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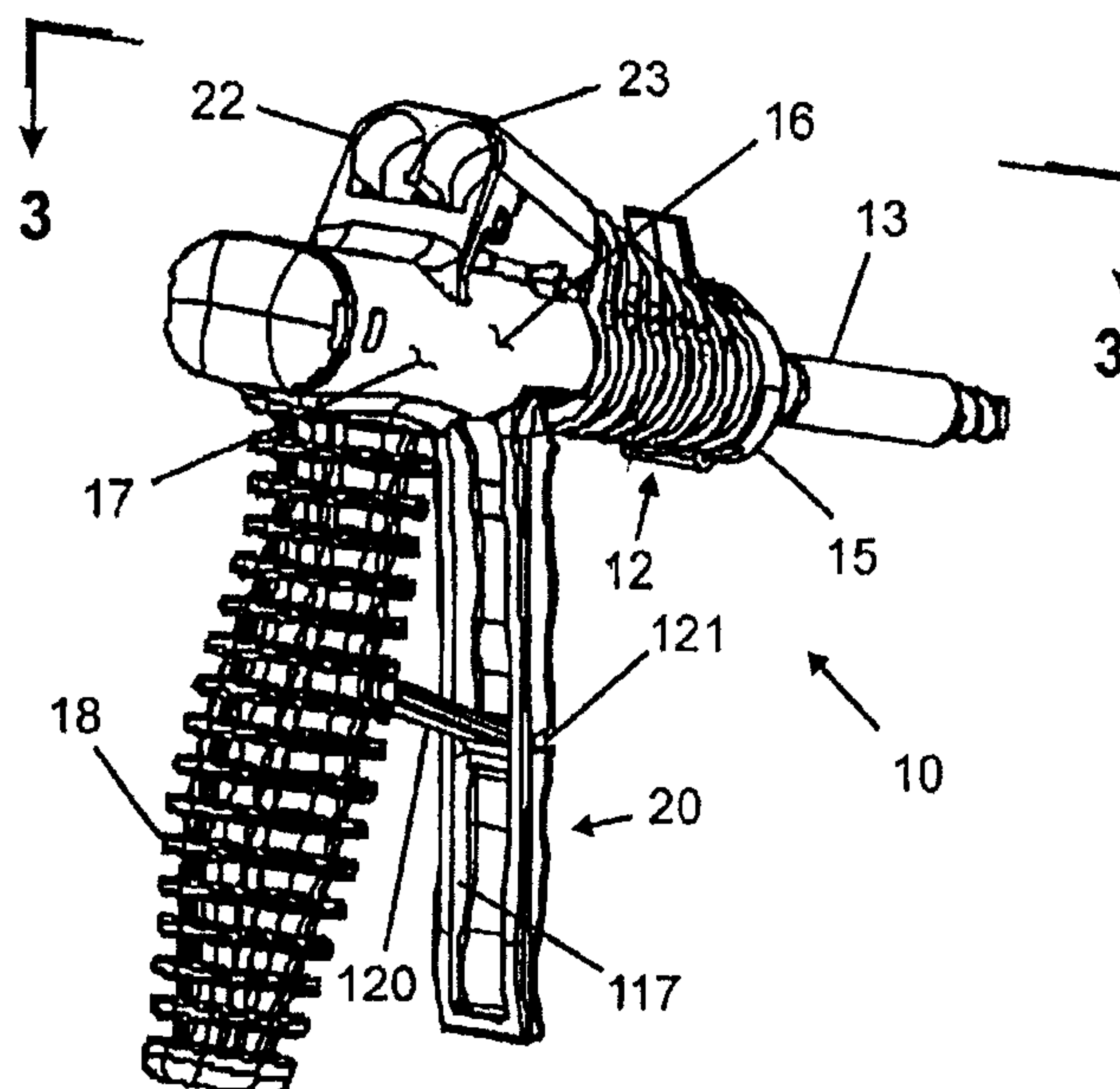
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(54) **Titre : FLEXIBLES ET BUSES DE CANON A MOUSSE A INDICATION THERMIQUE**

(54) **Title: TEMPERATURE INDICATING FOAM GUN NOZZLES & HOSES**



(57) **Abrégé/Abstract:**

The invention described herein generally pertains to temperature-indicating foam gun nozzles and/or at least one temperature-indicating hose which employs at least one thermochromic material disposed within said foam gun nozzle and/or hoses.

Abstract

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Temperature Indicating Foam Gun Nozzles & Hoses

[0001] *Technical Field*

[0002] The invention described herein pertains generally to temperature-indicating foam gun nozzles and hoses.

Background of the Invention

[0003] This invention is particularly suited for in-situ applications of liquid chemicals mixed and dispensed as a spray or a foam and more specifically, to in-situ application of polyurethane foam or froth and the measurement of the temperature of the chemicals used therewith. In-situ applications for polyurethane foam have continued to increase in recent years extending the application of polyurethane foam beyond its traditional uses in the packaging, insulation and molding fields. For example, polyurethane foam is being used with increasing frequency as a sealant in the building trades for sealing spaces between windows and door frames and the like and as an adhesive for gluing flooring, roof tiles, and the like.

[0004] Polyurethane foam for in-situ applications is typically supplied as a "one-component" froth foam or a "two-component" froth foam in portable containers hand carried and dispensed by the operator through either a valve or a gun. However, the chemical reactions producing the polyurethane froth foam in a "one-component" polyurethane foam is significantly different than the chemical reactions producing a polyurethane froth foam in a "two-component" polyurethane foam. Because the reactions are different, the dispensing of the chemicals for a two-component polyurethane foam involves different and additional concepts and concerns than that present in the dispensing apparatus for a "one-component" polyurethane froth foam.

[0005] A "one-component" foam generally means that both the resin and the isocyanate used in the foam formulation are supplied in a single pressurized container and dispensed from the container through a valve or a gun attached to the container. When the chemicals leave the valve, a reaction with moisture in the air produces a polyurethane froth or foam. Thus, the design concerns related to an apparatus for dispensing one-component polyurethane foam essentially concerns the operating characteristics of how the one-component polyurethane foam is throttled or metered from the pressurized container. While one-component guns can variably meter the polyurethane froth, they are typically used in caulk/glue applications where an adhesive or caulk bead is determined by the nozzle configuration. Post drip is a major concern in such applications as well as the dispensing gun not clogging because of reaction of the one component formulation with air (moisture) within the gun. To address or at least partially address such problems, a needle valve seat

is typically applied as close to the dispensing point by a metering rod arrangement which can be pulled back for cleaning. While metering can occur at the needle valve seat, the seat is primarily for shut-off to prevent post drip; and depending on gun dimensioning, metering may principally occur at the gun opening.

[0006] In contrast, a "two-component" froth foam means that one principal foam component is supplied in one pressurized container, typically the "A" container (i.e., polymeric isocyanate, fluorocarbons, etc.) while the other principal foam component is supplied in a second pressurized container, typically the "B" container (i.e., polyols, catalysts, flame retardants, fluorocarbons, etc.).

[0007] In a two-component polyurethane foam, the "A" and "B" components form the foam or froth, when they are mixed in the gun. Of course, chemical reactions with moisture in the air will also occur with a two-component polyurethane foam after dispensing, but the principal reaction forming the polyurethane foam occurs when the "A" and "B" components are mixed, or contact one another in the dispensing gun. The dispensing apparatus for a two-component polyurethane foam application has to thus address not only the metering design concerns present in a one-component dispensing apparatus, but also the mixing requirements of a two-component polyurethane foam.

[0008] Further, a "frothing" characteristic of the foam (foam assumes consistency resembling shaving cream) is enhanced by the fluorocarbon (or similar) component, which is present in the "A" and "B" components. This fluorocarbon component is a compressed gas which exits in its liquid state under pressure and changes to its gaseous state when the liquid is dispensed into a lower pressure ambient environment, such as when the liquid components exit the gun and enter the nozzle.

[0009] While polyurethane foam is well known, the formulation varies considerably depending on application. In particular, while the polyols and isocyanates are typically kept separate in the "B" and "A" containers, other chemicals in the formulation may be placed in either container with the result that the weight or viscosity of the liquids in each container varies as well as the ratios at which the "A" and "B" components are to be mixed. In the dispensing gun applications which relate to this invention, the "A" and "B" formulations are such that the mixing ratios are generally kept equal so that the "A" and "B" containers are the same size. However, the weight, more importantly the viscosity, of the liquids in the containers invariably vary from one another. To adjust for viscosity variation between "A" and "B" chemical formulations, the "A" and "B" containers are charged (typically with an inert gas,) at different pressures to achieve equal flow rates. The metering valves in a two-component gun, therefore, have to meter different liquids at different pressures at a precise ratio under varying flow rates. For this reason (among others), some dispensing guns have a design where each metering rod/valve is separately adjustable against a separate spring to compensate not only for ratio variations in different formulations but also viscosity variations between the components. The typical two-component dispensing gun in use today can be viewed as two separate one-component dispensing guns in a common housing discharging their components into a mixing chamber or nozzle. In practice, often the gun operator adjusts the ratio settings to improve gun "performance" with poor results. To counteract this

adverse result, the ratio adjustment then has to be "hidden" within the gun, or the design has to be such that the ratio setting is "fixed" in the gun for specific formulations. The gun cost is increased in either event and "fixing" the ratio setting to a specific formulation prevents interchangeability of the dispensing gun.

[0010] Besides the ratio control which distinguishes two-component dispensing guns from one-component dispensing guns, a concern which affects all two-component gun designs (not present in one-component dispensing guns) is known in the trade as "cross-over". Generally, "cross-over" means that one of the components of the foam ("A" or "B") has crossed over into the dispensing mechanism in the dispensing gun for the other component ("B" or "A"). Cross-over may occur when the pressure variation between the "A" and "B" cylinders becomes significant. Variation can become significant when the foam formulation initially calls for the "A" and "B" containers to be at high differential charge pressures and the containers have discharged a majority of their components. (The containers are accumulators which inherently vary the pressure as the contents of the container are used.) To overcome this problem, it is known to equip the guns with conventional one-way valves, such as a poppet valve (or other similarly acting device). While necessary, the dispensing gun's cost is increased.

[0011] Somewhat related to cross-over and affecting the operation of a two-component gun is the design of the nozzle. The nozzle is a throw away item detachably mounted to the gun nose. Nozzle design is important for cross-over and metering considerations in that the nozzle directs the "A" and "B" components to a static mixer in the gun.

[0012] A still further characteristic distinguishing two-component from one-component gun designs resides in the clogging tendencies of two-component guns. Because the foam foaming reaction commences when the "A" and "B" components contact one another, it is clear that, once the gun is used, the static mixer will clog with polyurethane foam or froth formed within the mixer. This is why the nozzles, which contain the static mixer, are designed as throw away items. In practice, the foam does not instantaneously form within the nozzle upon cessation of metering to the point where the nozzles have to be discarded. Some time must elapse. This is a function of the formulation itself, the design of the static mixer and, all things being equal, the design of the nozzle.

[0013] The dispensing gun of the present invention is particularly suited for use in two-component polyurethane foam "kits" typically sold to the building or construction trade. Typically, the kit contains two pressurized "A" and "B" cylinders of about 7.5 inches in diameter which are pressurized anywhere between 150-250 psi, a pair of hoses for connection to the cylinders and a dispensing gun, all of which are packaged in a container constructed to house and carry the components to the site where the foam is to be applied. When the chemicals in the "A" and "B" containers are depleted, the kit is sometimes discarded or the containers can be recycled. The dispensing gun may or may not be replaced. Since the dispensing gun is included in the kit, kit cost considerations dictate that the dispensing gun be relatively inexpensive. Typically, the dispensing gun is made from plastic with minimal usage of machined parts.

[0014] The dispensing guns cited and to which this invention relates are additionally characterized and distinguished from other types of multi-component dispensing guns in that they are, “airless” and do not contain provisions for cleaning the gun. That is, a number of dispensing or metering guns or apparatus, particularly those used in high volume foam applications, are equipped or provided with a means or mechanism to introduce air or a solvent for cleaning or clearing the passages in the gun. The use of the term “airless” as used in this patent and the claims hereof means that the dispensing apparatus is not provided with an external, cleaning or purging mechanism.

[0015] While the two-component dispensing guns discussed above function in a commercially acceptable manner, it is becoming increasingly clear as the number of in-situ applications for polyurethane foam increase, that the range or the ability of the dispensing gun to function for all such applications has to be improved. As a general example, the dispensing gun design has to be able to throttle or meter a fine bead of polyurethane froth in a sealant application where the kit is sold to seal spaces around window frames, door frames, and the like in the building trade. In contrast, where the kit is sold to form insulation, an ability to meter or flow a high volume flow of chemicals is required. Still yet, in an adhesive application, liquid spray patterns of various widths and thickness are required. While the “A” and “B” components for each of these applications are specially formulated and differ from one another, one dispensing gun for all such applications involving different formulations of the chemicals is needed.

[0016] At least one recurring quality issue facing the disposable polyurethane foam kit industry is the inability of end-users to effectively assess the core chemical temperature of the liquid and gas contents contained therein. Two important functions are often negatively impacted: achievement of maximum foam kit yield on the job site, and proper chemical cure of the “A” & “B” components.

[0017] Maximum yield is highly desired by purchasers of polyurethane foam kit products. If the chemicals are too cold for optimum use, the “B”-side viscosity increases, which in turn distorts the 1:1 ratio (by weight) required for proper yield. Lower-than-advertised yields carry significant economical consequences for the contractor.

[0018] Proper chemical cure (on-ratio ~1:1) is also critical to achieving maximum physical properties. It ensures that the cured foam meets building code specifications, e.g. fire ratings. In addition, a complete, on-ratio cure is critical for the health and safety of foam kit operators and building occupants. Again, cold chemical temperatures (below recommended) can create off-ratio foam, with the resulting incomplete chemical cure.

