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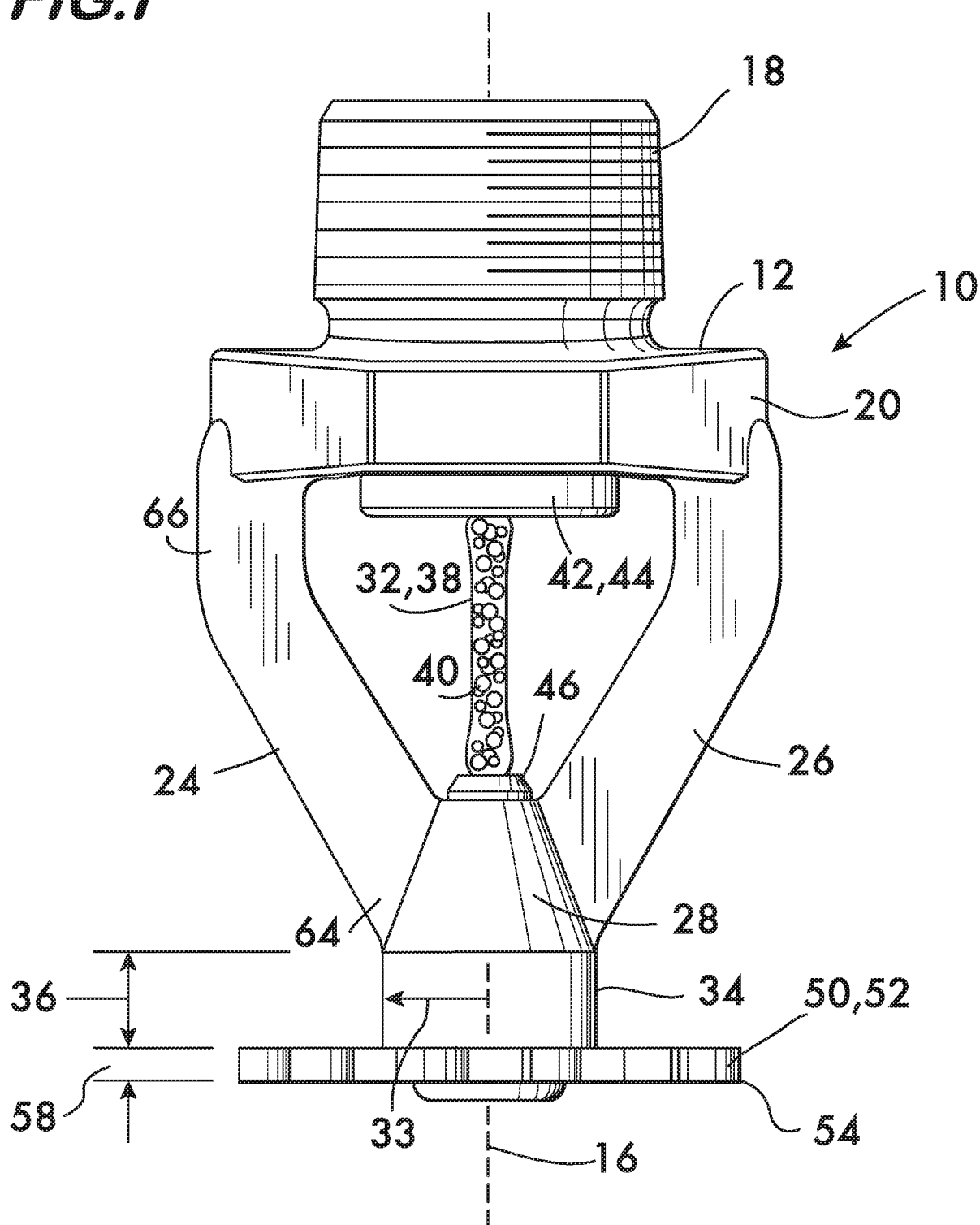
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Abstract

A sprinkler for a fire suppression system includes a deflector plate having five different types of slots extending from a periphery of the plate toward a center of the plate along radially extending lines. The slots are arrow shaped, club shaped and key hole shaped. Arrow head slots which align with frame arms supporting the deflector plate are wider than the thickness of the frame arms. Club shaped and arrow shaped slots proximate the plane of the frame arms are asymmetrical with respect to radial lines extending from the center of the plate, while arrow shaped and key hole shaped slots distal to the plane of the frame arms are symmetrical with respect to radial lines extending from the center of the plate.

FIG 1.

FIG.1



FIRE SUPPRESSION SPRINKLER AND DEFLECTOR

Cross Reference to Related Applications

[0001] This application is a divisional of Australian Patent Application No. 2024201949, which is a divisional of Australian Patent Application No. 2022201347, which is a divisional of Australian Patent Application No. 2019232686, the National Phase of International Application No. PCT/US2019/019213 filed 22 February 2019, which application is based upon and claims priority to US Provisional Application No. 62/640,208, filed March 8, 2018, all applications being hereby incorporated by reference.

Field of the Invention

[0002] This invention relates to fire suppression sprinklers and deflectors used with fire suppression sprinklers.

Background

[0003] Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

[0004] The growth of the warehousing storage market has created pressure to increase not only the square footage of warehouses, but also warehouse ceiling heights and the density with which products (known as commodities) may be stored in those warehouses. Sprinklers known as early suppression fast response (ESFR) fire suppression sprinklers were developed in the 1980s to face the fire challenges associated with warehouse storage. Sets of interrelated codes and standards, especially those promulgated by the National Fire Sprinkler Association (NFPA), UL, and FM Global set the standards for the minimum performance of ESFR sprinklers as well as for the applications in which the different ESFR sprinklers may be used depending on their individual performance. Such ESFR sprinklers are commonly classified by the amount of water they are capable of delivering at a given pressure, expressed as a “k-factor” which is defined as the relationship between the water discharge rate “Q” from a sprinkler to the water pressure “p” with in the sprinkler through the formula $Q=k(p)^{1/2}$, with ESFR sprinklers having standardized k-factors of approximately 14, 17, and 25 being exemplars. Higher k-factor sprinklers discharge

more water at a given pressure than do smaller k-factors, therefore, higher k-factor ESFR sprinklers are used to provide protection as ceiling heights increase, and standards such as NFPA-13 “Standard for the Installation of Sprinkler Systems” set forth certain maximum ceiling heights, commodity heights, and commodity spacing for use with given k-factor sprinklers.

[0005] A recent challenge to the design of ESFR sprinklers of k-factor 17 and greater (which are capable of being listed for use with ceiling heights of 40’ and greater) was a change to the performance criteria set forth by UL’s UL1767 standard that such sprinklers demonstrate the ability to meet the demands of what is known as “high clearance” applications via a live fire test. High clearance applications refer to the protection of commodities in warehouses having a large clearance between the warehouse ceiling and the commodity. Warehouses having a ceiling height of 40 feet and greater may have commodities shelved in racks at a height of 20 feet from the floor, leaving a clearance of twenty feet between the ceiling (near where the sprinklers are positioned) and the commodity. Where the clearance distance is greater than 10 feet, such applications are referred to as “high clearance” applications. The challenges to ESFR sprinklers operating at such high clearances include maintaining a core flow of fire suppressing liquid which has sufficient density and velocity to suppress a fire below the sprinkler itself while also maintaining an outer surrounding "umbrella" spray pattern to provide the required disbursement to protect the desired area, as well as sufficient flow in an intermediate range between the outer umbrella pattern and the core flow to prevent a fire in that intermediate zone from growing and overwhelming the outer umbrella. However, for some prior art ESFR sprinkler designs, a high clearance distance between the sprinkler and the commodity allows the spray pattern to become disbursed over too large an area, thereby reducing the spray pattern density, especially in the intermediate zone, and hence the sprinkler's fire suppression effectiveness. Such conditions may also allow updrafts created by the fire plume to disrupt and lift the outer umbrella spray pattern, which in some cases causes wetting and cooling of adjacent sprinklers, thereby preventing or delaying their operation. This phenomenon is known as "skipping" because the fire's heat plume "skips" the nearby cooled sprinklers which are otherwise best placed to suppress the fire. Furthermore, skipping also tends to permit the triggering of sprinklers that are more remote from the fire, and thus less effective at fire suppression. The result is an increase in both fire and water damage as well as additional risk to firefighters called to fight the blaze, as skipping may ultimately result in the fire protection system being overwhelmed.

[0006] In addition to the regulations which control the ceiling height and the height of the commodity shelved in racks below the ceiling at each given sprinkler k-factor, these regulations further set forth certain minimum clearance distances between the racks which store the commodity (known as the aisle width). These regulations exist because the demands on a system of ESFR sprinklers is affected not only by the maximum height at which a commodity is stored, but also by the number of racks of the commodity stored below any given grid of ESFR sprinklers. The minimum aisle width standards thus act in concert with the rack height standards as a limit on the amount of commodity which can be stored in a given area, while requiring clearance between the racks for the water plume from the sprinklers to travel unimpeded by the racks to reach the source of the fire as well as to wet adjacent racks of commodity to prevent ignition jumping from one rack to another. Smaller minimum aisle widths thus represent increasing demands on the performance of ESFR sprinklers as well as offering increased density of commodity storage at any given maximum storage height. Conversely, ESFR sprinklers which can exceed the minimum testing criteria necessary to achieve approvals for use at standard aisle widths, and which are approved for use at aisle widths less than the standard minimum aisle widths (known as Specific Application approvals) can be seen as having demonstrated improved performance which can improve fire suppression even at standard aisle widths.

[0007] The design of high k-factor ESFR sprinklers is therefore challenged not only by the need to pass the minimum performance criteria for such sprinklers, such that the sprinkler may be marketed as listed or approved for the default applications, but also by the desire to have performance that exceeds those minimum criteria in order to obtain Special Application approvals for use in a greater range of applications, especially those which permit a greater density storage of the commodity at smaller aisle widths than the minimum performance criteria in NFPA 13 allows. Such high performance ESFR sprinklers may be expected to provide improved protection even at standard storage densities and aisle widths.

[0008] There is clearly an opportunity to improve fire suppression sprinklers, particularly ESFR type sprinklers, to handle the challenges of high clearance warehouse fire protection and offer improved performance, including through demonstrating an ability to tolerate an increase the density at which commodities may be stored.

[0009] It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

Summary

[0010] Accordingly in a first aspect the invention provides a fire suppression sprinkler, said sprinkler comprising:

- a body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore;

- first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

- a nose mounted on the ends of said frame arms, said nose being positioned coaxially with said flow axis;

- a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

 - a plurality of slots of a first configuration extending from said periphery radially toward said center and terminating at a first distance from said center, at least two of said slots of said first configuration being disposed in said plane;

 - at least four slots of a second configuration extending from said periphery radially toward said center and terminating at a second distance from said center, said slots of said second configuration being located about said periphery such that one of said slots of said second configuration is positioned adjacent to each side of each of said slots of said first configuration which are disposed in said plane;

 - a plurality of slots of a third configuration extending from said periphery radially toward said center and terminating at a third distance from said center; wherein

 - said second distance is less than any of said first or third distances; and wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

[0011] Unless the context clearly requires otherwise, throughout the description and the claims, the words “comprise”, “comprising”, and the like are to be construed in an inclusive sense as

opposed to an exclusive or exhaustive sense; that is to say, in the sense of “including, but not limited to”.

