July 10, 1962 J. E. LINDBERG, JR 3,043,545

FIRE DETECTOR INSTALLATION AND SUPPORT BRACKET THEREFOR

Filed Aug. 10, 1959 4 Sheets-Sheet 1

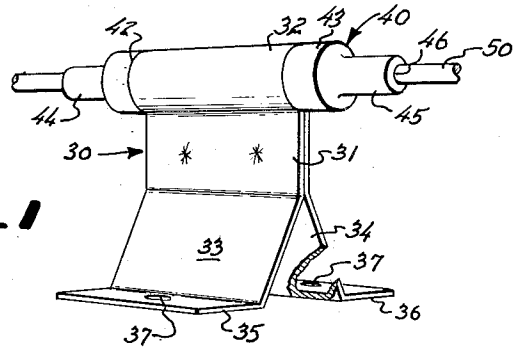


FIG. 1

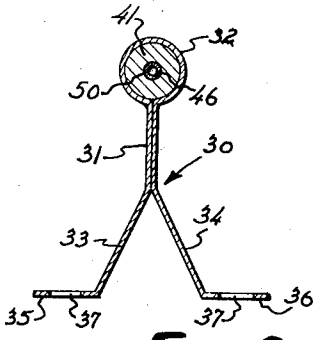


FIG. 3

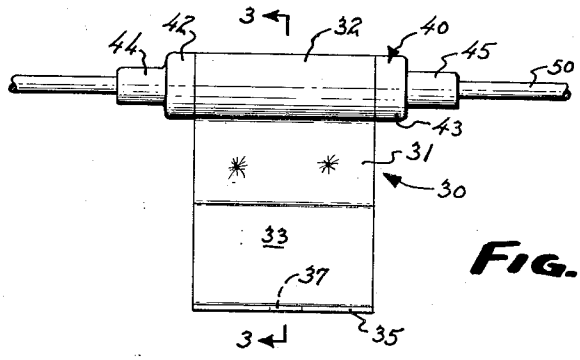


FIG. 2

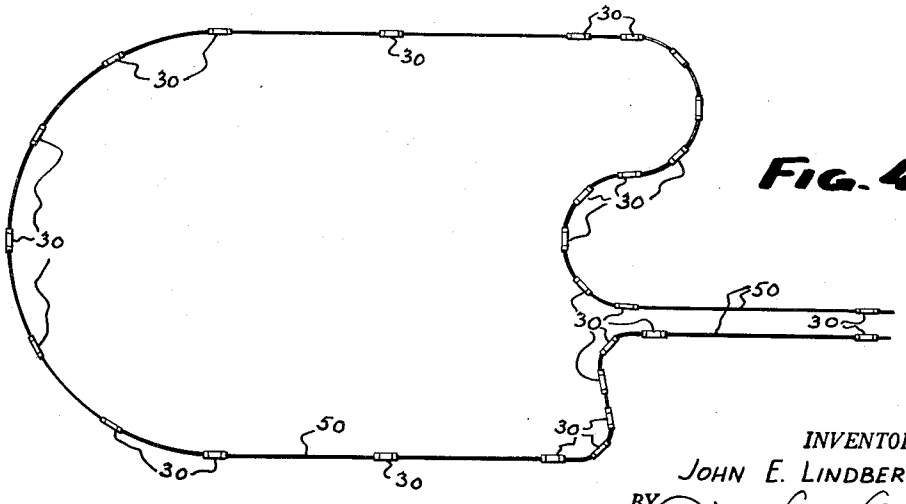


FIG. 4

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FIRE DETECTOR INSTALLATION AND SUPPORT BRACKET THEREFOR

