



Europäisches Patentamt  
European Patent Office  
Office européen des brevets



Publication number:

**0 456 596 B1**

12

## EUROPEAN PATENT SPECIFICATION

49 Date of publication of patent specification: **06.09.95** 51 Int. Cl.<sup>8</sup>: **F04D 29/22**

21 Application number: **91610041.5**

22 Date of filing: **06.05.91**

54 **A centrifugal pump.**

30 Priority: **10.05.90 DK 1172/90**

43 Date of publication of application:  
**13.11.91 Bulletin 91/46**

45 Publication of the grant of the patent:  
**06.09.95 Bulletin 95/36**

84 Designated Contracting States:  
**DE FR GB IT**

56 References cited:  
**FR-A- 1 139 152**  
**US-A- 1 030 561**  
**US-A- 4 874 293**

73 Proprietor: **GRUNDFOS INTERNATIONAL A/S**  
**7-11, Poul Due Jensensvej**  
**DK-8850 Bjerringbro (DK)**

72 Inventor: **Jensen, Niels Due**  
**Pilevej 1**  
**DK-8850 Bjerringbro (DK)**  
Inventor: **Langgaard, Gunnar**  
**Ogardshojen 1A**  
**DK-8800 Viborg (DK)**

74 Representative: **Noergaard, Tage et al**  
**Chas. Hude**  
**H.C. Andersens Boulevard 33**  
**DK-1553 Copenhagen V (DK)**

**EP 0 456 596 B1**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

## Description

The invention relates to a centrifugal pump comprising a casing and a rotary impeller provided with one or two cover plates and a plurality of spacing blade means fastened thereto, wherein each spacing blade means, radially seen, comprises an outer, solid section and an inner section having at least one cavity, the outer section forming an integral part with the inner section or being joined therewith, each section comprising one or more web segments.

DE-PS No. 2.800.723 discloses a fan impeller, where two successive blades are joined by means of a common base plate adjacent one of the two cover plates. Another known fan impeller comprises blades of bent sheet material. It is, however, not mentioned that the blades are made of simple web segments. Known impellers are expensive to manufacture, as they require a large number of working operations, especially a large number of foldings of the sheet material. Moreover, the impellers are difficult to adapt to a predetermined capacity or pressure. Further, large known pump impellers are known, which are provided with spacing blade means having a cavity. If the operating conditions (capacity, pressure) of a pump with such an impeller should be changed, the diameter of the impeller may be altered by turning, thus possibly puncturing a spacing blade means. The pump medium can then flow into the cavity of the spacing blade means, thus having a considerable, negative effect on the flow conditions at the outer periphery of the spacing blade means.

US-A-1 030 561 discloses a fan with an impeller arranged in a housing. In the impeller, a kind of spacing blade means is arranged between two cover plates. The sheet material forming the spacing blade means extends a small distance beyond said cover plates. The extending part of the spacing blade means undoubtedly will not contribute to the "pumping" capacity of the fan. Further, this construction is not for liquid but for air. Said sheet material is riveted to the cover plates all the way to the outer periphery of said plates. This prevents a simple adjustment of the capacity by shortening (cutting off) the length of the sheet material.

The object of the invention is to provide a centrifugal pump of the above-mentioned type, where the impeller is easily adapted to a variety of different operating conditions (capacity, pressure).

The centrifugal pump according to the invention is characterized in that the web segment or segments are fastened to the cover plates by welding or soldering spots at a radius smaller than or equal to  $0.85 R$  from the center of the cover plate,  $R$  being the radius of the cover plate, the web segment with the longest radial reach extending

not quite as far as to the outer periphery of the cover plate. As a result the impeller is easily adapted to the desired operating conditions (capacity, pressure) without affecting the flow conditions at the outer periphery of the impeller, because a slight reduction of the blade diameter is easily made by means of a cutting tool. A small part of the web segment is removed from the outer, solid section but not from the hollow section. The latter remains undamaged, and the flow conditions in the pump are consequently excellent.

According to the invention, web segment or segments of the outer section is without connection to the cover plate. Thus, it is particularly easy to remove material from the web segment or segments of the outer section during adaptation.

