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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F16L 37/092	A1	(11) International Publication Number: WO 98/54504
		(43) International Publication Date: 3 December 1998 (03.12.98)

(21) International Application Number: PCT/GB98/01533

(22) International Filing Date: 27 May 1998 (27.05.98)

(30) Priority Data:
9710919.3 27 May 1997 (27.05.97) GB

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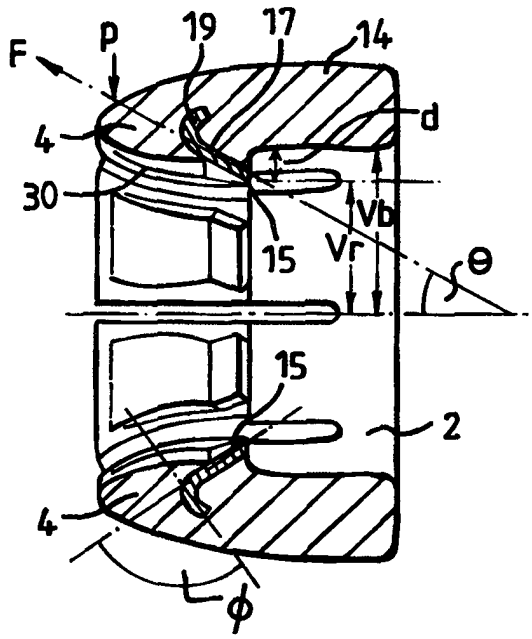
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: GRAB RING AND SOCKET INCORPORATING A GRAB RING

(57) Abstract

A plastics grab ring (14) for use in a push–fit socket comprises metal resistance members (16) embedded in its structure. The resistance members have elongate portions (17) which are aligned with an axis along which tensile force is transmitted under joint loading. In another aspect, a grab ring (14) comprises a mouth which has a tapering diameter due to axial fingers (4) of the grab ring (14) being provided with arcuate radially inner surfaces (30). The orientation of the resistance members provides strength and resistance to failure. The shape of the mouth serves to centre spigot during insertion, prior to admitting it to the socket.



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GRAB RING AND SOCKET INCORPORATING A GRAB RING

The invention relates to a grab ring and a pipe socket incorporating a grab ring. More particularly, but not exclusively, the invention relates to a grab ring and joint system for use in a push-fit pipe fitting. Such fittings are commonly used in various plumbing applications and have the advantage that few or no tools are required to form a joint between the fitting and the pipe spigot, which is received in a socket provided on the fitting. Such fittings are generally well-known.

Figure 5 of the accompanying drawings shows a partial sectional view through a known fitting and pipe spigot, together forming a joint. In the interest of clarity no seal or end-stop are shown. The principle of operation is straightforward. A pipe spigot 10 is inserted into the socket 12 in the direction of the arrow I until an end-stop (not shown) is reached. A gripping part 14 which typically comprises a contracting grab ring around the pipe 10 engages the pipe, for example by way of radial tooth 16. If a destructive axial force Fr is applied to the pipe 10 and tends to urge the pipe out of the socket, a frusto-conical camming surface 20 on the gripping part 14 co-operates with a complementary camming surface 18 situated in the mouth of the socket. These surfaces define an angle ϕ with respect to the insertion direction of the pipe. As the force Fr is applied to the pipe 10 the grab ring 14 moves with the pipe due to the action of the tooth 16. As a result of this movement and the consequent interaction of the camming surfaces 18,20 a radial closing force F is applied to the ring 14. The force F serves to embed the tooth 16 more firmly into the pipe 10 and thus grip the pipe 10 ever more securely. Eventually, the two camming surfaces wedge together, preventing any further axial displacement.

When the pipe is initially jointed, there needs to be sufficient inwardly radial force between the grab ring teeth and the pipe in order to create an initial "bite" into the pipe

to allow the wedge action to create a much greater "bite" thereby ensuring a good resistance to axial loading. This action relies upon the teeth not sliding on the pipe initially. In order to ensure this and in order to resist wearing and breakage of the teeth, it has been proposed to provide a grab ring having metal teeth. Such rings include two particular types. In the first type, the whole grab ring is formed from appropriately pressed and formed sheet metal. This provides excellent gripping qualities, but manufacture tends to be expensive and forming the metal to provide the desired operational characteristics can be complicated.

An alternative form of grab ring includes a generally plastics ring in which metal teeth are embedded. Such a grab ring is employed in a coupling disclosed in WO 97/03314. A grab ring of the type shown in WO 97/03314 can solve the problems associated with metal grab rings. However, it is desirable to provide a grab ring that is less susceptible to mechanical failure. The first aspect of the present invention sets out to provide such a grab ring.

