Nov. 15, 1966 L. P. HYNES 3,286,078

FLEXIBLE INTERNAL HEATER

Filed April 6, 1964 2 Sheets-Sheet 1

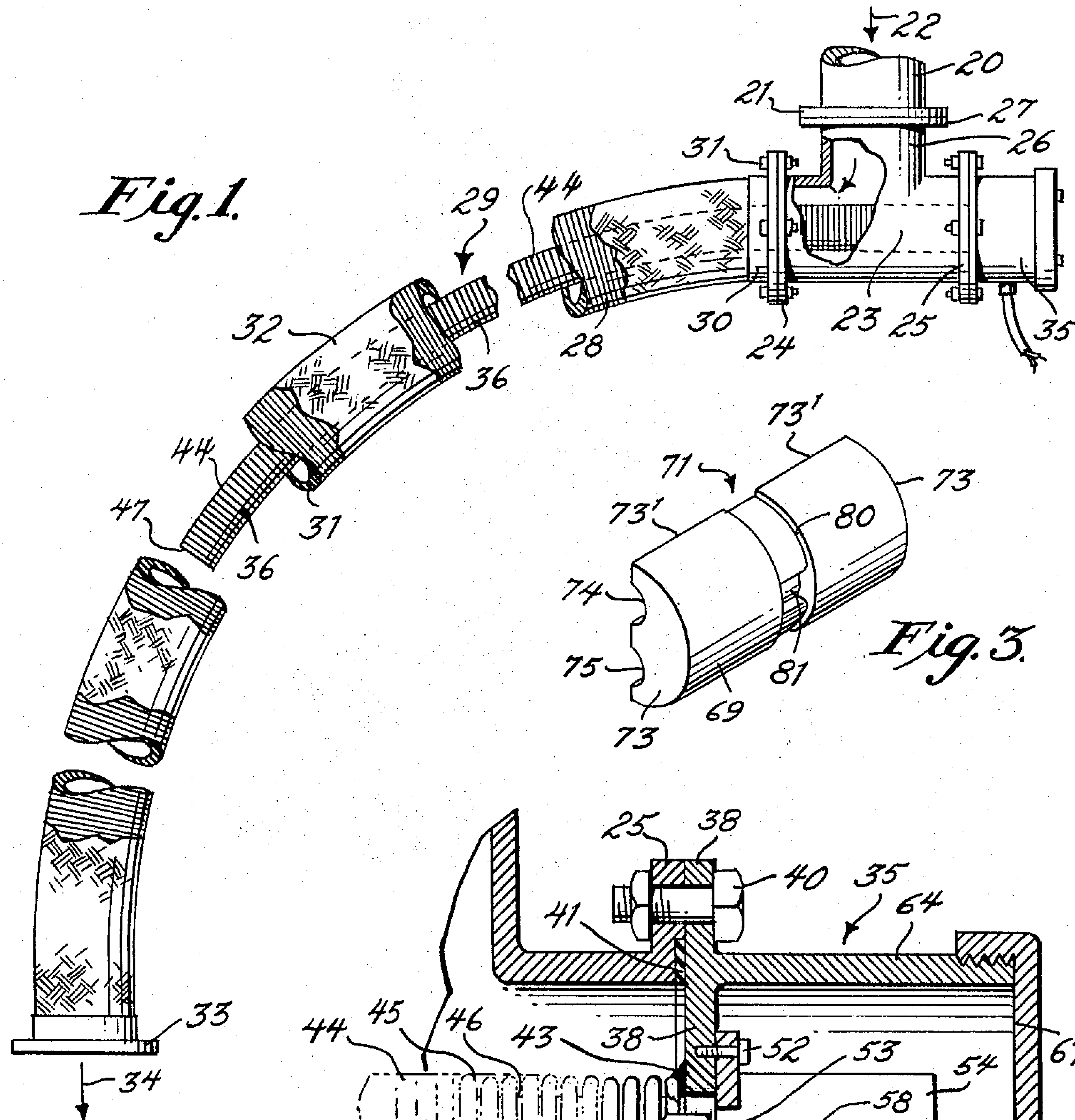

Fig. 1.

Fig. 3.

