

PATENT SPECIFICATION

(11) 1 529 357

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- (21) Application No. 18011/78
- (22) Filed 26 Sept. 1975
- (62) Divided out of No. 1 529 352
- (31) Convention Application No. 510 034
- (32) Filed 27 Sept. 1974
- (31) Convention Application No. 603 636
- (32) Filed 11 Aug. 1975 in
- (33) United States of America (US)
- (44) Complete Specification published 18 Oct. 1978
- (51) INT CL² B29C 27/20
- (52) Index at acceptance B5K 3



(54) FASTENING MEANS AND METHODS FOR APPLYING IT

(71) We, RAYCHEM CORPORATION, a Corporation organised according to the laws of the State of California, United States of America, of 300 Constitution Drive, Menlo Park, California 94025, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a fastening means for use with a closure assembly and to a method for installing such an assembly, especially the means.

There are many instances where it is desirable to provide a protective and/or insulative closure on a substrate (such as an elongate conduit or pipe) which does not have an accessible end over which conventional tubing can be drawn. Consequently, it is necessary to provide a split closure which may be positioned around a continuous elongate object and then joined at the edges. Two examples of such split closures incorporating heat-recoverable material are disclosed in United States Patent Specifications Nos. 3,379,218 and 3,455,336, the disclosures of which are incorporated herein by reference.

Heat-recoverable closure assemblies which can be positioned around a substrate and then joined at the edges generally require a relatively strong retaining device for holding the abutting or overlapping edges of the closure member during the heat-recovery, more especially heat-shrinking, process. Such retaining devices are also used to insure the integrity of the closure after it has been finally assembled around the object. The use of heat-recoverable material complicates the proper closure of such assemblies because of the inherently flexible nature of the heat-recoverable materials normally used in such applications. This flexible nature allows the closure member to be distorted under the high forces resulting from heat-

recovery of the closure member about an enclosed object. Such distortion normally results in reduced resistance to extraction of the closure member from the retaining device. Such material is also liable to be cut when stressed over sharp objects such as the sharp edges frequently found in conventional retainers.

It is also important that heat-recoverable closure assemblies, of the type discussed in the preceding paragraph, provide a seal along the joint or joints to prevent the intrusion of, *inter alia*, moisture and the like. Thus, close tolerances between closure retainers and closure members are often required as well as relatively complicated shapes for both the closure members and the retaining devices. Such close tolerances and complicated shapes adversely affect the cost of manufacturing and assembling of the closure assemblies. Further, if close tolerances and careful assembly procedures are not adhered to, such closure assemblies may fail either during heat-recovery of the closure members or at some later period. Furthermore, the bulk of such assemblies can render them impractical for use with small diameter substrates.

Our co-pending Application No. 39515/75 (Serial No. 1529352) from which the present application is divided provides a closure assembly which comprises a closure member comprising dimensionally heat-unstable material, the closure member having two opposite edge regions that can be brought into abutting relationship with each other, and fastening means for receiving at least a part of the edge regions and maintaining them in abutting relationship during recovery of the closure member, the edge regions and the fastening means being such that, before installation of the assembly and recovery of the member the fastening means may be positioned over the abutting edge regions, the space defined by the fastening means having a shape or dimension that does not conform closely to that of the abutting edge regions and such

that, during installation and recovery, the dimensions of the fastening means and/or the abutting edge regions are changeable to cause their shapes to conform more closely.

Advantageously each edge region comprises an outwardly extending wedge shaped ridge having one surface mating with the corresponding surface of the other edge region. Preferably the angle of the wedge is about 45° so that each ridge also comprises first and second surfaces disposed at that angle to the mating surface.

Preferably the mating surfaces comprise means for reducing sliding between them. Such means may be, for example, interlocking or interengaging means. The surfaces of the recoverable member or of the fastening means or both may be provided with an adhesive or sealant.

The edge regions are advantageously dimensionally heat unstable and are preferably capable of increasing in thickness on the application of heat. Advantageously if they are already wedge shaped they will change to increase the angle of the wedge and if they are not already wedge shaped they will become so on application of heat, at least in those portions which will be in contact with the free ends of the fastening means.

Advantageously the edge regions are capable of forming ridges when they are heated while being maintained in abutting relationship.

