US 20050230077A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0230077 A1**

**Meduric et al.** (43) **Pub. Date: Oct. 20, 2005**

(54) **CASTING PROCESS AND CAST PRODUCT**

(76) Inventors: **Mladen Meduric**, Christchurch (NZ); **Michael Hamilton**, Christchurch (NZ)

Correspondence Address:
**DANN, DORFMAN, HERRELL & SKILLMAN**
**1601 MARKET STREET**
**SUITE 2400**
**PHILADELPHIA, PA 19103-2307 (US)**

(21) Appl. No.: **10/503,698**

(22) PCT Filed: **Feb. 5, 2003**

(86) PCT No.: **PCT/NZ03/00015**

(30) **Foreign Application Priority Data**

Feb. 5, 2002 (NZ)..... 517037

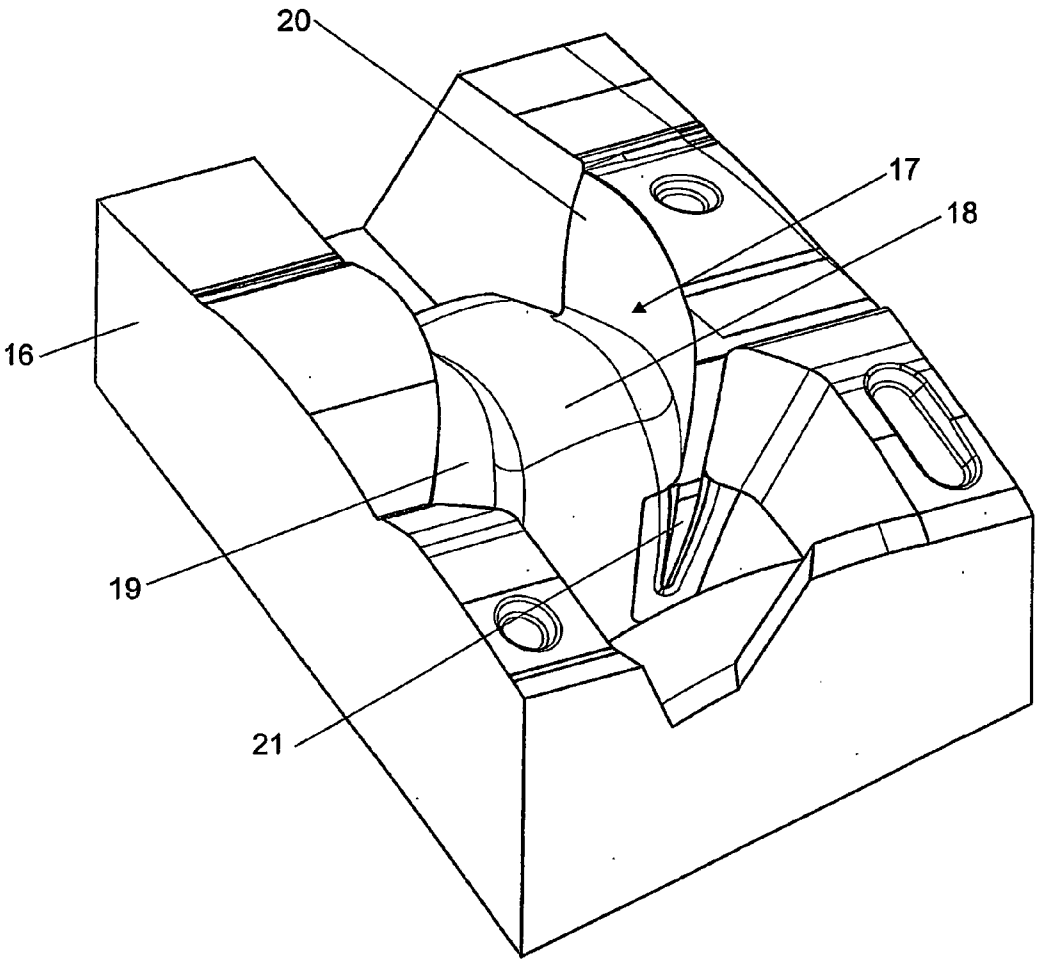
**Publication Classification**

(51) **Int. Cl.**[7] ..... **B22D 19/08**

(52) **U.S. Cl.** ..... **164/98**; 164/112

(57) **ABSTRACT**

A process for forming a cast product or component, including one or more parts having a passage or cavity on at least one side such as a stator or rotor from aluminium or magnesium alloy, comprises supporting one or more preformed insert or inserts for example stainless steel in association with a mould part or parts which define(s) the passage or cavities during the casting process, surrounding the mould part(s) with one or more other mould parts which define the balance of the product or component shape, filling the mould with molten material, and allowing the product to cool and removing the mould parts to leave the cast product with the preformed inserts cast in situ as an integral part or parts of the cast product or component. Typically the process is a sand casting process. Typically the preformed insert(s) are formed of a stronger or more wear-resistant material than the material from which the balance of the product is cast, such as stainless steel.



