

[54] **APPARATUS FOR CENTRIFUGALLY CASTING AN ANNULUS OF METAL ABOUT A HUB**

[75] Inventor: **Willi Schmitz**, Andernach, Rhine, Germany

[73] Assignee: **Mittelrheinische Metallgiesserei H. Beyer KG**, Andernach, Germany

[22] Filed: **May 18, 1972**

[21] Appl. No.: **254,365**

[52] U.S. Cl. 164/288, 164/112, 164/114

[51] Int. Cl. **B22d 13/04**

[58] Field of Search 164/111, 112, 114, 288

[56] **References Cited**

UNITED STATES PATENTS

3,094,753 6/1963 Klement..... 164/288 X

3,263,285 8/1966 Rojecki..... 164/114
 3,293,708 12/1966 Fruitman 164/114
 3,430,681 3/1969 Smith et al..... 164/111

FOREIGN PATENTS OR APPLICATIONS

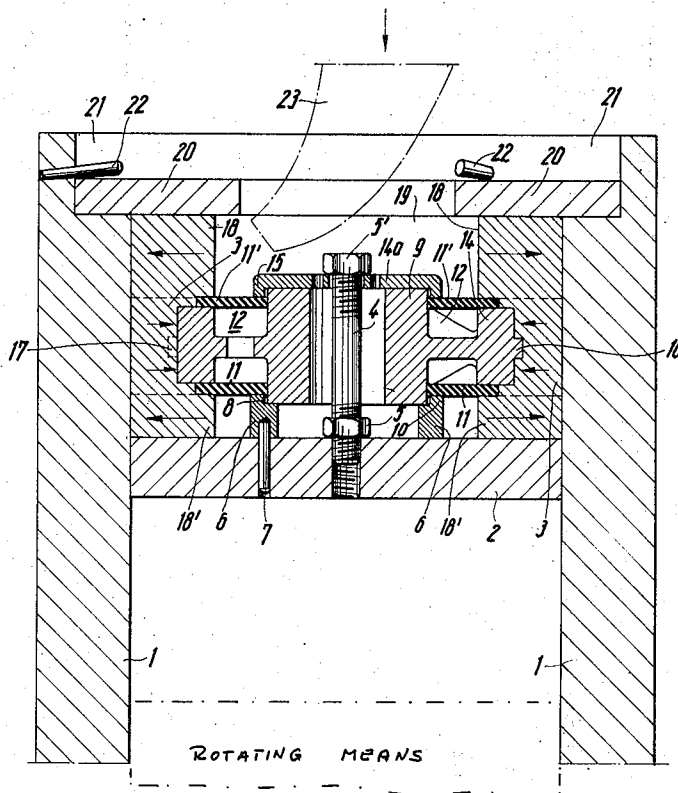
452,665 11/1948 Canada 164/288
 785,319 10/1957 Great Britain..... 164/114

Primary Examiner—R. Spencer Annear
 Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

A hub member is accommodated in the cavity of an upright mold, whereupon the latter is rotated with the hub member and metal which is to form the outer annular part of the gear is introduced into the mold to become united with the hub member by centrifugal casting. An apparatus for carrying out this method is also disclosed.

