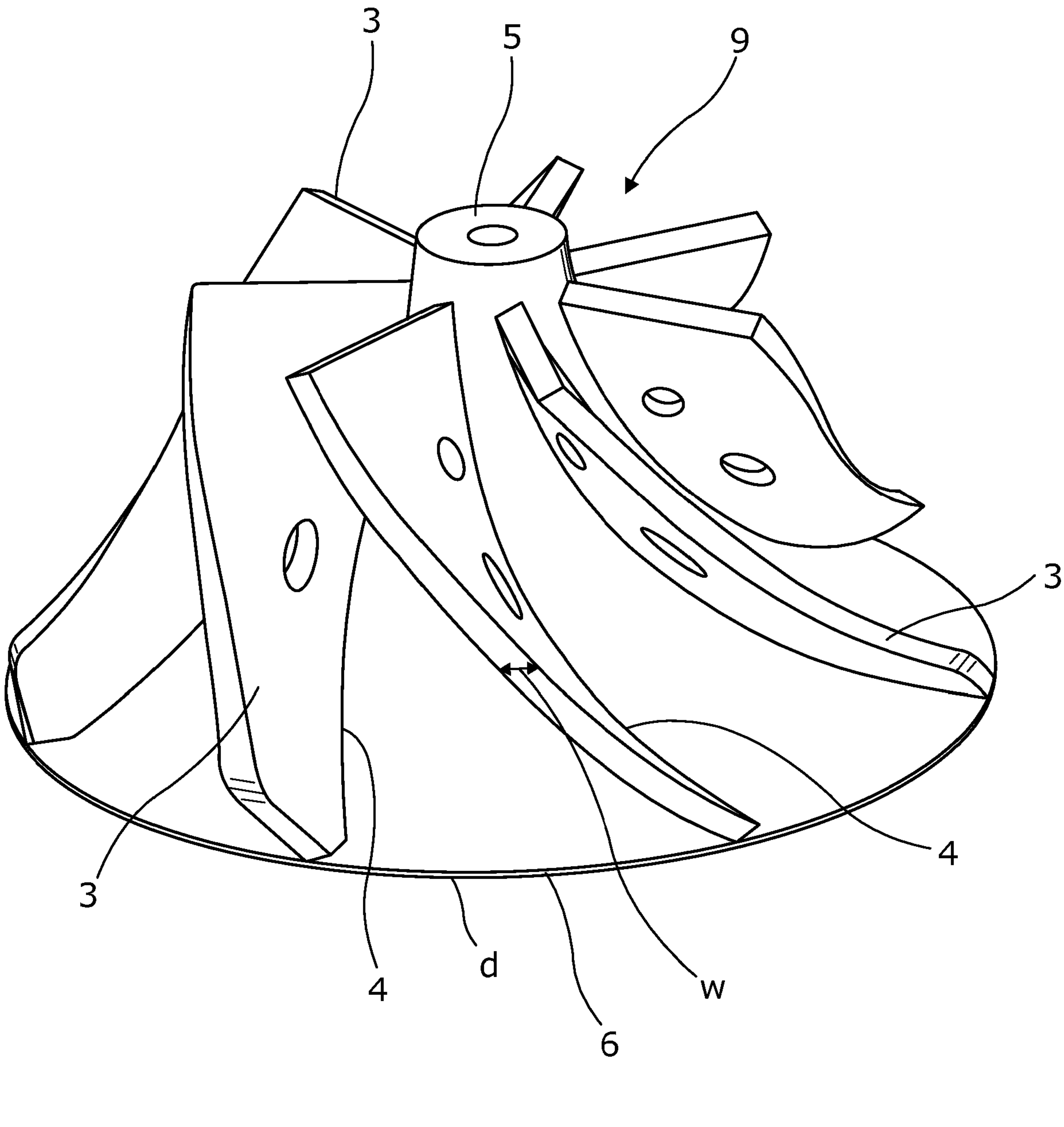

Fig. 4

IMPELLER

This invention relates to an impeller. In particular this invention relates to an impeller having improved efficiency for use, for example, in pumps such as centrifugal pumps and vertical pumps and in turbines such as wind turbines.

