

Flexible Assembly for Sprinklers

Field of the Invention

[0001] This invention relates to a flexible assembly for connecting sprinklers to branch lines in a fire suppression system.

5 Background Art

[0002] Fire suppression sprinkler systems used, for example, in structures such as office buildings, hotels, warehouses and private residences have a piping network comprising a riser pipe connected to a source of pressurized fire suppressing fluid, for example, a liquid, such as water, or a gas, such as halon.

10 Branch pipe lines are connected to the riser pipe at each floor of the structure and extend throughout each floor so that fire suppressing fluid may be delivered through the branch lines to any location on each floor. The branch lines are usually suspended on hangers attached to the structural ceiling of each floor. Sprinklers, which serve to discharge the fluid in the event of a fire, are connected
15 to the branch lines by flexible conduits. The use of flexible conduits provides a great advantage as it allows the position of the sprinklers to be easily adjusted, both laterally and vertically, in relation to the decorative ceiling which may be suspended beneath the structural ceiling of each floor. The flexible conduit saves time during installation, as it obviates the need for the technician to install a rigid
20 pipe assembly, comprised of couplings and pipe segments, to connect the branch line to each sprinkler head on the floor. With a rigid pipe assembly even a minor miscalculation, either in the design or installation, can be aesthetically and functionally unacceptable, and require a redesign and reinstallation.

[0003] Although advantageous, flexible conduits used to connect
25 sprinklers to branch lines of fire suppression systems have certain drawbacks. For example, one disadvantage which occurs when flexible conduits are used is the problem of over-torquing the conduit. The sprinklers may have threaded connections and torque is applied to connect them to the end of the flexible

conduit. Torque inadvertently applied to the conduit during installation of the sprinkler may cause leaks to occur, for example, at the fitting where the conduit is connected to the branch line. Additionally, torque may be applied to the flexible conduit as a result of a seismic event such as an earthquake due to relative motion between the branch line and the sprinkler. If the applied torque damages the flexible conduit, causing it to leak, that may prevent fire suppressing fluid from reaching other parts of the system where a fire has broken out as a result of the event. It is advantageous to avoid applying torque to the flexible conduit to avoid damage. There is clearly a need for a flexible assembly which avoids the disadvantages associated with known flexible conduit.

Summary of Invention

[0004] The invention concerns an assembly for connecting a sprinkler to a branch line of a fire suppression system. In one embodiment, the assembly comprises a flexible conduit having a first end connectable to the branch line, and a second end connectable to the sprinkler. The conduit provides fluid communication between the branch line and the sprinkler. An adapter is positioned between the sprinkler and the second end of the conduit for effecting attachment of the sprinkler to the conduit. The adapter has a bore providing fluid communication between the sprinkler and the conduit. The adapter has a first adapter portion attachable to the sprinkler and a second adapter portion attached to the second end of the conduit. The first and second adapter portions are rotatable relatively to one another.

[0005] In an example embodiment, the second adapter portion comprises a tube attached to the second end of the conduit. The tube is received within the bore of the first adapter portion. A ring seal is positioned between an outer surface of the tube and an inner surface of the bore of the first adapter portion for effecting a fluid-tight connection between the first and second adapter portions. A split ring is positioned between the outer surface of the tube and the inner surface of the bore of the first adapter portion. The split ring has an inner portion

sized to fit within an outwardly facing circumferential groove positioned in the outer surface of the tube. The split ring further has an outer portion sized to fit within an inwardly facing circumferential groove positioned in the inner surface of the bore of the first adapter portion. The split ring prevents relative axial
5 movement between the first and second adapter portions but permits relative rotation between the first and second adapter portions about a longitudinal axis concentric with the bore.

[0006] In another example embodiment, the first adapter portion comprises a concave spherical surface positioned at an end thereof. The concave
10 spherical surface surrounds the bore. The second adapter portion comprises a convex spherical surface surrounding the bore. The convex spherical surface is positioned at one end of the second adapter portion. An opposite end of the second adapter portion is attached to said second end of the conduit. The convex spherical surface fits within the concave spherical surface thereby permitting the
15 first and second adapter portions to rotate relatively to one another. This embodiment also has a retainer with concave spherical surface. The retainer surrounds the convex spherical surface of the second adapter portion and is attached to the first adapter portion. The second adapter portion is captured between the retainer and the first adapter portion.

20 [0007] In yet another embodiment, a second adapter is positioned between the branch line and the first end of the conduit for effecting attachment of the conduit to the branch line. The second adapter has a second bore providing fluid communication between the branch line and the conduit. The second adapter has a third adapter portion attachable to the branch line and a fourth
25 adapter portion attached to the first end of the conduit. The third and fourth adapter portions are rotatable relatively to one another.