[0012] In another aspect the invention provides an early suppression fast response fire suppression sprinkler, said sprinkler comprising:

- a body adapted for use in a pendent orientation, said body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore, said bore defining a k factor of $k=25.2$ or greater;

- first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

- a plug removably mounted on said body between said frame arms and overlying said bore;

- a nose mounted on ends of said frame arms at a distance from said plug less than 1.0 inches, said nose being positioned coaxially with said flow axis;

- a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

- a plurality of first slots extending from said periphery radially toward said center and terminating at a first distance from said flow axis, at least two of said first slots being disposed in said plane;

- a plurality of second slots extending from said periphery radially toward said center and terminating at a second distance from said flow axis, said second slots being located about said periphery such that one of said second slots is positioned adjacent to each side of each of said first slots which are disposed in said plane; wherein

- said second distance is less than said first distance; and wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

[0013] The invention concerns a fire suppression sprinkler. In an example embodiment the sprinkler comprises a body surrounding a bore. The bore defines a flow axis arranged coaxially with the bore. First and second frame arms are mounted on opposite sides of the body and extend therefrom in a direction along the flow axis. The frame arms define a plane. A nose is mounted on the ends of the frame arms. The nose is positioned coaxially with the flow axis. A

deflector plate is mounted on the nose and oriented transversely to the flow axis. The deflector plate has a periphery surrounding a center located on the flow axis. The deflector plate comprises two slots of a first configuration extending from the periphery radially toward the center. The two of the slots of the first configuration are disposed in the plane. Four slots of a second configuration extend from the periphery radially toward the center and are located about the periphery such that one of the slots of the second configuration is positioned adjacent to each side of each of the slots of the first configuration. Four slots of a third configuration extend from the periphery radially toward the center and are located about the periphery such that one of the slots of the third configuration is positioned adjacent to one of the slots of the second configuration. The slots of the second configuration have a greater area than the slots of the first and the third configurations.

[0014] An example embodiment further comprises four slots of a fourth configuration extending from the periphery radially toward the center. These slots are located about the periphery such that one of the slots of the fourth configuration is positioned adjacent to one of the slots of the third configuration. The slots of the fourth configuration have a greater area than the slots of the third configuration.

[0015] In an example embodiment the bore defines a k factor of $k=14.0$ or greater. The fire suppression sprinkler is adapted to be installed in a pendent orientation by way of example.

[0016] In a particular example embodiment the slots of the second configuration have a club shape comprising a handle extending from the periphery and a club head terminating at a distance from the center, wherein a width of the club head proximate to the handle is less than a width of the club head proximate to the center. In an example embodiment a widest width of the club head is wider than a widest width of the handle. Further by way of example, the club head has a curved tip at the distance from the center. In a specific example, the club head is asymmetric with respect to a line extending radially from the center for the slots of the second configuration. In an example embodiment, the club head is defined by a first edge oriented at a first angle with respect to the line, and a second edge, opposite to the first edge, the second edge oriented at a second angle with respect to the line, the second angle being different from the first angle.

[0017] Further by way of example, each of the slots of the second configuration are symmetric with respect to a line extending radially from the center. Additionally by way of example, the slots of the fourth configuration have a keyhole shape comprising a waist extending from the periphery and a key head terminating at a distance from the center. In an example embodiment, a widest width of the key head is wider than a widest width of the waist. By way of example, a width of the key head proximate to the waist is equal to a width of the key head proximate to the center. In a further example, the key head has a curved tip at the distance from the center. In another example embodiment, the key head is symmetric with respect to a line extending radially from the center.

[0018] In an example embodiment, the slots of the first configuration have an arrowhead shape comprising a shaft extending from the periphery and an arrowhead terminating at a first distance from the center. By way of example, the arrowhead is asymmetric with respect to a line extending radially from the center. In another example embodiment, the arrowhead is defined by a first edge oriented at a first angle with respect to the line, and a second edge, opposite to the first edge, the second edge oriented at a second angle with respect to the line, the second angle being different from the first angle. Further by way of example, a widest width of the arrowhead is wider than a widest width of the shaft. In a specific example, a width of the arrowhead proximate to the shaft is greater than a width of the arrowhead proximate to the center. In a further example, the arrowhead has a curved tip at the distance from the center. Also by way of example, the shaft has a width at the periphery which is greater than a width of the shaft proximate to the arrowhead. In an example embodiment, the shaft is defined by first and second oppositely disposed edges. The edge are angularly oriented with respect to a line extending radially from the center such that the shaft has a width at the periphery which is greater than a width of the shaft proximate to the arrowhead

[0019] The invention encompasses a fire suppression sprinkler, which, in an example embodiment comprises a body surrounding a bore. The bore defines a flow axis arranged coaxially with the bore. First and second frame arms are mounted on opposite sides of the body and extend therefrom in a direction along the flow axis. The frame arms define a plane. A nose is mounted on the ends of the frame arms. The nose is positioned coaxially with the flow axis. A deflector plate is mounted on the nose and oriented transversely to the flow axis. The deflector plate has a periphery surrounding a center located on the flow axis. The deflector plate comprises a plurality of slots of a first configuration extending from the periphery radially

toward the center and terminating at a first distance from the center. At least two of the slots of the first configuration are disposed in the plane. At least four slots of a second configuration extends from the periphery radially toward the center and terminate at a second distance from the center. The slots of the second configuration being located about the periphery such that one of the slots of the second configuration is positioned adjacent to each side of each of the slots of the first configuration which are disposed in the plane. A plurality of slots of a third configuration extend from the periphery radially toward the center and terminate at a third distance from the center. The second distance is less than any of the first or third distances in this example.

[0020] In an example embodiment the nose has a maximum radius measured from the flow axis. The first, second, and third distances are greater than the maximum radius.

[0021] In an example embodiment, the bore defines a k factor of $k=14.0$ or greater and the fire suppression sprinkler is adapted to be installed in a pendent orientation.

[0022] By way of example, the slots of the second configuration have a club shape comprising a handle extending from the periphery and a club head terminating at a distance from the center. A width of the club head proximate to the handle is less than a width of the club head proximate to the center in this example. Further by way of example, a widest width of the club head is wider than a widest width of the handle. Also by way of example, the club head has a curved tip at the distance from the center. In an example embodiment, the club head is asymmetric with respect to a line extending radially from the center. By way of example, the club head is defined by a first edge oriented at a first angle with respect to the line, and a second edge, opposite to the first edge. The second edge is oriented at a second angle with respect to the line, the second angle being different from the first angle.

[0023] In an example embodiment each of the slots of the second configuration are symmetric with respect to a line extending radially from the center. Further by way of example, the slots of the third configuration have a keyhole shape comprising a waist extending from the periphery and a key head terminating at a distance from the center. In an example embodiment, a widest width of the key head is wider than a widest width of the waist. Further by way of example, a width of the key head proximate to the waist is equal to a width of the key head proximate to the center. In a particular example, the key head has a curved tip at the distance from the center. By

way of example, the key head is symmetric with respect to a line extending radially from the center.

[0024] In an example embodiment, the slots of the first configuration have an arrowhead shape comprising a shaft extending from the periphery and an arrowhead terminating at a first distance from the center. The arrowhead may be asymmetric with respect to a line extending radially from the center in an example embodiment. By way of example the arrowhead is defined by a first edge oriented at a first angle with respect to the line, and a second edge, opposite to the first edge, the second edge oriented at a second angle with respect to the line, the second angle being different from the first angle. In an example embodiment, a widest width of the arrowhead is wider than a widest width of the shaft. In a further example, a width of the arrowhead proximate to the shaft is greater than a width of the arrowhead proximate to the center. In a particular example, the arrowhead has a curved tip at the distance from the center. Further by way of example, the shaft has a width at the periphery which is greater than a width of the shaft proximate to the arrowhead. In an example embodiment, the shaft is defined by first and second oppositely disposed edges. The edges are angularly oriented with respect to a line extending radially from the center such that the shaft has a width at the periphery which is greater than a width of the shaft proximate to the arrowhead.

[0025] The invention further encompasses an early suppression fast response fire suppression sprinkler, which, by way of example, comprises a body adapted for use in a pendent orientation. The body surrounds a bore. The bore defines a flow axis arranged coaxially with the bore. The bore further defines a k factor of $k=25.2$ or greater in this example. First and second frame arms are mounted on opposite sides of the body and extend therefrom in a direction along the flow axis. The frame arms define a plane. A plug is removably mounted on the body between the frame arms and overlying the bore. A nose is mounted on ends of the frame arms at a distance from the plug less than 1.0 inches in this example. The nose is positioned coaxially with the flow axis. A deflector plate is mounted on the nose and is oriented transversely to the flow axis. The deflector plate has a periphery surrounding a center located on the flow axis. In this example the deflector plate comprises a plurality of first slots extending from the periphery radially toward the center and terminating at a first distance from the flow axis. A least two of the first slots are disposed in the plane in this example. A plurality of second slots extend from the periphery radially toward the center and terminate at a second distance from the flow axis. The second slots are located about the periphery such that one of the second slots is positioned

adjacent to each side of each of the first slots which are disposed in the plane. In this example the second distance is less than the first distance. Further by way of example, the nose has a maximum radius measured from the flow axis. The first and second distances being greater than the maximum radius.

[0026] In another example embodiment, a fire suppression sprinkler comprises a body surrounding a bore. The bore defines a flow axis arranged coaxially with the bore. First and second frame arms are mounted on opposite sides of the body and extend therefrom in a direction along the flow axis. A nose mounted on ends of the frame arms. The nose is positioned coaxially with the flow axis. A deflector plate is mounted on the nose and is oriented transversely to the flow axis. The deflector plate has a periphery surrounding a center located on the flow axis and comprises a first slot extending from the periphery radially toward the center. The first slot has an arrow shape comprising a first shaft extending from the periphery and a first arrowhead terminating at a first distance from the center. The first slot is aligned with the first arm. A widest width of the first slot is equal to or greater than a thickness of the first arm in an example.

[0027] In an example embodiment the shaft is defined by first and second oppositely disposed edges. Each edge is angularly oriented with respect to a first line extending radially from the center such that the first shaft has a width at the periphery which is greater than a width of the first shaft proximate to the first arrowhead. Further by way of example, a widest width of the first arrowhead is wider than a widest width of the first shaft. In another example, a width of the first arrowhead proximate to the first shaft is greater than a width of the first arrowhead proximate to the center. Also by way of example, the first arrowhead has a curved tip at the first distance from the center. In an example the first slot is symmetric about a first line extending radially from the center.

[0028] Further by way of example, a second slot extends from the periphery radially toward the center. The second slot has a club shape comprising a handle extending from the periphery and a club head terminating at a second distance from the center. A width of the club head proximate to the handle is less than a width of the club head proximate to the center in an example. In an example embodiment a widest width of the club head is wider than a widest width of the handle. In a further example the club head has a curved tip at the second distance from the center. In another example the club head is asymmetric with respect to a second line extending radially

from the center. In an example embodiment the club head is defined by a first edge oriented at a first angle with respect to the second line, and a second edge, opposite to the first edge. The second edge is oriented at a second angle with respect to the second line. The second angle is different from the first angle in an example embodiment.

[0029] An example embodiment further comprises a third slot extending from the periphery radially toward the center. The third slot has a second arrow shape comprising a second shaft extending from the periphery and a second arrowhead terminating at a third distance from the center. The third arrowhead is asymmetric with respect to a third line extending radially from the center in an example embodiment.

[0030] Further by way of example, the second arrowhead is defined by a first edge oriented at a first angle with respect to the third line, and a second edge, opposite to the first edge. The second edge is oriented at a second angle with respect to the third line. The second angle is different from the first angle in an example embodiment. By way of example, a widest width of the second arrowhead is wider than a widest width of the second shaft. In another example, a width of the second arrowhead proximate to the second shaft is greater than a width of the second arrowhead proximate to the center. Further by way of example, the second arrowhead has a curved tip at the third distance from the center. In an example embodiment the second shaft has a width at the periphery which is greater than a width of the second shaft proximate to the second arrowhead. By way of example, the second shaft is defined by first and second oppositely disposed edges. Each edge is angularly oriented with respect to the third line such that the second shaft has a width at the periphery which is greater than a width of the second shaft proximate to the second arrowhead. An example embodiment comprises a fourth slot extending from the periphery radially toward the center. The fourth slot has a keyhole shape comprising a waist extending from the periphery and a key head terminating at a fourth distance from the center. In an example a widest width of the key head is wider than a widest width of the waist. In a further example, a width of the key head proximate to the waist is equal to a width of the key head proximate to the center. Further by way of example, the key head has a curved tip at the fourth distance from the center. In an example embodiment the key head is symmetric with respect to a fourth line extending radially from the center.