[0019] At least one important variable impacting the above issues is the core chemical temperature of the liquid/gas contents of the foam kit. The core chemical temperature of a kit before use must meet the manufacturer’s recommended temperature, usually ~75°F - 85°F, in order to meet the objectives of maximum yield and proper (complete) chemical cure. However, end-users typically do not condition the kits long enough at the recommended temperature. For example, kits stored in an unconditioned warehouse or

insulation truck in the winter months may have a core chemical temperature of only ~40°F. If dispensed without being conditioned for a sufficient amount of time, the result is foam of very poor physical quality and appearance. Also, improper chemical cure will most likely occur (unbalanced ratio of “A” to “B” chemical, which is typically 1:1 by weight). This “off-ratio” foam becomes a liability for the reasons mentioned above. It can take up to 48 hours to condition cylinders to the recommended chemical temperature, a recommendation often ignored by end-users.

[0020] The industry has long searched for an effective, economical way to allow end-users to gauge the core chemical temperature of a kit with a reasonable degree of qualitative accuracy before applying the foam. This invention utilizes thermochromism in both the nozzle and the hoses associated with the “A” and “B” chemicals to determine when the temperature of the chemicals falls within the acceptable use range, based upon the color change of the nozzle or hose due to a change in temperature of the flowing chemical.

Summary of the Invention

[0021] In accordance with the present invention, there is provided a frothable foam, the application temperature of which can be easily measured.

[0022] It is yet another aspect of the invention to provide a spray foam dispensing apparatus which includes: a container within which chemicals reside used to synthesize the foam, the container further comprising at least one pressurizing dispensing gas, and a dispensing conduit, the conduit consisting of at least a portion of metal or plastic and combinations thereof, the dispensing conduit comprising at least one thermochromic material which is disposed within the conduit when the at least a portion of the conduit is plastic and affixed thereupon or interposed within when the at least a portion of the conduit is metal.

[0023] In one aspect of the invention, the dispensing apparatus is a two-component spray gun which includes: a housing having a pair of inlet openings positioned in a canted orientation on top of the housing for insertion of an “A” and a “B” flexible plastic hose from respective “A” and “B” cylinders containing at least one chemical therein; the housing having a metering valve disposed within the housing; the housing having a removable plastic spray nozzle affixed to a front of the housing, the plastic spray nozzle comprising at least one thermochromic material disposed within or affixed thereupon the plastic nozzle.

[0024] In another aspect of the invention, the dispensing apparatus is a one-component spray canister containing multiple chemicals and said at least one pressurizing dispensing gas including: a canister having a single outlet valve; a plastic straw nozzle affixed to the outlet valve, the plastic straw nozzle comprising at least one thermochromic material disposed within or affixed thereupon said plastic nozzle.

[0025] In still another aspect of the invention, the dispensing apparatus is a one-component spray canister containing multiple chemicals including: a canister having a single outlet valve; a housing having one inlet for the canister affixed on top of the housing; the housing having a metering valve disposed within the housing;

the housing having an elongated metallic spray nozzle affixed to a front of the housing, the metallic spray nozzle comprising at least one thermochromic material either disposed within a plastic insert positioned along a length of the metallic spray nozzle or disposed within a plastic tip of the metallic spray nozzle or affixed thereupon the metallic spray nozzle.

[0026] The at least one thermochromic material is preferably a liquid crystal or a leuco dye. Often, at least two thermochromic materials are disposed within or thereupon said nozzle, each of the at least two thermochromic materials effecting a color change at a different temperature. In yet another aspect of the invention, at least three thermochromic materials are disposed within or thereupon the nozzle, each of the thermochromic materials effecting a color change at a different temperature.

[0027] In another aspect, at least one of the "A" and "B" plastic hoses affixed to the housing of the spray gun will have at least one thermochromic material disposed within or affixed thereupon the at least one plastic hoses.

[0028] Also disclosed is a process to determine if chemicals used to make a foam are at or above an acceptable use temperature range, the process comprising: using a dispensing apparatus having a nozzle comprising at least one thermochromic material contained therein or affixed thereupon. This may include monitoring at least one "A" or "B" side hose comprising at least one thermochromic material contained therein or affixed thereupon.

[0029] Also disclosed is a method of using a thermochromic dye to determine a temperature of dispensing chemicals comprising: actuating dispensing through a nozzle from a pressurized container within which chemicals reside used to synthesize a foam, the container further comprising at least one pressurizing dispensing gas; and monitoring dispensing temperature through a dispensing conduit, the conduit consisting of at least a portion of metal or plastic and combinations thereof, the dispensing conduit comprising at least one thermochromic material which is disposed within the conduit when the at least a portion of the conduit is plastic and affixed thereupon or interposed within when the at least a portion of the conduit is metal.

[0030] The step of actuating dispensing through a nozzle from a pressurized container is selected from the group consisting of: a two-component foam system and a one-component foam system; and further wherein the nozzle is selected from the group consisting of a removable plastic tip, a plastic straw, and an elongated metallic spray nozzle affixed to a front of a housing, the nozzles comprising at least one thermochromic material either disposed within the removable plastic tip, the plastic straw, or the plastic insert positioned along a length of the metallic spray nozzle or disposed within a plastic tip of the metallic spray nozzle or affixed thereupon the metallic spray nozzle.

Brief Description of the Drawings

[0032] The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in the specification and illustrated in the accompanying drawing which form a part hereof, and wherein:

[0033] *Figs. 1 & 2* are perspective views of the dispensing gun;

[0034] *Fig. 3* is a section view of the dispensing gun of the present invention taken generally along line 3 – 3 of *Fig. 1*;

[0035] *Fig. 4* is a section view of the dispensing gun of the present invention taken generally along line 4 – 4 of *Fig. 2*;

[0036] *Figs. 5 & 6* are perspective views of the nozzle;

[0037] *Fig. 7* is an exploded view of the nozzle shown in *Figs. 5 & 6*;

[0038] *Fig. 8* is a front view of the back plate used in the nozzle;

[0039] *Fig. 9* is a section view of the back plate taken generally along the lines designated 9 – 9 of *Fig. 8*;

[0040] *Fig. 10* is a top view of the back plate;

[0041] *Fig. 11* is a front view of the one-way valve;

[0042] *Fig. 12* is a cross-section view of the one-way valve of *Fig. 11* taken along line 12 – 12 of *Fig. 11*;

[0043] *Figs. 13A, 13B, & 13C* are schematic elevation views illustrating various positions of the metering rod in the valve seat of the gun;

[0044] *Figs. 14A & 14B* are schematic partially sectioned views indicating the position of the metering rod and trigger during operation of the dispensing gun of the present invention;

[0045] *Fig. 15* is a schematic section view of an alternative embodiment of the nozzle of the present invention;

[0046] *Fig. 16* is a section view of the nozzle taken along lines 16 – 16 of *Fig. 15*;

[0047] *Fig. 17* is an elevation view of the handle and trigger portions of the dispensing gun showing grooves for the lock tab of the dispensing gun;

[0048] *Fig. 18* is a front view of the nose surface of the dispensing gun of the present invention;

[0049] *Fig. 19* is a perspective view of a one-component straw foam in a pressurized container with insertable polymeric dispensing straw containing a thermochromic dye therein or thermochromic pigment affixed (printed) thereupon or thermochromic label affixed thereupon, the straw attached via threaded engagement with a mating dispensing valve inside the cap of the can; and

[0050] *Fig. 20* is a side perspective view of a one-component foam affixed to a dispensing gun having a primarily metallic nozzle, of which at least a portion of which has a thermochromic plastic component, the plastic component either being a thermochromic tip or thermochromic insert disposed between metallic components of the nozzle, or a thermochromic pigment affixed (printed) either directly onto the metallic component of the nozzle or upon a label affixed thereto.

[0051] ***Detailed Description of the Invention***

[0052] It is recognized that there are at least two locations at which point a temperature reading may be taken, namely on the exterior of each cylinder when "A" and "B" cylinders are used in a two-component application or on the exterior of a single cylinder (or canister) when a one-component application is being employed. While this gives an indication of temperature, research has indicated that it is not the best location to get an indication of the temperature of the reactant chemicals contained within the cylinder.

[0053] Studies have indicated that warming the chemicals resident within cylinders from a temperature of approximately 0°C (32°F) to the recommended foam spray dispensing temperature of between 21-27°C (75-85°F), can take approximately 36 hours, when in fact, a cylinder or canister temperature would indicate that the chemicals had reached the minimum temperature significantly earlier, thereby giving the user a false sense of security, due in large part to the varying latent heat capacities of the chemicals resident inside the cylinder. Further, it has been determined that rate of warming of the isocyanate cylinder is different (often by a factor of three) in comparison to the polyol cylinder. And further, the switch to blowing agents having higher boiling points (e.g., propellant 245fa (1,1,1,3,3-pentafluoropropane) has a boiling point of ~15.3°C (~59.5°F) in contrast to 134a (1,1,1,2-tetrafluoroethane) having a boiling point of ~-26.3°C (~-15.3°F)). Illustrative non-limiting examples of propellants (blowing agents) having higher boiling points include, but are not limited to HFC-245fa, HBA-2 (SOLSTICE™ LBA), FEA-1100, AFA-L1, AFA-L2, miscible blends and azeotropes thereof. The blowing agent preferably has a boiling point between approximately 10 – 40°C, although the applicability of the invention is useful for propellants having a boiling point lower than the range identified.

[0054] Temperature also has an impact on the viscosity of the resident chemicals in the cylinder(s) and/or canister, with cold temperature increasing the gap in viscosities, leading to differences in flow rates, which

leads to the formation of off-ratio foam. What the above observations have led to is that a more accurate indicator of the temperature of the resident chemicals is at the point of mixing, i.e., inside the nozzle, and more preferably, inside the nozzle of the gun, in contrast to measuring the skin temperature of the cylinder(s) or canister.

[0055] The invention relates to, as shown in perspective views in *Figs. 1 & 2*, an airless (as that term is previously defined) one- or two-component dispensing gun **10**. The gun depicted in the figure is a two-component gun. Dispensing gun **10** may be viewed as comprising a one-piece gun body **12** (which includes components to be described) to which is detachably secured a disposable nozzle **13**. In the preferred embodiment, the gun is molded from polypropylene and the nozzle is molded from an ABS (Acrylonitrile-Butadiene-Styrene) plastic. While one of the objects of the invention is to provide an inexpensive dispensing gun achieved in part by molding gun body **12** and nozzle **13** from plastic, the invention in its broader sense is not limited to a dispensing gun molded from the particular plastics specified nor, in fact, is the invention limited to a dispensing gun manufactured from plastic.

[0056] Gun body **12** may be further defined as having integral portions including a longitudinally-extending valve portion **15** to which nozzle **13** is connected and terminating at a longitudinally-extending trigger portion **16**, in turn, terminating at a longitudinally-extending spring portion **17** from which transversely extends a handle portion **18**. Within gun body housing **12** is a pair of hose openings **22, 23**, canted as shown, to which the "A" and "B" hoses (not shown) are attached, respectively, by conventional quick connect couplings or retaining mechanisms. Dispensing gun **10** is also provided with a trigger **20** extending within trigger body portion **16**. It should be appreciated that when the operator grasps dispensing gun **10** about handle **18** for finger actuation of trigger **20**, that the position of hose openings **22, 23** is such that the kit hoses will drape over the operator's forearm which surprisingly is preferred over other conventional hose attachment positions on the dispensing gun. For example, if the hose connections were attached to the handle bottom, it is possible for the hoses to become entangled with the operator's feet. If the hoses are attached to the rear end of the gun, the hoses rest on the operator's wrist. If the hoses are conventionally attached to the top of the gun, they can drape on either side of the gun and distort the pistol feel of the gun. Canting hose openings **22, 23** is thus believed to provide some ergonomic benefit while contributing to the improved performance of dispensing gun **10** as described below.

[0057] Referring now to *Figs. 3 & 4*, dispensing gun **10** is shown in vertical and horizontal cross-section views, respectively, to best illustrate the overall relationship of the gun components. In gun body valve portion **15**, there is formed a pair of parallel, open ended, laterally displaced and straight dispensing passages **25, 26** which are identical to one another so that a description of one dispensing passage such as a dispensing passage **25** for component "A" will apply to the other dispensing passage **26**. Within each dispensing passage is placed a longitudinally-extending metering rod **28** and the metering rod for dispensing the "A" component in passage **25** is not shown in *Fig. 4* for drawing clarity. Metering rod **28** will be defined in

further detail below but generally has tip section **29** at one end terminating in an intermediate sealing section **30**, in turn, terminating at a yoke collar section **31** at the opposite end of metering rod **28**. Metering rod sections **29**, **30** and **31** are cylindrical in the preferred embodiment but conceptually could be tubular. Each metering rod **28** has a pair of grooves **33** for an O-ring seal (not shown) to prevent the liquid component in dispensing passage **25** or **26** from escaping out end opening **34** in each dispensing passage **25**, **26** through which intermediate sealing section **30** extends. The opposite end opening of each dispensing passage **25**, **26** is formed as an especially configured valve seat **35** which will be explained in further detail below.

[0058] For consistency in terminology, when describing dispensing gun **10**, “longitudinal” will refer to the direction of the dispensing gun along the long axis of dispensing passage **25**, **26** of metering rods **28**, i.e., x – x plane; “transverse” will refer to the direction of the gun along the long axis of handle portion **18**, i.e., z – z plane; and, “laterally” will refer to the direction of the gun such as the distance spanning the spacing between dispensing passages **25**, **26**, i.e., the y – y plane.

[0059] Within valve body portion **15** are two laterally spaced and straight feed passages **37** in fluid communication at one end with a hose opening **22** or **23** and at the opposite end with a dispensing passage **25** or **26** at a position in a dispensing passage adjacent valve seat **35**. Feed passage **37** extends along an axis **38** which forms an acute angle of about 20° with dispensing passage **25** or **26**, preferably extending not greater than about 30°. The arrangement of feed passages **37**, dispensing passages **25**, **26** and metering rods **28** is believed to alleviate or reduce turbulent flow of the liquid components through dispensing gun **10**.

