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(54) Title: ELECTROFUSION FITTING

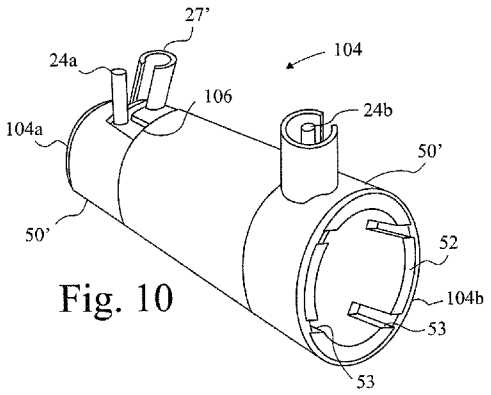

Fig. 10

(57) Abstract: A moulded electrofusion fitting (10) for connection to a plastics pipeline, comprises a hollow body (16) formed with a tubular opening that has a longitudinal axis (82) and is adapted to receive an end of the pipeline as a close sliding fit. An electrofusion element (22) is formed in the internal surface (52c) in the opening, spaced from its end (52b). Fingers (52) are on the end of the opening, circumferentially spaced around the opening and separated by slots (53) between them. Cam surfaces in the form of ribs (60) are defined on the fingers, and a grip ring (50) is received on the fingers and includes wedge elements in the form of grooves (62). These are adapted to fit the ribs so that, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, the ribs and grooves engage to press the fingers radially inwardly against the reaction of the grip ring whereby, said pipe is gripped by said grip ring and centralised in the opening. The grip ring may be integrated with a terminal pin (24), a bayonet slot (106) of the grip ring accommodating the terminal pin, a shroud boss (27') formed on the grip ring around the base of the bayonet slot.

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Electrofusion Fitting

This invention relates to the field of electrofusion fittings. Such fittings are employed to connect together plastics pipelines. They come in many kinds, from simple, inline couplers for two pipes to be joined end-to-end, to more complex fittings such as tapping tees to connect a branch service pipe to a mains pipe.

BACKGROUND

Generally, electrofusion fittings comprise one or more tubular openings adapted to receive a pipe to be connected to the fitting. The tubular opening has an electrofusion element embedded in the internal surface of the opening that lies against the pipe when the pipe is inserted in the fitting. The electrofusion element frequently comprises a coil of resistance wire. The coil generally begins well inside the mouth of the opening and ends before the end of the fully-inserted pipe. Usually a rib or the like forms a stop in the opening, determining when the pipe is fully inserted once its end abuts the stop. This ensures that the element is fully covered on both sides, by the pipe, on the one hand, and by the fitting on the other. When the electrofusion element is energised, the plastics material of the pipe and fitting adjacent the electrofusion element melts and fuses. Both the pipe and the fitting are sufficiently thick, and being made of plastics material which is a poor conductor of heat, so that the liquefied plastics does not penetrate out through the fitting, or in through the wall of the pipe. Moreover, because there is overlap of fitting at one end of the coil and pipe at the other, the melting does not penetrate to the end of the fitting or to the end of the pipe. So the melting is contained. Moreover, the plastics expands somewhat on melting, so that there is an increase in pressure in the melting zone that aids fusion. An aperture is sometimes provided in the fitting communicating with the bore thereof in the region of the coil, so that melted plastics is exuded through the aperture to indicate melting and probable completion of the weld.

When joints are made, they are not always successful. A successful joint is one where the fitting and pipe are fused in a ring around the fluid passage of the pipe, and over a considerable length of the pipe so that a leakage or fracture path, if one develops, has to penetrate a long distance. This applies both to a tubular fitting and to a saddle fitting. There can be a number of reasons why a joint is not successful, and sometimes the fact that it is unsuccessful is not immediately apparent. Of course, mating surfaces of the

fitting and pipe in the region of the electrofusion element have to be clean and "unskinned" (that is, having no oxide layer formed on the surface), otherwise proper fusion, which involves surface mixing between the two parts, may be inhibited. Also, the mating surfaces must lie close to one another over the entire fusion range, otherwise they may be too far apart for the liquefied plastics to meet over a long length of the complete circumference of the joint. Finally, there should be no relative movement between the pipe and fitting during the fusion process. If movement occurs, this can lead to the pipe not covering the fusion zone and thus weakening the joint.

Measures already exist to overcome these problems. For example, it is normal to scrape pipes to remove oxide layers, or provide them with a plastics surface skin that is peeled off prior to fusion to expose virgin plastics material. The present invention is not concerned with this aspect, however. It is also known to clamp pipes and fittings together prior to fusion, so that the possibility of movement is avoided. It is an object of the present invention to improve on this arrangement. In particular, it is desirable to provide a fitting where angular or axial misalignment between a pipeline and fitting is minimised, since this is another reason for some unsuccessful joints. Given that movements of the pipe at critical times, or occasions when the pipe is not sufficiently central, are rare, pipe failures are also rare. However, this means that users in the field tend to be complacent about employing the cumbersome clamping arrangements hitherto available. Thus an improved arrangement would be desirable.

BRIEF SUMMARY OF THE DISCLOSURE

In accordance with a first aspect of the present invention there is provided a moulded electrofusion fitting for connection to a plastics pipeline, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

fingers on the end of the opening circumferentially spaced around the opening and separated by slots between them;

cam surfaces defined on the fingers; and

a grip ring received on the fingers and including corresponding wedge elements adapted to fit said cam surfaces of the fingers,

wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said wedge and cam surfaces engage to press said fingers radially inwardly against the reaction of said grip ring whereby said pipe is gripped by said fingers.

Preferably, the electrofusion element terminates before a stop formed in the opening, which stop is adapted to limit insertion of the pipeline in the opening. Preferably, a circumferential flange is formed around the fingers to retain said grip ring on the end thereof.

The grip ring may be snapped over said flange to assemble the fitting, temporarily inwardly deflecting the fingers to permit such insertion. Indeed, said flange may have a surface lying in a radial plane with respect to said axis facing a corresponding surface of said grip ring when disposed on said, whereby said grip ring cannot be withdrawn from the fingers, at least not without difficulty involving inwardly deflecting all of the fingers simultaneously.

Preferably, said wedge and cam surfaces are mutually engaging cylindrical or conical ribs on the fingers and grooves in the grip ring, which ribs and grooves are parallel said longitudinal axis.

Preferably, in a clockwise direction of rotation of said grip ring with respect to said opening, looking in the direction of said opening, the inclination of said ribs and groove with respect to the tangent of the circle centred on said axis on which the facing surfaces of the fingers and grip ring otherwise lie, is less than in the anti-clockwise direction.

Conveniently, said ribs and grooves are arranged so that the deflection of the fingers on rotation of the grip ring is least at a proximal root of the fingers compared with a distal end of the fingers. For this purpose, said ribs and grooves may be conical surfaces. Alternatively, said ribs and grooves may be cylindrical surfaces with the axis of the cylinder inclined with respect to said longitudinal axis.

Said conical or cylindrical surface is preferably modified to provide said less inclination in said clockwise direction.

Facing surfaces of the grip ring and fingers between said ribs and grooves are preferably circular cylindrical. Shallow stop-grooves may be provided in said grip ring into which said ribs engage after rotation of the grip ring disengaging said ribs from said grooves. This tells the user that full engagement of the cam/wedges surfaces has been achieved by virtue of a subtle release of mechanical tension. Alternatively a positive stop may be used to limit travel.

There are conveniently four fingers. Moreover, the slots between said fingers may all be parallel with each other, whereby they may be formed by a mould splitting in half in a direction parallel said slots.

Preferably, the electrofusion element commences at a distance from the ends of said fingers. Said distance may be between 0.1 and 2 times the internal diameter of said opening (preferably between 0.75 and 1.25 times). Indeed, preferably, the distance from the ends of the fingers to the stop is between 0.5 and 3 times the internal diameter of said opening (preferably between 2 and 2.5 times). However, the larger end of these ranges are probably only achievable where there are not standards to be complied with, since spigot-type components only provide a certain available length for insertion in electrofusion fittings that may not be adequate to span a substantial length before engagement with the electrofusion element. Moreover, given that one primary purpose of the clamp ring provided by the present invention is to centralise the pipe (or spigot fitting, as the case may be) with respect to the electrofusion element in the fitting, the need for this centralisation diminishes the longer the lead-in is to the electrofusion element. Of course, the other primary purpose of the clamp ring is to inhibit movement of the inserted pipe or spigot into the fitting, either dislodging its proper location or during the solidification phase of the joint process.