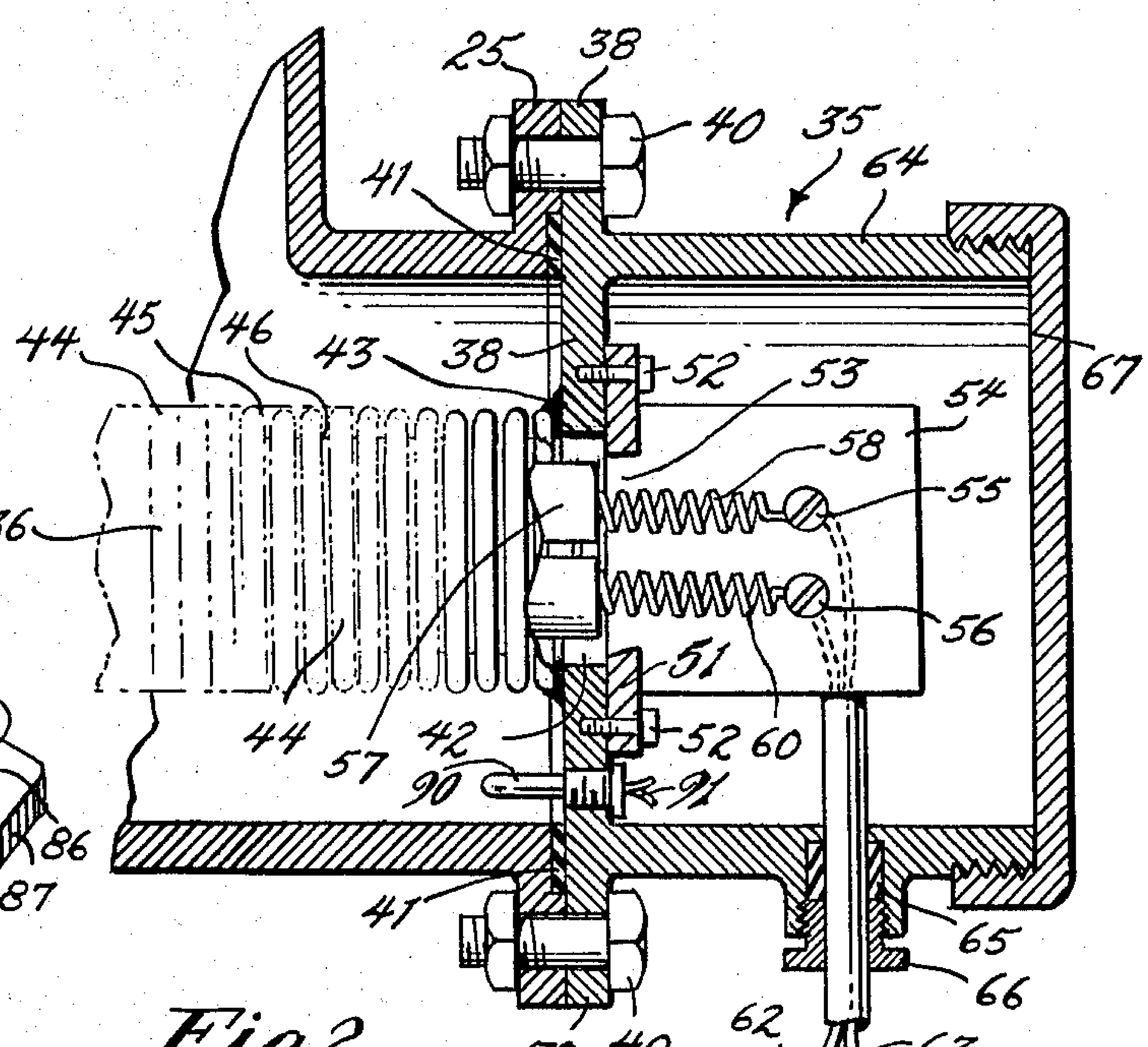

Fig. 2.

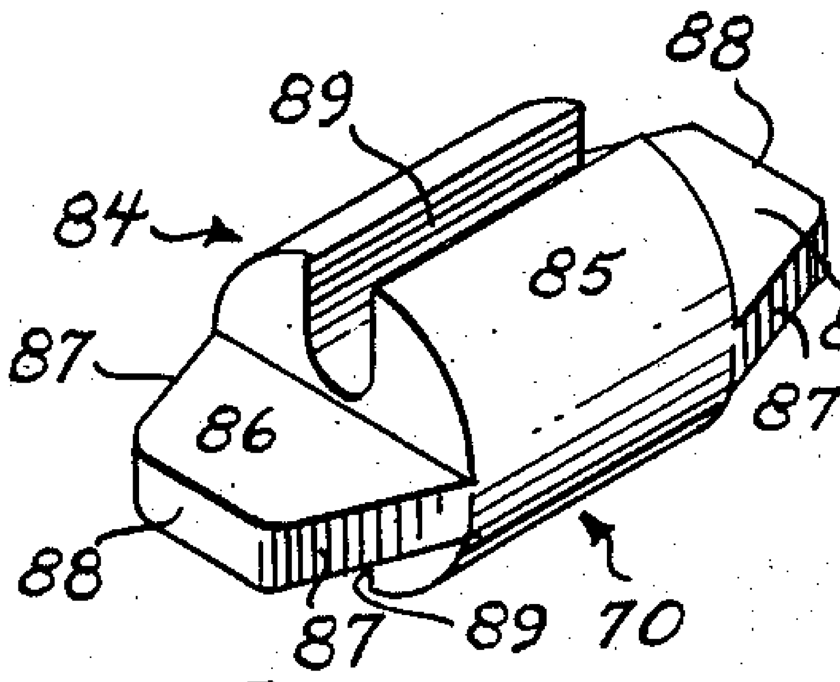

Fig. 4.