[0031] An example embodiment further comprises a fifth slot extending from the periphery radially toward the center. The fifth slot has a third arrow shape comprising a third shaft

extending from the periphery and a third arrowhead terminating at a fifth distance from the center. The third shaft is defined by third and fourth oppositely disposed edges. Each of the third and fourth edges is angularly oriented with respect to a fifth line extending radially from the center such that the third shaft has a width at the periphery which is greater than a width of the third shaft proximate to the arrowhead. In an example embodiment the third shaft has a width at the periphery wider than a width of the first shaft at the periphery. Further by way of example a widest width of the third arrowhead is wider than a widest width of the third shaft. In another example a width of the third arrowhead proximate to the third shaft is greater than a width of the third arrowhead proximate to the center. In another example the third arrowhead has a curved tip at the fifth distance from the center. In an example embodiment the third arrowhead is symmetric with respect to a fifth line extending radially from the center.

[0032] The invention further encompasses a fire suppression sprinkler comprising a body surrounding a bore. The bore defines a flow axis arranged coaxially with the bore. First and second frame arms are mounted on opposite sides of the body and extend therefrom in a direction along the flow axis. A nose is mounted on ends of the frame arms. The nose is positioned coaxially with the flow axis. A deflector plate is mounted on the nose and is oriented transversely to the flow axis. The deflector plate has a periphery surrounding a center located on the flow axis and comprises a first slot extending from the periphery radially toward the center. The first slot has an arrow shape comprising a first shaft extending from the periphery and a first arrowhead terminating at a first distance from the center. The first shaft is defined by first and second oppositely disposed edges. Each of the first and second edges is angularly oriented with respect to a first line extending radially from the center such that the first shaft has a width at the periphery which is greater than a width of the first shaft proximate to the first arrowhead. A second slot extends from the periphery radially toward the center. The second slot has an arrow shape comprising a second shaft extending from the periphery and a second arrowhead terminating at a second distance from the center. The second shaft is defined by first and second oppositely disposed edges. Each edge defines the second shaft as angularly oriented with respect to a second line extending radially from the center such that the second shaft has a width at the periphery which is greater than a width of the second shaft proximate to the second arrowhead. The second line is oriented at an angle with respect to the first line. A third slot extends from the periphery radially toward the center. The third slot has a club shape comprising a handle extending from the periphery and a club head terminating at a third distance from the center. In an example a width of the club head proximate to the handle is less than a width of the club head

proximate to the center. The third slot is positioned between the first and second slots. A fourth slot extends from the periphery radially toward the center. The fourth slot has an arrow shape comprising a third shaft extending from the periphery and a third arrowhead terminating at a fourth distance from the center. The fourth slot is positioned between the second and third slots. A fifth slot extends from the periphery radially toward the center. The fifth slot has a keyhole shape comprising a waist extending from the periphery and a key head terminating at a fifth distance from the center. The fifth slot is positioned between the second and fourth slots.

[0033] In an example embodiment the third slot has the greatest area of any of the first, second, fourth and fifth slots. Further by way of example, the angle between the first and second lines is 90° . In another example, the width of the second shaft at the periphery is greater than the width of the first shaft at the periphery. In an example the third distance is less than the first, second, fourth and fifth distances. Further by way of example the fifth distance is less than the first, second and fourth distances. In another example the first, second and fourth distances are equal to one another.

[0034] By way of example the club head is asymmetric with respect to a third line extending radially from the center. In another example the third arrowhead is asymmetric with respect to a fourth line extending radially from the center. An example further comprises a pair of the first slots positioned in the plate 180° from one another. Another example further comprises two of the second slots positioned in the plate respectively at 90° and 270° from one of the first slots. An example, further comprises four of the third slots positioned in the plate respectively at 22.5° , 157.5° , 202.5° and 337.5° from the one of the first slots. An example embodiment, further comprises four of the fourth slots positioned in the plate respectively at 45° , 135° , 225° and 315° from the one of the first slots. Another example embodiment comprises four of the fifth slots positioned in the plate respectively at 67.5° , 112.5° , 247.5° and 292.5° from the one of the first slots.

Brief Description of the Drawings

[0035] The invention will be more clearly understood from the following description of an embodiment thereof, given by way of example only, with reference to the accompanying drawings, in which: -

[0036] Figure 1 is a side view of an example fire suppression sprinkler according to the invention;

[0037] Figure 1A is a side view of an example fire suppression sprinkler according to the invention;

[0038] Figure 1B is an isometric view of an example fire suppression sprinkler shown in a pendent orientation;

[0039] Figure 2 is a partial longitudinal sectional view of the fire suppression sprinkler shown in Figure 1;

[0040] Figure 3 is an end view of the fire suppression sprinkler shown in Figure 1 and showing a plan view of an example deflector according to the invention;

[0041] Figure 3A is an end view of another embodiment of the fire suppression sprinkler according to the invention showing a plan view of an example deflector;

[0042] Figure 4 is a plan view of a quadrant of the example deflector shown in Figure 3; and

[0043] Figures 4a, 4B and 4C are plan views of sectors of the deflector, on an enlarged scale, as respectively denoted by arc lengths 4A, 4B and 4C in Figure 3.

Detailed Description

[0044] Figures 1 and 2 show an example fire suppression sprinkler 10 according to the invention. Sprinkler 10 may be, for example, an early suppression fast response (ESFR) sprinkler having a "k factor" from about 17 to about 34, and specifically 25.2.

[0045] As shown in Figure 2, sprinkler 10 comprises a body 12 which surrounds a bore 14. Bore 14 defines a flow axis 16 arranged coaxially with the bore. Body 10 has a nipple 18 for connection of the sprinkler 10 to a piping network of a fire suppression system (not shown) and a plurality of flat surfaces 20 (see Figure 1) which receive a wrench for applying torque to the sprinkler during installation. Nipple 18 may be threaded as shown in Figures 1 and 2, or, as shown in Figure 1A, nipple 18 may have a groove 22 to enable the use of a mechanical coupling

to connect the sprinkler to the piping network of a fire suppression system. First and second frame arms 24 and 26 extend from opposite sides of body 12 parallel to flow axis 16 and support a nose 28 mounted on the ends of the arms. Arms 24 and 26 extend along flow axis 16 by a length 30 as measured from the end of the bore 14 to the base of the nose 28 (see Figure 2). Nose 28 is positioned coaxially with the flow axis 16 and supports a heat sensitive trigger 32. Nose 28 in this example is conical and has a maximum radius 33 (measured from flow axis 16) which transitions into a flow conditioning portion 34. Flow conditioning portion 16 is advantageously cylindrical, and extends beyond the ends of arms 24 and 26 a length 36 (see Figure 1), thereby permitting a deflector to be mounted on nose 28 in spaced relation to the ends of arms 24 and 26.

[0046] In this example the heat sensitive trigger 32 comprises a frangible glass bulb 38 containing a heat sensitive liquid 40. Bulb 38 extends between nose 28 and a sealing member 42, in this example a plug 44 which overlies and seals the bore 14 through engagement with body 12. As shown in Figure 2, nose 28 also comprises a set screw 46, threaded within a bore 48 in nose 28 aligned with the bulb 38. The set screw 46 permits assembly of the bulb 38 into the sprinkler 10 and adjustment of the compression force on the bulb. Bulb 38 supports the plug 44 to maintain the sprinkler 10 in its closed configuration (shown). Bulb 38 breaks when the ambient temperature reaches a predetermined value, for example, indicative of a fire. In various embodiments, such predetermined temperature values may be approximately 155°F or 200°F. When the bulb 38 breaks it no longer supports plug 44 which is then released from engagement with the body 12 to open sprinkler 10 and allow water or other fire suppressing fluid to be discharged. Other heat sensitive triggers are also feasible, such as those having components held together by a solder which melts at a predetermined temperature to allow the sprinkler to open.

[0047] A deflector 50 is mounted on the nose 28. As shown in Figures 2 and 3, the example deflector 50 comprises plate 52, advantageously circular and in a plane oriented transversely to the flow axis 16. Plate 52 has a periphery 54 surrounding a center 56, the center being coincident with the flow axis 16. Plate 52 has a thickness 58 (see Figure 1). The deflector 50 is positioned in spaced relation to the ends of arms 24 and 26 at the distance 36. In an example embodiment, the distance 36 is greater than twice the thickness 58 of plate 52. In another example embodiment, the distance 36 is approximately three times the thickness 58 of the plate 52.

[0048] As shown in Figures 3 and 4, plate 52 defines a plurality of slots 62. Slots 62 are designed in conjunction with nose 28, arms 24 and 26 (including the length 30), flow conditioning region 34 (including length 36), and bore 14 to meet standards governing discharge rate, coverage area size and shape, and other performance standards in order to permit installation under NFPA 13, including passage of the testing set forth in standards promulgated by FM Global and UL, such standards including UL 1767 and FM 2008.

[0049] The example sprinkler 10 is further designed to achieve higher performance, including enabling the higher density storage of commodities by being qualified under UL 1767 (and permitted under NFPA 13) to be installed in specific applications where the ceiling height is a maximum of 48 feet, the commodity height is a maximum of 43 feet and where the aisle spacing is a minimum of 4 feet.

[0050] To this end, slots 62 comprise slots of five configurations, slots 64, slots 66, slots 68, slots 70, and slots 72, respectively, all of which extend radially from the periphery 54 of the plate 52 toward the plate center 56, each slot extending along a respective line 74, 76, 78, 80 and 82 which extend radially from the plate center 56.

[0051] As is apparent from Figure 3, slots 64 are aligned with the first and second arms 24 and 26 which are disposed in a plane 84. As shown in Figures 4 and 4C, slots 64 extend from the periphery 54 of the plate 52 and terminate at points 64a which lie at a distance 86 from the plate center 56. Slots 64 are of generally arrow shape, arrow shape meaning that slots 64 have a shaft 64b extending from the periphery 56 and an arrowhead 64c terminating in a curved tip 64d at point 64a. Slots 64 in this example are symmetric about line 74 and the arrowhead 64c has a width 64e proximate to the shaft 64b which is greater than its width 64f proximate the plate center 56. As shown in Figure 3, width 64e may be advantageously equal to or greater than the thicknesses 24a and 26a of the arms 24 and 26 respectively. With reference again to Figures 4 and 4C, width 64e, the widest width of the arrowhead 64c is also wider than the widest width of the shaft 64b in this example.

[0052] Advantageously, the shaft 64b is defined by first and second oppositely disposed edges 64g and 64h which are angularly oriented with respect to line 74 such that shaft 64b has a width 64i at the plate periphery 54 which is greater than a width 64j of the shaft 64b proximate to the arrowhead 64c.

[0053] As shown in Figures 3, 4 and 4B, slots 66 are adjacent each side of the two slots 64, and extend from the periphery 54 of plate 52 to terminate at points 66a which lie at a distance 88 from the plate center 56. Slots 66 are generally club shaped, club shape meaning that slots 66 comprise a handle 66b extending from the periphery 54 and a club head 66c terminating at point 66a. The width 66d of the club head 66c proximate to handle 66b is less than the width 66e of the club head proximate to the plate center 56. Club head 66c terminates at point 66a in a curved tip 66f. The widest width 66e of the club head is wider than the widest width 66g of the handle 66b.

[0054] As shown in Figure 4B, slots 66 are preferably asymmetric about lines 76. Club head 66c is defined by a first edge 66h oriented at a first angle 66i with respect to line 76, and a second edge 66j oriented at a second angle 66k with respect to line 76. Angle 66i is different from angle 66k to produce the asymmetry of slots 66. Slots 66 advantageously have the largest surface area of any of slots 64, 68, 70 and 72.

[0055] As shown in Figures 3, 4 and 4B, slots 68 extend from the periphery 54 of the plate 52 and terminate at points 68a which lie at a distance 90 from the plate center 56. Slots 68 are of generally arrow shape, arrow shape meaning that slots 68 have a shaft 68b extending from the periphery 56 and an arrowhead 68c terminating in a curved tip 68d at point 68a. The arrowhead 68c has a width 68e proximate to the shaft 68b which is greater than its width 68f proximate the plate center 56. Width 68e, the widest width of the arrowhead 68c is also wider than the widest width of the shaft 68b in this example.

[0056] Advantageously, the shaft 68b is defined by first and second oppositely disposed edges 68g and 68h which are angularly oriented with respect to line 78 such that shaft 68b has a width 68i at the plate periphery 54 which is greater than a width 68j of the shaft 68b proximate to the arrowhead 68c.