Conventional grab rings, whether made from plastics, metal or a combination of the two must not only securely retain a pipe spigot within the socket under axial loading, but also admit the pipe spigot into the socket with relative ease, upon insertion. The present invention also sets out to provide a grab ring which particularly facilitates this.

According to the first aspect of the invention there is provided a grab ring for securing a spigot within a socket; the grab ring comprising a substantially annular body portion formed from a first material and a resistance member for resisting axial movement of a spigot located coaxially within the body portion in one direction, whilst allowing axial movement of said spigot in a second, opposite axial direction, the said resistance member being embedded in the said body portion and formed from metal; wherein the said resistance member, when viewed in section, has an elongate portion which has a longitudinal axis that is aligned with a path along which the grab ring disperses force when it resists the axial withdrawal of a spigot from a socket during use.

Preferably, the elongate portion is inclined at an angle of from 30° to 40° with the axis of the grab ring.

The metal portion may be provided with an enlarged force-dispersing surface which faces generally in the direction of the said force dispersion path. In one preferred embodiment, the resistance member may include a transverse flange in a region thereof which is located at an end thereof which is opposite to a spigot-addressing end thereof. The flange may be defined by a portion of the resistance member which is bent through an angle in the said end region. The angle may be 90° to prevent the generation of forces which could detach the resistance member from the body portion. Other angles are possible but increase the reliance of a bond between the resistance member and the body portion.

The grab ring may comprise a radially outer contact region, for abutting a radially inner surface of a socket, which contact region defines the said path of force dispersion. The path of force dispersion is determined by the relative positions of the two contact points, one where the metal portion contacts the pipe and the other where the radially outer contact region abuts the radially inner surface of a socket.

The body portion of the grab ring may be defined by an annular support ring provided with a plurality of circumferentially spaced axially extending fingers. One or more of the fingers may be provided with a respective resistance member.

According to a second aspect of the invention there is provided a grab ring for securing a spigot within a socket, the grab ring comprising a body portion formed from an annular support ring and a plurality of integral, circumferentially spaced axially extending fingers formed upon the support ring and adapted to flex, in a radial direction, about their junctions with the support ring; wherein the distal ends of the fingers together define a mouth for receiving a spigot, and each of the fingers, in cross-section, has a convex radially inner surface in the region of the said mouth, the said

convex surfaces causing the mouth diameter to increase, at an increasing rate, with distance from an axially inner position to an axially outer position.

Such an arrangement is particularly advantageous, because the curved radially inner surfaces of the fingers present a greater angle with the axis at an axially outer position, than they do at an axially inner position. This causes the radial force needed to flex the fingers to reduce as the pipe spigot moves into the grab ring. As a consequence of this, during insertion, it is initially difficult for the spigot to flex the fingers, but this becomes easier as the spigot is inserted. Hence, the fingers initially centre the spigot within the mouth of the grab ring and then allow it to be inserted. This greatly facilitates spigot insertion, reduces risk of damage to both the grab ring and the pipe spigot and serves to ensure true and even radial loading of the spigot, which ensures a good axial load resistance.

The invention also provides a socket comprising a mouth for receiving a spigot and a grab ring for securing a spigot within the said mouth, the grab ring having the features of the first or second aspect of the invention set out above.

Embodiments of the invention will now be described by way of example and with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of a grab ring in accordance with the invention;

Figure 2 is a cross-section through the grab ring of Figure 1;

Figure 3 is a plan view of the grab ring of Figures 1 and 2;

Figure 4 is a part axial section showing the grab ring of Figures 1 to 3 in use in conjunction with a socket and a spigot; and

Figure 5 is a partial schematic sectional view of a known fitting.

Referring to Figure 1 it will be seen that the grab ring 14 comprises an annular support ring 2 integrally formed with six axially extending fingers 4. Each of the fingers 4 is capable of radial flexion about its junction with the support ring 2. The support ring is formed from a plastics material which may be, for example, PVDF or polysulfone.

Each of the fingers 4 is provided with a metal resistance member 16, which is generally directed radially inwardly for interaction with a radially outer surface of a pipe spigot, such as shown in Figure 4.