[0008] In an embodiment, the fourth adapter portion comprises a second tube attached to the first end of the conduit, the second tube being received within the second bore of the third adapter portion. A ring seal is positioned between an

outer surface of the second tube and an inner surface of the second bore for effecting a fluid-tight connection between the third and fourth adapter portions. Furthermore, a split ring is positioned between the outer surface of the second tube and the inner surface of the second bore. The split ring has an inner portion
5 sized to fit within an outwardly facing circumferential groove positioned in the outer surface of the second tube. The split ring further has an outer portion sized to fit within an inwardly facing circumferential groove positioned in the inner surface of the second bore. The split ring prevents relative axial movement between the third and fourth adapter portions but permits relative rotation
10 between the third and fourth adapter portions about a longitudinal axis concentric with the second bore.

[0009] In yet another embodiment, the third adapter portion comprises a concave spherical surface positioned at an end thereof. The concave spherical portion surrounds the second bore. The fourth adapter portion comprises a
15 convex spherical surface surrounding the second bore and positioned at one end thereof. An opposite end of the fourth adapter portion is attached to the second end of the conduit. The convex spherical surface of the fourth adapter portion fits within the concave spherical surface of the third adapter portion thereby permitting the third and fourth adapter portions to rotate relatively to one another.
20 This embodiment also includes a second retainer having a concave spherical surface. The second retainer surrounds the convex spherical surface of the fourth adapter portion and is attached to the third adapter portion. The fourth adapter portion is captured between the second retainer and the third adapter portion.

[0010] In still another example embodiment of an assembly for
25 connecting a sprinkler to a branch line of a fire suppression system, the assembly comprises a flexible conduit having a first end connectable to the branch line, and a second end connectable to the sprinkler. The conduit provides fluid communication between the branch line and the sprinkler. An adapter is positioned between the sprinkler and the first end of the conduit for effecting
30 attachment of the conduit to the branch line. The adapter has a bore providing

fluid communication between the branch line and the conduit. The adapter has a first adapter portion attachable to the branch line and a second adapter portion attached to the first end of the conduit. The first and second adapter portions are rotatable relatively to one another.

5 **[0011]** In one embodiment, the second adapter portion comprises a tube attached to the first end of the conduit. The tube is received within the bore of the first adapter portion. A ring seal is positioned between an outer surface of the tube and an inner surface of the bore of the first adapter portion for effecting a fluid-tight connection between the first and second adapter portions. A split ring
10 is positioned between the outer surface of the tube and the inner surface of the bore of the first adapter portion. The split ring has an inner portion sized to fit within an outwardly facing circumferential groove positioned in the outer surface of the tube. The split ring further has an outer portion sized to fit within an inwardly facing circumferential groove positioned in the inner surface of the bore
15 of the first adapter portion. The split ring prevents relative axial movement between the first and second adapter portions but permitting relative rotation between the first and second adapter portions about a longitudinal axis concentric with the bore.

[0012] In one example embodiment, the first adapter portion comprises a
20 concave spherical surface positioned at an end of the adapter portion and surrounding the bore. The second adapter portion comprises a convex spherical surface surrounding the bore and positioned at one end thereof. An opposite end of the second adapter portion is attached to the second end of the conduit. The convex spherical surface fits within the concave spherical surface thereby
25 permitting the first and second adapter portions to rotate relatively to one another. A retainer having a concave spherical surface surrounds the convex spherical surface of the second adapter portion and is attached to the first adapter portion. The second adapter portion is captured between the retainer and the first adapter portion.

[0013] In another embodiment, a second adapter is positioned between the sprinkler and the second end of the conduit for effecting attachment of the conduit to the sprinkler. The second adapter has a second bore providing fluid communication between the sprinkler and the conduit. The second adapter has a
5 third adapter portion attachable to the sprinkler and a fourth adapter portion attached to the second end of the conduit. The third and fourth adapter portions are rotatable relatively to one another.

[0014] In one example embodiment, the fourth adapter portion comprises a second tube attached to the second end of the conduit. The second tube is
10 received within the second bore of the third adapter portion. A ring seal is positioned between an outer surface of the second tube and an inner surface of the second bore of the third adapter portion for effecting a fluid-tight connection between the third and fourth adapter portions. A split ring is positioned between the outer surface of the second tube and the inner surface of the second bore of
15 the third adapter portion. The split ring has an inner portion sized to fit within an outwardly facing circumferential groove positioned in the outer surface of the second tube. The split ring further has an outer portion sized to fit within an inwardly facing circumferential groove positioned in the inner surface of the second bore of the third adapter portion. The split ring prevents relative axial
20 movement between the third and fourth adapter portions but permits relative rotation between the third and fourth adapter portions about a longitudinal axis concentric with the second bore.