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FIG. 6

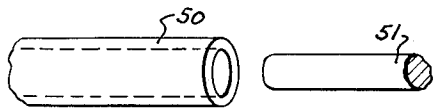


FIG. 5

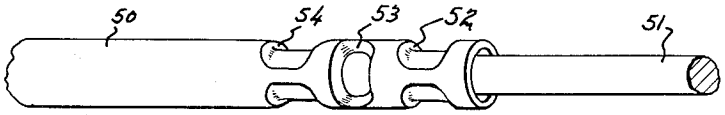


FIG. 7

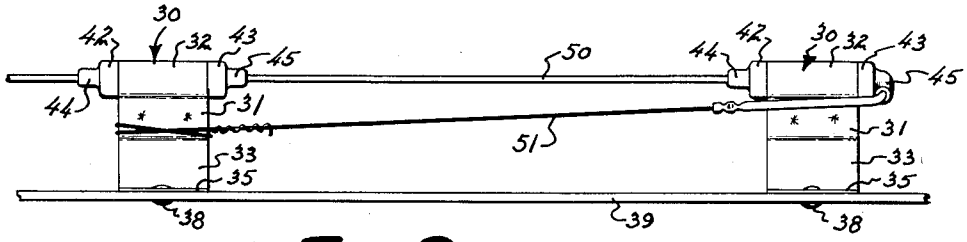


FIG. 8

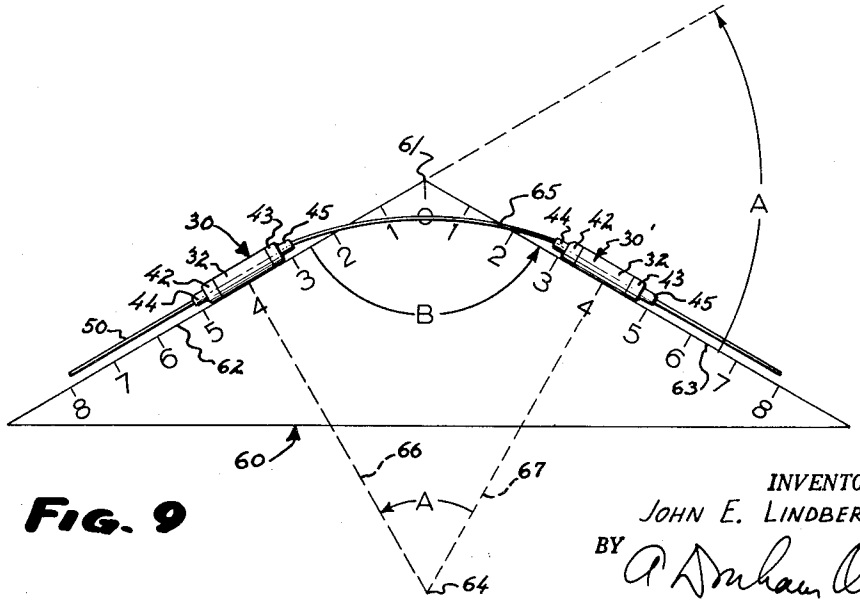


FIG. 9

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FIRE DETECTOR INSTALLATION AND SUPPORT BRACKET THEREFOR

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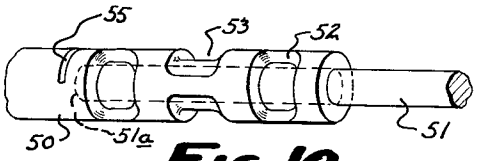