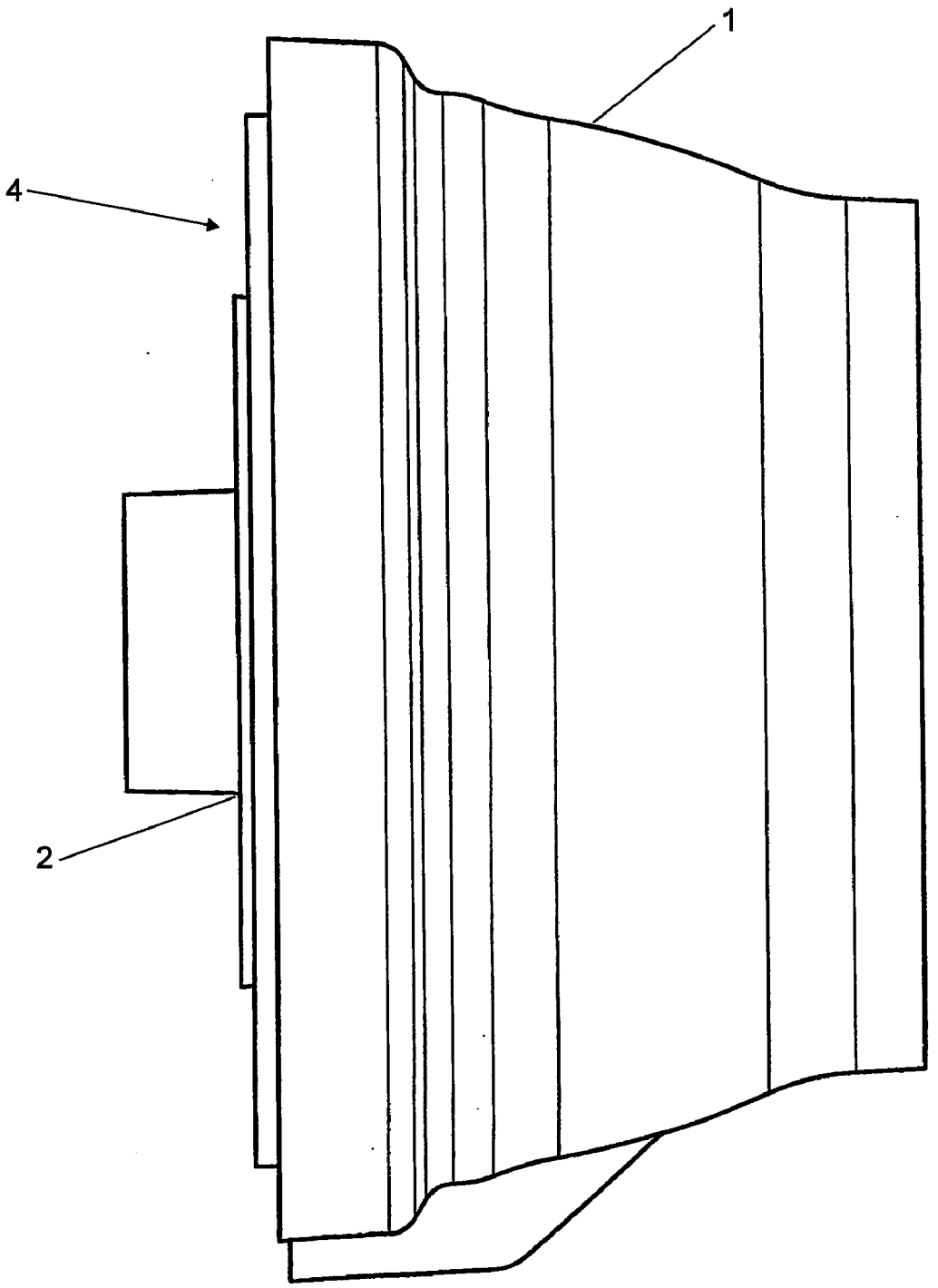



FIGURE 1

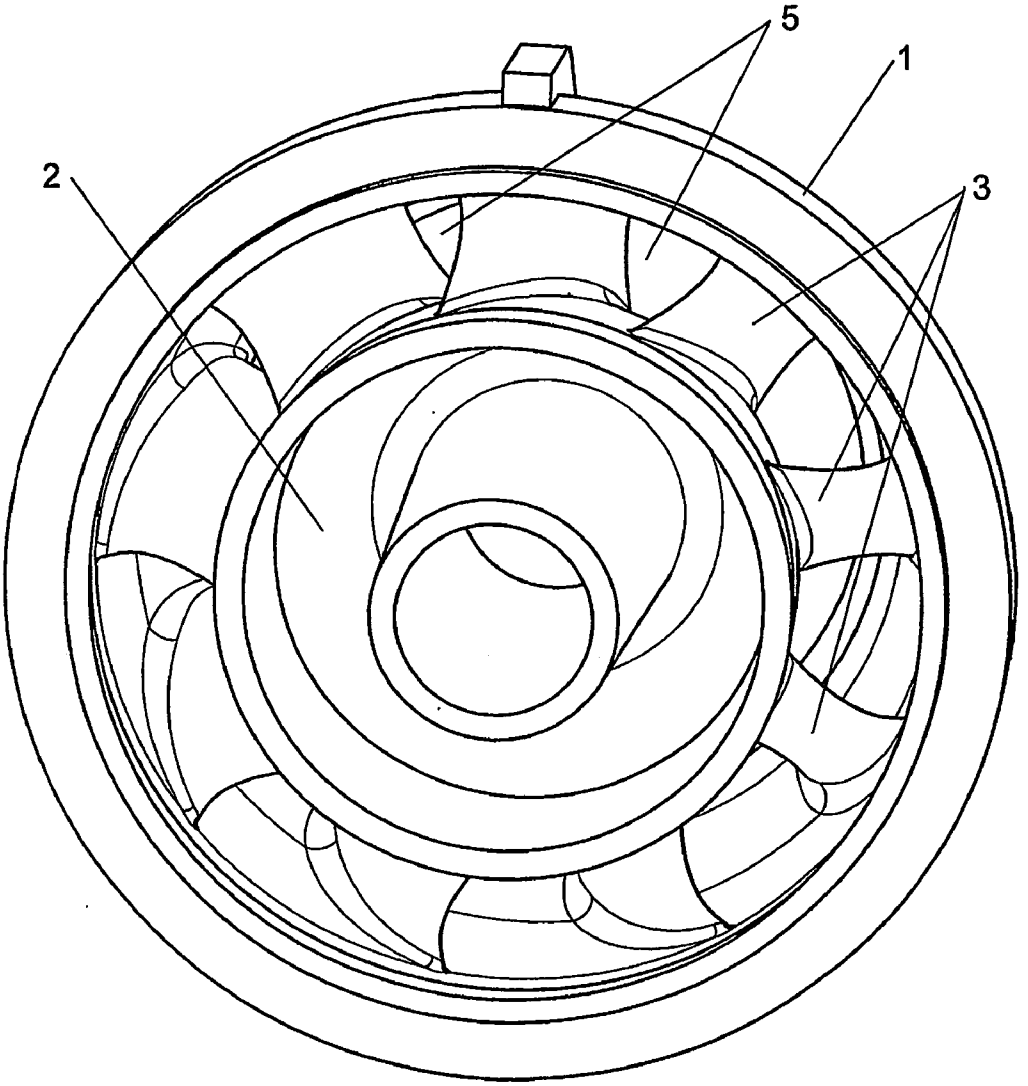



FIGURE 2

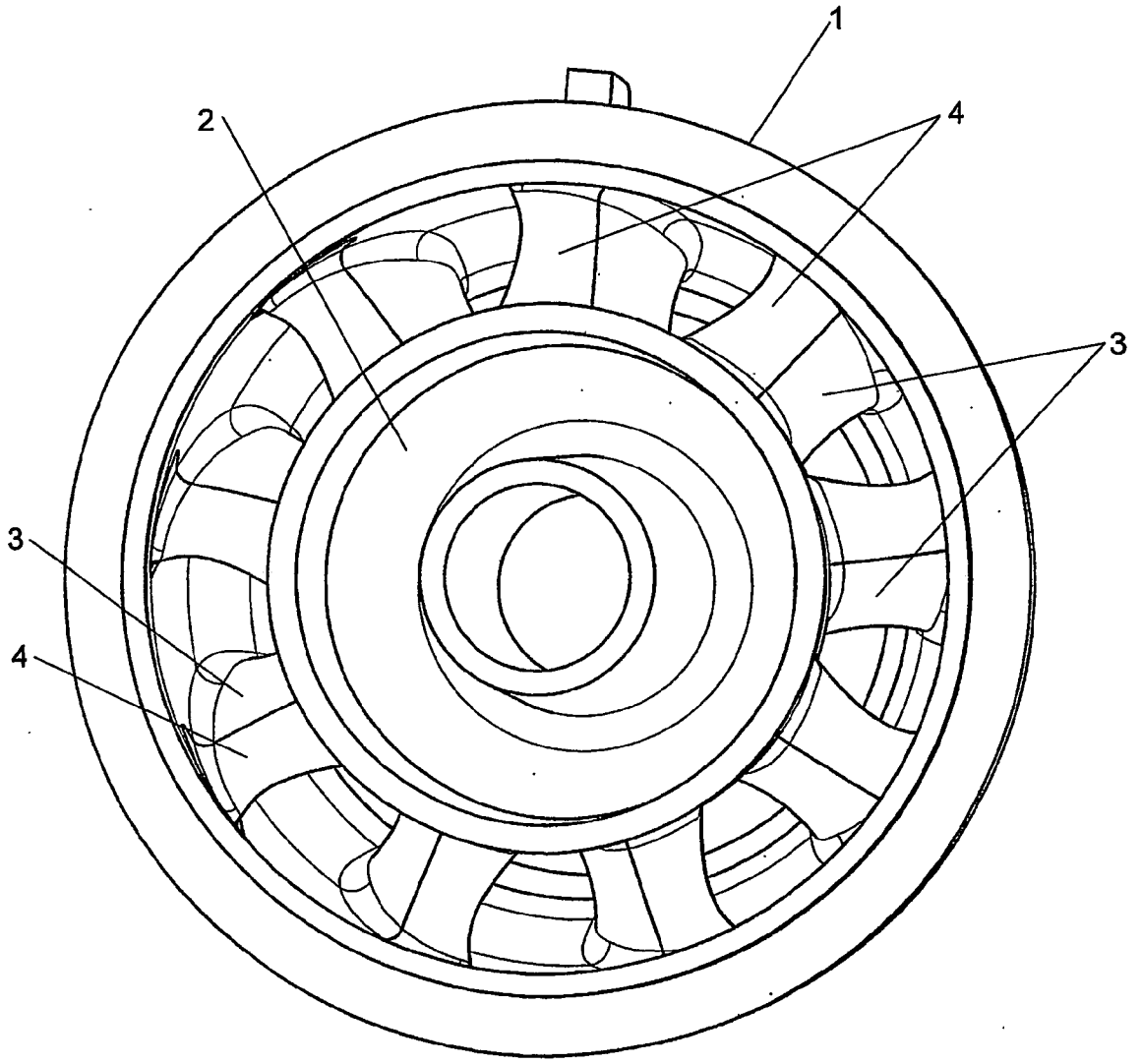



FIGURE 3

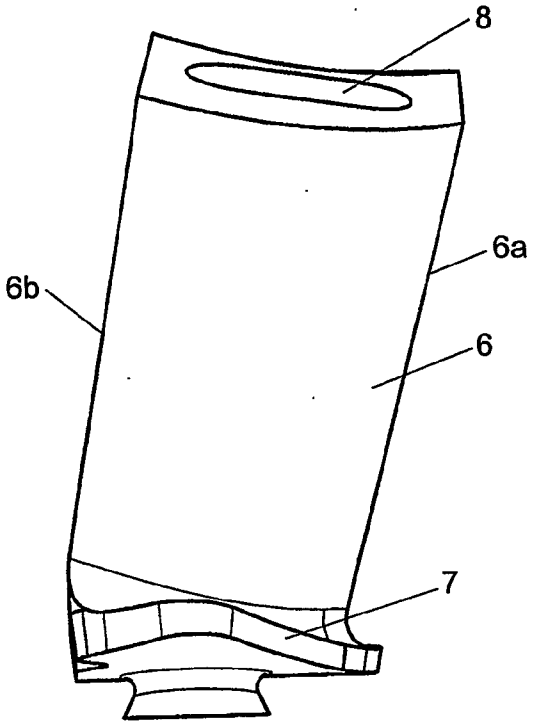



FIGURE 4A

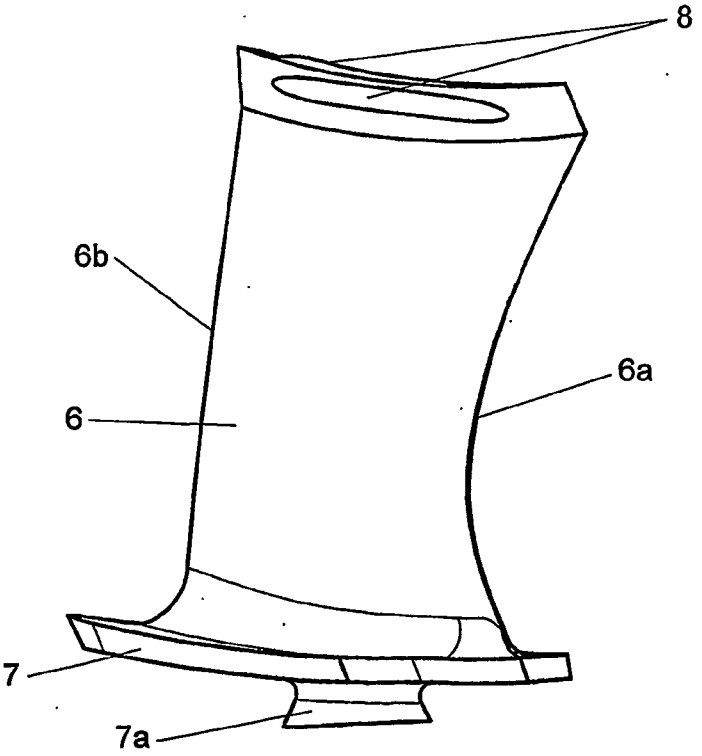



FIGURE 4B

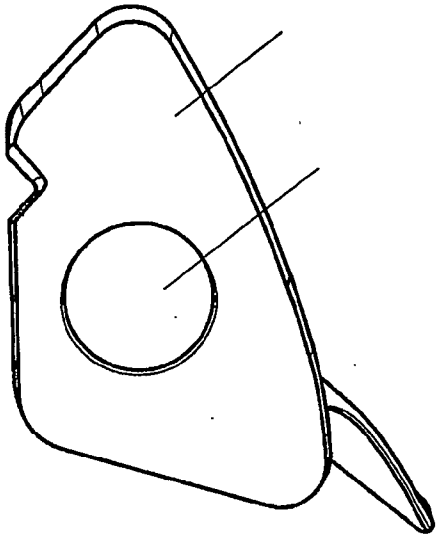


FIGURE 4C

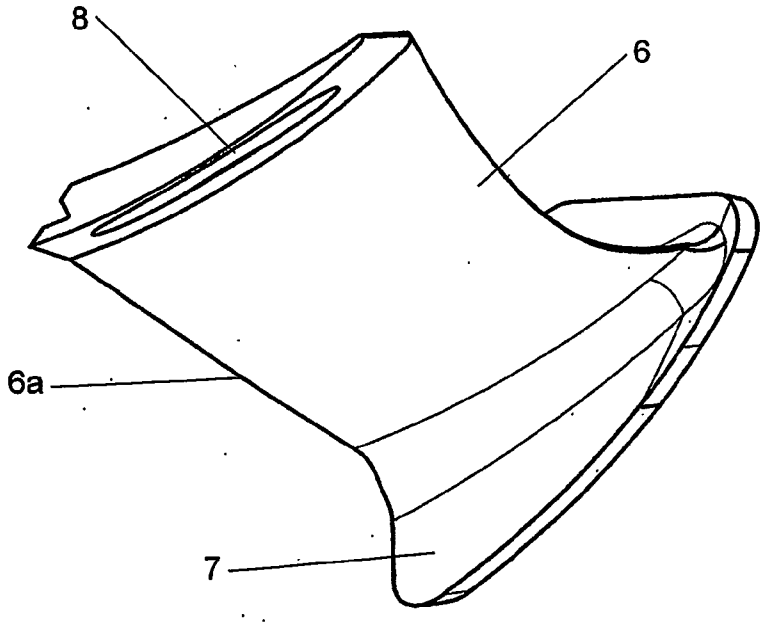



FIGURE 4D

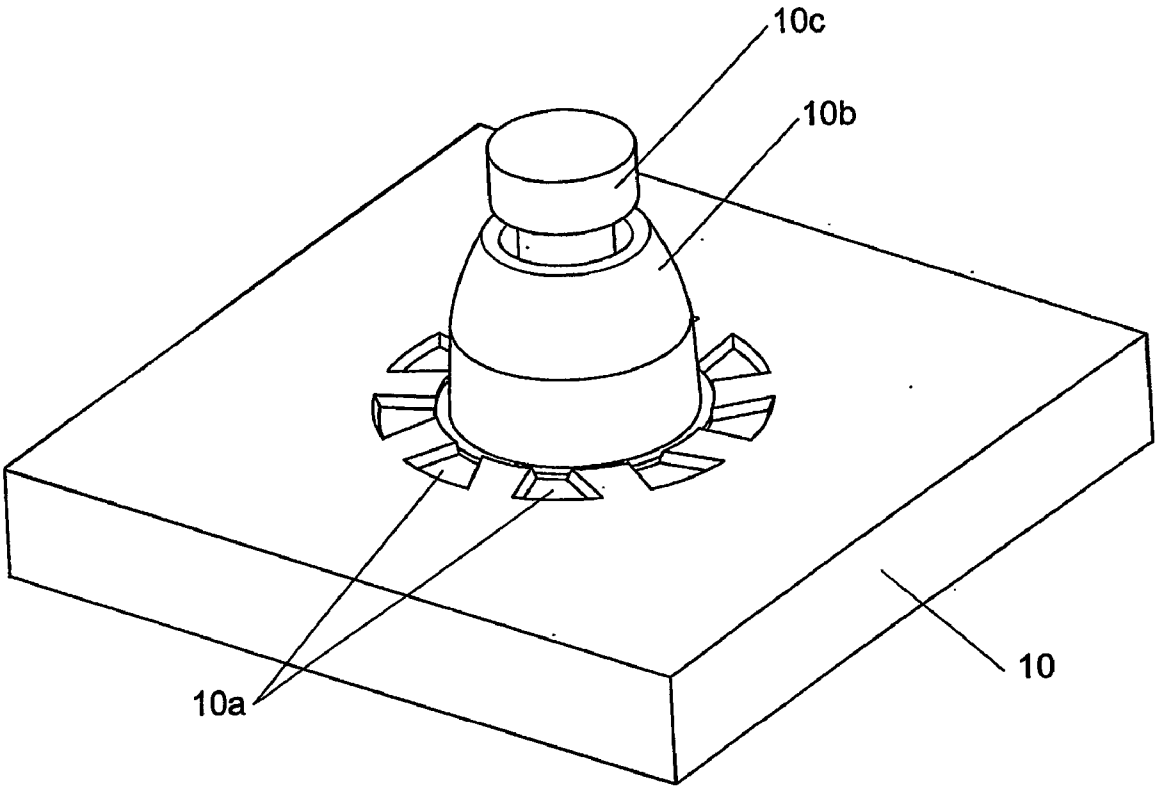



FIGURE 5

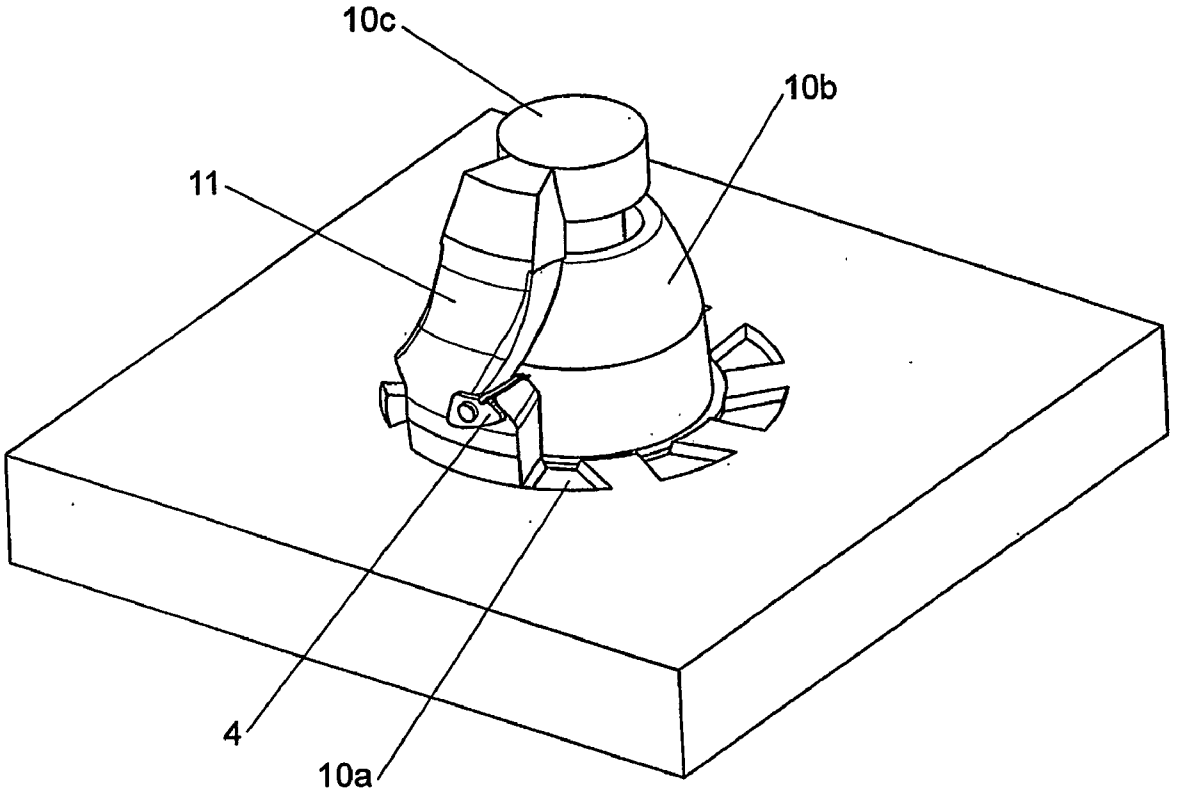



FIGURE 6

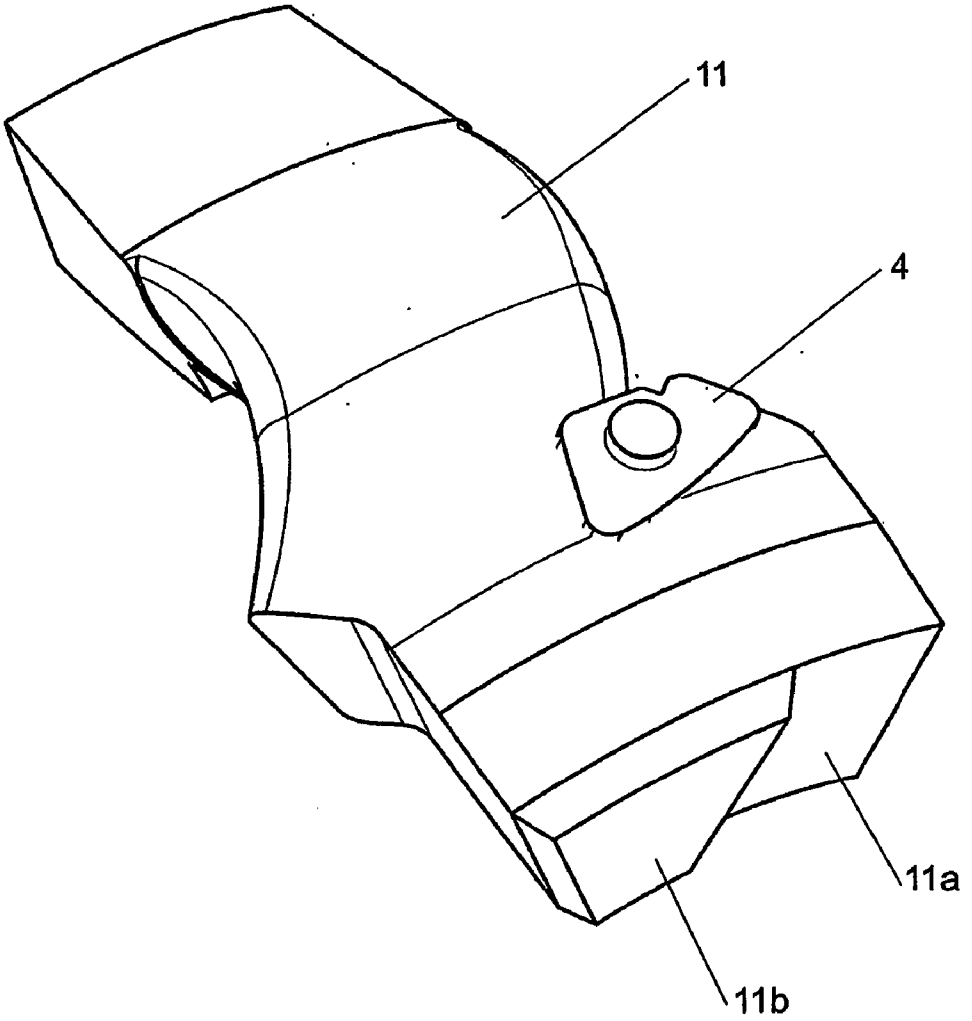



FIGURE 7

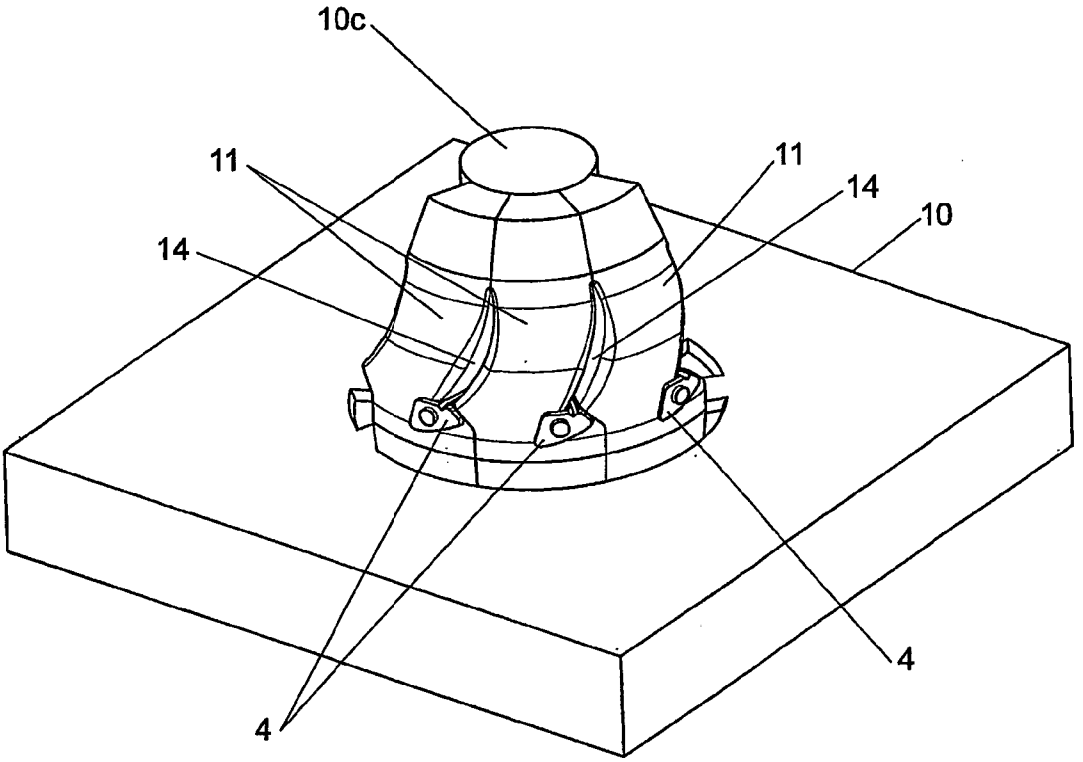



**FIGURE 8**

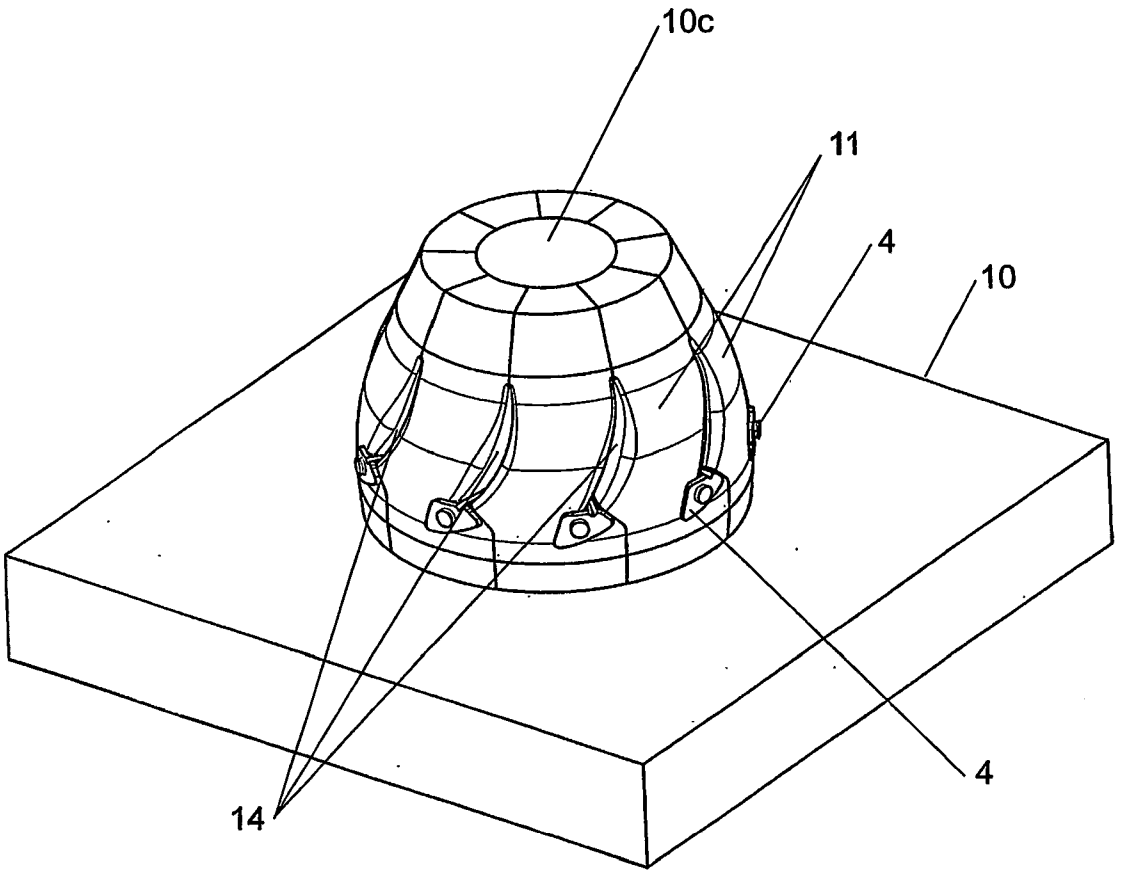



FIGURE 9

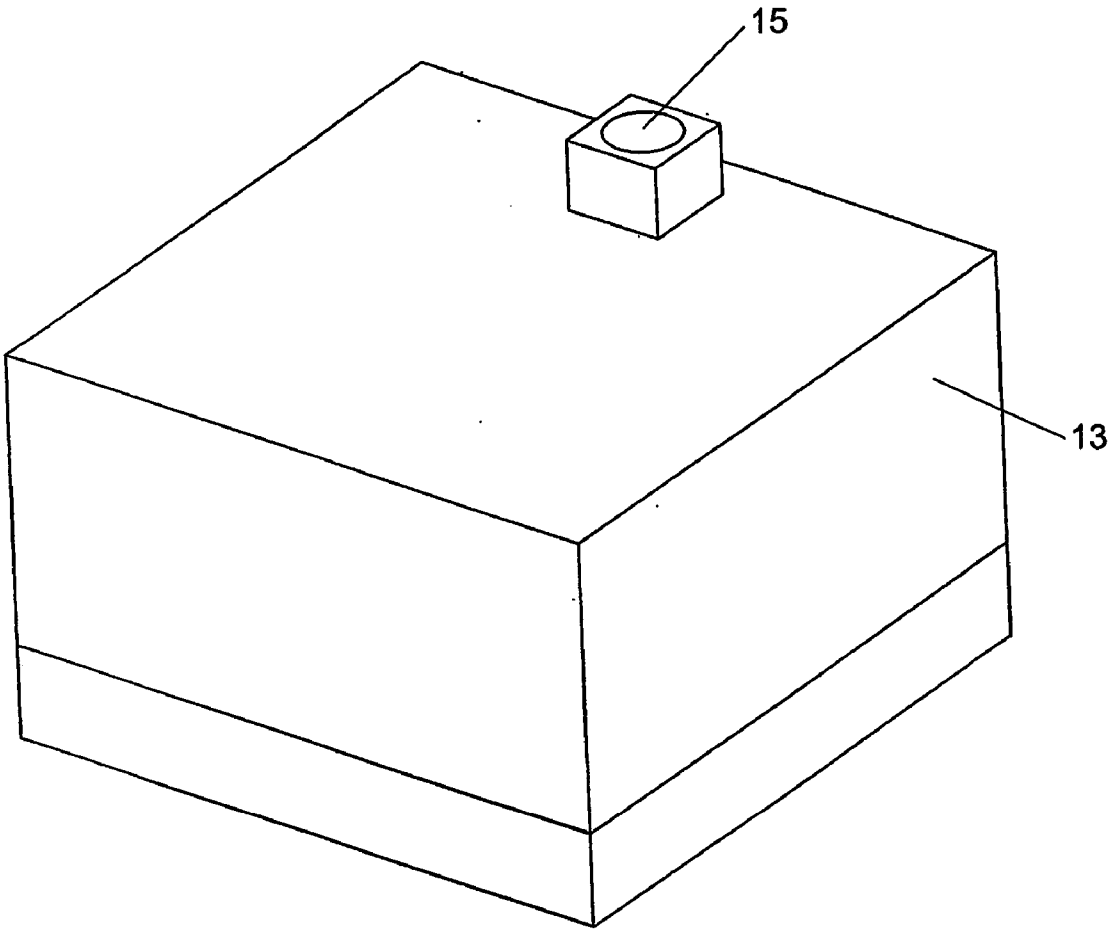



FIGURE 10

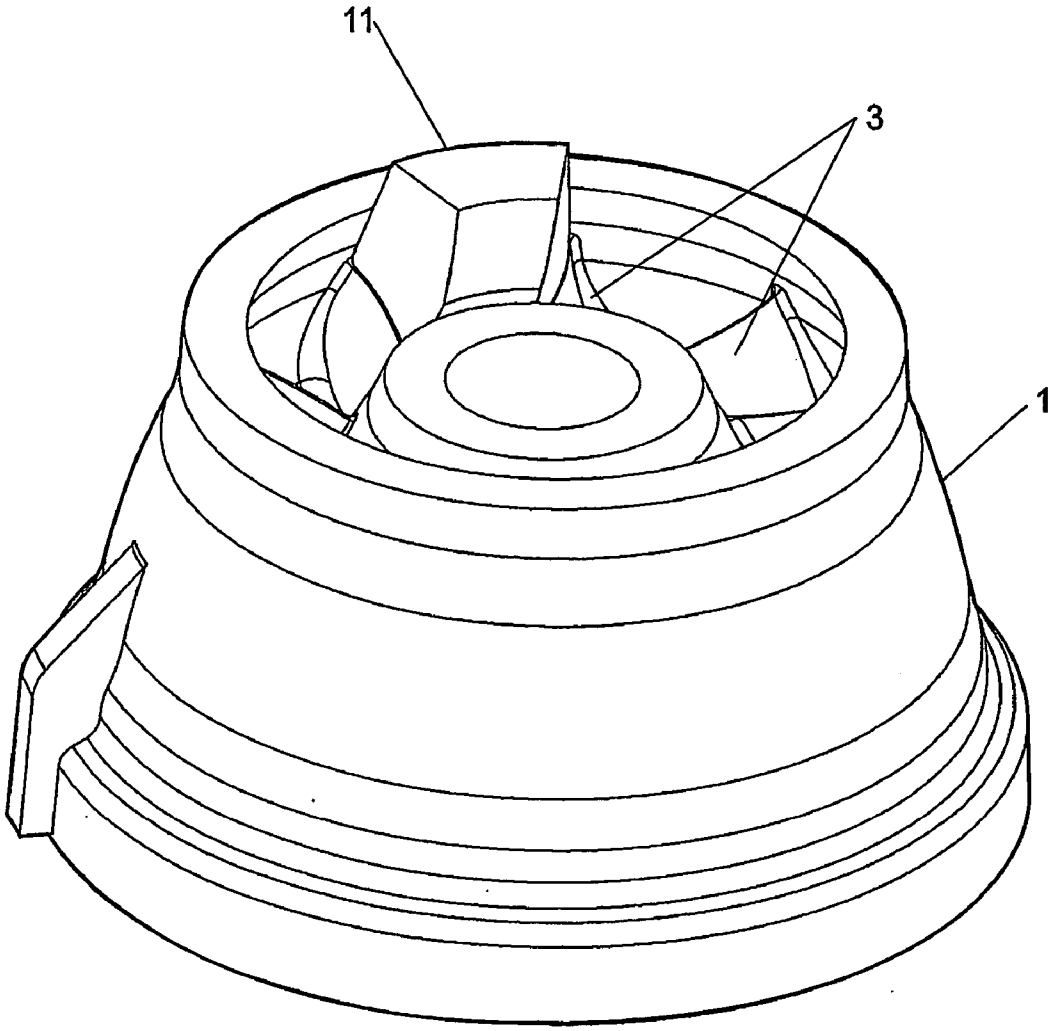



FIGURE 11

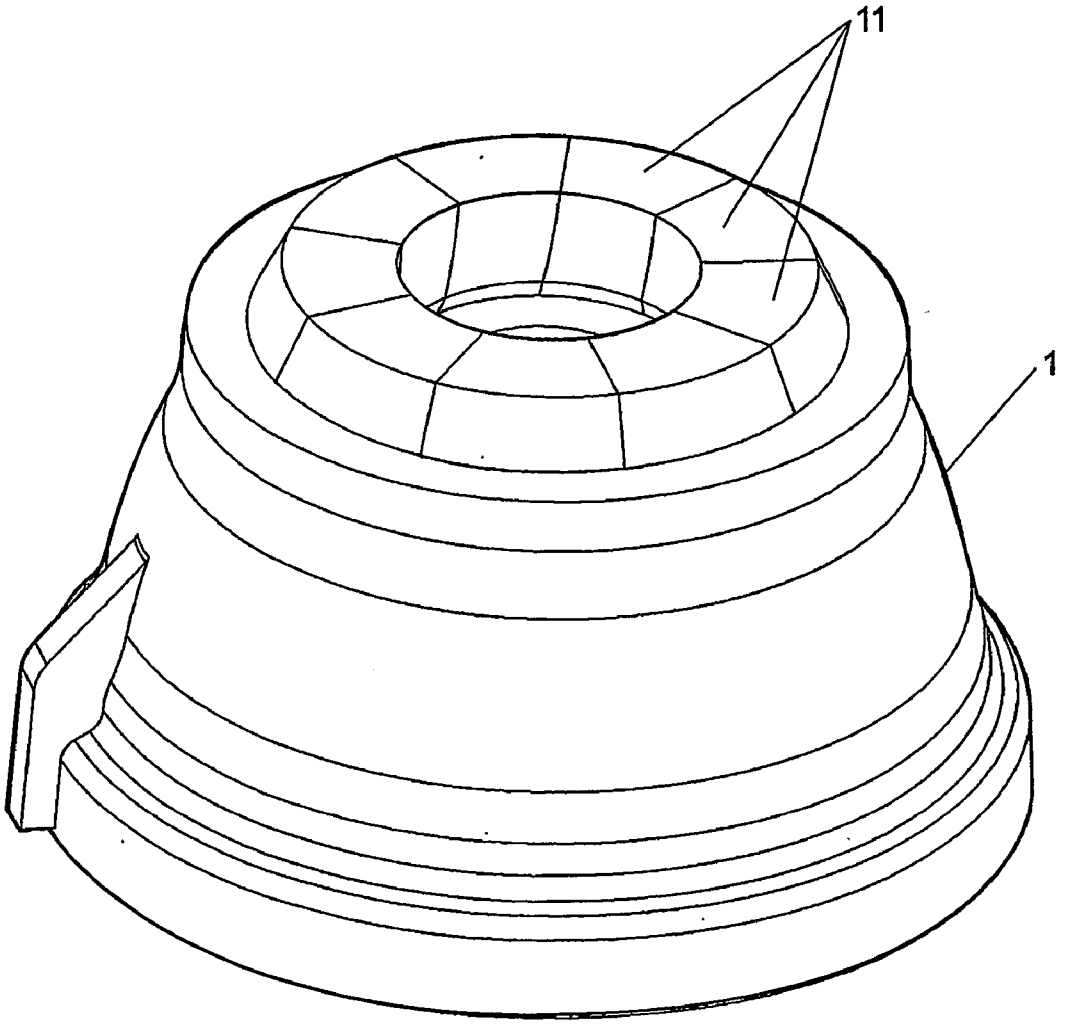



FIGURE 12

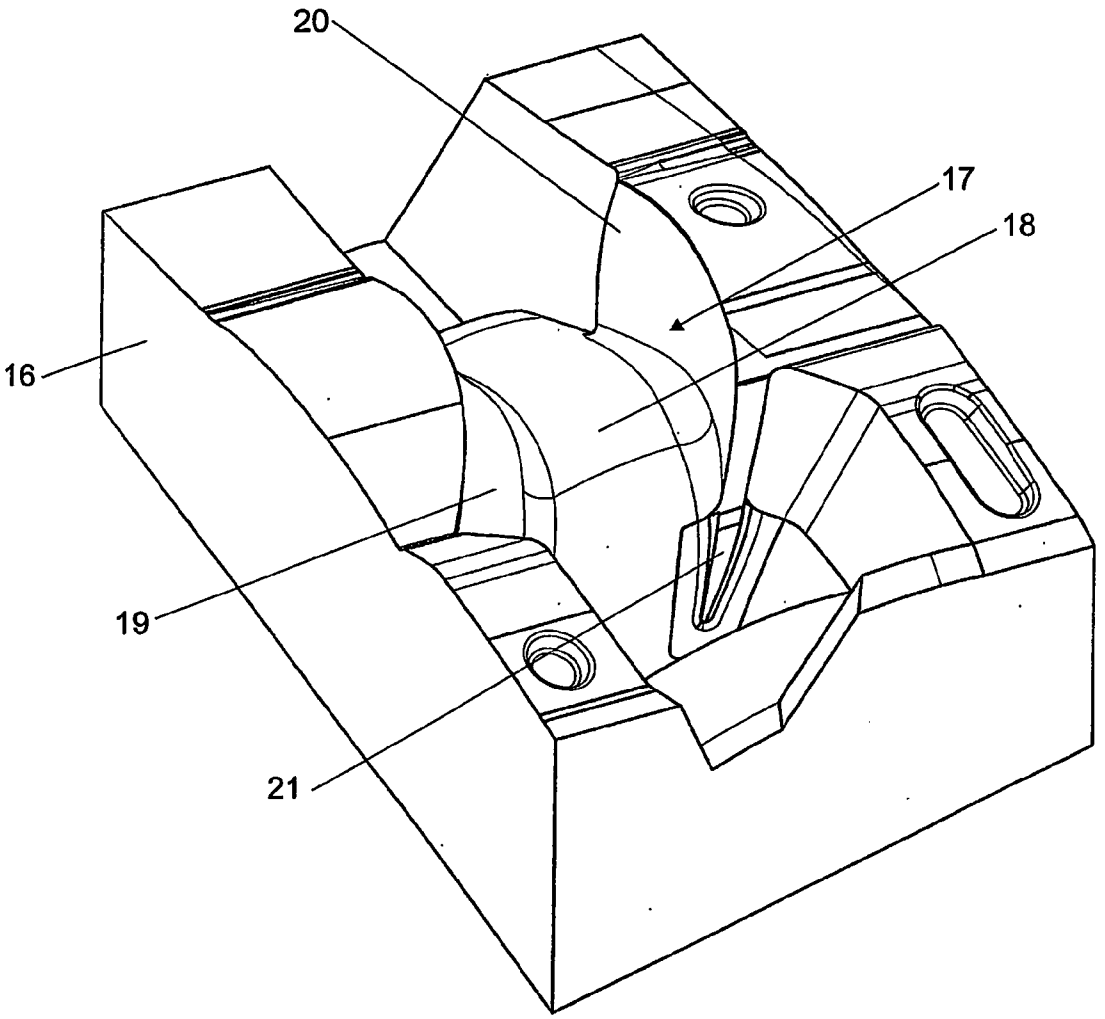



FIGURE 13

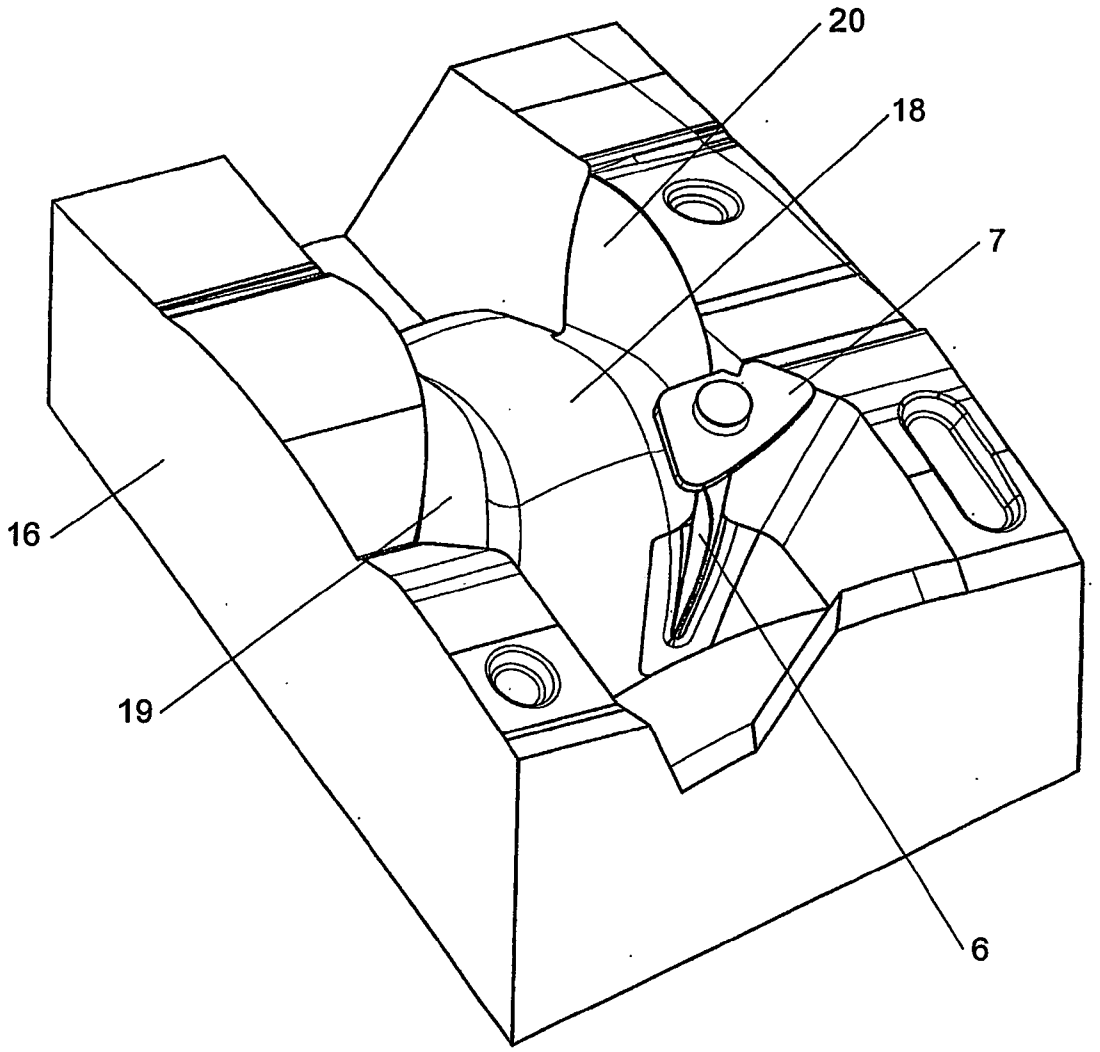



FIGURE 14

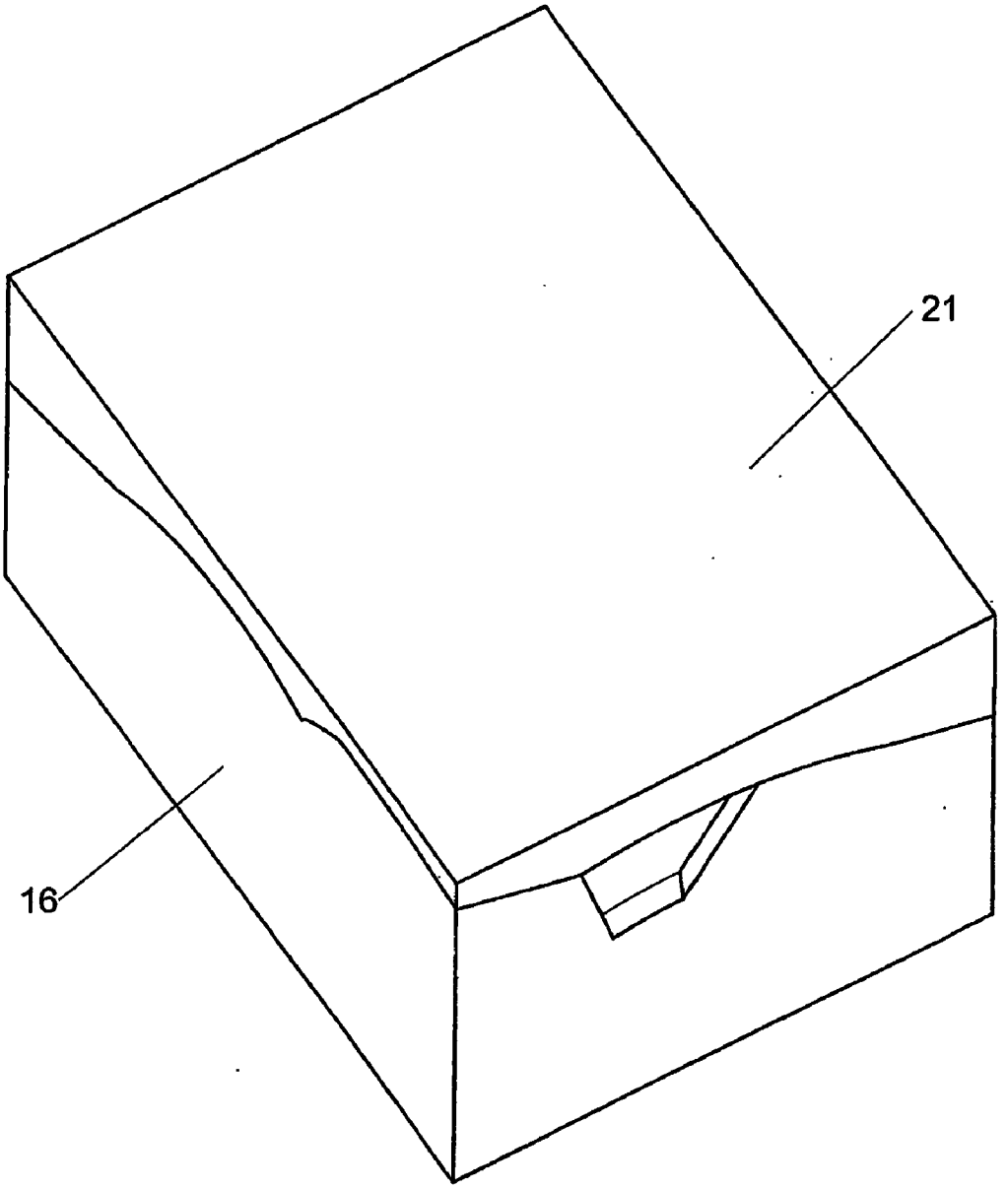



FIGURE 15

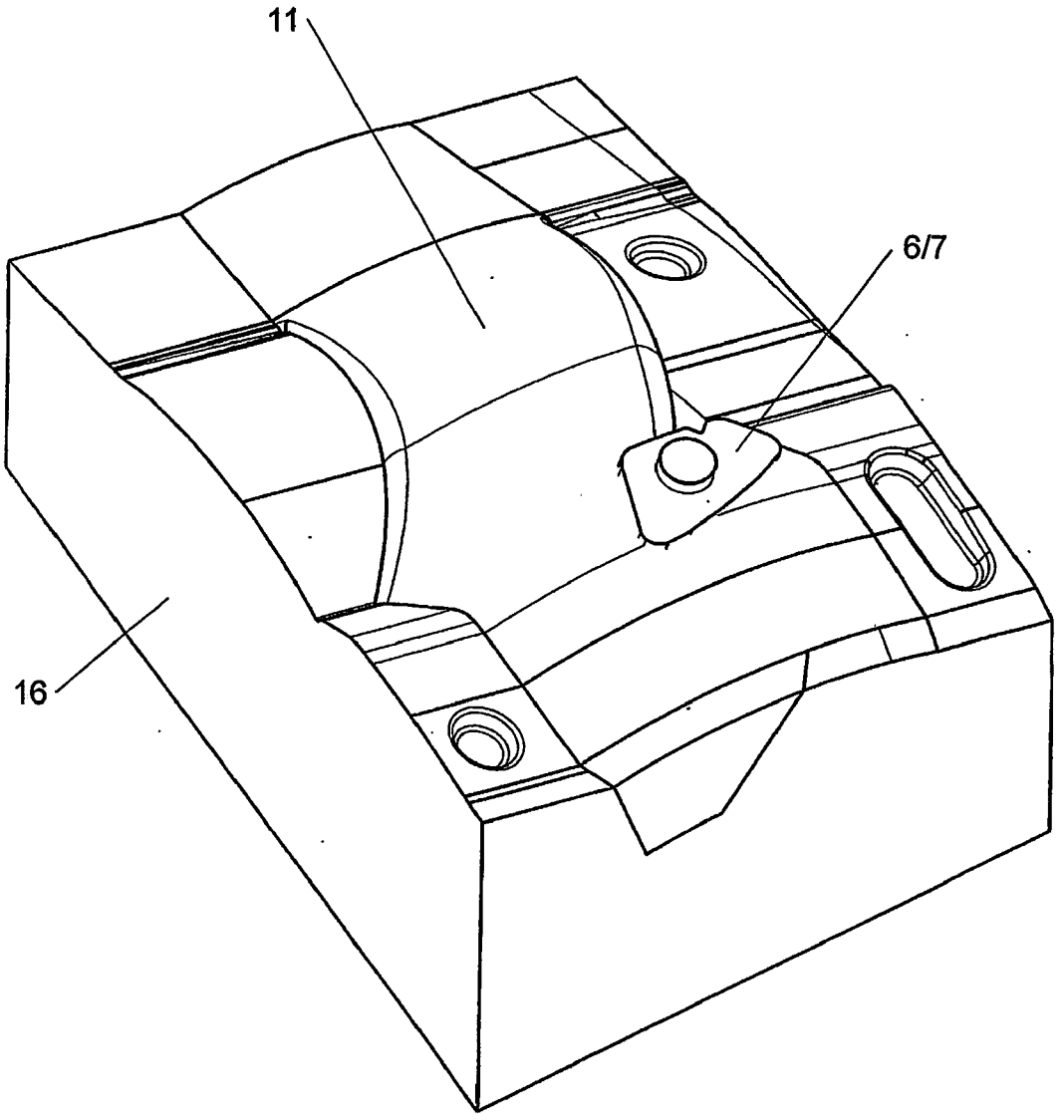



FIGURE 16

