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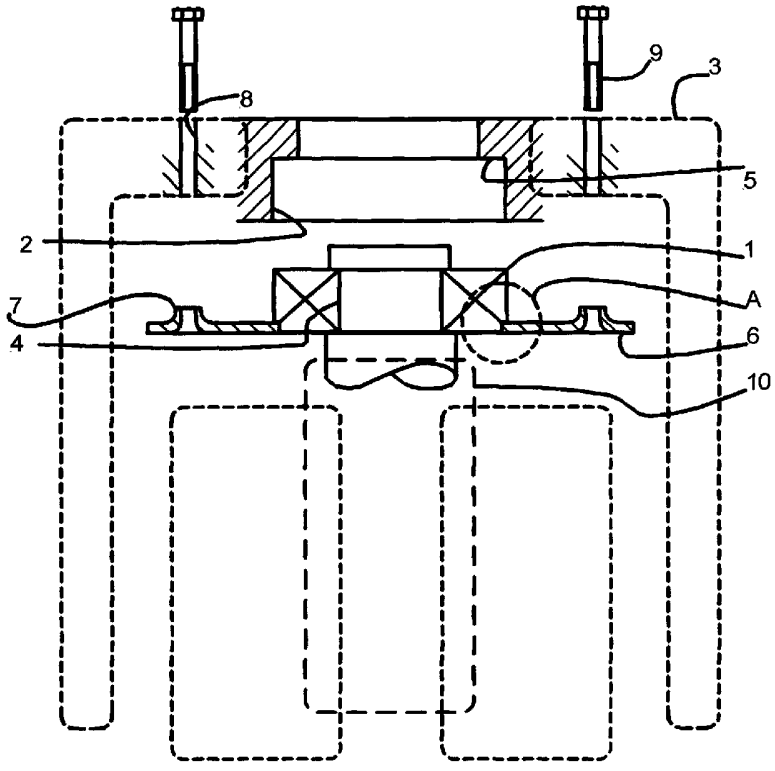
(54) Title: A BEARING ASSEMBLY



(57) Abstract: A bearing assembly is disclosed which addresses the problem of axially retaining a bearing journaled onto a shaft within a casing in an axially compact and technically economic and reliable way by first mounting a retaining plate (6) onto an outer race of the bearing (1). The mounting can be achieved by press fitting onto a shoulder so that the retaining plate can rotate relative to the outer race. The bearing is then journaled onto a shaft (4) and inserted into a compact casing (3) so that the outer race is guided into a housing (2) formed in an end wall of the casing (3). The retaining plate can then be rotated as required to align fastening bosses (7) with holes (8) to be engaged by screws (9) so that the retaining plate us urged axially against the outer race.

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European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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A Bearing Assembly

The present invention is concerned with the form of and a method of forming a bearing assembly particularly adapted for use where the bearing is subject to axial loads, in very compact machine assemblies without fastening tool access to the bearing housing and where robot machine assembly is desirable.

The present invention arose in addressing the problem of assembling a bearing into a compact vehicular gear box housing where the bearing is journaled onto a gear shaft of the gear box together with a number of other components such as gears. It will hereafter be described in that context but unless otherwise stated the invention may have applications in many other similar structures. In such a gear box the gear shaft is journaled onto a bearing and the bearing received into a bearing housing formed in the gear box casing. The fitting of the outer is typically an engineering interference fit or similar means of location such that the outer is not free to take up a different angular orientation. In operation the shaft is subject to axial forces which urge the bearing out of its housing in each axial direction. The forces directed axially out of the casing are resisted by a shoulder formed in the casing. However a retaining means must act between the outer race of the bearing and the casing to prevent axial displacement in the opposite direction. An example of conventional means may be a circlip received into a groove formed in the wall of the bearing housing. However, the installation of such retaining means requires access by a tool to the inside of the casing and is difficult to implement robotically. Further the use of circlips and like devices requires a loose fit between the bearing outer and the circlip which undesirably permits axial movement of the bearing and occupies space in the axial direction. Also, circlips and similar devices are not easy to disassemble without good tool access. If such access requirement can be obviated robot assembly will be possible and the bulk of the gear box can be reduced with numerous advantages which will be apparent to the skilled person.