[0060] Referring still to *Figs. 3 & 4*, trigger **20** has a yoke crossbar portion **40** with a pair of elongated metering rod openings **41** formed therein through which intermediate sealing section **30** of each metering rod extends. Extending transversely from yoke crossbar portion **40** of trigger **20** in the direction of handle **18** is a recessed trigger lever **44**. Transversely extending from the opposite side of yoke crossbar portion **40** is a rounded trigger pivot portion **45**. Trigger pivot portion **45** fits within a U-shaped trigger recess **47** formed within trigger body portion **16**. Trigger pivot portion **45** is not pinned or journaled within U-shaped recess **47** and can be viewed as floating. Movement of trigger lever **44** causes trigger pivot **45** to pivot within trigger recess **47** moving yoke crossbar **40** into contact with yoke collar section **31** of each metering rod **28** in a manner which causes metering of the “A” and “B” liquid components as will be described further below.

[0061] Within spring body portion **17** of dispensing gun **10**, which is open ended, is positioned, a single spring **50**. Spring **50** is compressed between an inner spring retainer **51** and an outer spring retainer **52** which perhaps, as best shown in *Fig. 4*, has a bayonet clip which snaps into openings in spring body portion **17**. Inner spring retainer **51** has a pair of tubular projections **53** extending therefrom which fit within openings formed in the rear surface of yoke collar section **31**. The design of inner spring retainer **51** thus provides a form of alignment assuring equal travel of each metering rod **28** in dispensing passages **25**, **26**. In conventional, two-component dispensing guns in commercial use, separate springs are provided for each

metering rod (perhaps to provide different spring forces for each metering rod). As noted in the Background, the polyurethane foam or froth components under discussion are formulated to provide equal ratios of the "A" and "B" components. When separate springs are used, it is possible for one spring to set when compared to the other spring, tending to result in an off ratio dispensing gun. Two-component dispensing gun **10** of the present invention avoids this concern by using a single spring in combination with inner spring retainer **51** and yoke crossbar **40** of trigger **20** to assure that movement of trigger **20** will result in equal movement of both metering rods **28** in dispensing passages **25, 26**. Equal ratio metering is mechanically forced and the single spring **50** exerts a constant force on both metering rods **28** so that binding within metering rod openings **41** of trigger crossbar portion **40** does not occur.

[0062] Dispensing gun **10** is easily assembled. Trigger **20** is inserted into gun body **12** such that trigger pivot portion **45** is within trigger recess **47**. Each metering rod **28** is then inserted through spring body portion **17** into its dispensing passage **25** or **26**. Inner spring retainer **51** is then inserted within spring body portion **17**. Spring **50** is then inserted and compressed when outer spring retainer **52** is snapped by the bayonet clips into spring body portion **17**.

[0063] Referring now to *Figs. 5, 6 & 7*, nozzle **13** has an outlet tip section or outlet tip **58**, a mixing chamber section or a mixing chamber **59** and an inlet chamber section or inlet chamber **60**. Nozzle **13** is molded so that each section, **58, 59, 60** is an integral part of nozzle **13**. However, dispensing tip **58** can be separately molded and threaded into mixing chamber **59** to permit a variety of differently shaped dispensing tips **58** to be fitted to nozzle **13**. Alternatively, different tips may be threaded onto or into dispensing tip **58**. Different gun application may require different spray patterns other than the conical spray pattern which will be produced through nozzle tip opening **62** provided in dispensing tip **58** of nozzle **13** shown in *Figs. 5-7*. Making outlet tip **58** detachable from mixing chamber **59** such as by a threaded engagement, allows for a variety of spray patterns. Within mixing chamber **59**, which is cylindrical, is a conventional static mixer (illustrated schematically in part as reference numeral **63** in *Fig. 15*).

[0064] Nozzle design is essential to the proper functioning of any two-component dispensing gun. In accordance with the invention, inlet chamber **60** introduces the "A" and "B" components to static mixer **63** in a somewhat non-turbulent manner and with only minimal contact between the "A" and "B" components so that static mixer **63** can effectively perform its mixing function. More particularly, the shape, construction and relationship of inlet chamber **60** relative to dispensing passages **25, 26** and relative to mixing chamber **59** is important. Perhaps as best shown in *Figs. 15 & 18*, to which reference should be had, dispensing passages **25, 26** exit valve gun portion **15** at a flat nose surface **65** in valve body portion **15**. Flat nose surface **65** is defined by an edge from which an edge lip **66** protrudes. Edge lip **66**, in the preferred embodiment, is defined by two identical, laterally spaced semi-circular edge portions **67, 68** connected to one another by laterally extending straight edge portions **69, 70** transversely spaced from one another. Alternatively, and somewhat conceptually preferable, edge lip **66** could be circular.

[0065] Longitudinally-extending from nose surface **65** and concentric with semi-circular edge lip portion **67**, **68** are a pair of valve seat protrusions **72**, **73** forming or continuing the metering tip valve seats of dispensing passages **25**, **26** respectively. Each valve seat protrusion **72**, **73** has a flat end surface **74** through which a central valve seat opening **75** extends. Valve seat opening is the minor diameter of a frustoconical surface which defines valve seat **35** in the preferred embodiment.

[0066] Referring again to *Figs. 5, 6 & 7*, inlet chamber **60** of nozzle **13** has a collar section **76** extending from its entrance end which is in the shape of nose edge and fits within nozzle edge lip **66**. Extending laterally and transversely from the bottom portion of collar section **76** is a positioning tab **78**. When nozzle **13** is applied to dispensing gun **10**, positioning tab **78** fits within a nozzle recess **79** best shown as extending between dash lines in *Fig. 18* and shown in cross-section in *Fig. 3*. Extending transversely upward from collar section **76** is a latch **80** which has a lock surface **81** adapted to engage a snap ledge **82** longitudinally-extending from nose edge lip **66** in the rearward direction perhaps as best shown in *Fig. 3*. To apply, the gun operator grasps nozzle **13** by its outlet tip **58** and mixing chamber **59** and inserts positioning tab **78** into nozzle recess **79**. At this point, nozzle **13** will be at a slight downward angle relative to gun nose surface **65**. As the remaining portion of collar section **76** is brought within edge lip **66**, positioning tab **78** will rotate within nozzle recess **79** so that snap ledge **82** will snap into locking engagement with lock surface **81**. To remove nozzle **13**, the gun operator depresses latch tip **83** formed in latch **80** to unseat lock surface **81** on snap ledge **82**. Nozzle **13** can then be rotated so that positioning tab **78** can be lifted from nozzle recess **79**. The latch mechanism described in the preferred embodiment is particularly preferred because the rigidity of latch **80** can be designed in combination with the lever force exerted by the operator to achieve desired sealing of nozzle **13** to gun body **12**. However, other arrangements which will produce desired sealing can be employed. In particular, collar section **76** of nozzle **13** and edge lip **66** of gun nose surface **65** can be made circular and provided with a mason jar lid type thread. The pitch of the thread can be established to produce the desired sealing in less than 360° of rotation. Still another mechanism for attaching nozzle **13** to gun body **12** would be to simply provide the nozzle with opposing bayonet clips which would snap into recesses or clip holders foamed into gun body **12** adjacent nose surface **65** or vice-versa. Thus, in its broader sense, the invention contemplates attaching nozzle **13** to gun body **12** in a sealing manner either through pivoting such as shown by latch **80**, or by rotation such as by a threaded connection or by a straight, snap in connection such as achieved by bayonet type clips.

[0067] Referring now to *Figs. 7, 8, 9 & 10*, backplate **85** having an edge configuration similar to collar section **76** is permanently affixed to collar section **76** of nozzle **13**. Backplate **85** is "glued" to nozzle collar section **76** and is sealed thereto about its entire periphery. Because nozzle **13**, in the preferred embodiment, is an ABS plastic, it lends itself to "solvent welding" with a variety of common solvents. Backplate **85** has a forward surface **86** and a rearward surface **87** shaped as shown to provide a pair of cup shaped recesses **88** opening to nozzle face surface **65**. At the base of each cup shaped recess **88** is a valve extension opening **89** and a sealing rib **90** extends from the base of cup shaped recess **88** circumscribing valve seat extension

opening 89. Sealing rib 90 thus contacts flat end surface 74 of each valve seat protrusion when nozzle 13 is latched to gun body 12. Because the plastic composition of nozzle 13 has a different hardness than the plastic composition of body 12, a deformation will occur between sealing lip 90 and flat end surface 74 with the positive lock nozzle arrangement described above. In the preferred embodiment, nozzle 13 is harder than the plastic of gun body 12 so that sealing lip 70 will deform flat end surface 74 to effect sealing of nozzle 13 to gun body 12. However, the deformation from sealing is not beyond the memory of the plastic so that permanent set is not experienced in the gun body and any number of nozzles can be repeatedly sealed to gun body 12. Nozzle sealing conventionally occurs in commercial applications by means of conventional O-rings and like resilient seals.

[0068] Referring now to *Figs. 7, 8, 11 & 12*, a resilient strip 92 of flexible material such as any number of plastics (ABS is used in the preferred embodiment) or natural or synthetic rubber or similar elastomers is secured to rear surface 87 of backplate 85 by an attachment portion 93 wedged into centrally positioned attachment recess 94 formed in backplate 85 and opening to rearward surface 87 thereof. Resilient strip 92 as best shown in *Fig. 4* extends over to cover valve seat extension openings 89. Resilient strip 92 acts as a flapper valve to prevent crossover. When dispensing gun 10 is operated, pressure of the "A" and "B" liquid components will force resilient strip 92 to flex away from valve seat extension openings 89 to a flex position such as shown by the dash lines in *Fig. 15*. Should one of the components significantly drop in pressure, so that the pressure in nozzle inlet chamber 60 is greater than the pressure in one of the dispensing passages 25, 26, the resilient strip 92 will cover that dispensing passage's valve seat extension opening 89. This provides an effective one way valve positively sealing dispensing passages 25 and 26 in the event a crossover condition occurs. Preferably, a single resilient strip 92 as shown is utilized. However, each valve seat extension opening 89 can be provided with its own separate resilient strip of material 92. It must be noted that the flexibility of resilient strip 92 is a design variable. It is believed that resilient strip 92 aids in the fine metering characteristics of dispensing gun 10. As already noted, dispensing gun 10 is provided with a plurality of nozzles 13 having various outlet tip 58 configurations suitable for specific applications. In those applications requiring a small bead of polyurethane foam to be applied such as in a window frame sealant application, a nozzle having a relatively long outlet tip 58 with a narrow opening 62 is provided with a stiffer resilient strip 92 than that which may be provided in a universal nozzle provided with the kit. Still further, there are applications where full flow of the gun is required. For example, mining applications which use polyurethane foam to seal shaft "doors" or "bulkheads" in mine shafts in the event of a fire require the dispensing gun to meter the components at very high dispensing rates. In such applications, nozzle 13 would be supplied without resilient strip 92.

[0069] The choice of flexibility or rigidity of resilient strip 92 is believed to be a factor also with respect to "post" drip which is foam dripping from outlet tip 58 when dispensing gun 10 is stopped. To some extent post drip is inherent and will always occur because the components within static mixer of mixing chamber began to react and force the foam from outlet tip 58. It is believed that, depending on the rigidity of resilient strip 92, a

seal can be additionally maintained at valve seat extension opening **89**. The rigidity of resilient strip **92** has to be balanced against gun performance so that full flow performance is not adversely affected. However, to the extent resilient material **92** snaps back into contact with valve seat extension opening **89**, some additional sealing assistance in alleviating post drip may be present.

[0070] Referring still to *Figs. 5, 6 & 7*, it can be seen that the cross-sectional area of nozzle **13** at its entrance end, i.e., collar **76** is greater than the cross-sectional area of inlet chamber **60** at its exit end, i.e., the intersection with mixing chamber **59**. The nozzle wall forming inlet chamber **60** has semi-circular portions **96** corresponding to nose edge surfaces **67, 68** which take the shape of truncated cones as the nozzle extends from its entrance to its exit end. Similarly, the wall forming nozzle chamber **60** also has top and bottom flat portions **97** corresponding to nose straight edge surfaces **69, 70** which assume a triangular shape as inlet chamber **60** transitions from its entrance to its exit end. Generally speaking, inlet chamber **60** is in the shape of a funnel or a truncated cone. This configuration is believed to result in a somewhat smooth flow of the "A" and "B" liquid components into mixing chamber **59** as they travel through inlet chamber **60** after exiting valve seat extension openings **89**. That is, significant mixing or contact of the "A" and "B" components does not occur while components are flowing through inlet chamber **60**. In this regard, reference can be had to *Fig. 15* in which it can be seen that the flexure of resilient strip **92** will direct components "A" and "B" away from one another towards semi-circular portions **96** of inlet chamber **60**. It is, of course, understood that some quantity of the "A" and "B" components will contact one another at the center of inlet chamber **60**. It is not believed that the contact is detrimental to the gun operation because the flow within inlet chamber **60** is somewhat non-turbulent. Contact at the nozzle center will thus occur at a somewhat laminar flow condition while the components are directed into static mixer **63**. Further, there may be some benefit to a slight mixing contact just prior to entering mixing chamber **59**. The geometry of the centrally positioned valve seat protrusions **72, 73**, within nozzle inlet chamber **60** which is frustoconical in combination with resilient strip **92** provides a generally smooth, somewhat, non-turbulent flow of the "A" and "B" components, maintained somewhat separately, to the inlet of static mixer **63**. The flow does not experience any impingement against corners or dead end against any flat wall surfaces. Thus, the non-turbulent type flow of the "A" and "B" components within gun body **12** is carried through nozzle **13**.

[0071] It is to be appreciated that the interaction between the "A" and "B" components within nozzle **13** are complex. Further, the words "laminar" and "turbulent" are not used herein in their strict, classical sense but are used in a relative sense. Inlet chamber **60** is believed to be relatively "quiescent".