5 Claims, 2 Drawing Figures



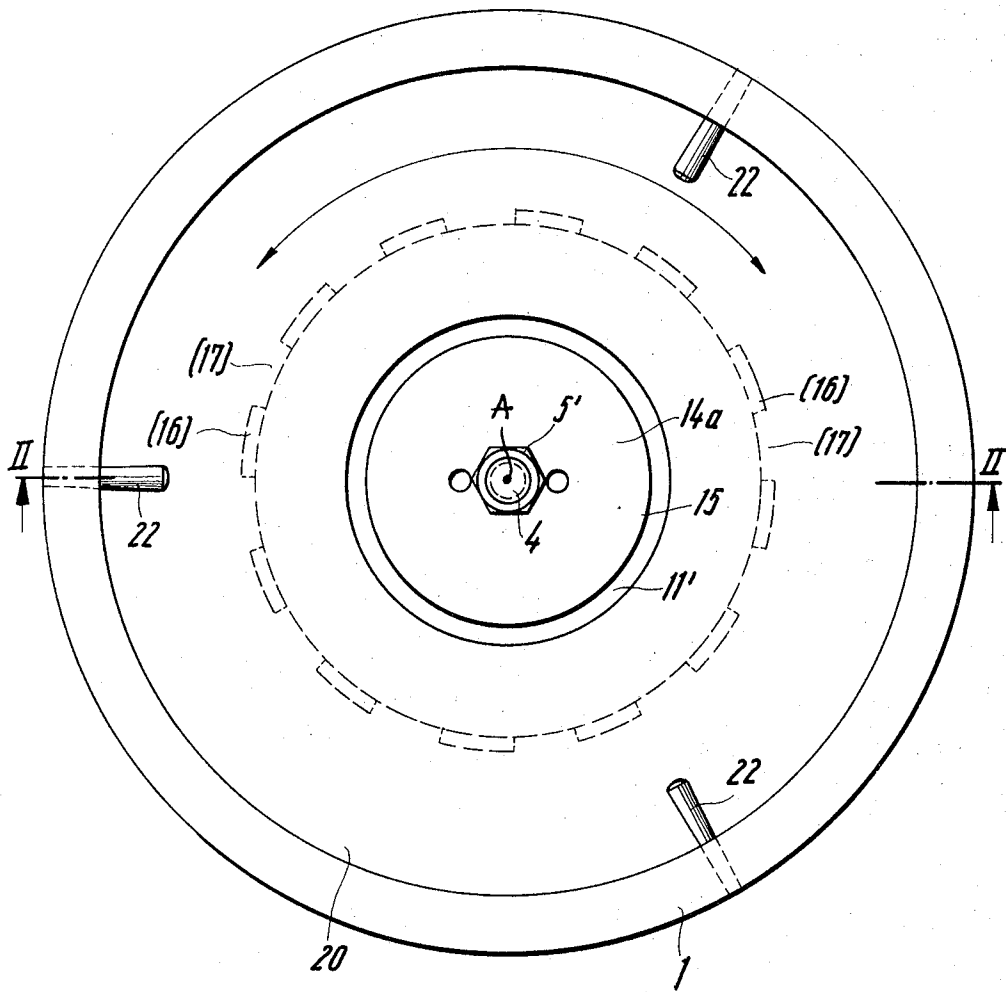


Fig. 1

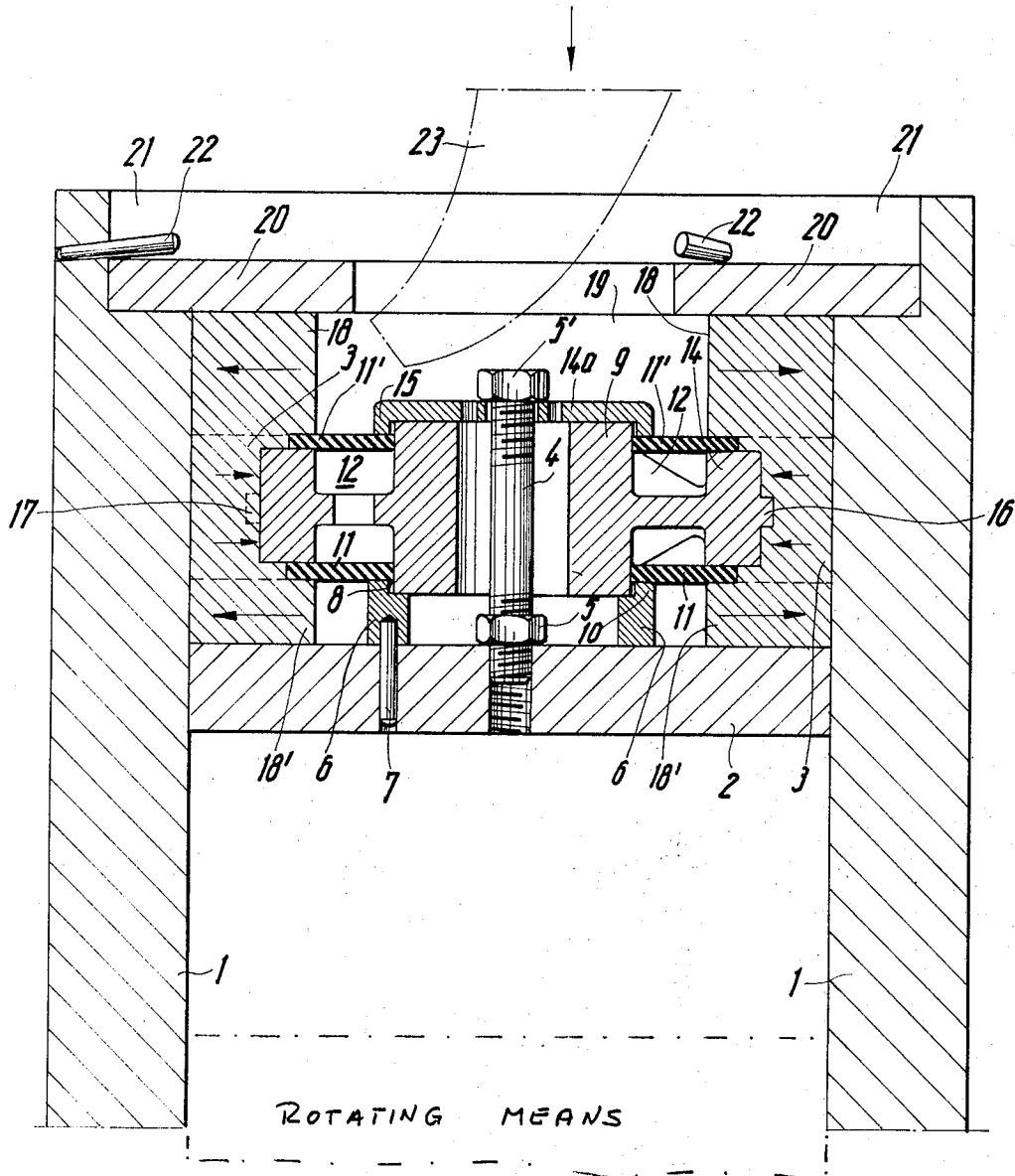


Fig. 2
(II-II)

APPARATUS FOR CENTRIFUGALLY CASTING AN ANNULUS OF METAL ABOUT A HUB

BACKGROUND OF THE INVENTION

The present invention relates generally to the making of gears or the like, and in particular to the manufacture of gears whose outer annular portion is of centrifugally cast metal whereas the inner hub is of a different metal which is not cast together with the outer annular portion. The invention is also concerned with an apparatus for carrying out the method.

It is already known that in many instances, it is desirable that meshing gears be made of two different metals. For instance, it has been found that making one gear of steel and another gear which meshes with it of a different material for instance bronz or the like, is highly advantageous and more particularly in gear arrangements which are subjected to high stress requirements. Bronz gears, especially those of relatively large dimensions, are usually made of two parts in order to reduce the expenses involved. It is customary to make the hub of such a gear of cast iron or steel, and the outer annular portion which carries the teeth is made of bronz or the like. The outer annular portion is manufactured and is then placed about the hub and shrink-fitted onto the latter, thereby establishing a connection between them. Other possibilities are to screw-threadedly or similarly connect the hub with the outer annular portion or to directly cast the outer annular portion onto the hub by the sand casting method. Finally, it is also known to cast an outer annular portion of bronz about a steel hub and to subject the thus obtained gear to diffusion annealing under exclusion of the ambient atmosphere in order to obtain a strong connection between the two dissimilar metals.

All of the prior-art approaches, are, however, possessed of certain disadvantages.

Thus, it is known that in the case of outer annular portions which are shrunk onto the hub, substantial heating of the outer annular portion due to friction may result in sufficient expansion of the outer annular portion for the connection thereof for the hub to become separated. If the hub and the outer annular portion are screw-threadedly connected with one another, a sudden reversal force acting on the turning gear may result in a loosening of the connection between the hub and the outer annular portion due to deformation of the metal, and this can sooner or later result in difficulties in the operation of the gear.

Insofar as the casting of the outer annular portion onto the hub by the sand casting method is concerned, it has been observed that there is a frequent occurrence of voids which usually appear only later when material is removed from the outer annular portion to form the teeth thereon. At this point it is of course too late to do anything by discard the gear; not, however, before already substantial time and money has been invested in its production to that stage.

Thus it will be seen that none of the approaches of the prior art are wholly satisfactory. SUMMARY OF THE INVENTION

It is, accordingly a general object of the present invention to overcome the disadvantages of the prior art.

More particularly, it is an object of the present invention to provide a method of making a gear or the like,

in which the outer annular portion has a homogeneous structure without any voids or other problems.