Also known in the prior art is EP1265339 which discloses a bearing assembly in a motor. A retaining plate is first mounted temporarily onto a shaft. A bearing is then journaled onto the shaft. The assembled retaining plate and bearing are then inserted into the motor casing with the outer race of the bearing being inserted into a bearing housing. This presents a problem in that the retaining plate must be dismounted from the shaft before operation. Further the retaining plate cannot be arranged to sit flush with the inner end of the bearing so that the axial length of the bearing and housing assembly is not minimised.

Accordingly to alleviate these problems the present invention provides a bearing assembly comprising:

a bearing assembly comprising: a bearing having an outer race for reception in a bearing housing formed in a casing and an inner race to be journaled onto a shaft, and a retaining plate mounted onto the outer race before assembly into the bearing housing or onto the shaft and provided with fastening means to cooperate with fastening means provided in or on a wall of the casing opposing the retaining plate.

The retaining plate may be irrotatably fastened for some applications, for example by press fitting. However, in the preferred embodiment of the invention the retaining plate is fastened so as to rotate with respect to the outer race thus providing for convenient alignment of the fastening means after the outer race is irrotatably retained in the housing.

Further according to the present invention there is provided a method of forming a bearing assembly comprising the steps of:

mounting a retaining plate on an outer race of a bearing whereby when the bearing is seated in a bearing housing it is axially retained by the retaining plate which is secured by fastening means acting between a casing in which the bearing housing is formed and the retaining plate.

According to another aspect of the present invention there is provided a method of forming a boss in a plate to be subject to cyclic fatigue loads in use comprising,

selecting the material of the plate to have a high strain hardening coefficient in excess of 0.35, and

press forming the boss against a die such that the radius of curvature of the region between the original plate and the wall of the boss complies with the formula:

radius = plate thickness X A

where "A" has a value between 0.3 and 0.7 such that the arcuate portion of the boss work hardens under load to produce a region having a high local tensile strength.

The bearing assembly of the present invention alleviates the problems discussed above as will be apparent from the following non limiting detailed description of one embodiment of the bearing assembly and method of forming a bearing assembly which refers to the figures described briefly as follows:

Figure 1 is a sectional elevation through a gear box casing showing the bearing assembly during installation in a bearing housing formed in the casing,

Figure 2 is an enlarged sectional elevation through a die punch showing the formation of a clinching lip (17) on a retaining plate of the assembly,

Figure 3 is an enlarged sectional view through a shoulder of a bearing as the retaining plate is mounted on it,

Figure 4 is an enlarged sectional view showing the engagement of the clinching lip (17) with the groove in the retaining plate,

Figure 5 is a sectional view through the retaining plate alone and,

Figure 6 is a plan view of the retaining plate.

Figures 7A and 7B show the formation of a boss in the retaining plate.

Referring to the drawings, figure 1 shows a bearing assembly comprising, a bearing 1 having an outer race for reception in a bearing housing 2 formed in a casing 3 for a vehicular gear box. The inner race of the bearing 1 is journaled onto a shaft 4. The bearing 1 is to be received into the bearing housing 2 so that it abuts a shoulder 5 formed in the housing to prevent displacement of the bearing in the axial direction (with respect to the shaft) out of the casing 3. To prevent the bearing 1 being displaced in the opposite axial direction a retaining plate 6 is mounted for rotation with respect to the outer race of the bearing 1. When the bearing 1 is seated in the housing fastening means provided by threaded bosses 7, formed in the retaining plate 6, are aligned with through holes 8 formed through the casing 3 so that screws 9 can be driven through the holes to engage in the bosses 7 and retain the retaining plate 6. The bearing assembly can therefore be installed where the components 10 are mounted on the shaft in such close proximity to the retaining plate as to prevent the operation of the tools between the retaining plate and the components and where the casing surrounds the bearing shaft, components and retaining plate to the extent that a fastening tool cannot operate on the retaining plate. This in turn allows further components such as gears 10 to be assembled on to the shaft in very close proximity to the bearing 1 before the bearing assembly and shaft is installed.

The retaining plate 6 is formed from metal strip by first punching out the bosses 7. A centre hole 11 is then punched out. A plurality of clinching lip (17)s 12 are then formed along arcs spaced around the circular inside edge of the retaining plate 6. In the present example three lip (17)s are formed, however, according to specific requirements two to five lip (17)s may be formed.