FIG. 10

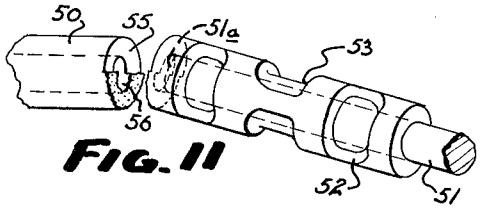


FIG. 11

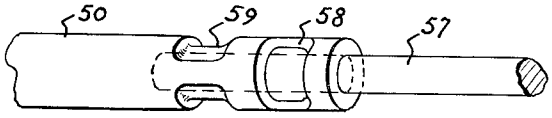


FIG. 12

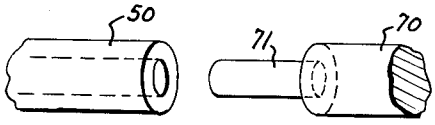


FIG. 13

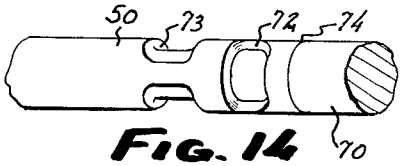


FIG. 14

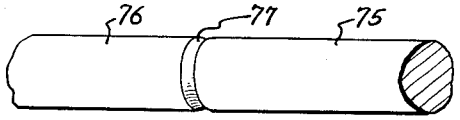


FIG. 15

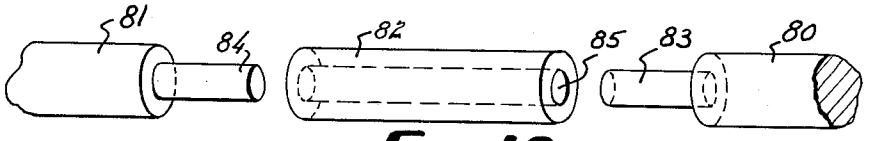


FIG. 16

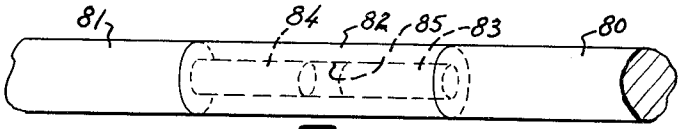


FIG. 17

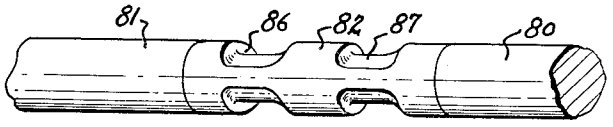


FIG. 18

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FIRE DETECTOR INSTALLATION AND SUPPORT BRACKET THEREFOR

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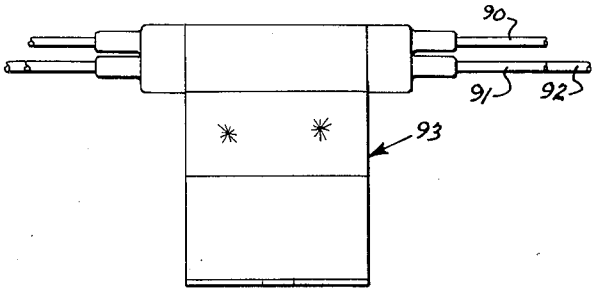


FIG. 19

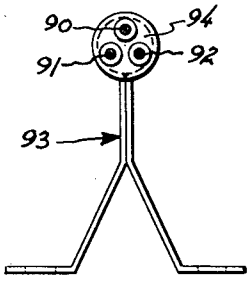


FIG. 20

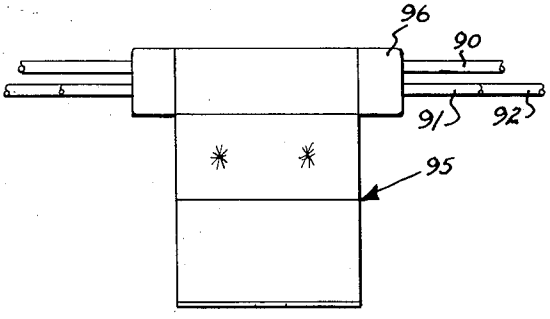


FIG. 21

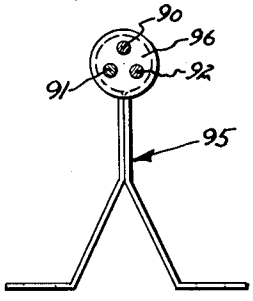


FIG. 22

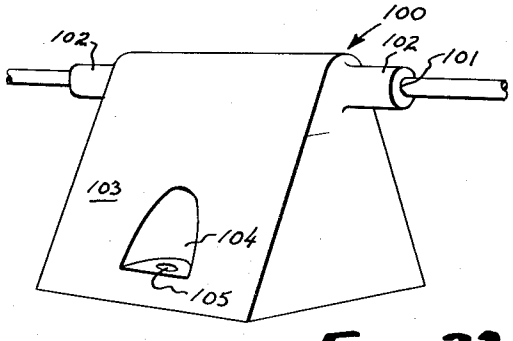


FIG. 23

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United States Patent Office

3,043,545

Patented July 10, 1962

3,043,545

FIRE DETECTOR INSTALLATION AND SUPPORT BRACKET THEREFOR

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Filed Aug. 10, 1959, Ser. No. 832,771

13 Claims. (Cl. 248—49)

This invention relates to an improved fire-detector installation and to an improved bracket for use therein and generally for supporting filamentary devices, especially long, flexible wires and tubes, such as continuous-type sensing elements for fire-detectors of the type used on aircraft.