[0015] In another embodiment, the third adapter portion comprises a concave spherical surface positioned at an end thereof and surrounding the
25 second bore. The fourth adapter portion comprises a convex spherical surface surrounding the second bore and positioned at one end thereof. An opposite end of the second adapter portion is attached to the second end of the conduit. The convex spherical surface of the fourth adapter portion fits within the concave spherical surface of the third adapter portion thereby permitting the third and
30 fourth adapter portions to rotate relatively to one another. A second retainer has a

concave spherical surface. The second retainer surrounds the convex spherical surface of the fourth adapter portion and is attached to the third adapter portion. The fourth adapter portion is captured between the second retainer and the third adapter portion.

- 5 **[0016]** In another embodiment, the assembly comprises a flexible conduit having a first end connectable to the branch line, and a second end connectable to the sprinkler. The flexible conduit provides fluid communication between the branch line and the sprinkler. An adapter is positioned between the sprinkler and the second end of the flexible conduit for effecting attachment of the sprinkler to
- 10 the flexible conduit. A sleeve co-axially surrounds a portion of the flexible conduit proximate to the adapter. The sleeve and the flexible conduit are rotatable relatively to one another thereby preventing torque being applied to the flexible conduit through the sleeve.

Brief Description of the Drawings

- 15 **[0017]** Figure 1 is an isometric/partial sectional view of an example embodiment of an assembly for connecting a sprinkler to a branch line of a fire suppression system according to the invention;

[0018] Figure 1A is a partial view of an alternate embodiment of the assembly shown in Figure 1;

- 20 **[0019]** Figure 2 is an exploded view of an example embodiment of an assembly according to the invention;

[0020] Figure 3 is an exploded isometric view of a portion of the embodiment of the assembly shown in Figure 2;

[0021] Figure 4 is a partial sectional view taken at line 4-4 of Figure 3;

- 25 **[0022]** Figure 5 is an exploded isometric view of a portion of an example embodiment of an assembly according to the invention;

[0023] Figure 6 is an exploded isometric view of a portion of the embodiment of the assembly shown in Figure 5;

[0024] Figure 7 is a partial sectional view taken at line 7-7 of Figure 6;

[0025] Figure 8 is an isometric view of a portion of an example
5 embodiment of an assembly according to the invention;

[0026] Figure 9 is an isometric view of a portion of an example embodiment of an assembly according to the invention;

[0027] Figure 10 is a partial sectional view of the embodiment shown in Figure 9;

10 [0028] Figure 11 is an isometric view of a portion of an embodiment of an assembly according to the invention; and

[0029] Figure 12 is a partial sectional view of the embodiment shown in Figure 11.

Detailed Description of the Embodiments

15 [0030] Figure 1 shows an assembly 10 for connecting a branch line 12 of a fire suppression system to a sprinkler 14. Note that sprinkler is defined herein as any device which discharges a fire suppression fluid, and includes, but is not limited to, items such as sprinklers, heads, nozzles, emitters and the like, whether they be open or closed and open in response to a fire. Assembly 10 comprises a
20 flexible conduit 16 which has a first end 18 connected to the branch line 12, and a second end 20 which is connected to the sprinkler 14. The branch line 12 is supported by a pipe hanger 22 attached to a portion of the structure in which the fire suppression system is mounted, in this example, to the structural ceiling 24 of a building. Branch line 12 is one of many branch lines connected to a riser pipe
25 26 in fluid communication with a pressurized source of a fire suppressing fluid, such as water (not shown). A portion of the assembly 10 near the second end 20

of the flexible conduit 16 is engaged by a bracket 28 that is mounted on a cross beam 30 which extends between and is mounted on support rails 32 which support a decorative ceiling, such as a suspended ceiling or a drop ceiling (not shown) intended to hide the structural ceiling 24. Bracket 28 has various
5 embodiments; the embodiment shown in Figure 1 is disclosed in U.S. Patent No. 7,784,746, hereby incorporated by reference herein. Bracket 28 includes sidewalls 34 and 36 connected to a back wall 38 in spaced relation to one another so as to receive cross beam 30. Bracket 28 also has a u-shaped opening 40 which receives the portion of the assembly 10. A locking unit, in this example, a wire
10 bail 42 is pivotably attached to the sidewalls 34 and 36 and cooperates with them to affix the assembly to the cross beam 30. Figure 1A illustrates another example bracket 44 which is disclosed in U.S. Patent No. 7,735,787 and hereby incorporated by reference herein. Bracket 44 comprises sidewalls 46 and 48 each attached to a back wall 50 in spaced relation to one another so as to receive cross
15 beam 30. Bracket 44 also has a u-shaped opening 52 which receives the portion of the assembly 10. A locking unit, in this example, a finger 54 is pivotably attached at one end to the sidewalls 46 and 48. The opposite end is secured to the sidewalls 46 and 48 by a pivoting wing nut assembly 55 to affix the assembly to the cross beam 30.