According to a second aspect of the invention there is provided a moulded electrofusion fitting for connection to a plastics pipeline or spigot, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline/spigot inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

a grip ring including a clamping arrangement wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said clamping arrangement engages said pipe to minimise movement thereof during electrofusion,

characterised in that the fitting further comprising at least one radially-protruding terminal pin connected to an end of said electrofusion element, and wherein said grip ring has a bayonet slot for receiving said terminal pin, and an integral upstanding boss that projects radially from said grip ring,

wherein said bayonet slot permits disposition of the grip ring on the fitting firstly by movement of the grip ring with an axial component whereby the terminal pin enters a mouth of the slot, and secondly by said rotation of the grip ring about said axis to guide said terminal pin through an opening in said upstanding boss.

According to a third aspect of the invention there is provided a moulded electrofusion fitting for connection to a plastics pipeline or spigot, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline/spigot inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

a grip ring including a clamping arrangement wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said clamping arrangement engages said pipe to minimise movement thereof during electrofusion, characterised in that the fitting further comprises

at least one radially-protruding terminal pin connected to an end of said electrofusion element;

a first integral upstanding boss that projects radially from said fitting and which at least partially surrounds said terminal pin and is preferably fixed with respect thereto;

said grip ring having a second integral upstanding boss that projects radially from said grip ring,

wherein, when aligned together, said first and second upstanding bosses substantially surround said terminal pin so as to prevent connection of an electrical connector thereto; and

wherein said rotation of said grip ring moves said second upstanding boss away from said first upstanding boss so as to allow access to said terminal pin.

Other features of the invention are defined in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are further described hereinafter, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an exploded perspective view of a tapping tee embodying one aspect of the present invention;

Figure 2 is a side section of the tapping tee of Figure 1;

Figure 3 is a plan section of the tapping tee assembly of Figure 1, taken along the line C-C in Figure 4;

Figure 4 is an end view of the same tapping tee;

Figure 5 is a section on the line D-D in Figure 4 ;

Figures 6a and b are a plan (in the direction of Arrow X in Figure 6b) and side view a grip ring forming part of the tapping tee of Figures 1 to 4;

Figures 7a and b are sections on the lines A-A and B-B in Figure 6a respectively;

Figure 8 is a perspective view of the grip ring of Figures 6 and 7;

Figures 9a and b are a cross sectional side view of a standard length shouldered fitting disposed in a standard (prior art) socket and a partial cross sectional side view of the same standard length shouldered fitting disposed in a socket in accordance with the present invention;

Figure 10 is a perspective view of an inline coupler in accordance with a further embodiment of the present invention provided with an integral grip ring at each end;

Figures 11a and b are top down views of an end of the inline coupler of Figure 10 with the integral grip ring at different degrees of rotation;

Figure 12 is a cross sectional side view of a section of the inline coupler along the line E-E in Figure 11b;

Figure 13 is a perspective view of an inline coupler in accordance with a further embodiment of the invention, having two shrouds on a grip ring;

Figures 14A and 14B are perspective views of the grip ring of Figure 13, showing the shrouds in more detail;

Figure 15 is a perspective view of an inline coupler in accordance with a further embodiment of the present invention, with the terminal pin covered by a shroud; and

Figure 16 shows the inline coupler of Figure 15, with the terminal pin uncovered.

DETAILED DESCRIPTION

Referring to the embodiment disclosed in Figure 1, a tapping tee assembly **10** comprises an integrally moulded saddle **12**, body **14** and socket **16**. The saddle **12** is provided with a saddle-shaped electrofusion element mat **18**, which is attached thereto by over-moulding, snap-fit, screws or other fastening means such as terminal stud **38** and electrical connecting pin **28** as described further below. The body **14** has an axially extended screw threaded bore **20**, and disposed within the bore, a metal cutter **15** having a screw threaded outer surface that cooperates with the screw thread of the bore **20**. The socket **16** is adapted to receive a branch pipe or spigot (not shown) and is provided with an internal tubular spigot electrofusion element **22** (see Figures 2 and 3).

An electrofusion element **30**, in the form of an electrical resistance wire, is embedded in a spiral track formed on either side of the mat **18**, which is a disc of fusible polymer material having central aperture **35**, adapted to coincide with the bore **20**. The mat **18** is provided with a hole **32** adjacent the aperture **35** and through which the electrofusion element **30** passes from one side of said polymer material to the other. The ends of the wire are led to another hole **33** adjacent the outside rim of the mat **18.**

Socket electrofusion element **22** further comprises two electrical connectors in the form of a second electrical stud terminal **24** and a dovetailed anvil **26** (see Figure 3). The electrical stud **24** and dovetailed anvil **26** are connected to opposite ends of the socket electrofusion element **22**, which is wound as a coil in the internal surface of the socket **16**. The electrical stud terminal **24** is surrounded by an upstanding boss **27** forming a socket to receive the plug of an electrical connector of a power source. Said dovetailed anvil **26** electrically connects the two electrofusion elements **30,22** via said intermediate connecting pin **28**. A similar socket **29** is provided for the stud **38,** between terminal pins or studs **24,38** an electrical power source (not shown) may be connected to energise the two electrofusion elements **30,22.**

The circuit of the tapping tee assembly **10** comprises the upper and lower components of the electrofusion element **30** embedded in the saddle-shaped electrofusion mat **18** connected in parallel with one another, and in series with the socket electrofusion

element **22** of the socket **16**. Both pin **28** and stud **38** are provided with heads **28c,38c** respectively in order to retain the mat **18** in place.

On the end of the socket **16** is provided a grip ring **50**. The end of the socket is formed with four fingers **52** separated from one another by slots **53**. The slots are all parallel to enable shell moulds forming the exterior surface features of the tapping tee **10** to form them and yet simply split along a plane including the body **14** and the socket **16** (or at least their respective axes **80**,**82** - see Figure 2). The fingers have a proximal root end **52a** and distal extreme end **52b**. The fingers define an end-flange or ring-rib **54** which is chamfered at the ends **52b** of the fingers, but is cut squarely at its proximal edge **54c**, so as to lie in a plane radial with respect to the axis **82**. A rear edge **56** at the root **52a** of the fingers **52** is also radial and between that and the rib **54**, an annular channel **58** is defined to receive the ring **50**. Once the fingers **52** have been deflected inwardly to permit insertion of the ring **50**, the fingers snap back, retaining the grip ring in position. The surface of the base of the channel **58** is circular cylindrical, or conical, in either case with axes coincident with the axis **82**. But for the features described further below, the ring **50** would be freely rotatable in the channel **58**, being a close sliding fit thereon. However, the fingers **52** are provided with ribs **60**, and the ring **50** with corresponding grooves **62**.

Four each of said ribs and grooves are provided at 90° to each other around the axis **82** and, when they coincide with each other, the internal face **52c** of the fingers **52** remains circular cylindrical. Four shallow detent grooves **64** are also provided at 45° angles to the grooves **62**.

Grooves **62** and ribs **60** are conical in profile with their cone axes parallel the axis **82** and with their apex pointing at the body **14**. When the ring is rotated about axis **82**, the ribs and grooves come out of registration, deflecting the fingers **52** inwardly. Because of the coned profile of the ribs and grooves **60** the deflection of the fingers at their distal ends **52b** is much greater than their deflection at their roots **52a**. This avoids unnecessary shear stresses in the material at the fingers, and, in any event, ensures maximum deflection of the fingers. Without this relief at the roots of the fingers, instead of maximum deflection of the fingers, the roots, in resisting inward deflection would also prevent full inward deflection of the distal ends. Instead, the ring would simply be deflected outwardly more harshly than inevitably occurs in any event.

As can be seen in Figures 5 and 7a, the groove **62** are provided with a shallow lead-in **62a**. This is in the clockwise direction of rotation of the ring **50** on the socket **16** when viewed in the direction of the body **14**. This lead-in reduces the angle of attack between the groove **62** and rib **60**, which angle is the angle of the mating surfaces to the tangent of the base circular surface of the channel base **58**. Consequently, less resistance is experienced by the user in turning the ring clockwise, this being the traditional tightening direction of rotation of screwed fittings. In fact, in the present instance, the ribs and grooves, constituting mating cams and wedges surfaces, could be rotated in either direction, the only purpose being to de-register them so that the ribs **60** press against the internal circular (conical or cylindrical) surface **66** of the ring **50** (the surface **66** is cylindrical as shown). However, rotation in the anticlockwise direction would meet more resistance and would, in any event, be counter-intuitive to most users.

