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(54) **Heat shrinkable member for connecting tubular sections**

(57) The member has shrinkable end portions (11) for connecting on respective adjacent end surfaces of the tubular sections (13, 14) adjacent a joint (19), with an integral shrinkable middle portion (12) spanning the joint, the end portions (11) being thinner than the middle portion (12) so that the end portions (11) tend to shrink preferentially on exposure to heating. The member is a tubular preform or is formed from a wrap-around sleeve, optionally formed of different width sections. The end portions can have uniform thickness, be tapered or stepped.

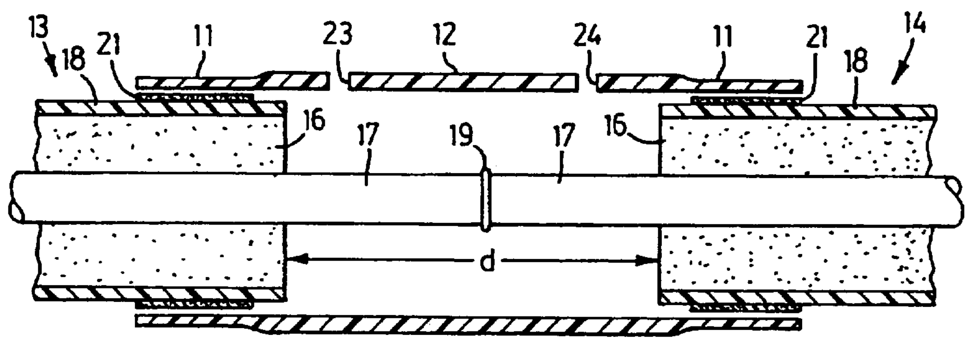

FIG.2

GB 2 319 316 A

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

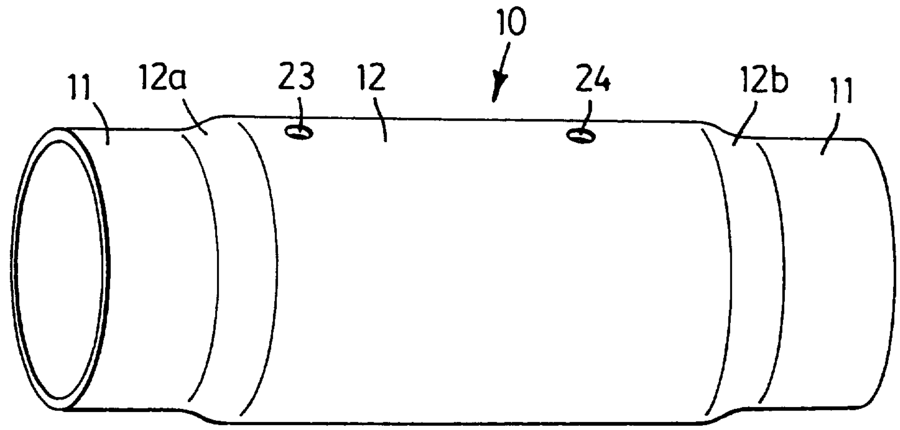

FIG.1

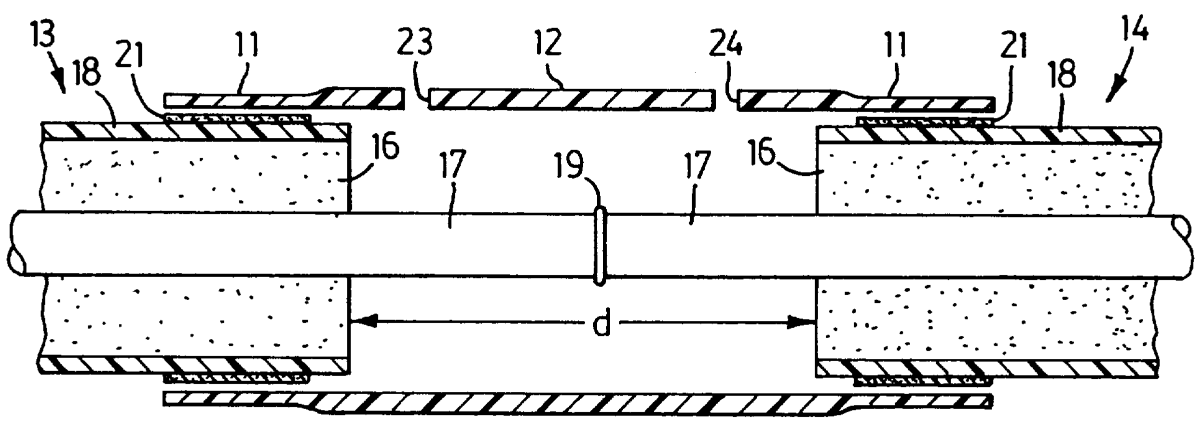

FIG.2

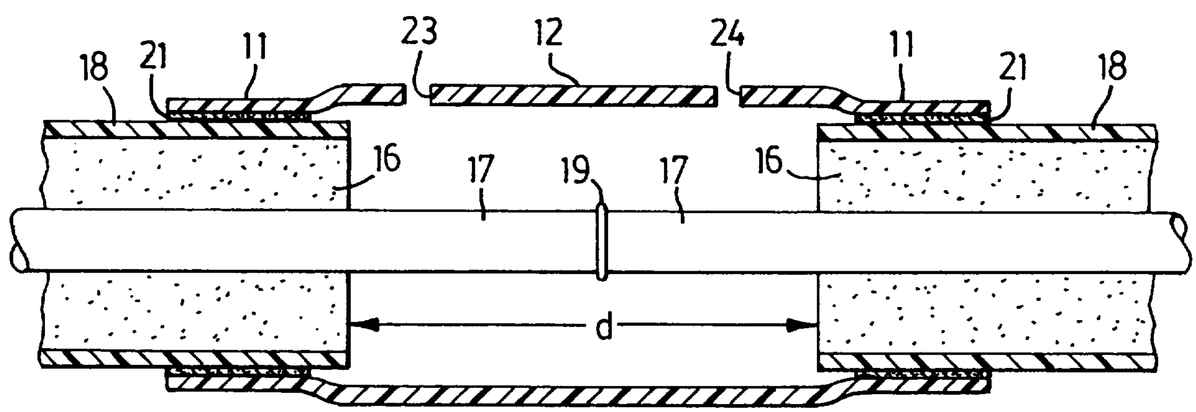

FIG.3

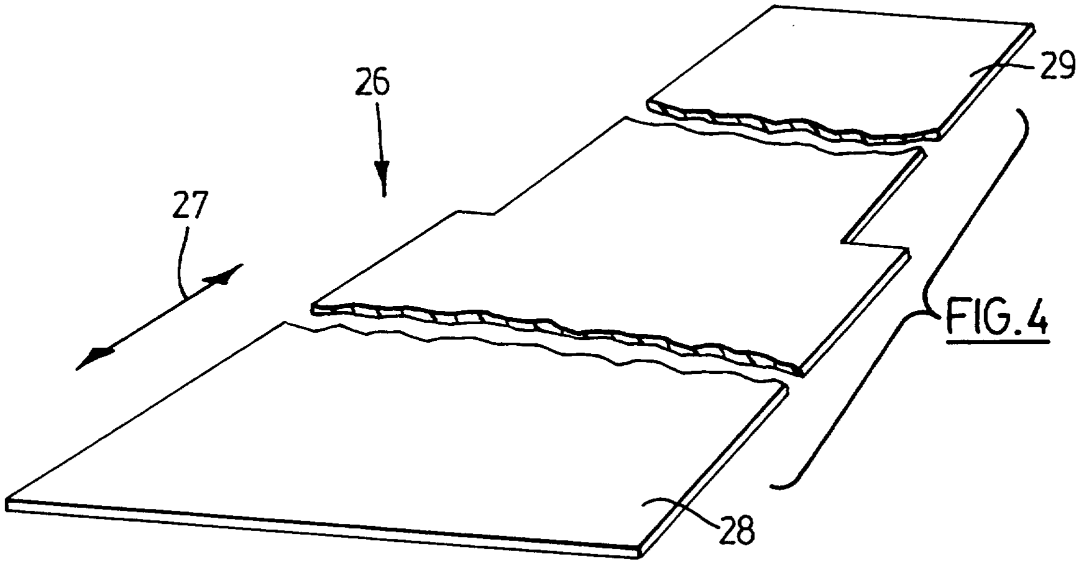

FIG.4

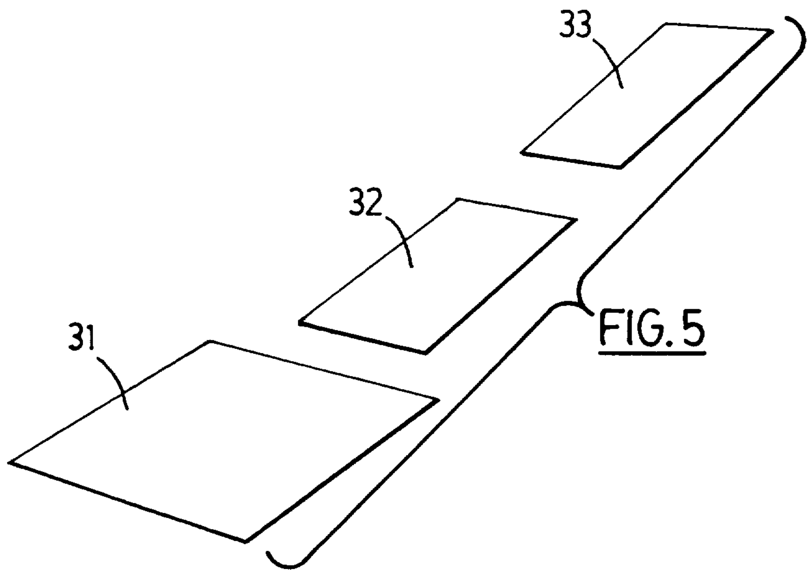

FIG.5