20 **[0031]** Figure 2 illustrates in detail an example embodiment of the assembly 10, wherein the flexible conduit 16 comprises a corrugated stainless steel hose 56 which provides a flexible yet robust fluid tight member which resists corrosion. At the first end 18 of the assembly 10, the conduit 16 (hose 56) is connected to a saddle fitting 58. The saddle fitting comprises a saddle 60
25 which sealingly engages one side of the branch line 12 through an opening therein and is attached to the branch line by a strap 62 which wraps around the opposite side of the branch line 12 and is bolted to the saddle 60. Although various means, such as direct welding using an adapter, or using a threaded “tee” fitting, for connecting conduit 16 to the branch line 12 are also feasible, use of the
30 saddle fitting 58 provides an advantage over these other connection means

because the saddle fitting can be installed anywhere along the length of the branch line 12 merely by drilling the appropriate size opening in the branch line at a desired location, engaging the saddle 60 with the opening, and bolting the strap 62 to the saddle 60. The saddle fitting 58 thus eliminates welding as well as
5 the need to determine the exact position of the connection point in a design, and allows the installer to position the connection where it is best suited relative to the desired position of the sprinkler 14 and the length of the conduit 16. This feature saves time in both the design phase of a project as well as during installation, as the designer need not calculate and specify the exact location of a
10 large number of tee fittings in a system, and obvious errors in design can be avoided during installation since the installer is not constrained to make the connection where a tee fitting is located but is permitted greater freedom of action.

[0032] With reference again to the exploded view of Figure 2, the
15 connection of the conduit 16 to the sprinkler 14 (as well as to the branch line 12 via saddle fitting 58) may be effected by a rotatable adapter 64. As shown in detail in Figures 3 and 4, the example adapter 64 is positioned between the sprinkler 14 and the conduit 16. The adapter 64 has a longitudinal bore 66 and is formed of a first adapter portion 68 which is attachable to the sprinkler 14, and a
20 second adapter portion 70 which is attached to the end 20 of conduit 16. In this example, attachment of the sprinkler 14 to the adapter portion 68 is effected using internal screw threads 72 (NPT threads, for example) at one end which receive compatible external screw threads 74 of the sprinkler 14. Other attachment means, such as brazing, welding, soldering and threadless connections such as
25 bayonet mounts, are of course also feasible.

[0033] Adapter portions 68 and 70 are rotatable relatively to one another about a longitudinal axis 74 concentric with the bore 66. By allowing the adapter portions to rotate relatively to one another, application of torque to the conduit 16 about axis 74 is prevented, for example, when attaching the sprinkler 14 to the

adapter, or when mounting the adapter onto a bracket or other support (see also Figure 1), as well as torque caused by seismic activity or vibrations.

[0034] As shown in detail in Figure 4, relative rotation between the adapter portions 68 and 70 is permitted through the use of a split ring 76. Second adapter portion 70 comprises a tube 78 attached to the end 20 of the conduit 16. The bore 66 of the first adapter portion 68 is sized to receive the tube 78. The split ring 76, commercially known as a “snap ring”, is used to prevent relative axial movement between the adapter portions and thereby join the conduit 16 to the sprinkler 14 while allowing relative rotation between those parts. Split ring 76 has an inner portion 80 sized to fit within an outwardly facing circumferential groove 82 positioned in the outer surface 84 of tube 78. Split ring 76 further has an outer portion 86 sized to fit within an inwardly facing circumferential groove 88 positioned on an inner surface 90 of the first adapter portion 68. Engagement between the split ring 76 and the circumferential grooves 82 and 88 does not inhibit relative rotation between the adapter portions 68 and 70, but prevents relative axial motion. The fact that the ring 76 is split allows it to be compressed or expanded into a smaller or larger diameter by forcing the free ends of the ring toward or away from one another as is well understood for split rings. This permits the ring portions to be disengaged from the circumferential grooves in the adapter portions and thereby allow assembly and disassembly of the adapter portions 68 and 70 as is well understood for split rings. One or more ring seals 92, for example elastomeric O-rings, are positioned between the outer surface 84 of tube 78 and the inner surface 90 of the adapter portion 68 for effecting the fluid tight connection between the adapter portions. As shown in Figure 2, the example rotatable adapter 64 may be used between the conduit 16 and the sprinkler 14, and/or between the conduit 16 and the saddle fitting 58 (or other attachment means).