Conventional supporting brackets for wires and tubes have proven unsatisfactory for use with continuous-type aircraft fire detectors. Such detectors include long, slender, somewhat flexible tubular or wire-type sensing elements which are supported in a zone under surveillance and actuate an alarm when the temperature of any portion of any sensing element exceeds a certain critical level defined by the requirements of the installation. To enable rapid detection of the fire, substantially the entire length of the sensing element must be exposed instead of being encased or shielded by support devices; so the support devices must be short and spaced well apart from each other. The sensing element must be removable for testing and for replacement; so the support devices must enable such removal, and the easier the removal and replacement are, the better. In addition, the support devices must be light in weight and easy to install.

Heretofore, installations have used clamps with snaps or spring clips that held the sensing element in place. With such clamps, each support point had to be accessible so that it could be unclamped when the sensing element was removed and replaced. Since each support point had to be reached when the elements were being changed, cowling and other parts of the aircraft had to be removed to give access. When such brackets were used, the use of long, one-piece sensing elements was unduly expensive and cumbersome, and it became the usual practice to join a series of comparatively short-length sensing elements end to end, using suitable couplers. Some types of sensing elements do not lend themselves to such coupling; so the shortcomings in the support brackets prevented the use of such types of fire-detection equipment. One object of the present invention is to make practical the use of continuous, long, sensing elements.

Rendering long sensing elements practical is important, for the detectors made by joining short-length sensors together have proven unsatisfactory. For example, difficulties occurred in continuous-type fire detectors utilizing a change in the electrical characteristics of the sensing element that resulted from exposure to flame temperatures. With such detectors, the couplers for the short lengths had to include electrical contacts. The sensing elements were usually of high impedance, and even a small amount of moisture between the contacts caused failure of the system, especially when the moisture contained dissolved salts, as was often the case with transoceanic and marine aircraft. Attempts to seal the connectors hermetically against moisture invasion were neither satisfactory nor consistent with easy removal of the sensing-element sections. Insulating fluids such as silicone jelly have been inserted into the fittings to try to prevent moisture from entering and causing trouble, but this approach has also proved unsatisfactory.

Another difficulty with sensing systems employing couplers was that, in most cases, the weight of the couplers had to be supported entirely by the sensing element, for if the brackets supported the couplers, they could not be disconnected easily. The weight of the coupler produced

an additional stress concentration on the sensing element at the point where it entered the coupler, and this stress concentration was further increased when vibration caused motion of the coupler and subsequent flexing of the sensing element. A frequent result was failure of the system.

The present invention avoids all the shortcomings of these older practices. Indefinitely long sensing elements may be used; so no fittings or connectors are required. After the initial installation of the support brackets, access is required only at the two ends of the long element, which can be close together if the overall route of the element is a loop. The support brackets of this invention are preferably permanently attached to the structure, for no access to them is required in order to free the sensing element. The installation and changing of elements is therefore fast, easy, and economical.

Other objects and advantages of the invention will appear from the following description of some preferred embodiments thereof.

In the drawings:

FIG. 1 is a view in perspective of a support bracket embodying the principles of the invention, shown supporting a filamentary device, whose ends have been broken off to conserve space. A portion of the bracket is broken away and shown in section.

FIG. 2 is a view in side elevation of the device of FIG. 1.

FIG. 3 is a view in end elevation and in section, taken along the line 3—3 in FIG. 2.

FIG. 4 is a top plan diagrammatic view of an installation of a continuous filamentary device using a series of the supporting brackets of the type shown in FIGS. 1–3.

FIGS. 5–7 are fragmentary views in perspective, showing the attachment of a tube to a draw-wire as used in the method of this invention. FIG. 5 shows the ends of the tube and draw-wire before insertion; FIG. 6, the insertion; and FIG. 7, the crimped securement.

FIG. 8 is a view in side elevation showing the end securement of the draw-wire.