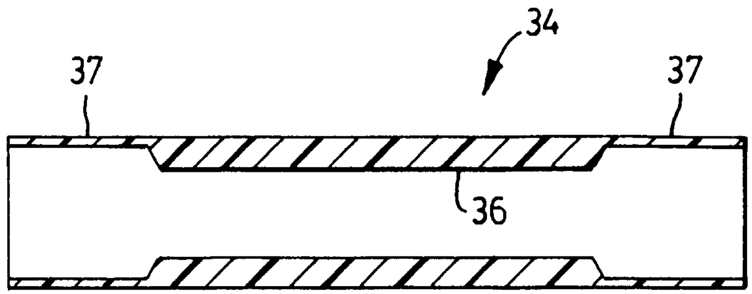

FIG.6

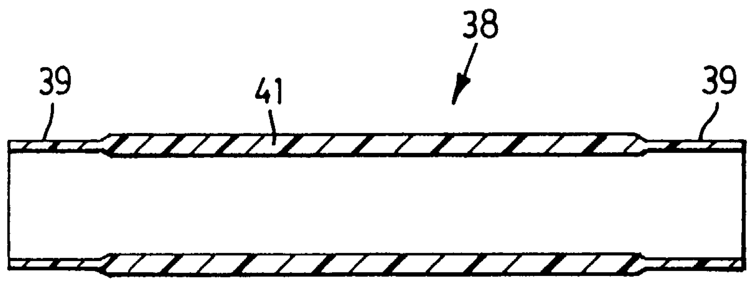

FIG.7

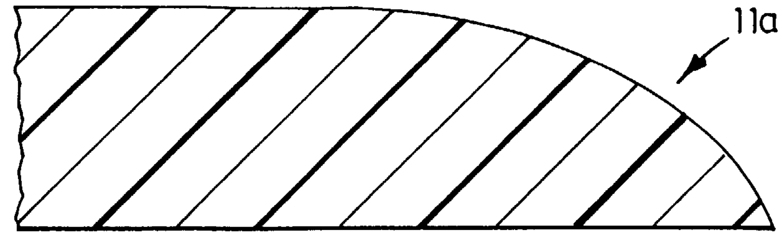

FIG.8A

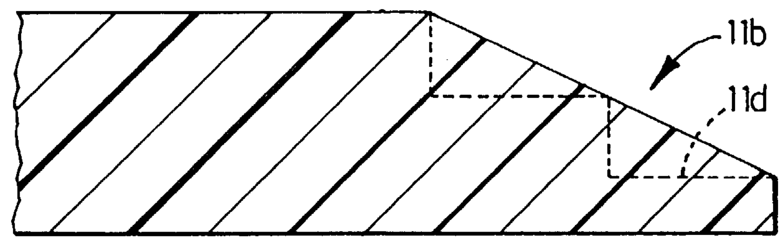

FIG.8B

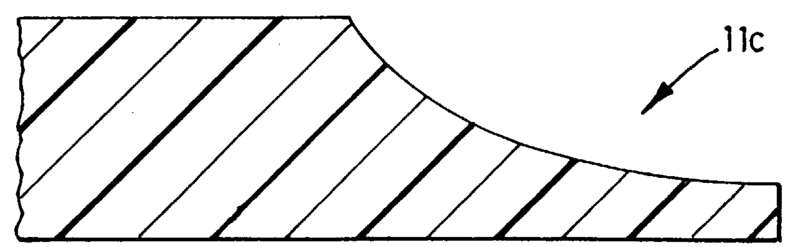

FIG.8C

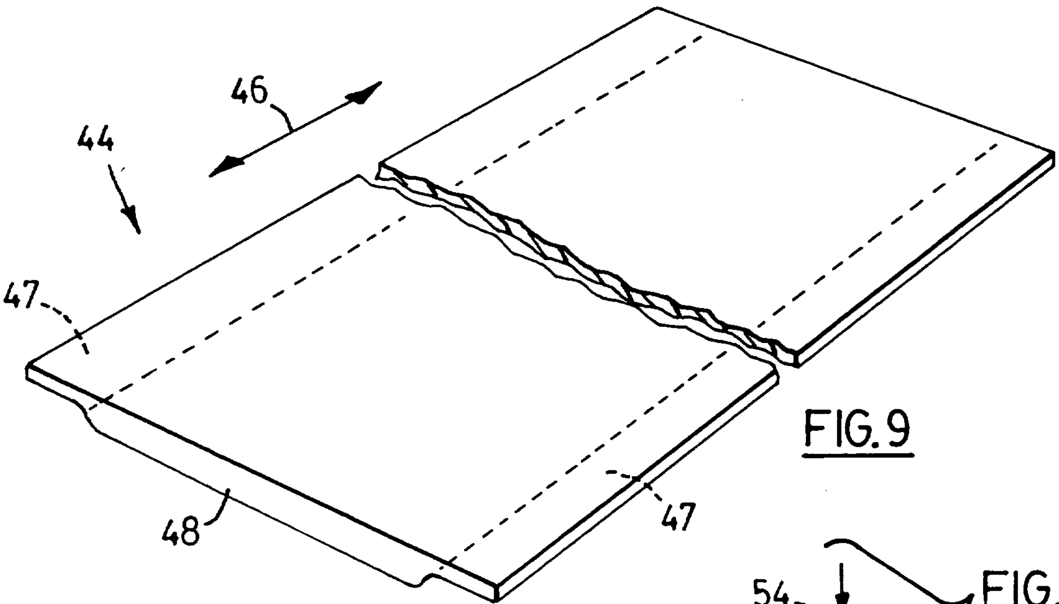

FIG.9

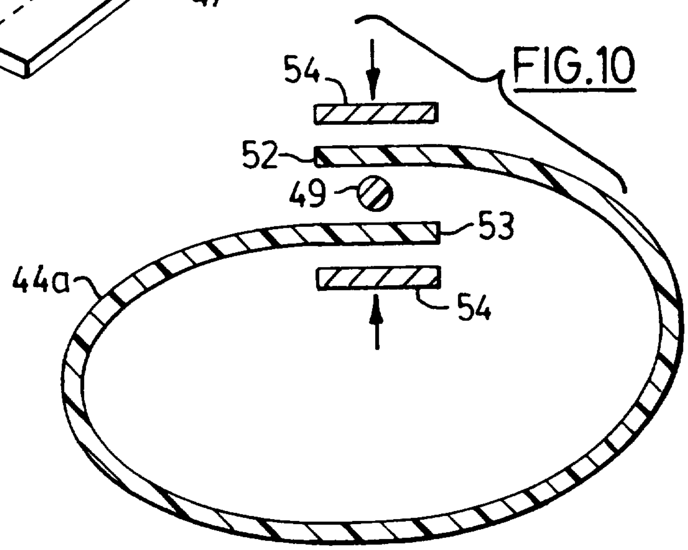

FIG.10

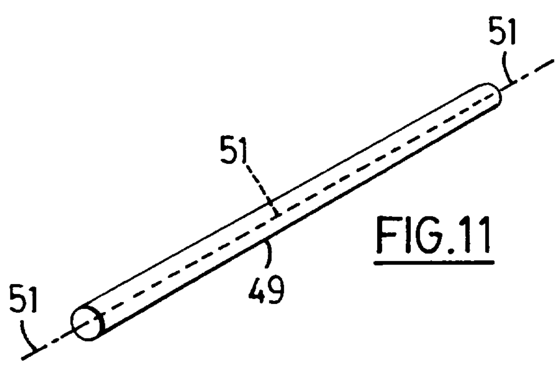

FIG.11

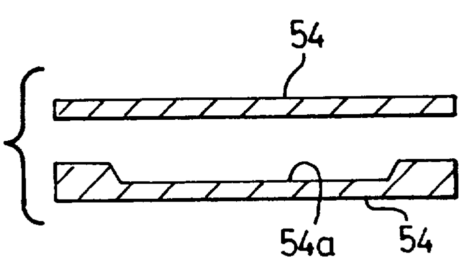

FIG.10A

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The present invention relates to heat shrinkable members for forming a connection between tubular sections.

Such members may be used for connecting a variety of tubular sections together. For example, they may be used as coupling sleeves for joining plastic tubes or pipes.

A further example of the use of such members is in the formation of casings for preinsulated pipe joints.

Preinsulated pipelines for carrying fluids at non-ambient temperatures typically consist of a service or carrier pipe, covered with insulating material such as foam. The insulating material is generally encased within a jacket which may for example be made from a polymeric material, such as high density polyethylene, or a metal such as steel or aluminum. The pre-insulated pipes are connected in the field by welding the service pipe which extends beyond the insulation at each end, and then insulating and encasing the joint.

A suitable casing on the joint is a critical component of the pipeline, as it must provide a water-tight connection to the rest of the pipe and mechanical protection to the insulation. The formation of the foam insulation may be done before or after the joint casing is applied. It is often desirable to employ the joint casing to facilitate the formation of foam insulation in the joint, in which case the casing serves as a mould into which the foam components are introduced. In order that the casing continues to protect the joint from water ingress, it is necessary that the casing itself is not damaged, or dislocated from the joint area, or undergo distortion so that a path is created for water ingress to occur.