[0035] Figures 5-7 illustrate another example of a rotatable adapter 94 which can be used to isolate conduit 16 from torsional forces imposed about any axis. As shown in Figure 5, the adapter 94 may be positioned between a sprinkler

14 and the conduit 16 and/or between the conduit and the attachment means to the branch line (in this example a saddle fitting 58). As shown in detail in Figures 6 and 7 for the attachment of the sprinkler 14 to the conduit 16, the rotatable adapter 94 comprises a first adapter portion 96 having a concave spherical surface 98 positioned at one end and surrounding a bore 100. The sprinkler 14 may be mounted on the opposite end of the first adapter portion 96. A second adapter portion 102 has, at one end, a convex spherical surface 104 surrounding bore 100. The opposite end of the adapter portion 102 is attached to the conduit 16. The convex spherical surface 104 is sized to fit within the concave spherical surface 98 of adapter portion 96, thereby creating a ball joint which allows relative rotation between the adapter portions about any three mutually perpendicular axes, thus isolating the conduit 16 from any torsional force imposed by relative motion between the sprinkler and the branch line, as well as from forces applied to the sprinkler or adapter portion 96, for example, when the sprinkler is installed or the assembly is mounted on a support. The adapter portions 96 and 102 are held together by a retainer 106. Retainer 106 has a concave spherical surface 108 which surrounds the convex spherical surface 104 of the second adapter portion 102. The retainer is attached to the first adapter portion 96. In the example shown in Figure 7 the retainer comprises a nut 110 which engages the first adapter portion 96 using screw threads 112. Other attachment means are also feasible. To ensure fluid tightness of the adapter 94 a seal 114 may be positioned between the second adapter portion 102 and the retainer 106 and another seal 116 may be positioned between the retainer 106 and the first adapter portion 96. The seals may be elastomeric rings, such as O-rings.

[0036] Figure 8 shows another example assembly embodiment which comprises a sleeve 115 that co-axially surrounds a portion of the flexible conduit 16 proximate to an adapter 117. Adapter 117 is joined to the conduit 16 in this example by a union fitting 118 positioned at one end of the adapter and receives the external threads of the sprinkler (not shown) with internal threads 120 at the

other end to effect attachment. Sleeve 115 may be made of a durable material, such as stainless steel, and may have a plurality of outwardly facing flat surfaces 122 allowing it to be easily captured by a mounting bracket, such as bracket 28 shown in Figure 1. In the example sleeve shown in Figure 8 there are six flat
5 surfaces 122 which form a hexagonal sleeve cross section.

[0037] In the embodiment shown in Figure 8, the sleeve 115 is formed of a split unitary body 124 having a first longitudinally extending edge 126 in facing relation with a second longitudinally extending edge 128. The edges 126 and 128 may be in spaced relation to one another so as to define a gap 130. This
10 configuration allows the sleeve 115 to act as a collet with the ability to expand contract radially. In this embodiment the sleeve 115 is free to rotate about the conduit 16 but axial motion is prevented by a pair of fixed radially projecting shoulders 132 and 134. Shoulder 132 is mounted on the conduit 16 positioned between the sleeve 115 and the adapter 117 and shoulder 134 is positioned at the
15 opposite end of the sleeve from shoulder 132. The shoulders 132 and 134 project radially outwardly from the conduit 16 and capture the sleeve 115 between them by engaging the ends of the sleeve.

[0038] Figures 9 and 10 illustrate another assembly embodiment having a sleeve 136 mounted on a flexible conduit 16 with a corrugated outer surface 138.
20 The corrugated outer surface is comprised of a plurality of crests 140 and troughs 142 which extend helically around and define a central space 144. As shown in Figure 10, sleeve 136 has a corrugated inwardly facing surface 146 comprising a plurality of crests 148 and troughs 150 which extend helically and are sized and spaced so as to fit within the crests 140 and troughs 142 of the corrugated outer
25 surface 138 of the flexible conduit 16. Engagement between the crests and troughs of the sleeve 136 and the conduit 16 prevents axial sliding motion of the sleeve relatively to the conduit, but screw action upon rotation of the sleeve 136 relative to the conduit 16 allows the sleeve to be positioned as required along the conduit so that the sprinkler (not shown) is at the proper location relative to the
30 decorative ceiling when the sleeve 136 is received by a support such as bracket

28 (see Figure 1). The threaded engagement between the sleeve 136 and the corrugated surface 138 of conduit 16 allows limited rotation of the conduit relative to the sleeve (thereby preventing torque from being applied to the conduit 16) without significant axial motion of the conduit relative to the sleeve. In the example embodiment of Figure 9, an adapter 152 is connected to the conduit 16 by a union fitting 154, the adapter having internal threads 156 to receive the external threads of a sprinkler.

