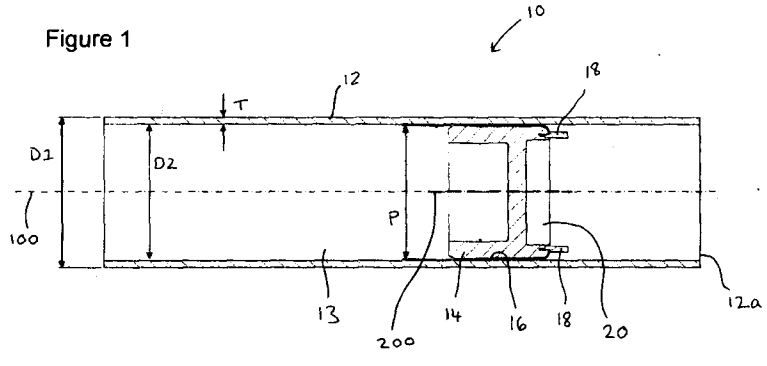
ABSTRACT

"METHOD OF SEALING A PLASTICS PIPE AND APPARATUS THEREFOR"

A method of sealing a plastics pipe (12) with a plug (14), wherein said plug (14) includes an electrofusion element (16) around an outer surface thereof, said method comprising the steps of inserting said plug (14) in a bore (13) of the pipe and energising said electrofusion element (16) whilst said pipe (12) and said plug (14) are radially urged against one another to form a seal between said plug (14) and said pipe (12).

Figure 1



CLAIMS

1. A method of sealing a plastics pipe with a plug, wherein said plug includes an electrofusion element on an outer surface thereof, said method comprising the steps of:

inserting said plug in a bore of the pipe and energising said electrofusion element whilst said pipe is urged radially inwardly against said plug to form a seal between said plug and said pipe.

2. A method according to claim 1, wherein an inner diameter of said pipe is expanded prior to inserting said plug in said bore, and said pipe is urged radially inwardly against said plug by elastic relaxation of said pipe following said expansion.

3. A method according to claim 2, wherein said plug has an initial outer diameter greater than said inner diameter of said pipe prior to expansion.

4. A method according to claim 2 or 3, wherein said inner diameter of said pipe is expanded using a pipe expansion tool.

5. A method according to claim 4, wherein said pipe expansion tool expands an inner diameter of said pipe by applying a radially outward expansion force to said pipe.

6. A method according to claim 5, wherein said pipe expansion tool is inserted into the bore of said pipe and said expansion force is applied to an inner surface of said pipe.

7. A method according to claim 6, wherein said pipe expansion tool is removed from said bore prior to insertion of said plug in said bore, thereby allowing elastic relaxation of said pipe.

8. A method according to any of claims 2 to 7, wherein said inner diameter of said pipe is expanded by between about 4% and 6%.

9. A method according to claim 1, wherein said pipe is urged radially inwardly against said plug by compressing said pipe radially inwardly against said plug.

10. A method according to claim 9, wherein said pipe is compressed by applying a substantially uniform radially inward force around an outer surface of the pipe.

11. A method according to claim 10, wherein said pipe is compressed using a pipe compression band that is around said outer surface of the pipe.

12. A method according to any preceding claim, wherein said plug comprises a fusible polymeric material and said electrofusion element is embedded therein.

13. A method according to claim 12, wherein said fusible polymeric material is polyethylene.

14. A method according to any preceding claim, wherein said plastics pipe is composed of polyethylene.

15. A method according to any preceding claim, wherein said pipe is sterilised prior to forming a seal between said pipe and said plug.

16. A method according to any preceding claim, wherein said plug and said seal formed between said pipe and said plug are capable of resisting an internal pipe pressure up to 1.5 times the rated maximum operating pressure of said pipe.

17. A method according to any preceding claim, wherein said pipe is a coiled pipe.

18. A method according to any preceding claim, wherein said pipe is sealed at both ends.

19. A method according to claim 18, wherein said pipe is commissioned by cutting the sealed ends off the pipe and connecting the pipe to a fluid network.