FIG. 9 is a top plan view of two brackets with the filamentary device curved between them and a triangle used in making such an installation.

FIGS. 10–12 are views in perspective showing the detachment of an old draw-wire and the attachment of a new one used during replacement of a sensing element. FIG. 10 shows a scored sensing element, FIG. 11 a broken-off connection, and FIG. 12 the attachment of the new draw-wire.

FIGS. 13 and 14 are fragmentary views in perspective, showing a modified form of attachment of a draw-wire the same size as the tube, but with an end of reduced diameter, FIG. 13 showing the members apart and FIG. 14 showing them joined together.

FIG. 15 is a fragmentary view in perspective of a brazed juncture of a filamentary device to a draw-wire of the same diameter.

FIGS. 16–18 are fragmentary views in perspective of a sleeve-type connection between a filamentary device and a draw-wire, FIG. 16 showing the three elements before insertion, FIG. 17 showing them after insertion, and FIG. 18 showing them crimped together.

FIG. 19 is a view in side elevation of a modified form of bracket for supporting three filamentary elements, the ends of the elements being broken off to conserve space.

FIG. 20 is a view in end elevation of the bracket of FIG. 19.

FIG. 21 is a view in side elevation of a modified form of bracket generally like that of FIG. 20.

FIG. 22 is a view in end elevation of the bracket of FIG. 21.

FIG. 23 is a view in perspective of another modified form of bracket assembly.

The bracket 30 of FIG. 1 may be made from sheet stock of any metal suitable to the application, spot-welded at a web 31 and shaped to provide a cylindrical sleeve 32. The bracket 30 is spread apart below the web 31 at angularly extending portions 33 and 34 and bent at the ends to form bases 35 and 36. The bases 35 and 36 are preferably punched with holes 37 to receive screws, rivets, or other fastening members 38 (FIG. 8) by which the bases 35 and 36 are secured to a supporting structure 39, such as an engine housing. Alternatively, the bases 35 and 36 may be welded in place.

The bracket 30 also includes a suitable plastic bushing 40, which is put in place in the sleeve 32 before the web 31 is welded together. Preferably, the bushing 40 is made from polytetrafluoroethylene (e.g., Teflon), which has an extremely low coefficient of sliding friction against smooth metal surfaces. The tubular body 41 of the bushing 40 is of substantially the same diameter as the inside of the sleeve 32 and fits snugly within it. Enlarged portions 42 and 43 at the ends of the body 41 engage the sleeve 32 and prevent the bushing 40 from slipping out or being pulled out of the sleeve 32. There are also extensions or nipples 44, 45 at each end. A longitudinal hole 46 in the bushing 40 slidably receives the sensing element 50, or other filamentary device.

The nipples 44 and 45 provide a controlled degree of stiffness to damp out vibratory motion of the sensing element 50 and thus reduce the concentration in the sensing element 50 of high, localized stresses due to vibratory motion. If the structure 39, to which the support brackets 30 are affixed, executes vibratory motion, this motion is transferred to the device 50 mounted on the brackets 30. Due to the mass of the device 50, however, its motion will not be exactly the same as that of the brackets 30 and therefore the device 50 will be subject to flexing, concentrated largely at the points where the device 50 enters the bushing 40. If the bushings 40 are rigid at these points, then all of the flexure of the device 50 will be concentrated in a very limited region of the device and may significantly shorten the lifetime of the device. The extensions 44 and 45 provide flexible support for the device 50 at this point, so that any vibratory motion is spread out over the relatively long segments of the device, in the extensions thus reducing the stress concentration. In addition, the flexible plastic material imparts to the extensions 44, 45 some degree of damping to the vibratory motion of the device 50 with respect to the brackets 30, further reducing the stress concentration at the points where the device enters the bushings.

The extensions 44 and 45 also are stiff enough to prevent the device 50 from being bent in a sharp corner at the point where it enters the bushing (see FIG. 8). Instead, the extensions 44, 45 provide a definite radius of curvature through which the device 50 is bent. This feature is especially valuable for installations which require the device to be run over a complicated, crooked route.

