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Declarations under Rule 4.17:

— as to the identity of the inventor (Rule 4.17(i))

[Continued on next page]

(54) Title: MODULAR WATER PUMP

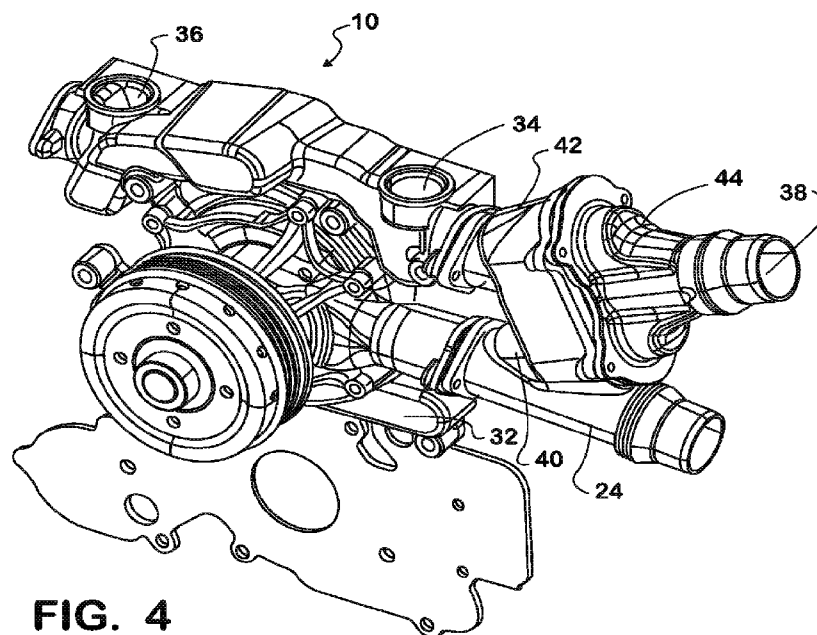


FIG. 4

(57) Abstract: A water pump apparatus is provided having a plurality of modular components, which allows for construction of various configurations of the water pump apparatus depending on specific vehicle requirements. The water pump apparatus modular components include a pump housing with a fluid chamber formed therein, a bearing housing for attachment to the pump housing, and a thermostat housing for connecting to the bearing housing and the pump housing. A method for forming modular components for assembling a water pump apparatus for use in an internal combustion engine is also provided.



— *as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

MODULAR WATER PUMP

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a water pump apparatus for an internal combustion engine. Particularly, the present invention provides a modular water pump apparatus with interchangeable modular components.

BACKGROUND OF THE INVENTION

[0002] Internal combustion engines include a massive engine block within which the engine cylinders are formed. Typically, the block is water cooled by means of forming passageways through the block and pumping coolant liquid through the passageways. Usually, the coolant is formed of a mixture of water and anti-freeze additive and the like.

[0003] In conventional engines, a water pump is mounted on brackets, which are in turn mounted either upon the engine or more usually, within the engine compartment of the vehicle. These water pumps generally comprise a rotating impeller mounted upon a shaft which also carries a drive wheel. The drive wheel is located outside of the pump housing for connection to a suitable belt, chain or gear drive, which is connected to a power source. The impeller is sealed within the pump housing. Inlet and outlet openings are formed in the pump housing and suitable hoses or tubing connect these openings to the engine block coolant passageways. Thus, coolant liquid or water flow into the pump housing and are forced outwardly of the pump housing by the rotating impeller blades to return to the engine block coolant passageways.

[0004] Although modern water pumps are relatively small in size, nevertheless such pumps require space within the engine compartment where space is at a premium. Further, in order to compensate for smaller spaces, and perhaps for simpler assembly or specific vehicle requirements, it may also be desirable to locate the thermostat housing nearer to the water pump. In addition, the manner in which the water pump components are typically constructed may not offer options or alternatives for attachment based on the specific vehicle space and operation requirements.