Furthermore, according to the invention, the outer and inner sections form an integral part and comprise at least one first curved web segment, preferably two such segments, to define ducts between the spacing blade means, one portion of the first web segment or of one of the web segments, respectively, of each spacing blade means radially projecting further than the remaining portion of the first web segment or of the other web segments, respectively, of the spacing blade means, the projecting part of the abovementioned portion of the first web segment or of one of the web segments, respectively, being without any connection to the cover plate. As a result, it is particularly easy to adapt an impeller to the desired operating conditions (capacity, pressure) after manufacture, as a technician can easily shorten the web segment(s) a little at the outer periphery by means of a simple cutting tool so that the impeller is adapted without affecting the flow conditions at the outer periphery of the impeller.

Moreover, according to the invention, the web segment with the longest radial projection advantageously extends not quite as far as the cover plate.

In one embodiment of the invention each spacing blade means comprises at least three relatively small web segments defining at least one closed cavity, resulting in a relatively light impeller. Moreover, it is thus easier to shape a spacing blade means in such a way that the pump medium flows into the duct between two successive spacing blade means at an easily adjustable angle.

In another embodiment of the invention, one or more of the web segments of the inner section form an internal bracing therein, thus increasing the strength of the impeller.

In a further embodiment of the invention, the web segments are manufactured with a small cross-section by means of extrusion, resulting in a particularly inexpensive manufacture of the impeller.

In yet another embodiment of the invention, the cover plate and the web segments are made of

sheet metal, preferably having a thickness of 0.5-3.0 mm, especially 0.8-2.0 mm, thus facilitating manufacture.

In yet a further embodiment of the invention the end portion of the inner section comprised by the web segment or segments and closest to the centre of the impeller is provided with an inwardly facing nose, optionally only a single projection of the web segment, to ensure a locally defined extension of the cross-section of the duct immediately behind the duct inlet with respect to the flow direction of the pump medium through the duct, thus allowing for the most advantageous design of a duct inlet.

In a particularly advantageous embodiment of the invention, the web segments are substantially of C-, S- or wing-shape.

In another advantageous embodiment of the invention each web segment is fastened with two, preferably four, welding or soldering spots.

The invention is described in greater detail below and with reference to the accompanying drawings in which:

Figure 1 is a frontal view of a first embodiment of an impeller of a centrifugal pump according to the invention, where the impeller is provided with one cover plate,

Figure 2 shows a second embodiment of the impeller corresponding to Figure 1, where spacing blade means of different shapes are schematically shown; an impeller according to the invention is, however, always provided with spacing blade means of the same shape; and

Figure 3 is a sectional view of the impeller of Figure 1 along the line III-III.

The impeller of Figure 1 rotates inside a casing of a centrifugal pump (not shown). The impeller is provided with one cover plate 8 but may, in principle, be provided with two. The impeller is further provided with a plurality of spacing blade means 2, a pair of spacing blade means defining a duct 4. Each spacing blade means 2 comprises an outer, solid section 2b' and an inner, hollow section, i.e. the section of the spacing blade means 2 situated radially inwardly with respect to the outer section 2b'. The outer, solid section 2b' (cf. also 2bo) may form an integral part with the inner section or may be joined with the latter. The outer section 2b' (optionally 2bo) is thus not directly connected to the cover plate 8. The outer and inner sections may form an integral part and comprise two web segments 2a, 2b. The web segments are fastened to the cover plate by means of welding, preferably spot welding, or soldering. As is apparent, each inner section comprises at least one inner closed cavity 6.

As is furthermore apparent, the web segment 2b extends as far as the outer peripheral edge 8a

of the cover plate 8. A technician assembling the impeller parts can easily shorten the outer section 2b' of the web segment 2b to a greater or lesser extent by means of a simple cutting tool, thus adapting the impeller to a variety of operating conditions. Moreover it is apparent that the inner section may be provided with inwardly facing noses, in the present case the radially innermost end 2b'' of the web segment 2b. As a result the portion of the duct 4 forming the duct inlet is locally extended, thus creating particularly advantageous flow conditions through the duct 4 in some pump types.

Prior to the above-mentioned cutting with a tool, a web segment may optionally extend over a considerable distance, as denoted by 2bn at the bottom left corner of Figure 1, without, however, reaching the peripheral edge 8a of the cover plate.

Instead of two web segments a spacing blade means may comprise three web segments, as shown at the bottom right corner of Figure 1, where a web segment 2c forms a bracing. The web segment 2a at the top of Figure 1 may optionally be two web segments adjoining at a bend 15.