The bracket assemblies are preferably installed permanently in the aircraft, being spaced at suitable intervals, which depend upon the radius of the arc through which the sensing element 50 is bent. The spacing of the bracket assemblies must, in general, be decreased as the bend radius decreases. FIG. 4 shows several bracket assemblies 30 mounted in a hypothetical pattern, the length of the brackets 30 being exaggerated somewhat.

After the bracket assemblies 30 have been installed, a smooth, strong, flexible draw-wire 51 is threaded through the bushings 40, following the planned path of the sensing element 50. This draw-wire 51 is fastened to the end of the sensing element 50 by some convenient means. FIGS. 5–7 show one such means, wherein the draw-wire 51 is first inserted a suitable distance, e.g., one-half inch, into a tubular sensing element 50, and then the tube is crimped onto the draw-wire 51 by a suitable crimping tool, producing the crimps 52, 53, and 54. In any event, the draw-wire 51 is joined to the sensing element 50 in such a manner that the juncture will pass smoothly and easily through the bushings 40. Thus, the juncture should not result in an enlarged knob.

The sensing element 50 is then pulled by the draw-wire 51 through the bushings 40. When the element 50 is in the proper position, as shown in FIG. 8, the draw-wire 51 may be tied to some steady point nearby, for example the next-to-the-last mounting bracket 30, and the excess length of draw-wire is clipped off. The tie provides a slight constant tension on the sensing element 50 which keeps it in place without slipping. The installation of the sensing element is completed with this step. Connection between the element 50 and the other elements of the fire detector or other device with which it is used are standard and need not be shown here.

Occasionally, for example, when using a very long sensing element or when running the element over a very complicated path, it may be found that a small amount of lubrication assists the installation of the element 50. In this event, any common type of fluid lubricant, such as engine oil, may be used. The lubricant may be satisfactorily applied by means of a rag soaked in the lubricant, the rag being used to wipe the sensing element as it is being drawn into place in the bracket assemblies.

There is a maximum angle A through which the sensing element 50 may be bent between two support bracket assemblies 30 and still slip easily and properly through the bushings 40. This angle A depends upon the strength and stiffness of the particular element 50. For any particular material, this invention provides an installation aid, comprising an isosceles triangle 60 preferably made of sheet metal and laid out as shown in FIG. 9, with the angle B at its vertex 61 equal to 180° minus A. The sides 62, 63 of the triangle 60 are marked in terms of bend radius, as calculated from the angle A, starting with zero at the vertex 61 and increasing in both directions along the sides 62 and 63.

The triangle 60 is used as follows. One side 62 is placed against the latest-installed support bracket assembly 30 opposite the number corresponding to the desired bend radius. The next bracket assembly 30′ is then held against the other side 63 of the triangle 60 opposite the same number. This procedure gives the correct position for the next bracket assembly 30′. Note that the center of curvature 64 of the path 65 of the sensing element 50 lies at the intersection of the perpendiculars 66, 67 from the two bracket assemblies. The bend radius is the distance from the center of curvature 64 to either of the brackets. The bracket assemblies 30 are installed one by one in this way, with the triangle always giving the correct spacing and orientation for any chosen bend radius.

When it is desired to replace the device, the old draw-wire 51 is removed as shown in FIGS. 10–12 by scoring the tube 50 at 55 (FIG. 10) and breaking it there (FIG. 11) just beyond the end 51*a* of the old wire 51, thus exposing an open end 56 of the tube 50. A new draw-wire 57 may then be fastened to the device by crimps 58 and 59 (FIG. 12) and is pulled into place along the route as the device 50 is pulled out. This procedure leaves the draw-wire 57 in place for the subsequent installation of a new device 50, if desired, either immediately or at a future time.

Where there is a possibility that the point at which the draw-wire 51 is fastened to the device might catch on the edges of the holes 46 in the support-bracket bushings 40 and hinder the proper drawing into place of the device, this possibility can be eliminated by using a draw-wire 70 of the same diameter as the device 50, as shown in FIGS. 13 and 14, and reducing the diameter of the wire 70 at an end portion 71, so that it will fit into the open end of the device, where it can be secured by crimps 72 and 73, thereby providing a joint with a smooth juncture 74.