[0057] As shown in 4B, slots 68 in this example are asymmetric about line 78. Arrowhead 68c is defined by a first edge 68k oriented at a first angle 68m with respect to line 78, and a second edge 68n oriented at a second angle 68p with respect to line 78. Angle 68m is different from angle 68p to produce the asymmetry of slots 68.

[0058] As shown in Figures 3, 4 and 4A, slots 70 lie between slots 68 and 72 and extend along line 80 from the plate periphery 54 to terminate at a point 70a at a distance 92 from the plate

center 56. Slots 70 are generally elongate keyhole shaped, elongate keyhole shaped meaning that slots 70 comprise a waist 70b extending from periphery 54 and a key head 70c terminating at point 70a in a curved tip 70d. Slots 70 are symmetric about lines 80 in this example. The width 70e of the key head 70c proximate the waist 70b is equal to the width 70f of the key head proximate the plate center 56. The widest width 70e or 70f is wider than the widest width 70g of the waist 70b.

[0059] Figure 3A shows another embodiment wherein slots 70, having the keyhole shape, are positioned adjacent each side of the two slots 64, and extend from the periphery 54 of plate 52, effectively replacing slots 66.

[0060] As shown in Figures 3, 4 and 4A, slots 72 extend from the periphery 54 of the plate 52 and terminate at points 72a which lie at a distance 94 from the plate center 56. Slots 72 are of generally arrow shape, arrow shape meaning that slots 72 have a shaft 72b extending from the periphery 56 and an arrowhead 72c terminating in a curved tip 72d at point 72a. Slots 72 in this example are symmetric about lines 82 and the arrowhead 72c has a width 72e proximate to the shaft 72b which is greater than its width 72f proximate the plate center 56. Width 72e, the widest width of the arrowhead 72c is also wider than the widest width of the shaft 72b in this example.

[0061] Advantageously, the shaft 72b is defined by first and second oppositely disposed edges 72g and 72h which are angularly oriented with respect to line 82 such that shaft 72b has a width 72i at the plate periphery 54 which is greater than a width 72j of the shaft 72b proximate to the arrowhead 72c. It is also advantageous when width 72i is greater than the width 64i of the shaft 64b at the periphery. It is also advantageous for line 82 to be oriented at 90° to line 74, resulting in slot 72 being oriented at 90° to slot 64. Additionally, with respect to the distances 86, 88, 90, 92 and 94, it is advantageous if distance 88 is less than distances 86, 90, 92 and 94. It is further advantageous if the distance 92 is less than distances 86, 90 and 94. Moreover, it is advantageous if distances 86, 90 and 94 are equal to one another.

[0062] The example arrangement of the slots 62 shown in Figure 3 is expected to be advantageous. In this arrangement there are five different types of slots 62. Slots 64 may be regarded as a pair of first slots (first configuration) positioned in plate 52 at 180° from one another. Slots 72 may be considered a pair of second slots (second configuration) positioned in

plate 52 at 90° and 270° from either one of the first slots 64. Slots 66 may be considered as third slots (third configuration). In the example arrangement, there are four of the third configuration slots 66 positioned in plate 52 at 22.5° , 157.5° , 202.5° and 337.5° from one of the first slots 64. Slots 68 may be considered to be fourth slots (fourth configuration). In the example arrangement there are four fourth configuration slots positioned in plate 52 respectively at 45° , 135° , 225° and 315° from one of the first slots 64. Slots 70 may be considered to be fifth slots (configuration type). In the example arrangement there are four fifth configuration slots positioned in plate 52 respectively at 67.5° , 112.5° , 247.5° and 292.5° from one of the first slots 64. It is understood that the angular separation of the slots are exemplary nominal angles subject to manufacturing tolerances and thus may vary from those as specified herein.

[0063] The arrangement of slots 62 as shown in Figure 3 may also be characterized based upon the distance at which the slots terminate from the flow axis 16. In the example embodiment shown, a plurality of first slots, including, for example, slots 64, 68 and 72, and a plurality of second slots, including, for example, slots 66 and 70, extend radially from the periphery 54 toward the flow axis 16. In particular, two of the first slots 64 are disposed in the plane 84 (aligned with the arms 24 and 26) and one of the second slots 66 are positioned adjacent to each side of each of the first slots 64 which are disposed in plane 84. With reference to Figure 4, it is thought advantageous for the termination distance 88 of second slots 66 from the flow axis 16 be less than the termination distance 86 from the flow axis of the first slots 64. Further advantage is believed possible if the termination distances 88 and 86 from the flow axis 16 are greater than the maximum radius 33 (see Figure 1) of the nose 28. For a pendent ESFR sprinkler 10 (see Figures 1 and 1B) with the arrangement of first and second slots described above, it is desirable that the nose 28 be mounted on ends of the frame arms 24 and 26 at a distance 96 of less than 1.0 inches from the plug 44 as shown in Figure 1. As shown in Figure 1A, pendent sprinklers are mounted in a pipeline 98 with the flow axis 16 oriented vertically so that the discharge of fire suppressing fluid is in a downward direction.

[0064] The arrangement of slots 62, meaning their angular separation, shape, sizing as well as their orientation and spacing with respect to arms 24 and 26 according to the invention is believed to promote improved performance of fire sprinklers, especially of ESFR sprinklers, by advantageously compensating for the effect known as frame shadowing, whereby arms 24 and 26 represent a discontinuity in the flow of fluid exiting bore 14 to impinge upon deflector 50. In particular, it is believed that the location of slots with the largest surface area or which extend

the deepest toward the axis 16 (such as slots 66) adjacent to the slots located above the frame arms (such as slots 64) helps to compensate for frame shadowing. It is further believed that the location of symmetric slots remote from the location of the frame arms (such as slots 70 and 72) where the effect of frame shadowing is at a minimum promotes uniform distribution of fluid where the flow is at its most uniform due to the limited effects of frame shadowing. This arrangement may also be viewed as one where any of slot length, area, and asymmetry is generally reduced from a localized maximum above or adjacent to the frame arms to a localized minimum equidistant from the frame arms, and that such reduction takes place independently on the first and second slots having different termination distances from the flow axis. The advantageous arrangements of the invention, which offer improved compensation for the effects of frame shadowing, result in a more uniform distribution of water discharged from sprinkler 10 is promoted that is believed to result in improved performance.

[0065] Fire suppression sprinklers according to the invention are expected to meet or exceed the standards for ESFR sprinklers including by meeting the requirements of UL1767 and resulting in approvals at reduced aisle widths, and better, more uniform performance under all listed conditions.

[0066] Example embodiments of aspects of the invention are disclosed in the clauses below.

Clause 1. A fire suppression sprinkler, said sprinkler comprising:

- a body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore;

- first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

- a nose mounted on the ends of said frame arms, said nose being positioned coaxially with said flow axis;

- a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

- a plurality of slots of a first configuration extending from said periphery radially toward said center, at least two of said slots of said first configuration being disposed in said plane;

- at least four slots of a second configuration extending from said periphery

radially toward said center and being located about said periphery such that one of said slots of said second configuration is positioned adjacent to each side of each of said slots of said first configuration which are disposed in said plane;

a plurality of slots of a third configuration extending from said periphery radially toward said center; wherein

said slots of said second configuration have a greater area than said slots of said first configuration.

Clause 2. The fire suppression sprinkler according to clause 1, wherein said slots of said second configuration have the greatest area of any of said slots of said first and said third configurations.

Clause 3. The fire suppression sprinkler according to clause 1, wherein said bore defines a k factor of $k=14.0$ or greater and wherein said fire suppression sprinkler is adapted to be installed in a pendent orientation.

Clause 4. The fire suppression sprinkler according to Clause 1, wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

Clause 5. The fire suppression sprinkler according to clause 4, wherein a widest width of said club head is wider than a widest width of said handle.

Clause 6. The fire suppression sprinkler according to clause 5, wherein said club head has a curved tip at said distance from said center.

Clause 7. The fire suppression sprinkler according to clause 4, wherein said club head is asymmetric with respect to a line extending radially from said center.

Clause 8. The fire suppression sprinkler according to clause 7, wherein said club head is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.

Clause 9. The fire suppression sprinkler according to clause 4, wherein each of said slots of said second configuration are symmetric with respect to a line extending radially from said center.

Clause 10. The fire suppression sprinkler of Clause 1, where said slots of said second configuration have a keyhole shape comprising a waist extending from said periphery and a key head terminating at a distance from said center.

Clause 11. The fire suppression sprinkler according to clause 10, wherein a widest width of said key head is wider than a widest width of said waist.

Clause 12. The fire suppression sprinkler according to clause 10, wherein a width of said key head proximate to said waist is equal to a width of said key head proximate to said center.

Clause 13. The fire suppression sprinkler according to clause 10, wherein said key head has a curved tip at said distance from said center.

Clause 14. The fire suppression sprinkler according to clause 10, wherein said key head is symmetric with respect to a line extending radially from said center.

Clause 15. The fire suppression sprinkler of Clause 1, where said slots of said first configuration have an arrowhead shape comprising a shaft extending from said periphery and an arrowhead terminating at a first distance from said center, wherein said arrowhead is asymmetric with respect to a line extending radially from said center.

Clause 16. The fire suppression sprinkler according to clause 15, wherein said arrowhead is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.

Clause 17. The fire suppression sprinkler according to clause 15, wherein a widest width of said arrowhead is wider than a widest width of said shaft.

Clause 18. The fire suppression sprinkler according to clause 15, wherein a width of said arrowhead proximate to said shaft is greater than a width of said arrowhead proximate to said center.

Clause 19. The fire suppression sprinkler according to clause 15, wherein said arrowhead has a curved tip at said distance from said center.

Clause 20. The fire suppression sprinkler according to clause 15, wherein said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead.

Clause 21. The fire suppression sprinkler according to clause 15, wherein said shaft is defined by first and second oppositely disposed edges, each said edge being angularly oriented with respect to a line extending radially from said center such that said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead

Clause 22. The fire suppression sprinkler of Clause 1, wherein said deflector plate further comprises a plurality of slots of a fourth configuration.

Clause 23. The fire suppression sprinkler of Clause 22, wherein said deflector plate further comprises a plurality of slots of a fifth configuration.

Clause 24. A fire suppression sprinkler, said sprinkler comprising:

- a body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore;

- first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

- a nose mounted on the ends of said frame arms, said nose being positioned coaxially with said flow axis;

- a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

- a plurality of slots of a first configuration extending from said periphery radially toward said center and terminating at a first distance from said center, at least two of said slots of said first configuration being disposed in said plane;

- at least four slots of a second configuration extending from said periphery

radially toward said center and terminating at a second distance from said center, said slots of said second configuration being located about said periphery such that one of said slots of said second configuration is positioned adjacent to each side of each of said slots of said first configuration which are disposed in said plane;

a plurality of slots of a third configuration extending from said periphery radially toward said center and terminating at a third distance from said center; wherein said second distance is less than any of said first or third distances.

Clause 25. The fire suppression sprinkler of Clause 24, where said nose has a maximum radius measured from said flow axis, said first, second, and third distances being greater than said maximum radius.

Clause 26. The fire suppression sprinkler according to clause 24, wherein said bore defines a k factor of $k=14.0$ or greater and wherein said fire suppression sprinkler is adapted to be installed in a pendent orientation.

Clause 27. The fire suppression sprinkler according to Clause 24, wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

Clause 28. The fire suppression sprinkler according to clause 27, wherein a widest width of said club head is wider than a widest width of said handle.

Clause 29. The fire suppression sprinkler according to clause 28, wherein said club head has a curved tip at said distance from said center.

Clause 30. The fire suppression sprinkler according to clause 27, wherein said club head is asymmetric with respect to a line extending radially from said center.

Clause 31. The fire suppression sprinkler according to clause 30, wherein said club head is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.

Clause 32. The fire suppression sprinkler according to clause 27, wherein each of said slots of said second configuration are symmetric with respect to a line extending radially from said center.

Clause 33. The fire suppression sprinkler of Clause 24, where said slots of said second configuration have a keyhole shape comprising a waist extending from said periphery and a key head terminating at a distance from said center.

Clause 34. The fire suppression sprinkler according to clause 33, wherein a widest width of said key head is wider than a widest width of said waist.

Clause 35. The fire suppression sprinkler according to clause 33, wherein a width of said key head proximate to said waist is equal to a width of said key head proximate to said center.