INVENTOR
LEE P. HYNES
BY
[signature]
ATTORNEYS

FLEXIBLE INTERNAL HEATER

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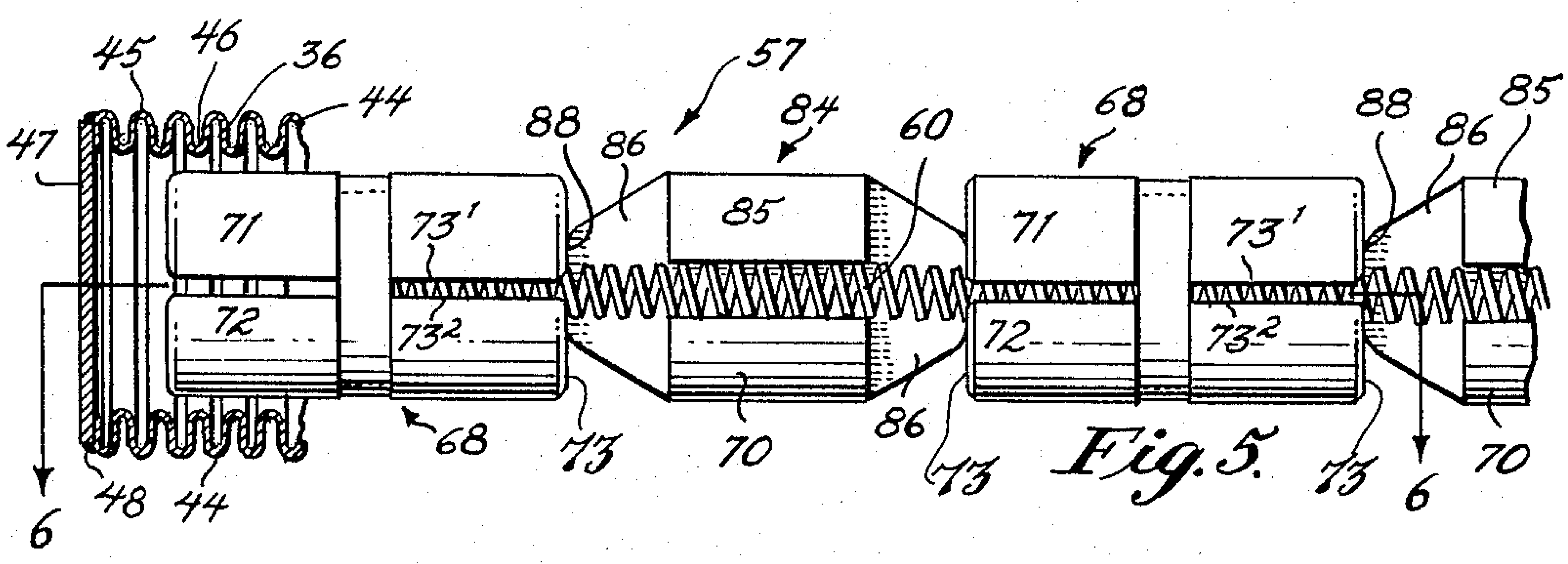

Fig. 5.

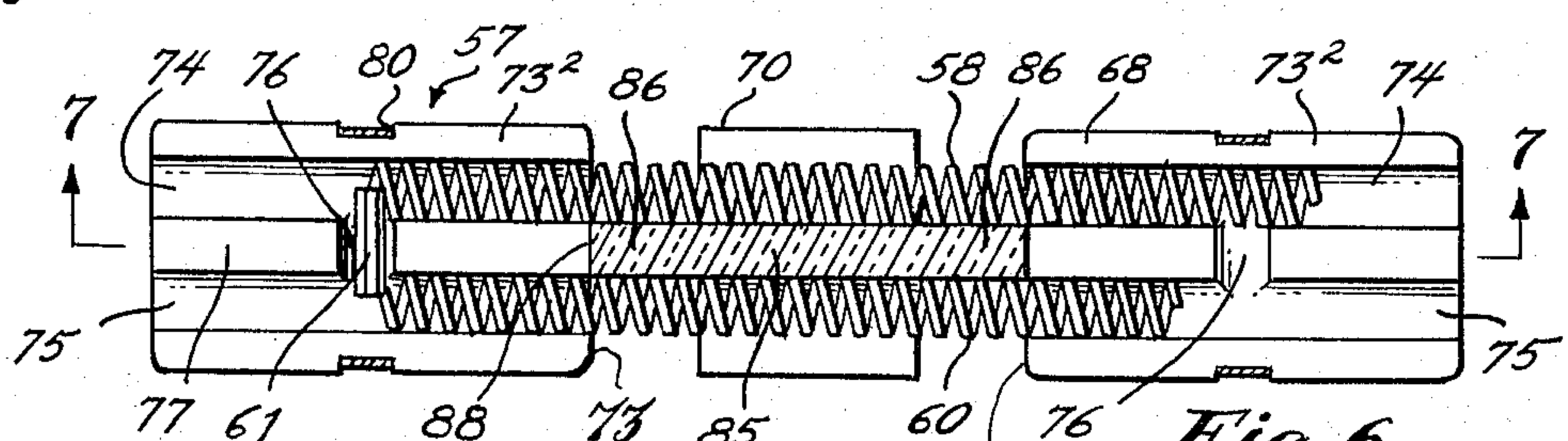

Fig. 6.