In some applications, it is desirable to pre-form the foam insulation within a mold usually consisting of sheet metal applied around the joint cavity. The foam precursor is poured through a hole in the mold and allowed to rise and set, after which the mold is removed. This allows the installer to check the quality and integrity of the foam before encasing it within a joint casing member.

In other applications, it may not be convenient or possible to pre-form the insulation and in such case it is usual to apply the joint casing over the joint and to unite it to the pipe jacketing before introducing the foam precursor into the casing and allowing the precursor to foam and set. In this case, the casing itself acts as the mold for the foam.

It is desirable to provide a casing that is versatile in its mode of application and that may be applied over a preformed foam insulation or that may be used as a mold within which the foam insulation may be formed after the casing has been installed.

It has been proposed to provide heat shrinkable casing members that may be applied before or after the foam insulation has been formed. In order to unite the ends of the casing with the pipe jacketing, the ends are heated, for example by application of a propane, butane or natural gas torch flame, to shrink them down into conformity with the exterior surface of the pipe jacketing. A difficulty with known structures of which the applicant is aware is that when the end portions of the casing are heated, there is a tendency for portions of the casing adjacent the cavity to shrink inwardly into the cavity, thereby deforming the casing inwardly. As a result, the foam subsequently formed within the deformed casing has insufficient thickness in the inwardly deformed areas, and can present problems of insufficient protection or excessive heat transfer through the insufficiently insulated areas. It has been proposed in U.S. patent

4,514,241 issued April 30, 1985 (Maukola) to employ a coil shaped support member to preserve the desired contour of the casing during the shrinking process, but this is inconvenient and expensive because of the additional costs and inventory requirements of the coil system.

In the present invention there is provided a heat shrinkable member for forming a connection between tubular sections, the member having heat shrinkable end portions for connecting on respective adjacent end surfaces of the tubular sections at the joint, and a heat shrinkable middle portion formed integrally with the end portions, for spanning between the end surfaces of the tubular sections, the end portions each comprising a zone having a relatively small wall thickness and the middle portion having a relatively large wall thickness so that the said zones tend to shrink preferentially on exposure to heating.

With this arrangement, when applying heating to the end portions for the purpose of shrinking them down onto the end surfaces of the adjacent tubular sections, control of the heating, such that predominantly only the thinner zones of the end portions are heated sufficiently to a temperature at which they shrink, is greatly facilitated. The thicker middle portions are less readily heated to a point at which shrinkage commences. The structure of the invention avoids or mitigates risk of inadvertent shrinking of the middle portion into the cavity between the pipe jacketings or other tubular sections to be connected.

With the structure of the invention, the middle portion can be of a wall thickness that provides a preferred degree of mechanical strength or that imparts some other desired property to the joint, while the thin zones of the end portions may be substantially thinner.

The heat shrinkable member of the invention may be provided in the form of a circumferentially shrinkable tubular sleeve. In such case, the tinner zones are preferably continuous and in the form of an annulus disposed adjacent the outer ends or sides of the member, that is to say adjacent the longitudinal ends of the tubular member. Alternatively, the heat shrinkable member of the invention may be in the form of a wrap-around sleeve, and may comprise generally a longitudinally shrinkable sheet that is, or of which sections are, adapted to be formed into a tubular sleeve by connecting longitudinally opposed ends together, the sheet having said thinner zones adjacent the lateral margins and a thick middle portion. Preferably, the thinner zones are disposed adjacent the outer sides of the sheet and extend continuously along the sheet. In use, the ends of the wrap-around sleeve may be connected together using, for example, a mechanical fastener arrangement as described in U.S. patent 4,532,168 (Steele et al), or may be provided with edge beads adapted to be connected using a channel section connector, for example as described in U.S. patent 3,455,336(Ellis). Alternatively, the ends of the sleeve may be welded together.

The end portions of the heat shrinkable member of the invention may be of substantially uniform thickness throughout or they may have a wall portion that decreases laterally outwardly from the middle portion toward the outer ends or sides of the member. The profile may decrease in thickness smoothly or in a stepped fashion.

The wall thickness of the thinner zones (or of the thickest portions of the thinner zones in the case in which the thickness varies in the direction between the middle portion and the outer ends or sides of the member) is preferably no more than 95% the thickness of the middle portion, more preferably no more than 90%, still more preferably no more than 80%, and still more preferably no more than 70%, the thickness of the middle portion.

Desirably, the middle portion is of substantially uniform wall thickness throughout. In the event the middle portion is of varying wall thickness, reference to the thickness of the thinner zones relative to the thickness of the middle portion refer to the thickness of the thinnest portion of the middle portion.

In the preferred form, the heat shrinkable members of the invention comprise cross-linked plastic materials, for example organic polymers or elastomers or mixtures thereof. Examples of suitable plastics material usable for the heat shrinkable members are well known to those skilled in the art and need not be discussed in detail herein. Further, the methods of cross-linking the plastics materials, and the degrees of cross-linking required to provide sufficient resistance to melting to allow the cross-linked polymers to be readily heated with torch flames or the like for a period sufficient to induce shrinking are well known to those skilled in the art and need not be described in detail. Likewise, the techniques that are employed for heating and expanding or stretching or cooling suitable materials in order to impart to them a heat shrink property are conventional and well known to those of skill in the art and again need not be described in detail.

Preferably, the middle and the end portions of the heat shrinkable member of the invention comprise material that has been stretched for example expanded circumferentially in the case of a tubular sleeve or stretched longitudinally in the case of a wrap-around sheet, from an original heat stable form to a dimensionally heat unstable form capable of moving in the direction of its original form by the application of heat alone.

For further details of suitable plastics material compositions and of crosslinking and stretching and expansion techniques, reference may be made to U.S. patents

3,297,819 (Wetmore); 4,200,676 (Caponigro) and 4,472,468 (Tailor et al).

Examples of shrinkable members in accordance with the invention will now be described in more detail, by way of example only, with reference to the accompanying drawings.

Fig. 1 is a perspective view of a heat shrinkable member in accordance with the invention.

Fig. 2 is a side view, partially in section, through the member of Fig. 1 used as a casing in forming a preinsulated pipeline joint.

Fig. 3 is a view similar to Fig. 2 showing the ends of the casing shrunk down.