A spacing blade means 12 may comprise two web segments, cf. Figure 2, one of which 12f is substantially of C-shape, the other 12g substantially of S-shape. Optionally a spacing blade means may have the shape of an airplane wing made from one web segment, cf. 12h. Furthermore a spacing blade means may be made from a single web segment provided with an inwardly facing nose 12m'', cf. 12m.

A web segment may be manufactured with a small cross-section by means of extrusion. It is also possible to make the segments and the cover plate of sheet metal having a thickness of preferably 0.5-3.0 mm, especially 0.8-2.0 mm.

As is shown by means of the web segment 2b of Figure 1, the web segment of a spacing blade means is fastened to the cover plate by means of welding or soldering spots 20 and within a radius of less than or equal to 0.85 R (R being the radius of the cover plate). A web segment is fastened with at least two, preferably four, welding or soldering spots 20.

### Claims

1. A centrifugal pump comprising a casing and a rotary impeller (1) provided with one or two cover plates (8) and a plurality of spacing blade means (2) fastened thereto, wherein each spacing blade means, radially seen, comprises an outer, solid section (2b', 2bo) and an inner section having at least one cavity (16, 17), the outer section forming an integral part with the inner section or being joined therewith, each section comprising one or more web seg-

ments, **characterized** by the web segment or segments being fastened to one of the cover plates by welding or soldering spots (20) at a radius smaller than or equal to  $0.85 R$  from the center (10) of the cover plate (8),  $R$  being the radius of the cover plate (8), the web segment with the longest radial reach extending not quite as far as to the outer periphery of the cover plate(s) (8).

2. A centrifugal pump as claimed in claim 1, **characterized** by the web segment or segments of the outer section (2b', 2bo) being without connection to the cover plate (8).
3. A centrifugal pump as claimed in claim 1, **characterized** by the outer and inner sections forming an integral part and comprising at least one first curved web segment (12m, 12h), preferably two such segments (2a, 2b; 2c; 12f, 12g, 12j, 12k), to define ducts (4) between the spacing blade means, one portion (2b') of the first web segment or of one of the web segments (2b), respectively, of each spacing blade means radially projecting further than the remaining portion of the first web segment or of the other web segments, respectively, of the spacing blade means, the projecting part of the above-mentioned portion (2b') of the first web segment or of one of the web segments, respectively, being without any connection to the cover plate.
4. A centrifugal pump as claimed in claim 1, 2 or 3, **characterized** by each spacing blade means (2) comprising at least three relatively small web segments (2a, 2b, 2c) defining at least one closed cavity (16, 17).
5. A centrifugal pump as claimed in one or more of the claims 1-4, **characterized** by one or more of the web segments of the inner section forming an internal bracing (2c) therein.
6. A centrifugal pump as claimed in one or more of the claims 1-5, **characterized** by the web segments being manufactured with a small cross-section by means of extrusion.
7. A centrifugal pump as claimed in one or more of the claims 1-6, **characterized** by the cover plate and the web segments being made of sheet metal, preferably having a thickness of 0.5-3.0 mm, especially 0.8-2.0 mm.
8. A centrifugal pump as claimed in one or more of the claims 1-7, **characterized** by the end portion (2) of the inner section comprised by

the web segment (2m) or segments (2b, 2f, 2k) and closest to the centre (10) of the impeller being provided with an inwardly facing nose (12m''), optionally only a single projection (2b'') of the web segment, to ensure a locally defined extension (34, 25) of the cross-section of the duct immediately behind the duct inlet with respect to the flow direction of the pump medium through the duct.

9. A centrifugal pump as claimed in one or more of the claims 1-8, **characterized** by the web segments being substantially of C-, S- or wing-shape (12f, 12g, 12h, 12j, 12k, 12m).
10. A centrifugal pump as claimed in claim 9, **characterized** by two, preferably four, welding or soldering spots (20) for fastening a web segment.