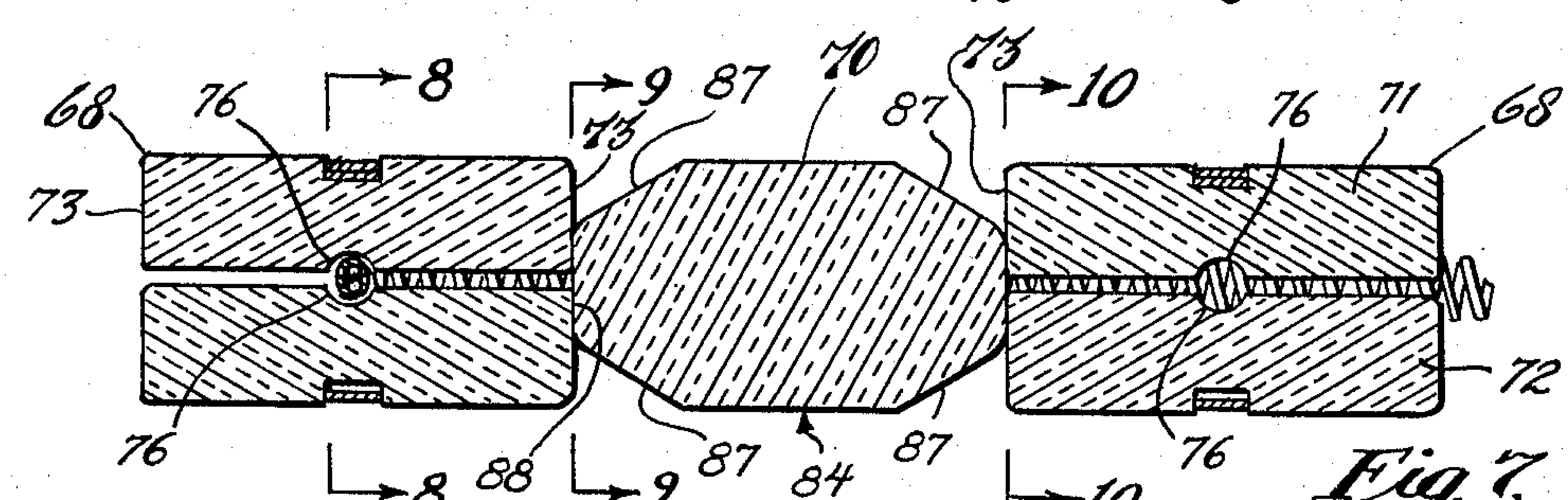

Fig. 7.

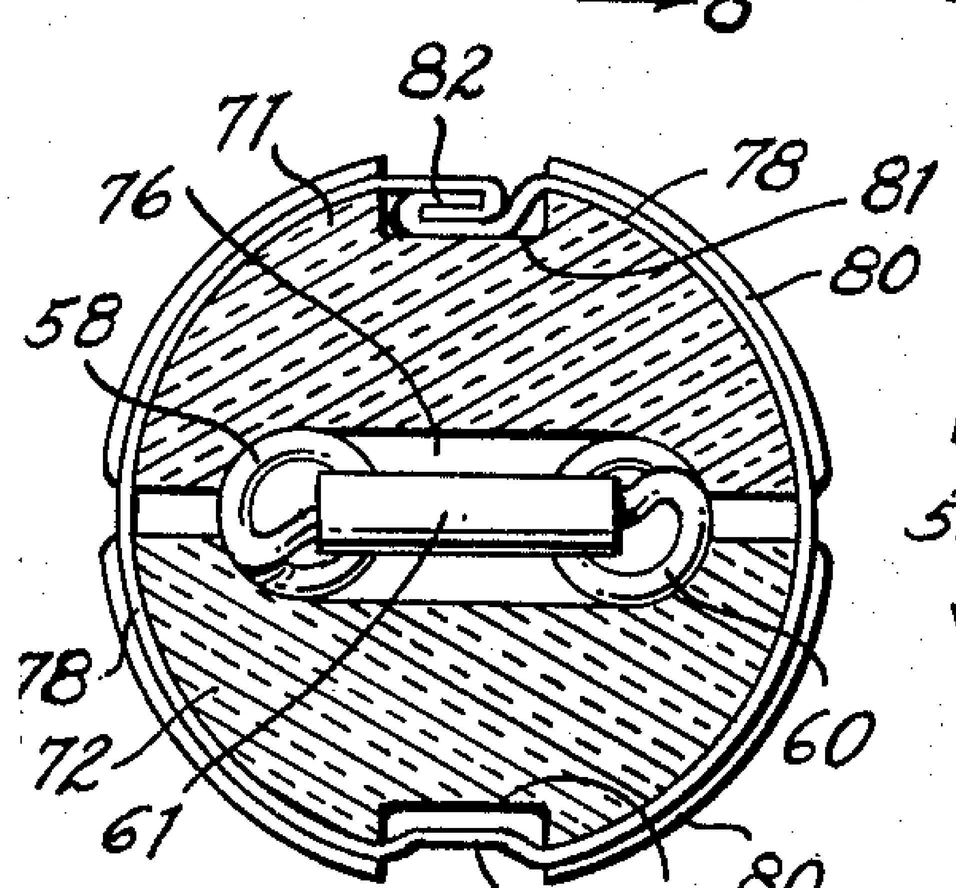

Fig. 8.