Figs. 4 and 5 are perspective views of sheets employable in fabricating the casing of Fig. 1.

Figs. 6 and 7 are longitudinal cross sections through further forms of heat shrinkable member in accordance with the invention.

Figs. 8A, 8B and 8C are partial longitudinal cross sectional views showing the profile of the end portions of further forms of heat shrinkable member in accordance with the invention.

Fig. 9 shows a wraparound sleeve in accordance with the invention.

Figs. 10 and 10A are transverse and longitudinal cross sections through an apparatus and assembly that may be used in forming the sleeve of Fig. 9 into a tubular sleeve.

Fig. 11 is a perspective view of a fusible rod insert employed in the assembly of Fig. 10.

Referring to the drawings, Figs. 1 and 2 show a heat shrinkable member in the form of a one piece circumferentially shrinkable tubular sleeve 10. The sleeve 10 is generally cylindrical, and has relatively thin walled tubular end portions 11 and a relatively thick wall tubular middle portion 12.

In the example of Figs. 1 to 3, the sleeve 10 is initially of substantially constant inside diameter and the outside diameter increases from the thin walled end portions 11 to the middle portion 12 along generally conically flaring transitional portions 12a and 12b.

Figs. 2 and 3 show the sleeve 10 of Fig. 1 employed in forming a joint between two preinsulated pipe sections 13 and 14. Each pipe section 13 and 14 comprises insulation material, for example polyurethane foam 16, in the form of a cylinder disposed concentrically around a metal, for example steel, pipe 17. The insulation 16 is jacketed within a cylindrical pipe jacket 18 which may for example be a plastics material, for example high density polyethylene, or a metal such as steel or aluminium.

In use, before uniting the pipe sections 13 and 14, the sleeve 10 may be slid over the end of one of the sections 13 and 14 and shifted rearwardly from the end sufficiently to reveal the bare end of the pipe 17. As manufactured, the pipe sections have the jacketing 18 and insulation 16 terminating short of the ends of the pipe 17, to expose end portions of the pipe 17 for welding.

The juxtaposed ends of the pipe 17 are then welded together at a weld 19.

Preferably, a functional material 21 that facilitates forming a water tight seal is provided between the end portions 11 and the jacketing 18. The functional material may, for example, comprise a sealant, mastic or adhesive applied either to the external circumference of the jacketing 18 or to the internal surface of the end portions 11. For example, as shown, the functional material 21 may comprise an adhesive applied to the exterior of the jacketing 18. For example, it may comprise a hot melt adhesive layer that will become molten when the end portions 11 are heated to shrink them.

In the preferred form, the sleeve 10 is positioned so that the end portions 11 overlie portions of the jacket 18 offset a small distance inwardly from the ends of the insulation 16. Preferably, the length of the thick middle portion 12 is such that it is slightly longer than the length d of the cavity formed between the ends of the insulation 16 when the pipes 17 are welded together, such that each end of the thick middle portion 12 overlaps by 25 to 50 mm over the ends of the jackets 18.

The thin end portions 11 are heated in a conventional manner, for example with a gas torch flame to cause them to shrink and to activate the hot melt adhesive or other functional material 21 so that the shrunk down ends 11 grip tightly on the functional material 21 and exert a hoop stress ensuring a water tight seal between the ends 11 and the casing 18. In the preferred form, the end portions 11 are relatively thin such that the heating applied to the end portions 11 in the conventional manner, and that is ample to shrink the portions 11 and activate the functional material 21, can be applied in a relatively short time span. There is then little opportunity for conduction of heat into the adjacent marginal portions of the relatively thick middle portion 12. Further, once the heating has terminated, there is less residual heat in the heated end portions 11 or in the materials underlying them and therefore there is less tendency for substantial residual heat to be conducted into the adjacent middle portion 12. Further, it has been found that when the wall thickness of a shrinkable substrate is high, the response times to heat-induced shrinking is slow and a considerably greater length of time elapses before shrinking commences. As a result, the thinner end portions will shrink preferentially even when the middle and end portions are exposed to the similar heating conditions, for example when they are exposed to similar heat flux from an external heating source, such as a torch or the like, for similar periods of time.

While some small degree of shrinkage of the transition portions 12a and 12b and of the immediately adjacent marginal portion of the thick portion 12 overlying the jacket 18 may occur, with the structure of the invention it is a relatively simple matter for the installer to confine the heating and shrinkage generally to the end portions 11 so that shrinkage of the middle portion 12 inwardly into the cavity between the ends of the insulation 16 and jacketing 18 does not occur.

In the case in which the foam insulation for the cavity 22 is formed after the tubular sleeve 10 is applied, a liquid precursor of a foam composition is poured into the cavity 22 through a hole 23 which may be provided in the sleeve 10 as manufactured, or may be drilled in the middle portion 12 before installation on the pipe joint. A hole 24 may be drilled before or after installation of the sleeve 10 on the joint, and acts as a vent for air to escape when the foam expands. The foam precursor is allowed to foam and set. The holes 23 and 24 may then be plugged to render them water tight in the conventional manner.

In the case in which the tubular sleeve 10 is applied after formation of foam insulation in the cavity 22, the above procedure is followed, except after positioning the sleeve 10 and effecting the weld 19, a half shell or similar mold is positioned around the cavity, the foam is formed and the half shell mould removed. After shrinking down one end 11, the middle portion 12 is deliberately heated to effect shrinkage of it onto the cylindrical surface of the foam insulation filling the cavity 12 while leaving the other end portion 11 unshrunk to allow air to escape. The other end portion 11 is then shrunk down. In such a case, the sleeve 10 would not ordinarily have or be formed with pour and vent holes 23 and 24.

Where the tubular sleeve is applied prior to foaming a joint between insulated pipe sections having a jacket, it is ordinarily desirable that the middle portion 12 have a wall thickness similar to the wall thickness of the jacket 18 so that the tubular sleeve casing offers mechanical protection to the joint foam equivalent to that provided by the pipe jacket 18 to the pipe foam 16. The thickness of the middle portion 12 of the sleeve 10 may however differ by as much as 25% from the jacket thickness 18 for a given pipe size while still providing adequate mechanical protection. Usually, the larger the diameter of the pipe section such as pipe 13 or 14, the greater is the thickness of the jacket 18 provided by the manufacturer to offer mechanical protection for the foamed insulation 16. Preferably, the wall thickness of the middle portion 12 of the heat shrinkable member of the invention is in the range 1.8 to 12.5 mm.

