[0005] Installation of dry sprinklers can be difficult. During installation of the sprinkler system, the fluid distribution system is usually first installed, including the network of pipes with the branch fluid supply lines. Once the branch lines are installed, the installer determines the lengths of the dry sprinkler that is needed based on the distance from the desired sprinkler head location to the connector fitting on the branch line. The dry sprinklers are ordered at the specific length and configuration determined by the installer, and the dry sprinklers are then made-to-order and shipped to the installer, which can cause delays in construction of up to two weeks or more. Such delays are undesirable and can greatly increase construction expense. Alternatively, the system designer and/or specifications may mandate the sprinkler lengths. However, even in those circumstances, adjustments may have to be made in the field, which may cause undesired delays.

[0006] Also, once the branch line piping has been installed, it is difficult to move the location of the sprinkler head. Likewise, in some cases, the location of the sprinkler head will be limited by the construction based on where the branch line pipe can be installed.

[0007] According to one aspect, a dry sprinkler is provided that includes a fluid conduit that is configured to couple to a fluid supply, the conduit having a first end and a second end; a valve that is positioned proximate to a first end of the conduit, the valve having a closed state that prevents fluid from the fluid supply from flowing through the conduit and an open state that allows fluid from the fluid supply to flow through the conduit, a fire sprinkler head positioned proximate to a second end of the conduit, the fire sprinkler head having a thermally responsive element that reacts to an elevated temperature condition, ~~and~~ an unbiased tie positioned within the conduit that is operably coupled to the valve, ~~and the thermally responsive element,~~ where the unbiased tie has at least an unengaged state and an engaged state, wherein the unbiased tie is not biased towards the sprinkler head in the unengaged state, and. ~~The unbiased tie is not biased towards the sprinkler head in the unengaged state, the reaction of the thermally responsive element to the elevated temperature condition causes the tie to change from the unengaged state to the engaged state, and changing the tie to the engaged state from the unengaged state allows the valve to change from the closed state to the open state.~~

an engagement action that is coupled to the unbiased tie, the engagement action being triggered when the thermally responsive element reacts to the elevated temperature condition, the triggering of the engagement action causing the tie to change from the unengaged state to the engaged state thereby allowing the valve to change from the closed state to the open state, wherein the engagement action is configured to apply tension to the unbiased tie when the engagement action is triggered; the engagement action comprising: a) a tubular bushing member arranged within the fluid conduit proximate to the second end; and b) a tie coupling member that is coupled to the unbiased tie, the tie coupling member being supported by the tubular bushing member when the tie is in the unengaged state, wherein in the unengaged state the unbiased tie contains slack, and the reaction of the thermally responsive element to the elevated temperature condition causes the tubular bushing member and tie coupling member to move within the conduit toward the fire sprinkler head, which removes the slack from the unbiased tie and causes the tie to change from the unengaged state to the engaged state

[0008] According to another aspect, a dry sprinkler is provided that includes a flexible conduit that is configured to be coupled to a fluid supply, the flexible conduit having a first end that is a fluid inlet and a second end that is a fluid outlet; a valve positioned proximate to a first end of the conduit, the valve having a sealing member that is urged to a closed position in which fluid from the fluid supply is prevented from flowing through the conduit, the sealing member being movable to an open position in which fluid from the fluid supply flows through the conduit, a fire sprinkler head positioned proximate to a second end

of the conduit, the fire sprinkler head having a thermally responsive element that is configured to react to an elevated temperature condition, an unbiased tie positioned within the flexible conduit and being present in the flexible conduit in a state such that the unbiased tie is not biased toward the fire sprinkler head, the unbiased tie having a first portion and a second portion, the first portion of the unbiased tie being operably coupled to the sealing member to urge it to the open position when the unbiased tie is engaged, and an engagement action connected to the second portion of the unbiased tie, the engagement action being operably coupled to the thermally responsive element so that when the thermally responsive element reacts to the elevated temperature condition, the engagement action is triggered to apply tension to the unbiased tie thereby causing the tie to move the sealing member to the open position.; the engagement action comprising: a) a tubular bushing member arranged within the fluid conduit proximate to the second end; and b) a tie coupling member that is coupled to the unbiased tie, the tie coupling member being supported by the tubular bushing member when the unbiased tie is not biased toward the sprinkler head, wherein, when the unbiased tie is not biased toward the sprinkler head, the unbiased tie contains slack, and the reaction of the thermally responsive element to the elevated temperature condition causes the tubular bushing member and tie coupling member to move within the conduit toward the fire sprinkler head, which removes the slack from the unbiased tie and then applies tension to the tie.