Clause 36. The fire suppression sprinkler according to clause 33, wherein said key head has a curved tip at said distance from said center.

Clause 37. The fire suppression sprinkler according to clause 33, wherein said key head is symmetric with respect to a line extending radially from said center.

Clause 38. The fire suppression sprinkler of Clause 24, where said slots of said first configuration have an arrowhead shape comprising a shaft extending from said periphery and an arrowhead terminating at a first distance from said center, wherein said arrowhead is asymmetric with respect to a line extending radially from said center.

Clause 39. The fire suppression sprinkler according to clause 38, wherein said arrowhead is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.

Clause 40. The fire suppression sprinkler according to clause 38, wherein a widest width of said arrowhead is wider than a widest width of said shaft.

Clause 41. The fire suppression sprinkler according to clause 38, wherein a width of said arrowhead proximate to said shaft is greater than a width of said arrowhead proximate to said center.

Clause 42. The fire suppression sprinkler according to clause 38, wherein said arrowhead has a curved tip at said distance from said center.

Clause 43. The fire suppression sprinkler according to clause 38, wherein said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead.

Clause 44. The fire suppression sprinkler according to clause 38, wherein said shaft is defined by first and second oppositely disposed edges, each said edge being angularly oriented with respect to a line extending radially from said center such that said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead.

Clause 45. The fire suppression sprinkler of Clause 24, wherein said deflector plate further comprises a plurality of slots of a fourth configuration.

Clause 46. The fire suppression sprinkler of Clause 45, wherein said deflector plate further comprises a plurality of slots of a fifth configuration.

Clause 47. An early suppression fast response fire suppression sprinkler, said sprinkler comprising:

a body adapted for use in a pendent orientation, said body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore, said bore defining a k factor of $k=25.2$ or greater;

first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

a plug removably mounted on said body between said frame arms and overlying said bore;

a nose mounted on ends of said frame arms at a distance from said plug less than 1.0 inches, said nose being positioned coaxially with said flow axis;

a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

a plurality of first slots extending from said periphery radially toward said center and terminating at a first distance from said flow axis, at least two of said first slots being disposed in said plane;

a plurality of second slots extending from said periphery radially toward said center and terminating at a second distance from said flow axis, said second slots being located about said periphery such that one of said second slots is positioned adjacent to each side of each of said first slots which are disposed in said plane; wherein

said second distance is less than said first distance.

Clause 48. The fire suppression sprinkler of Clause 47, where said nose has a maximum radius measured from said flow axis, said first and second distances being greater than said maximum radius.

Clause 49. A fire suppression sprinkler, said sprinkler comprising:

a body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore;

first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis;

a nose mounted on ends of said frame arms, said nose being positioned coaxially with said flow axis;

a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis and comprising:

a first slot extending from said periphery radially toward said center, said first slot having an arrow shape comprising a first shaft extending from said periphery and a first arrowhead terminating at a first distance from said center, said first slot being aligned with said first arm, a widest width of said first slot being equal to or greater than a thickness of said first arm.

Clause 50. The sprinkler according to clause 49, wherein said shaft is defined by first and second oppositely disposed edges, each said edge being angularly oriented with respect to a first line extending radially from said center such that said first shaft has a width at said periphery which is greater than a width of said first shaft proximate to said first arrowhead.

Clause 51. The sprinkler according to clause 49, wherein a widest width of said first arrowhead is wider than a widest width of said first shaft.

Clause 52. The sprinkler according to clause 49, wherein a width of said first arrowhead proximate to said first shaft is greater than a width of said first arrowhead proximate to said center.

Clause 53. The sprinkler according to clause 49, wherein said first arrowhead has a curved tip at said first distance from said center.

Clause 54. The sprinkler according to clause 49, wherein said first slot is symmetric about a first line extending radially from said center.

Clause 55. The sprinkler according to clause 49, further comprising a second slot extending from said periphery radially toward said center, said second slot having a club shape comprising a handle extending from said periphery and a club head terminating at a second distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

Clause 56. The sprinkler according to clause 55, wherein a widest width of said club head is wider than a widest width of said handle.

Clause 57. The sprinkler according to clause 55, wherein said club head has a curved tip at said second distance from said center.

Clause 58. The sprinkler according to clause 55, wherein said club head is asymmetric with respect to a second line extending radially from said center.

Clause 59. The sprinkler according to clause 58, wherein said club head is defined by a first edge oriented at a first angle with respect to said second line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said second line, said second angle being different from said first angle.

Clause 60. The sprinkler according to clause 49, further comprising a third slot extending from said periphery radially toward said center, said third slot having a second arrow shape

comprising a second shaft extending from said periphery and a second arrowhead terminating at a third distance from said center, wherein said third arrowhead is asymmetric with respect to a third line extending radially from said center.

Clause 61. The sprinkler according to clause 60, wherein said second arrowhead is defined by a first edge oriented at a first angle with respect to said third line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said third line, said second angle being different from said first angle.

Clause 62. The sprinkler according to clause 60, wherein a widest width of said second arrowhead is wider than a widest width of said second shaft.

Clause 63. The sprinkler according to clause 60, wherein a width of said second arrowhead proximate to said second shaft is greater than a width of said second arrowhead proximate to said center.

Clause 64. The sprinkler according to clause 60, wherein said second arrowhead has a curved tip at said third distance from said center.

Clause 65. The sprinkler according to clause 60, wherein said second shaft has a width at said periphery which is greater than a width of said second shaft proximate to said second arrowhead.

Clause 66. The sprinkler according to clause 60, wherein said second shaft is defined by first and second oppositely disposed edges, each said edge being angularly oriented with respect to said third line such that said second shaft has a width at said periphery which is greater than a width of said second shaft proximate to said second arrowhead.

Clause 67. The sprinkler according to clause 49, further comprising a fourth slot extending from said periphery radially toward said center, said fourth slot having a keyhole shape comprising a waist extending from said periphery and a key head terminating at a fourth distance from said center.

Clause 68. The sprinkler according to clause 67, wherein a widest width of said key head is wider than a widest width of said waist.

Clause 69. The sprinkler according to clause 67, wherein a width of said key head proximate to said waist is equal to a width of said key head proximate to said center.

Clause 70. The sprinkler according to clause 67, wherein said key head has a curved tip at said fourth distance from said center.

Clause 71. The sprinkler according to clause 67, wherein said key head is symmetric with respect to a fourth line extending radially from said center.

Clause 72. The sprinkler according to clause 50, further comprising a fifth slot extending from said periphery radially toward said center, said fifth slot having a third arrow shape comprising a third shaft extending from said periphery and a third arrowhead terminating at a fifth distance from said center, wherein said third shaft is defined by third and fourth oppositely disposed edges, each of said third and fourth edges being angularly oriented with respect to a fifth line extending radially from said center such that said third shaft has a width at said periphery which is greater than a width of said third shaft proximate to said arrowhead.

Clause 73. The sprinkler according to clause 72, wherein said third shaft has a width at said periphery wider than a width of said first shaft at said periphery.

Clause 74. The sprinkler according to clause 72, wherein a widest width of said third arrowhead is wider than a widest width of said third shaft.

Clause 75. The sprinkler according to clause 72, wherein a width of said third arrowhead proximate to said third shaft is greater than a width of said third arrowhead proximate to said center.

Clause 76. The sprinkler according to clause 72, wherein said third arrowhead has a curved tip at said fifth distance from said center.

Clause 77. The sprinkler according to clause 72, wherein said third arrowhead is symmetric with respect to a fifth line extending radially from said center.

Clause 78. A fire suppression sprinkler, said sprinkler comprising:
a body surrounding a bore, said bore defining a flow axis arranged coaxially with said

bore;

first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis;

a nose mounted on ends of said frame arms, said nose being positioned coaxially with said flow axis;

a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis and comprising:

a first slot extending from said periphery radially toward said center, said first slot having an arrow shape comprising a first shaft extending from said periphery and a first arrowhead terminating at a first distance from said center, said first shaft being defined by first and second oppositely disposed edges, each of said first and second edges being angularly oriented with respect to a first line extending radially from said center such that said first shaft has a width at said periphery which is greater than a width of said first shaft proximate to said first arrowhead;

a second slot extending from said periphery radially toward said center, said second slot having an arrow shape comprising a second shaft extending from said periphery and a second arrowhead terminating at a second distance from said center, said second shaft being defined by first and second oppositely disposed edges, each said edge defining said second shaft being angularly oriented with respect to a second line extending radially from said center such that said second shaft has a width at said periphery which is greater than a width of said second shaft proximate to said second arrowhead, said second line being oriented at an angle with respect to said first line;

a third slot extending from said periphery radially toward said center, said third slot having a club shape comprising a handle extending from said periphery and a club head terminating at a third distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center, said third slot being positioned between said first and second slots;

a fourth slot extending from said periphery radially toward said center, said fourth slot having an arrow shape comprising a third shaft extending from said periphery and a third arrowhead terminating at a fourth distance from said center, said fourth slot being positioned between said second and third slots;

a fifth slot extending from said periphery radially toward said center, said fifth slot having a keyhole shape comprising a waist extending from said periphery and a key head

terminating at a fifth distance from said center, said fifth slot being positioned between said second and fourth slots.

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CLAIMS:

1. A fire suppression sprinkler, said sprinkler comprising:
 - a body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore;
 - first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;
 - a nose mounted on the ends of said frame arms, said nose being positioned coaxially with said flow axis;
 - a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:
 - a plurality of slots of a first configuration extending from said periphery radially toward said center and terminating at a first distance from said center, at least two of said slots of said first configuration being disposed in said plane;
 - at least four slots of a second configuration extending from said periphery radially toward said center and terminating at a second distance from said center, said slots of said second configuration being located about said periphery such that one of said slots of said second configuration is positioned adjacent to each side of each of said slots of said first configuration which are disposed in said plane;
 - a plurality of slots of a third configuration extending from said periphery radially toward said center and terminating at a third distance from said center; wherein
 - said second distance is less than any of said first or third distances; and wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.
2. The fire suppression sprinkler according to Claim 1, wherein said nose has a maximum radius measured from said flow axis, said first, second, and third distances being greater than said maximum radius.

3. The fire suppression sprinkler according to claim 1, wherein said bore defines a k factor of $k=14.0$ or greater and wherein said fire suppression sprinkler is adapted to be installed in a pendent orientation.
4. The fire suppression sprinkler according to claim 1, wherein a widest width of said club head is wider than a widest width of said handle.
5. The fire suppression sprinkler according to claim 4, wherein said club head has a curved tip at said distance from said center.
6. The fire suppression sprinkler according to claim 1, wherein said club head is asymmetric with respect to a line extending radially from said center.
7. The fire suppression sprinkler according to claim 6, wherein said club head is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.
8. The fire suppression sprinkler according to claim 1, wherein each of said slots of said second configuration are symmetric with respect to a line extending radially from said center.
9. The fire suppression sprinkler according to Claim 1, wherein said slots of said third configuration have a keyhole shape comprising a waist extending from said periphery and a key head terminating at a distance from said center.
10. The fire suppression sprinkler according to claim 9, wherein a widest width of said key head is wider than a widest width of said waist.
11. The fire suppression sprinkler according to claim 9, wherein a width of said key head proximate to said waist is equal to a width of said key head proximate to said center.
12. The fire suppression sprinkler according to claim 9, wherein said key head has a curved tip at said distance from said center.