[0039] In another assembly embodiment, shown in Figures 11 and 12, the crests and troughs 140 and 142 forming the corrugated surface 138 of the conduit 16 are not helically arranged, but extend circumferentially around and define the central space 144. In this embodiment a sleeve 158 also has a plurality of crests 160 and troughs 162 which extend circumferentially around the sleeve inner surface 164. The crests 160 and troughs 162 of the sleeve 158 are sized and spaced to engage the crests 140 and troughs 142 of the conduit 16 and thus prevent sliding axial motion of the sleeve 158 relatively to the conduit 16 while permitting relative rotational motion between the two parts. In this embodiment, the sleeve 158 is split, as evidenced by the gap 166 (see Figure 11). This allows the sleeve 158 to be positioned axially along the conduit by elastically deforming the sleeve outwardly to disengage its crests and troughs from the troughs and crests of the conduit 16, moving the sleeve along the conduit to the desired position, and then releasing the sleeve, allowing it to return to its undeformed shape engaging the crests and troughs by virtue of its resilient characteristics.

[0040] The embodiments provided herein show union joints by way of example, it being understood that other types of connections, such as fixed NPT sprinkler outlets, swivel sprinkler outlets as well as NPT adapters are also feasible for use with the assembly according to the invention.

[0041] The assembly for connecting a sprinkler to a branch line of a fire suppression system according to the invention will provide numerous advantages over the prior art. The assembly is easy to install on a branch line and provides

- great adjustability of the final position of the sprinkler, thereby simplifying design and installation tasks. It is much more difficult to over-torque the assembly due to the rotational freedom afforded by the rotatable adapter or the sleeve, resulting in a significantly decreased potential for damage upon
- 5 installation or during a seismic event. Additionally, the assembly can be pressure loss tested as a unit (with or without the sprinkler installed) thereby providing the system designer one equivalent length number indicative of head loss instead of resorting to calculating the equivalent length as the sum of equivalent lengths for each component of the assembly. This should improve the accuracy of hydraulic
- 10 calculations. Furthermore, the entire assembly, including the sprinkler head, may be K-factor tested which will provide a single, simplified K-factor number of increased accuracy, the K-factor being a constant of proportionality used to determine the flow rate of a nozzle as a function of the square root of the pressure at the nozzle.
- 15 **[0042]** While the example assembly embodiments disclosed herein are described in the context of a fire suppression system, it is understood that the descriptions are examples and that the assembly embodiments disclosed herein may also be used with other systems, such as hydronic systems, where a fluid is conveyed by a flexible conduit which it is desired to isolate from unwanted and
- 20 potentially damaging applied torques.

CLAIMS

What is claimed is:

1. An assembly for connecting a sprinkler to a branch line of a fire suppression system, said assembly comprising:

5 a flexible conduit having a first end connectable to said branch line, and a second end connectable to said sprinkler, said conduit providing fluid communication between said branch line and said sprinkler;

 an adapter positioned between said sprinkler and said second end of said conduit for effecting attachment of said sprinkler to said conduit, said
10 adapter having a bore providing fluid communication between said sprinkler and said conduit, said adapter having a first adapter portion attachable to said sprinkler and a second adapter portion attached to said second end of said conduit, said first and second adapter portions being rotatable relatively to one another.

15 2. The assembly according to Claim 1, wherein:

 said second adapter portion comprises a tube attached to said second end of said conduit, said tube being received within said bore of said first adapter portion;

 a ring seal is positioned between an outer surface of said tube and an
20 inner surface of said bore of said first adapter portion for effecting a fluid-tight connection between said first and second adapter portions;

 a split ring is positioned between said outer surface of said tube and said inner surface of said bore of said first adapter portion, said split ring having an inner portion sized to fit within an outwardly facing circumferential groove
25 positioned in said outer surface of said tube, said split ring further having an outer portion sized to fit within an inwardly facing circumferential groove positioned in

said inner surface of said bore of said first adapter portion, said split ring preventing relative axial movement between said first and second adapter portions but permitting relative rotation between said first and second adapter portions about a longitudinal axis concentric with said bore.

5 3. The assembly according to Claim 1, wherein:

said first adapter portion comprises a concave spherical surface positioned at an end thereof and surrounding said bore;

said second adapter portion comprises a convex spherical surface surrounding said bore and positioned at one end thereof, an opposite end of said
10 second adapter portion being attached to said second end of said conduit, said convex spherical surface fitting within said concave spherical surface thereby permitting said first and second adapter portions to rotate relatively to one another;

a retainer having a concave spherical surface, said retainer
15 surrounding said convex spherical surface of said second adapter portion and being attached to said first adapter portion, said second adapter portion being captured between said retainer and said first adapter portion.

4. The assembly according to Claim 3, further comprising a first seal positioned between said second adapter portion and said retainer, and a second
20 seal positioned between said retainer and said first adapter portion.

5. The assembly according to Claim 3, wherein said retainer comprises a nut which threadedly engages said first adapter portion.

