(12) UK Patent Application (19) GB (11) 2 387 881 (13) A

(43) Date of A Publication 29.10.2003

(21) Application No 0209224.5

(22) Date of Filing 23.04.2002

(71) Applicant(s)
Metaldyne International (UK) Limited
(Incorporated in the United Kingdom)
131 Parkinson Lane, HALIFAX, HX1 3RD,
United Kingdom

(72) Inventor(s)
John Martin Allport

(74) Agent and/or Address for Service
Marks & Clerk
Sussex House, 83-85 Mosley Street,
MANCHESTER, M2 3LG, United Kingdom

(51) INT CL^7
F16C 33/02 // B29C 45/14 , F16C 9/00 33/00 33/20 33/64 43/00

(52) UK CL (Edition V)
F2A AD06 AD38 AD70 A121 A122 A123 A181 A308 A309 A6C A6K
B5A AB18 A1R214A A1R314C1A A1R444 A2E9 A2K2 A20T14
F2S S803 S812 S813

(56) Documents Cited
GB 2359869 A
JP 590037328 A
JP 040275137 A
US 6354953 B1
DE 040304188 A1
JP 070317772 A
JP 030268915 A

(58) Field of Search
UK CL (Edition V) B5A, F2A
INT CL^7 B29C, F16C
Other: Online: EPODOC, WPI & PAJ.

(54) Abstract Title
Method of moulding a bearing construction on to an annular inertia member

(57) A method for providing a bearing 227 on to an annular inertia member 202, possibly of a torsional vibration viscous fluid damper, involves placing at least part of the member 202 in to a two-piece 204, 209 mould so as to define a cavity 208 between the outer surfaces 212, 217 of the member 202 and the inner surface of the mould and injecting a plastic/nylon bearing material in to the cavity 208 via a plugged 214 aperture 213, so as to form a bearing surface 227 directly in to the inertia member 202. The bearing surface may be applied to any or all of the surfaces of member 202 and in a case where all surfaces are moulded on to, the bearing material formed on the radially inner periphery (320, Fig 5) is thicker than that formed on the outer periphery (331). Supporting stud members may be provided so as to support the inertia member within the mould. Inertia member 202 may have a V-shaped annular groove reservoir 11 on its radially extending surface 212. A comparable method for constructing a torsional vibration viscous fluid damper, and such a damper per se, are also disclosed.