The present invention provides a fastening means for use in the closure assembly, when means comprises an elongate channel member having a pair of inter-connected webs having straight portions which are parallel or convergent, the end of the portions remote from the interconnection between the webs having outwardly extending flanges, the channel member being deformable by force to bring the said ends into pinching relationship and being such that on release of the force the ends remain in pinching relationship.

Advantageously, the fastening means is deformable by crimping.

Advantageously, the fastening means comprises a central web, or portion and two side webs, or portions, each side web, or portion being such that it is deformable during installation on the closure member to contact a surface of the ridge. In certain circumstances, the shapes of the fastening means and the edge regions may conform closely before installation and recovery, the fastening means being deformable to cause it to enclose the edge regions even more closely.

The closure member may comprise a plurality of sheets of dimensionally heat-unstable material, each of the sheets having two edge regions each of which can be

brought into abutting relationship with an edge region of another sheet.

The present invention also provides a method of applying the fastening means of the invention to a closure member having two opposite edge regions, which comprises bringing the opposite edge regions into abutting relationship with each other, applying the fastening means over the abutting edge regions and deforming the fastening means to bring the said ends into pinching relationship.

The invention further provides a method of covering a substrate, which comprises applying a closure member comprising dimensionally heat-unstable material to the substrate and bringing opposite edge regions of the member into abutting relationship to cause the member to surround the substrate applying the fastening means of the invention to the abutting edge regions, and deforming the fastening means to pinch together the abutting edge regions.

One form of fastening means constructed in accordance with the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIGURE 1 is a perspective view of a fastening means constructed according to the present invention during installation;

FIGURE 2 is an end view of a closure member before installation of the fastening means thereon;

FIGURE 3 is an end view of the fastening means according to the present invention during installation;

FIGURE 4 is an end view of the installed fastening means;

FIGURE 5 is an end view of a tool which may be used in the installation of the fastening means of the present invention;

FIGURE 6 shows a second form of closure member; and

FIGURE 7 shows the use of multiple sheets and fastening means forming a single closure;

Referring now to the drawings, Figure 1 shows a closure member generally designated by the reference numeral 10. The closure member 10 comprises a single elongate sheet of material capable of being deformed into a tubular configuration as illustrated in Figure 1. The present invention applies equally to a multiple sheet closure member as seen, for example, in Figure 7. A specific embodiment is illustrated in our co-pending Application No. 39516/75 (Serial No. 1529353). The closure member 10 comprises dimensionally heat-unstable material.

As can be seen most clearly from Figure 2, the closure member 10 comprises a sheet of heat-recoverable material which may have wedge shaped ridges on one side thereof

extending lengthwise along two parallel edges 12 and 14 of the sheet. The width and length of each closure member 10 will depend on its ultimate use. The width of the sheet between the ridges must be such that it will easily wrap about the object to be enclosed when in the expanded state and yet shrink tightly to enclose the object when heated to a temperature above the crystalline melting temperature.

The elongate parallel edges 12 and 14 of the closure member 10 include wedge-shaped ridges 16 and 18 positioned on one side of the closure member 10 and flat surfaces for abutment 20 and 22 on the opposite side of the sheet from the wedge shaped ridges 16 and 18. In the embodiment of the invention illustrated in Figures 1 to 5, the flat surfaces 20 and 22 extend across the entire inner surface of the closure member 10 to form a single continuous surface.

To enclose an elongate object (substrate) with the closure member 10, parallel edges 12 and 14 are brought together about the object with the wedge shaped ridges 16 and 18 extending outwardly therefrom. In this configuration, the flat surfaces 20 and 22 are contiguous and the wedge-shaped ridges 16 and 18 form a bead which may be grasped by a retaining device.