13. The fire suppression sprinkler according to claim 9, wherein said key head is symmetric with respect to a line extending radially from said center.
14. The fire suppression sprinkler according to Claim 1, wherein said slots of said first configuration have an arrowhead shape comprising a shaft extending from said periphery and an arrowhead terminating at a first distance from said center.
15. The fire suppression sprinkler according to claim 14, wherein said arrowhead is asymmetric with respect to a line extending radially from said center.
16. The fire suppression sprinkler according to claim 14, wherein said arrowhead is defined by a first edge oriented at a first angle with respect to said line, and a second edge, opposite to said first edge, said second edge oriented at a second angle with respect to said line, said second angle being different from said first angle.
17. The fire suppression sprinkler according to claim 14, wherein a widest width of said arrowhead is wider than a widest width of said shaft.
18. The fire suppression sprinkler according to claim 14, wherein a width of said arrowhead proximate to said shaft is greater than a width of said arrowhead proximate to said center.
19. The fire suppression sprinkler according to claim 14, wherein said arrowhead has a curved tip at said distance from said center.
20. The fire suppression sprinkler according to claim 14, wherein said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead.
21. The fire suppression sprinkler according to claim 14, wherein said shaft is defined by first and second oppositely disposed edges, each said edge being angularly oriented with respect to a line extending radially from said center such that said shaft has a width at said periphery which is greater than a width of said shaft proximate to said arrowhead.
22. An early suppression fast response fire suppression sprinkler, said sprinkler comprising:
a body adapted for use in a pendent orientation, said body surrounding a bore, said bore defining a flow axis arranged coaxially with said bore, said bore defining a k factor of $k=25.2$ or

greater;

first and second frame arms mounted on opposite sides of said body and extending therefrom in a direction along said flow axis, said frame arms defining a plane;

a plug removably mounted on said body between said frame arms and overlying said bore;

a nose mounted on ends of said frame arms at a distance from said plug less than 1.0 inches, said nose being positioned coaxially with said flow axis;

a deflector plate mounted on said nose and oriented transversely to said flow axis, said deflector plate having a periphery surrounding a center located on said flow axis, said deflector plate comprising:

a plurality of first slots extending from said periphery radially toward said center and terminating at a first distance from said flow axis, at least two of said first slots being disposed in said plane;

a plurality of second slots extending from said periphery radially toward said center and terminating at a second distance from said flow axis, said second slots being located about said periphery such that one of said second slots is positioned adjacent to each side of each of said first slots which are disposed in said plane; wherein

said second distance is less than said first distance; and wherein said slots of said second configuration have a club shape comprising a handle extending from said periphery and a club head terminating at a distance from said center, wherein a width of said club head proximate to said handle is less than a width of said club head proximate to said center.

23. The fire suppression sprinkler according to Claim 22, where said nose has a maximum radius measured from said flow axis, said first and second distances being greater than said maximum radius.