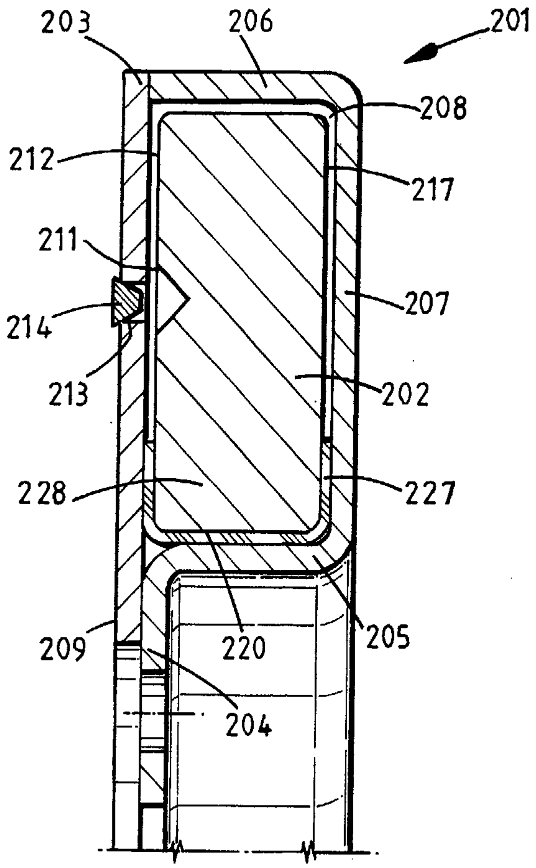

FIG.3

GB 2 387 881 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

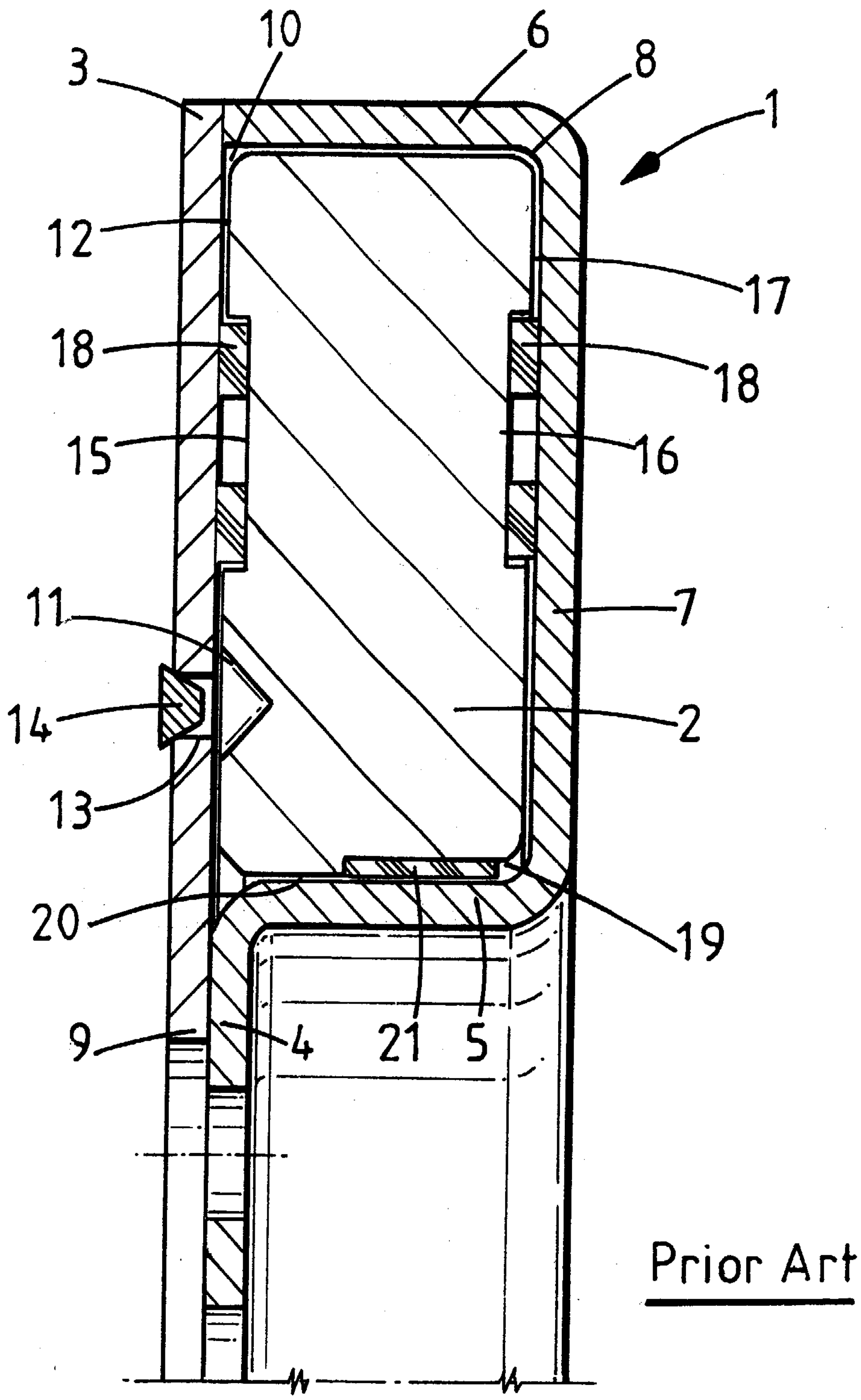

FIG.1

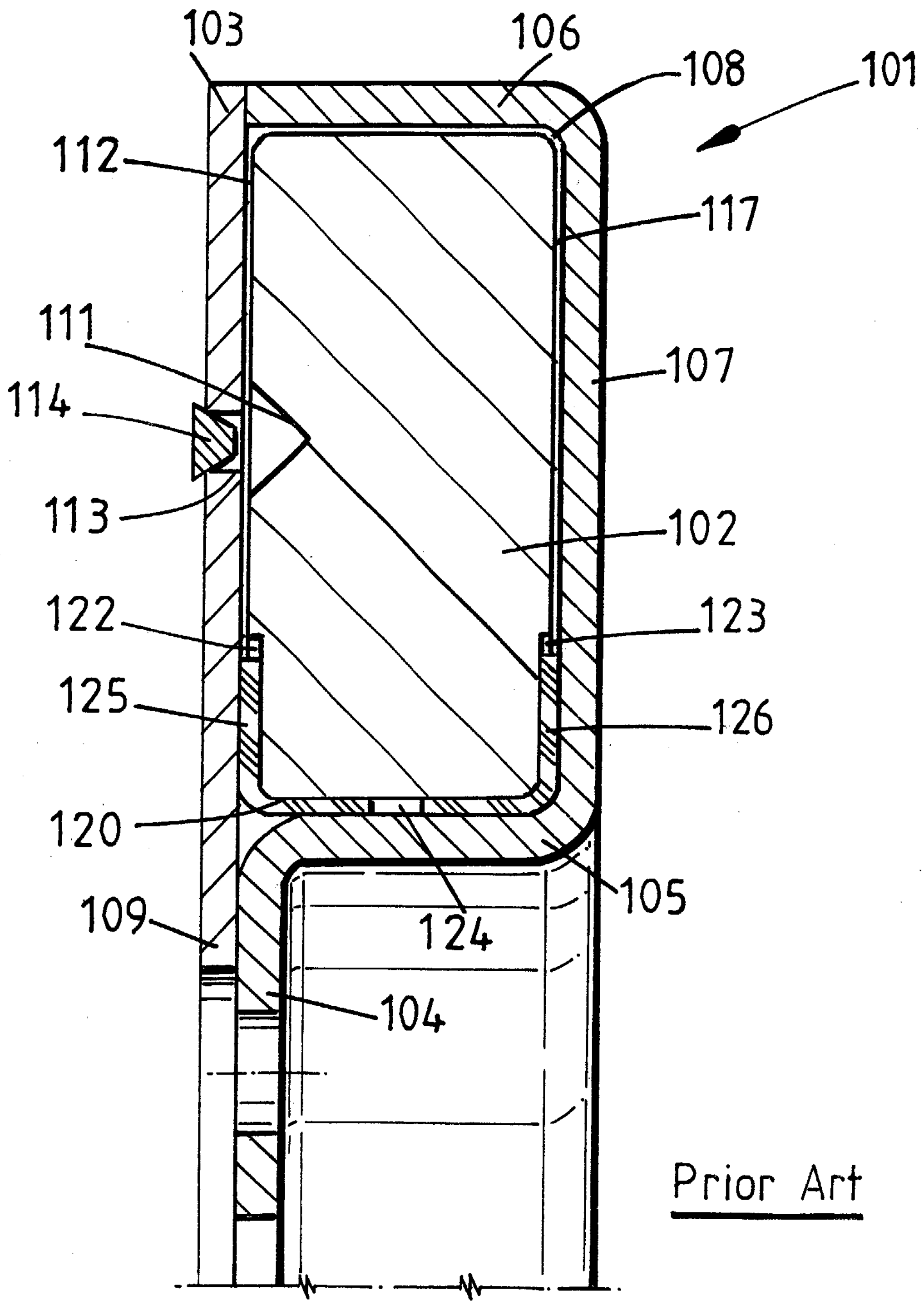
103
106
108
101
112
117
111
107
114
113
102
122
123
125
126
120
124
105
109
104
Prior Art