#### Patentansprüche

1. Kreiselpumpe, umfassend ein Gehäuse und ein rotierendes Laufrad (1), das mit einer oder mehreren Abdeckplatten (8) und einer Mehrzahl von daran befestigten beabstandeten Schaufelelementen (2) versehen ist, wobei jedes beabstandeten Schaufelelement, radial gesehen, einen äußeren massiven Abschnitt (2b', 2bo) und einen inneren Abschnitt mit mindestens einem Hohlraum (16, 17) umfaßt, welcher äußere Abschnitt mit dem inneren Abschnitt einstückig ausgebildet oder mit diesem verbunden ist, wobei jeder Abschnitt ein oder mehrere Stegsegmente umfaßt, dadurch gekennzeichnet, daß das oder die Stegsegmente durch Schweiß- oder Lötunkte (20) in einem Radius kleiner oder gleich  $0,85 R$  von der Mitte (10) der Abdeckplatte (8) an einer der Abdeckplatten befestigt sind, wobei  $R$  der Radius der Abdeckplatte (8) ist, und daß sich das Stegsegment mit der längsten radialen Reichweite nicht ganz bis zu dem äußeren Umfang der Abdeckplatte(n) (8) erstreckt.
2. Kreiselpumpe nach Anspruch 1, dadurch gekennzeichnet, daß das oder die Stegsegmente des äußeren Abschnittes (2b', 2bo) nicht mit der Abdeckplatte (8) verbunden sind.
3. Kreiselpumpe nach Anspruch 1, dadurch gekennzeichnet, daß der äußere und innere Abschnitt einstückig ausgebildet sind und mindestens ein erstes gekrümmtes Stegsegment (12m, 12h), vorzugsweise zwei solche Segmente (2a, 2b; 2c; 12f, 12g, 12j, 12k), zur Begrenzung von Kanälen (4) zwischen den beabstandeten Schaufelelementen aufweisen,

- daß sich ein Teil (2b') des ersten Stegsegments bzw. eines der Stegsegmente (2b) jedes beabstandeten Schaufelelements radial über den restlichen Teil des ersten Stegsegments oder der anderen Stegsegmente des beabstandeten Schaufelelements hinaus erstreckt und daß der vorstehende Teil des obengenannten Teils (2b') des ersten Stegsegments oder eines der Stegsegmente nicht mit der Abdeckplatte verbunden ist.
4. Kreiselpumpe nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß jedes beabstandete Schaufelelement (2) zumindest drei verhältnismäßig kleine Stegsegmente (2a, 2b, 2c) umfaßt, die mindestens einen geschlossenen Hohlraum (16, 17) begrenzen.
5. Kreiselpumpe nach einem oder mehr der Ansprüche 1-4, dadurch gekennzeichnet, daß eines oder mehr der Stegsegmente des inneren Abschnittes darin eine innere Verstrebung (2c) bilden.
6. Kreiselpumpe nach einem oder mehr der Ansprüche 1-5, dadurch gekennzeichnet, daß die Stegsegmente durch Extrusion mit einem kleinen Querschnitt hergestellt sind.
7. Kreiselpumpe nach einem oder mehr der Ansprüche 1-6, dadurch gekennzeichnet, daß die Abdeckplatte und die Stegsegmente aus Blech, vorzugsweise mit einer Dicke von 0,5-3,0 mm, insbesondere 0,8-2,0 mm, bestehen.
8. Kreiselpumpe nach einem oder mehr der Ansprüche 1-7, dadurch gekennzeichnet, daß der Endteil (2) des inneren Abschnittes, der aus dem Stegsegment (2m) oder den Segmenten (2b, 2f, 2k) besteht und der Mitte (10) des Laufrades am nächsten liegt, mit einem nach innen gerichteten Ansatz (12m'') versehen ist, wahlweise mit nur einem einfachen Fortsatz (2b'') des Stegsegmentes, um eine örtlich begrenzte Erweiterung (34, 25) des Querschnittes des Kanales unmittelbar hinter dem Kanaleinlaß in bezug auf die Strömungsrichtung des Fördermediums durch den Kanal zu bilden.
9. Kreiselpumpe nach einem oder mehr der Ansprüche 1-8, dadurch gekennzeichnet, daß die Stegsegmente im wesentlichen C-, S- oder flügel förmig sind (12f, 12g, 12h, 12j, 12k, 12m).
10. Kreiselpumpe nach Anspruch 9, gekennzeichnet durch zwei, vorzugsweise vier, Schweiß- oder Lötunkte (20) zur Befestigung eines Stegsegmentes.