Another object of the present invention is to provide such a method according to which the outer annular portion is reliably and intimately connected with the hub.

An additional object of the invention is to provide an apparatus for carrying out the present method.

In pursuance of these objects and of others which will become apparent hereafter, one feature of the invention resides in a method of making a gear or the like, which briefly stated, comprises the steps of providing a hub member, and rotating the hub member about a vertical axis while centrifugally casting about its periphery an annulus of metal. This centrifugal casting results in the formation of metallic deadheads at opposite axial ends of the hub member and the exertion by such deadheads of pressure causing the liquid metal to flow into intimate contact with the hub member during casting and formation of the annulus.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a top-plan view of an apparatus according to the present invention; and

FIG. 2 is a section taken on line II—II of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Discussing the drawing in detail, it will be seen that in FIGS. 1 and 2 I have illustrated an exemplary embodiment of an apparatus for carrying out the novel method. This apparatus according to the present invention utilizes a cylindrical mold 1 which is rotatable about an upright axis A (see FIG. 1), and in the interior mold cavity of which there is mounted a plate 2 extending transversely to the axis A. The plate 2 can be shifted axially of the mold cavity, that is in FIG. 2 it can be raised and lowered depending upon the axial width which it is desired to obtain for an annulus 3 to be cast onto a hub member.

Centrally connected with the plate 2 is a screw 4, with the aid of a nut 5. There is further mounted on the plate 2, with the aid of pins or similar elements 7 a spacing ring 6 the free axial end of which (that is the end which faces away from the plate 2) has an annular recess 8 (see FIG. 2) in which there is centrally mounted the hub member 9. The hub member 9 has an annular portion 14 surrounding it and being of one piece with it.

The non-recessed portion of the free end of the spacing ring 6, identified with reference numeral 10, retains an asbestos ring 11 which overlies and covers the space 12 between the hub member 9 and the annular portion 14. A pressure plate 14a is provided with a rim 15 and can be drawn down by the aid of nut 5' which also cooperates with the screw 4, so that the pressure plate 14a presses the hub member 9 against the spacing ring 6 and thereby the plate 2.

There is provided an additional asbestos ring 11' which is pressed against the annular portion 14 by the rim 15 and thus covers and seals the space 12 between hub member 9 and annular portion 14 at the opposite axial end of the hub member.

The outer circumferential edge face of the annular portion 14 is provided with a circumferentially extending bead 16 which has circumferentially spaced recesses 17 (see FIG. 1) whose purpose is to provide for a mechanical interlock with the outer metallic annulus 3 which is to be formed on the hub member by means of centrifugal casting. This more reliably assures that there can be no axial or circumferential displacement between the annulus 3 and the hub member after the former has been provided.

The mold or casting space 19 is closed off by an annular member 20 which can be inserted into a recess 21 of the mold 1 and is retained against movement by suitable means here illustrated by way of example in form of conical retainer pins 22.

When the assembly has progressed to this point, which is shown in FIG. 2, but at which time the outer annulus 3 is of course still absent, the mold 1 is rapidly rotated about its upright axis A by means of the rotating means which is diagrammatically illustrated in FIG. 2 and which requires no further discussion because it is known per se. Liquid metal, for instance liquid bronze, is then introduced via the diagrammatically illustrated inlet 23 into the casting space 19. The centrifugal force resulting from the rotation of the mold 1 about the axis A causes the entering molten metal to be forced outwardly in the direction of the arrows in FIG. 2. The resulting pressure on the liquid metal causes a tendency of the latter to flow back in the direction of the opposite arrows in FIG. 2, that is to flow inwardly towards the annular portion 14, and this results in a tight intimate connection of the liquid metal with the annular portion 14. Above and below (this is true in FIG. 2, and can be generalized by saying at opposite axial ends of the hub member 9) there are formed quantities of lost metal, so-called "deadheads" 18, 18' which of course exert this reverse or inwardly directed pressure upon the metal which flows into intimate engagement with the annular portion 14 to become cast about and to form after hardening the outer annulus 3. The hydraulic considerations governing this exertion of pressure by the deadheads 18, 18' upon the quantity of metal which subsequently forms the annulus 3, and which cause the inwardly directed pressure of the metal of the annulus 3 against the annular portion 14 are well known and require no explanation.