One purpose of the grip ring **50** is to grip and hold pipes inserted in the socket **16** for electrofusion by the element **22**. A pipe (not shown) when it is to be connected to the socket **16,** is offered up to the outside surface with its end parallel mark **70** formed on the outside of the socket. A mark is then made on the pipe coincident with the ends **52b** of the fingers **52** in order to show the required insertion of the pipe in the socket **16**. The surface of the pipe is scraped to remove the oxidised skin of the said pipe. The pipe is then inserted until the mark made on the pipe is flush with the ends **52b** and at this point the end of the pipe will abut a stop formed by end **26a** of the anvil **26** (a rib may also, or instead, be formed to constitute the stop). The grip ring is then rotated to squeeze the fingers **52** against the pipe and clamp it in position.

The fingers, particularly their ends **52b** are spaced some distance from the electrofusion element **22** (preferably, but not essentially, at least one pipe diameter). Moreover, the stop is preferably at least 2.25 pipe diameters from the end **52**, with the effective end of the electrofusion element being about 2 pipes diameters from the end. The purpose of these arrangements are twofold: first, to provide the normal overlap between pipe end and socket end with respect to the electrofusion element; second, to provide distance from the end of the pipe to the centralising effect of the fingers **52** and grip ring **50** on the pipe with respect to the socket **16**, so that the surfaces of the pipe adjacent the electrofusion element **22** are more likely to be parallel the axis **82** in that region. Consequently, two objects are achieved. Firstly, the employment of the grip ring by users in the field is easy, so that even if it is unnecessary to employ in many instances, it

will tend to be employed so that even rare failures of the joint formed can be avoided. Secondly, by virtue of the arrangement, misalignment of the pipe with the socket is minimised. Indeed, although having the substantial (ie one pipe diameter) separation between the ends of the fingers and the start of the electrofusion element is desirable, this substantial distance actually reduces the dependency on a centralising grip ring. Thus the grip ring actually has most requirement, from this perspective, when the distance between finger ends and electrofusion element is necessarily small. It is small in many instances of standard electrofusion couplers where an increase in overall length of a coupler is prohibited by the need to accommodate short spigots of other fittings (eg T-pieces).

Manufacture of the tapping tee assembly **10** requires injection moulding of a polymer material within a rigid mould that will not deform under temperatures around the melting point of said polymer material. Since the present invention comprises hollow tubes, a pair of moulding cores must be used within the main mould. The mould is not shown but comprises two or more shell moulds that form the external profile of the tapping tee **10**, together with the core moulds, whereby a hollow product of relatively uniform wall thickness is formed.

The component of the main mould that produces the saddle **12** component of the tapping tee assembly **10** comprises a core-pin (not shown) that forms a tunnel bore **68** extending upwards from the saddle **12**, through the wall of body **14** parallel the main bore **20**. Said element also prevents an eye **46** of said dovetailed anvil **26** from filling with polymer material during moulding. With said saddle-shaped electrofusion mat **18** fixed in place to said saddle **12**, the hole **32** through said saddle-shaped electrofusion mat **18** is in line with the saddle end of said tunnel **66**. The electrical connecting pin **28** can then be disposed in the tunnel **66** forming an electrical bridge between said saddle electrofusion element **30** of said saddle-shaped electrofusion mat **18** and said eye **46** of the dovetailed anvil **26**.

The saddle electrofusion element **18** and socket electrofusion element **22** are composed of a conducting material that produces sufficient heat to melt said fusible polymer material when an electrical current is passed through it, but does not itself melt or break. Said dovetailed anvil **26**, electrical studs **24, 38** and electrical connecting pin **28** are composed of a good electrically conducting material that does not produce significant heat when an electric current is passed through it.

In the embodiment described above, the gripper ring assembly increases the overall length of a standard socket. Although a change in socket length does not affect the connection of a pipe, there are consequences when connecting shouldered spigot fittings designed for use with standard sockets, as shown in Figures 9a and b.

When a shouldered fitting **100** is inserted into a standard (prior art) socket **16**, a limit is reached when the shoulder **100a** abuts the opening **16a** of the socket **16** (and/or when the end **100b** of the fitting **100** abuts an insertion limiting rib **102** of the socket **16**). The shoulder **100a** of a shouldered fitting **100**, (designed for use with a standard length socket **16**, is distanced from the end **100b** of the fitting **100** to allow enough length to enter the socket **16** such that its end **100b** extends beyond the end of the electrofusion element **22**. In the industry, the standard length now accepted for service pipe sizes is 41 mm for the depth of sockets and 42 mm for the length of spigots to be inserted in sockets.

However, when inserted into a socket **16'** (see Figure 9b) provided the additional grip ring **50** of the present invention, the shoulder **100a** prevents the fitting **100** entering the socket **16'** far enough to allow it to be surrounded by the entire electrofusion element **22**. In such cases, only a poor electrofusion joint would be possible. For the grip ring to be used effectively with fittings that have been designed for use with standard sockets, the grip ring assembly must be added to the standard socket such that it does not increase its overall length.

One solution might be to translate the position of the grip ring, thereby reducing the distance between the finger ends and electrofusion element. However, this solution is limited by the obstruction caused by the terminal pin **24** and its upstanding boss **27**. The pin 24 cannot be placed over the electrofusion coil **22** without considerable manufacturing difficulty and the danger of shorting out the coil. The entire electrofusion element could be shortened, but this would reduce the effectiveness (i.e. its length) of the fused joint and is also limited by the industry specification.

Figure 10 discloses an inline coupler **104** in accordance with a modified embodiment of the present invention. This coupler is for joining two pipes (not shown) end-to-end, although the principles discussed below apply to any coupler, such as an elbow, T-joint or even a tapping tee. The coupler **104** has two internal electrofusion elements (not

shown) connected in series to each other and to two terminal pins **24a**,**b**. The terminal pins **24a**,**b** project radially from the fingers **52** in between the slots **53** that define the fingers **52**. Integral grip rings **50'** attach over fingers **52** at both ends **104a**,**b** of the inline coupler **104**. The integral grip ring **50'** is identical to the grip ring **50** described above, except that the integral grip ring **50'** further comprises a slot **106,** and an integral upstanding boss or shroud **27'** coincident therewith. The terms "boss" and "shroud" are used interchangeably in the following description.

Figures 11a and b show how the terminal pin **24a** passes through the slot **106** to finally be disposed within the boss **27'**. As Figure 11a shows, the grip ring **50'** is placed on the fingers **52** such that the terminal pin **24a** passes through mouth **106a** of the slot **106**. For the grip ring **50'** to attach onto the coupler **104**, the fingers **52** must deflect inward and the ribs **60** of the fingers **52** must register with the grooves **62** of the grip ring **50'** (ribs **60** and grooves **62** not shown in Figures 11a,b). The slot **106** is angularly positioned on the grip ring so that this registration of the ribs/grooves **60**/**62** is achieved when the mouth **106a** of the slot engages the pin**24a.** The slot continues parallel the longitudinal axis **82** of the coupler until the point where the entire grip ring **50'** has passed over the ring-rib **54** on the ends of the fingers **52.** Thus the grip ring **50'** is restricted to only moving parallel the longitudinal axis **82** by contact between the terminal pin **24a** and the sides of the slot **106**. Once fully inserted, the ring-rib **54** of the fingers **52** and the shoulder **56** prevents further movement parallel the longitudinal axis **82**. At this point, the terminal pin **24a** has moved in the slot **106** such that only a transverse part **106b** remains as an option for further movement.

Before further movement is made, however, a pipe or spigot of a fitting (neither shown) to be electrofused by the coupler **104** is inserted in the socket end **104a,b.** Clockwise rotation of the grip ring **50'** (when looking through the open end **104a** of the coupler **104** along axis **82**) then has two simultaneous effects. The first causes relative movement of the terminal pin **24a** along the transverse part **106b** of the slot **106** until it passes through an opening **27a'** in the boss shroud **27'** and abuts the end **106c** of the slot **106** within the boss **27'**. The second is that the cam surfaces **60, 62** (not shown in Figures 10 to 12) engage compressing the fingers **52** against the pipe or spigot both securing and centralising it in the socket **104**.

Figure 12 shows a cross sectional view of the grip ring **50'** securely fastened around the terminal pin **24a** (as in Figure 11b). With the upstanding boss **27'** integral with the grip ring **50'**, the grip ring **50'** can be incorporated further down the coupler **104**, allowing the terminal pin **24a** to pass through the slot **106** and be shrouded by the boss **27'**. In this embodiment, neither the terminal pin **24a** nor boss **27'** interferes with the positioning of the grip ring **50'** and fingers **52**. The integral grip ring therefore allows for the correct fitting of components that would otherwise be prevented from entering the socket sufficiently for a good electrofusion join to be made.