[0005] Thus, there is a need for a water pump apparatus comprised primarily of modular components, including those relating to a pump housing, a bearing housing and a thermostat housing, having simple and cost-effective construction. There is also a need for a modular water pump apparatus that can be cast from primarily three main die casts, wherein the modular components will provide different water pump configurations and options for

assembly, using the same castings, and based on the desired coolant flow direction and/or engineering requirements of the specific vehicle.

SUMMARY OF THE INVENTION

[0006] There is disclosed herein an improved water pump apparatus and method having modular components, which avoids disadvantages of prior devices, while affording additional structural and operating advantages.

[0007] Generally speaking, a water pump apparatus is disclosed having a plurality of modular components, which allows for construction of various configurations depending on specific vehicle requirements. The water pump apparatus modular components include a pump housing with a fluid chamber formed therein, a bearing housing for attachment to the pump housing, and a thermostat housing for connecting to the bearing housing and the pump housing.

[0008] In an embodiment of the invention, the pump housing includes a front portion and a back portion forming a fluid chamber therein. The bearing housing includes a water inlet. There is a rotational shaft rotatably supported within the bearing housing by a set of bearings, and an impeller fixed to the shaft, wherein the impeller is located within the fluid chamber of the pump housing. A thermostat housing connects with the bearing housing and the pump housing, the thermostat housing being integrally connected to a water inlet passage and a water outlet passage. The bearing housing is interchangeably connected to one of either a right side or a left side of the pump housing.

[0009] In another embodiment of the invention, the water inlet passage of the thermostat housing sealingly connects to the water inlet of the bearing housing, such that the bearing housing and the thermostat housing are interchangeably connected to one of either a right side or a left side of the pump housing.

[0010] In yet another embodiment of the invention, the bearing housing is rotatable about a 180° axis before attachment to the pump housing and subsequently to the thermostat housing.

[0011] In yet another embodiment of the invention, a method for forming modular components for assembling a water pump apparatus for use in an internal combustion engine, is disclosed. The method comprises the steps of forming a modular component casting mold, forming the modular component through introduction of molten material into the casting mold, cooling the molten material for a specific time, removing the cast modular component from the mold, and assembling the modular components into the water pump apparatus.

having one of a right hand assembly or a left hand assembly, the modular components comprising a pump housing, a bearing housing and a thermostat housing.

[0012] These and other aspects of the invention may be understood more readily from the following description and the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] For the purpose of facilitating an understanding of the subject matter sought to be protected, there are illustrated in the accompanying drawings embodiments thereof, from an inspection of which, when considered in connection with the following description, the subject matter sought to be protected, its construction and operation, and many of its advantages should be readily understood and appreciated.

[0014] FIG. 1 is an exploded view of an embodiment of the present invention.

[0015] FIG. 2 is a disassembled view of a left hand configuration of the present invention.

[0016] FIG. 3 is a disassembled view of a right hand configuration of the present invention.

[0017] FIG. 4 is a constructed assembly of the present invention.

[0018] FIG. 5 is a schematic drawing of the method of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] While this invention is susceptible of embodiments in many different forms, there is shown in the drawings and will herein be described in detail a preferred embodiment of the invention with the understanding that the present disclosure is to be considered as an exemplification of the principles of the invention and is not intended to limit the broad aspect of the invention to embodiments illustrated.

[0020] Referring to FIG. 1, there is illustrated an exploded view of a modular water pump apparatus 10 of the present invention. Generally speaking, the water pump apparatus 10 is comprised of three main modular components, including a pump housing 12, a bearing housing 14 and a thermostat housing 16. The modular components, and in particular, the pump housing 12 and the bearing housing 14, can be constructed of any suitable materials, including a die cast aluminum. The thermostat housing 16 may be constructed from any know materials, including an injection molded plastic. The general operation of a water

pump apparatus is well-understood by those skilled in the art and, for the sake of clarity and conciseness, will not be described in greater detail herein.