FIG. 2

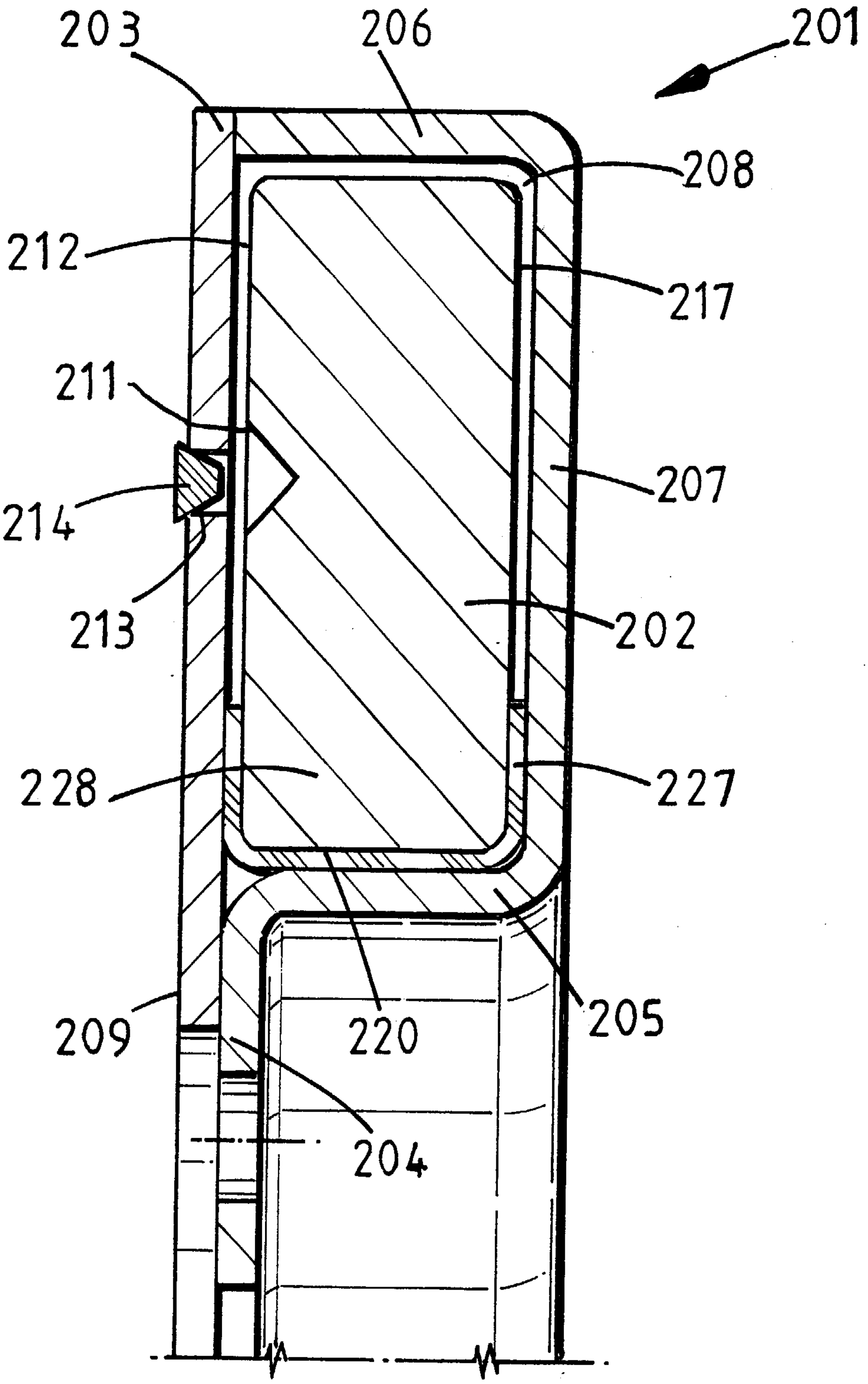
203
206
201
208
212
217
211
207
214
213
202
228
227
209
220
205
204