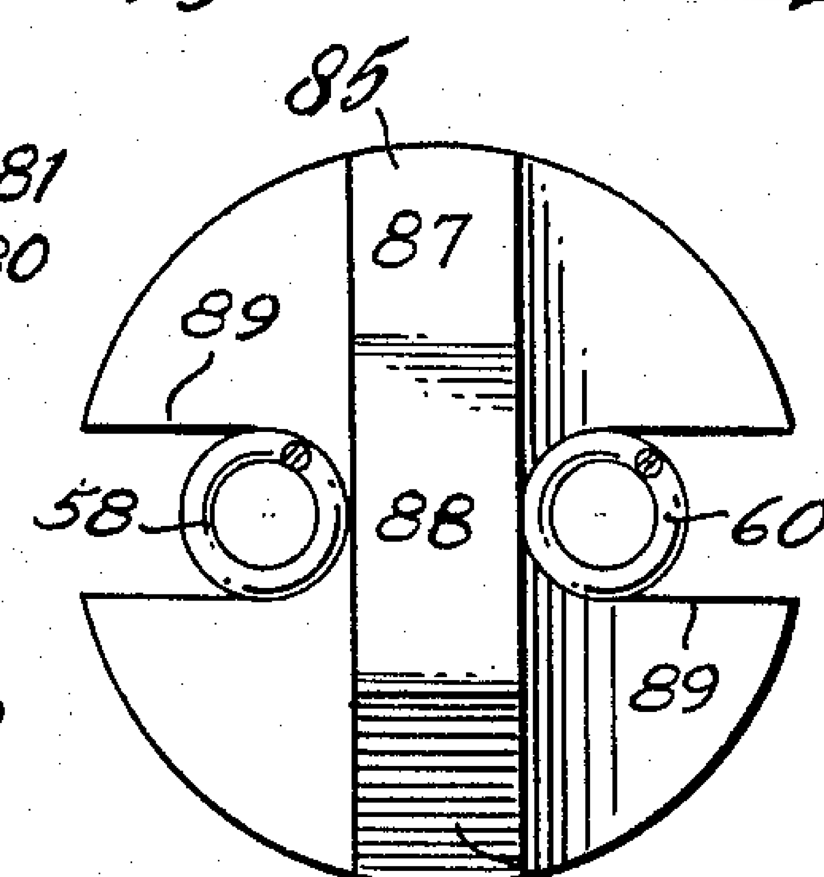

Fig. 9.

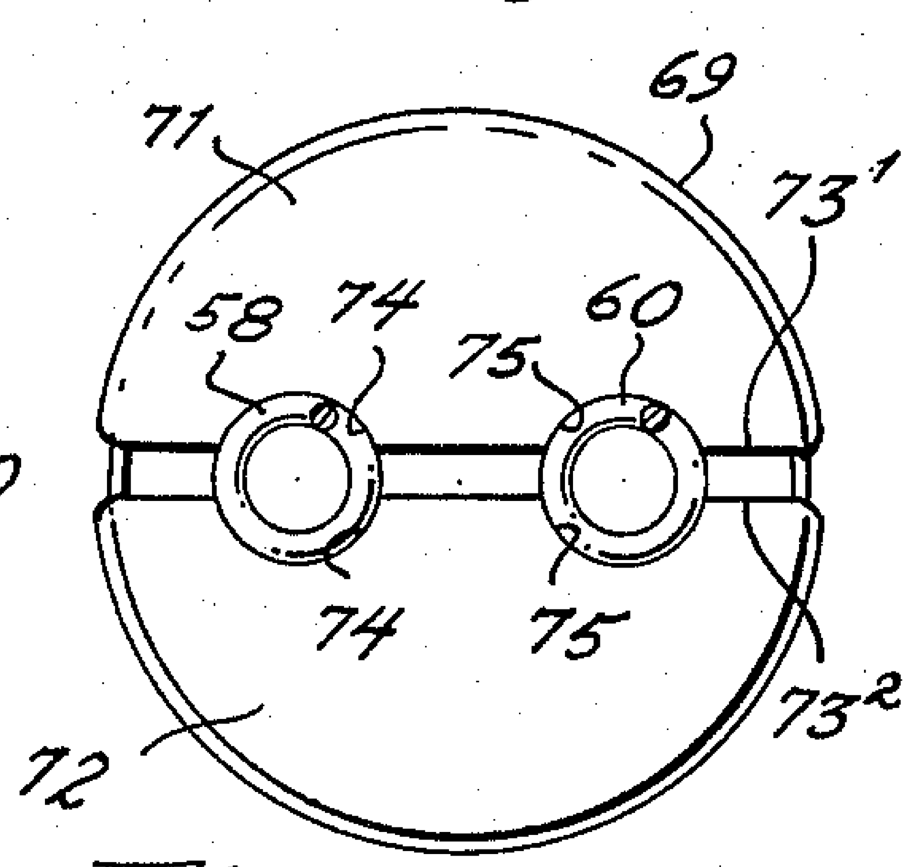

Fig. 10.

INVENTOR
LEE P. HYNES
BY
ATTORNEYS

United States Patent Office

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3,286,078

FLEXIBLE INTERNAL HEATER

Lee P. Hynes, Haddonfield, N.J., assignor to Hynes Electric Heating Company, Kenilworth, N.J., a corporation of New Jersey

Filed Apr. 6, 1964, Ser. No. 357,397
2 Claims. (Cl. 219—306)

The present invention relates to electric heaters for fluids and more particularly to flexible internal heaters for fluid conduits in the form of flexible hose, bent rigid pipe, or other irregular shapes.

A purpose of the invention is to provide an electric heater which can be used internally within a fluid conduit in the form of a flexible hose or bent rigid tubing.

A further purpose of the invention is to provide a flexible electric heater which can be readily inserted within or withdrawn from a flexible hose or bent rigid tubing.

A further purpose of the invention is to provide a flexible electric heater wherein the heater elements can be readily inserted and withdrawn from an enclosure in the form of a flexible metal tubing.

A further purpose is to provide an electric heater which has a high flexibility and great resistance to fatigue failure from repeated bending.

A further purpose of the invention is to provide insulators which support and space resistors from a flexible metal tubing while allowing flexibility of the resistors and insulators to accommodate the contour and bending of the hose.

A further purpose of the invention is to provide a flexible electric heater which is positioned inside a hose.

A further purpose of the invention is to provide a flexible heater for the inside of a hose wherein the resistor elements can be readily removed and inserted into a flexible metal tubing.

A further purpose is to provide an electric heater wherein heater elements can be chosen to achieve performance characteristics over a wide range of requirements, including wattage, voltage, and temperature.

A further purpose is to provide an electric heater which can be readily assembled to any length specification.

A further purpose is to use commercial flexible metal tubing in a flexible electric heater.

A further purpose is to provide a heater for vaporizing fluids.