BACKGROUND

Impellers are widely used to move fluids and/or extract energy from them. For example, impellers are typically used in pumps (e.g. centrifugal pumps) to pump fluids such as gas or liquid. Impellers are also used in turbines which extract energy from fluid flow (e.g. wind, steam or water), the energy being used, for example, to generate electricity.

As a fluid is moved by or moves an impeller, it is preferable to keep the flow as parallel to the blade surfaces as possible to reduce friction and turbulence which leads to energy loss. As fluid flows through the rotating impeller, a pressure difference builds up across of each blade as the rotational motion causes the fluid to drag more on one side of the blade surface than the other. This pressure difference causes an increase in the torque needed to rotate the impeller. In is a preferred aim of the present invention to reduce the torque needed to rotate an impeller thus improving the efficiency of pumps/turbines incorporating such impellers.

A centrifugal pump comprises an impeller as a rotary element and a stationary casing (volute). Rotation of the impeller within the volute accelerates the liquid causing it to exit the impeller blades at a greater velocity than that at which it entered the impeller. This acceleration reduces pressure at the impeller inlet causing more liquid to enter. The liquid exiting the impeller is collected in the volute where its flow momentum is converted to pressure before leaving the pump.

Diffusion loss (which causes inefficient conversion of momentum to pressure) results from flow friction with the walls of the volute, flow separation and turbulence within the fluid. It is a preferred aim of the present invention to reduce diffusion loss in a centrifugal pump.

Furthermore, it is a preferred aim of the present invention to provide an impeller which can be formed from plastics material using injection moulding.

SUMMARY OF THE INVENTION

In a first aspect there is disclosed an impeller having a central hub carrying the leading edges of a plurality of blades, each of uniform width, and extending to a base plate, wherein the depth of the base plate is less than a quarter of the width of each of said plurality of blades.

The term “depth of the base plate” is intended to refer to the depth in the axial direction of the base plate. Where the base plate is integral with the central hub and/or has the same diameter as the maximum central hub diameter, the base plate is intended to refer to the plate having a constant diameter provided at the base of the central hub.

The term “width of each of said plurality of blades” is intended to refer to the distance between the two opposing surfaces of each blade i.e. the distance between the two edges of a cross-section through a blade.

In known impellers, the depth of the base plate is typically larger than the width of the blades. By providing a base plate having a base plate of reduced depth, it is possible to reduce the diffusion limit of a pump incorporating such an impeller. The reduction in the base plate thickness provides an elongation of the overall blade dimension which helps to reduce drag.

The central hub is preferably frusto-conical with a non-linear (concave) taper. In this case, it is preferable that the diameter of the base of the central hub matches the diameter of the base plate.

The base plate may be integral with the central hub.

The impeller may be a closed impeller i.e. with a shroud or it may be an open or semi-open impeller.

At least one blade may comprises at least one aperture.

By providing an aperture extending through at least one blade in an impeller, it is possible to balance the fluid (e.g. liquid or air) pressure across the blade. This pressure balance means that less torque is required to rotate the impeller which, in turn, increases energy efficiency of a pump incorporating such an impeller. Furthermore, the presence of the at least one aperture in the at least one blade reduces the fluid pressure within the impeller which results in an increase in fluid momentum within the impeller. This results in a greater suction at the impeller inlet and improved flow rate through the impeller. Finally, it is thought that the edges of the at least one aperture act to grip the fluid and provide an improved flow movement inside the impeller.

Preferably more than one (and preferably all) of the plurality of blades comprises a respective at least one aperture.

By providing more than one (and preferably all) of said plurality of blades with a respective at least one aperture, it is possible to balance the fluid pressure across a number (and preferably all) blades which, in turn, leads to an even greater increase in energy efficiency and improvement in flow rate and flow movement.

More preferably, the at least one blade comprises a plurality of apertures. Even more preferably, more than one of said plurality of blades, and most preferably all blades, comprise a respective plurality of apertures.

In this way, the maximum pressure balance can be achieved across the entire length of each blade to lead to the maximum increase in energy efficiency and maximum improvement in flow rate and flow movement.

The or each aperture has openings on either side of the respective blade. The opening may be of any shape or dimension. For ease of formation, the openings typically have a circular shape or they may have an ellipse or oval shape.