As described above, the grip ring **50'** is rotatable between a first position, as shown at the far end of Figure 10, in which the terminal pin **24a** is exposed, and a second position as shown at the near end of Figure 10 in which the terminal pin **24b** is centrally located within the shroud **27'**.

In the first position, although the terminal pin **24a** is exposed, it is not possible to connect it to an electrical power source because of the close proximity of the shroud **27'** which encroaches into the space required to accommodate the power source's electrical connector (not shown).

Therefore, in order to connect the power source, the user is required to rotate the grip ring **50'** so that the shroud **27'** moves to the position shown at the near end of Figure 10, in which the terminal pin **24b** is centrally located within the shroud **27'**. In this position, there is sufficient space between the terminal pin **24b** and the shroud **27'** to accommodate the connector from the electrical power source. The shroud **27'** is suitably sized and shaped to permit this, depending upon the expected type of electrical connector.

In requiring the user to rotate the grip ring before an electrical connection can be made, it is ensured that the user also engages the grip ring against the pipe or spigot to clamp it in place before electrofusion can be initiated.

Figures 13, 14A and 14B show an inline coupler **400** in accordance with a further embodiment of the present invention. Again, this coupler is for joining two pipes (not shown) end-to-end, although the principles discussed below apply to any coupler, such as an elbow, T-joint or even a tapping tee. The coupler **400** has two internal electrofusion elements (not shown) connected in series to each other and to two terminal

pins **24a**,**b**. The terminal pins **24a**,**b** project radially from the fingers **52**. Integral grip rings **401** attach over fingers **52** at both ends of the inline coupler **400**. The integral grip ring **401** is identical to the grip ring **50'** described above, except that the integral grip ring **401** comprises a generally T-shaped slot **402,** and two integral upstanding bosses or shrouds **403, 404** coincident therewith.

The grip ring **401** is placed on the fitting **400** in a similar manner to that described in relation to Figures 11A and 12A above. Slot **402** may be provided with a narrowed portion (not illustrated) to reduce the likelihood of the grip ring **401** being removed again once placed on the fitting.

The grip ring **401** is rotatable between a first position, as shown at the far end of Figure 13, in which the terminal pin **24a** is located within a first shroud **404**, and a second position as shown at the near end of Figure 13 in which the terminal pin **24b** is centrally located within the second shroud **403**.

In the first position, the terminal pin **24a** located within first shroud **404.** The shroud **404** is preferably of rectangular cross-section and fits closely around the terminal pin **24a** such that it is not possible to connect the terminal pin to an electrical power source because of the close proximity of the shroud **404** which encroaches into the space required to accommodate the power source's electrical connector (not shown).

Therefore, in order to connect the power source, the user is required to rotate the grip ring **401** into the position shown at the near end of Figure 13, in which the terminal pin **24b** is centrally located within the shroud **403**. The transverse section of slot **402** guides the travel of the terminal pin between the two shrouds in the manner described above in relation to Figures 11A and 11B. When the terminal pin is in transition, intermediate the two shrouds, it is still not possible to connect the terminal pin to an electrical power source because there is insufficient space between the shrouds to accommodate the power source's electrical connector. As the terminal pin approaches the end of its travel in the slot **402** (or indeed in the slot **106** of the embodiment described above), it may pass a narrowed portion of the slot (not illustrated) which deflects outwardly to allow the pin to pass thereby. Once the terminal pin has passed the narrowed portion and is located within the shroud **403**, the narrowed portion serves to resist movement of the terminal pin back in the direction from which it has come, thus resisting undesirable removal of the pin from the shroud and undoing of the grip ring's clamping function.

Once the terminal pin is within the second shroud **403,** there is sufficient space between the terminal pin **24b** and the shroud **403** to accommodate the connector from the electrical power source. The shroud **403** is suitably sized and shaped to permit this, depending upon the expected type of electrical connector.

In requiring the user to rotate the grip ring before an electrical connection can be made, it is ensured that the user also engages the grip ring against the pipe or spigot to clamp it in place before electrofusion can be initiated.

In the embodiments of Figures 10-14B, the shrouds **27', 404, 403** are entirely located on the grip rings **50', 401.** Figures 15 and 16 show an alternative embodiment in which a shroud is partially located on the grip ring and partially located on the fitting (together with the terminal pin).

Referring to Figure 15, a coupler **300** includes an integral grip ring **301** which has an upstanding partial shroud **302.** A terminal pin **24a** (not visible in Figure 15) is located on a fitting **305**, the terminal pin being at least partially surrounded by a second upstanding partial shroud **303.** As shown in Figure 15, the upstanding shrouds **302, 303** fit together to surround the terminal pin so as to render it inaccessible for connection to an electrical power source. The partial shroud **302** may be provided with a lid **304** so as to completely enclose the terminal pin, but this is not essential, depending upon the geometry of the partial shrouds. What is important is that the presence of partial shroud **302** in the vicinity of the terminal pin makes it impossible to connect the electrical power source.

In order to connect the power source, the user is required to rotate the grip ring **301,** in the direction of the arrow in Figure 16, so that the partial shroud **302** moves to a position in which the terminal pin **24a** can be seen centrally located within the partial shroud **303**. The partial shroud **303** is fixed with respect to the terminal pin **24a** and has the added advantage of providing protection for the terminal pin during transport and storage of the fitting, before use. In the position illustrated in Figure 16, there is sufficient space between the terminal pin **24a** and the partial shroud **303** to accommodate the connector from the electrical power source, now that the partial shroud **302** has been moved out of the way. The shroud **303** is suitably sized and shaped to permit this, depending upon the expected type of electrical connector. Again, in requiring the user to rotate the grip

ring before an electrical connection can be made, it is ensured that the user also engages the grip ring against the pipe or spigot to clamp it in place before electrofusion can be initiated.

Although the inline couplers of Figures 10-16 have been illustrated in conjunction with the above-described grip ring (i.e. having wedges and cam surfaces), it will be appreciated that the arrangements of terminal pins and shrouds described above could be used in any inline coupler where it is desired to prevent connection to the terminal pin prior to a predefined rotation of a grip ring. The actual grip ring or clamping arrangement used need not be identical to that described and illustrated in Figures 1-9.

Throughout the description and claims of this specification, the words “comprise” and “contain” and variations of the words, for example “comprising” and “comprises”, means “including but not limited to”, and is not intended to (and does not) exclude other moieties, additives, components, integers or steps.

Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A moulded electrofusion fitting for connection to a plastics pipeline or spigot, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline/spigot inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

fingers on the end of the opening circumferentially spaced around the opening and separated by slots between them;

cam surfaces defined on the fingers; and

a grip ring received on the fingers and including corresponding wedge elements adapted to fit said cam surfaces of the fingers,

wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said wedge and cam surfaces engage to press said fingers radially inwardly against the reaction of said grip ring whereby said pipe is gripped by said fingers.

2. A fitting according to claim 1, wherein said electrofusion element terminates before a stop formed in the opening, which stop is adapted to limit insertion of the pipeline in the opening.

3. A fitting according to claim 1 or 2, wherein a circumferential flange is formed around the fingers to retain said grip ring on the end thereof.

4. A fitting according to claim 3, wherein said grip ring is snapped over said flange to assemble the fitting, temporarily inwardly deflecting the fingers to permit such insertion.

5. A fitting according to claim 3 or 4, wherein said flange has a surface lying in a radial plane with respect to said axis facing a corresponding surface of said grip ring when disposed on said, whereby said grip ring cannot be withdrawn from the fingers.

6. A fitting according to any preceding claim, wherein said wedge and cam surfaces are mutually engaging cylindrical or conical ribs on the fingers and grooves in the grip ring, which ribs and grooves are parallel said longitudinal axis.

7. A fitting according to claim 6, wherein, in a clockwise direction of rotation of said grip ring with respect to said opening, looking in the direction of said opening, the inclination of said ribs and groove with respect to the tangent of the circle centred on said axis on which the facing surfaces of the fingers and grip ring otherwise lie, is less than in the anti-clockwise direction.

8. A fitting according to claim 6 or 7, wherein said ribs and grooves are arranged so that the deflection of the fingers on rotation of the grip ring is least at a proximal root of the fingers compared with a distal end of the fingers.

9. A fitting according to claim 8, wherein said ribs and grooves are conical surfaces.

10. A fitting according to claim 8, wherein said ribs and grooves are cylindrical surfaces with the axis of the cylinder inclined with respect to said longitudinal axis.

11. A fitting according to claim 8 or 9 when dependent on claim 7, wherein said conical or cylindrical surface is modified to provide said less inclination in said clockwise direction.