After the metal has hardened the conical retainer pins 22 are withdrawn, the annular member 20 removed, the nut 5' loosened and the blank or gear composed of the portions 9, 14 and 3 is taken out of the mold 1. A new hub member 9 with its annular portion 14 can then immediately be inserted and the mold is ready for a new casting operation.

Insofar as the just produced blank is concerned, the deadheads 18, 18' are removed by suitable material removal methods and their metal can be recirculated for further use, whereas the blank is now ready for further processing, for instance for the formation of teeth in the outer circumferential surface of the annulus 3.

It is a particularly advantageous feature of the invention that the hub member 9, 14 can be used in form of a rough blank that is that it need not be specially

worked before it can be employed in having the annulus 3 cast about it. This of course eliminates the need for time consuming and expensive finishing work on the member 9, 14 and, furthermore, it is not necessary to employ time consuming measurements in the production and installation of the member 9, 14 in the mold 1. The same is true of the avoidance of any necessity for having to precisely fit the member 9, 14 into the annulus 3, as is the case if the annulus is separately produced and then united by shrink-fitting or the like with the member 9, 14.

In a gear produced according to the present invention and in the apparatus according to the present invention the annulus 3 is tightly connected with the hub member 9, 14 without any play whatsoever, and in fact the material of the annulus 3 enters into the pores of the hub member 9, 14 at their interface whereby an intimate and very strong connection between them is established, which can be separated or loosened neither by heating of the annulus 3 nor by sudden reversal of forces upon the rotating gear.

In addition, a gear cast according to the present invention does not have any voids or other imperfections, because this is impossible due to the forces acting upon the liquid metal during centrifugal casting of the annulus 3. Thus, the structure of the annulus 3 is uniform throughout and there is no loss due to the a necessity for discarding imperfectly cast blanks.

In addition, because of the homogeneity of the material of the annulus 3, there is assured an always even stressing of the material in operation of the gear, and this of course means that the wear is uniform and reduced to the minimum possible amount.

It will be clear therefore, that the present invention not only eliminates the need for expensive fitting or finishing operations before the annulus 3 and the hub member 9, 14 can be connected but also eliminates loss of finished gears due to the existence of imperfections so that a blank composed of the portions 9, 14 and 3 can be produced not only much more rapidly than previously, but also less expensively and without any need for the use of expensive machinery and tools. Special molds are not required except for the very simple cylindrical mold 1 which has been illustrated in the drawing, and the time required from the beginning of casting to the removal of the cooled product can be reduced very significantly by cooling the mold rapidly, so that gear blank can be produced in much shorter time than was heretofore possible.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of constructions differing from the types described above.

While the invention has been illustrated and described as embodied in the making of gears and the like, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge readily adapt it for various applications without omitting features that from the standpoint of prior art, fairly constitute essential characteristics of the specific or generic aspects of this invention and, therefore, such adaptations should and

5

6

are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. Apparatus for centrifugally casting an annulus of metal about a hub, comprising mold means mounted for rotation about an upright axis and having an upright cylindrical cavity; a plate longitudinally slidably mounted in said cavity; holding means for centrally holding on said plate a hub member which defines a clearance between its periphery and the cavity wall, said hub member having an inner hub portion and an outer hub portion concentric with and connected to said inner hub portion; closure means for closing said cavity; admitting means for admitting liquid metal into said cavity, so that such metal is centrifugally cast about and forms an annulus in said clearance upon rotation of said mold means about said upright axis; a spacer ring on an inwardly directed side of said plate; fixing means fixing said spacer ring to said plate; and a heat-resistant annular seal carried by said spacer ring and bridging the distance between said hub portions to

prevent the entry of liquid metal therebetween.

2. Apparatus as defined in claim 1, said spacer ring having an inner axial end face provided with an annular recess, and said seal being lodged in said recess for retention against lateral displacement.

3. Apparatus as defined in claim 1;

further comprising a pressure plate received in said cavity intermediate said closure means and the axial end of said hub member which faces away from said spacer ring, said pressure plate having a shoulder; and further comprising an additional seal of heat-resistant material engaging and retained by said shoulder and bridging the distance between said hub portions.

4. Apparatus as defined in claim 3, said heat-resistant material being asbestos.

5. Apparatus as defined in claim 3; further comprising connecting means connecting said plates with one another and urging the same toward one another in direction longitudinally of said cavity and of said hub member.

* * * * *

25

30

35

40

45

50

55

60

65