# CASTING PROCESS AND CAST PRODUCT

## FIELD OF INVENTION

[0001] The invention comprises a casting process for forming a cast product from one material incorporating preformed inserts of another material, and a cast product incorporating inserts within the cast product of a different material which are integral in the finished product.

## BACKGROUND

[0002] Casting processes such as sand casting are well known and commonly used in industry for forming a wide range of products and product components for numerous applications. Without intending to be limiting, many of the components of water jet propulsions systems for watercraft are produced by casting, typically from aluminium or an aluminium alloy.

## SUMMARY OF INVENTION

[0003] In a first aspect the invention comprises a process for forming a cast production component, including one or more parts having a passage or cavity on at least one side, comprising supporting a preformed insert or inserts in association with a mould part or parts which define(s) the passage or cavities during the casting process, surrounding the mould part(s) with one or more other mould parts which define the balance of the product or component shape, filling the mould with molten material, and allowing the product to cool and removing the mould parts to leave the cast product with the preformed inserts cast in situ as an integral part or parts of the cast product or component.

[0004] In broad terms in another aspect the invention comprises a cast product including one or more parts having a passage or cavity on at least one side, at least a portion of which part(s) are formed by a preformed insert or inserts about which the balance of the production component has been cast.

[0005] The part or parts of the cast product or component (hereinafter: product) of which at least a portion is formed by a preformed insert may be one or more vanes, blades, ribs, or wall sections for example. A portion such as a leading edge, trailing edge, or a central portion of the part(s) may comprise a preformed insert of a stronger or more wear resistant material than the material from which the balance of the product is cast. For example the preformed inserts may be formed from stainless steel while the balance of the product is cast from aluminum or an aluminium alloy (or any other material such as magnesium or a magnesium alloy for example).