## Revendications

1. Pompe centrifuge comprenant un carter et un rouet tournant (1) pourvu d'un ou de deux flasques (8) et d'une pluralité de moyens formant ailette de séparation (2) reliée à ceux-ci, dans laquelle chaque moyen formant ailette de séparation, vu dans le sens radial, comprend une section externe pleine (2b', 2bo) et une section interne disposant au moins d'une cavité (16, 17), la section externe constituant une seule pièce avec la section interne ou étant reliée avec celle-ci, chaque section comprenant un ou plusieurs segments d'âme, caractérisée par un segment ou des segments d'âme fixés sur l'un des flasques par des points de brasure ou de soudure (20) sur un rayon inférieur ou égal à  $0,85 R$  par rapport au centre (10) du flasque (8),  $R$  représentant le rayon du flasque (8), le segment d'âme présentant la radiale la plus longue atteignant une extension non supérieure à la périphérie externe du (des) flasque(s) (8).
2. Pompe centrifuge selon la revendication 1, caractérisée par un segment ou des segments d'âme de la section externe (2b', 2bo) qui ne présentent pas de liaisons avec le flasque (8).
3. Pompe centrifuge selon la revendication 1, caractérisée par des sections externe et interne formées en une pièce et comprenant au moins un premier segment d'âme courbe (12m, 12h), de préférence, deux segments analogues (2a, 2b; 2c; 12f, 12g, 12j, 12k), pour définir des conduits (4) entre les moyens formant ailette de séparation, une partie (2b') du premier segment d'âme ou respectivement de l'un des segments d'âme (2b), de chaque moyen formant ailette de séparation étant radialement plus en saillie que la partie restante du premier segment d'âme ou respectivement des autres segments d'âme des moyens formant ailette de séparation, la partie en saillie de la partie (2b') mentionnée précédemment du premier segment d'âme ou respectivement de l'un des segments d'âme ne disposant pas de liaisons avec le flasque.
4. Pompe centrifuge selon les revendications 1, 2 ou 3 caractérisée en ce que chaque moyen formant ailette de séparation (2) comprend au moins trois segments d'âme relativement petits (2a, 2b, 2c) définissant au moins une cavité fermée (16, 17).
5. Pompe centrifuge selon l'une ou plusieurs des revendications 1 à 4, caractérisée en ce qu'un

ou plusieurs des segments d'âme de la section interne forment un raidisseur interne (2c) dans celle-ci.