20. A method according to any preceding claim, wherein said electrofusion element is connected to a terminal pin at each end thereof, and said terminal pins are adapted to connect said electrofusion element to an electrical power source.

21. An apparatus for sealing a bore of a plastics pipe, comprising:
a plug including an electrofusion element on a fusible outer surface thereof; and
a pipe expansion tool for radially expanding an inner diameter of the pipe.

22. An apparatus for sealing a bore of a plastics pipe, comprising:

a plug including an electrofusion element on a fusible outer surface thereof; and

a pipe compression tool for radially compressing an inner diameter of the pipe.

23. An apparatus according to claim 21 or 22, wherein said electrofusion element is embedded in said fusible outer surface.

24. An apparatus according to claim 21, 22 or 23 wherein said fusible outer surface comprises a fusible polymeric material.

25. An apparatus according to claim 24, wherein said fusible polymeric material is polyethylene.

26. An apparatus according to any of claims 21 to 25, wherein said electrofusion element is connected to a terminal pin at each end thereof, and said terminal pins are adapted to connect said electrofusion element to an electrical power source.

27. An apparatus according to claim 22, wherein said pipe compression tool comprises a pipe compression band that fits around an outer surface of the pipe.

28. An apparatus for sealing a bore of a plastics pipe substantially as hereinbefore described with reference to the accompanying drawings.

29. A method of sealing a plastics pipe with a plug substantially as hereinbefore described with reference to the accompanying drawings.

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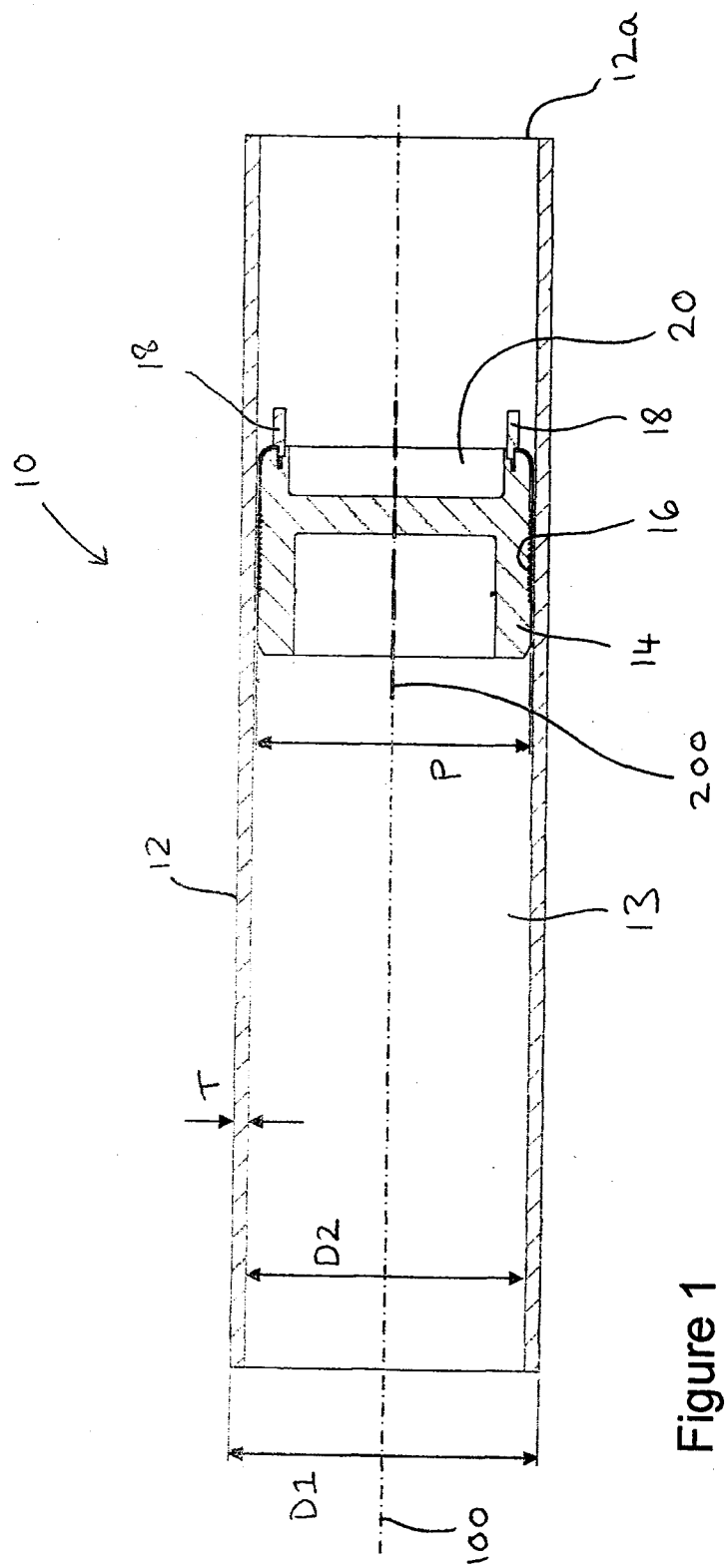