Referring to Figure 2, it will be seen that each finger 4 has a convex radially outer surface 20 and a convex radially inner surface 30 in an end region which is distal relative to the support ring 2. The convex radially outer portion 20 is adapted to cam against a radially inwardly directed surface 18 of a socket mouth 12, as described generally above in relation to Figure 5. The radially inner convex surface 30 serves to assist insertion of the pipe spigot into the grab ring 14. The stiffness of each finger 4 is sufficiently large that the radial force needed to flex it significantly cannot be generated by a spigot end pushing against the axially outer part of the radially inner convex surface 30 (to the left of Figure 2) because the lead-in angle at this point is relatively large. Consequently, the fingers 4 initially resist radial deflection and direct the spigot into axial alignment with the grab ring. Once the spigot is forced, by the stiffness of the fingers 4 into axial alignment, the radially outward forces on the fingers increase because at this axially inner part of the radially inner convex surfaces 30, the lead-in angle is much smaller. The higher forces are then sufficient to flex the fingers 4 apart in order to allow the spigot to enter. This effect can be controlled by adjusting the flexibility of the fingers 4 in the radial direction (by selection of appropriate materials, or finger thickness, for example). Such adjustment will determine the axial point at which the fingers will admit a spigot of a given diameter being inserted with a given force.

The teeth 15 of the grab ring are defined by the metal resistance members 16. As will be seen from Figure 2, the resistance members take the form of metal inserts which have a cross-sectional profile which is defined by a straight elongate portion 17 and a radial portion 19. The straight portion 17 has its longitudinal axis aligned with the direction in which a force F is transmitted into the grab wedge under axial tension. The distribution of these forces can be understood by reference to Figure 4 in which a pipe spigot 10 is subjected to an axial force W which tends to urge the pipe spigot 10 out of the socket 12. Here it will be seen that the tooth 15 of the resistance member 16 exerts a biting force B into the spigot and the withdrawal of the spigot exerts a force F in the grab ring. Because the elongate portions 17 of the metal inserts 16 are aligned along the line of the forces F, B, there is no tendency for lateral separation between the metal insert 16 and the surrounding plastics of the finger 4. It will be seen that the contact region P of the radially outer surface 20 of the grab wedge fingers defines the line of the forces F and B. Therefore, the plastics material of the finger portions 4 between the contact point and the embedded end of the resistance member 16 is compressed and serves to resist movement of the resistance member 16 along the line of the forces F and B relative to the surrounding plastics of the finger 4. To assist this further, the metal insert 16 comprises a lateral portion 19 which is formed by bending an end portion of the resistance member 16. Although curved when viewed in cross section, as in Figure 2, for example, the lateral portion 19 extends generally along a cross-sectional axis which is at an angle ϕ relative to the line of action of the forces F and B. In this embodiment, $\phi = 90°$, although other angles are possible. By this configuration, the resistance member 16 can disperse the force F acting through it over a much wider area and thereby reduce the risk of the metal insert 16 moving along the direction of the force F within the finger 4 very significantly. Other forms can be applied to this end of the resistance member with similar effect, providing they have the effect of enlarging the force-dispersing area. For example, the end of the resistance member could be turned through substantially 360° to define a bead. Alternatively a lateral flange could project on either side of the elongate portion to define a cruciform arrangement. The illustrated embodiment has the advantage of providing the desired effect while being relatively simple to manufacture.

In this example, the elongate portion 17 of each metal insert is aligned at an angle θ to the longitudinal axis of the grab ring. An angle of 30° has been found empirically to be the best angle of inclination of the inserts. The angle provides a compromise between conflicting aims. If the angle is smaller then there is an increased tendency to cutting or shaving the plastics pipe. If the angle is larger, there is a greater tendency to breaking away of the metal inserts from the surrounding plastics of the finger. The angle may be varied for different pipe materials. It has been found, however, that an angle of between 30° and 40° is satisfactory.

The annular support ring 2 has an internal radius r_b that is greater than the internal radius r_t defined by the tips of the teeth 15 (see fig. 2). The difference *d* between the two radii is of the order of 0.5 mm. This difference restricts the distance that the teeth can penetrate into the radially outer surface of the pipe spigot 10, as can be seen from Figure 4. If *d* is too small, the teeth 15 will slide along the surface of the spigot. If this distance is too large, there is a danger that the teeth will cause failure by cutting through the pipe spigot.

In the example shown, the outside diameter of the fingers 4 is 3 mm greater than the inside diameter, giving a finger thickness of 1.5 mm.

The stiffness of the radial flexion of the fingers 4 is such as to provide an inward radial force and thereby cause an initial bite of the teeth 15 into a radially outer surface of a spigot, when inserted. This ensures a much greater, axial displacement resisting bite from the application of an axial load to the spigot. The thickness and length of the fingers are influential in this, as is the torsional rigidity of the support ring 2. These characteristics take into account the outer diameter of the spigot with which the grab wedge is to be used, because the difference between r_t and the outer radius of the spigot will also affect the level of radial force.