The use of the draw-wire is not, of course, limited to devices in the form of open-ended tubes. A draw-wire 75 may, for example, be butt-welded, either by brazing

or by electric welding, to the end of a solid device **76**, giving a smooth joint **77**, as shown in FIG. 15.

A means of fastening a draw-wire **80** to a solid device **81** by means of a sleeve **82** is shown in FIGS. 16–18. Here, reduced end portions **83** and **84** are provided in the wire **80** and device **81**, respectively, and the ends **83** and **84** are inserted in the tubular opening **85** in the sleeve **82**. The sleeve **82**, wire **80**, and device **81** all have the same outside diameter. Crimps **86**, **87** complete the juncture.

An additional variation of this general scheme is to use, instead of the draw-wire described above, a draw-tube for pulling the device into place. This tube can be slipped over the end of the device and crimped down there, or can be joined by a nipple. The passages **46** in the support-bracket bushings **40** naturally have to be large enough for the draw-tube to pass through them, but no difficulty can be encountered from the joint's catching on the edges of the holes, because a small-diameter section follows a larger-diameter section as the joint passes each support bracket . If desired, the end of the device to be mounted can be reduced in diameter so that it will fit inside a draw-tube of the same outside diameter as the device.

The methods just outlined for attaching the draw-wire or draw-tube to the device to be mounted are primarily intended to be used in cases where the device is metallic, so that the techniques of crimping and brazing are applicable. However, it is by no means necessary that the use of these support brackets be limited to supporting metallic devices. Flexible plastic or rubber tubes or rods can easily be attached to the draw-wire by means of suitable cement, such as epoxy resins. Endless variations will no doubt suggest themselves to anyone interested in the use of this invention, without departing from the principles embodied therein.

The application of this invention is not limited to use with aircraft fire detectors, although very useful therewith. Any device which is long, thin, and flexible can suitably be supported by using this invention, and the invention will be particularly suitable if the device needs to be replaced more or less frequently. Examples of such devices might be electrical wires, tubing, and control wires for transmitting motion.

This invention would prove especially useful for supporting electrical wires when it is expected that frequent rerouting of the wires will be necessary. There is no restriction to the number of wires which might be placed in one bushing—as is exemplified by FIGS. 19 and 20, where three wires **90**, **91**, and **92** are carried by each bracket assembly **93**. Its bushing **94** is simply made large enough and is provided with one hole for each wire. The ease and speed with which the wires could be inserted and withdrawn are apparent from the foregoing discussion. In addition, the brackets **93** make it quite feasible to avoid the use of insulated wire by proper design of the bushings **94** so that the physical spacing of the wires is preserved. Thus, not only are short circuits between the respective wires prevented, but the characteristic impedance between pairs of wires is maintained, so they can be used for transmitting alternating current. The dielectric properties of polytetrafluoroethylene are quite good, and short circuits to ground are therefore prevented.

FIGS. 21 and 22 show another form of bracket assembly **95** for supporting more than one device in each support bracket. Again, each wire **90**, **91** and **92** is supported in its own hole in a bushing **96**. For some installations, no extensions are needed on the bushing, because vibration is no problem. The bushing **96** omits the extensions, to illustrate this fact.

By means of this invention, control wires which transmit motion to actuate mechanical devices may be run over quite complicated routes. The low friction between the control wires and the bracket bushings helps to maintain high efficiency in the control system.

The convenience with which the component supported with this invention is installed and removed is useful in installations of flexible tubing, either metallic or non-metallic, for fluid or gas transfer, especially when such installations require occasional re-routing of the tubing. The self-lubricating property of the bushing material makes it unnecessary to provide any other lubricant to reduce the friction between the tubing and the bushings when installing or removing lengths of the tubing.