Figure 1

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Method of Sealing a Plastics Pipe and Apparatus therefor

[0001] This invention relates to a method of sealing a plastics pipe and apparatus therefor, and in particular to a method of sealing a plastics pipe with a plug.

BACKGROUND

[0002] Increasingly, plastics pipes are being used in the utilities industry to carry domestic water supplies and waste. However, before a plastics pipe is commissioned for a potable water supply, it must be disinfected to achieve a required level of sterility.

[0003] Traditionally, the plastics pipes are installed in the ground and are then disinfected by chlorination before the potable water supply is introduced. To achieve this, large volumes of chlorine solution need to be supplied to the site, passed through the pipes and then disposed of safely.

[0004] The need to disinfect the installed pipes means that the time between installation and commissioning of the pipes may be undesirably long. In addition to increased labour costs, the time delay between installation and commissioning increases the duration of road works and/or disruption to water supplies. It is therefore highly desirable to negate the requirement of onsite sterilisation.

[0005] UK patent application GB-A-2431611 (Glynwed Pipe Systems Limited) describes a method of manufacturing pipe coils that are sterilised and sealed prior to installation. In particular, a molten polymer compound is extruded, cooled and cut to form a pipe. The pipe is either sterilised during or after extrusion and the sterilised pipe is sealed at each end using sealing means that either comprises a heat shrinkable sealing cap or a heat shrinkable sleeve and a plug. The sealing means then maintain the sterility of the pipe so that no chlorination, or a reduced chlorination, is required onsite to disinfect the pipe between installing and commissioning. Prior to commissioning, the sealing means are peeled away from the pipe end or cut and removed from the pipe end.

[0006] It is an object of the present invention to provide an alternative method of sealing a plastics pipe prior to installation and apparatus suitable therefor.

BRIEF SUMMARY OF THE DISCLOSURE

[0007] In accordance with a first aspect of the present invention there is provided a method of sealing a plastics pipe with a plug, wherein said plug includes an electrofusion element on an outer surface thereof, said method comprising the steps of:

inserting said plug in a bore of the pipe and energising said electrofusion element whilst said pipe and said plug are radially urged against one another to form a seal between said plug and said pipe. Preferably, the pipe is a coiled pipe and is preferably sealed at both ends.

[0008] The present invention provides a method of sealing a plastics pipe where the seal is preferably formed after the pipe has been sterilised. Therefore, little or no onsite sterilisation will be required allowing a cheaper, quicker and more convenient installation/commissioning process. Since the plug forms a seal inside the bore of the pipe, no sealing components project radially from the pipe making a pipe sealed in accordance with the present invention suitable for any installation operation, including mains insertion replacement techniques.