[0009] There is disclosed a dry sprinkler that includes a flexible conduit that is configured to be coupled to a fluid supply line, a valve positioned proximate to a first end of the conduit, the valve having a closed state in which fluid from the fluid supply is prevented from flowing through the conduit and an open state in which fluid from the fluid supply is allowed to flow through the conduit, an unbiased tie having a first portion that is operably coupled to the valve to open the valve when the unbiased tie is engaged, the unbiased tie being present in a state such that the tie is not biased toward the second end of the conduit, a sheath member that is located within the conduit and surrounds the unbiased tie over most of the length of the unbiased tie, and a fire sprinkler head positioned proximate to a second end of the conduit, the fire sprinkler head having a thermally responsive element that reacts to an elevated temperature condition. The unbiased tie is operably connected to the thermally responsive element so that the reaction of the thermally responsive element to the elevated temperature condition causes the tie to be engaged.

[0010] There is disclosed a dry sprinkler that includes a flexible conduit, a valve located proximate to a first end of the flexible conduit, a fire sprinkler head located proximate to a second end of the flexible conduit, an unbiased tie located within the flexible conduit and being present in a state such that the unbiased tie is not biased toward the fire sprinkler head, a first portion of the unbiased tie being operably coupled to the valve such that tensioning the tie allows the valve to move to an open position, and tensioning means for applying tension to the unbiased tie.

[0011] There is also disclosed a fire protection sprinkler system that includes a network of pipes connected to a fluid supply, a control valve in fluid communication with the network of pipes and the fluid supply, the control valve configured

having a thermally responsive element that reacts to an elevated temperature condition, wherein the uncompressed tie is operably connected to the thermally responsive element.

[0014] There is disclosed a dry sprinkler that includes a flexible conduit that is configured to be coupled to a fluid supply, a valve positioned proximate to a first end of the conduit, the valve having a closed state in which fluid is prevented from flowing through the conduit and an open state in which fluid is allowed to flow through the conduit, a substantially non-rigid tie having a first portion that is operably coupled to the valve such that engaging the non-rigid tie allows the valve to open, and a fire sprinkler head positioned proximate to a second end of the conduit, the fire sprinkler head having a thermally responsive element that reacts to an elevated temperature condition, wherein the non-rigid tie is operably connected to the thermally responsive element.

[0015] ~~According to yet another aspect,~~ There is disclosed a method of triggering a dry sprinkler to release fluid from a fluid supply in the event of a fire is provided, where the dry sprinkler includes (i) a conduit that is coupled to the fluid supply, (ii) a valve that is positioned proximate to a first end of the conduit and is urged to a closed state to prevent fluid from the fluid supply from flowing through the conduit, (iii) a fire sprinkler head that is positioned proximate to a second end of the conduit and includes a thermally responsive element that reacts to an elevated temperature condition, and (iv) a nontensioned tie that is operably coupled to the valve such that engaging the nontensioned tie allows the valve to open, and the method includes the steps of engaging the tie upon reaction of the thermally responsive element to the elevated temperature condition and applying tension to the tie at least until the valve opens and allows fluid from the fluid supply to flow through the conduit.

[0016] There is also disclosed a method of installing a flexible dry sprinkler on a branch fluid line. The method includes (i) providing a flexible dry sprinkler, which includes a flexible conduit, a valve disposed proximate to the inlet end of the flexible conduit, the valve having a closed state that prevents flow of fluid from the fluid supply through the conduit and an open state that allows flow of fluid from the fluid supply through the conduit, a fire sprinkler head positioned proximate to the outlet end of the conduit, the fire sprinkler head having a thermally responsive element that reacts to an elevated temperature condition, and a tie positioned within the flexible conduit, the tie having a first portion and a second portion, the first portion being operably connected to the valve to urge the valve to an open position when the tie is engaged, and the second portion being operably connected to the thermally responsive element to engage the tie when the thermally responsive element reacts to an elevated temperature condition, (ii) connecting the flexible