[0021] Referring to FIGS. 1-4, there are illustrated embodiments of the modular water pump apparatus 10 or portions thereof. The pump housing 12 includes a fluid chamber 12a formed therein. Associated with the pump housing 12 are two lower coolant passages 30 and 32 for passage of coolant from the fluid chamber to the engine (not shown), and two upper coolant passages 34 and 36 for receipt of heated coolant from the engine. Projecting from either side of the pump housing is a flanged opening 34a and 36a, which connects to one of the upper coolant passages, respectively. Depending on the configuration of the water pump apparatus, and the desired direction of coolant flow, a plug 46 may be positioned within either of the flanged openings 34a or 36a. The pump housing 12 is attached to the front of a crankcase cover 10a in a well-known manner.

[0022] A second modular component of the present invention is a bearing housing 14. The bearing housing 14 includes a water inlet 18, which permits flow of the coolant into the fluid chamber 12a of the pump housing 12. In addition, the bearing housing 14 receives a rotatable shaft 20, which is supported within the bearing housing by a plurality of bearings (not shown). For connecting the bearing housing 14 to the pump housing 12, the bearing housing includes a plurality of mounting receptacles 14a, which receive an appropriate fastener for mounting to an mounting receptacle 12b on the pump housing. The bearing housing 14 and the water inlet 18 are rotatable about a 180° axis between a left hand configuration (FIG. 2) and a right hand configuration (FIG. 3), based on the position of the water inlet 18, prior to attachment to the pump housing 12, and subsequent attachment to the thermostat housing 16. The mounting receptacles 14a on the bearing housing 14 are symmetrically placed to permit the bearing housing to be attached to the pump housing in either the right hand or left had configuration. Rotation of the bearing housing 14 provides options for changing the configuration of the water pump apparatus, as well as, the direction of coolant flow through the water pump apparatus.

[0023] As further shown in FIG. 1, the water pump apparatus 10 includes a fan-shaped impeller 22. The impeller 22 is mounted to the rotatable shaft 20, positioned opposite the bearing housing 14, and is received within the fluid chamber 12a of the pump housing 12. The impeller 22 is constructed of known materials, and includes a plurality of vanes 22a positioned on a flange 22b, which forms a seal within the fluid chamber 12a of the pump housing 12. In operation, when coolant enters the fluid chamber 12a, the coolant is thrown

by centrifugal force by the impeller vanes 22a to the two lower coolant passages 30 and 32 for re-entry into the engine (not shown).

[0024] In connection with the impeller 22, an impeller shroud and gasket 24 are shown in FIGS. 1 and 2. The impeller shroud and gasket 22 is positioned between the bearing housing 14 and the front of the pump housing 12, when the bearing housing is attached to the pump housing. The impeller shroud and gasket 22 forms a water impermeable seal between the pump housing 12 and the bearing housing 14, sealing the impeller 22 within the fluid chamber 12a of the pump housing, and can be constructed from known materials, including from an injection molded plastic.

[0025] As shown in FIGS. 2 and 4, the water pump apparatus includes a thermostat housing 16. The thermostat housing 16 is a modular unit having a base 42 for containing the thermostat (not shown) and a cover 44, which includes a coolant return passage 38. The cover 44, which is removable for access to the thermostat, may be attached to the base 42 in a known manner. The thermostat housing 16 also includes a water outlet passage 26, for connecting to one of the respective flanged openings 34a or 36a of the pump housing 12 and for receiving coolant returning from the engine, a water inlet passage 24, and a by-pass passage 40, wherein all of the passages are formed as integral pieces with the base 42 of the housing. When the thermostat housing 16 is connected to the bearing housing 14, and more specifically, when the water inlet passage 24 of the thermostat housing is connected to the water inlet 18 of the bearing housing, coolant enters the pump housing 12 and its fluid chamber 12a through the water inlet passage 24 and water inlet when it returns from the radiator. Coolant may also enter the fluid chamber 12a through the by-pass passage 40 of the thermostat housing 16.

[0026] FIG. 5 shows a method for forming the modular water pump apparatus 10 of the present invention. In a first step 100, casting molds (not shown) are formed to be used in the casting the desired modular components, namely, the pump housing 12, bearing housing 14 and thermostat housing 16. Those skilled in the art will recognize that the final configuration of the modular water pump apparatus will depend on the requirements of the particular vehicle it will be used in. The casting molds are formed using typical and well-known die casting techniques.