[0009] In one preferable embodiment, said pipe and said plug are radially urged against one another by radially expanding said plug against an inner surface of said pipe. Preferably, the plug is adapted to receive a plug expansion tool for radially expanding said plug against said inner surface of said pipe. Further preferably, an outer diameter of said plug is expanded by said plug expansion tool at a rate of about 2 mm/min. Said plug and said pipe each have a longitudinal axis and said plug is held relative to said pipe so that the longitudinal axis of said plug is substantially coaxial with the longitudinal axis of said pipe during said energisation of said electrofusion element. Preferably, said plug expansion tool holds said plug relative to said pipe so that the longitudinal axis of said plug is substantially coaxial with the longitudinal axis of said pipe during said energisation of said electrofusion element.

[0010] In an alternative preferable embodiment, an inner diameter of said pipe is expanded prior to inserting said plug in said bore, where said plug preferably has an initial outer diameter greater than said inner diameter of said pipe prior to expansion. Preferably, said inner diameter of said pipe is expanded by between about 4% and 6%. Preferably, said inner diameter of said pipe is expanded using a pipe expansion tool. The pipe expansion tool preferably expands an inner diameter of said pipe by applying a radially outward expansion force to said pipe, where the pipe expansion tool is preferably inserted into said bore of said pipe and said expansion force is preferably applied to an inner surface of said pipe. Said pipe expansion tool is preferably removed from said bore prior to insertion of said plug in said bore. The pipe and said plug are preferably radially urged against one another by elastic relaxation of said pipe after removal of said radially outward expansion force.

[0011] In a further alternative preferable embodiment, the pipe and the plug are radially urged against one another by compressing said pipe radially inwardly against said plug. Preferably, the pipe is compressed by applying a substantially uniform radially inward force around an outer surface of the pipe. This will ensure that a uniformly even electrofusion joint is formed. In a particularly preferable embodiment, the pipe is compressed using a pipe compression band that fits around said outer surface of the pipe.

[0012] In all embodiments, said plug preferably comprises a fusible polymeric material and said electrofusion element is embedded therein, where said fusible polymeric material is preferably polyethylene. The plastics pipe is preferably composed of polyethylene. Good and reliable joints are achievable by exploiting a combination of thermal expansion and mechanical expansion or compression during the electrofusion process. The present invention is therefore suitable for sealing pipes whose inner diameter may vary due to a combination of toleranced dimensions.

[0013] Preferably, said electrofusion element is connected to a terminal pin at each end thereof, and said terminal pins are adapted to connect said electrofusion element to an electrical power source. The terminal pins allow the electrofusion element to be energised quickly and easy once the plug is positioned in the pipe.

[0014] Preferably, said plug and said seal are capable of resisting an internal pipe pressure up to 1.5 times the rated maximum operating pressure of said pipe. In this embodiment, the sealed pipe will withstand standard pressure testing and will maintain sterility throughout pressure testing.

[0015] Preferably, the pipe is commissioned by cutting the sealed ends off the pipe and connecting the pipe to a fluid network. Thus, the sterility of the pipe may be maintained throughout installation and commissioning.

[0016] In accordance with a second aspect of the present invention, there is provided a plug for sealing a bore of a plastics pipe, wherein said plug includes an electrofusion element on a fusible outer surface thereof, and said plug comprises a socket that is adapted to receive a plug expansion tool for radially expanding said plug. The electrofusion element is preferably embedded in said fusible outer surface which preferably comprises a fusible polymeric material. Further preferably, the fusible polymeric material is polyethylene.

[0017] In a particularly preferable embodiment, the electrofusion element is connected to a terminal pin at each end thereof, and said terminal pins are adapted to connect said electrofusion element to an electrical power source.