FIG. 23 shows an assembly **100** molded from one piece of Teflon. It has a tubular opening **101** in a bushing-like portion **102**, and a bracket portion **103**, generally triangular in cross section with a recess **104** and openings **105** on each side to receive suitable screws or other fastening means. Operation is the same as before.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. A support assembly for a fire-detector sensing element of the continuous unitary type, comprising: a one-piece metal bracket having a cylindrical sleeve, a web closing said sleeve axially thereof, and support legs for said web; and a one-piece unsplit tubular bushing snugly filling said sleeve and having enlarged portions at each end of said sleeve locking said bushing against sliding movement relative to said sleeve and having flexible extensions of reduced diameter projecting beyond said enlarged potrions, to aid in damping vibrations transmitted through said assembly to said sensing element, said bushing being made of flexible material having a low coefficient of sliding friction and providing at least one seamless circumferentially fully closed through cylindrical passage of constant bore, so that said sensing element of substantially the same diameter as said passage can be pulled therethrough without loosening said bracket.

2. A fire detector installation, including in combination: an elongated, substantially filamentary, continuous, one-piece, unjointed, somewhat flexible sensing element; a filamentary draw-element secured to one end of said sensing element; and a plurality of support means spaced apart from each other to describe a path, said support means supporting said sensing element and each comprising a support bracket and a one-piece tubular bushing supported by said bracket and having a seamless circumferentially fully closed smooth cylindrical opening at least as large as said sensing element extending longitudinally therethrough and a low coefficient of sliding friction, said draw-element being used to be pulled through said openings of said bushings for pulling said sensing elements thereafter into a position where they are all supported by said support means.

3. The installation of claim 2 wherein said bushing is made from polytetrafluoroethylene.

4. The installation of claim 2 wherein said draw-element is a wire smaller in diameter than said sensing element, said sensing element being a tube crimped to said draw-wire.

5. The installation of claim 2 wherein said draw-element is the same diameter as said sensing element.

6. The installation of claim 5 wherein said draw-element has an end of reduced diameter and said sensing element is tubular, said draw-element reduced end being fully inserted in said sensing element and said sensing element crimped to said reduced end.

7. The installation of claim 5 wherein said draw-element and said sensing element are butt-welded together.

8. The installation of claim 5 wherein both said draw-element and said sensing element have ends of reduced diameter, and a sleeve crimped to said ends, said ends being fully inserted in said sleeves.

9. The installation of claim 2 wherein there is anchor means near the last said support means and at the end of said path said draw-element is brought around and tied to said anchor means to place tension on said element.

10. The installation of claim 9, wherein said anchor means includes the next-to-last said support means.

11. A fire detector installation, including in combination: an elongated, substantially filamentary, continuous, one-piece, unjointed, somewhat flexible sensing element; a draw element secured to one end of said sensing element; and a plurality of support elements supporting said sensing element and spaced apart from each other to describe a desired path, each said support element including a support bracket and a one-piece tubular bushing supported by said bracket and having a seamless circumferentially fully closed smooth cylindrical opening of substantially the same diameter as said sensing element, said draw-element being used by being pulled through said support elements to pull said sensing element thereafter.

12. A fire detector installation, including in combination: an elongated, substantially filamentary, continuous, somewhat flexible sensing element; a draw-wire; means securing said draw-wire to one end of said sensing element by a joint no larger in diameter than said sensing element; and a plurality of support assemblies spaced apart from each other to describe a path, said assemblies supporting said flexible sensing element and each comprising a support bracket having a sleeve and a one-piece tubular low-friction-plastic bushing snugly fitting in said sleeve and having enlarged portions engaging the ends of said sleeve and extensions of reduced diameter extending beyond said enlarged portions and a seamless circumferentially fully closed opening at least as large as said sensing element extending longitudinally therethrough, said draw-wire being used to be pulled through said openings of said bushings for pulling said sensing elements thereafter.

13. A fire detector installation, including in combination: an elongated, substantially filamentary, continuous, one-piece, unjointed, somewhat flexible sensing element; a draw wire secured to one end of said sensing element; and a plurality of support assemblies spaced apart from each other to describe a looped path with the first and last ones close together, said assemblies supporting said sensing element and each comprising a metal support bracket having a cylindrical sleeve and a one-piece tubular plastic bushing snugly fitting in said sleeve and having enlarged portions engaging the ends of said sleeve and extensions of reduced diameter extending beyond said enlarged portions and a seamless circumferentially fully closed opening at least as large as said sensing element extending longitudinally therethrough, said draw-wire being used to be pulled through said openings of said bushings for pulling said sensing elements thereafter, said plastic having a low coefficient of sliding friction.

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