[0006] The parts such as vanes, blades, ribs or wall sections may have a passage or cavity on one or both sides. For example in a stator or rotor component the parts may be vanes or blades of the stator or rotor, on either side of which fluid flows in use. The leading edge for example, or a greater part of the stator or rotor vane or blade, may be formed from stainless steel, in a body of the stator or rotor which is otherwise cast from aluminium or aluminium alloy. The leading edge for example will thus be formed of a more wear resistant material. Alternatively a center part of a stator or rotor vane or blade may be formed of a preformed stainless steel component to give the stator or rotor blade increased strength. The product need not necessarily be a product in which vanes or blades radiate from a center core as in a stator or rotor, but may comprise vanes, blades, ribs or the leading edges of corner wall sections, which extend in the finished product generally parallel to each other, across a fluid flow for example. Corner wall sections or similar may have a passage on one side through which fluid flows, or cavity, vanes or ribs may have a passage on both sides. For example it may be desired to incorporate in a cast product a harder insert at the corner of an internal passage around which fluid passes in use, and which is prone to wear or corrosion damage or similar. Numerous variations of products may be formed by the process of the invention are possible.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The process and a product of the invention are described with reference to the accompanying drawings, by way of example and without intending to be limiting, in which:

[0008] **FIG. 1** is a side view of a stator component,

[0009] **FIG. 2** is a view from one end of a conventionally cast stator component, in the direction of arrow A in **FIG. 1**,

[0010] **FIG. 3** is a view similar to **FIG. 2** but of a stator component of the invention,

[0011] **FIGS. 4***a* to *d* are views from different angles of one of the preferred form stainless steel inserts, which are preformed and incorporated into the stator of **FIG. 3** during casting,

[0012] FIGS. **5** to **10** show mould parts and illustrate the casting process of the invention,

[0013] **FIG. 11** is a view of a cast stator component with a single mould core insert part unremoved,

[0014] **FIG. 12** is a view of the cast stator component similar to **FIG. 11** but with all of the mould core insert parts unremoved, and

[0015] FIGS. **13** to **16** show forming of a core insert mould part carrying a preformed stainless steel insert.

## DETAILED DESCRIPTION OF PREFERRED FORM

[0016] The casting process of the invention is described in detail with reference to the casting of a stator component, by way of example only and as previously indicated the process of the invention may be used to form a wide range of cast products and components.

[0017] Referring to FIGS. **1** to **3**, and also **FIGS. 11 and 12**, the stator component comprises a generally tapered cylindrical body having external wall **1** and a center part **2** which are joined by a series of radial vanes **3**. Passages **5** pass through the stator between the angled vanes **3**. Conventionally the stator component is entirely formed by casting from a material such as aluminium or aluminium alloy for example.

[0018] **FIG. 3** shows a product of the invention, which is a stator similar to that of **FIG. 2** except that the leading edge of each vane **3** is formed from stainless steel. Each stator vane **4** is formed partly by a stainless steel insert **6**, which

is preformed and incorporated in the product during the casting process so as to be an integral part of the final product.