[0018] In accordance with a third aspect of the present invention, there is provided an apparatus for sealing a bore of a plastics pipe, comprising:

a plug including an electrofusion element on a fusible outer surface thereof; and

a plug expansion tool for radially expanding said plug;

wherein said plug comprises a socket that is adapted to receive said plug expansion tool.

[0019] In accordance with a fourth aspect of the present invention, there is provided an

apparatus for sealing a bore of a plastics pipe, comprising:

a plug including an electrofusion element on a fusible outer surface thereof; and

a pipe expansion tool for radially expanding an inner diameter of the pipe.

[0020] In accordance with a fifth aspect of the present invention, there is provided an apparatus for sealing a bore of a plastics pipe, comprising:

a plug including an electrofusion element on a fusible outer surface thereof; and

a pipe compression tool for radially compressing an inner diameter of the pipe.

Preferably, said pipe compression tool comprises a pipe compression band that fits around an outer surface of the pipe.

[0021] Preferably, in accordance with the third, fourth and fifth aspects of the present invention, said electrofusion element is embedded in said fusible outer surface which preferably comprises a fusible polymeric material. Further preferably, said fusible polymeric material is polyethylene. In a particularly preferable embodiment, said electrofusion element is connected to a terminal pin at each end thereof, and said terminal pins are adapted to connect said electrofusion element to an electrical power source.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a pipe and plug according to the present invention.

DETAILED DESCRIPTION

[0023] The present invention seeks to provide a method and apparatus for sealing a plastics pipe so that, preferably, the pipe may be sterilised in a factory environment prior to sealing and then be delivered to an installation site where it may be installed and commissioned whilst maintaining its sterility. A sealed pipe made in accordance with the present invention will be suitable for carrying potable water supplies or other fluids where cleanliness is of particular importance. Alternatively, sealed pipes made in accordance with the present invention may be made to resist internal pressures of up to 1.5 times the rated maximum operating pressure of the pipe making them particularly suited to withstanding the pressure testing that is necessary before pipes are commissioned to carry pressurised fluids such as domestic gas or water supplies.

[0024] Figure 1 shows a sealing system 10 which comprises a plastics pipe 12 and a plug 14. The pipe 12 is substantially tubular and has a bore 13. In the preferable embodiment shown in

Figure 1, the pipe 12 is a hollow cylinder centred on a longitudinal axis 100 of the pipe 12. The pipe 12 is defined by a wall of thickness T and has an outer diameter D1 and an inner diameter D2. The pipe 12 is preferably made from at least one polymeric material and is preferably made from polyethylene. The pipe 12 may be formed as a coiled pipe for easy transportation to installation sites.

[0025] The plug 14 is shaped to conform to the profile of the pipe bore 13. In the embodiment shown in Figure 1, the plug 14 is cylindrical, having a longitudinal axis 200 and an outer diameter P. The plug 14 has an electrofusion element 16 that is coiled around an outer surface of the plug 14 and is embedded in a fusible polymeric material such as polyethylene. The electrofusion element 16 is an electrically resistive wire that heats up when an electric current is passed therethrough. Each end of the electrofusion element 16 is connected to a terminal pin 18 which is connectable to a power source for electrically energising the electrofusion element 16. In one embodiment, the plug 14 may additionally comprise a socket 20 that is shaped to receive a plug expansion tool that is capable of applying a radially outward expansion force on the plug 14.

[0026] As is conventional in the plastics pipe industry, the pipe 12 may be sized according to its nominal outer diameter D1. Often, the outer diameter D1 and the wall thickness T are each made to a tolerance, $\Delta D1$ and ΔT respectively, so that the magnitude of the inner diameter D2 is determined by the actual magnitudes of the outer diameter D1 and wall thickness T.