One or more of the or each aperture(s) may have an axis which is perpendicular to the surface of the respective blade. In this manner, for an aperture with circular openings, the aperture has a circular cross section and a cylindrical profile.

Alternatively, one or more of the or each aperture(s) may have an axis which is angled relative to the surface. If a circular tool is used to form such apertures, the openings are typically oval or an ellipse.

For blades having a plurality of apertures, the apertures need not all extend through the blade at the same angle and they need not all have the same shape openings.

For blades having a plurality of apertures, the apertures may be arranged in any manner on the blade. However, they are typically spaced over the surface of blade e.g. in an arc or row extending from an outlet end of the impeller to an input end of the impeller.

The size of the or each aperture on the or each blade is not limited. However, it is preferable that apertures closer to the output end of the impeller are larger than apertures closer to the input end of the impeller. Thus, in a row or arc of apertures on any blade, the cross-sectional dimension of the apertures increases from the input end to the output end of the impeller.

The impeller may be any type of impeller, for example, it may be a centrifugal impeller, an axial flow impeller, a radial flow impeller, a turbine or a propeller.

It may or may not have a central hub for supporting the plurality of blades. A central hub typically supports the leading edges of the blades. The leading edges are those encountered first in fluid flow.

It may be a closed impeller with a shroud e.g. a funnel shaped shroud to increase the volume of the impeller. A shroud typically supports the trailing edge of the blades. The trailing edges are those encountered last in fluid flow.

The impeller may be formed of any suitable material e.g. metal or plastics material.

Also disclosed is an impeller having a central hub carrying the leading edges of a plurality of blades and extending to a base plate, a shroud carrying the trailing edges of said plurality of blades and defining an impeller inlet distal the base plate, each of said plurality of blades further having an outlet edge extending from the respective trailing edge distal the impeller inlet to the base plate wherein the diameter of the base plate is smaller than the diameter of the impeller inlet.

The term “leading edge” is intended to refer to the edge of the blade encountered first by fluid flow. The term “trailing edge” is intended to refer to the edge of the blade encountered last by fluid flow.

By providing the base plate with a smaller diameter than the impeller inlet, two significant advantages are achieved.

In known impellers having a shroud (known as closed impellers), the base plate is larger than the impeller inlet (suction diameter) and, typically, extends to the limits of the trailing edges of the blades such that no free outlet edges of the blades are exposed. It is not possible to manufacture such closed impellers using injection moulding of plastics material because it is impossible to extract the manufacturing tool after moulding. By reducing the diameter of the base plate such that it is smaller than the suction diameter defined by the inlet of the shroud, it is possible to form a closed impeller using injection moulding of plastics material because the manufacturing tool can be withdrawn from the moulded impeller without any interference with the base plate. Use of injection moulding significantly reduces manufacturing costs and simplifies precision manufacturing and balancing of closed impellers formed of plastics material.

A further advantage is that the omission of the larger base plate makes it is possible to reduce the diffusion limit of a centrifugal pump incorporating the impeller because there is a reduced distance between the impeller outlet and the volute and there is reduced friction against the base plate.

It will be readily appreciated that the impeller is preferably formed of plastics material.

In preferred embodiments, the outlet edge and/or the leading edge adjacent the base plate of each of said plurality of blades is thickened in width. This is to strengthen and minimise flexing of the blades.

Preferred embodiments of the present invention will now be described with reference to the accompanying Figures in which:

Figure 1 shows a first embodiment of an impeller;

Figure 2 shows a second embodiment of an impeller;

Figure 3 show a third embodiment of an impeller; and

Figure 4 shows a fourth embodiment of an impeller.

DETAILED DESCRIPTION OF THE DRAWINGS

Figures 1 to 4 show various embodiments of an impeller. Figures 1 and 3 show a closed or shrouded impeller 1. Figures 2 and 4 show an open impeller 2 without any shroud.

Each impeller 1, 2 comprises a plurality of blades 3. The leading edges (i.e. the edges encountered first by any fluid flow) 4 of the blades 3 are supported on a central hub 5 which extends to a base plate 6. The base plate 6 is a cylindrical plate having a depth, d.