Victaulic Company

Patent Attorneys for the Applicant/Nominated Person

SPRUSON & FERGUSON

FIG.1

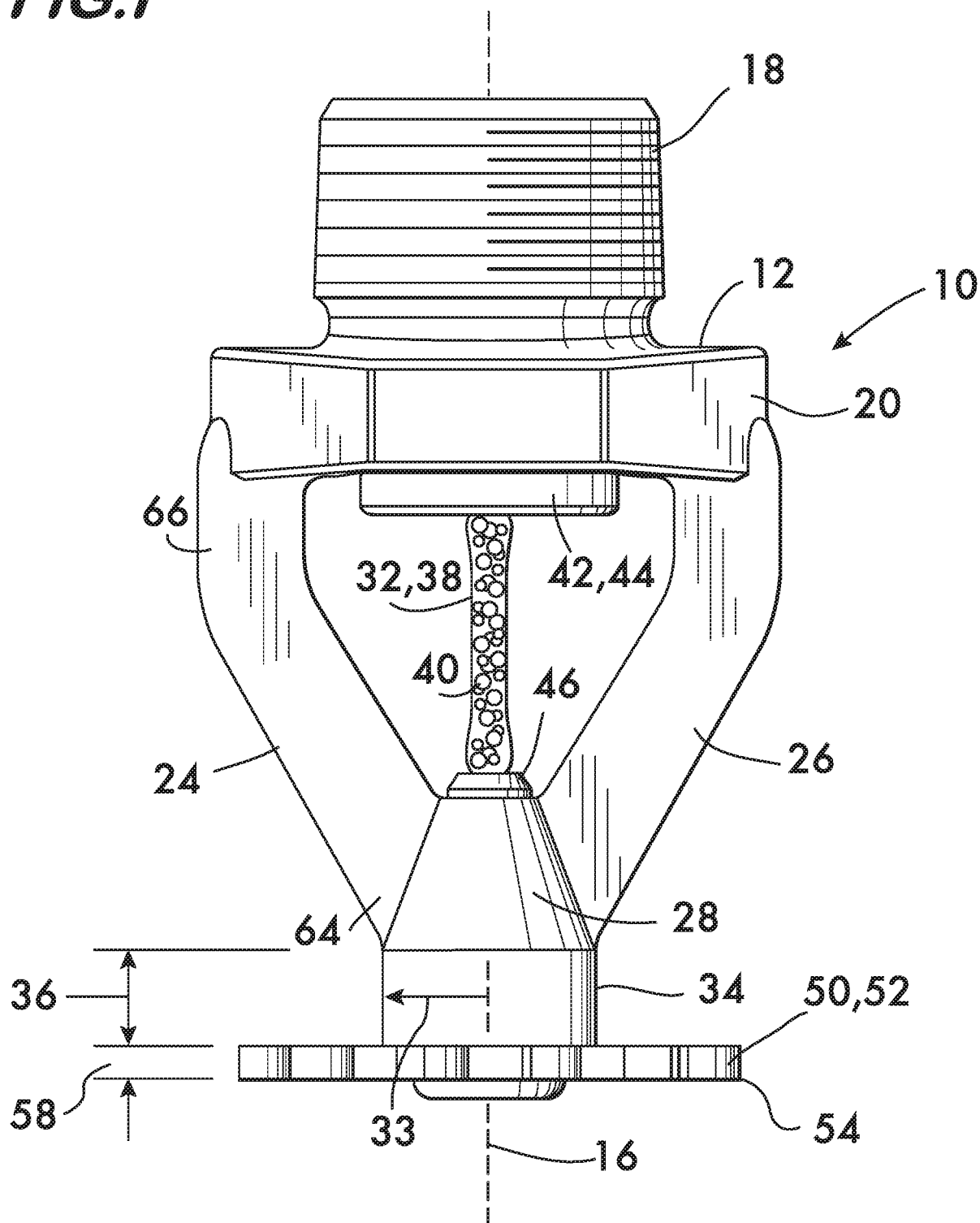


FIG. 1A

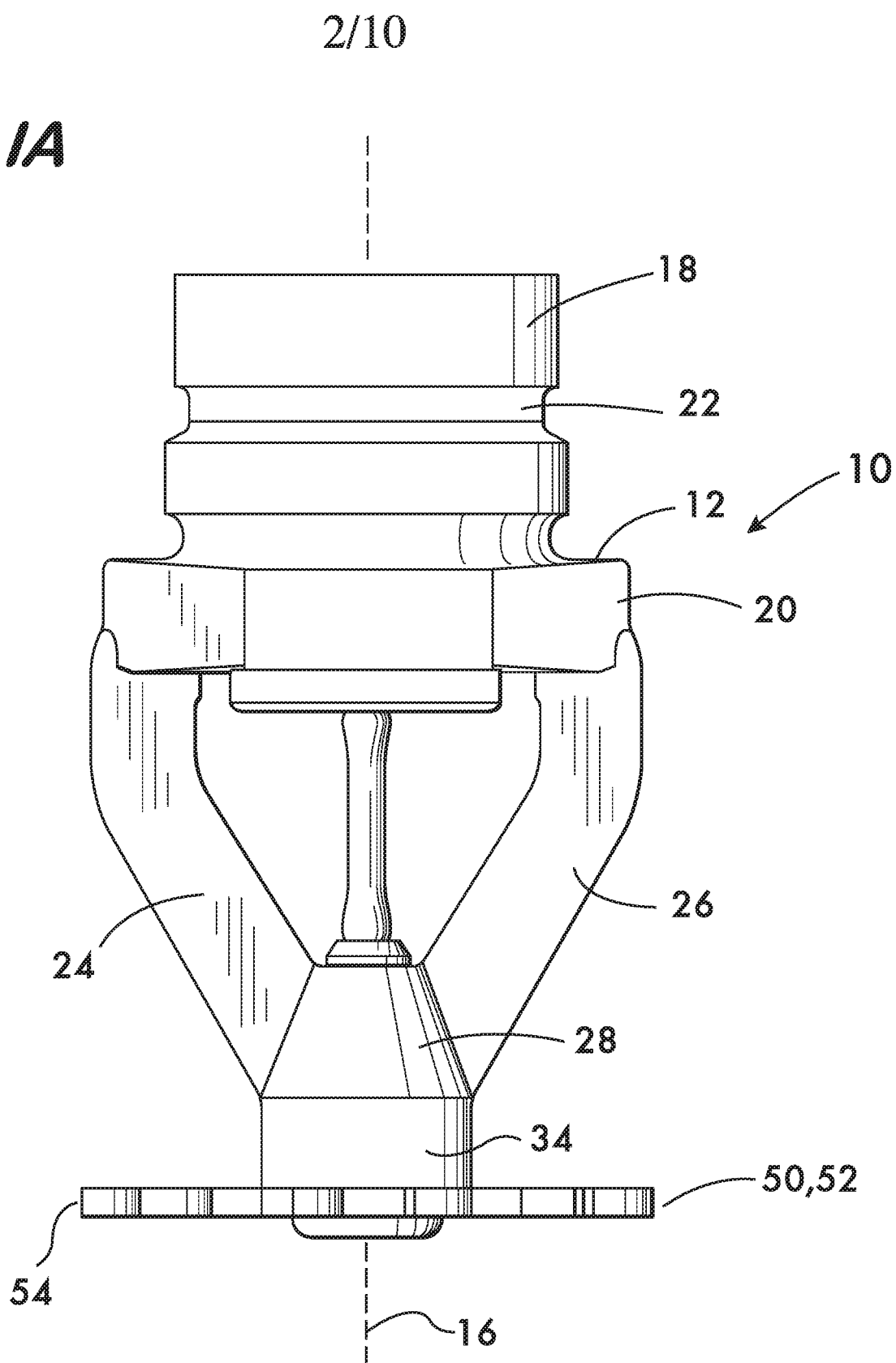


FIG.1B

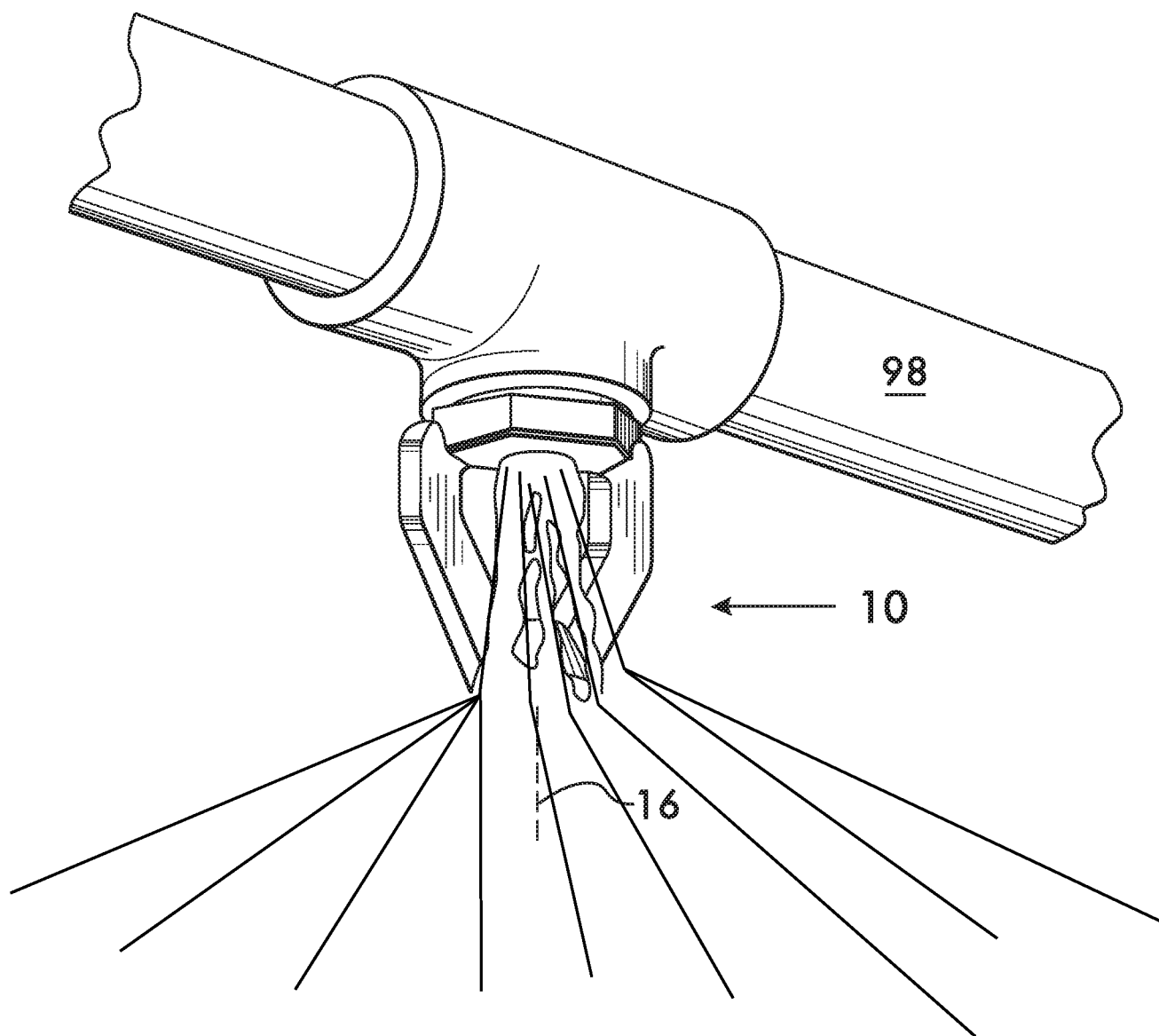


FIG. 2

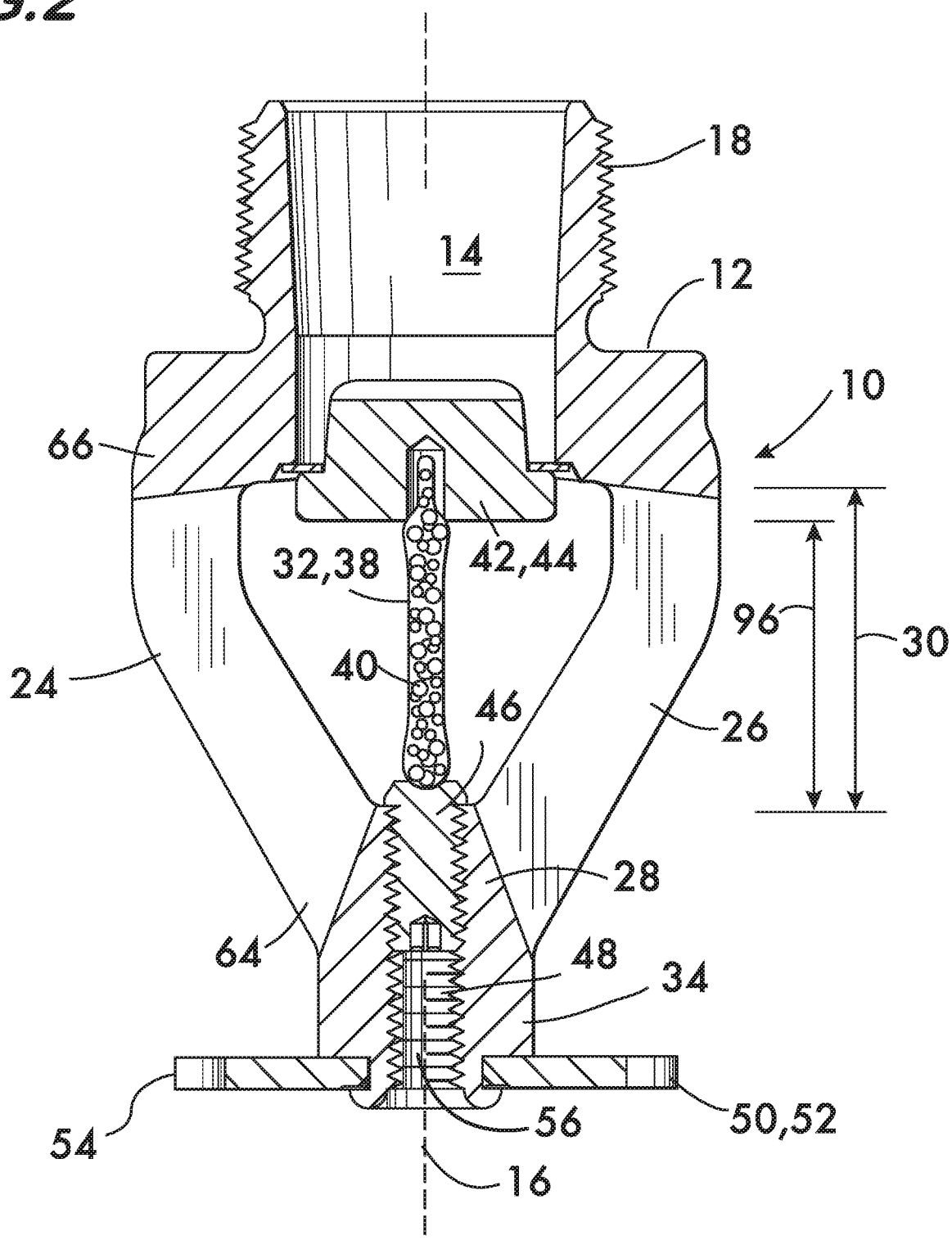