[0027] Traditionally, pipe electrofusion fittings are designed as socket fittings that operate on the outer surface of a pipe. In that case, only one toleranced dimension (the outer diameter, D1) needs to be considered. In contrast, one must consider two toleranced dimensions when forming an electrofusion joint on the inside of a pipe whose inner diameter D2 is determined by the magnitudes of the outer diameter D1 and wall thickness T. Thus, for pipes of this type, the inner diameter D2 potentially varies over a wide range as a result of the compound of the tolerances $\Delta D1$ and ΔT. Therefore, a plug 14 of diameter P may be a close fit in the bore of one pipe (where $D2 - P \approx 0$), but a significant gap may exist when the same plug is inserted into the bore of another pipe of the same nominal outer diameter D1 (where $D2 - P >> 0$). Consequently, the potential variation in inner pipe diameters D2 can lead to inconsistent and possibly ineffective electrofusion joints being formed using a given plug 14.

[0028] The present invention solves this problem by providing a method of forming consistently successful electrofusion joints inside the bore of plastics pipes by radially urging one of the pipe 12 and plug 14 against the other during electrofusion. Therefore, any gap (D2-P) that may exist between the plug 14 and the pipe 12 as a result of the above-mentioned tolerances is reduced to zero so that effective electrofusion joints can be made.

[0029] In a first embodiment of the invention, the diameter P of the plug 14 is sized to match the smallest inner diameter D2 allowed by the tolerances of the outer diameter D1 and the wall thickness T. Therefore, the plug 14 is either a close fit in the bore 13 of the pipe 12 ($D2 \approx P$) or an annular gap (D2-P) exists around the plug 14 if the plug is held coaxially with the pipe 12. To form an electrofusion joint between the plug 14 and the pipe 12, the terminal pins 18 of the plug 14 are connected to a power source and energised for a predetermined time period. As an electric current is passed through the electrofusion element 16, heat is generated due to electrical resistance which causes the fusible polymeric material in which the electrofusion element 16 is embedded to melt forming a melt bubble around the outer surface of the plug 14. Due to the coefficient of thermal expansion of the fusible polymeric material, the outer surface of the plug 14 expands radially outwardly as a result of the heating. The radial expansion of the fusible polymeric material will reduce the size of the gap if $D2>P$ or will bear against the inner surface of the pipe 12 if $D2 \approx P$. In addition to being thermally expanded, the plug 14 is mechanically expanded during the electrofusion process. In particular, prior to the electrofusion element taking place, the plug expansion tool (not shown) is received in the socket 20 of the plug 14. During the electrofusion process, the plug expansion tool is operated to mechanically expand the plug 14 radially outwardly. Preferably, holding means hold the plug 14 relative to the pipe 12 so that the longitudinal axis 200 of the plug 14 is coaxial with the longitudinal axis 100 of the pipe 12 during electrofusion and expansion. Further preferably, the plug expansion tool is the holding means.

[0030] During the electrofusion process, the plug expansion tool expands the plug at a steady rate, preferably expanding the diameter P of the plug 14 radially outwards at a rate of about 2 mm/min. The combination of thermal expansion and mechanical expansion of the plug 14 causes the fusible polymeric material around the surface of the plug 14 to exude between the hot wires of the electrofusion element 16. This exerts a radially outward force on the inner surface of the pipe and ultimately closes the gap between the plug 14 and the pipe 12. A bond between the plug 14 and the pipe 12 is created when the current flowing through the electrofusion element 16 is switched off and the fusible polymer material around the outside surface of the plug 14 is allowed to cool and harden.

[0031] In a second embodiment of the invention, the diameter P of the plug 14 is sized to match the largest inner diameter D2 allowed by the tolerances of the outer diameter D1 and the wall thickness T. For pipes 12 whose inner diameter D2 are the largest size allowed by the tolerances $\Delta D1$ and ΔT, the plug 14 will be a close fit in the bore 13 of the pipe 12 and no gap will exist. In most cases however, the pipe 12 will have an inner diameter D2 that is less than the diameter P of the plug 14 and so the plug 14 will not fit into the bore 13 of the pipe 12. In these cases, part of the pipe 12 may be radially expanded by a pipe expansion tool (not shown)