[0027] In a second step 102, the modular components are formed by pouring molten material, preferably aluminum, which exhibits good weight and strength characteristics, into the casting molds. One skilled in the art will recognize that other materials may be suitable, such as grade cast iron, steel or gray steel, depending on specific engine applications.

Similarly, the thermostat housing 16 and the impeller shroud 24 may be constructed from an appropriate injection molded plastic.

[0028] In a third step 103, after an appropriate cooling time, the modular components are removed from their respective casting molds, and finished appropriately. In a final step 104, the resulting modular components are connected to one another using known attachment means such as fastening bolts and coordinating mounting receptacles, to create the appropriate water pump apparatus configuration for the particular vehicle construction and application. By rotating the bearing housing 14 by 180° prior to attachment to the pump housing 12, the resulting water pump apparatus can have either a left hand configuration (FIG. 2) or a right hand configuration (FIG. 3) assembly. Options in the configuration of the water pump offer advantages relating to cost-savings in manufacturing time and complexity, and installation of these components.

[0029] The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. While particular embodiments have been shown and described, it will be apparent to those skilled in the art that changes and modifications may be made without departing from the broader aspects of applicants' contribution. The actual scope of the protection sought is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.

CLAIMS

What is claimed is:

1. A modular water pump apparatus comprising:
 - a pump housing having a front portion and a back portion, and a fluid chamber formed therein;
 - a bearing housing for attachment to the front portion of the pump housing, the bearing housing having a water inlet;
 - a rotational shaft rotatably supported within the bearing housing by a set of bearings;
 - an impeller fixed to the shaft, the impeller located within the fluid chamber of the pump housing;
 - a thermostat housing for connecting to the bearing housing and the pump housing;
 - wherein the bearing housing is interchangeably connected to one of either a right side or a left side of the pump housing.
2. The modular water pump apparatus of claim 1, wherein the apparatus further includes an impeller shroud having a gasket.
3. The modular water pump apparatus of claim 2, wherein the impeller shroud and gasket are positioned between the bearing housing assembly and the front portion of the pump housing.
4. The modular water pump apparatus of claim 1, wherein the back portion of the pump housing is connected to a front cover of a crankcase.
5. The modular water pump apparatus of claim 1, wherein the thermostat housing is integrally connected with a water inlet passage and a water outlet passage.
6. The modular water pump apparatus of claim 5, wherein the water inlet passage sealingly engages the water inlet of the bearing housing.
7. The modular water pump apparatus of claim 1, wherein the bearing housing is rotatable about a 180° axis before attachment to the pump housing.

8. The modular water pump apparatus of claim 1, wherein the thermostat housing is interchangeably connected to one of either the right side or the left side of the pump housing.

9. The modular water pump apparatus of claim 1, wherein the bearing housing and the thermostat housing are interchangeably connected to one of either the right side or the left side of the pump housing.

10. A water pump apparatus having a plurality of modular components, the water pump apparatus comprising:

a pump housing having a front portion and a back portion, and a fluid chamber formed therein;

a bearing housing for attachment to the front portion of the pump housing, the bearing housing having a water inlet;

a rotational shaft rotatably supported within the bearing housing by a set of bearings;

an impeller fixed to the shaft, the impeller located within the fluid chamber of the pump housing;

a thermostat housing for connecting with the bearing housing and the pump housing;

wherein the bearing housing and the thermostat housing are interchangeably connected to each other and to one of either a right side or a left side of the pump housing.

11. The water pump apparatus of claim 10, wherein the apparatus further includes an impeller shroud having a gasket.

12. The water pump apparatus of claim 11, wherein the impeller shroud and gasket are positioned between the bearing housing assembly and the front portion of the pump housing.

13. The water pump apparatus of claim 12, wherein the thermostat housing is integrally connected with a water inlet passage and a water outlet passage.

14. The water pump apparatus of claim 12, wherein the water inlet passage of the thermostat is sealingly engaged to the water inlet of the bearing housing.

15. The water pump apparatus of claim 10, wherein the bearing housing is rotatable about a 180° axis before attachment to the thermostat housing and the pump housing.