6. The assembly according to Claim 1, further comprising said sprinkler.

7. The assembly according to Claim 1, further comprising:

25 a second adapter positioned between said branch line and said first end of said conduit for effecting attachment of said conduit to said branch line,

said second adapter having a second bore providing fluid communication between said branch line and said conduit, said second adapter having a third adapter portion attachable to said branch line and a fourth adapter portion attached to said first end of said conduit, said third and fourth adapter portions
5 being rotatable relatively to one another.

8. The assembly according to Claim 7, wherein:

said fourth adapter portion comprises a second tube attached to said first end of said conduit, said second tube being received within said second bore of said third adapter portion;

10 a ring seal is positioned between an outer surface of said second tube and an inner surface of said second bore for effecting a fluid-tight connection between said third and fourth adapter portions;

a split ring is positioned between said outer surface of said second tube and said inner surface of said second bore, said split ring having an inner
15 portion sized to fit within an outwardly facing circumferential groove positioned in said outer surface of said second tube, said split ring further having an outer portion sized to fit within an inwardly facing circumferential groove positioned in said inner surface of said second bore, said split ring preventing relative axial movement between said third and fourth adapter portions but permitting relative
20 rotation between said third and fourth adapter portions about a longitudinal axis concentric with said second bore.

9. The assembly according to Claim 7, wherein:

said third adapter portion comprises a concave spherical surface positioned at an end thereof and surrounding said second bore;

25 said fourth adapter portion comprises a convex spherical surface surrounding said second bore and positioned at one end thereof, an opposite end of said fourth adapter portion being attached to said second end of said conduit,

said convex spherical surface of said fourth adapter portion fitting within said concave spherical surface of said third adapter portion thereby permitting said third and fourth adapter portions to rotate relatively to one another;

5 a second retainer having a concave spherical surface, said second retainer surrounding said convex spherical surface of said fourth adapter portion and being attached to said third adapter portion, said fourth adapter portion being captured between said second retainer and said third adapter portion.

10 10. The assembly according to Claim 9, further comprising a third seal positioned between said second retainer and said fourth adapter portion and a fourth seal positioned between said second retainer and said third adapter portion.

11. The assembly according to Claim 9, wherein said second retainer comprises a nut which threadedly engages said third adapter portion.

12. The assembly according to Claim 7, further comprising said sprinkler.

15 13. An assembly for connecting a sprinkler to a branch line of a fire suppression system, said assembly comprising:

a flexible conduit having a first end connectable to said branch line, and a second end connectable to said sprinkler, said conduit providing fluid communication between said branch line and said sprinkler;

20 an adapter positioned between said sprinkler and said first end of said conduit for effecting attachment of said conduit to said branch line, said adapter having a bore providing fluid communication between said branch line and said conduit, said adapter having a first adapter portion attachable to said branch line and a second adapter portion attached to said first end of said conduit, said first
25 and second adapter portions being rotatable relatively to one another.

14. The assembly according to Claim 13, wherein:

said second adapter portion comprises a tube attached to said first end of said conduit, said tube being received within said bore of said first adapter portion;

5 a ring seal is positioned between an outer surface of said tube and an inner surface of said bore of said first adapter portion for effecting a fluid-tight connection between said first and second adapter portions;

a split ring is positioned between said outer surface of said tube and said inner surface of said bore of said first adapter portion, said split ring having an inner portion sized to fit within an outwardly facing circumferential groove positioned in said outer surface of said tube, said split ring further having an outer portion sized to fit within an inwardly facing circumferential groove positioned in said inner surface of said bore of said first adapter portion, said split ring preventing relative axial movement between said first and second adapter portions but permitting relative rotation between said first and second adapter portions about a longitudinal axis concentric with said bore.

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15. The assembly according to Claim 13, wherein:

said first adapter portion comprises a concave spherical surface positioned at an end thereof and surrounding said bore;

said second adapter portion comprises a convex spherical surface surrounding said bore and positioned at one end thereof, an opposite end of said second adapter portion being attached to said second end of said conduit, said convex spherical surface fitting within said concave spherical surface thereby permitting said first and second adapter portions to rotate relatively to one another;

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25 a retainer having a concave spherical surface, said retainer surrounding said convex spherical surface of said second adapter portion and

being attached to said first adapter portion, said second adapter portion being captured between said retainer and said first adapter portion.

16. The assembly according to Claim 15, further comprising a first seal positioned between said second adapter portion and said retainer, and a second
5 seal positioned between said retainer and said first adapter portion.

17. The assembly according to Claim 15, wherein said retainer comprises a nut which threadedly engages said first adapter portion.