Reference is now made to Figure 3. In particular the fact that the inner edges of each of the metal inserts has a radius which is greater than the radius of the pipe they are in contact with. This provides two features:

(1) The contact point is very narrow initially so the pressure on the pipe from the metal insert is relatively high - helping to provide a good initial "bite". As the metal insert bites into the pipe due to the wedge action the contact width will increase rapidly, providing a substantial cross sectional area of contact to resist the axial loads.

(2) The tooth shape shown prevents the sharp corners of the teeth from "scoring" the pipe during insertion. This is particularly important when the rubber sealing ring is axially inwards from the grab ring because damage to the pipe surface during insertion could cause leakage.

Many further modifications and variations will suggest themselves to those versed in the art upon making reference to the foregoing description which is given by way of example and which is not intended to limit the scope of the invention, that being determined by the appended claims.

CLAIMS

1. A grab ring for securing a spigot within a socket; the grab ring comprising a substantially annular body portion formed from a first material and a resistance member for resisting axial movement of a spigot located coaxially within the body portion in one direction, whilst allowing axial movement of said spigot in a second, opposite axial direction, the said resistance member being embedded in the said body portion and formed from metal; wherein the said resistance member, when viewed in section, has an elongate portion which has a longitudinal axis that is aligned with a path along which the grab ring disperses force when it resists the axial withdrawal of a spigot from a socket during use.

2. A grab ring according to Claim 1, wherein the elongate portion is inclined at an angle of from 30° to 40° with the axis of spigot insertion.

3. A grab ring according to Claim 1 or 2, wherein the resistance member is provided with an enlarged force-dispersing surface which faces generally along the said path of force dispersion.

4. A grab ring according to Claim 3, wherein the enlarged force-dispersing surface is defined by a transverse flange provided on the resistance member in a region thereof which is located at an end thereof which is opposite to a spigot-addressing end thereof.

5. A grab ring according to Claim 4, wherein the flange is defined by a portion of the resistance member which is bent through an angle in the said end region.

6. A grab ring according to Claim 5, wherein the angle is 90°.

7. A grab ring according to any preceding claim comprising a radially outer contact region, for abutting a radially inner surface of a socket, the said contact region being situated on the said force-dispersion path.

8. A grab ring according to any preceding claim wherein the said body portion of the grab ring is defined by an annular support ring provided with a plurality of circumferentially spaced axially extending fingers.

9. A grab ring according to Claim 8, wherein one or more of the fingers is provided with a respective resistance member.

10. A grab ring according to Claim 9, wherein the distal ends of the fingers together define a mouth for receiving a spigot, and each of the fingers, in cross-section, has a convex radially inner surface in the region of the said mouth, the said convex surfaces causing the mouth diameter to increase, at an increasing rate, with distance from an axially inner position to an axially outer position.

11. A grab ring for securing a spigot within a socket, the grab ring comprising a body portion formed from an annular support ring and a plurality of integral, circumferentially spaced axially extending fingers formed upon the support ring and adapted to flex, in a radial direction, about their junctions with the support ring; wherein the distal ends of the fingers together define a mouth for receiving a spigot, and each of the fingers, in cross-section, has a convex radially inner surface in the region of the said mouth, the said convex surfaces causing the mouth diameter to increase, at an increasing rate, with distance from an axially inner position to an axially outer position.

12. A grab ring substantially as hereinbefore described with reference to any one of Figures 1 to 4 of the accompanying drawings.