12. A fitting according to any preceding claim, wherein facing surfaces of the grip ring and fingers between said ribs and grooves is circular cylindrical.

13. A fitting according to any of claims 6 to 12, in which there are shallow stop-grooves in said grip ring into which said ribs snap after rotation of the grip ring disengaging said ribs from said grooves.

14. A fitting according to any preceding claim, wherein there are four fingers.

15. A fitting according to claim 14, wherein said slots between said fingers are all parallel with each other, whereby they may be formed by a mould splitting in half in a direction parallel said slots.

16. A fitting according to any preceding claim, wherein the electrofusion element commences at a distance from the ends of said fingers of between 0.1 and 2 times the internal diameter of said opening, preferably between 0.75 and 1.25 times.

17. A fitting according to any of claims 2 to 16, wherein the distance from the ends of the fingers to the stop is between 0.5 and 3 times the internal diameter of said opening, preferably between 2 and 2.5 times.

18. A fitting according to any preceding claim, further comprising at least one terminal pin protruding radially from one of said fingers and connected to an end of said electrofusion element, wherein said grip ring has:

a bayonet slot for receiving said terminal pin, and

an integral upstanding boss that projects radially from said grip ring,

wherein said bayonet slot permits disposition of the grip ring on the fitting firstly by movement of the grip ring with an axial component onto the fingers whereby the terminal pin enters a mouth of the slot, and secondly by said rotation of the grip ring about said axis to guide said terminal pin through an opening in said upstanding boss.

19. A moulded electrofusion fitting for connection to a plastics pipeline or spigot, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline/spigot inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

a grip ring including a clamping arrangement wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said clamping arrangement engages said pipe to minimise movement thereof during electrofusion,

characterised in that the fitting further comprising at least one radially-protruding terminal pin connected to an end of said electrofusion element, and wherein said grip ring has a bayonet slot for receiving said terminal pin, and an integral upstanding boss that projects radially from said grip ring,

wherein said bayonet slot permits disposition of the grip ring on the fitting firstly by movement of the grip ring with an axial component whereby the terminal pin enters

a mouth of the slot, and secondly by said rotation of the grip ring about said axis to guide said terminal pin through an opening in said upstanding boss.

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20. A fitting according to claim 18 or claim 19, wherein said bayonet slot is an L-shaped slot or a T-shaped slot

21. A fitting according to any of claims 18-20, wherein said bayonet slot comprises an axial section and a tranverse section and, when said terminal pin is located within said transverse section but is outside said upstanding boss, the length of the transverse section is insufficient to allow space for connection of an electrical connector to said terminal pin without interference from said upstanding boss.

22. A fitting according to any of claims 18-21 including a second integral upstanding boss that projects radially from said grip ring, rotation of said grip ring being capable of guiding said terminal pin, via said slot, from within the first upstanding boss to within said second upstanding boss.

23. A moulded electrofusion fitting for connection to a plastics pipeline or spigot, comprising:

a hollow body formed with a tubular opening that has a longitudinal axis and is adapted to receive an end of the pipeline/spigot inserted in the direction of said axis as a close sliding fit against an internal surface of the opening;

an electrofusion element formed in the internal surface in the opening spaced from its end;

a grip ring including a clamping arrangement wherein, when a pipeline is inserted in the opening and the grip ring is rotated about said axis, said clamping arrangement engages said pipe to minimise movement thereof during electrofusion, characterised in that the fitting further comprises

at least one radially-protruding terminal pin connected to an end of said electrofusion element;

a first integral upstanding boss that projects radially from said fitting and which at least partially surrounds said terminal pin and is preferably fixed with respect thereto;

said grip ring having a second integral upstanding boss that projects radially from said grip ring,

wherein, when aligned together, said first and second upstanding bosses substantially surround said terminal pin so as to prevent connection of an electrical connector thereto; and

wherein said rotation of said grip ring moves said second upstanding boss away from said first upstanding boss so as to allow access to said terminal pin.

24. A fitting according to any of claims 1-17, further comprising

at least one terminal pin protruding radially from one of said fingers and connected to an end of said electrofusion element;

a first integral upstanding boss that projects radially from said fitting and which at least partially surrounds said terminal pin and is preferably fixed with respect thereto;

said grip ring having a second integral upstanding boss that projects radially from said grip ring,

wherein, when aligned together, said first and second upstanding bosses substantially surround said terminal pin so as to prevent connection of an electrical connector thereto; and

wherein said rotation of said grip ring moves said second upstanding boss away from said first upstanding boss so as to allow access to said terminal pin.

25. A fitting according to claim 23 or claim 24 wherein said second upstanding boss is suitably sized and shaped to align with said first upstanding boss so as to entirely enclose said terminal pin.

26. A fitting according to any of claims 18-25, wherein said upstanding boss is a hollow cylinder, a longitudinal axis of the cylinder being parallel said terminal pin when said terminal pin is disposed within said cavity.

27. A fitting according to claim 26 when dependent on claim 13, in which said terminal pin and boss are coaxial when said ribs snap into said shallow stop-grooves.