CLAIMS

1. A dry sprinkler comprising:

a fluid conduit that is configured to couple to a fluid supply, the conduit having a first end and a second end;

a valve that is positioned proximate to the first end of the conduit, the valve having (i) a closed state that prevents fluid from the fluid supply from flowing through the conduit, and (ii) an open state that allows fluid from the fluid supply to flow through the conduit;

a fire sprinkler head positioned proximate to the second end of the conduit, the fire sprinkler head having a thermally responsive element that reacts to an elevated temperature condition; ~~and~~

an unbiased tie positioned within the conduit and being operably coupled to the valve, ~~and the thermally responsive element,~~ the unbiased tie having at least an unengaged state and an engaged state, wherein the unbiased tie is not biased towards the sprinkler head in the unengaged state, and

~~wherein (i) the unbiased tie is not biased towards the sprinkler head in the unengaged state, (ii) the reaction of the thermally responsive element to the elevated temperature condition causes the tie to change from the unengaged state to the engaged state, and (iii) changing the tie to the engaged state from the unengaged state allows the valve to change from the closed state to the open state.~~

an engagement action that is coupled to the unbiased tie, the engagement action being triggered when the thermally responsive element reacts to the elevated temperature condition, the triggering of the engagement action causing the tie to change from the unengaged state to the engaged state thereby allowing the valve to change from the closed state to the open state, wherein the engagement action is configured to apply tension to the unbiased tie when the engagement action is triggered;

the engagement action comprising:

a) a tubular bushing member arranged within the fluid conduit proximate to the second end; and

b) a tie coupling member that is coupled to the unbiased tie, the tie coupling member being supported by the tubular bushing member when the tie is in the unengaged state,

wherein in the unengaged state the unbiased tie contains slack, and the reaction of the thermally responsive element to the elevated temperature condition causes the tubular bushing member and tie coupling member to move within the conduit toward the fire sprinkler head, which removes the slack from the unbiased tie and causes the tie to change from the unengaged state to the engaged state.

~~2. The dry sprinkler according to claim 1, further comprising an engagement action that is coupled to the unbiased tie, the engagement action being triggered when the thermally responsive element reacts to the elevated temperature condition, the engagement action causing the tie to change from the unengaged state to the engaged state thereby allowing the valve to change from the closed state to the open state, wherein the engagement action is configured to apply tension to the unbiased tie when the engagement action is triggered.~~

32. The dry sprinkler according to claim 21, wherein the engagement action is configured to store energy that is releasable when the thermally responsive element reacts to the elevated temperature condition, and the engagement action is configured to apply a load to the unbiased tie when the stored energy is released.

43. The dry sprinkler according to claim 1, further comprising a valve catch that is coupled to the tie, wherein the valve catch includes a biasing member that biases the valve in the closed state and a release member that translates a load applied to the tie when the tie changes from the unengaged state to the engaged state to release the bias applied by the bias member, thereby allowing the valve to move to the open state.

54. The dry sprinkler according to claim 1, wherein the unbiased tie comprises any of the following: a cord, a rope, a string, a loop, a chain, a chain-like member, a cable, a ribbon, a tube, a wire, a monofilament line, and a multifilament line.

65. The dry sprinkler according to claim 54, wherein a first portion of the unbiased tie is connected to a valve catch that is configured to allow the valve to move from the closed state to the open state when the unbiased tie changes from the unengaged state to the engaged state and a second portion of the unbiased tie is connected to an engagement action that is configured to apply a load to the tie when the thermally responsive element reacts to the elevated temperature condition.

76. The dry sprinkler according to claim 65, wherein the unbiased tie is provided with slack such that a free length of the unbiased tie extending from the valve catch to the engagement action is longer than a portion of the conduit that extends from the valve catch to the engagement action.

~~8. The dry sprinkler according to claim 2, wherein the engagement action comprises:~~

~~a) a tubular bushing member arranged within the fluid conduit proximate to the second end; and~~

~~b) a tie coupling member that is coupled to the unbiased tie, the tie coupling member being supported by the tubular bushing member when the tie is in the unengaged state,~~

~~wherein in the unengaged state the unbiased tie contains slack, and the reaction of the thermally responsive element to the elevated temperature condition causes the tubular bushing member and tie coupling member to move within the conduit toward the fire sprinkler head, which removes the slack from the unbiased tie and causes the tie to change from the unengaged state to the engaged state.~~

~~97~~. The dry sprinkler according to claim ~~81~~, wherein the tie coupling member is a pin that is directly connected to the tubular bushing member.