[0072] *Figs. 15 & 16* illustrate an alternative embodiment to nozzle **13** which can be utilized for applications requiring fine metering of the "A" and "B" components. In the alternative embodiment illustrated, a central wall **99** is provided. Central wall **99** extends from static mixer **63** to a distance short of resilient strip **92** so as not to affect flexure of resilient strip **92**. While wall **99** could be a flat, straight wall, it is preferred that the wall be curved such as shown in *Fig. 16* providing two truncated cone "A" and "B" component passage ways **100**,

101 in nozzle inlet chamber **60**. Truncated cone passageways **100**, **101** positively assure generally non-turbulent liquid component flow until the components reach static mixer **63**, which as noted above, enhance the metering characteristics of dispensing gun **10**. While wall **99** does not divide the nozzle into two separate compartments as in the known prior art nozzles, wall **99** serves to maintain the components separate at the inlet of mixing chamber **59**. The funneling nature of nozzle inlet chamber **60** is enhanced. While tests have not been conducted, some improvement in the "clogging" time is expected, and where the wall is curved, the possible adverse effects at very high flow may be somewhat alleviated.

[0073] Referring now to *Figs. 13A, 13B, & 13C*, tip section **29** of each metering rod **28** has a cylindrical tip portion **104** at its end terminating in a truncated cone or frustoconical portion **105** which in turn terminates in a larger cylindrical portion **106** which intersects with intermediate sealing section **30**. Metering tip section **29** as thus defined is conventional and is traditionally used in one-component dispensing guns and also used in two-component guns, although, when used in two-component guns, the metering tip has been used in combination with other valves.

[0074] Valve seat **35** is a frustoconical or truncated cone seat. Both frustoconical valve seat **35** and truncated cone metering rod portion **105** form the same angle with longitudinal centerline **109** of each dispensing passage **25**, **26** designated by reference arrow "A" in *Fig. 13B*. For reasons which will be discussed, truncated cone angle A is not to exceed about 10°. Frustoconical valve seat **35** reduces to a minimum at valve seat opening **75** in flat end surface **74** designated by reference letter B in *Fig. 13C* which is the minor diameter of the frustoconical surface forming valve seat **35**. Diameter B is slightly larger than the outside diameter of cylindrical tip portion **104**. In the preferred embodiment of the invention, valve seat extension opening **89** is cylindrical and has a diameter indicated by reference letter C in *Fig. 13C* which is equal to or greater than diameter B. However, in an alternative embodiment of the invention, diameter C is less than diameter B (but still greater than metering rod cylindrical tip portion **104**) and can extend for some slight distance (i.e., 1/8" to 1/4") into valve seat **35** before the valve seat assumes its conical configuration.

[0075] Each dispensing passage **25**, **26** is sealed when truncated cone portion **105** of metering rod **28** seats against frustoconical valve seat **35** as shown in *Fig. 13A*. When metering rod **28** initially is pulled rearward in dispensing passage **25** or **26**, the annular clearance space which exists between cylindrical tip portion **104** and valve seat extension opening **89** can function as the metering orifice and remains relatively constant until nozzle tip portion **104** exits valve seat extension opening **89** such as shown in *Fig. 13B*. When metering rod **28** is retracted to positions as shown in *Fig. 13B & 13C*, metering occurs at the distance or clearance (i.e., orifice) between the end of metering tip portion **104** and frustoconical valve seat **35**, generally in the annular space occupied by dot-dash lines **110** in *Figs. 13B & 13C* (technically dot-dash lines are perpendicular to frustoconical valve seat **35**). Specifically, the smallest (diametrical) opening, whether in valve seat extension opening **89** (designated by reference letter "C" in *Fig. 13C*) or in frustoconical valve seat **35** (designated by reference letter "B" in *Fig. 13C*) is larger in area than the clearance between cylindrical tip portion **104** and

frustoconical valve seat **35** lying generally along dot-dash line **110** throughout the travel of metering rod **28** (between full open and close portions of trigger lever **44**). If valve seat extension opening "C" **89** is sized significantly larger than the minimum diametrical opening of frustoconical valve seat **75**, (reference letter "B"), variable metering will occur once cylindrical tip **104** clears "B". If, in an alternative embodiment of the invention, valve seat extension opening "C" **89**, (and the extension of "C" into the frustoconical valve seat **35**) is sized smaller than the minor diameter of frustoconical valve seat **35** (i.e., the frusto-conical surface thereof), a somewhat constant "fine" metering of the components will occur until the end of cylindrical tip portion **104** reaches the frustoconical surface of frustoconical valve seat **35**.

[0076] Dimensionally the areas of cylindrical tip portion **104**, the truncated cone angle of metering rod **28** and frustoconical valve seat **35** (reference letter "A" less than **1020**), and the minor diameter of frustoconical valve seat **35** (reference letter "B") are selected so that the minimum annular clearance between cylindrical tip portion **104** and frustoconical valve seat **35** at the fully retracted position of metering rod **28**, i.e., full open, is equal to or less than the minimum diametrical opening **75** of frustoconical valve seat **35**, i.e., reference letter "B". In the preferred embodiment, the fully open portion of dispensing gun **10** establishes an orifice between metering rod cylindrical tip portion **104** and frustoconical valve seat **35** of about 94-96% of the area of valve seat opening **75**, defined, in the preferred embodiment as the minor diameter of frustoconical valve seat **35**. This relationship allows variable metering of the gun throughout its travel range. In all cases, metering rod tip portion **104** is within the frustoconical surface of frustoconical valve seat **35** and functions as the orifice. Valve seat extension opening **89**, in the preferred embodiment, is sized greater than minimum frustoconical diameter "B". In the alternative embodiment, the diameter of valve seat extension opening "C" is sized equal to or less than minimum frustoconical diametrical opening "B" for generally constant fine metering of the gun over an initial travel. In both embodiments, variable progressive metering occurs when cylindrical tip portion **104** is within the frustoconical surface of valve seat **35**.

[0077] Dispensing gun **10** of the present invention exhibits excellent metering characteristics throughout its range of travel. Without wishing to be bound by any theory of operation, it is believed the arrangement described is especially advantageous for polyurethane foam in which chemical components, such as fluorocarbons, expand from a liquid to a gaseous state at defined pressures for a given temperature. In particular, a pressure gradient exists about the variable orifice which, as defined, is the minimum distance between the frustoconical surface of frustoconical valve seat **35** and cylindrical tip portion **104** of metering rod **28**. As the orifice opens the gradient expands increasing the distance whereat state change of the chemical occurs. This result, in turn, increases the backpressure exerted by the components on the orifice as the gun is increasingly opened. This increase in backpressure is believed to partially account for the improved metering of dispensing gun **10** especially at higher flow conditions. Thus, dispensing gun **10** of the present invention is able to dispense the components at slow flow rates and controllably meter the components at high or full rates at the limits of the gun's travel.

[0078] It should be noted that the length of cylindrical tip portion **104** is not especially significant, about 1/8" in the preferred embodiment. While most dispensing guns employ some form of a pivot arm arrangement for the gun's trigger, and the travel of any pivoting lever can be increased by increasing the lever length, there is a limit to the lever length and it is desirable to provide some form of increased motion for the gun's trigger when fine metering of the "A" and "B" components is desired, whether the fine metering is progressively variable as in the preferred embodiment or constant for a fixed travel length as in the alternative embodiment.

[0079] Referring now to *Figs. 14A & 14B*, there is shown a pivoting arrangement used in dispensing gun **10** which provides increased travel of trigger **20** to enhance fine metering of dispensing gun **10** while also providing increased control of dispensing gun **10** at full flow conditions. Trigger body portion **16** as noted has a U-shaped trigger recess **47** formed therein. Trigger pivot portion **45** of trigger **20** simply fits within U-shaped recess **47** and because the curved portion of trigger pivot **45** is a sharper radius than that of trigger recess **47** there is some translational movement of trigger **20** when trigger lever **44** is moved such as shown when comparing the relative trigger positions of *Figs. 14A & 14B*. Thus, trigger pivot **45** is not fixed in the sense of being pinned or journaled within a fixed pivot. While spring **50** will maintain the curved surfaces together in rolling contact there will be some translation which is believed to assist in lever travel at the travel limits. Yoke crossbar portion **40** of trigger **20** at its intersection with elongated metering rod opening **41**, makes a line contact **112** with yoke collar section **31** of metering rod **28**. Yoke collar section **31** of metering rod **28** has a flat spring base surface **114** at its end, i.e., the end of metering rod **28**, and an annular surface **115** at the intersection of intermediate sealing section **30** with yoke collar section **31**. Annular surface **115** is chamfered (as a straight line) or curved or formed as a compound curve such as the S-shaped curve shown in *Figs. 14A & 14B*, to provide a camming surface for crossbar line contact **112**. Forming annular surface **115** as a camming surface allows increased motion of trigger lever **44** at the limits of longitudinal travel of metering rod **28**. The increased motion allows for better operator control and gun feel for fine and full open metering applications.

[0080] Referring now to *Figs. 1, 3 & 17* (in which handle body portion **18** has been "sliced" to better illustrate the invention) trigger lever **44** is formed with a trigger lever recess **117** which faces or opens to handle body portion **18**. Within trigger lever recess **117** is lock tab **120** which at one end has ears **121** snapped into openings formed in trigger lever **44** so that lock tab **120** is pivotal into and out of trigger lever recess **117**. Handle body portion **18** has its surface which faces trigger lever **44** in the form of a curve or arc indicated by dot-dash line **121** in *Fig. 17* from which a series of indentations forming grooves are formed. In particular, one groove is formed as a locking groove **122** into which lock tab **120** is positioned as shown in *Figs. 1-3* and at which trigger **20** is locked to render the gun inoperable. In accordance, however, with the fine metering aspects of the invention, additional grooves **123** and **124** are also provided which allow some motion of trigger lever **44** until locking tab seats in the groove. In accordance with the preferred embodiment, grooves **123, 124** provide a fixed stop corresponding to a fixed orifice size between cylindrical tip portion **104** of metering rod **28** and frustoconical valve seat **35**. In accordance with the alternative embodiment, (smaller

orifice "C") very fine metering groove **123** establishes a generally constant, very fine metering stop. In order to provide positive placement of lock tab **120**, bumps or protrusions **125** can be formed within trigger lever recess **117** at which lock tab **120** assumes a pivoted position engaging the intended locking groove.

[0081] Referring back to *Fig. 5*, the ability to determine the chemical temperature as it exits the "A" and "B" cylinders through respective "A" and "B" flexible plastic hoses (not shown) or the ability to determine the chemical temperature as it enters and/or exits disposable nozzle **13** is effected either by having a thermochromic material contained within the plastic used to mold disposable nozzle **13** or to fabricate the flexible plastic hoses. Still another approach involves affixing label **130** either permanently using a permanent adhesive or non-permanently, using a pressure-sensitive adhesive (the label optionally having thermochromic text or thermochromic graphic material printed thereupon) which changes in one instance from colored (below the recommended use temperature, illustrated by the text "Cold" in the figure), to colorless or a different color when the chemicals have transferred a sufficient amount of heat to the nozzle or label.

[0082] Referring to *Fig. 19*, the invention is not limited to two-component foams as described above, but is also applicable to one-component foams, which are dispensed from single pressurized canisters **150**. These pressurized canisters have a generally cylindrical body **154** for storage of the chemicals which react with moisture in the air to form the foam and are dispensed through a valve (not shown) positioned underneath removable cap **152**. In operation plastic straw dispensing nozzle **160** is matingly engaged with the dispensing valve by mating threads **164** on the proximal end **158** of the straw. As illustrated in the figure, distal end **164** is often molded at an acute angle to the longitudinal axis of proximal end **158**. Trigger **162** is positioned normal to the longitudinal end and often contains at least one scallop shape for grasping by a user's fingers when dispensing one-component foam. The temperature-indicating aspect of the invention may be achieved by the incorporation of a thermochromic dye or pigment into the polymer used to make the straw nozzle, or by the incorporation of a thermochromic paint or dye affixed (printed) onto the straw nozzle, or by the affixing (permanently or removably) of a label containing at least some thermochromic material on or within the label. When employing labels, the adhesive (permanent or removable) must not be a temperature insulator, but rather must conduct thermal energy (heat) or the lack of thermal energy (cool) through the adhesive and into the label so that the end-user will be able to determine if the proper chemical reaction temperature is being employed during the foaming process.

[0083] Referring to *Fig. 20*, a further variation is disclosed and described in which a one-component foam **170** is dispensed through a combination of pressurized canister **172** in combination with foam spray dispensing gun **180**. The one-component foam pressurized canister has a generally cylindrical body **172** with a peripherally protruding lip **174** upon which is frictionally fit a cap such as is illustrated in *Fig. 19* at **152**. Not illustrated is valve and valve stem positioned at the apex of dome **176**, but rather valve stem is matingly inserted into collar **178** of dispensing spray gun **180**. The gun includes angled handle **182** and pivotally connected squeezable trigger **186** which controls longitudinal axial movement of a needle valve within

housing **190** by housing body **188**. Fine metering control is effected through rotatable knob **184**. Upon opening of the needle valve by squeezing trigger **186** toward handle **182**, chemicals resident within cylindrical housing **172** begin to be dispensed through metallic nozzle **192**. While metallic nozzle is a generally elongated hollow cylinder, in one aspect of this invention, the metallic nozzle is comprised of reducing frustoconical segment **196** and an insertable nozzle tip segment **198a** or **198b**.

[0084] In one embodiment, nozzle tip **198a**, frustoconical segment **196** and nozzle **192** are all metallic, in which case, temperature sensing of the dispensing chemicals is monitored either through a thermochromic label **194** affixed to nozzle **192** or by affixing (printing) thermochromic letters or designs on nozzle **192**. As with *Fig. 19*, when employing labels, the adhesive (permanent or removable) must not be a temperature insulator, but rather must conduct thermal energy (heat) or the lack of thermal energy (cool) through the adhesive and into the label so that the end-user will be able to determine if the proper chemical reaction temperature is being employed during the foaming process. In another embodiment, nozzle tip **198a** and nozzle **192** are constructed out of metal and frustoconical segment **196** is plastic, this segment insertable into the proximal end of nozzle tip **198a** and the distal end of nozzle **192**. The temperature-indicating aspect of the invention may be achieved by the incorporation of a thermochromic dye or pigment into the polymer used to make frustoconical segment **196**. In yet another embodiment, nozzle **192** is metal, frustoconical segment and nozzle tip **198b** are both plastic with the thermochromic dye or pigment incorporated into at least one of the nozzle tip or the frustoconical segment. In yet another embodiment, only nozzle tip **198c** is plastic and insertable into frustoconical segment **196**.