13. A socket comprising a mouth for receiving a spigot and a grab ring according to any of the preceding claims.

14. A socket substantially as hereinbefore described with reference to Figure 4 of the accompanying drawings.

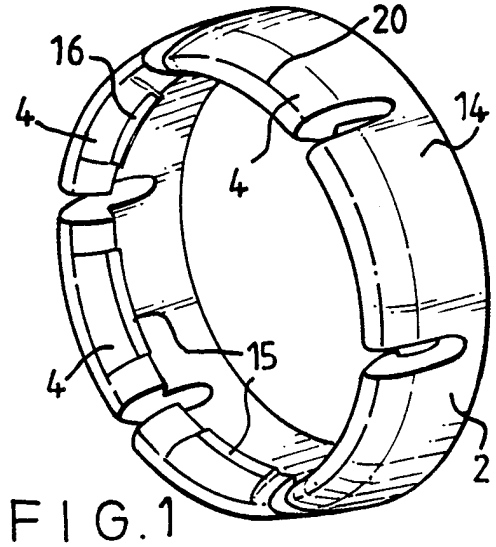

FIG.1

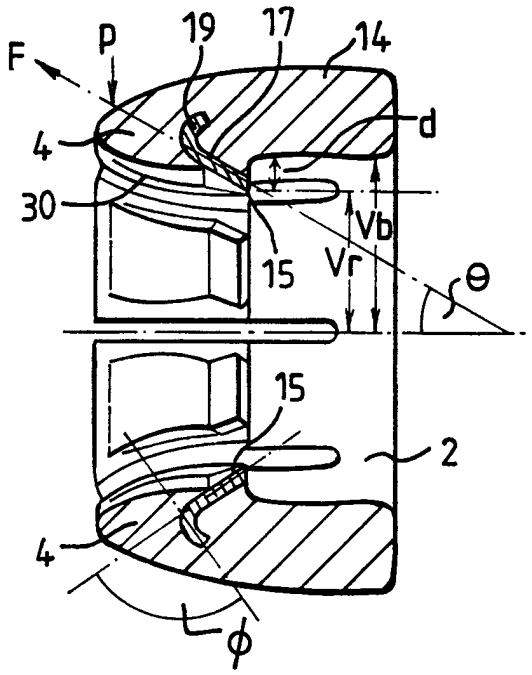

FIG.2

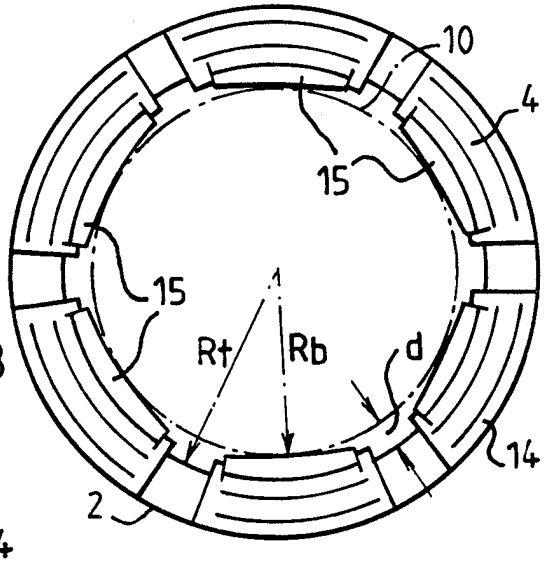

FIG.3

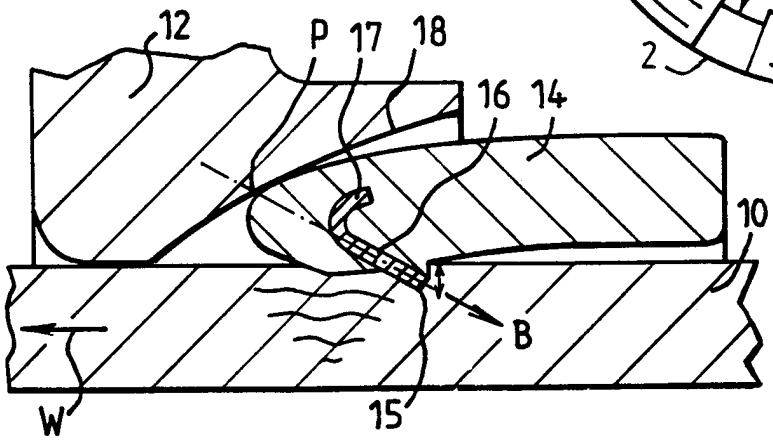

FIG.4

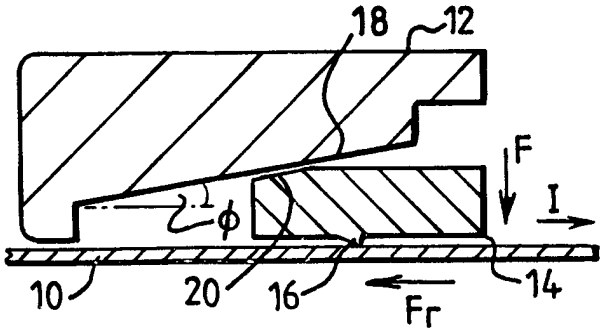

FIG.5

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16L37/092

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 6 F16L

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 380 483 A (J. D. GUEST) 8 September 1978 see page 11, line 33-40; claims 1-14; figures 1-3	1-14
X	GB 2 301 158 A (J. D. GUEST) 27 November 1996 see abstract; figures 1-3	1,2
X	GB 2 150 243 A (J. D. GUEST) 26 June 1985 see abstract; figure 1	1,2

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☒ Patent family members are listed in annex.

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