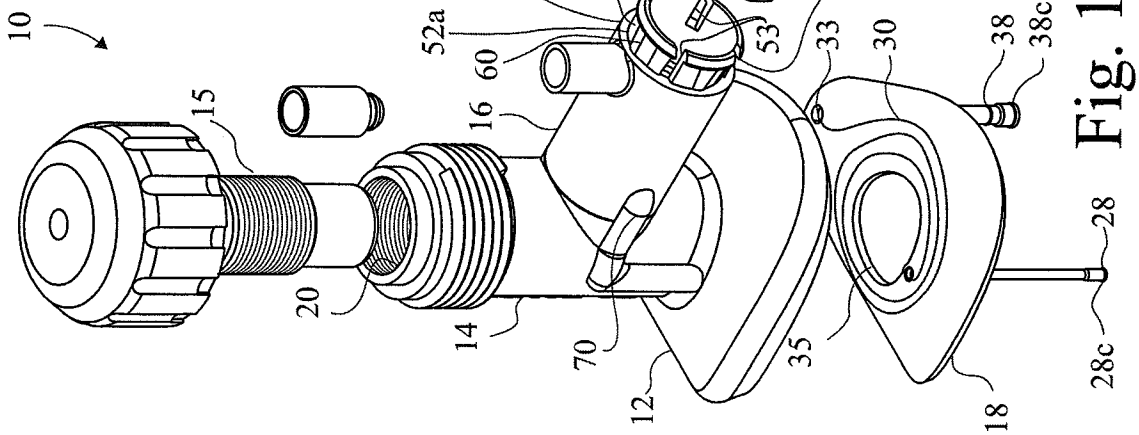

Fig. 1

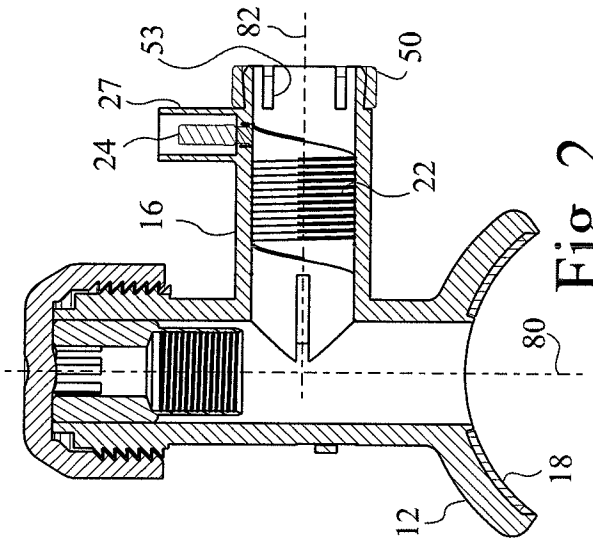

Fig. 2

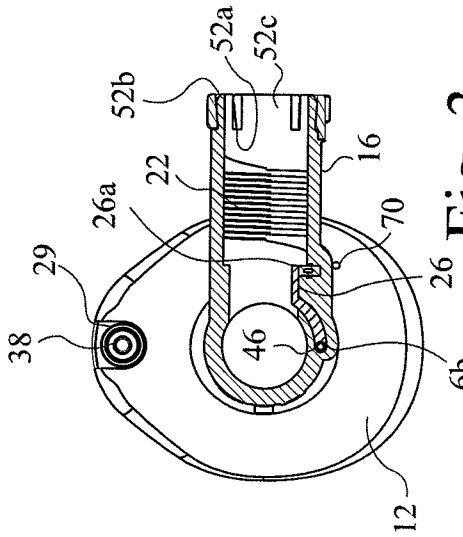

Fig. 3

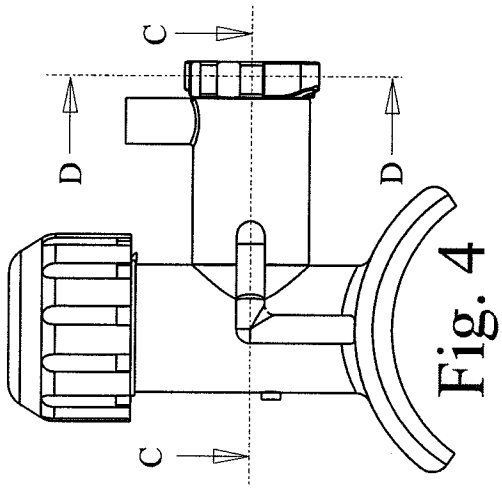

Fig. 4

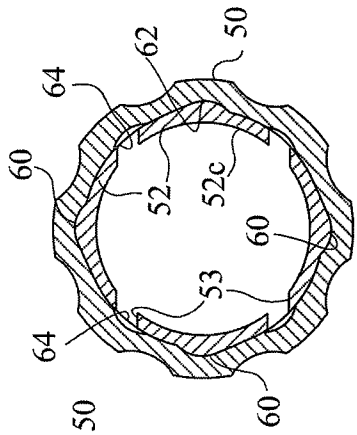

Fig. 5

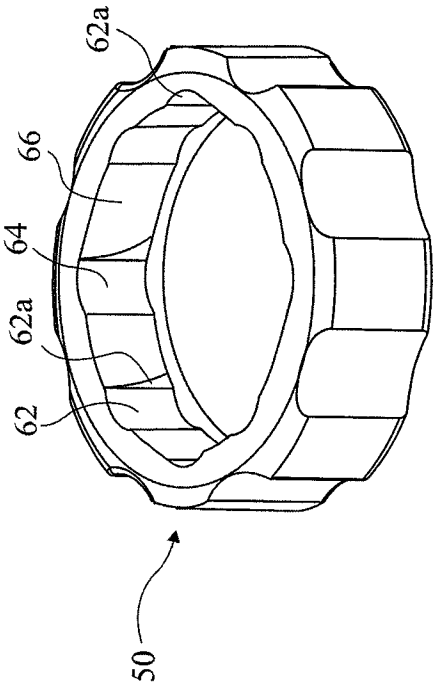

Fig. 8

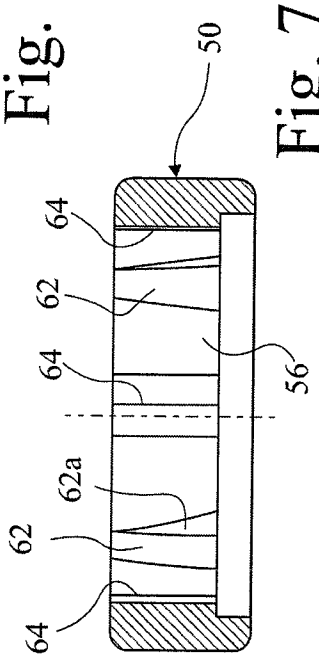

Fig. 7a

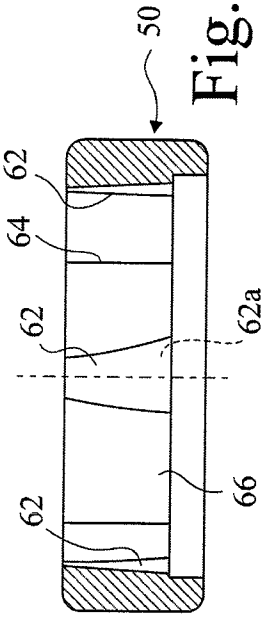

Fig. 7b

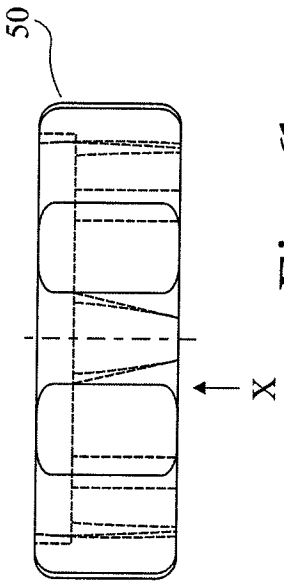

Fig. 6b

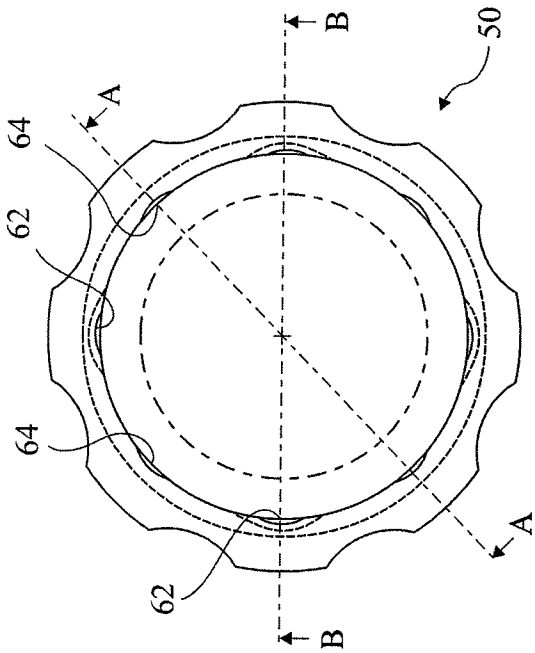

Fig. 6a

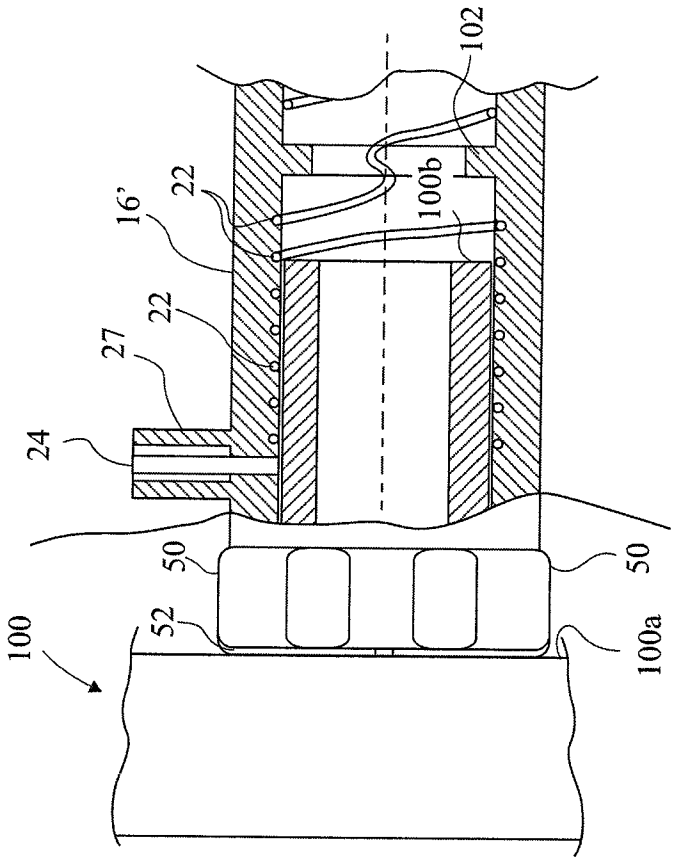
102
16'
22
100b
22
27
24
50
50
52
100a
100