A further purpose is to provide a flexible sealed heater for normally inaccessible locations and irregular shaped areas where heat is required.

A further purpose of the invention is to utilize repetitive insulator elements and continuous lengths of resistors and flexible metal tubing in a flexible internal heater to satisfy a wide variety of requirements.

A further purpose is to provide a flexible heater having a standard flexible casing which can be readily assembled with a selected resistor to provide any desired heat output with available voltage.

A further purpose is to provide ease of assembly and disassembly when replacing elements.

A further purpose is to use rigid insulator supports in the form of matching semi-cylindrical elements bound together with an enclosing strap, binder or band.

A further purpose is to provide recesses in the insulator into which the band or binder can be depressed from its normal curvature to provide tension on the band.

A further purpose is to recess a band or binder into an insulator to keep the band or binder below the surface of the insulator and to prevent interference with the flexible metal tubing.

A further purpose is to use rigid insulator segments in a flexible heater which are in pivotal relationship to one another along the resistors.

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Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which my invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

FIGURE 1 is a fragmentary view of the hose and heater of the invention.

FIGURE 2 is an enlarged sectional view of the upstream end of the heater and housing.

FIGURE 3 is a perspective view of one half of a fulcrum insulator used in the invention.

FIGURE 4 is a perspective view of a pivot insulator used in the invention.

FIGURE 5 is a fragmentary view partly sectional of the downstream end of the heater.

FIGURE 6 is a section taken on the line **6—6** of FIGURE 5.

FIGURE 7 is a section taken on the line **7—7** of FIGURE 6.

FIGURE 8 is an enlarged axial section taken on the line **8—8** of FIGURE 7.

FIGURE 9 is a section taken on the line **9—9** of FIGURE 7.

FIGURE 10 is an enlarged section taken on the line **10—10** of FIGURE 7.

Describing in illustration but not in limitation and referring to the drawings:

The present invention is concerned with heating fluids in conduits in the form of flexible hose, bent rigid tubing, or other irregular shapes, where the conduit is generally of metal.

The invention will be explained, for purposes of clarity, in use with a flexible hose, but it should be understood that the same principles apply to the other uses, including those stated above. Flexible hoses are extensively used for loading and unloading fluids between transport vehicles and fixed pipe lines or reservoirs. Transport vehicles include ships, railroad tank cars, barges, and tank trucks. These flexible hoses are normally exposed to the weather during use. When the weather is cold, the fluids in the hose often tend to solidify or freeze, so that flow is greatly restricted or stopped. For instance, materials such as tallows, greases, waxes, pitch, asphalt, heavy chemicals, and the like solidify readily at the cooler temperatures and flow is not possible.

In the prior art, efforts have been made to heat these hoses in order to soften or condition the fluids for more ready flow. These efforts included steam or flame torches applied to the outside of the hose to get flow started. This has been unsatisfactory because of lack of control, creation of a fire hazard, and substantial loss of heat to the atmosphere. In other instances, tracer lines have been used along the outside of the hoses but these have been unsatisfactory because of the difficulty of installation, maintenance, and protection from external damage.

In most prior art efforts, the heat has not been applied where most necessary, namely, on the inside of the hose in the fluid being conveyed. Prior art internal heaters have included those shown in my United States Patent 2,750,487 and 2,963,539, where a small degree of flexibility is obtained by using a longitudinal supporting strap along one side of the insulators. However, such heaters wer not sufficiently flexible for use in flexible hoses or irregularly bent rigid pipes which are commonly used in conveying fluids, particularly from or to transport vehicles.

In the heater of the present invention, a flexible metal tubing containing insulated flexible resistors extends within the flexible hose conduit and heats the fluid within the hose conduit. The upstream end of the heater is anchored at a T-connection, and suitable electrical leads are attached to the heater at that point. The downstream end of the flexible heater is allowed to float freely within the hose. The flexible metal tubing of the heater is entirely closed so that complete isolation of the live resistors of the heater from the fluid is obtained. In this way, the action of the resistors is not interfered with and the fluid is not contaminated. The assembly of insulated resistors can be readily inserted and withdrawn from the flexible metal tubing while the heater is in position wthin a hose, or, in the alternative, the entire flexible heater including the flexible metal tubing and insulated resistors can be withdrawn from the hose. The resistors are flexibly insulated and supported within the flexible metal tubing by repetitive, alternate, pivoted, rigid, insulators.

As shown in the drawings and referring to FIGURE 1, fluid flows from any suitable source through the conduit **20** in the direction shown by the arrow **22**. This fluid can be of any type including heavy oils, greases, waxes, pitch and many other materials. A T-connection **23** having side outlets **24** and **25** is connected at **26** by means of a suitable flange **27** to flange **21** of the supply conduit **20**. A conventional flexible hose **28**, generally metallic, having a flange **30** is bolted by means of bolts **31** to the flange **24** of T**26**. The flexible hose **28** can be, for instance, of a type having an inner transversely corrugated structure **31** and an outer braided metal cover **32**. The hose can extend for any suitable length and has at its downstream end a flange **33** or other connector, or, in other instances, a plain end which can be used for pouring or discharging into a suitable vessel. The material which enters at **22** flows out of the flexible hose at **34** in the direction shown by the arrow. The conduit **20** and hose **28** are of conventional prior art construction.