to permit insertion of the plug 14 in the bore 13 of the pipe 12. The pipe expansion tool may cause expansion of the pipe 12 by direct mechanical means or by hydraulic or pneumatic means. Preferably, the pipe expansion tool radially expands the inner diameter D2 of the pipe by approximately 4% to 6%. The pipe expansion tool is then removed from the bore 13 of the pipe 12 and the plug 14 is promptly inserted before the pipe 12 elastically relaxes towards its original (unexpanded) dimensions. Elastic relaxation of the pipe 12 begins immediately after the pipe expansion tool is removed (although the rate of relaxation may be quite slow) so the plug 14 must be inserted in the bore 13 of the pipe 12 before the pipe's inner diameter D2 contracts to a size that is less than the diameter P of the plug 14. Once the plug 14 has been inserted into the bore 13 of the pipe 12, the relaxing pipe 12 will contract around the plug 14 exerting a radially inward force on the plug 14. At this point, there will be no annular gap between the plug 14 and the pipe 12 and so the two may be welded together by energising the electrofusion element in the manner described above.

[0032] In a third embodiment of the invention, the diameter P of the plug is sized to the smallest inner diameter D2 allowed by the tolerances of the outer diameter D1 and the wall thickness T as with the first embodiment. Therefore, the plug 14 is either a close fit in the bore 13 of the pipe 12 ($D2 \approx P$) or an annular gap (D2-P) exists around the plug 14 if the plug is held coaxially with the pipe 12. The terminal pins 18 of the plug 14 are connected to a power source and energised for a predetermined time period to form an electrofusion joint between the plug 14 and the pipe 12. As an electric current is passed through the electrofusion element 16, heat is generated due to electrical resistance which causes the fusible polymeric material in which the electrofusion element 16 is embedded to melt forming a melt bubble around the outer surface of the plug 14. Due to the coefficient of thermal expansion of the fusible polymeric material, the outer surface of the plug 14 expands radially outwardly as a result of the heating. The radial expansion of the fusible polymeric material will reduce the size of the gap if $D2>P$ or will bear against the inner surface of the pipe 12 if $D2 \approx P$. As the outer surface of the plug 14 thermally expands, the pipe 12 is radially inwardly compressed by a pipe compression tool to bear against the plug 14. This requires a uniform application of pressure to the pipe 14 since any imbalance could potentially lead to gaps in the annular electrofusion joint. A suitable pipe compression tool comprises a uniform compression band that fits around the outer surface of the pipe 14 and is tightened to uniformly compress the pipe 14 radially inwardly against the plug 12. The magnitude of compression must be great enough to radially urge against the plug 12, but not so great that cold flow (creep) occurs which may lead to non-uniform electrofusion joint.

[0033] Prior to sealing the pipe 12 using any of the methods described above, the pipe 12 may be sterilised by passing a sterilising fluid through its bore 13. Prompt sealing of each end of the pipe 12 following sterilisation allows the sealed and sterilised pipe to be transported and

supplied to an installation site where it may be installed with little or no onsite sterilisation treatment. Thus, the time required to install and commission the pipe is significantly reduced thereby reducing labour costs and minimising disruption caused by road works or interrupted utility supplies.

[0034] Before a pipeline is commissioned, it is normal and sometimes necessary to perform a pressure test to confirm that the pipe will maintain its integrity for its intended purpose. The above-described methods allow seals to be formed that are capable of withstanding high pressures and will preferably withstand pressures up to 1.5 times the maximum operating pressure of a given pipe. Therefore, the pipe may be pressure tested with the seals in place thus maintaining sterility up until the pipe is ready to be commissioned.

[0035] Once the pipe has been installed (and optionally pressure tested), a final connection may be made by cutting the sealed end off the pipe 12 and connecting the pipe 12 to a valve or another pipe already in-situ.

[0036] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of them mean "including but not limited to", and they are not intended to (and do 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.

[0037] 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. 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. 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.

[0038] 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.