FIG.3

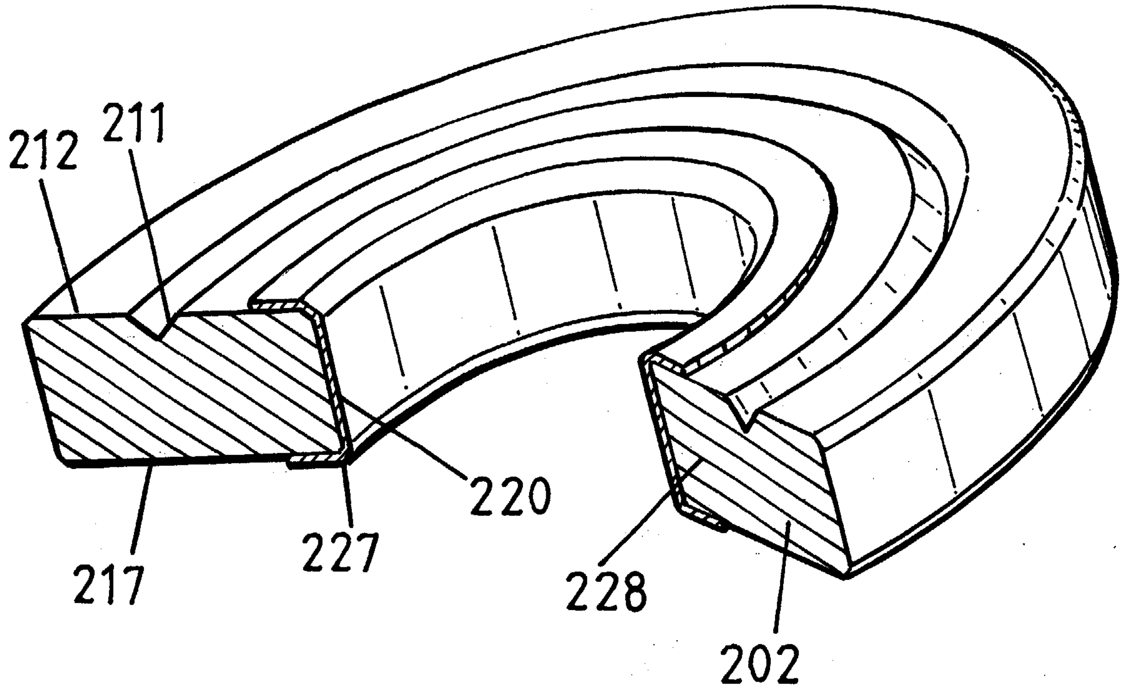

FIG. 4

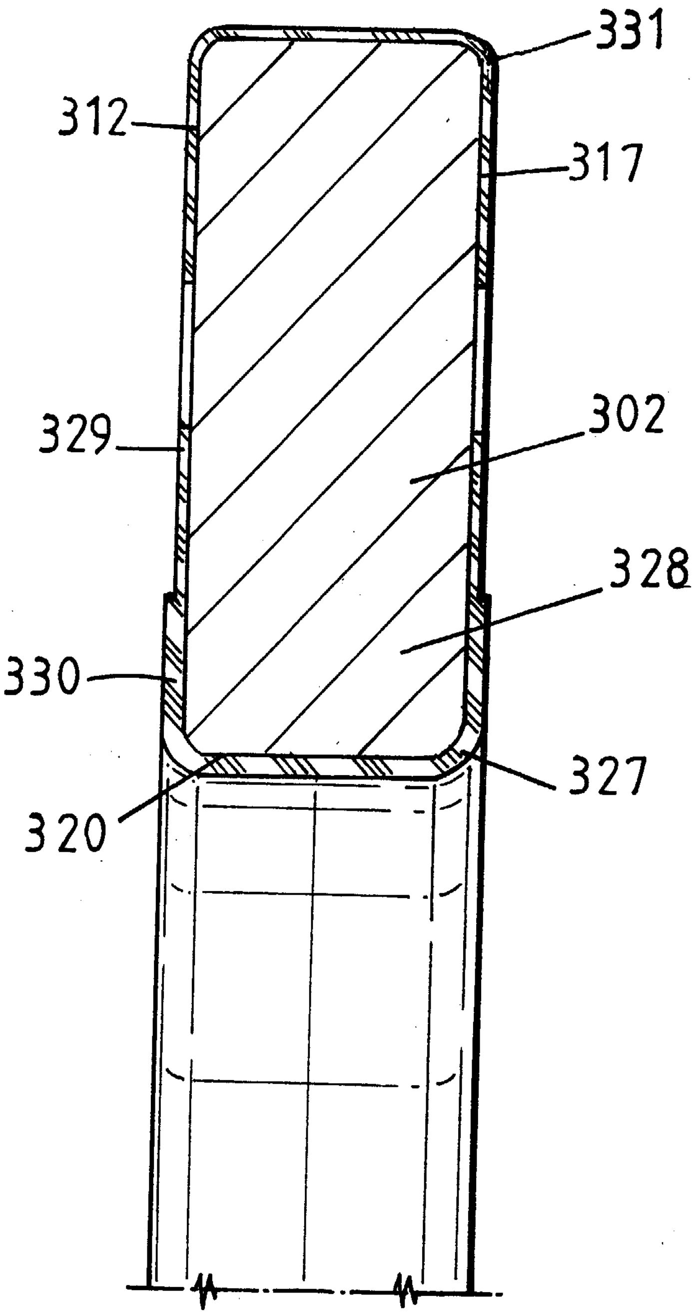

FIG. 5

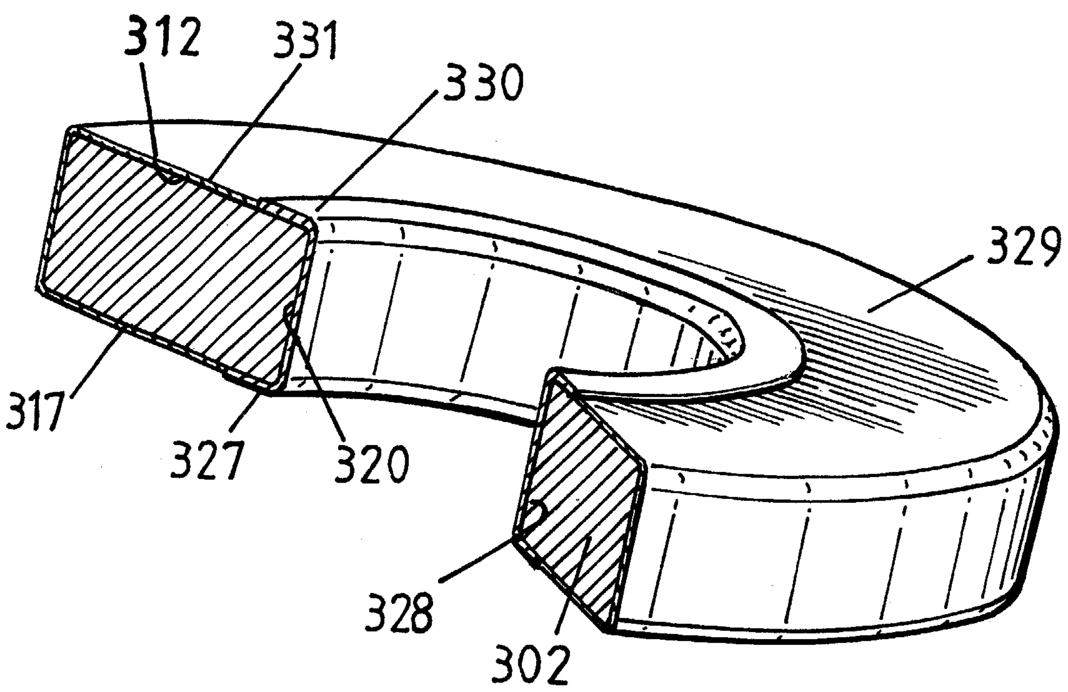

FIG. 6

2387881

METHOD OF BEARING CONSTRUCTION

The present invention relates to a method for providing a bearing on an annular inertia member, particularly but not exclusively, for use in a torsional vibration viscous fluid damper.

Torsional vibration dampers are used to limit the rotational vibrations that occur in a crankshaft of an internal combustion engine. Such dampers generally comprise an annular inertia member disposed within an annular chamber defined by a housing. A viscous fluid fills the space between the inertia member and the housing and the resistance to shear of the fluid serves to damp relative movement between the inertia member and the housing. Various forms of bearings are used to ensure that the inertia member is correctly supported within the annular housing so as to maintain its concentricity within the housing during relative rotation and to reduce wear. Bearings which are commonly used include split PTFE tape disposed in the radial clearance between the inertia member and the housing, with PTFE buttons disposed in an axial clearance between the inertia member and the housing (described below in relation to figure 1), and split 2-piece nylon rings (described below in relation to figure 2). In each case the bearings are manufactured and assembled on to the inertia member prior to its insertion into the annular housing.

However, PTFE bearings are relatively expensive; not only is the raw material of relatively high cost, but the bearings must be produced by casting which is an expensive process.

In order to reduce costs, bearings manufactured from nylon have become more widely used. Nylon is a much cheaper raw material and has an advantage over PTFE in that it can be moulded.

Unfortunately, nylon has a tendency to absorb small amounts of moisture from the atmosphere during the manufacture and storage of such bearings. This presents a problem since the moisture held within the nylon structure may egress once in place in the damper and breakdown the viscous damping fluid. The nylon bearings must therefore be processed in a dry atmosphere or be completely dried before use, offsetting some of the costs benefits obtained by using nylon over PTFE. The nylon bearings are also usually in the form of split 2-piece rings which complicate the assembly process.

The object of the present invention is to obviate or mitigate the aforementioned problems.

According to a first aspect of the present invention there is provided a method for providing a bearing on an annular inertia member, the method comprising placing at least a part of the inertia member into a mould to define a mould cavity between the inertia member and the mould, and injecting a bearing material into the mould cavity so as to form a bearing directly on to the inertia member.