[0085] Thermochromism is typically implemented via one of two common approaches: liquid crystals and leuco dyes. Liquid crystals are used in precision applications, as their responses can be engineered to accurate temperatures, but their color range is limited by their principle of operation. Leuco dyes allow wider range of colors to be used, but their response temperatures are more difficult to set with accuracy.

[0086] Some liquid crystals are capable of displaying different colors at different temperatures. This change is dependent on selective reflection of certain wavelengths by the crystalline structure of the material, as it changes between the low-temperature crystalline phase, through anisotropic chiral or twisted nematic phase, to the high-temperature isotropic liquid phase. Only the nematic mesophase has thermochromic properties. This restricts the effective temperature range of the material.

[0087] The twisted nematic phase has the molecules oriented in layers with regularly changing orientation, which gives them periodic spacing. The light passing through the crystal undergoes Bragg diffraction on these layers, and the wavelength with the greatest constructive interference is reflected back, which is perceived as a spectral color. A change in the crystal temperature can result in a change of spacing between the layers and therefore in the reflected wavelength. The color of the thermochromic liquid crystal can therefore continuously range from non-reflective (black) through the spectral colors to black again, depending on the temperature. Typically, the high temperature state will reflect blue-violet, while the low-temperature

state will reflect red-orange. Since blue is a shorter wavelength than red, this indicates that the distance of layer spacing is reduced by heating through the liquid-crystal state.

[0088] Some such materials are cholesteryl nonanoate or cyanobiphenyls. Liquid crystals used in dyes and inks often come microencapsulated, in the form of suspension. Liquid crystals are used in applications where the color change has to be accurately defined.

[0089] Thermochromic dyes are based on mixtures of leuco dyes with suitable other chemicals, displaying a color change (usually between the colorless leuco form and the colored form) in dependence on temperature.

The dyes are rarely applied on materials directly; they are usually in the form of microcapsules with the mixture sealed inside. An illustrative example would include microcapsules with crystal violet lactone, weak acid, and a dissociable salt dissolved in dodecanol; when the solvent is solid, the dye exists in its lactone leuco form, while when the solvent melts, the salt dissociates, the pH inside the microcapsule lowers, the dye becomes protonated, its lactone ring opens, and its absorption spectrum shifts drastically, therefore it becomes deeply violet. In this case the apparent thermochromism is in fact halochromism.

[0090] The dyes most commonly used are spirolactones, fluorans, spiropyrans, and fulgides. The weak acids include bisphenol A, parabens, 1,2,3-triazole derivatives, and 4-hydroxycoumarin and act as proton donors, changing the dye molecule between its leuco form and its protonated colored form; stronger acids would make the change irreversible.

[0091] Leuco dyes have less accurate temperature response than liquid crystals. They are suitable for general indicators of approximate temperature. They are usually used in combination with some other pigment, producing a color change between the color of the base pigment and the color of the pigment combined with the color of the non-leuco form of the leuco dye. Organic leuco dyes are available for temperature ranges between about 23°F (−5°C) and about 140°F (60°C), in wide range of colors. The color change usually happens in about a 5.4°F (3°C) interval.

[0092] The size of the microcapsules typically ranges between 3–5 μm (over 10 times larger than regular pigment particles), which requires some adjustments to printing and manufacturing processes.

[0093] Thermochromic paints use liquid crystals or leuco dye technology. After absorbing a certain amount of light or heat, the crystalline or molecular structure of the pigment reversibly changes in such a way that it absorbs and emits light at a different wavelength than at lower temperatures.

[0094] The thermochromic dyes contained either within or affixed upon either the disposable nozzle or hoses may be configured to change the color of the composition in various ways. For example, in one embodiment, once the composition reaches a selected temperature, the composition may change from a base color to a white color or a clear color. In another embodiment, a pigment or dye that does not change

color based on temperature may be present for providing a base color. The thermochromic dyes, on the other hand, can be included in order to change the composition from the base color to at least one other color.

[0095] In one particular embodiment, the plurality of thermochromic dyes are configured to cause the cleansing composition to change color over a temperature range of at least about 3°C., such as at least about 5°C., once the composition is heated to a selected temperature. For example, multiple thermochromic dyes may be present within the cleansing composition so that the dyes change color as the composition gradually increases in temperature. For instance, in one embodiment, a first thermochromic dye may be present that changes color at a temperature of from about 23°C to about 28°C and a second thermochromic dye may be present that changes color at a temperature of from about 27°C to about 32°C. If desired, a third thermochromic dye may also be present that changes color at a temperature of from about 31°C to about 36°C. In this manner, the cleansing composition changes color at the selected temperature and then continues to change color in a stepwise manner as the temperature of the composition continues to increase. It should be understood that the above temperature ranges are for exemplary and illustrative purposes only.

[0096] Any thermochromic substance that undergoes a color change at the desired temperature may generally be employed in the present disclosure. For example, liquid crystals may be employed as a thermochromic substance in some embodiments. The wavelength of light ("color") reflected by liquid crystals depends in part on the pitch of the helical structure of the liquid crystal molecules. Because the length of this pitch varies with temperature, the color of the liquid crystals is also a function of temperature. One particular type of liquid crystal that may be used in the present disclosure is a liquid crystal cholesterol derivative. Exemplary liquid crystal cholesterol derivatives may include alkanoic and aralkanoic acid esters of cholesterol, alkyl esters of cholesterol carbonate, cholesterol chloride, cholesterol bromide, cholesterol acetate, cholesterol oleate, cholesterol caprylate, cholesterol oleyl-carbonate, and so forth. Other suitable liquid crystal compositions are possible and contemplated within the scope of the invention.

[0097] In addition to liquid crystals, another suitable thermochromic substance that may be employed in the present disclosure is a composition that includes a proton accepting chromogen ("Lewis base") and a solvent. The melting point of the solvent controls the temperature at which the chromogen will change color. More specifically, at a temperature below the melting point of the solvent, the chromogen generally possesses a first color (e.g., red). When the solvent is heated to its melting temperature, the chromogen may become protonated or deprotonated, thereby resulting in a shift of the absorption maxima. The nature of the color change depends on a variety of factors, including the type of proton-accepting chromogen utilized and the presence of any additional temperature-insensitive chromogens. Regardless, the color change is typically reversible.

[0098] Although not required, the proton-accepting chromogen is typically an organic dye, such as a leuco dye. In solution, the protonated form of the leuco dye predominates at acidic pH levels (e.g., pH of about 4 or less). When the solution is made more alkaline through deprotonation, however, a color change occurs. Of

course, the position of this equilibrium may be shifted with temperature when other components are present. Suitable and non-limiting examples of leuco dyes for use in the present disclosure may include, for instance, phthalides; phthalanes; substituted phthalides or phthalanes, such as triphenylmethane phthalides, triphenylmethanes, or diphenylmethanes; acyl-leucomethylene blue compounds; fluoranes; indolylphthalides, spiropyrans; cumarins; and so forth. Exemplary fluoranes include, for instance, 3,3'-dimethoxyfluorane, 3,6-dimethoxyfluorane, 3,6-di-butoxyfluorane, 3-chloro-6-phenylamino-fluorane, 3-diethylamino-6-dimethylfluorane, 3-diethylamino-6-methyl-7-chlorofluorane, and 3-diethyl-7,8-benzofluorane, 3,3'-bis-(p-dimethyl-aminophenyl)-7-phenylaminofluorane, 3-diethylamino-6-methyl-7-phenylamino-fluorane, 3-diethylamino-7-phenyl-aminofluorane, and 2-anilino-3-methyl-6-diethylamino-fluorane. Likewise, exemplary phthalides include 3,3',3''-tris(p-dimethylamino-phenyl)phthalide, 3,3'-bis(p-dimethyl-aminophenyl)phthalide, 3,3-bis(p-diethylamino-phenyl)-6-dimethylamino-phthalide, 3-(4-diethylaminophenyl)-3-(1-ethyl-2-methylindol-3-yl)phthalide, and 3-(4-diethylamino-2-methyl)phenyl-3-(1,2-dimethylindol-3-yl)phthalide.

[0099] Although any solvent for the thermochromic dye may generally be employed in the present disclosure, it is typically desired that the solvent have a low volatility. For example, the solvent may have a boiling point of about 150°C or higher, and in some embodiments, from about 170°C to 280°C. Likewise, the melting temperature of the solvent is also typically from about 25°C to about 40°C, and in some embodiments, from about 30°C to about 37°C. Examples of suitable solvents may include saturated or unsaturated alcohols containing about 6 to 30 carbon atoms, such as octyl alcohol, dodecyl alcohol, lauryl alcohol, cetyl alcohol, myristyl alcohol, stearyl alcohol, behenyl alcohol, geraniol, etc.; esters of saturated or unsaturated alcohols containing about 6 to 30 carbon atoms, such as butyl stearate, methyl stearate, lauryl laurate, lauryl stearate, stearyl laurate, methyl myristate, decyl myristate, lauryl myristate, butyl stearate, lauryl palmitate, decyl palmitate, palmitic acid glyceride, etc.; azomethines, such as benzylideneaniline, benzylidenelaurylamide, o-methoxybenzylidene laurylamine, benzylidene p-toluidine, p-cumylbenzylidene, etc.; amides, such as acetamide, stearamide, etc.; and so forth.

[0100] The thermochromic composition may also include a proton-donating agent (also referred to as a "color developer") to facilitate the reversibility of the color change. Such proton-donating agents may include, for instance, phenols, azoles, organic acids, esters of organic acids, and salts of organic acids. Exemplary phenols may include phenylphenol, bisphenol A, cresol, resorcinol, chlorolucinol, b-naphthol, 1,5-dihydroxynaphthalene, pyrocatechol, pyrogallol, trimer of p-chlorophenol-formaldehyde condensate, etc. Exemplary azoles may include benzotriazoles, such as 5-chlorobenzotriazole, 4-laurylamino-sulfobenzotriazole, 5-butylbenzotriazole, dibenzotriazole, 2-oxybenzotriazole, 5-ethoxycarbonylbenzotriazole, etc.; imidazoles, such as oxybenzimidazole, etc.; tetrazoles; and so forth. Exemplary organic acids may include aromatic carboxylic acids, such as salicylic acid, methylenebissalicylic acid, resorcylic acid, gallic acid, benzoic acid, p-oxybenzoic acid, pyromellitic acid, b-naphthoic acid, tannic acid, toluic acid, trimellitic acid, phthalic acid, terephthalic acid, anthranilic acid, etc.; aliphatic carboxylic acids, such as stearic acid, 1,2-hydroxystearic acid, tartaric acid, citric acid, oxalic acid, lauric acid, etc.; and so forth. Exemplary esters may include alkyl

esters of aromatic carboxylic acids in which the alkyl moiety has 1 to 6 carbon atoms, such as butyl gallate, ethyl p-hydroxybenzoate, methyl salicylate, etc.

[0101] The amount of the proton-accepting chromogen employed may generally vary, but is typically from about 2 wt. % to about 20 wt. %, and in some embodiments, from about 5 to about 15 wt. % of the thermochromic substance. Likewise, the proton-donating agent may constitute from about 5 to about 40 wt. %, and in some embodiments, from about 10 wt. % to about 30 wt. % of the thermochromic substance. In addition, the solvent may constitute from about 50 wt. % to about 95 wt. %, and in some embodiments, from about 65 wt. % to about 85 wt. % of the thermochromic composition.

[0102] Regardless of the particular thermochromic substance employed, it may be microencapsulated to enhance the stability of the substance during processing. For example, the thermochromic substance may be mixed with a thermosetting resin according to any conventional method, such as interfacial polymerization, in-situ polymerization, etc. The thermosetting resin may include, for example, polyester resins, polyurethane resins, melamine resins, epoxy resins, diallyl phthalate resins, vinylester resins, and so forth. The resulting mixture may then be granulated and optionally coated with a hydrophilic macromolecular compound, such as alginic acid and salts thereof, carrageenan, pectin, gelatin and the like, semisynthetic macromolecular compounds such as methylcellulose, cationized starch, carboxymethylcellulose, carboxymethylated starch, vinyl polymers (e.g., polyvinyl alcohol), polyvinylpyrrolidone, polyacrylic acid, polyacrylamide, maleic acid copolymers, and so forth. The resulting thermochromic microcapsules typically have a size of from about 1 to about 50 micrometers, and in some embodiments, from about 3 to about 15 micrometers. Various other microencapsulation techniques may also be used.

[0103] Thermochromic dyes are commercially available from various sources. In one embodiment, for instance, thermochromic dyes marketed by Chromadic creations, Hamilton, Ontario and sold under the trade name SpectraBurst Thermochromic Polypropylene.

[0104] The thermochromic dyes can be present in the composition in an amount sufficient to have a visual effect on the color of the composition. The amount or concentration of the dyes can also be increased or decreased depending upon the desired intensity of any color. In general, the thermochromic dyes may be present in the composition in an amount from about 0.01% by weight to about 9% by weight, such as from about 0.1% by weight to about 3% by weight. For instance, in one particular embodiment, the thermochromic dyes may be present in an amount from about 0.3% to about 1.5% by weight.

[0105] As described above, thermochromic dyes typically change from a specific color to clear at a certain temperature, e.g., dark blue below 60°F to transparent or translucent above 60°F. If desired, other pigments or dyes can be added to the composition in order to provide a background color that remains constant independent of the temperature of the composition. By adding other pigments or dyes in combination with the thermochromic dyes to the composition, the thermochromic dyes can provide a color change at certain temperatures rather than just a loss of color should the thermochromic dye become clear. For instance, a

non-thermochromic pigment, such as a yellow pigment, may be used in conjunction with a plurality of thermochromic dyes, such as a red dye and a blue dye. When all combined together, the cleansing composition may have a dark color. As the composition is increased in temperature, the red thermochromic dye may turn clear changing the color to a green shade (a combination of yellow and blue). As the temperature further increases, the blue thermochromic dye turns clear causing the composition to turn yellow.