16. The water pump apparatus of claim 15, wherein the rotatable bearing housing results in one of either a left hand water inlet assembly or a right hand water inlet assembly.

17. A modular water pump apparatus having a plurality of modular components, the water pump apparatus comprising:

a pump housing having a front portion and a back portion, and a fluid chamber formed therein;

a bearing housing for attachment to the front portion of the pump housing, the bearing housing having a water inlet;

a rotational shaft rotatably supported within the bearing housing by a set of bearings;

an impeller fixed to the shaft, the impeller located within the fluid chamber of the pump housing;

a thermostat housing for connecting with the bearing housing and the pump housing;

wherein the bearing housing is rotatable about a 180° axis for interchangeably connecting to one of either a right side or a left side of the pump housing.

18. A method for forming modular components for assembling a water pump apparatus for use in an internal combustion engine, the method comprising the steps of:

forming a modular component casting mold;

forming the modular component through introduction of molten material into the casting mold;

cooling the molten material for a specific time;

removing the cast modular component from the mold; and

assembling the modular components into the water pump apparatus having one of a right hand assembly or a left hand assembly, the modular components comprising a pump housing, a bearing housing and a thermostat housing.

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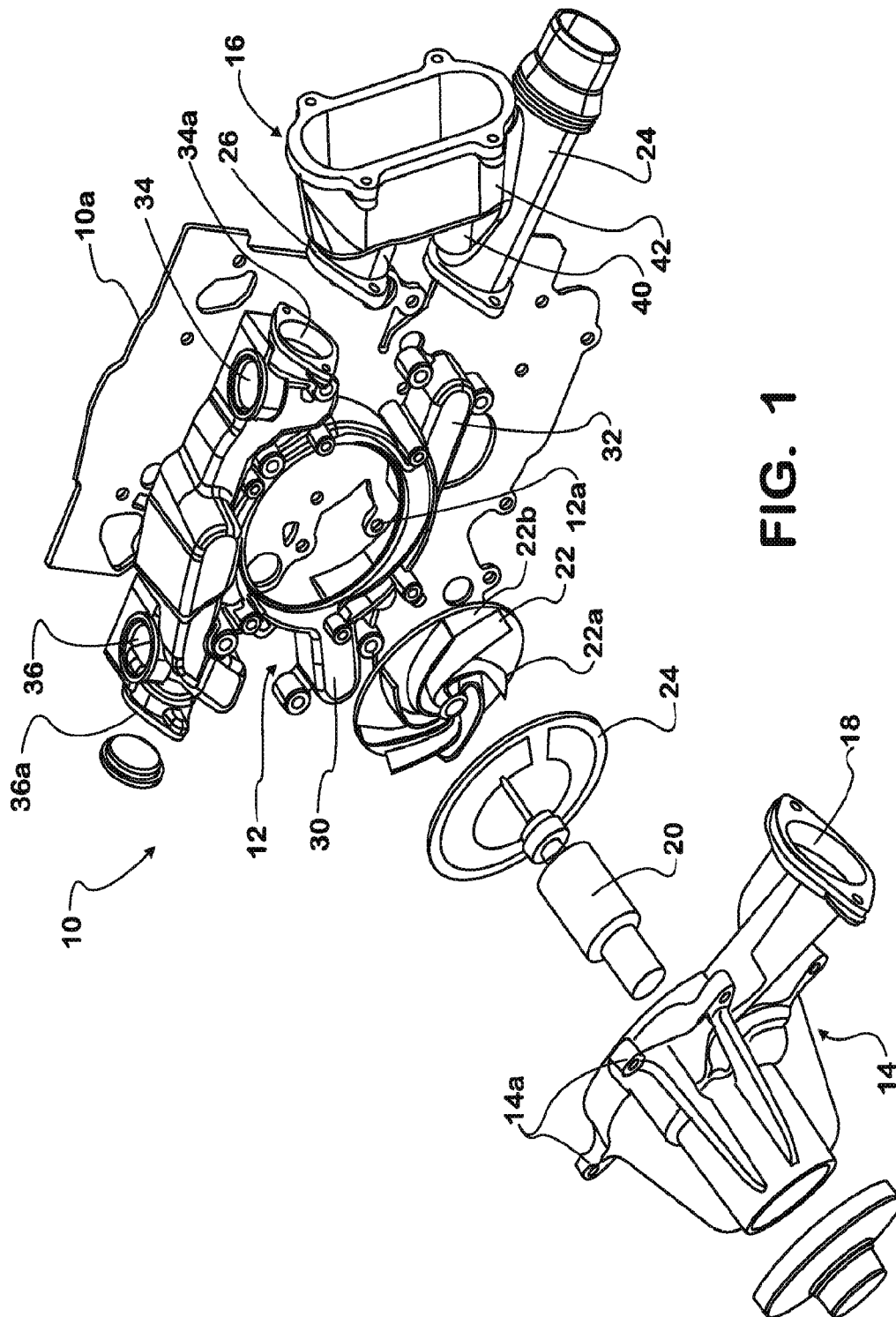