Figure 2 shows the use of a specially designed punch tool to form the clinching lip (17). The hole 11 is located on a die plate 13 surrounding a circular guide 14. A platen ring 15 is then pressed against the exposed surface of the plate before a coining punch 16 is driven part way into the surface of the retaining plate spaced a small

distance from the edge of the hole. The coining punch has a wedge shaped blade 17 which engages in the surface of the retaining plate to plastically deform the edge of the plate so forming a lip (17) 17 on the edge which projects up, i.e. in the axial direction, from the surface of the retaining plate and leaves a groove 18 along its edge remote from the hole. The coining punch may also form notches 19 at each end of the arc to control the deformation at each end. Each arc deformed by the coining punch extends over between 12 and 36 degrees of arc so that the total part of the edge deformed is between 10% and 30%.

A shoulder 20 is formed on the edge of the outer bearing race of the bearing 1. A triangular shaped groove 21is formed in the shoulder 20 adjacent the axial face 22 formed with the shoulder. In the present example the groove is of the order of 0.3-0.4 mm deep and the clinching lip (17) 17 is of a similar height. The hole in the retaining plate is made oversize in relation to the diameter of the shoulder 21.

To secure the retaining plate 6 to the bearing 1 the retaining plate is located over the bearing with the clinching lip (17) 17 engaging the axial face 22. It may be noted that the fit of the hole 11 over the shoulder 20 is loose as indicated by the exaggerated gap shown in figures 3 and 4. An assembly force is then applied in the direction of the arrow in figure 3 which plastically deforms the clinching lip (17) causing it to engage in the groove 21 as shown in figure 4.

The retaining plate 6 also provides a retaining element in the form of a "U" shaped bracket 23 projecting from an outer periphery of the plate. The Forks of the "U" shaped plate engage a gear change support rod (not shown).

It is undesirable that the plate gauge should be any greater than necessary in order to minimise the space occupied by the retaining plate. It is essential that the bearing is retained with minimal movement so that the fastening means need to provide the retaining plate with a clamping action against the axial face of the bearing. It is furthermore the case that the retaining plate is subject to cyclic axial loads during

operation which present a metal fatigue problem. Conventionally punch forming the bosses onto the plate exacerbates the metal fatigue problem by work hardening the plate so that punch forming the bosses is contraindicated. However, punch forming presents substantial economies by comparison with alternative conventional solutions to the formation of fastening means. It is a further problem with punch forming the bosses to ensure that the end faces of the bosses are exactly flat.

In order to enable punch forming of the bosses the plate may conveniently be formed from a material having a high strain hardening coefficient. Preferred examples are austentitic stainless steel grade 304 and plain carbon steel grades 1020-1040. An alternative approach is to select a highly formable material and after formation of the bosses to subject it to further processes such as surface hardening or the Nitrotec process to improve its fatigue tolerance.

Figures 7A and 7B illustrates the tooling designed for formation of the bosses. The tooling comprises a die 24 having an arcuate rim 25. The radius of the arc must be carefully formed to prevent necking in the restraining plate 6. The radius of the arc is preferably formed in compliance with the formula:

radius = plate thickness X A

where "A" has a value between 0.3 and 0.7.

A punch tool 26 is specially shaped to ensure that in cooperation with the die the end face "F" of the boss 7 is flat and square.

Although the example described uses screws to fasten the plate the use of other fastening means such as rivets is envisaged as within the scope of the invention.

Claims.

1. A bearing assembly comprising:

a bearing (1) having an outer race for reception in a bearing housing (2) formed in a casing (3) and an inner race to be journaled onto a shaft (4), characterised in that

a retaining plate (6) is mounted onto the outer race before assembly into the bearing housing (2) and provided with fastening means (7) to cooperate with fastening means (9) provided in or on a wall of the casing (3) opposing the retaining plate (6).

2. An assembly according to claim 1 wherein the retaining plate (6) is mounted for relative rotation with respect to the outer race.

3. An assembly according to claim 1 or claim 2 wherein the retaining plate (6) is mounted by means of a press action loose fitting clinching lip (17) (17) formed on a circular inside edge of the retaining plate (6) which deforms plastically to engage in a circular groove (21) formed in a circular shoulder (20) in the outer race of the bearing (1).

4. An assembly according to claim 3 wherein the clinching lip (17) is formed only on spaced parts of the circular inside edge of the retaining plate (6).

5. An assembly according to claim 4 wherein the total circumferential length of the spaced parts is between 10% and 30% of the circumference of the inside edge.