[0106] It should be understood, that all different sorts of thermochromic dyes and non-thermochromic pigments and dyes may be combined in order to produce a composition having a desired base color and one that undergoes desired color changes. The color changes, for instance, can be somewhat dramatic and fanciful. For instance, in one embodiment, the composition may change from green to yellow to red.

[0107] In an alternative embodiment, however, the composition can contain different thermochromic dyes all having the same color. As the temperature of the composition is increased, however, the shade or intensity of the color can change. For instance, the composition can change from a vibrant blue to a light blue to a clear color.

[0108] In addition to the above, it should be understood that many alterations and permutations are possible. Any of a variety of colors and shades can be mixed in order to undergo color changes as a function of temperature.

[0109] The best mode for carrying out the invention has been described for purposes of illustrating the best mode known to the applicant at the time. The examples are illustrative only and not meant to limit the invention, as measured by the scope and merit of the claims. The invention has been described with reference to preferred and alternate embodiments. Obviously, modifications and alterations will occur to others upon the reading and understanding of the specification. It is intended to include all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

What is claimed is:

1. A spray foam dispensing apparatus comprising:
 - a container within which chemicals reside used to synthesize said foam, said container further comprising at least one pressurizing dispensing propellant; and
 - a dispensing conduit, the conduit consisting of at least a portion of metal or plastic and combinations thereof, the dispensing conduit comprising at least one thermochromic material which is disposed within the conduit when the at least a portion of the conduit is plastic and affixed thereupon or interposed within when the at least a portion of the conduit is metal,
 - said thermochromic material changing color by measuring the temperature of either the high volume flow of pressurized chemicals or high volume flow of synthesized froth foam or both flowing through said plastic nozzle to illustrate to the end-user of the spray gun if the pressurized chemicals and propellant used to prepare the polyurethane foam or the polyurethane froth are at a minimum temperature for proper chemical cure, the propellant comprising a fluorocarbon and an inert gas in which the propellant enters into the nozzle as a liquid component under pressure and changes to a gaseous state component during travel through the nozzle and egress therefrom into the environment with turbulent flow between the liquid components, gaseous components and synthesized froth foam.
2. The dispensing apparatus of claim 1 wherein said dispensing apparatus is a two-component spray gun comprising:
 - a housing having a pair of inlet openings positioned in a canted orientation on top of said housing for insertion of an "A" and a "B" flexible plastic hose from respective "A" and "B" cylinders containing at least one chemical therein;
 - said housing having a metering valve disposed within said housing;
 - said housing having a removable plastic spray nozzle affixed to a front of said housing, said plastic spray nozzle comprising at least one thermochromic material disposed within or affixed thereupon said plastic nozzle.
3. The dispensing apparatus of claim 1 wherein said dispensing apparatus is a one-component spray canister containing multiple chemicals and said at least one pressurizing dispensing propellant comprising:
 - a canister having a single outlet valve;
 - a plastic straw nozzle affixed to the outlet valve, the plastic straw nozzle comprising at least one thermochromic material disposed within or affixed thereupon said plastic nozzle.

4. The dispensing apparatus of claim 1 wherein said dispensing apparatus is a one-component spray canister containing multiple chemicals comprising:
 - a canister having a single outlet valve;
 - a housing having one inlet for said canister affixed on top of said housing;
 - said housing having a metering valve disposed within said housing;
 - said housing having an elongated metallic spray nozzle affixed to a front of said housing, said metallic spray nozzle comprising at least one thermochromic material either disposed within a plastic insert positioned along a length of the metallic spray nozzle or disposed within a plastic tip of the metallic spray nozzle or affixed thereupon the metallic spray nozzle.
5. The spray gun of any one of claims 1 to 3 wherein
 - said at least one thermochromic material is a liquid crystal or a leuco dye.
6. The spray gun of any one of claims 1 to 3 wherein
 - said at least one thermochromic material is at least two thermochromic materials disposed within or thereupon said nozzle, each of said at least two thermochromic materials effecting a color change at a different temperature.
7. The spray gun of claim 6 wherein
 - said at least one thermochromic material is at least three thermochromic materials disposed within or thereupon said nozzle, each of said at least three thermochromic materials effecting a color change at a different temperature.
8. The spray gun of claim 2 wherein
 - at least one of said "A" and "B" plastic hoses affixed to said housing of said spray gun comprise at least one thermochromic material disposed within or affixed thereupon said at least one plastic hoses.
9. The spray gun of claim 8 wherein
 - said at least one thermochromic material is a liquid crystal or a leuco dye.
10. The spray gun of claim 8 or 9 wherein
 - said thermochromic material is affixed upon at least one of said plastic hoses by a label containing said at least one thermochromic material.
11. The spray gun of claim 8 wherein

said at least one thermochromic material is at least two thermochromic materials disposed within or thereupon said at least one plastic hose, each of said at least two thermochromic materials effecting a color change at a different temperature.

12. The spray gun of claim 6 wherein

said at least one thermochromic material is at least three thermochromic materials disposed within or thereupon said at least one plastic hose, each of said at least three thermochromic materials effecting a color change at a different temperature.

13. The spray gun of any one of claims 1 to 12 wherein

said propellant is selected from the group consisting of HFC-245fa, HBA-2 (SOLSTICE™ LBA), FEA-1100, AFA-L1, AFA-L2, miscible blends and azeotropes thereof; and further wherein the blowing agent has a boiling point between approximately 10 – 40°C.

14. A process to determine if chemicals used to make a foam are at or above an acceptable use temperature range, the process comprising:

using a dispensing apparatus having a nozzle comprising at least one thermochromic material contained therein or affixed thereupon,

said thermochromic material changing color by measuring the temperature of either the high volume flow of pressurized chemicals or high volume flow of synthesized froth foam or both flowing through said plastic nozzle to illustrate to the end-user of the spray gun if the pressurized chemicals and propellant used to prepare the polyurethane foam or the polyurethane froth are at a minimum temperature for proper chemical cure, the propellant comprising a fluorocarbon and an inert gas in which the propellant enters into the nozzle as a liquid component under pressure and changes to a gaseous state component during travel through the nozzle and egress therefrom into the environment with turbulent flow between the liquid components, gaseous components and synthesized froth foam.

15. The process of claim 14 which further comprises:

using at least one “A” or “B” side hose comprising at least one thermochromic material contained therein or affixed thereupon.

16. The process of claim 14 wherein

said nozzle is a removable plastic nozzle; and

said at least one thermochromic material is a liquid crystal or a leuco dye.

17. The process of claim 14 wherein

said nozzle is a plastic straw nozzle; and

said at least one thermochromic material is a liquid crystal or a leuco dye.

18. The process of claim 14 wherein

said nozzle is an elongated metallic spray nozzle affixed to a front of said housing, said metallic spray nozzle comprising at least one thermochromic material either disposed within a plastic insert positioned along a length of the metallic spray nozzle or disposed within a plastic tip of the metallic spray nozzle or affixed thereupon the metallic spray nozzle.

19. A method of using a thermochromic dye to determine a temperature of dispensing chemicals comprising:

actuating dispensing through a nozzle from a pressurized container within which chemicals reside used to synthesize a foam, said container further comprising at least one pressurizing dispensing propellant; and

monitoring dispensing temperature through a dispensing conduit, the conduit consisting of at least a portion of metal or plastic and combinations thereof, the dispensing conduit comprising at least one thermochromic material which is disposed within the conduit when the at least a portion of the conduit is plastic and affixed thereupon or interposed within when the at least a portion of the conduit is metal,

said thermochromic material changing color by measuring the temperature of either the high volume flow of pressurized chemicals or high volume flow of synthesized froth foam or both flowing through said plastic nozzle to illustrate to the end-user of the spray gun if the pressurized chemicals and propellant used to prepare the polyurethane foam or the polyurethane froth are at a minimum temperature for proper chemical cure, the propellant comprising a fluorocarbon and an inert gas in which the propellant enters into the nozzle as a liquid component under pressure and changes to a gaseous state component during travel through the nozzle and egress therefrom into the environment with turbulent flow between the liquid components, gaseous components and synthesized froth foam.

20. The process of claim 19 wherein said step of actuating dispensing through a nozzle from a pressurized container is selected from the group consisting of

a two-component foam system and a one-component foam system; and further wherein

said nozzle is selected from the group consisting of a removable plastic tip, a plastic straw, and an elongated metallic spray nozzle affixed to a front of a housing,

said nozzles comprising at least one thermochromic material either disposed within the removable plastic tip, the plastic straw, or the plastic insert positioned along a length of the metallic spray nozzle or disposed within a plastic tip of the metallic spray nozzle or affixed thereupon the metallic spray nozzle.