FIG. 1

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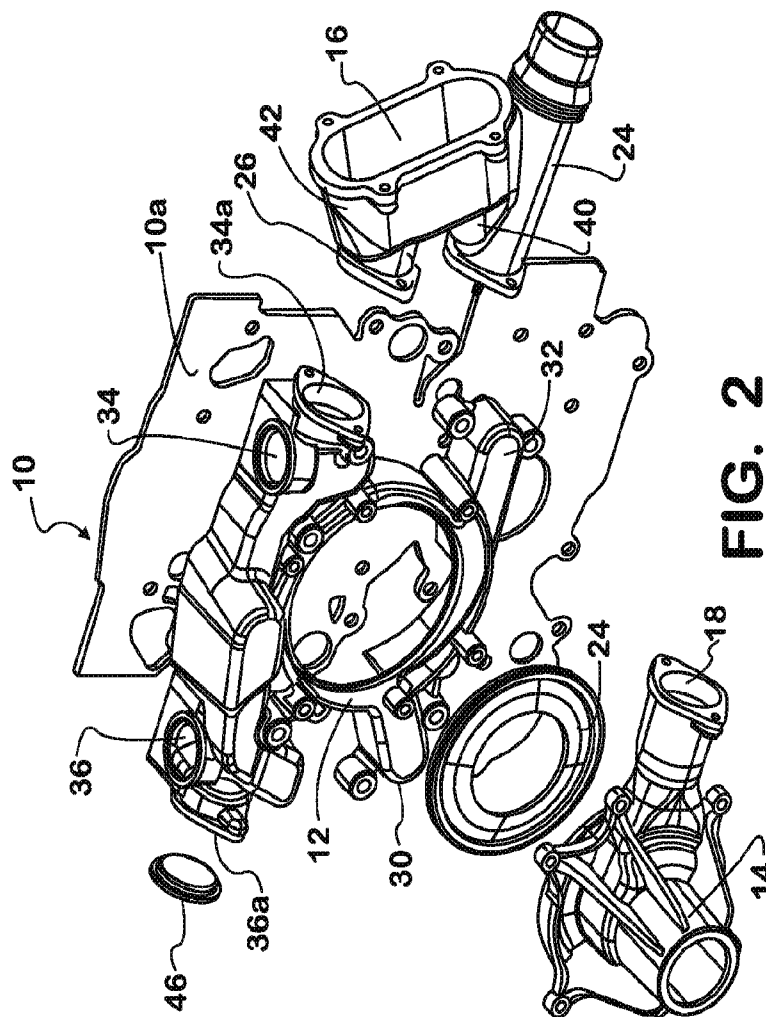