In one preferred form of the member of the present invention, the thickness of the middle portion 12 is less than 5 mm, for example is 1.8 to 5 mm. This is particularly advantageous in the case in which foam insulation for the joint is formed before the joint casing is applied. It has been found that, with the usual cross linked plastics material, and the usual modes of heating, the prolonged heating required for effecting shrinkage of a wall thickness over about 5 mm is so great that the plastics material tends to char or degrade to an undesirable extent.

Desirably, the wall thickness of the end portions 11 of the member of the invention is no more than 95% the thickness of the middle portion 12. If the thickness differential between the end portion 11 and middle portion 12 is insufficient, there may be insufficient tendency for the end portions 11 to shrink preferentially and there may be a tendency for residual heat remaining after the shrinking of the end portions 11 has been completed to cause shrinkage of areas of the middle portion 12 into the cavity. Further, it is desirable that the thickness of the end portions should be sufficiently small that the end portions will readily shrink uniformly when heating is applied to them within a reasonable period of time without degradation of the heat shrinkable material occurring. More preferably, the wall thickness of the end portions 11 is no more than 90%, still more preferably 80% and even more preferably 70% the wall thickness of the middle portion 12, and is in the range of 0.5 to 6 mm, more preferably is 1 to 4 mm.

If the thickness differential between the end and middle portions is excessively large, the end portions 11 may be of insufficient thickness to resist foam pressures and temperatures. Where post-foaming is conducted, the internal pressure can exceed 0.5 bar and the temperatures can exceed 60°C. If the end portions 11 of the casing are excessively thin, they may have insufficient strength to withstand these foam pressures and temperatures without elongating and ballooning. Further, if the end portions 11 are excessively thin, they may provide insufficient hoop stresses on shrinking to provide an effective seal against the ingress of water and other elements.

Where the middle portion 12 is very thick, for example in the case of a sleeve 10 adapted to be applied to large diameter pipes, the thickness differential between the end portion 11 and the middle portion 12 may be large. Preferably, the wall thickness of the end portions 11 is at least 2%, still more preferably at least 5% the thickness of the middle portion 12.

Preferably, the sleeve 10 is uniformly shrinkable along its length. For example, in a preferred form, the sleeve 10 exhibits on heating to a fully shrunk condition a degree of circumferential shrinkage of 5 to 60% in circumference, preferably at all transverse cross sections, based on the circumference of the unshrunk sleeve.

Various procedures may be employed for manufacturing the heat shrinkable members such as the sleeve 10 shown in Figs. 1 and 2.

For example, the sleeve 10 may be formed by extruding a tube, and compression forming the end sections to a thinner cross section, followed by cross linking, expansion and cooling in the conventional manner. Alternatively, a tube of the configuration shown in Figs. 1 and 2 may be formed by rotational molding or blow molding, and is then cross linked, expanded and cooled to yield a heat shrinkable product in the conventional manner.

In one preferred procedure, a heat shrinkable polymeric sheet, for example as indicated at 26 in Figure 4 is employed. The heat shrinkable sheet is formed by extrusion, crosslinking, expansion and cooling in the conventional manner to provide it with a heat shrink capability in the longitudinal direction indicated by the arrow 27 in Fig. 4. The heat shrinkable sheet may be cut to the form indicated in Fig. 4 having a wider end 28 and an inwardly stepped narrower end 29. The sheet 26 is then wound on a collapsible mandrel commencing with the wider end 28 to form one or more turns of the wider portion 28 and one or more turns of the narrower portion 29, with its heat shrink axis 27 wound circumferentially around the mandrel. The multiple layer structure is then heated to fuse it together and form a monolithic tubular unit, and the fused structure is cooled and the mandrel collapsed and removed. For example, in making a 600 mm wide sleeve 10, and having each end portion 11 100 mm wide, two turns of end portion 28 of sheet 26 of width 600 mm, followed by three turns of portion 29 400 mm wide may be wound on the mandrel. If each layer is 1.0 mm thick, then the 400 mm long middle portion is 5 mm thick and the two ends are each 3 mm thick.

The heat shrinkable member of the invention may comprise dimensionally heat stable components and in the case in which it comprises plastics material it may comprise two or more different plastics materials and may contain uncrosslinked plastics.

For example, in a modification of the method described above with reference to Fig. 4, a plurality of distinct sheets are employed, for example a wide heat shrinkable cross linked sheet 31, a narrower uncrosslinked dimensionally heat stable plastics sheet 32 and a third heat shrinkable cross linked sheet 33 which may be of the same width as sheet 32. These are wound on a mandrel and fused together as before, cooled and removed from the mandrel.

The intermediate sheet 32 may be of the same plastic as the sheets 31 and 33 or may be different. For example if sheets 31 and 33 comprise high density polyethylene, it may comprise low density polyethylene or polypropylene. The resulting heat shrinkable sleeve, having an external appearance and properties similar to the sleeve 10 described above in detail with reference to Figs. 1 to 3 comprises an inner lamina desired from sheet 32 that is uncrosslinked and that may comprise a different plastics material from an outer lamina desired from sheet 33. When the middle portion 12 of the sleeve is heated the heat shrinkable outer lamina compresses and deforms the inner lamina so that the middle portion as a whole is heat shrinkable.

One advantage of the form of sleeve of Figs. 1 and 2, wherein the sleeve 10 has a varying outside diameter, is that the transition portions 12a and 12b provide a visual demarcation line, indicating to the installer the limits of the area to which heat is applied.

However the sleeve as described above in detail with reference to Figs. 1 to 3 may be modified in that it has a constant outside diameter, as indicated for the sleeve 34 in Fig. 6 having a thick-walled middle portion 36 and thin end portions 37, wherein the inside diameter of the sleeve varies as seen in Fig. 6. The sleeve 34, which in all other respects may be similar to the sleeve 10 described above, offers the advantage that the inner surfaces of the inwardly recessed end portions 37 can have a layer of a functional material, for example an adhesive, applied to them without reducing the internal diameter of the sleeve. This arrangement therefore in some circumstances allows the use of a sleeve of somewhat smaller outside diameter than the arrangement of Figs. 1 and 2. A circumferential line may be printed on the outside of the sleeve to indicate the extent of each end portion 37.