Providing a moulded bearing directly on to at least a part of the inertia member in this way allows bearings of any desirable form to be produced. Furthermore, since the bearing covers a part of the surface of the inertia member this surface no longer needs to be machine finished to the same manufacturing tolerances as in conventional dampers, thus reducing production time and costs.

A further advantage of the present invention is that the provision of an inertia member with a premoulded bearing increases the speed and ease of assembly of the damper. Increasing the speed of assembly reduces the likelihood that the bearing will absorb moisture which, in turn, reduces the possibility of moisture subsequently egressing from the bearing and breaking down any viscous damping fluid present.

Alternatively, the part of the inertia member in the mould comprises a radial inner periphery of the inertia member and may comprise at least a portion of a radially extending surface of the inertia member.

The part of the inertia member in the mould may comprise substantially all of the exterior surface of the inertia member.

Providing a layer of bearing material over substantially all of the exterior surface of the inertia member in this way allows manufacturing tolerances to be controlled more easily and reduces the need for machine finishing of the inertia member's exterior surface. Moreover the bearing layer prevents any harmful substances from egressing from the inertia member during use. For example, inertia members used in torsional vibration viscous fluid dampers may be manufactured from sintered metals which require de-oiling prior to use since any oil present in the finished inertia member may escape and breakdown the viscous damping fluid. Coating the surface of the inertia member with a layer of bearing material would therefore remove the need to de-oil such materials which would improve production efficiency.

The layer of bearing material formed on a radially inner periphery of the inertia member is preferably thicker than the layer formed on the remainder of the surface of the inertia member.

Alternatively the layer of bearing material formed on at least a portion of a radially extending surface of the inertia member may be thicker than the layer formed on the remainder of the exterior surface of the inertia member.

Optionally the layer of bearing material formed on a radially inner periphery of the inertia member and at least a portion of a radially extending surface of the inertia member is thicker than the layer formed on the remainder of the exterior surface of the inertia member.

Formation of thicker regions of the layer of bearing material in specific areas permits these areas to act as radial and/or axial thrust bearings. By virtue of these areas being moulded they can, of course, take any convenient form and be positioned in any desired location.

Preferably the bearing material is a plastics material, which may be nylon.

The part of the inertia member in the mould is preferably supported therein by at least one supporting member. The, or each, supporting member may be a stud.

Preferably the mould is formed from a plurality of sections which are assembled around the part of the inertia member so as to define the mould.

According to a second aspect of the present invention there is provided an annular inertia member having a bearing moulded thereon which may be provided by a method as described above.

According to a third aspect of the present invention there is provided a method for constructing a torsional vibration viscous fluid damper having an annular inertia member rotatably disposed in an annular chamber of a housing, the method comprising placing at least a part of the inertia member into a mould to define a mould cavity between the inertia member and the mould, and injecting a bearing material into the mould cavity so as to form a bearing directly on to the inertia member.

According to a fourth aspect of the present invention there is provided a torsional vibration viscous fluid damper having an annular inertia member having a bearing moulded thereon.

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view of half of a torsional vibration viscous fluid damper with a bearing arrangement in accordance with a first prior art design;

Figure 2 is a cross-sectional view of half of a torsional vibration viscous fluid damper with a bearing arrangement in accordance with a second prior art design;

Figure 3 is a cross-sectional view of half of a torsional vibration viscous fluid damper with a moulded bearing arrangement in accordance with an aspect of the present invention;

Figure 4 is a perspective view of the inertia member and bearing arrangement of figure 3 shown partially cut away;

Figure 5 is a cross-sectional view of half of an annular inertia member with a layer of bearing material moulded over substantially all of the exterior surface of the inertia member in accordance with a further aspect of the present invention; and

Figure 6 is a perspective view of the annular inertia member with the moulded outer skin of figure 5 shown partially cut away.

Referring now to figure 1, a first prior art torsional vibration viscous fluid damper 1 comprises an annular inertia member 2 supported within a two-piece annular housing 3. A first piece 4 has a pair of axially extending walls 5, 6 at its peripherary connected by a radially extending wall 7 which define an annular chamber 8 within which the inertia member 2 is located. The chamber 8 is closed by a second piece 9 of the housing which serves as a cover plate.

A viscous fluid, such as a silicone based fluid, occupies the clearance 10 in the chamber 8 between the inertia member 2 and the housing 3 and acts to damp motion of the inertia member 2 relative to the housing 3. An annular groove 11 of V-shaped cross section is formed in a radially extending face 12 of the inertia member 2 to act as a fluid reservoir. An aperture 13 (shown closed by a removable plug 14) is formed in the cover plate 9 in line with the groove 11 to facilitate injection of viscous damping fluid into the housing.

A plurality of equi-angularly spaced pairs of recesses 15, 16 are formed in the opposed radially extending surfaces 12, 17 of the inertia member 2. Each recess 15, 16 is configured to receive an annular PTFE button 18 which acts as an axial thrust bearing. A recess 19 extends axially across a portion of the radially inner periphery 20 of the inertia member 2 and receives a split PTFE ring 21 which acts as a radial thrust bearing. The buttons 18 and ring 21 thus ensure that the inertia member 2 is concentrically supported within the housing 3. PTFE is used for the bearings in this prior art arrangement owing to its low friction characteristics and its resistance to degradation by the viscous damping fluid. Moreover, PTFE does not degrade the viscous damping fluid.