~~108~~. The dry sprinkler according to claim ~~81~~, wherein the engagement action further includes a compression spring that biases the tubular bushing member toward the fire sprinkler head.

~~119~~. The dry sprinkler according to claim 1, wherein the conduit is flexible.

~~1210~~. The dry sprinkler according to claim 1, further comprising a sheath member that is located within the conduit and surrounds the unbiased tie over most of its length.

~~1311~~. A dry sprinkler comprising:

a flexible conduit that is configured to be coupled to a fluid supply, the flexible conduit having a first end that is a fluid inlet and a second end that is a fluid outlet;

a valve positioned proximate to the first end, the valve having a sealing member that is urged to a closed position in which fluid from the fluid supply is prevented from flowing through the conduit, the sealing member being movable to an open position in which fluid from the fluid supply flows through the conduit;

a fire sprinkler head positioned proximate to the second end of the conduit, the fire sprinkler head having a thermally responsive element that is configured to react to an elevated temperature condition;

an unbiased tie positioned within the flexible conduit and being present in the flexible conduit in a state such that the unbiased tie is not biased toward the fire sprinkler head, the unbiased tie having a first portion and a second portion, the first portion of the unbiased tie being operably coupled to the sealing member to urge it to the open position when the unbiased tie is engaged; and

an engagement action connected to the second portion of the unbiased tie, the engagement action being operably coupled to the thermally responsive element so that when the thermally responsive element reacts to the elevated temperature condition, the engagement action is triggered to apply tension to the unbiased tie thereby causing the tie to move the sealing member to the open position.;

the engagement action comprising:

a) a tubular bushing member arranged within the fluid conduit proximate to the second end; and

b) a tie coupling member that is coupled to the unbiased tie, the tie coupling member being supported by the tubular bushing member when the unbiased tie is not biased toward the sprinkler head,

wherein, when the unbiased tie is not biased toward the sprinkler head, the unbiased tie contains slack, and the reaction of the thermally responsive element to the elevated temperature condition causes the tubular bushing member and tie coupling member to move within the conduit toward the fire sprinkler head, which removes the slack from the unbiased tie and then applies tension to the tie.

~~14~~12. The dry sprinkler according to claim ~~13~~11, wherein the flexible conduit comprises any one of the following: a corrugated tube, a hose, a braided tube.

~~15~~13. The dry sprinkler according to claim ~~13~~11, wherein the flexible conduit maintains a bent shape when bent.

~~16~~14. The dry sprinkler according to claim ~~13~~11, wherein the unbiased tie comprises any of the following: a cord, a rope, a string, a loop, a chain, a chain-like member, a cable, a ribbon, a tube, a wire, a monofilament line, and a multifilament line.

~~17~~15. The dry sprinkler according to claim ~~12~~10, wherein the sheath member has a cross-sectional dimension that is less than half of the cross-sectional dimension of the flexible conduit.

~~18~~16. The dry sprinkler according to claim ~~12~~10, wherein the sheath member is centrally positioned in the conduit.

~~19. A method of triggering a dry sprinkler to release fluid from a fluid supply in the event of a fire, wherein the dry sprinkler includes (i) a conduit that is coupled to the fluid supply, (ii) a valve that is positioned proximate to a first end of the conduit and is urged to a closed state to prevent fluid from the fluid supply from flowing through the conduit, (iii) a fire sprinkler head that is~~

~~positioned proximate to a second end of the conduit and includes a thermally responsive element that reacts to an elevated temperature condition, and (iv) a nontensioned tie that is operably coupled to the valve such that engaging the nontensioned tie allows the valve to open, the method comprising the steps of engaging the tie upon reaction of the thermally responsive element to the elevated temperature condition and applying tension to the tie at least until the valve opens and allows fluid from the fluid supply to flow through the conduit.~~

~~20. The method according to claim 19, wherein the nontensioned tie is arranged within the conduit and is provided with slack, and the step of engaging the tie includes eliminating the slack in the nontensioned tie.~~