The closed impeller shown in Figures 1 and 3 has a shroud 7 which is frusto-conical in shape with a non-linear (concave) taper. The trailing edges (i.e. the edges encountered last by any fluid flow) 8 of the blades 3 are supported on an inner surface of the shroud 7. The shroud 7 defines a shroud inlet 9 which corresponds to the impeller inlet, 9’. The blades 3 further include a respective outlet edge 10 which, in figure 1, are joined to the base plate 6. Each outlet edge 10 extends from the trailing edge 8 most distal the shroud/impeller inlet towards the central hub 5.

In the closed impeller 1, the central hub 5 is cylindrical. In the open impeller, the central hub 5 is frusto-conical with a non-linear (concave) taper. The maximum diameter of the central hub 5 is at the base of the central hub 5 adjacent the impeller outlet and the maximum diameter of the central hub 5 matches the diameter of the base plate 6. The central hub 5 and base plate 6 are integral.

Each of the blades 3 carries a plurality of apertures 11 which extend through the blade. In Figures 2 and 4, each blade has two apertures. In Figures 1 and 3, each blade has three apertures 11 (only two visible in Figure 1).

By providing an aperture extending through at least one blade in an impeller, it is possible to balance the fluid (e.g. liquid or air) pressure across the blade. This pressure balance means that less torque is required to rotate the impeller which, in turn, increases energy efficiency of a pump incorporating such an impeller. Furthermore, the presence of the at least one aperture in the at least one blade reduces the fluid pressure within the impeller which results in an increase in fluid momentum within the impeller. This results in a greater suction at the impeller inlet and improved flow rate through the impeller. Finally, it is thought that the edges of the at least one aperture act to grip the fluid and provide an improved flow movement inside the impeller.

In Figures 1 and 3, the apertures 11 extend in an arc along each blade. They have circular openings and the axes through each aperture extend perpendicular to the surfaces of the blade.

In Figures 2 and 4, the apertures 11 closest to the impeller inlet 9' have circular openings whilst the apertures closest to the impeller outlet have oval openings.

In Figure 1, a conventional base plate 6 is shown. This base plate is larger than the impeller inlet/suction diameter defined by the shroud inlet 9 and extends to the limits of the trailing edges 8 of the blades 3 such that no free outlet edges 10 of the blades 3 are exposed.

In Figure 3, the base plate 6’ has a smaller diameter than the suction diameter defined by the shroud inlet 9. As a result, two significant advantages are achieved.

By reducing the diameter of the base plate such that it is smaller than the impeller inlet/suction diameter defined by the inlet 9 of the shroud 7, it is possible to form a closed impeller using injection moulding of plastics material because the manufacturing tool can be easily withdrawn from the moulded impeller. Use of injection moulding significantly reduces manufacturing costs and simplifies precision manufacturing and balancing of closed impellers formed of plastics material.

A further advantage is that the omission of the larger base plate, it is possible to reduce the diffusion limit of a centrifugal pump incorporating the impeller because there is a reduced distance between the impeller outlet and the volute and there is reduced friction against the base plate.

In Figure 2, a conventional base plate 6 is shown with the depth d of the base plate being greater than the width, w of the blades.

In Figure 4, the depth d of the base plate 6 is less than the width w of the blades.

By providing a base plate having a base plate of reduced depth, it is possible to reduce the diffusion limit of a pump incorporating such an impeller.

A person skilled in the art will appreciate that the Figures show preferred embodiment and that carious modifications can be made.

CLAIMS

1. An impeller having a central hub carrying the leading edges of a plurality of blades, each of uniform width, and extending to a base plate, wherein the depth of the base plate is less than a quarter of the width of each of said plurality of blades.

2. An impeller according to any one of the preceding claims wherein the central hub is frusto-conical with a non-linear taper.

3. An impeller according to claim 2 wherein the base plate is integral with the central hub.

4. An impeller according to any one of the preceding claims wherein each of said plurality of blades comprises at least one aperture extending across the width of the blade.

5. An impeller according to claim 4 wherein each of said plurality of blades comprises a plurality of apertures arranged in an arc or row extending along the respective blade from an inlet end to an outlet end of the impeller.

6. An impeller according to any one of the preceding claims formed of injection moulded plastics material.

7. A pump comprising an impeller according to any one of the preceding claims.