The heater **29** of the invention is inserted through T**26** into hose **28** through side outlet **25**. The heater **29** of the invention consists of a terminal portion **35** and a heater portion **36**. Terminal portion **35** as seen in FIGURES 1 and 2 includes a flange **38** which is held to flange **25** by bolts **40**. A suitable gasket **41** provides a fluid seal between flanges **25** and **38**. The flange **38** has a central annular opening **42** which has secured and sealed thereto at **43** a flexible metal tubing **44**. The flexible metal tubing **44** can be of any suitable type, for instance, one having alternate corrugations of extensions **45** and depressions **46** in a well known bellows fashion. Metal tubing of this type has excellent flexibility and resistance to kinking. The tubing **44** is secured in opening **42** at **43** as by welding or other means to provide a completely fluid tight connection to the flange **38**. At the downstream end toward discharge **34**, flexible tubing **44** has a sealed end cap **47** as best seen in FIGURE 5 which is welded to the flexible metal tubing **44** at **48**. By means of the seal at **43** and the seal at **48**, the interior of flexible tubing **44** is completely isolated from the fluid flow which occurs in the hose **28** from the inlet **22** to the outlet **34**. The flexible metal tubing **44** can be made of any desired length.

Considering now the terminal portion **35**, a flange **51** is secured to flange **38** by means of cap screws **52**. Flange **51** has an annular opening at **53**. Flange **51** has integral therewith terminal block **54** mounting insulated electrical terminals **55** and **56**.

Extending within flexible metal tubing **44** is a heating element **57**. The heating element **57** consists of resistors **58** and **60** which are shown as being helically wound but which may be of any suitable type. The resistors **58** and **60** may be for instance, of a round cross section wire or of a flat ribbon. The resistors are connected at terminal portion **35** to terminals **55** and **56**. At the other end of the heater element **57** as best seen in FIGURE 6, the resistors **58** and **60** are suitably spliced by means of a metal element **61** either welded or crimped to the end of the resistors. Alternatively, the resistors **58** and **60** could be integral and merely bent rather than spliced.

Suitable electric leads **62** and **63** pass through terminal box **64** which is suitably integral with flange **38**. Leads **62** and **63** pass through packing **65** and follower **66** to make a waterproof connection. A cap **67** is screwed onto terminal box **64** to provide a weatherproof enclosure for the entire electrical assembly and prevent moisture or other foreign matter from entering the terminal box **64** as well as the interior of the flexible metal tubing **44**.

The resistors **58** and **60** are supported and spaced within flexible metal tubing **44** by fulcrum insulators **68** and pivot insulators **70**. Considering first the fulcrum insulators **68**, each insulator consists of two identical semi-cylindrical portions **71** and **72**. Since the halves **71** and **72** are identical, only one half **71** as best seen in FIGURE 3 will be described in detail. Portion **71** has a curved surface **69** and opposing flat ends **73**. Additionally, resistor half **71** has a flat, longitudinally extending plane surface **73'** which extends in spaced parallel relationship with a flat surface **73²** on an opposed half **72**. Suitable semi-circular channels or grooves **74** and **75** as best seen in FIGURES 3 and 6 extend longitudinally of the insulator halves **71** and **72** and are of a size which properly grips and supports the resistors **58** and **60**. Each of the portions **71** and **72** of the fulcrum insulators **68** has a transverse groove **76** which is adapted to receive the connector **61** at the end of the resistors, which serves to connect the resistors together at the end opposite the terminals **55** and **56**. It will be evident that although all of the fulcrum insulators will carry such transverse grooves, only the endmost fulcrum insulator will be utilized for the purpose of cross connecting the resistors. This is clearly shown in FIGURE 6 where the end of the insulator away from the resistor as at **77** acts as a suitable barrier for insulating the end of the resistor at **61** away from the flexible tubing **44** at the end cap **47**.

Matching fulcrum insulator halves **71** and **72** are held in spaced gripping relationship about the resistors **58** and **60**, as best seen in FIGURE 8, by a band or strap **78** which lies in a recessed groove **80** which extends annularly around the longitudinal midsection of the insulator halves **71** and **72**.

The groove **80** has recesses or slots **81** below groove **80** at a position midway on the circumference, the slot being best seen in perspective in FIGURE 3 and in section in FIGURE 8. The slot receives in one instance a splice **82** suitably in the form of bent interlocked ends of the band **78** depressed into the slot. In a slot **81** opposite to the splice **82**, the band is depressed as at **83** into the slot to achieve a tensioning of the band during or after the splice **82** is completed. Both the splice **82** and the depression **83** may be performed by any suitable tool, such as clamps, vices or opposed jaws. It should be understood that splice or joint **82** is merely illustrative and that band **78** could be spliced by any suitable means such as spot welding or other fastenings.

In applying the band **78** and also in the subsequent splicing and tensioning by means of depression **83**, the insulators **71** and **72** grip the resistors **58** and **60** securely in their longitudinally extending grooves **74** and **75** in a resilient but firm manner, whereby relative longitudinal movement between the fulcrum insulators **68** and the resistors **58** and **60** is prevented.

Pivot insulators **70**, as best seen in FIGURE 4, are alternately spaced between the fulcrum insulators **68**, as shown in FIGURES 5 to 7. The pivot insulator **70** consists of a cylindrical portion **85** and abutment portions **86** suitably integral with portion **85**. The abutment portion **86** is tapered at **87** with an end abutment at **88**. The portion **85** has extending therethrough longitudinally extending opposed slots **89** which receive the resistors **58** and **60** as best seen in FIGURES 5, 6 and

9. The resistors **58** and **60** resiliently abut against the inner portions of the slots **89** so that the pivot insulator **70** is firmly held positioned between the fulcrum insulators **68** but is not fixedly connected thereto. The resistors **58** and **60** serve to resiliently hold insulators **68** and **70** in abutting relationship at faces **73** and **88** respectively while allowing the insulators **68** and **70** to pivot in a universal direction with respect to one another at these faces to achieve flexibility as flexible tubing **44** bends to conform to the contour of flexible conduit hose **28**.