Fig. 9b

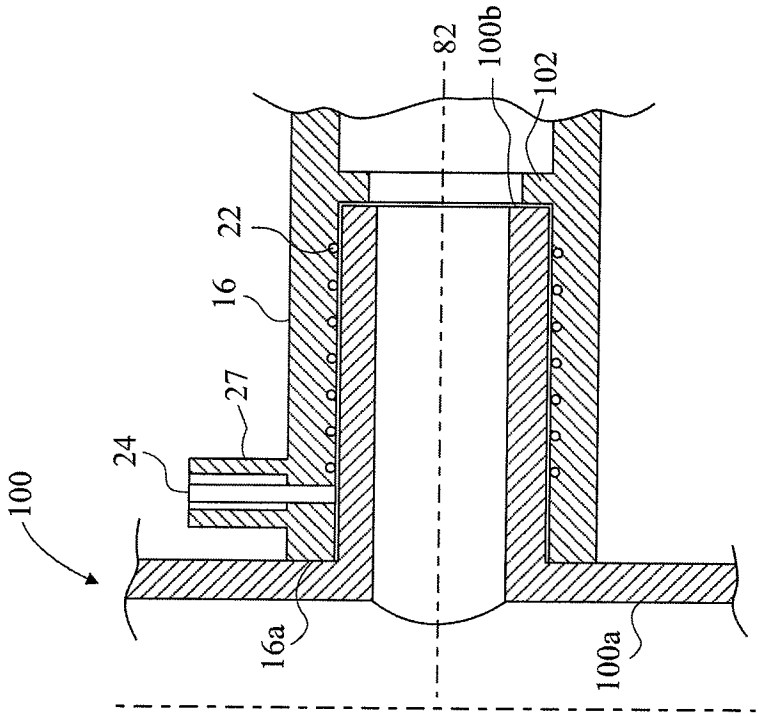
82
100b
102
22
16
27
24
100
16a
100a

Fig. 9a

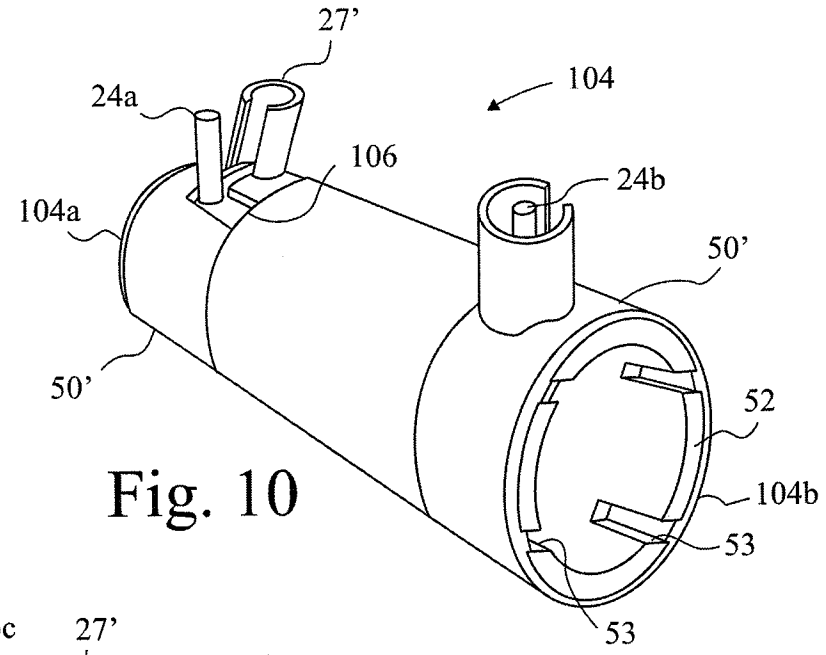

Fig. 10

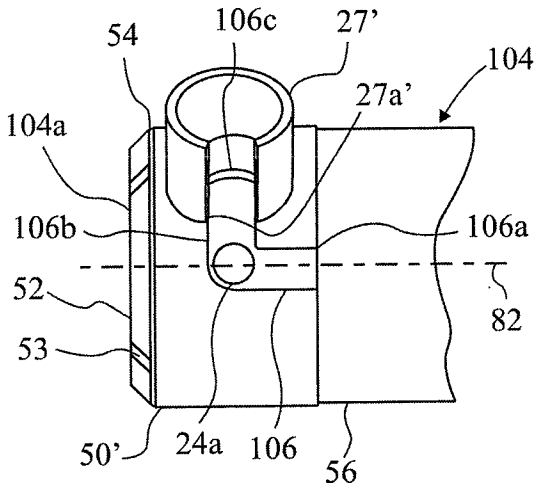

Fig. 11a

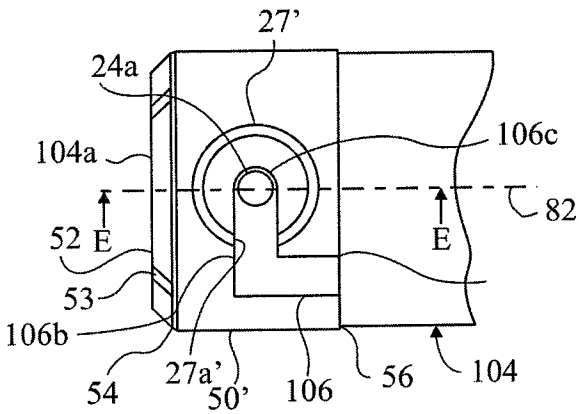

Fig. 11b

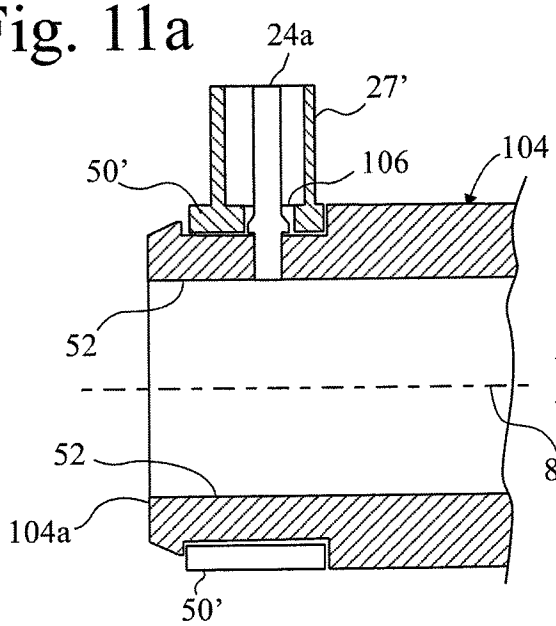

Fig. 12

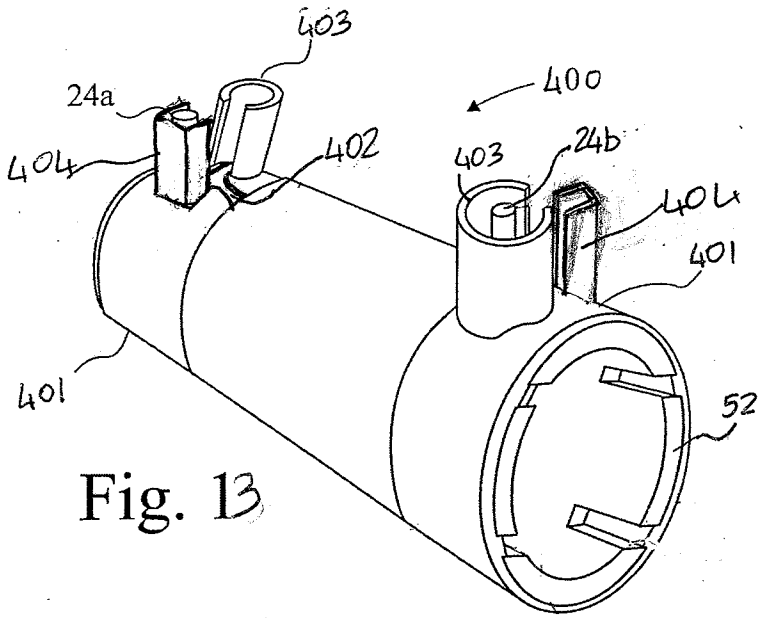

Fig. 13

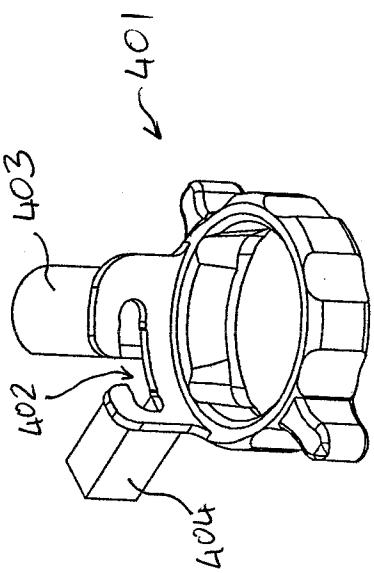

FIGURE 14A

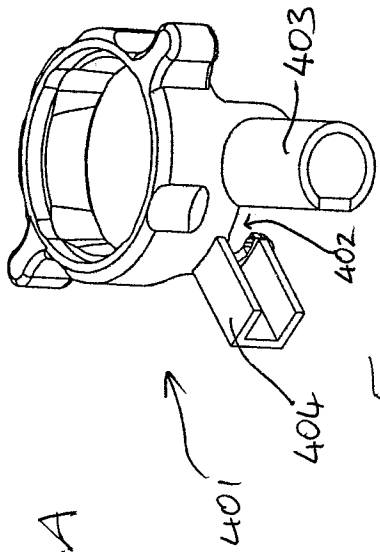

FIGURE 14B

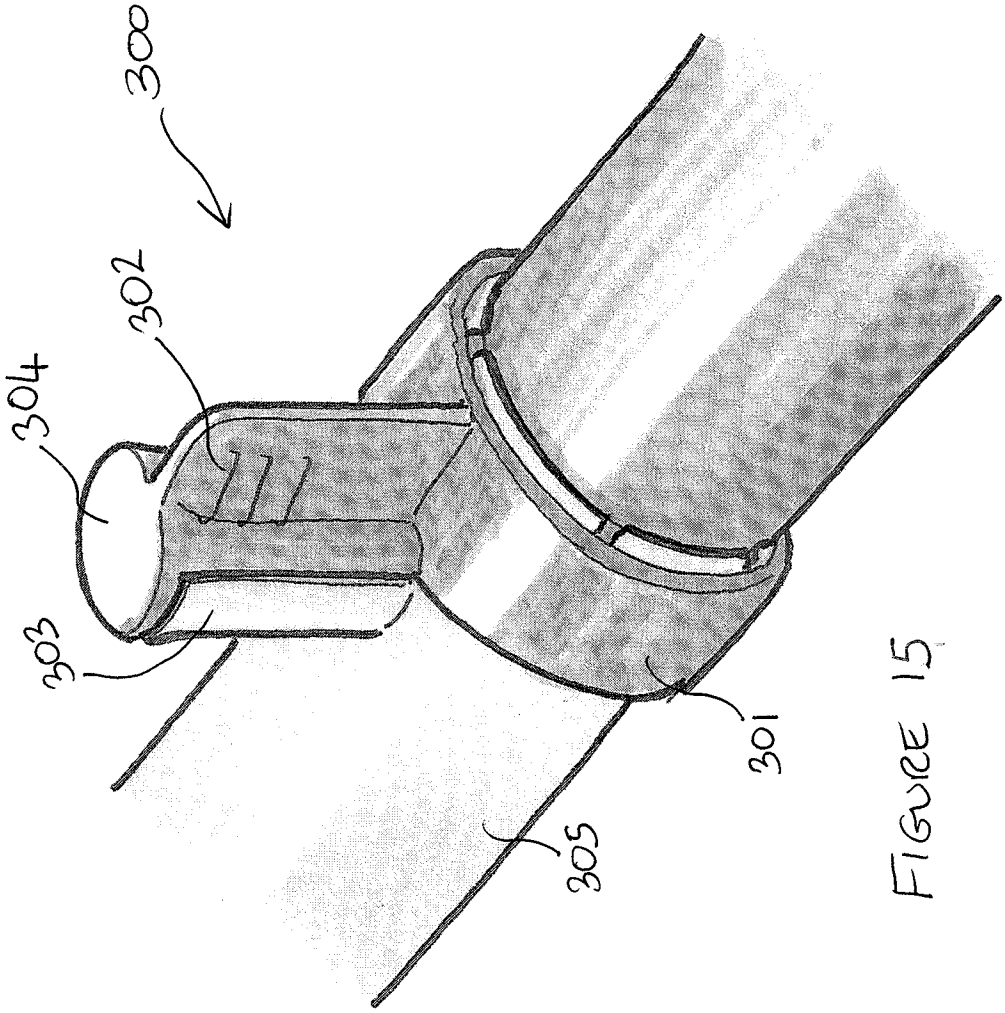

FIGURE 15

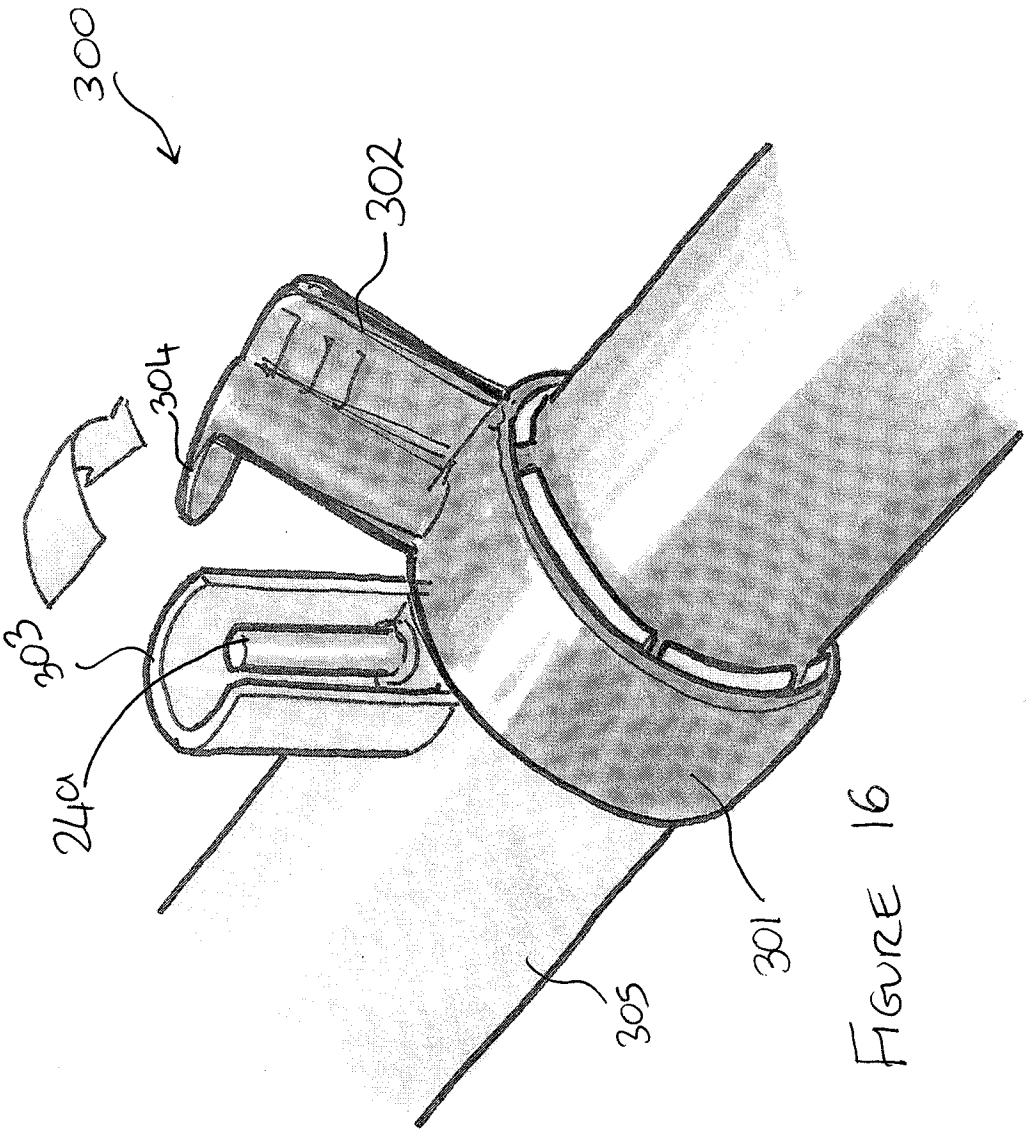

FIGURE 16

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2008/050580

A. CLASSIFICATION OF SUBJECT MATTER
INV. B29C65/00 F16L37/133 F16L47/03

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)
B29C 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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 44 37 407 A1 (GRUBER ALOIS AGRU GMBH [AT]) 25 April 1996 (1996-04-25)	1-17
A	column 1, lines 33-48 column 2, line 46 - column 3, line 64 figures	18-27
A	US 3 506 519 A (BLUMENKRANZ JAMES J) 14 April 1970 (1970-04-14) the whole document	1-27
A	WO 01/20219 A (PETROTECHNIK LTD [GB]; GEORG FISCHER WAVIN AG [CH]; RUFFLE STEPHEN COL) 22 March 2001 (2001-03-22) figures 4A-4F	19-27
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☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* 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 document 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	Date of mailing of the international search report
17 September 2008	25/09/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Durrenberger, Xavier

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2008/050580

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 additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an 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 reportcovers 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.:

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-18, 20-22, 24-27

   Electrofusion coupling with fingers clamping the hose inserted therein.

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2. claim: 19

   Electrofusion coupling wherein a grip ring including clamping arrangement has a bayonet slot receiving a terminal pin of the coupling

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3. claim: 23

   Electrofusion coupling with a terminal pin partially surrounded by a first upstanding boss, wherein a grip ring has a second uspstanding boss

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2008/050580

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