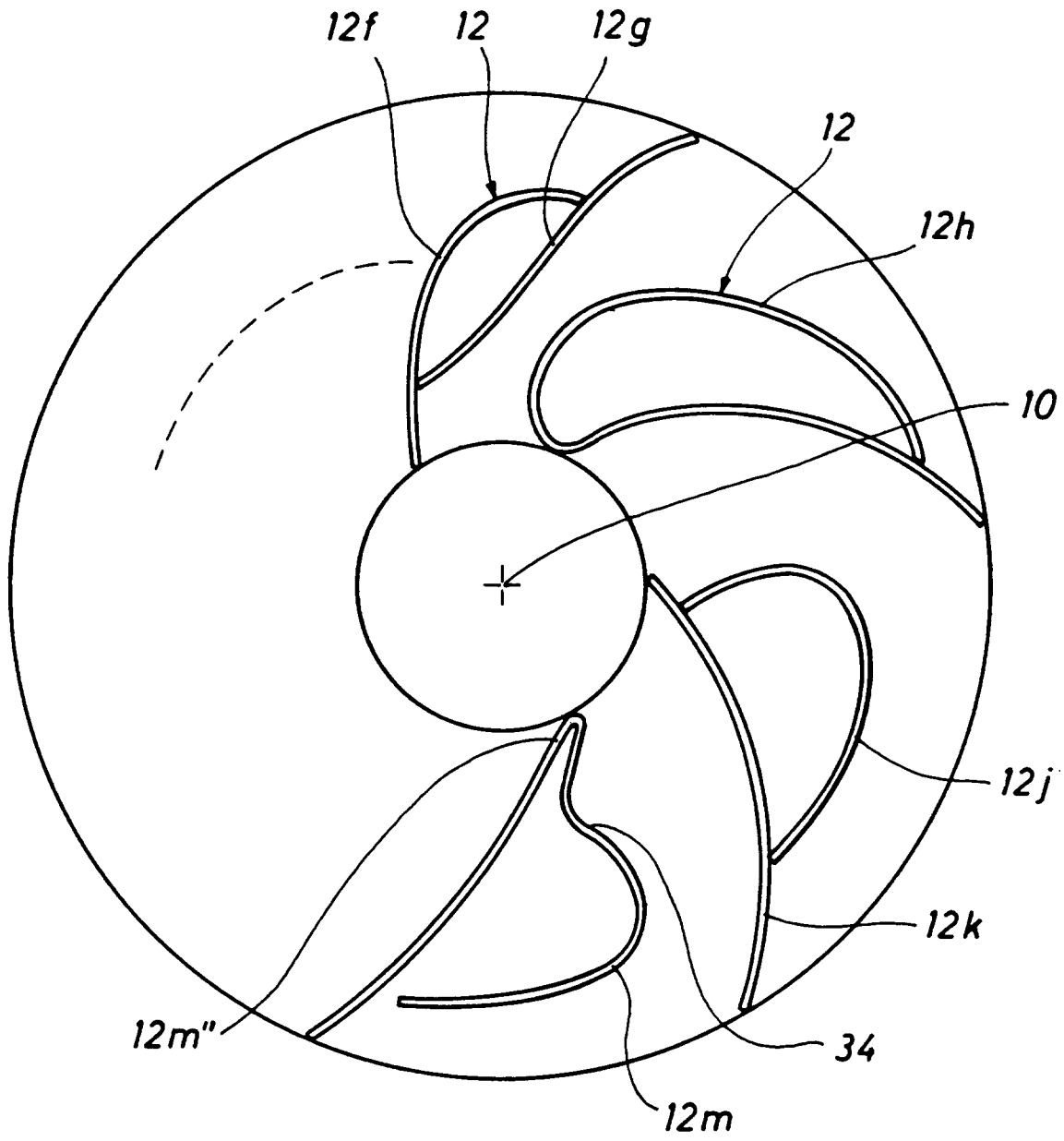
6. Pompe centrifuge selon l'une ou plusieurs des revendications 1 à 5, caractérisée en ce que les segments d'âme sont réalisée par extrusion, avec une faible section transversale. 5
7. Pompe centrifuge selon l'une ou plusieurs des revendications 1 à 6, caractérisée par un flasque et des segments d'âme réalisés à partir d'une feuille métallique, de préférence, présentant une épaisseur de 0,5 à 3,0 mm, plus particulièrement de 0,8 à 2,0 mm. 10  
15
8. Pompe centrifuge selon l'une ou plusieurs des revendications 1 à 7, caractérisée en ce que la partie d'extrémité (2) de la section interne constituée du segment d'âme (12m) ou des segments d'âme (2b, 12f, 12k) et la plus proche du centre (10) du rouet est pourvue d'un nez faisant face à l'intérieur (12m''), en variante seule une simple saillie (2b'') du segment d'âme, afin d'assurer une extension (34, 25), définie localement, de la section transversale du conduit immédiatement derrière l'entrée du conduit par rapport au sens du débit du fluide pompé à travers le conduit. 20  
25  
30
9. Pompe centrifuge selon l'une ou plusieurs des revendications 1 à 8, caractérisée par les segments d'âme (12f, 12g, 12h, 12j, 12k, 12m) globalement en forme de C, de S ou d'aile. 35
10. Pompe centrifuge selon la revendication 9, caractérisée par deux, de préférence par quatre points de brasure ou de soudure (20) pour la fixation d'un segment d'âme. 40

45

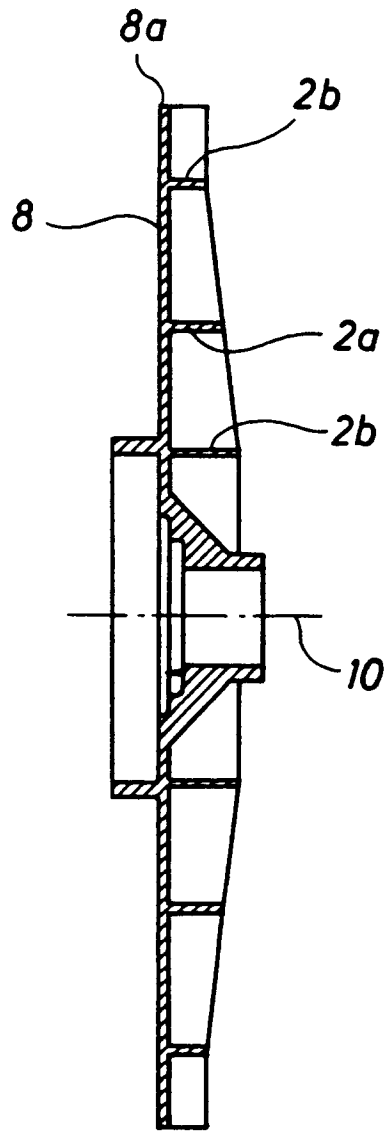
50

55





**Fig.2**



*Fig.3*