Referring now to Figures 1 and 3 to 5, a fastening means generally designated 24 is employed with the closure member 10 to form an elongate tubular closure. The fastening means 24 forms an elongate channel having walls (or webs) 26 and 28 (see Figure 3) which extend outwardly from an apex 30. The walls 26 and 28 are preferably at an angle with respect to one another to accommodate the upper portion of the bead formed by the wedge shaped ridges 16 and 18. Depending from the walls 26 and 28 respectively are straight leg portions 32 and 34. The portions 32 and 34 terminate respectively in flanges 36 and 38 which extend outwardly from the channel defined by the walls 26 and 28 and the portions 32 and 34. The distance between the portions 32 and 34 is sufficient to allow the means 24 to be placed over the bead formed by the wedge-shaped ridges 16 and 18. Once the means is in position (where it acts also as a retaining device, a term hereinafter used) the portions 32 and 34 may be crimped inwardly so that they are mutually convergent. This condition is best illustrated in Figure 4. When the retaining device 24 has been forced around the bead formed by the wedge-shaped ridges 16 and 18, the legs 32 and 34 act to engage the wedge-shaped ridges to prevent their separation. The flanges 36 and 38 are employed to prevent the lower edges of the portions 32 and 34 from biting into the closure member 10.

In assembling the closure, the closure member 10 is wrapped about the elongate object to be enclosed so that flat surfaces 20 and 22 are brought into contiguous relationship. An adhesive or sealant may if desired be employed between the surfaces 20 and 22 and between the closure and substrate to insure a leakproof seal. Such an adhesive may be heat-activated in order that it will better form a seal during the heat-shrinking process. With the surfaces 20 and 22 positioned together in abutting relationship, the wedge-shaped ridges 16 and 18 form a bead over which the retaining device 24 is positioned. The portions 32 and 34 are then forced inwardly to fit tightly about the wedge-shaped ridges 16 and 18 and thereby retain the elongate parallel edges 12 and 14 in contiguous relationship.

When the portions 32 and 34 have been brought into the desired position, heat is then applied to the closure member 10 to cause it to shrink about the elongate object being enclosed. The heat-recoverable material within the retaining device 24 may, if desired, be allowed to change dimensionally on heating to fill the wedge-shaped portion of the cavity within the retaining device to form or enhance the bead associated with the edges of the closure member. Once the shrinking is completed, the temperature of the closure member 10 is allowed to drop below the crystalline melting temperature of the material. Normally, tension still remains in the closure member which continues to tightly hold the object enclosed. the tension also tends to separate the edges 12 and 14 if these are not properly constrained.

Instead of being such that the legs 32 and 34 must be forced inwardly to contact the wedge-shaped ridges, the retaining device 24 may be preformed to conform closely to the bead formed by the wedge-shaped ridges 16 and 18. The retaining device may then be slid over the end of the bead into place and further crimped if desired to hold the edges 12 and 14 tightly.

Referring in detail to the mechanical relationships between the wedge-shaped ridges 16 and 18 and the enclosing leg portions 32 and 34, a closure assembly is formed which assures a compressed joining of the flat surfaces 20 and 22. It is believed that this joint is enhanced by the residual tension remaining after the heat-recovery process. The wedge-shaped ridges 16 and 18 extend outwardly defining first thrust surfaces 40 and 42 (see Figure 3). Second surfaces 44 and 46 extend upwardly to the edge of the closure member 10. These surfaces 40, 42, 44 and 46 are all, in the embodiment of the invention shown in Figures 1 to 5, disposed at 45° with respect to the

surfaces 20 and 22. However, a broad range of angles is believed to be acceptable.

5 When the leg portions 32 and 34 are forced inwardly about the wedge-shaped ridges 16 and 18, the inner surfaces of the leg portions 32 and 34 engage the thrust surfaces 40 and 42, preventing the extraction of the edges 12 and 14 of the closure member 10 from the retaining device 24. 10 Tension forces, imposed during the heat-recovery of the closure 10 and remaining after recovery has been completed, tend to withdraw and rotate the edges 12 and 14 from the retaining device 24. The converging nature of the assembled retaining device 24 at leg portions 32 and 34 as well as the wedge-shape of the bead formed by ridges 16 and 18, however, insure proper closure between the surfaces 20 and 22. 15 Thus, the closure member 10 is placed in tension tending to withdraw the edges 12 and 14 from the retaining device 24 the thrust surfaces 40 and 42 are forced against the inner side of leg portions 32 and 34. 20 This tends to force the surfaces 20 and 22 together forming a tight seal. The tendency for the edges 12 and 14 to rotate out of the retaining device 24 also further tightens the seal. The wedge-shaped ridges 16 and 18 extend upward between the second surfaces 44 and 46; these extensions of the wedge-shaped ridges 16 and 18 between the second surfaces 44 and 46 and the flat surfaces 20 and 22 resist such rotation. Thus, the surfaces 20 and 22 are forced together. In this way, the seal is tightened and the edges 16 and 18 are held within the retaining device 24. 35