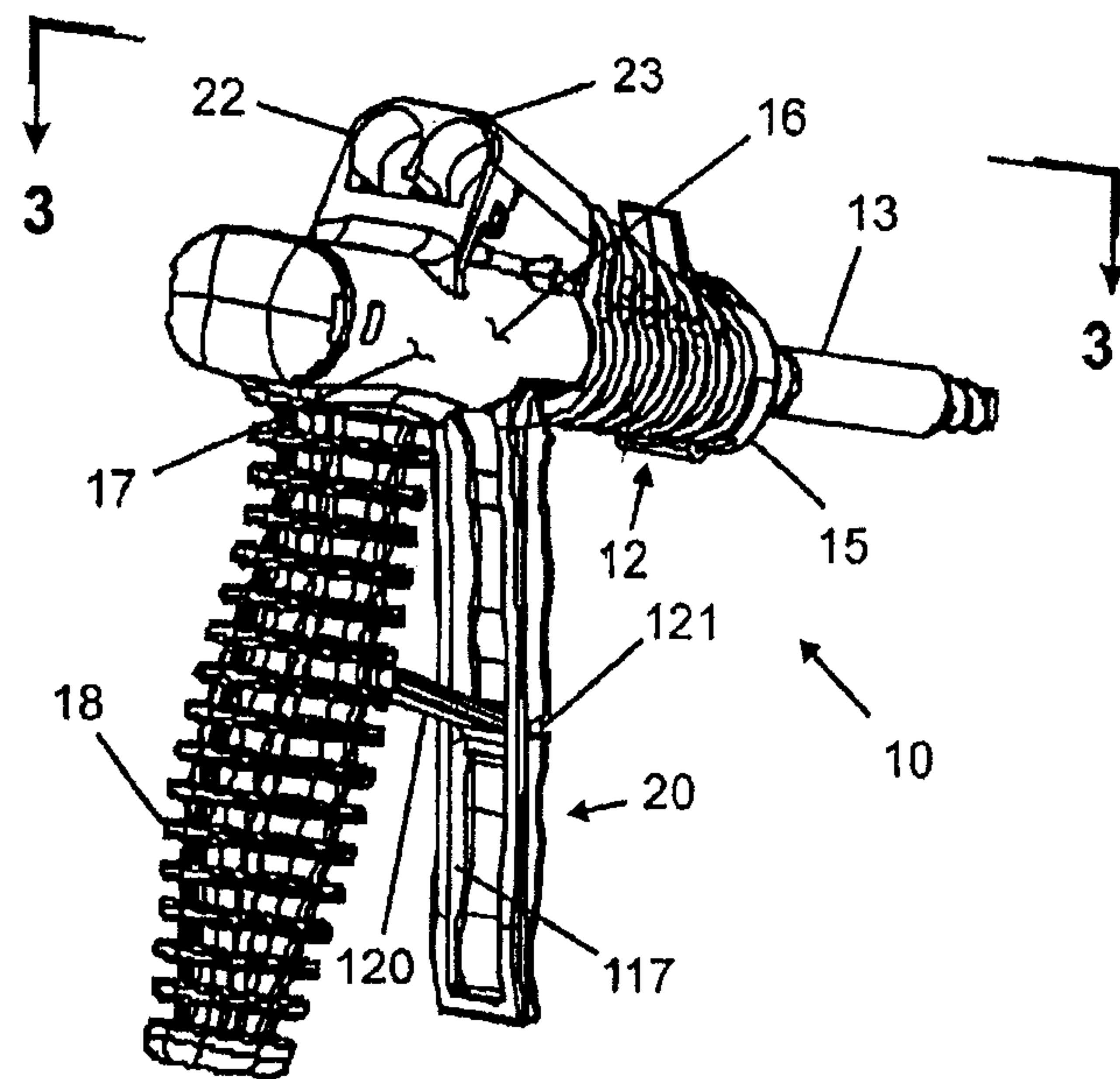


FIG. 1

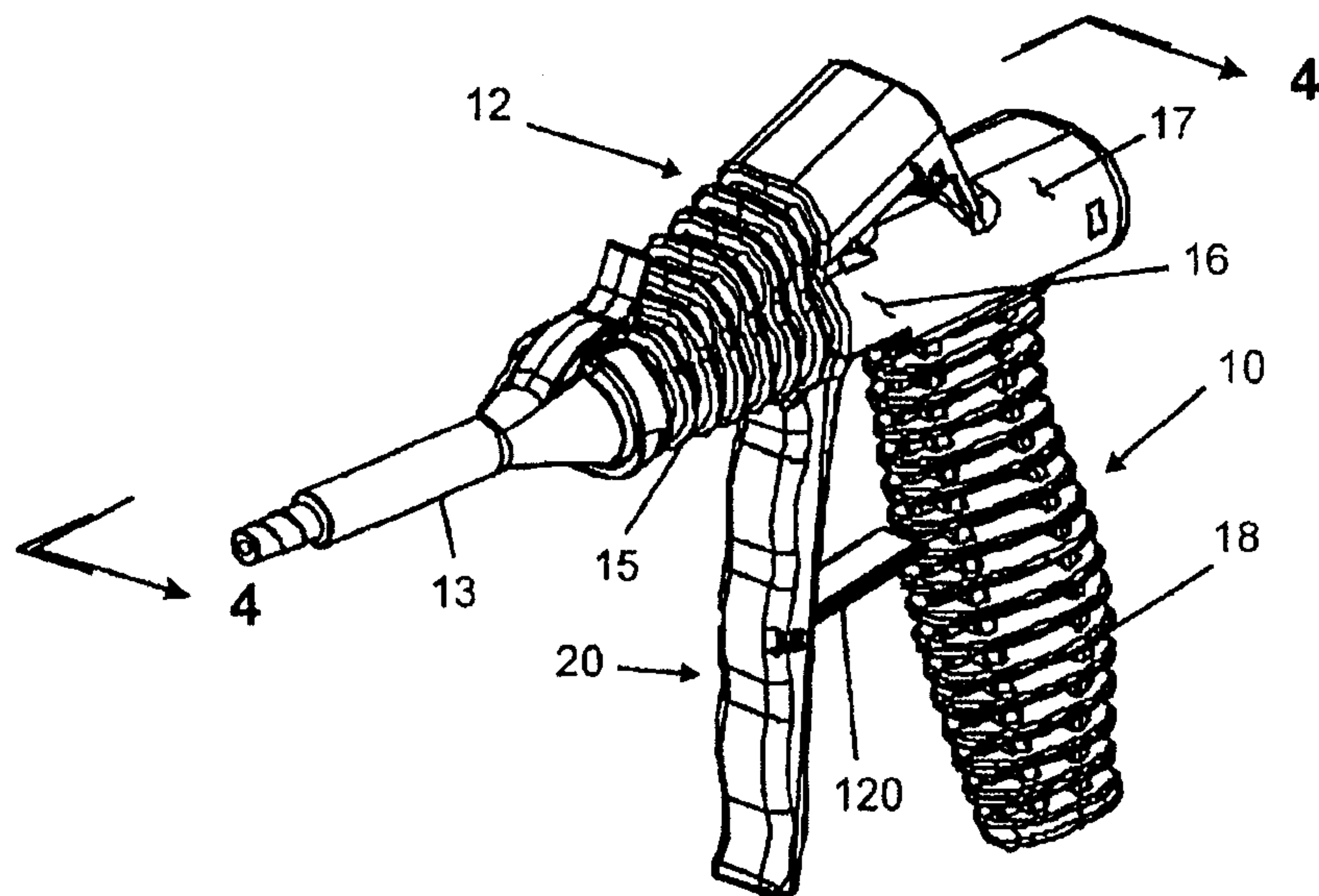


FIG. 2

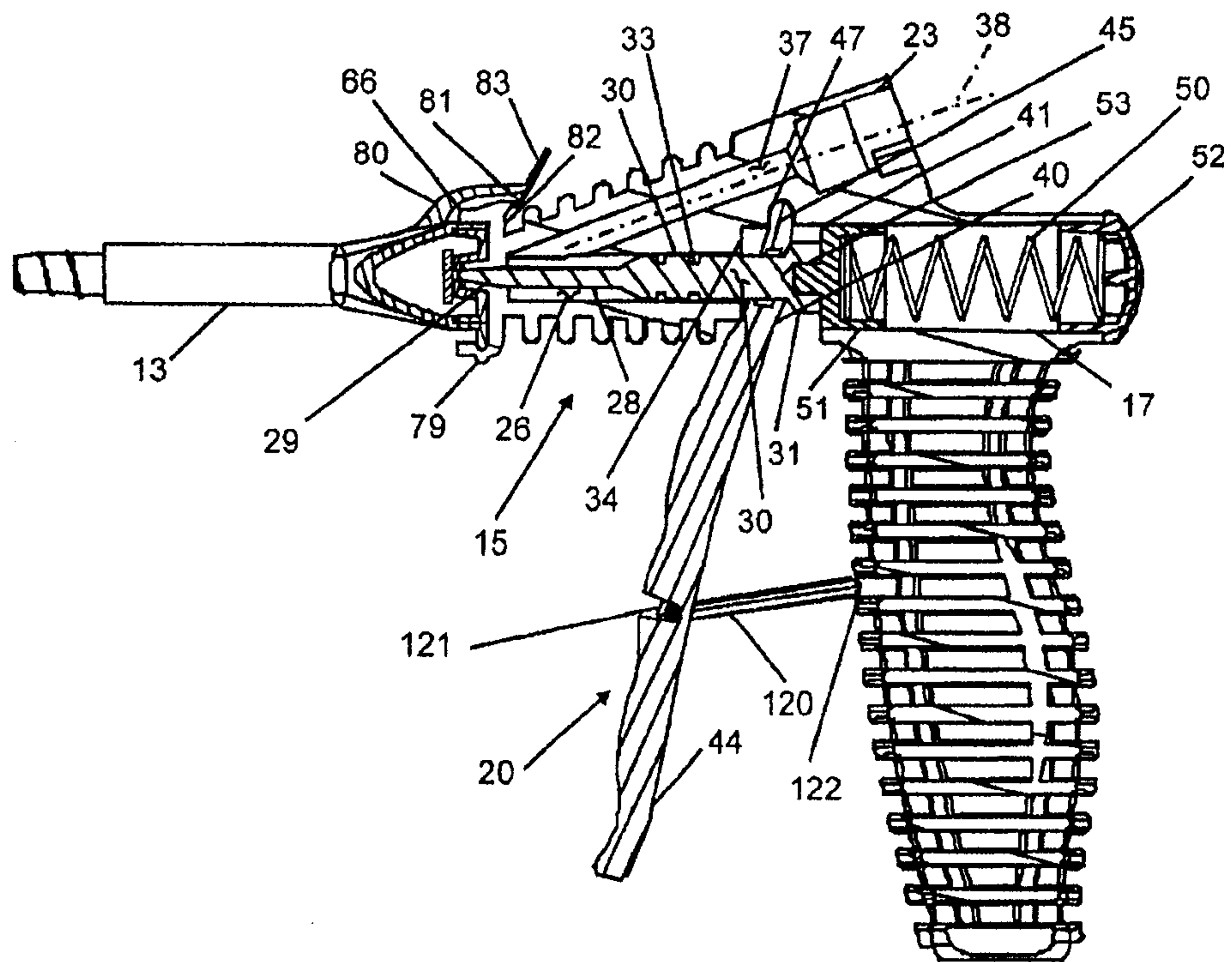


FIG. 3

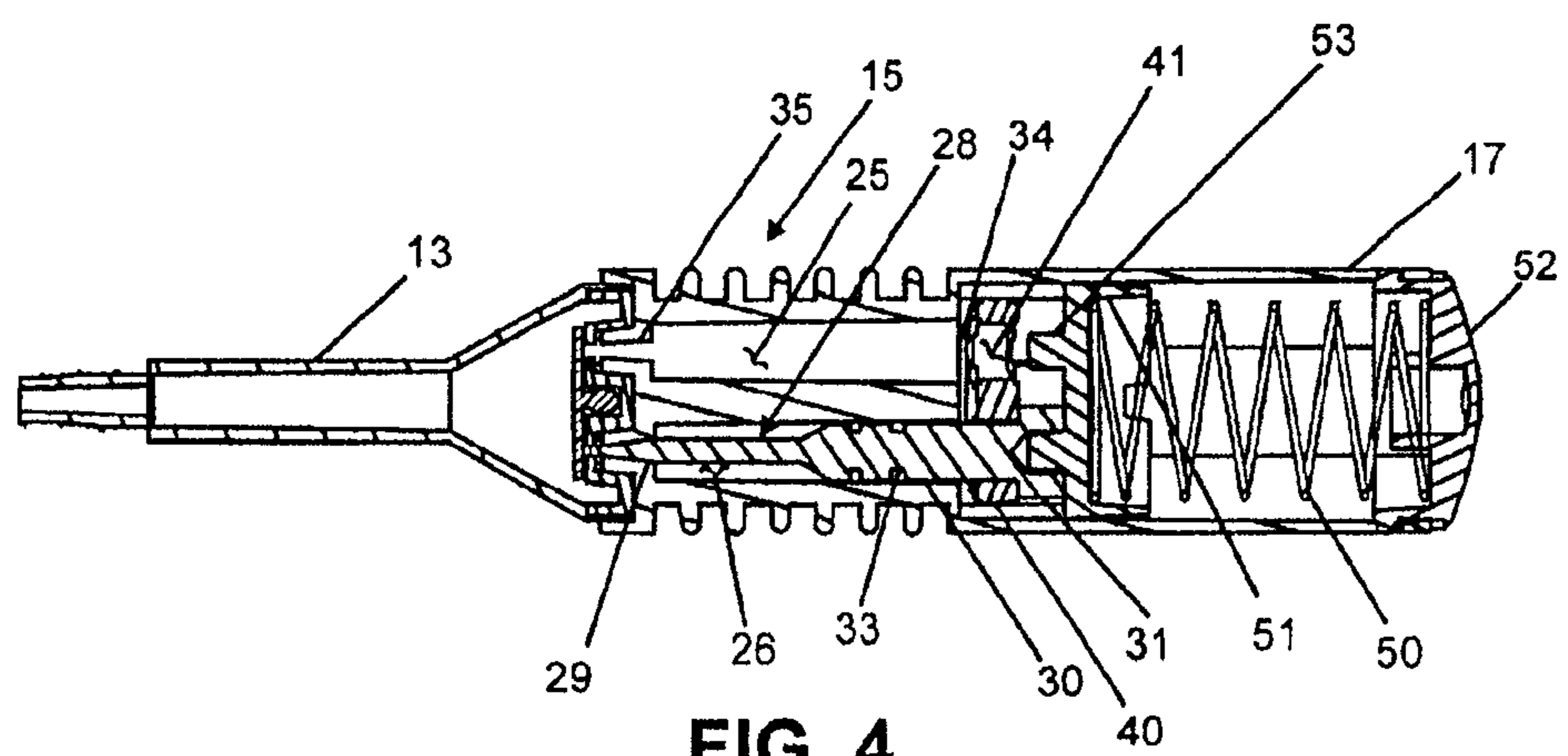


FIG. 4

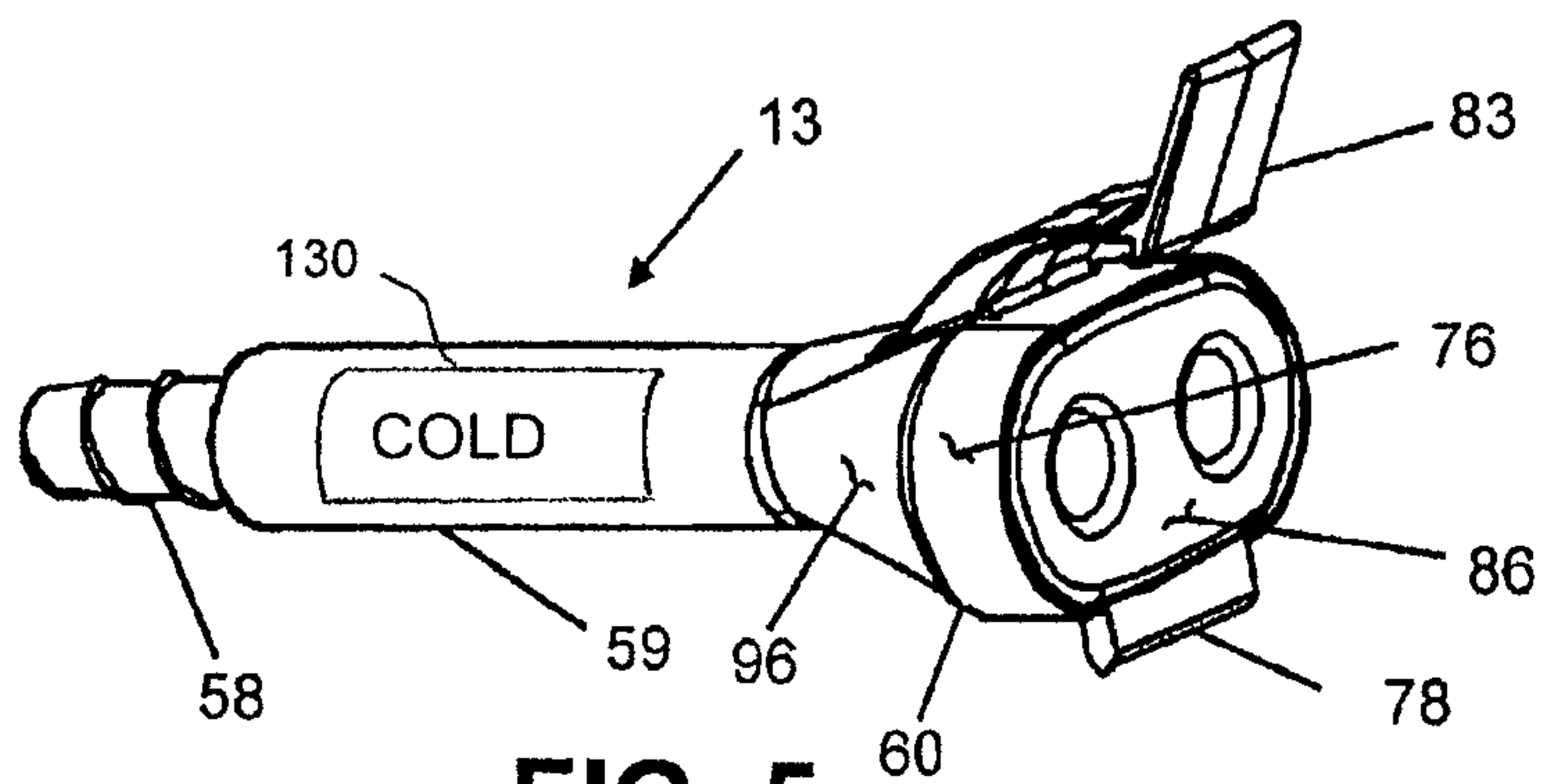