[0019] A single preformed insert **6** is shown in more detail in **FIGS. 4***a* to **4***d*. The insert forms the leading edge of a vane **4**. The forward edge **6***a* of the insert **6** forms the tip of the leading edge of the stator vane, and a rear edge **6***b* abuts so as to be flush and integral with the balance of the vane which is formed from aluminium alloy during the casting process. In the preferred form the particular preformed leading edge vane insert shown has a base **7** incorporating protrusion **7***a*, which is surrounded by cast material during the casting process so that the top surface of the base **7** is flush with the interior surface of the stator. At its other end the preformed insert has grooves **8** to assist in fixing the other end of the preformed component in the cast material. The preformed insert is shown by way of example only and could be of any desired shape for any desired application, such as a corner shaped insert for example. Where a preformed insert has height as shown, at its either end it may comprise a base **7** and optionally a protrusion **7***a*, ribs or depressions **8**, or any other irregularity or means for fixing the preformed component so that in the finished cast product the preformed insert is an integral part of the product.

[0020] In relation to water jet propulsion systems it is well known that the leading edges of the vanes of the tail pipe stator are prone to damage from cavitation, abrasion, and galvanic corrosion, and that it is necessary to inspect, repair, and if necessary replace the tail pipe stators of water jet propulsion systems periodically. A tail pipe stator of the invention formed as described with stainless steel inserts will have substantially greater life due to the increased wear resistance and resistance to galvanic corrosion of the stainless steel leading edges of the stator vanes. Similar advantages are likely to be obtained with product or components for other applications which are cast by the process of the invention, with an insert or inserts formed of a different material having different wear characteristics or other desirable properties for the particular application, relative to the material from which the balance of the component is cast.

[0021] The casting process of the invention as applied to forming the stator of **FIG. 3** is illustrated by FIGS. **5** to **12**. As is conventional, the stator component is cast using a number of mould components which define the external and internal shapes including internal passages of the stator component, which are formed of sand in a sand casting process. **FIG. 5** shows a base mould part **10**. Portions **10***b* and **10***c* of the mould base part **10** define the shape of the center **2** of the stator. A number of core insert mould parts **11**, one of which is shown in **FIG. 7**, and which are formed from sand if the product is to be formed using sand casting, are assembled together on the base component as shown in **FIGS. 6, 8** and **9**. Each of the core insert part **11** defines the passage space between two vanes during the casting process. A number of the core insert parts **11** are mounted on the mould base **10** in assembly of the mould—**FIG. 6** shows a first core insert part **1** in position on the mould base **10**, **FIG. 8** shows three core insert parts **1** in position, and **FIG. 9** shows all of the core inserts in position on the mould base part. The way in which the core insert parts define the passages between the vanes in the finished stator product is illustrated by **FIG. 11** which shows a cast stator with a single core insert part unremoved (before breaking out of the final core insert part), and **FIG. 12** which shows a cast stator with all of the core insert parts in situ, before breaking out of the core inserts.

[0022] When the mould is assembled before filling the mould with molten material to carry out the casting process, one of the preformed stainless steel inserts **6** is carried by each core insert part **11**, as shown, so that each core insert part **11** holds a preformed stainless steel insert **6** in the correct position during casting, when the cavities between the mould base **10** mould top **13**—see **FIG. 10**, and core insert part **11** of the mould are filled with molten material. It is apparent from **FIGS. 8 and 9** how the core insert parts **11** when assembled together each carry a preformed insert **6** in the correct position around the mould from the center of the mould, so that in the finished cast product the preformed inserts will form the leading edges of the radiating stator vanes. Referring to **FIGS. 8 and 9**, the shaped spaces **14** between each two adjacent mould insert parts **11** form the stator vanes, with the preformed stainless steel inserts as the leading edges thereof.

[0023] In the preferred form the mould base **10** includes recesses **10***a* into which protrusions **11***b* on the bottom end **11***a* of the core inserts **11** fit to assist in retaining the core insert parts **11** in position on the mould base **10**. After all of the core inserts have been put in position as shown in **FIG. 9**, the top part **13** of the mould is placed over the mould base and core inserts, as shown in **FIG. 10**. Beneath the mould top part **13** and exterior surfaces of the assembled core insert part **11** is defined the cavity which forms the outer tapered circular wall section **1** of the stator.

[0024] The mould is then filled with molten material, through port **15** for example, the molten material is allowed to cool, and the mould is disassembled, in a sand casting process by breaking the mould components away from around the cooled stator product formed by the casting process. The core inserts parts **11** are removed, and in the finished cast product the preformed inserts **6** will form the leading edges of the stator vanes **3** as shown in **FIG. 3**.

[0025] FIGS. **13** to **16** show how, in the preferred form, the sand core insert mould parts **11** are formed around the preformed stainless steel inserts **6** so as to carry the inserts during the moulding process, until the sand core inserts **11** are broken away from around the cooled stator product formed by the casting process. Each sand core insert mould part **11** is formed in a mould **16** having an internal cavity **17**, which generally comprises a base surface **16** and side walls **17** and **19**. In the preferred form, in forming the core insert **11** a preformed stainless steel insert **6** is first inserted into the mould **16**, as shown in **FIG. 14**. The end of the insert **6** opposite the base **7** engages into a complementary shaped slot **21** in the base surface **16** of the insert mould to hold the preformed insert **6** in position while the mould **16** is filled with sand and binder to form the core insert, and the base **7** of the insert **6** similarly engages into the underside of the top **21** of the mould. The top **21** which has a suitably shaped undersurface to complete the interior surfaces of the mould cavity, is placed on the mould **16** as shown and the mould is filled with sand and binder. **FIG. 16** shows a core insert **11** in the mould **16** after removal of the mould top **21** and prior to removal of the core insert **11** from the mould. Referring to the description of the casting process of the invention as applied to forming a stator as described above,

prior to assembly of the stator mould parts the required number of sand core inserts **11** are formed as described immediately above with reference to FIGS. **13** to **16**.

[**0026**] Because the core insert parts **11** are formed around the stainless steel preformed inserts **6**, they hold the preformed inserts in the correct position and securely during the casting process. Subsequently in disassembly of the mould the core insert parts **11** are broken away from within the cast product, leaving the stainless steel inserts, now an integral part of the cast product, behind. In an alternative arrangement, it is possible that the preformed inserts **6** may simply be slotted or placed into mould parts which hold the preformed parts during the casting process, rather than the mould parts (such as the core inserts **11**) being first formed around the preformed inserts (stainless steel inserts **6**) as described.

[**0027**] The foregoing describes the process of the invention in the application of forming a cast stator component, in which the preformed inserts form the leading edges of the stator vanes, by way of example only and as previously indicated the process of the invention may be used to form a wide range of products or components in which it is desired to provide inserts of a different material having different properties for any desired reason such as to obtain increased resistance to wear, corrosion, or similar for part of the cast product.

[**0028**] The foregoing describes the invention including a preferred form thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated in the scope thereof as defined in the accompanying claims.

**1**. (canceled)
**2**. (canceled)
**3**. (canceled)
**4**. (canceled)
**5**. (canceled)
**6**. (canceled)
**7**. (canceled)
**8**. (canceled)
**9**. (canceled)
**10**. (canceled)
**11**. (canceled)
**12**. (canceled)
**13**. (canceled)

**14**. A process for forming a cast stator or rotor component, which includes a number of radially extending vanes or blades, comprising supporting preformed inserts, each of which in the cast stator or rotor component will form a leading portion of a vane or blade of the rotor or stator component, in association with a mould part or parts which define(s) passages between the vanes or blades during the casting process, surrounding the mould part(s) with one or more other mould parts which define the balance of the stator or rotor component shape, filling the mould with molten material, and allowing the molten material to cool and removing the mould parts to leave the cast stator or rotor component with each preformed insert cast in situ as an integral leading portion of a vane or blade with a trailing portion of the vane or blade being formed of the material from which the balance of the stator or rotor component is cast, said preformed inserts being formed of a stronger or more wear-resistant material than the material from which the balance of the product is cast.

**15**. A process according to claim 14 wherein at least some of said mould parts are formed of sand by sand casting.

**16**. A process according to claim 15 wherein the preformed inserts are formed from stainless steel.

**17**. A process according to claim 16 wherein the balance of the stator or rotor is cast from a metal selected from the group consisting of aluminum, an aluminum alloy, magnesium, and a magnesium alloy.

**18**. A process according to claim 14 wherein the stator or rotor component is a stator component which comprises a center part, a generally cylindrical body around the center part, and a series of said vanes spaced around the center part and extending radially from the center part to the cylindrical body.

**19**. A process according to claim 18 wherein the preformed inserts extend the length of the vanes in a radial direction and include an enlarged end at either end of the preformed inserts, which enlarged ends are surrounded by the material of the balance of the stator during casting of the product.

**20**. A process according to claim 19 including the steps of positioning the preformed inserts in a mould base, positioning one or more core insert parts of the mould in association with the mould base and so as to hold or assist in holding the preformed inserts in position, and fitting a mould top part to the mould.

**21**. A process according to claim 20 including positioning the preformed inserts in the mould base by fitting the preformed inserts into one or more recesses in the mould base.

**22**. A stator or rotor including a number of radially extending vanes or blades, the leading portions of which are formed by preformed inserts about which a trailing portion of each of the vanes or blades and the balance of stator or rotor have been cast, the preformed inserts being formed of a stronger or more wear-resistant material than the material from which the trailing portions of the vanes or blades and balance of the stator or rotor has been cast.

**23**. A stator or rotor according to claim 22 wherein the preformed inserts are formed from stainless steel.

**24**. A stator or rotor according to claim 23 wherein the balance of the stator or rotor is cast from a metal selected from the group consisting of aluminum, an aluminum alloy, magnesium, and a magnesium alloy.

**25**. A stator according to claim 24 which comprises a center part, a generally cylindrical body around the center part, and a series of said vanes spaced around the center part and extending radially from the center part to the cylindrical body.

**26**. A stator according to claim 22 wherein the preformed inserts extend the length of the vanes in a radial direction and include an enlarged end at either end of the preformed inserts which enlarged ends are surrounded by the material of the balance of the stator during casting of the product.

* * * * *