6. An assembly according to any one of the preceding claims in combination with a shaft (4) on which are mounted components in such close proximity to the retaining plate (6) that a fastening tool cannot be operated between the components and the retaining plate (6).

7. An assembly according to any one of the preceding claims in combination with a bearing housing (2) formed in a casing (3) wherein once the bearing (1) is received into the housing, the casing (3) and components prevent a fastening tool from acting on the retaining plate (6).

8. An assembly according to any one of the preceding claims wherein the fastening means (9) comprises a screw received into a boss in the retaining plate (6) via a through hole formed in the casing (3).

9. An assembly according to claim 8 wherein the fastening means (9) act together to angularly align the retaining plate (6) to a predetermined orientation.

10. An assembly according to any one of the preceding claims wherein the retaining plate (6) includes further locating or retaining elements to locate or retain other components of the assembly.

11. An assembly according to claim 10 in combination with a gear box.

12. An assembly according to claim 11 wherein at least one further locating element is a hole or recess which receives an end of a gear change support rod.

13. A method of forming a bearing assembly comprising the steps of:

first mounting a retaining plate (6) on an outer race of a bearing (1) whereby, when the bearing (1) is subsequently seated in a bearing housing (2) it is axially retained by the retaining plate (6) which is secured by fastening means (9) acting between a casing (3) in which the bearing housing (2) is formed and the retaining plate (6).

14. A method according to claim 13 wherein the retaining plate (6) is mounted onto the outer race to rotate relative to the outer race.

15. A method according to claim 13 or 14 comprising the steps of:
forming a shoulder on an outer edge of an outer race of the bearing (1),
forming a groove in the shoulder,
forming the retaining plate (6) by punching a hole in strip material,
punching a sizing nose onto the retaining plate (6) in an arc around the hole,
locating the hole of the retaining plate (6) over the shoulder and
pressing the retaining plate (6) axially against the side of the outer race to upset the clinching lip (17) so that a reshaped lip (17) is formed engaging in the groove.

16. A method of forming a bearing assembly according to claim 15 comprising the steps of forming a plurality of circumferentially spaced clinching lip (17)s around parts of the circumference of the hole.

17. A method according to claim 15 wherein the clinching lip (17)s are formed around arcs extending in total between 10% and 30% around the hole.

18. A method according to any one of claims 13 to 17 wherein fastening means (9) is formed into the retaining plate (6).

19. A method according to claim 18 wherein the fastening means (9) is formed by punching a plurality of bosses through the plate around the hole.

20. A method according to claim 19 wherein the radius of curvature formed between the body of the plate and the boss complies with the formula:

radius = plate thickness X A

where "A" has a value between 0.3 and 0.7 and the material from which the retaining plate (6) is formed has high strain hardening coefficient exceeding 0.35 such that the arcuate portion of the boss work hardens under load to produce a region having a high local tensile strength.

21. A method according to anyone of claims 13 to 20 wherein the material from which the plate is formed is selected from Austentitic stainless steel grade 304.

22. A method according to any one of claims 13 to 21 comprising the steps of journaling the assembled bearing (1) and retaining plate (6) onto a shaft (4) in such close proximity to other components mounted on the shaft (4) that a fastening tool cannot operate between the components and the retaining plate (6).

23. A method according to any one of claims claim 13 to 22 wherein the bearing (1) is journaled onto a shaft (4) and inserted into a bearing housing (2) formed in a casing (3), and

fastenings are driven through the casing (3) to engage the fastening means (9) formed in the retaining plate (6).

24. A method according to claim 23 wherein the fastenings are screws.

25. A method of forming a boss in a plate to be subject to cyclic fatigue loads in use comprising,

selecting the material of the plate to have a high strain hardening coefficient in excess of 0.35, and

press forming the boss against a die such that the radius of curvature of the region between the original plate and the wall of the boss complies with the formula:

radius = plate thickness X A

where "A" has a value between 0.3 and 0.7 such that the arcuate portion of the boss work hardens under load to produce a region having a high local tensile strength.