The prior art torsional vibration viscous fluid damper shown in figure 2 is of the same general construction as that of figure 1 but has a different bearing arrangement. Components corresponding to those of figure 1 will be denoted by the same reference numerals but increased by 100 and will not be further described except in so far as they differ from their counterparts in figure 1.

In this design the inertia member 102 has a pair of radially extending recesses 122, 123 formed in the radially extending surfaces 112, 117 of the inertia member 102. The inertia member 102 is formed so as to define an axially extending clearance 124 between the radially inner periphery 120 of the inertia member 102 and the axially extending wall 105. Clearance 124 and recesses 122, 123 are configured to receive a pair of nylon rings 125, 126 of L-shaped cross section which act as combined axial and radial thrust bearings and support the inertia member 102 concentrically within the housing 103.

Referring now to the embodiment of the present invention shown in figures 3 and 4, the torsional vibration viscous fluid damper shown in figure 3 and the inertia member shown in figure 4 are of the same general construction to those of figures 1 and 2. Components corresponding to those of figure 1 will be denoted using the same reference numerals but increased by 200 and will not be further described except in so far as they differ from their counterparts in figure 1.

The inertia member 202 is supported by an annular bearing 227 so that a clearance 208 is defined between the housing 203 and the inertia member 202. The bearing 227 is of U-shaped cross section and is disposed between the inner periphery 220 of the inertia member 227 and the wall 205 of the housing 203. The bearing 227 thus acts to support the inertia member 202 within the housing 203. The bearing 227 is formed of nylon and is moulded directly on to the surface of a radially inner portion 228 of the inertia member 202 as described below. It covers the radially inner periphery 220 and a portion of radially extending surfaces 212, 217 of the inertia member 202 and thus acts as a combined axial and radial thrust bearing.

The annular inertia member shown in figures 5 and 6 is of a similar construction to that shown in figure 4 and is intended for use within an annular housing similar to that shown in figure 3. Components corresponding to those of figures 3 and 4 will be denoted using the same reference numerals but increased by 100 and will not be further described except in so far as they differ from their counterparts in figures 3 and 4.

In this embodiment of an aspect of the present invention a nylon layer 329 has been moulded over the entire exterior surface of the inertia member 302 (using a method described below). The radially inner region 330 of the layer 329 surrounding the radially inner periphery 320 and part of the radially extending surfaces 312, 317 of the inertia member 302 is thicker than the radially outer region 331 and acts as a combined axial and radial thrust bearing 327. In this embodiment, the inertia member 302 has not been formed with an annular V-shaped groove, instead the annular housing (not shown) will be provided with a suitable groove, or the like.

The moulded layer 329 shown in figures 5 and 6 is formed over the exterior surface of the inertia member 302 by the following method. A first set of supporting studs are placed in a first mould section (not shown). The inertia member 302 is then positioned on the studs with its rotational axis vertical so that it is located in the first mould section and spaced apart therefrom by a distance corresponding to the desired shape and thickness of the layer 329. A second set of supporting studs are then placed on the surface of the inertia member 302 and a second mould section placed on to the second set of studs and connected to the first mould section so as to form the complete mould.

Liquid nylon, or other plastics material, is injected through ports into the mould and allowed to cool so as to form a layer of nylon over the exterior surface of the inertia member 302. The mould is disassembled and the inertia member 302, with moulded layer 329, is removed ready for mounting within an annular housing (not shown).

The moulded bearing 227 shown in figures 3 and 4 is formed in the same way as the nylon layer 329 but using a differently shaped mould which is complementary to the desired shape and thickness of the bearing 227. The mould may take any convenient interior and/or exterior formed to suit the desired application. It is envisaged that when forming a moulded bearing similar to that shown in figures 3 and 4, the mould is constructed so as to cover only the radially inner portion 228 of the inertia member 202.

Moulding a bearing directly on to the inertia member in this way simplifies the assembly process by removing the need to mount a plurality of components (such as PTFE tape/buttons and split nylon rings) on to the inertia member and facilitates greater automation of the damper assembly process. The bearing is also less likely to become dislodged from the inertia member during use.

Bearings of any desirable form can be produced, and since the bearing covers at least a part of the surface of the inertia member this surface no longer needs to be machine finished to the same manufacturing tolerances as in conventional dampers. This means that the inertia member can be, if desired, cut away from an elongate bar without the need for subsequent significant machining. Problems associated with moisture absorption by bearings formed of nylon and other similar materials are also overcome by the increase in speed of assembly of the bearing by moulding it directly on to the inertia member *in situ*.

When the method of the present invention is used to form a layer of bearing material over substantially all of the exterior surface of the inertia member, this layer prevents any particles of metal becoming separated from the member and causing wear or oil egressing from the inertia member during use. The need to de-oil such materials is eliminated and this improves production efficiency by allowing cheaper sintered metals to be used.