FIG. 2

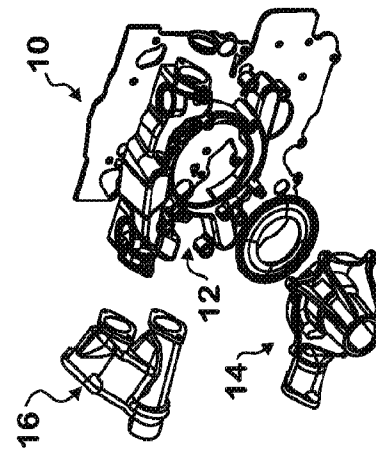


FIG. 3

3/4

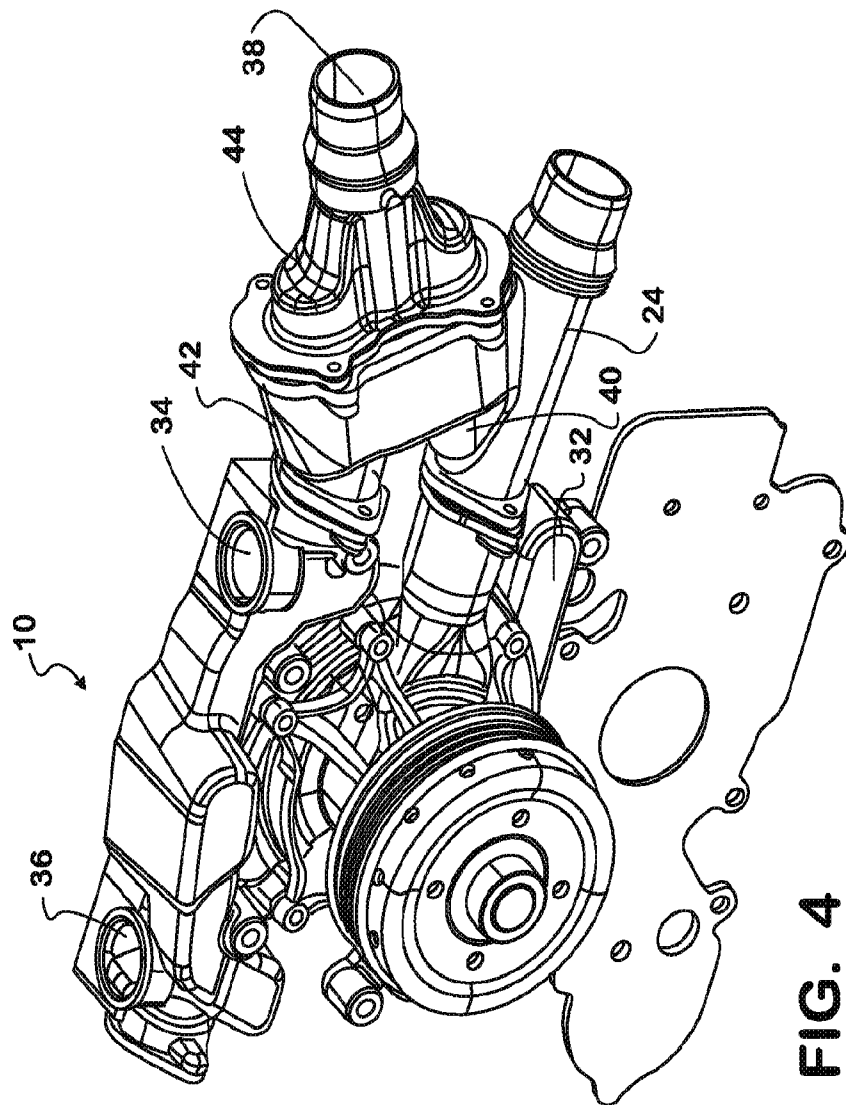
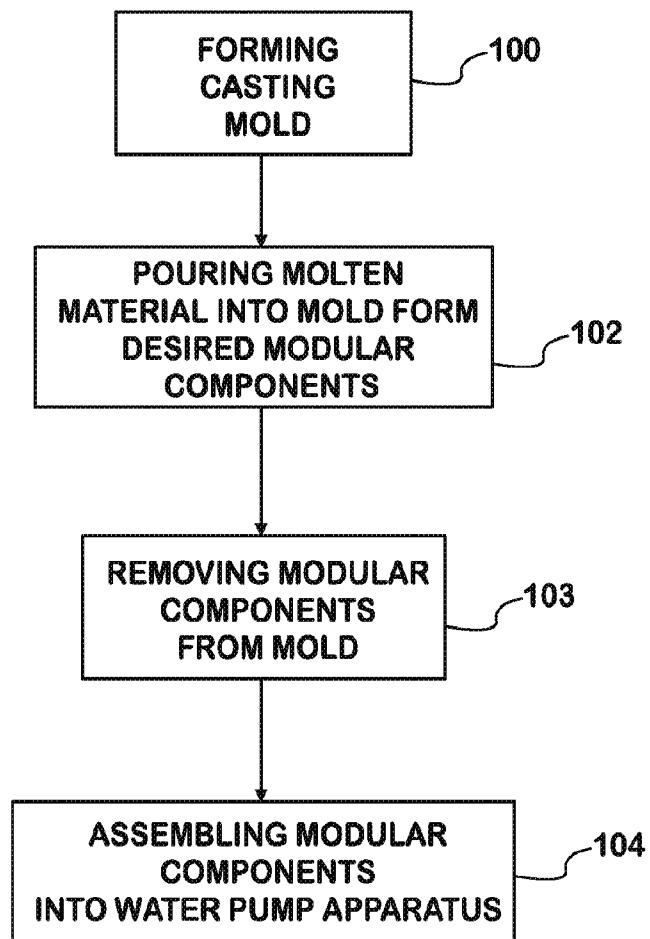