40 The upward extension of the edges 12 and 14 to surfaces 44 and 46 also creates a geometrical structure which cannot be easily pulled from the retaining device. The cross-sectional width of the wedge-shaped ridge continues to increase with increasing distance from the open end of the crimped retaining device as measured along perpendiculars to a line bisecting the angle between surfaces 20 and 40 or surfaces 22 and 42. This cross-sectional dimension roughly indicates the amount of material which must be compressed for the closure member to be pulled through the opening in the retaining device 24. As the cross-section continues to increase, the resistance to extraction increases in spite of the ductility or flexibility of the heat-recoverable closure material. 55

60 In assembling the retaining device 24 about the edges 12 and 14 of the closure member 10, a tool having guide rollers may be employed. A suitable tool is illustrated by way of example in Figures 1 and 5 and includes a support member 48 and guide rollers 50 and 52 rotatably mounted on the support member. The guide rollers 50 and 65

52 define a passageway therebetween which approximately conforms to the desired final configuration of the retaining device 24. Mechanical leverage may be conventionally applied where high forces are required for closure of the leg portions 32 and 34. The closure of the portions 32 and 34 around the wedge-shaped ridges accommodates variation in the edges 12 and 14 when the retaining member 24 is deformed. Thus, close tolerances on the closure member 10 and the retaining device 24 are not required. The ability of the assembly to tolerate dimensional anomalies in the component parts may also be enhanced by heat-recovery of the edges held within the retaining device 24. On such heat-recovery, the edges tend to shorten and thicken to fill the wedge-shaped cavity formed. 70 75 80

85 Referring now to Figure 6, a second form of construction is illustrated for the elongate parallel ridges 16 and 18; Figure 6 illustrates the use of interlocking means for preventing sliding movement between edges 12 and 14. In the embodiment shown in Figure 6, longitudinal channels 54 and 56 are provided respectively in the flat surfaces 20 and 22. These channels 54 and 56 form an elongate cavity in which a rod may be positioned to further insure the integrity of the closure. The surfaces 20 and 22 may also, or alternatively, be serrated to prevent longitudinal movement of one edge relative to the other. 90 95

WHAT WE CLAIM IS:—

100 1. A fastening means for use in a closure assembly which comprises a closure member comprising dimensionally heat-unstable material, the closure member having two opposite edge regions that can be brought into abutting relationship with each other, the fastening means comprising an elongate channel member having a pair of interconnected webs having straight portions which are parallel or convergent, the ends of the portions remote from the interconnexion between the webs having outwardly extending flanges, the channel member being deformable by force to bring the said ends into pinching relationship and being such that on release of the force the ends remain in pinching relationship. 105 110 115

2. A fastening means as claimed in claim 1, which is deformable by crimping.

3. A fastening means as claimed in claim 1, substantially as described with reference to or as illustrated by any one or more of Figs. 1, and 3 to 7 of the accompanying drawings. 120

4. A method of applying a fastening means as claimed in any one of claims 1 to 3 to a closure member having two opposite edge regions, which comprises bringing the opposite edge regions into abutting 125



surfaces 20 and 22. However, a broad range of angles is believed to be acceptable.