It will be understood that numerous modifications can be made to the embodiments of the invention described above without departing from the underlying inventive concept and that these modifications are intended to be included within the scope of the invention. For example, the annular inertia member and housing may take any convenient form to suit the particular application. The moulded bearings may, of course, take any desired form and may be manufactured from any suitable bearing material.

CLAIMS

1. A method for providing a bearing on an annular inertia member, the method comprising placing at least a part of the inertia member into a mould to define a mould cavity between the inertia member and the mould, and injecting a bearing material into the mould cavity so as to form a bearing directly on to the inertia member.

2. A method in accordance with claim 1, wherein the part of the inertia member in the mould comprises at least a radial inner periphery of the inertia member.

3. A method in accordance with claims 1 or 2, wherein the part of the inertia member in the mould comprises at least a portion of a radially extending surface of the inertia member.

4. A method in accordance with claim 1, 2 or 3, wherein the part of the inertia member in the mould comprises substantially all of the exterior surface of the inertia member.

5. A method in accordance with claim 4, wherein the bearing material formed on at least a radially inner periphery of the inertia member is thicker than that formed on the remainder of the exterior surface of the inertia member.

6. A method in accordance with claim 4 or 5, wherein the layer of bearing material formed on at least a portion of a radially extending surface of the inertia member is thicker than that formed on the remainder of the exterior surface of the inertia member.

7. A method in accordance with any preceding claim, wherein the bearing material is a plastics material.

8. A method in accordance with claim 7, wherein the plastics material is nylon.

9. A method in accordance with any preceding claim, wherein the part of the inertia member in the mould is supported therein by at least one supporting member during moulding.

10. A method in accordance with claim 9, wherein the, or each, supporting member is a stud.

11. A method in accordance with any preceding claim, wherein the mould is formed from a plurality of sections which are assembled around the part of the inertia member so as to define the mould.

12. An annular inertia member having a bearing moulded thereon.

13. An annular inertia member in accordance with claim 12, wherein the bearing is moulded on at least a radial inner periphery of the inertia member.

14. An annular inertia member in accordance with claim 12 or 13, wherein the bearing is moulded on at least a portion of a radially extending surface of the inertia member.

15. An annular inertia member in accordance with claim 12, 13 or 14, wherein the bearing is moulded on substantially all of the exterior surface of the inertia member.

16. An annular inertia member in accordance with claim 15, wherein the bearing moulded on at least a radially inner periphery of the inertia member is thicker than that formed on the remainder of the exterior surface of the inertia member.

17. An annular inertia member in accordance with claim 15, wherein the bearing moulded on at least a portion of a radially extending surface of the inertia member is thicker than that formed on the remainder of the exterior surface of the inertia member.

18. An annular inertia member in accordance with any one of claims 12 to 17, wherein the bearing material is a plastics material.

19. An annular inertia member in accordance with claim 18, wherein the plastics material is nylon.

20. A method for constructing a torsional vibration viscous fluid damper having an annular inertia member rotatably disposed in an annular chamber of a housing, the method comprising placing at least a part of the inertia member into a mould to define a mould cavity

between the inertia member and the mould, and injecting a bearing material into the mould cavity so as to form a bearing directly on to the inertia member.

21. A torsional vibration viscous fluid damper having an annular inertia member having a bearing moulded thereon.

22. A method for providing a bearing on an annular inertia member substantially as hereinbefore described with reference to figures 3 and 4, or 5 and 6 of the accompanying drawings.

23. An annular inertia member having a bearing moulded thereon substantially as hereinbefore described with reference to figures 3 and 4, or 5 and 6 of the accompanying drawings.

24. A method for constructing a torsional vibration viscous fluid damper substantially as hereinbefore described with reference to figures 3 and 4, or 5 and 6 of the accompanying drawings.

25. A torsional vibration viscous fluid damper substantially as hereinbefore described with reference to figures 3 and 4, or 5 and 6 of the accompanying drawings.

The Patent Office

INVESTOR IN PEOPLE

Application No: GB 0209224.5
Claims searched: 1-11

Examiner: David J Evans
Date of search: 26 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1-2, 7-9 & 11	GB 2359869 A	(AP TMF LTD.) especially see fig 6, page 2 paragraphs 2 & 7, page 3 paragraphs 1-4 and page 10 paragraph 5.
X	1-3, 7-8 & 11	JP 7317772 A	(NTN TOYO BEARING CO. LTD.) see figs 1, 3 & 7 and abstract translation.
X	1, 3, 7-8 & 11	DE 4304188 A1	(VORWERKCO. INTERHOLDING) see figs and abstract translation.
X	1, 3, 7-8 & 11	JP 3268915 A	(ONKYO KK) refer to figs 1-3 and abstract translation.
X	1-2, 7-8 & 11	JP 4275137 A	(BRIDGESTONE CORP.) refer to figs 7 & 9 and abstract translation.
X	1-2, 7-8 & 11	JP 59037328 A	(HATA GIKEN KK) see figs 7-13 & abstract translation.
X	1-2 & 7-8	US 6354953 B1	(HERCHENBACH) especially see figs 2-3, column 1 lines 31-36 and column 3 lines 44-46.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

B5A, F2A

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

B29C, F16C

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI & PAJ.