In a further modification, as seen in Fig. 7, a sleeve 38 has thin walled end portions 39 the surfaces of which are offset inwardly with respect to both the inner and outer surfaces of a relatively thick-walled middle portion 41. This sleeve provides a visual and non-erasable demarcation of the end portions as well as accommodating a thin layer of functional material on the inner circumference of the end portions 39.

The circumferentially heat shrinkable members 34 and 38 may be formed by the techniques of extrusion of tubing, and compression forming of the ends or by rotational molding or blow molding as discussed above, followed by cross linking, expansion and cooling in the conventional manner.

The wall thickness of the end portions 11 of the heat shrinkable members of the invention may be substantially uniform at all cross sections, or the thickness may vary. For example, each end portion may have a section or sections that have a wall thickness less than the wall thickness of the middle portion. For example each end portion may decrease in thickness laterally outwardly from the middle portion toward the outer ends or sides of the member. This variation may be smoothly progressive or it may be stepped in discrete increments. Examples of profiles of varying thickness are shown in longitudinal cross section of end portions 11a, 11b and 11c, respectively, in Figs. 8A to 8C.

Fig. 8B shows a cross section that varies linearly in thickness while in Figs. 8A and 8C the variation is geometric to provide convexly arcuate and concavely arcuate profiles, respectively. A stepped configuration is shown in broken lines at 11d in Fig. 8B.

These profiles may be formed on the inner or outer surfaces of the end portions of the sleeves, or on both the inner and outer surfaces. The sleeves may be formed by blow moulding or rotational moulding or compression forming, for example, followed by expansion and cooling or in the case in which the profiles are on the outer surface, by the technique of winding stretched sheets correspondingly tapering in width followed by fusing, cooling and removing the fused structure from the mandrel.

In a further modification, the heat shrinkable member may comprise a wraparound sleeve 44 as indicated in Fig. 9 comprising a sheet that is heat shrinkable in the longitudinal direction, indicated by the arrow 46 in Fig. 9 and that has thin lateral margin portions 47 and a thick middle portion 48. A sheet of this profile may, for example, be formed by extrusion, cross linking and longitudinal expansion or by fusing two sheets together for example by passing them through the nip of a pair of rolls while hot during the longitudinal expansion process, followed by cooling in the conventional manner.

In one advantageous form of the invention, longitudinally continuous heat shrinkable sheets, for example of the general form as seen in Fig. 9 are provided, from which lengths may be severed in the field according to the desired circumference of the sleeve form casing to be employed and formed into endless sleeves by welding the longitudinally opposed ends together. This has the advantage that sleeves of any desired circumference can be formed, matching the girth of the pipeline sections to be joined.

A welding procedure as somewhat schematically illustrated in Figs. 10 and 10A may for example be employed, using a welding insert rod 49 as shown in Fig. 11. Rod 49 comprises a fusible plastics material having an electrical resistance wire 51 passing coaxially through it.

A portion 44a severed from the longitudinal sheet 44 as seen in Fig. 9 is positioned with its longitudinally opposed ends 52 and 53 overlapping, and with the insert rod 49 interposed between them. A current is then passed through the wire 51 to fuse the rod 49 while compression is exerted on the ends 52 and 53 by inward pressure of a pair of platens 54 until a weld has been achieved. Depending on whether the planar side of the sheet 44 is turned innermost or outermost, the resulting welded wraparound sleeve has a constant inside diameter profile as with the sleeve of

Figs. 1 and 2 or a constant outside diameter as with the sleeve of Fig. 6.

Further, a sleeve having the form illustrated in Fig. 7 may be formed using a sheet similar to the sheet 44 except having the upper and lower surfaces of each of the thin margin portions 47 offset inwardly with respect to the adjacent surfaces of the thick middle portion 48.

The profiles of the platens 54 may be configured to match the longitudinal cross sectional profile of the welded sleeve. For example Fig. 10A shows a lower platen 54 having a recess 54a to accommodate an inwardly turned thick middle portion 48 when forming a sleeve of constant outside diameter such as sleeve 34 shown in Fig. 6.

The welding technique described with reference to Figs. 10, 10A and 11 is merely illustrative and other welding techniques such as ultrasound and induction welding among others may be employed.

In a further modification, a wraparound sleeve member having a thick middle portion and thin lateral margin portions, for example generally similar to sheet 44, as seen in Fig. 9 and having rail engaging beads extending along its longitudinally opposed ends may be formed, similar in principle to the known sleeves as described in U.S. patent 3,455,336 (Ellis). Such sleeve may be formed for example by casting it from a plastics material composition, followed by crosslinking, longitudinal stretching and cooling to impart heat shrinkability in the conventional manner. Alternatively, a longitudinally heat shrinkable sheet, such as sheet 44 may have its longitudinally opposed ends provided with a mechanical fastener arrangement in the manner described in U.S. patent 4,532,168 (Steele et al). In either case, the longitudinally shrinkable sheet can then be formed into a circumferentially heat shrinkable sleeve by connecting together the longitudinally opposed ends either through application of a rail connector or by using the mechanical fastening arrangement. Again, these fastening methods are merely illustrative and various other fasteners and fastening techniques can be employed.

The wraparound sleeves described above generally may have dimensions, thicknesses and thickness ratios similar to those of the one piece tubular sleeves as described above, and can generally be employed in a manner similar to the sleeves described in more detail above with reference to Figs. 1 to 8C.

Similar to the one piece tubular sleeves of Figs. 1 to 8C, the sheet form wraparound sleeves preferably exhibit a substantially uniform degree of shrinkage of about 5 to about 60% in length, based on the length of the unshrunk sheet.

While in the above description the use of the heat shrinkable members as a heat shrinkable casing for preinsulated pipe joints has been described in detail, it will be appreciated that the heat shrinkable members can be used for various other purposes. For example, they may be used as a coupling between tubular articles such as pipes or the like by heat shrinking the thin walled end portions onto the surfaces of the pipes or the like adjacent their ends in any instance in which it is desired that the middle portion of the coupling should not intrude into the cavity or space between the tubular section.

An example of a heat shrinkable member in accordance with the invention and its mode of application will now be described in more detail.

EXAMPLE

Fabrication of Casing

A size 160 heat shrinkable casing with thin ends was fabricated.

A 0.78 mm thick and 700 mm wide sheet was extruded from high density polyethylene resin using the following formulation.