When the leg portions 32 and 34 are forced inwardly about the wedge-shaped ridges 16 and 18, the inner surfaces of the leg portions 32 and 34 engage the thrust surfaces 40 and 42, preventing the extraction of the edges 12 and 14 of the closure member 10 from the retaining device 24. Tension forces, imposed during the heat-recovery of the closure 10 and remaining after recovery has been completed, tend to withdraw and rotate the edges 12 and 14 from the retaining device 24. The converging nature of the assembled retaining device 24 at leg portions 32 and 34 as well as the wedge-shape of the bead formed by ridges 16 and 18, however, insure proper closure between the surfaces 20 and 22. Thus, the closure member 10 is placed in tension tending to withdraw the edges 12 and 14 from the retaining device 24 the thrust surfaces 40 and 42 are forced against the inner side of leg portions 32 and 34. This tends to force the surfaces 20 and 22 together forming a tight seal. The tendency for the edges 12 and 14 to rotate out of the retaining device 24 also further tightens the seal. The wedge-shaped ridges 16 and 18 extend upward between the second surfaces 44 and 46; these extensions of the wedge-shaped ridges 16 and 18 between the second surfaces 44 and 46 and the flat surfaces 20 and 22 resist such rotation. Thus, the surfaces 20 and 22 are forced together. In this way, the seal is tightened and the edges 16 and 18 are held within the retaining device 24.

The upward extension of the edges 12 and 14 to surfaces 44 and 46 also creates a geometrical structure which cannot be easily pulled from the retaining device. The cross-sectional width of the wedge-shaped ridge continues to increase with increasing distance from the open end of the crimped retaining device as measured along perpendiculars to a line bisecting the angle between surfaces 20 and 40 or surfaces 22 and 42. This cross-sectional dimension roughly indicates the amount of material which must be compressed for the closure member to be pulled through the opening in the retaining device 24. As the cross-section continues to increase, the resistance to extraction increases in spite of the ductility or flexibility of the heat-recoverable closure material.

In assembling the retaining device 24 about the edges 12 and 14 of the closure member 10, a tool having guide rollers may be employed. A suitable tool is illustrated by way of example in Figures 1 and 5 and includes a support member 48 and guide rollers 50 and 52 rotatably mounted on the support member. The guide rollers 50 and

52 define a passageway therebetween which approximately conforms to the desired final configuration of the retaining device 24. Mechanical leverage may be conventionally applied where high forces are required for closure of the leg portions 32 and 34. The closure of the portions 32 and 34 around the wedge-shaped ridges accommodates variation in the edges 12 and 14 when the retaining member 24 is deformed. Thus, close tolerances on the closure member 10 and the retaining device 24 are not required. The ability of the assembly to tolerate dimensional anomalies in the component parts may also be enhanced by heat-recovery of the edges held within the retaining device 24. On such heat-recovery, the edges tend to shorten and thicken to fill the wedge-shaped cavity formed.

Referring now to Figure 6, a second form of construction is illustrated for the elongate parallel ridges 16 and 18; Figure 6 illustrates the use of interlocking means for preventing sliding movement between edges 12 and 14. In the embodiment shown in Figure 6, longitudinal channels 54 and 56 are provided respectively in the flat surfaces 20 and 22. These channels 54 and 56 form an elongate cavity in which a rod may be positioned to further insure the integrity of the closure. The surfaces 20 and 22 may also, or alternatively, be serrated to prevent longitudinal movement of one edge relative to the other.

WHAT WE CLAIM IS:—

1. A fastening means for use in a closure assembly which comprises a closure member comprising dimensionally heat-unstable material, the closure member having two opposite edge regions that can be brought into abutting relationship with each other, the fastening means comprising an elongate channel member having a pair of interconnected webs having straight portions which are parallel or convergent, the ends of the portions remote from the interconnexion between the webs having outwardly extending flanges, the channel member being deformable by force to bring the said ends into pinching relationship and being such that on release of the force the ends remain in pinching relationship.

2. A fastening means as claimed in claim 1, which is deformable by crimping.

3. A fastening means as claimed in claim 1, substantially as described with reference to or as illustrated by any one or more of Figs. 1, and 3 to 7 of the accompanying drawings.

4. A method of applying a fastening means as claimed in any one of claims 1 to 3 to a closure member having two opposite edge regions, which comprises bringing the opposite edge regions into abutting



relationship with each other, applying the fastening means over the abutting edge regions and deforming the fastening means to bring the said ends into pinching relationship.

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5. A method of covering a substrate, which comprises applying a closure member comprising dimensionally heat-unstable material to the substrate and bringing opposite edge regions of the member into abutting relationship to cause the member

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to surround the substrate, applying a fastening means as claimed in any one of claims 1 to 3 to the abutting edge regions, and deforming the fastening means to pinch together the abutting edge regions. 15

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.