18. The assembly according to Claim 13, further comprising said sprinkler.

10 19. The assembly according to Claim 13, further comprising:

a second adapter positioned between said sprinkler and said second end of said conduit for effecting attachment of said conduit to said sprinkler, said second adapter having a second bore providing fluid communication between said sprinkler and said conduit, said second adapter having a third adapter portion
15 attachable to said sprinkler and a fourth adapter portion attached to said second end of said conduit, said third and fourth adapter portions being rotatable relatively to one another.

20. The assembly according to Claim 19, wherein:

said fourth adapter portion comprises a second tube attached to said
20 second end of said conduit, said second tube being received within said second bore of said third adapter portion;

a ring seal is positioned between an outer surface of said second tube and an inner surface of said second bore of said third adapter portion for effecting a fluid-tight connection between said third and fourth adapter portions;

25 a split ring is positioned between said outer surface of said second tube and said inner surface of said second bore of said third adapter portion, said

split ring having an inner portion sized to fit within an outwardly facing circumferential groove positioned in said outer surface of said second tube, said split ring further having an outer portion sized to fit within an inwardly facing circumferential groove positioned in said inner surface of said second bore of
5 said third adapter portion, said split ring preventing relative axial movement between said third and fourth adapter portions but permitting relative rotation between said third and fourth adapter portions about a longitudinal axis concentric with said second bore.

21. The assembly according to Claim 19, wherein:

10 said third adapter portion comprises a concave spherical surface positioned at an end thereof and surrounding said second bore;

said fourth adapter portion comprises a convex spherical surface surrounding said second bore and positioned at one end thereof, an opposite end of said fourth adapter portion being attached to said second end of said conduit,
15 said convex spherical surface of said fourth adapter portion fitting within said concave spherical surface of said third adapter portion thereby permitting said third and fourth adapter portions to rotate relatively to one another;

a second retainer having a concave spherical surface, said second retainer surrounding said convex spherical surface of said fourth adapter portion
20 and being attached to said third adapter portion, said fourth adapter portion being captured between said second retainer and said third adapter portion.

22. The assembly according to Claim 21, further comprising a third seal positioned between said second retainer and said fourth adapter portion and a fourth seal positioned between said second retainer and said third adapter portion.

25 23. The assembly according to Claim 21, wherein said second retainer comprises a nut which threadedly engages said third adapter portion.

24. The assembly according to Claim 19, further comprising said sprinkler.

25. An assembly for connecting a sprinkler to a branch line of a fire suppression system, said assembly comprising:

5 a flexible conduit having a first end connectable to said branch line, and a second end connectable to said sprinkler, said flexible conduit providing fluid communication between said branch line and said sprinkler;

 an adapter positioned between said sprinkler and said second end of said flexible conduit for effecting attachment of said sprinkler to said flexible
10 conduit;

 a sleeve co-axially surrounding a portion of said flexible conduit proximate to said adapter, said sleeve and said flexible conduit being rotatable relatively to one another thereby preventing torque being applied to said flexible conduit through said sleeve.

15 26. The assembly according to Claim 25, wherein said sleeve comprises a plurality of flat outwardly facing surfaces.

 27. The assembly according to Claim 26, wherein said sleeve comprises six flat outwardly facing surfaces forming a hexagonal cross section.

 28. The assembly according to Claim 25, wherein said sleeve comprises a
20 unitary body having a first longitudinally extending edge and a second longitudinally extending edge in facing relation with said first longitudinally extending edge.

 29. The assembly according to Claim 28, wherein said first longitudinally extending edge is positioned in spaced relation to said second longitudinally
25 extending edge so as to define a gap therebetween.

30. The assembly according to Claim 25, wherein said flexible conduit has a corrugated outer surface, said corrugated outer surface comprising a plurality of first crests and troughs extending circumferentially around and defining a central space, said sleeve having a corrugated inwardly facing surface comprising a plurality of second crests and troughs extending circumferentially and spaced so as to fit within said first crests and troughs and thereby prevent axial sliding motion of said sleeve relatively to said conduit.

31. The assembly according to Claim 25, wherein said flexible conduit has a corrugated outer surface, said corrugated outer surface comprising a plurality of first crests and troughs extending helically around and defining a central space, said sleeve having a corrugated inwardly facing surface comprising a plurality of second crests and troughs extending helically and spaced so as to fit within said first crests and troughs and thereby prevent axial sliding motion of said sleeve relatively to said conduit.

32. The assembly according to Claim 25, further comprising:

a first shoulder mounted on said flexible conduit between said sleeve and said adapter, said first shoulder projecting radially outwardly from said flexible conduit;

a second shoulder mounted on said flexible conduit and positioned at an opposite end of said sleeve from said first shoulder, said second shoulder projecting radially outwardly from said flexible conduit, said sleeve being captured between said first and second shoulders.

33. The assembly according to Claim 25, further comprising said sprinkler.