FIG. 3

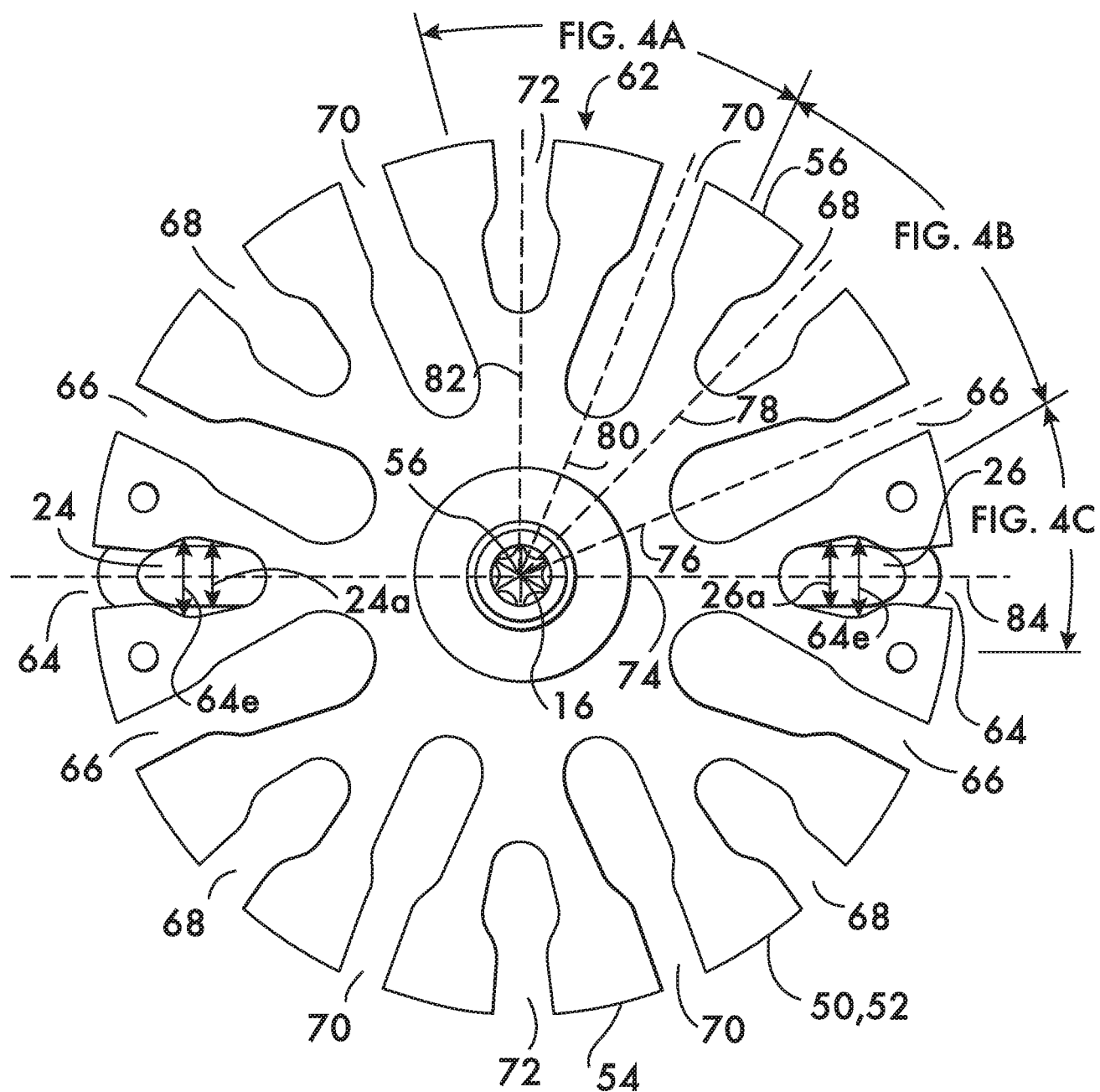


FIG. 3A

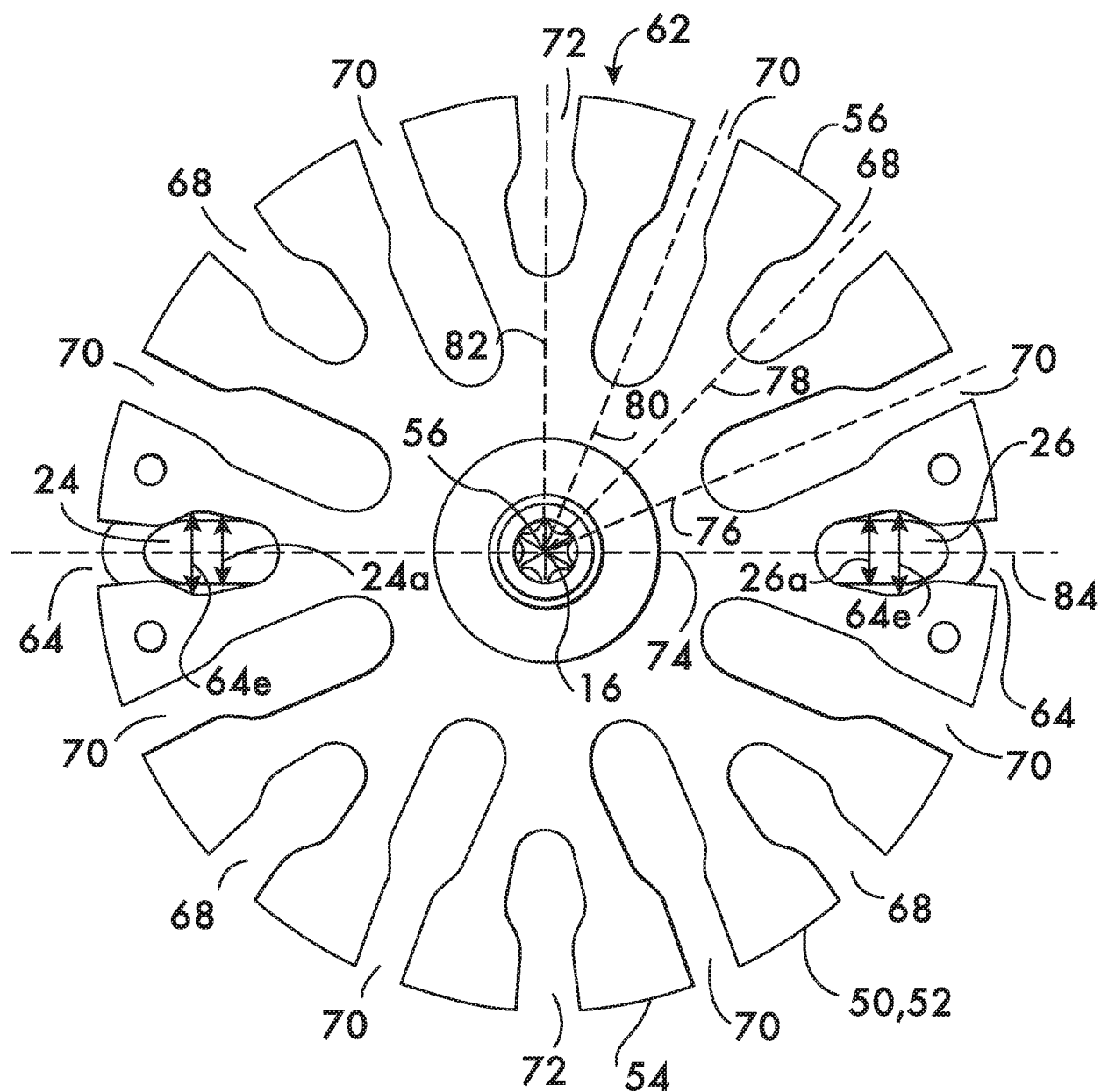


FIG. 4

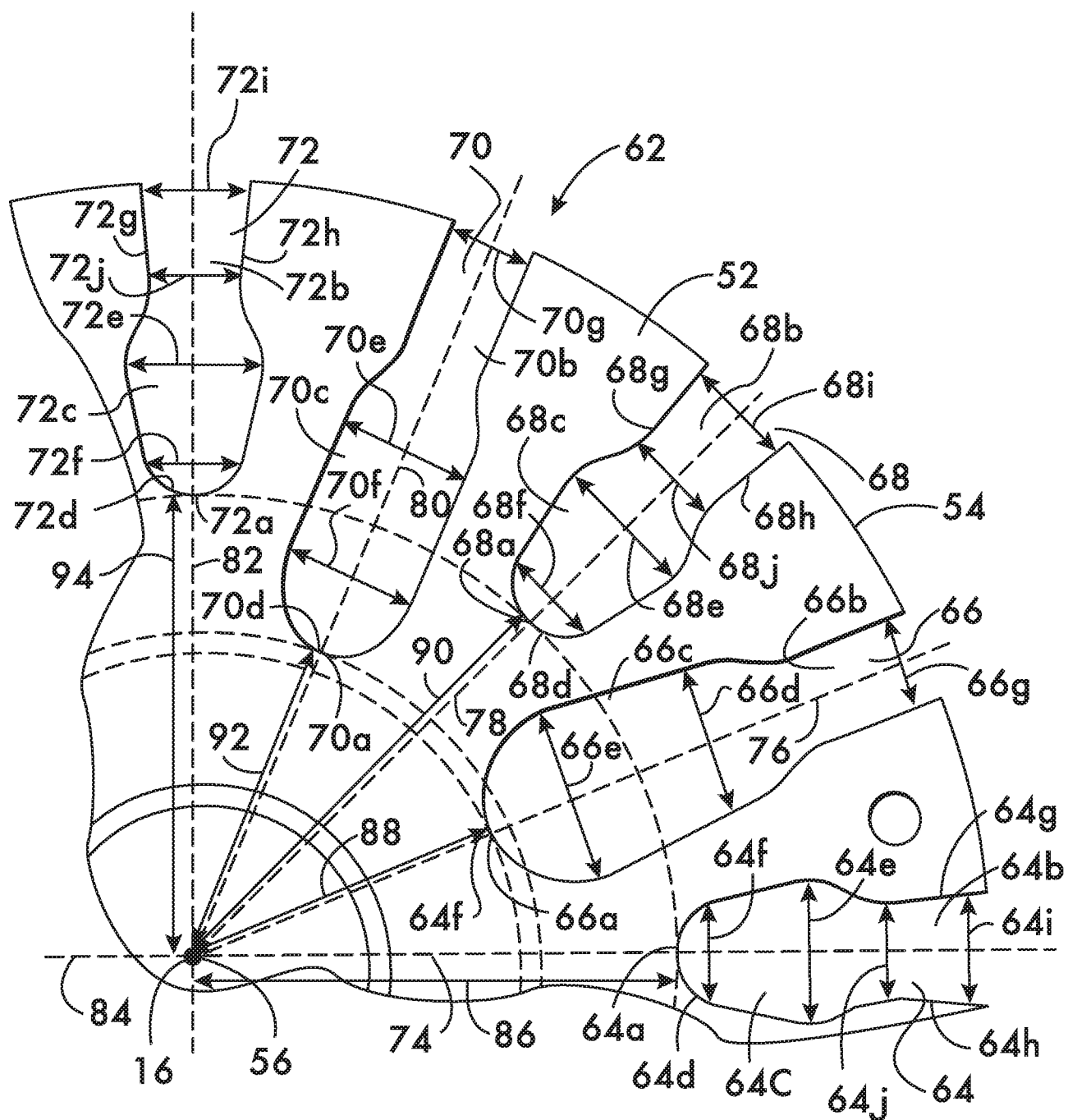


FIG. 4A

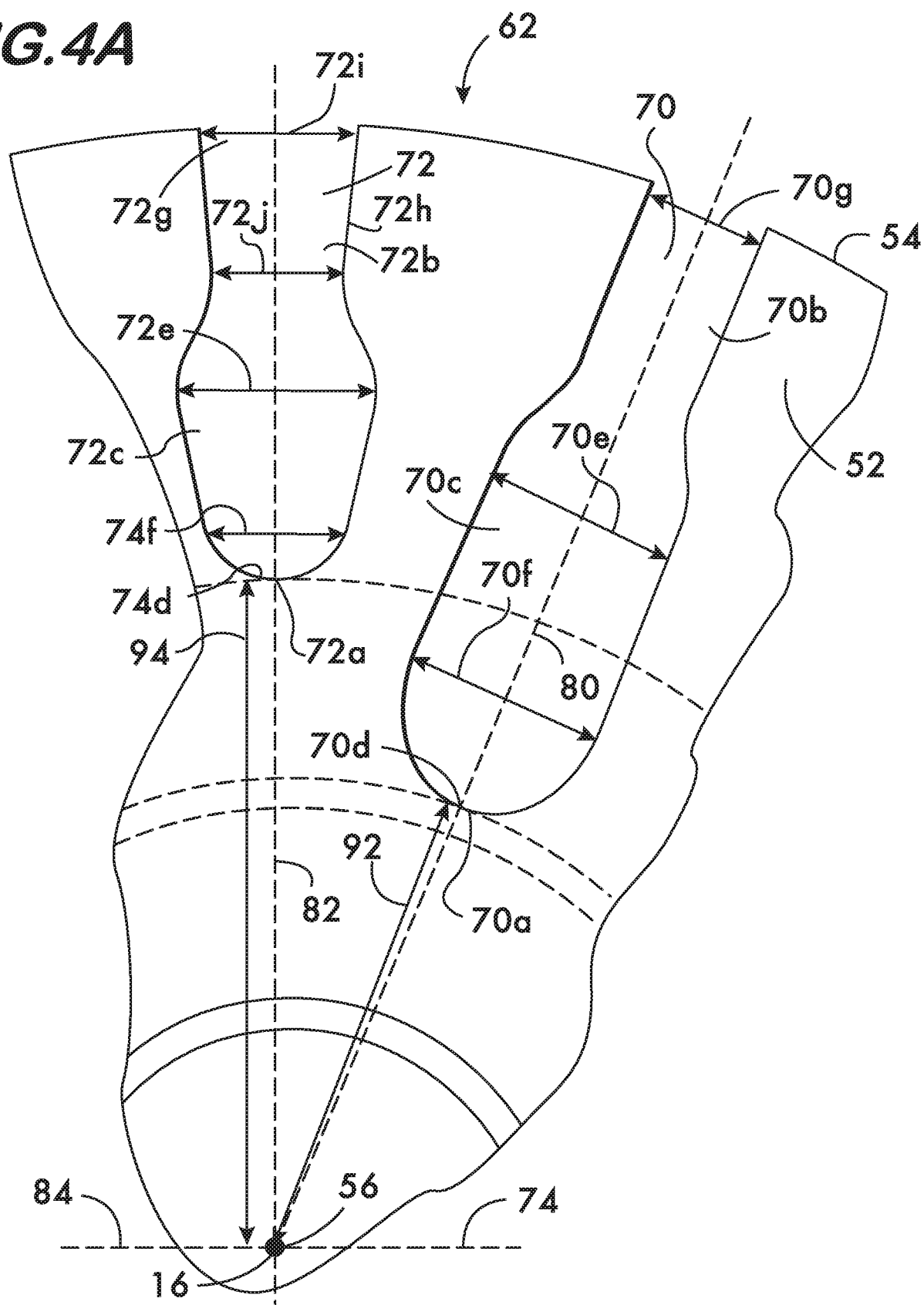


FIG. 4B

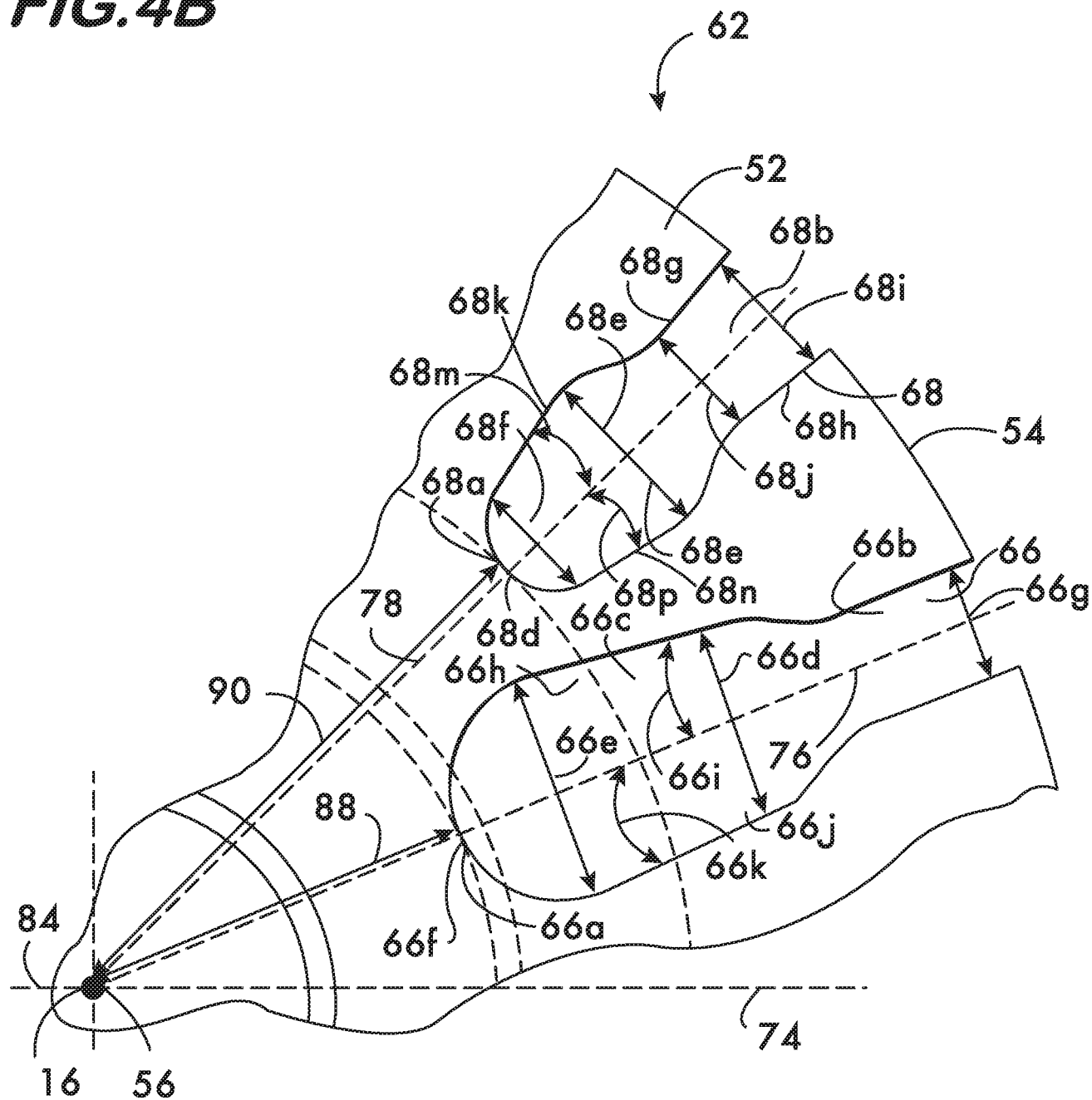


FIG. 4C