Novacor HEY 449A (ex Nova Corp. Calgary, Alberta, Canada)	95%
Duex 2959 Carbon black (ex Dunlop Plastics Canada, Ajax, Ontario, Canada)	3.0%
Irganox 1010 (ex Ciba-Geigy Canada, Mississauga, Ontario Canada)	1%
Irganox 1035 (" ")	1.%

The sheet was then crosslinked by irradiation with an electron beam, giving it a dose of 7 Mega Rads. The sheet was then expanded by 30% in the longitudinal direction and cooled in the conventional manner. The expanded sheet thickness was now 0.6 mm, and was trimmed to 650 mm width.

A 850 mm wide cylindrical, collapsible metal mandrel was fabricated with an expanded outside diameter of 175 mm. First two layers of 0.6 mm stretched sheet in a width of 400 mm were snugly wound centrally onto the mandrel. Then three layers of 650 mm wide sheet were wound on top of the two 400 mm wide layers. The loose edge of the topmost layer was secured by clamping a metal bar with a silicone release agent across the width of the edge. The assembly was then placed in an oven at 180°C for 10 minutes.

The assembly was then removed, cooled to room temperature and removed after collapsing the mandrel. The two ends were now 1.8 mm thick. These were trimmed to obtain 100 width of the thinner ends. The extreme edges of the thinner ends were chamfered to about 45 degree angle on a router machine. The middle 400 mm wide portion was 3.0 mm thick.

Installation of Casing

A joint of size 160 mm preinsulated pipe was prepared having a total cavity width of 350 mm between the jacketed insulated pipes.

The jacketing of pipes was marked for the positioning of the casing. A 1.0 mm thick, 100 mm wide strip of hot melt adhesive was wrapped onto the jacketing, where marked, so that the thin ends would shrink directly onto the adhesive. The adhesive used was the type "D" from Canusa, Division of Shaw Industries, Rexdale, Ontario, Canada. Then the casing was inserted over the pipe and positioned over the joint. One 28 mm hole was drilled in the middle portion.

A 7.5 mm thick plastics material spacer 4 cm x 1 cm was placed on the pipe jacketing adjacent each side of the cavity on which the casing rested in order to keep the casing concentrically centred around the pipe.

Using a propane fuel flame torch, the two ends were shrunk down in less than 4 minutes. The heat transmitted through the casing also melted the adhesive which sealed the joint.

The entire thin area of the casing shrunk down uniformly, and the adjacent middle thick portions had just begun to shrink. Approximately 5.0 mm of the thick sections had slightly shrunk as expected, thus maintaining the integrity of the cavity, which was 25 mm away, since, as noted the middle portion was 400 mm wide, while the cavity was 350 mm wide.

After the casing had cooled, a pressure of 2 bars was applied through the hole for 15 minutes to check the air tightness and the seal. There were no leaks.

A second hole was made, and polyurethane foam liquid was poured into the cavity and was allowed to foam. Later, the holes were sealed by welding plugs to the casing.

The finished joint with the casing was then subjected to a Soil Stress Test as per the European Standard CEN EN489 for 100 cycles, followed by External Water Test at 30 Kpa for 24 hours without any failure. This demonstrated the effectiveness of the casing to seal the joint and also withstand the abuse of the external forces to which it may be subjected in service.

CLAIMS

1. A heat shrinkable member for forming a connection between tubular sections, the member having heat shrinkable end portions, for connecting on respective adjacent end surfaces of the tubular sections adjacent the joint, and a heat shrinkable middle portion formed integrally with the end portions, for spanning between the end surfaces of the tubular sections, the end portions comprising a zone having a relatively small wall thickness and the middle portion having a relatively large wall thickness so that said zones of the end portions tend to shrink preferentially on exposure to heating.

2. A heat shrinkable member according to claim 1 wherein the wall thickness of said zone is no more than 95% of the thickness of the middle portion.

3. A heat shrinkable member according to claim 2 wherein the wall thickness of said zone is no more than 90% of the thickness of the middle portion.

4. A heat shrinkable member according to claim 2 wherein the wall thickness of said zone is no more than 80% of the thickness of the middle portion.

5. A heat shrinkable member according to claim 2 wherein the wall thickness of said zone is no more than 70% of the thickness of the middle portion.

6. A heat shrinkable member according to any preceding claim in the form of a one piece circumferentially shrinkable tubular sleeve.

7. A heat shrinkable member according to claim 6 that has a degree of shrinkage 5 to 60% in circumference, based on the circumference of the unshrunk sleeve.

8. A heat shrinkable member according to any of claims 1 to 5 in the form of a wrap-around sleeve comprising a longitudinally shrinkable sheet that is, or of which sections are, adapted to be formed into a tubular sleeve by connecting longitudinally opposed ends together.

9. A heat shrinkable member according to claim 8 that has a degree of shrinkage of 5 to 60% in length, based on the length of the unshrunk sheet.

10. A heat shrinkable material according to claim 7 or 9 wherein the degree of shrinkage is 10 to 40%.

11. A heat shrinkable member according to claim 10 where the degree of shrinkage is 20 to 30%.

12. A heat shrinkable member according to any preceding claim wherein the end portions and at least an outer lamina of the middle portion comprise a crosslinked plastics material.

13. A heat shrinkable member according to claim 12 wherein an inner lamina of the middle portion comprises uncrosslinked plastics material.

14. A heat shrinkable member according to claim 12 or 13 wherein an or said inner lamina of the middle portion comprises a plastics material different from the plastics material of the outer lamina.

15. A heat shrinkable member according to any preceding claim wherein each end portion is of substantially uniform thickness.

16. A heat shrinkable member according any of claims 1 to 14 wherein each end portion has a section or sections that have wall thickness less than the wall thickness of the middle portion.

17. A heat shrinkable member according to any of claims 1 to 14 wherein each end portion has a wall thickness that decreases laterally outwardly from the middle portion.

18. A heat shrinkable member substantially as described with reference to the drawings.

The Patent Office

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Claims searched: 1-18

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X, Y	GB 2046032 A	(RAYCHEM CORP), see especially page 2, lines 36 to 47.	X - 1-6, 12, 14, 16, 17 Y - 7-11
Y	EP 0188363 A1	(SHAW INDUSTRIES), see especially page 10, lines 1 to 6.	7, 10, 11
Y	EP 0100170 A1	(SHAW INDUSTRIES), see especially page 11, lines 27 to 35.	8, 9

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