FIG. 4

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**FIG. 5**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/021665

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F01P 5/00 (2012.01)

USPC - 123/41.44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - F01P 3/00, 20, 5/00, 10, 12, 7/00, 14, 16; F04D 29/04, 046 (2012.01)

USPC - 123/41.01, 41.02, 41.08, 41.09, 41.1, 41.44; 41.47; 415/110, 111, 229, 230; 417/364

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Orbit.com, Proquest

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0116921 A1 (LEE et al) 19 May 2011 (19.05.2011) entire document	1-17
Y	US 2004/0178281 A1 (MORIYAMA et al) 16 September 2004 (16.09.2004) entire document	1-17
A	US 2008/0317595 A1 (HOJI) 25 December 2008 (25.12.2008) entire document	1-17
A	US 2004/0062635 A1 (SERIO) 01 April 2004 (01.04.2004) entire document	1-17

☐ Further documents are listed in the continuation of Box C.


* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 June 2012

Date of mailing of the international search report

13 JUL 2012

Name and mailing address of the ISA/US

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/021665

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

(see Extra Sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-17

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2012/021665

Group I, claims 1-17, are drawn to a water pump apparatus comprising a pump housing having a front portion and a back portion, and a fluid chamber therein; a bearing housing for attachment to the front portion of the pump housing, the bearing housing having a water inlet; a rotational shaft rotatably supported within the bearing housing by a set of bearings; an impeller fixed to the shaft, the impeller located within the fluid chamber of the pump housing; a thermostat housing for connecting to the bearing housing and the pump housing; wherein the bearing housing is interchangeably connected to one of either a right side or a left side of the pump housing.

Group II, claim 18, is drawn to a method for forming modular components for assembling a water pump apparatus for use in an internal combustion engine comprising forming a modular component casting mold; forming the modular component through introduction of molten material into the casting mold; cooling the molten material for a specific time; removing the cast modular component from the mold; and assembling the modular components into the water pump apparatus having one of a right hand assembly or a left hand assembly, the modular components comprising a pump housing, a bearing housing and a thermostat housing.

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical features of the Group I invention: a water pump apparatus with housing, inlet, impeller, shaft, and thermostat components arranged in a specific and defined fashion, are not present in Group II; and the special technical features of Group II, a method for forming, casting, and assembling modular components of a water pump apparatus from casting molds, are not present in Group I.

Groups I and II share the technical features of a water pump apparatus containing a pump housing, a bearing housing, and a thermostat housing. However, these shared technical features do not represent a contribution over the prior art. Specifically, US 6,112,706 to Heer teaches an internal combustion engine with a water pump/thermostat unit including water pump 2, bearings 4, and a bearing 4a that serves the thermostat 5 within the water pump housing (Fig. 1; Col. 2, ln. 51-62).

Since none of the special technical features of Group I and II are found in more than one of the inventions, unity is lacking.