The abutment portion **86** of pivot insulator **70** additionally serves as an insulating barrier between resistors **58** and **60** at all times, as shown particularly in FIGURES 6 and 9, whether the heater **29** is flexed or in a straight position.

A temperature sensing device **90** with suitable leads **91** may be inserted through, or attached to, the surface of the flow conduit at any desired location to sense the fluid temperature for control purposes.

In operation, the connection between the inlet conduit **20** and the flexible hose **28** is provided by a T-connection **23** having flanges on each end as described above. The heater portion **36** of flexible heater **29** is inserted into the side opening of the T-connection **23** at **25** and pushed into the interior of the flexible hose **28**. The heater portion **36** is pushed into the hose until the flange **38** of the terminal portion **35** abuts against flange **25** and the flanges are bolted together by bolts **40**. The heater portion **36** will have already inserted within flexible metal tubing **44**, the assembly of the resistors **58** and **60** and the insulators **68** and **70** as taught in the description above. The resistors **58** and **60** will be connected to terminals **55** and **56** as by screw connections and suitable electric current will be applied to the resistors through conductors **62** and **63**. The end cap **67** is then threaded onto the terminal box **64** so that the electrical connections as well as the resistors and insulators are fully protected against moisture and other elements.

In assembling the resistors and insulators prior to insertion into flexible tubing **44**, the fulcrum insulators **68** are applied to the resistors by assembling the halves **71** and **72** in opposed relationship as shown, for instance, in FIGURE 8 and the band **78** applied in place around each pair of insulators in the groove **80**. The band is then spliced at **82** and the band **78**, at a diametrically opposed position is then depressed at **83** to apply the proper tension to the band. A pivot insulator **70** is placed adjacent the fulcrum insulator **68** into a position described above. Another fulcrum insulator **68** is brought into position in abutting relationship as shown in FIGURES 5 to 7. The second fulcrum insulator is then held in position around the resistors by applying the band **78** in a manner already described. Alternate fulcrum and pivot insulators are applied along the entire length of the resistors. Fulcrum insulators are used at both ends of the assembly. The pivot insulator **70** is then confined between a pair of fulcrum insulators **68** and the resitors **58** and **60** so that it is kept securely in position while allowing freedom of movement of the resistors, so that the pivot insulators can toggle at both ends against the fulcrum insulators. This provides desired flexibility throughout the length of the resistors to conform to the contour of the flexible metal tubing **44** which in turn conforms to the changing contour of the flexible hose **28**.

It will be seen that by removing bolts **40**, the entire heater **29** can be removed from its installation in flexible hose **28** by merely withdrawing the entire terminal portion

35 which in turn withdraws the flexible metal tubing **44** which is permanently attached thereto. In the event that it is further desired to withdraw the heater element **57** from within the flexible metal tubing **44**, it is merely necessary to unscrew cap **67**, remove the connections of leads **62** and **63** from terminals **55** and **56**, and remove cap screws **52** from flange **38**. Terminal block **54**, with integral flange **51**, and heater element **57** may then be withdrawn from within flexible tubing **44**. Suitable replacements can be made of, for instance, the resistor elements where different requirements have to be met by the heater. In the event that it is desired to change the heat output of the heater element, or if the resistors or other parts should fail, they can be readily replaced by disassembling and reassembling with new resistors or replacement parts without disturbing any fluid connections.

In view of my invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a flexible fluid heater adapted to extend within a fluid enclosure through an opening in the fluid enclosure, a terminal portion, a flexible, bendable, metallic tube secured to said terminal portion at one end and closed at the other end whereby fluid is prevented from entering into the metallic tube, flexible, bendable, substantially longitudinally non-stretchable and longitudinally non-compressible, self-supporting, parallel resistors extending longitudinally within the tube and extending into the terminal portion, rigid sectional fulcrum insulators spaced longitudinally along the resistors, each of the said insulators comprising radial sections with resistor receiving portions within the sections, and tensioning means on each of the insulators for securely holding each of the insulators in secure gripping relationship to the resistors; each of said insulators having an outer radial surface generally conforming in shape to the inner surface of the metal tube, said insulator outer surface and said tube inner surface being in bearing relationship, wherein the resistors are free to bend at positions longitudinally between fulcrum insulators and are securely gripped and held within the fulcrum insulators.

2. A heater of claim **1**, in combination with pivot insulators extending longitudinally between the fulcrum insulators, said pivot insulators having longitudinal grooves adapted to receive the resistors in longitudinal sliding relationship thereto.

References Cited by the Examiner

UNITED STATES PATENTS

1,699,323	1/1929	Apfel	219—306
1,829,785	11/1931	Christian	219—335
2,058,769	10/1936	Brown	219—331 X
2,064,248	12/1936	Doyon	219—331
2,888,546	5/1959	Kinney	219—528 X
2,963,539	12/1960	Hynes	174—138.8
3,016,441	1/1962	Hackman et al.	174—138.8 X
3,017,688	1/1962	Cummings et al.	338—214 X

FOREIGN PATENTS

398,589	9/1933	Great Britain.
32,387	3/1934	Netherlands.

RICHARD M. WOOD, *Primary Examiner.*

C. L. ALBRITTON, *Assistant Examiner.*