26. A method according to claim 25 wherein the material of the plate is Austentitic stainless steel grade 304.

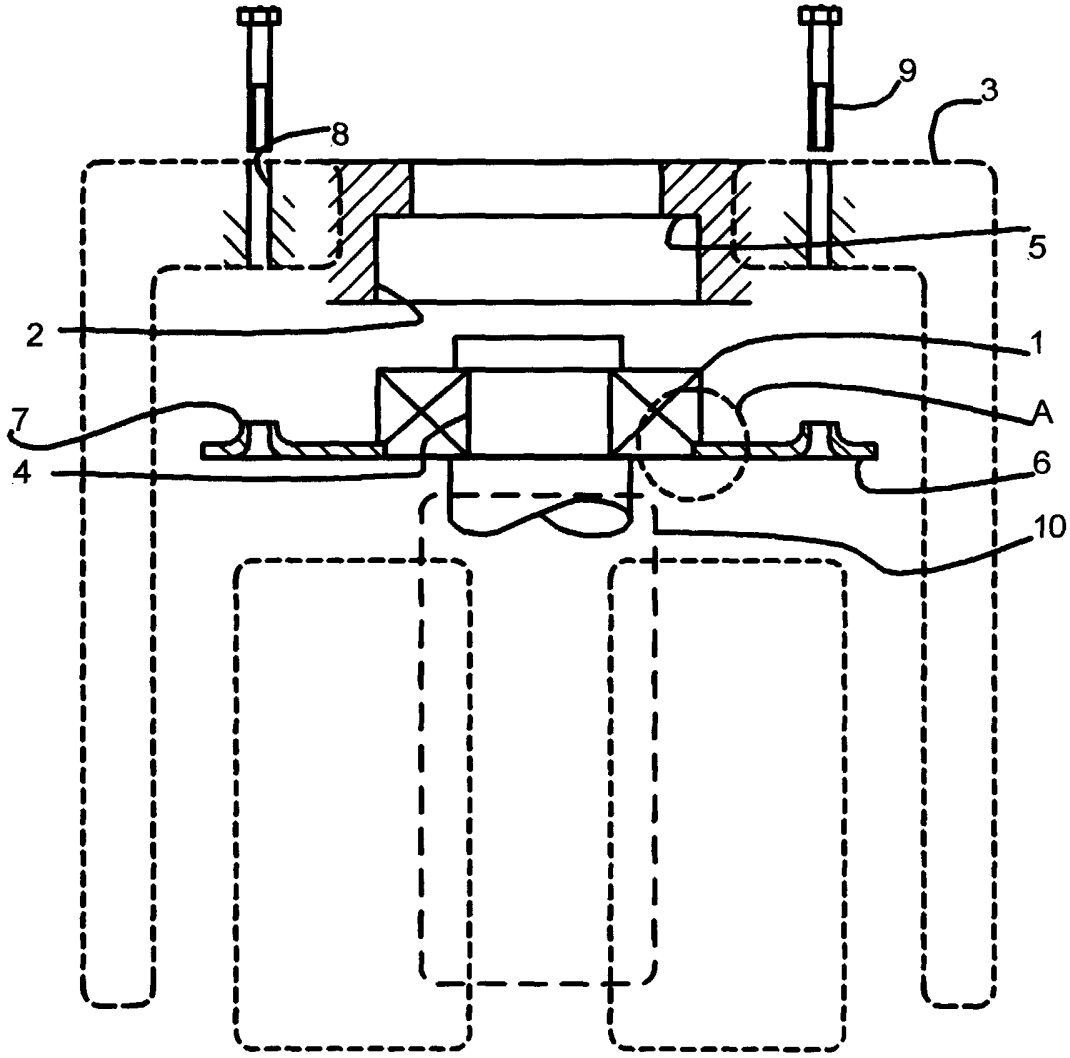

Fig 1

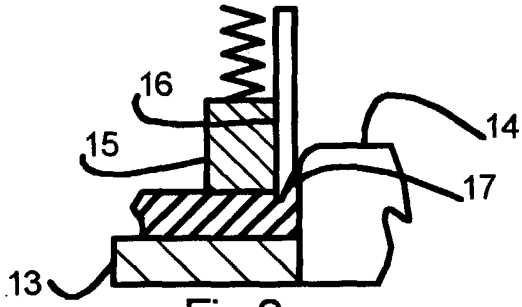

Fig 2

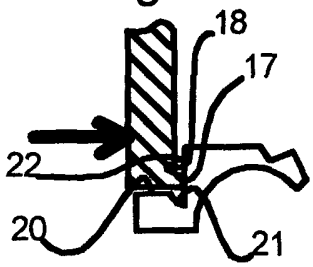

Fig 3

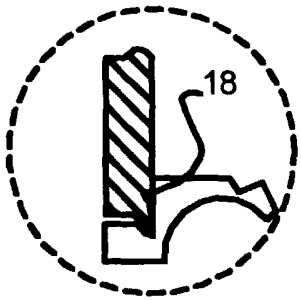

Fig 4

Fig 5

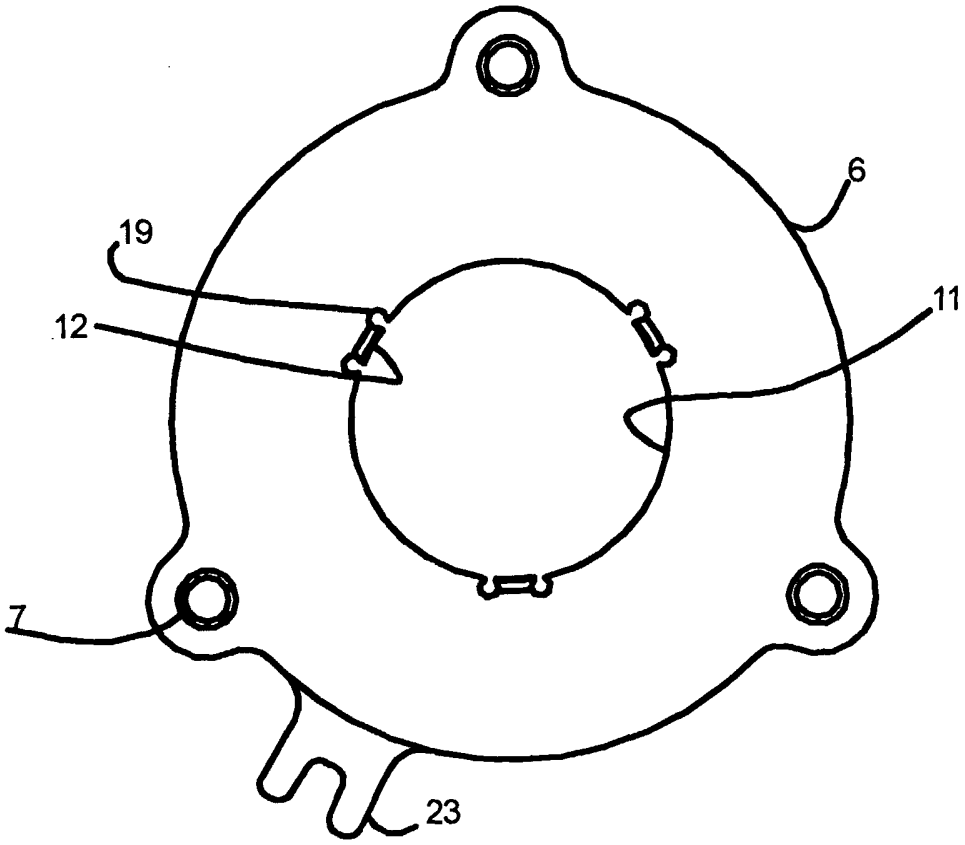

Fig 6

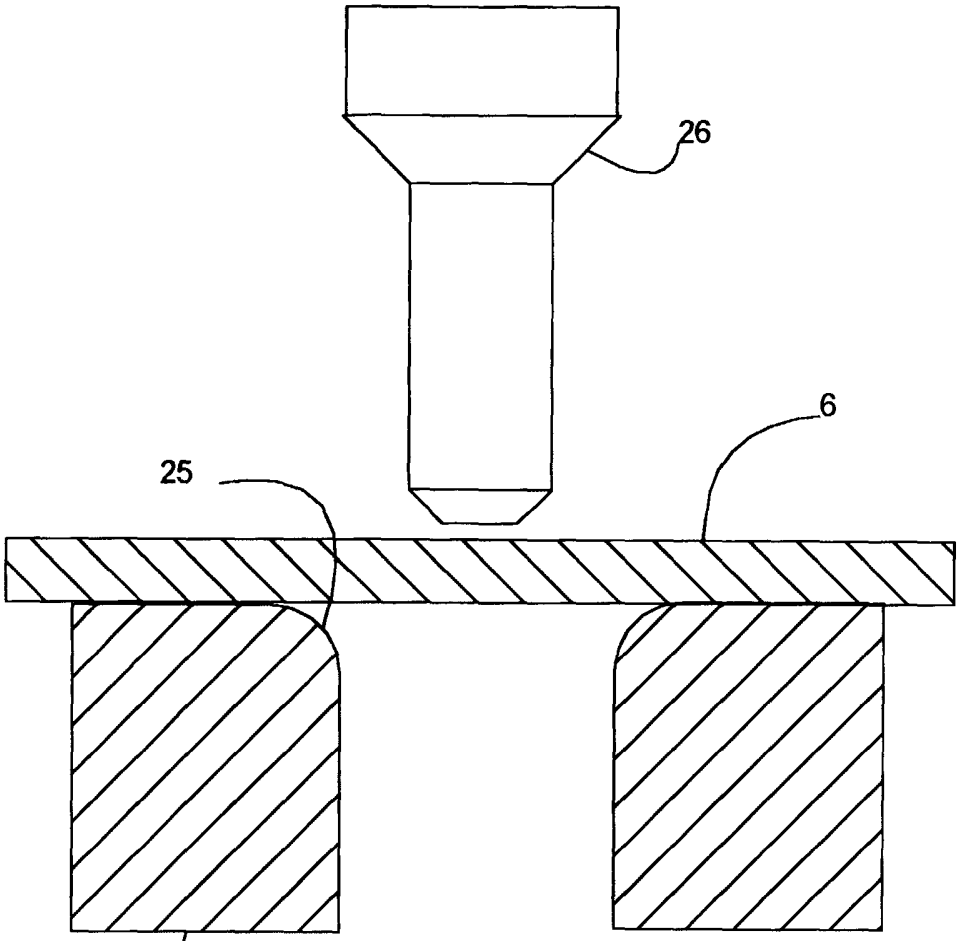

Fig 7A

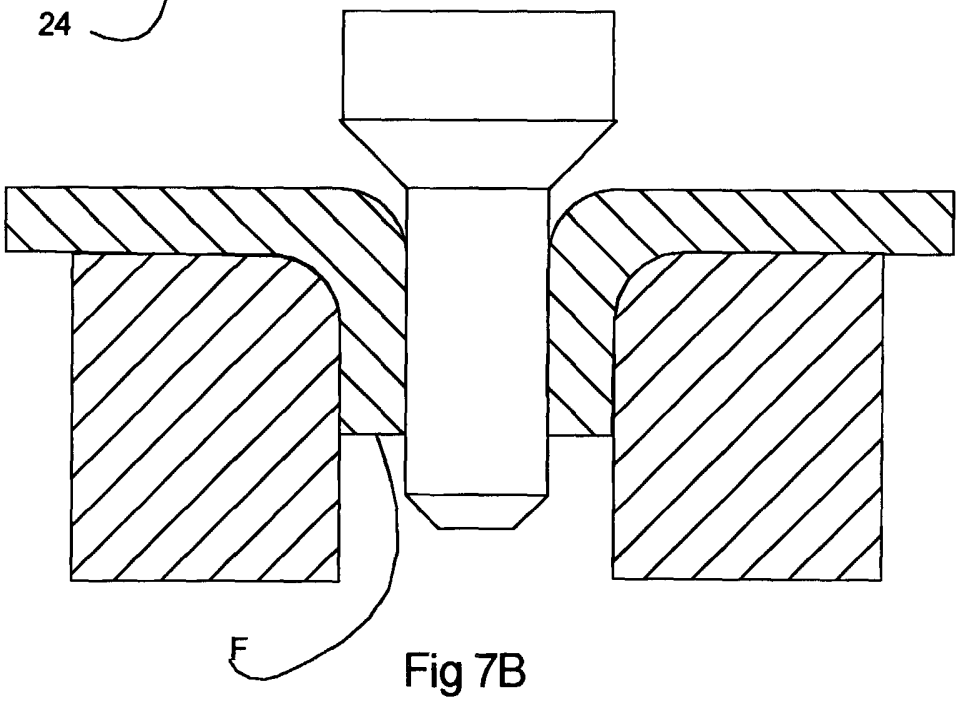

Fig 7B

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB2004/003778

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16C35/067 B21D28/26

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 7 F16C B60K H02K F16H B21D

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 practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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

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Date of the actual completion of the international search	Date of mailing of the international search report
9 December 2004	22/12/2004

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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