FIG. 5

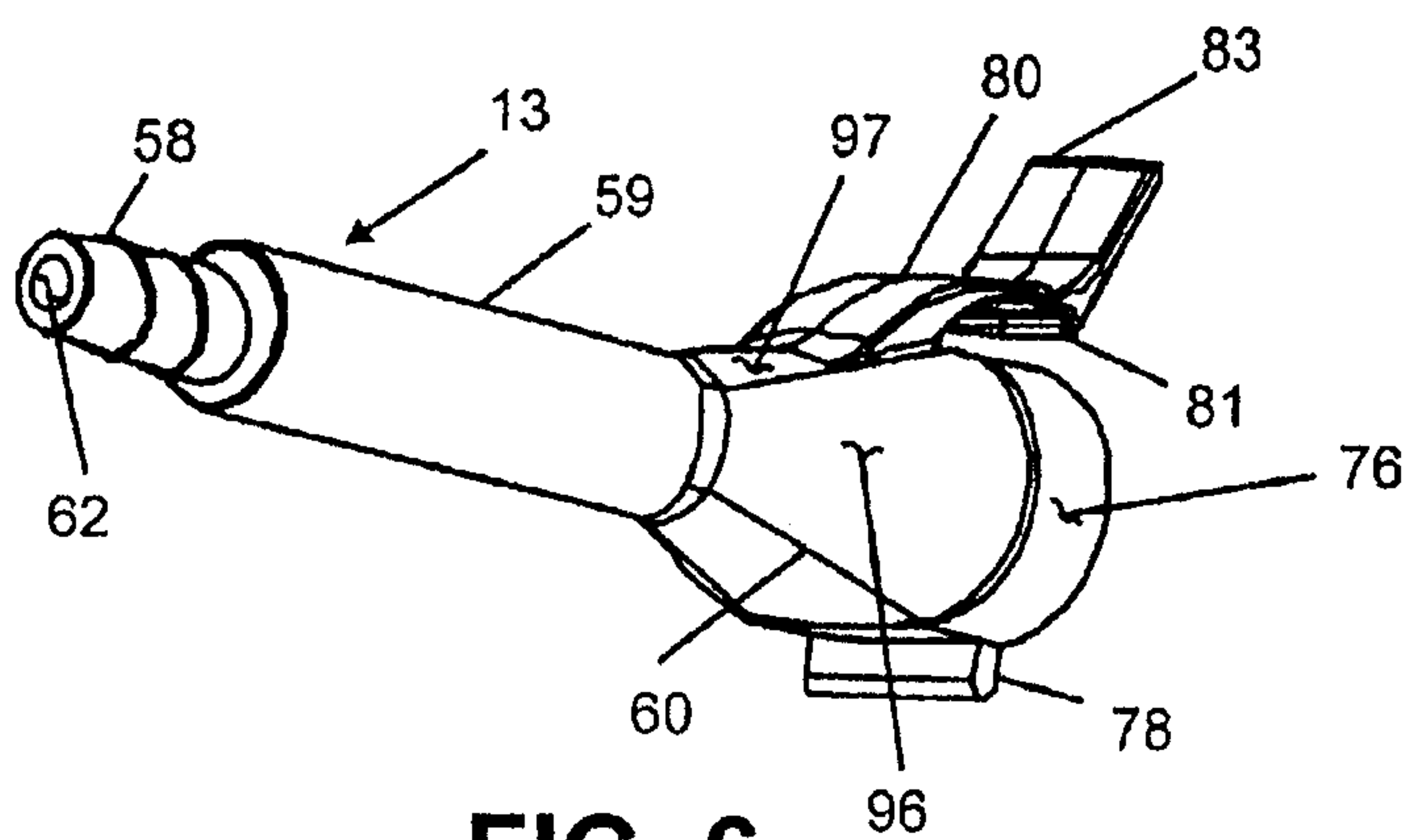


FIG. 6

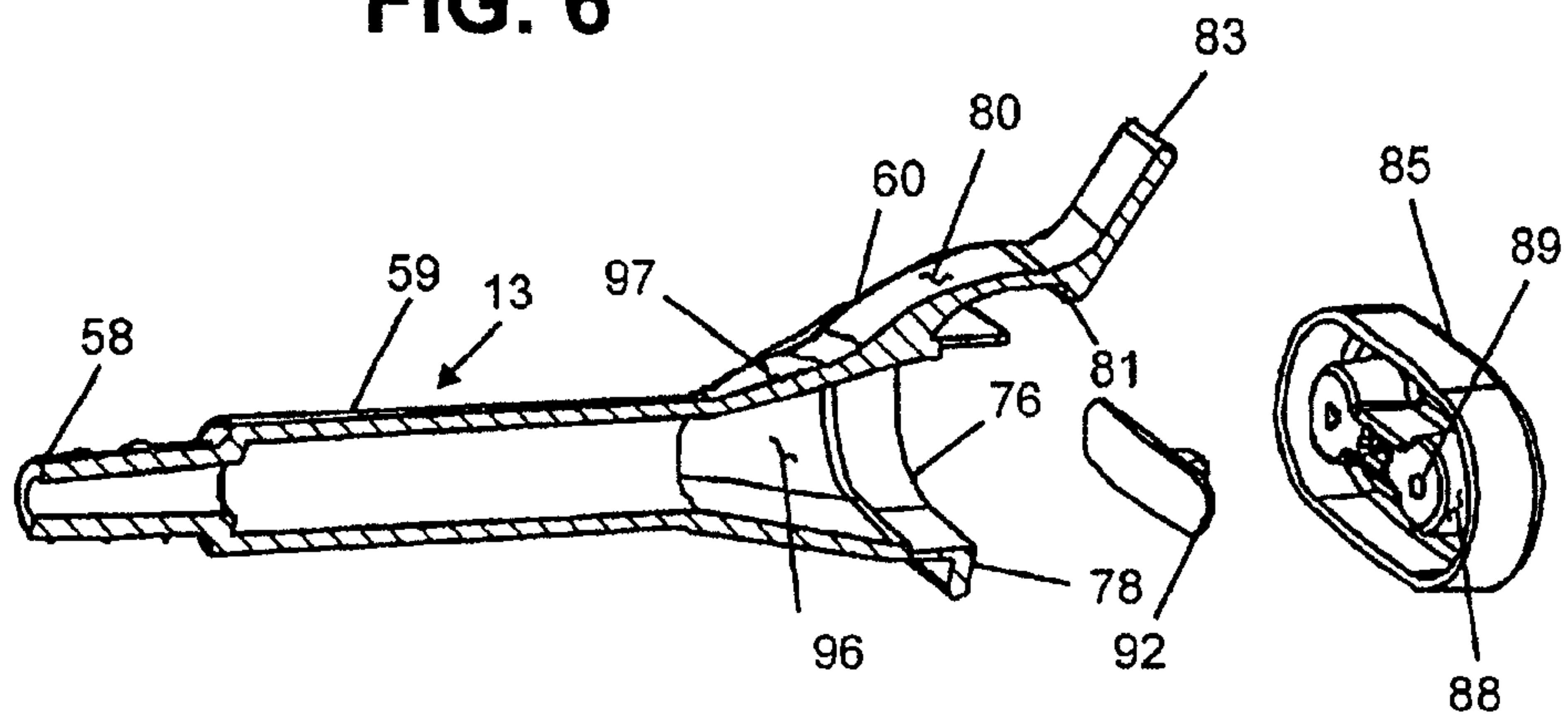


FIG. 7

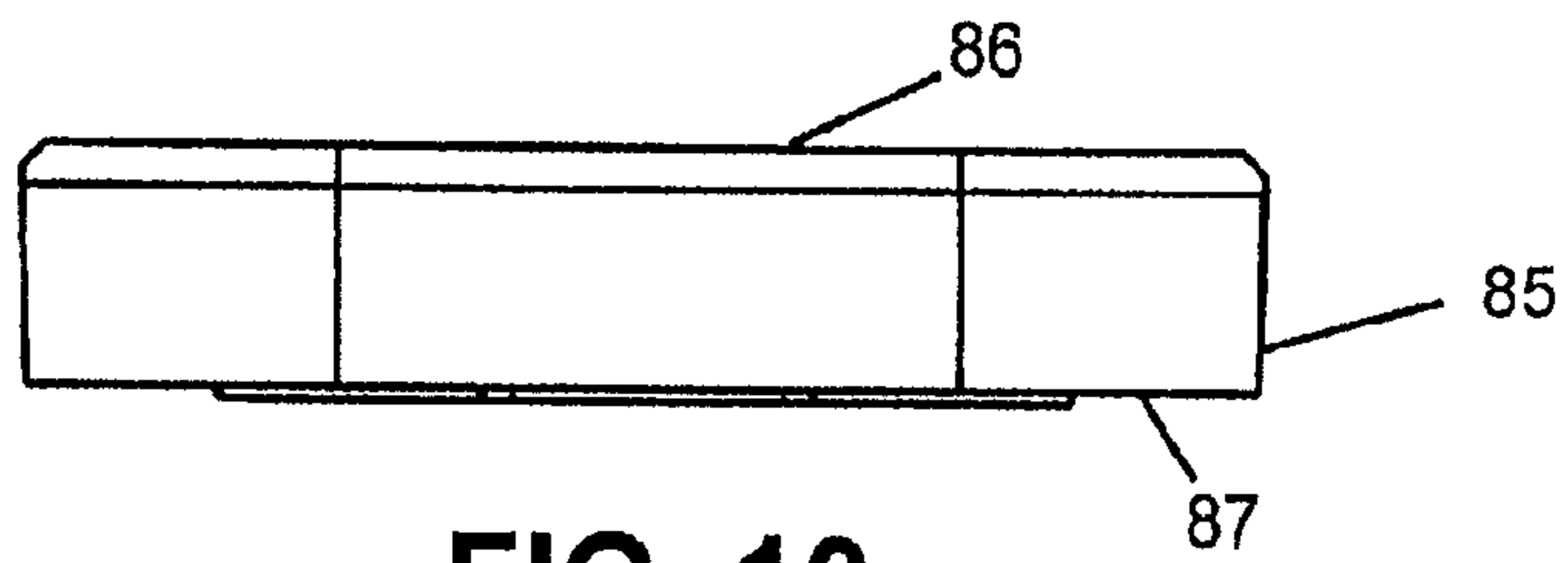


FIG. 10

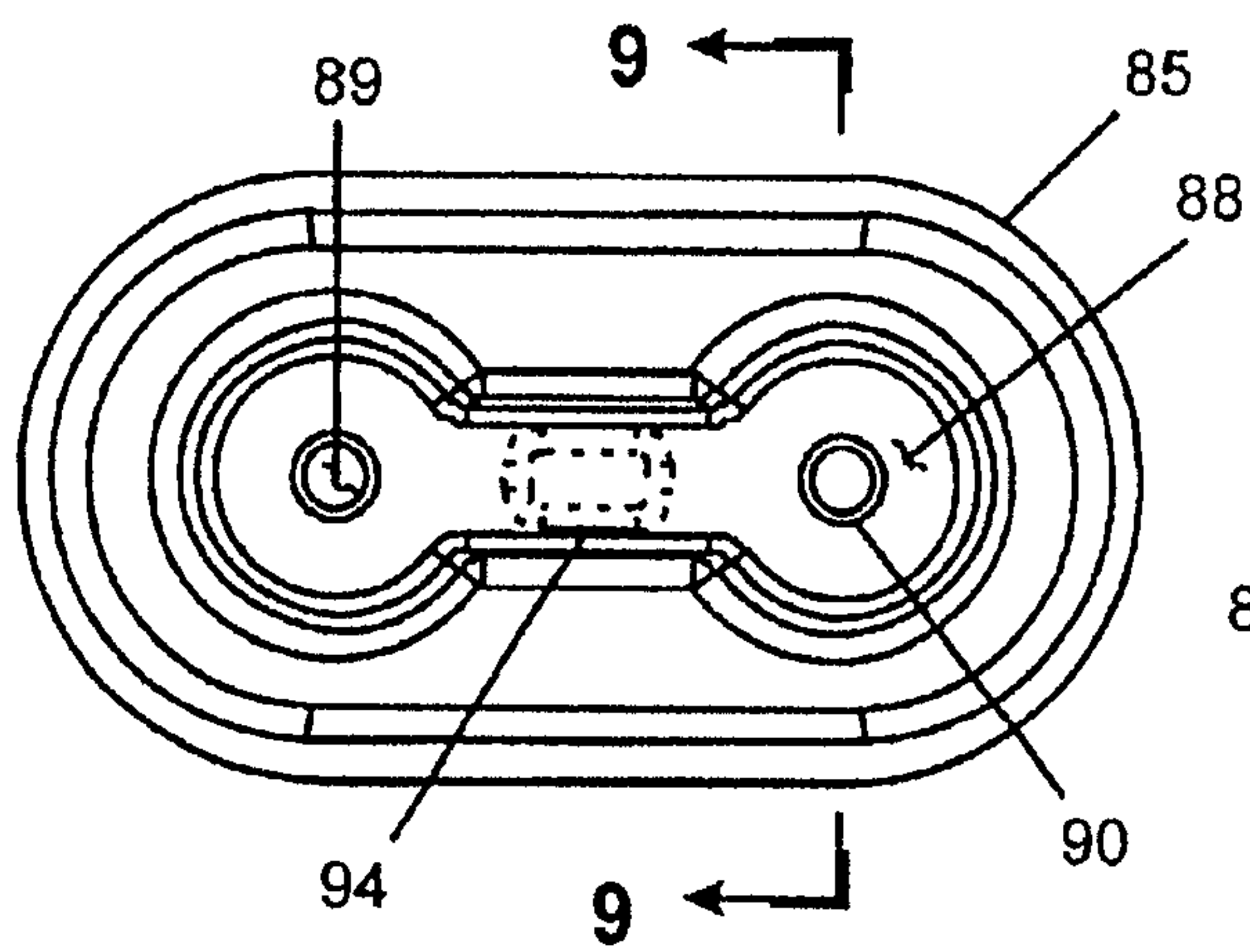


FIG. 8

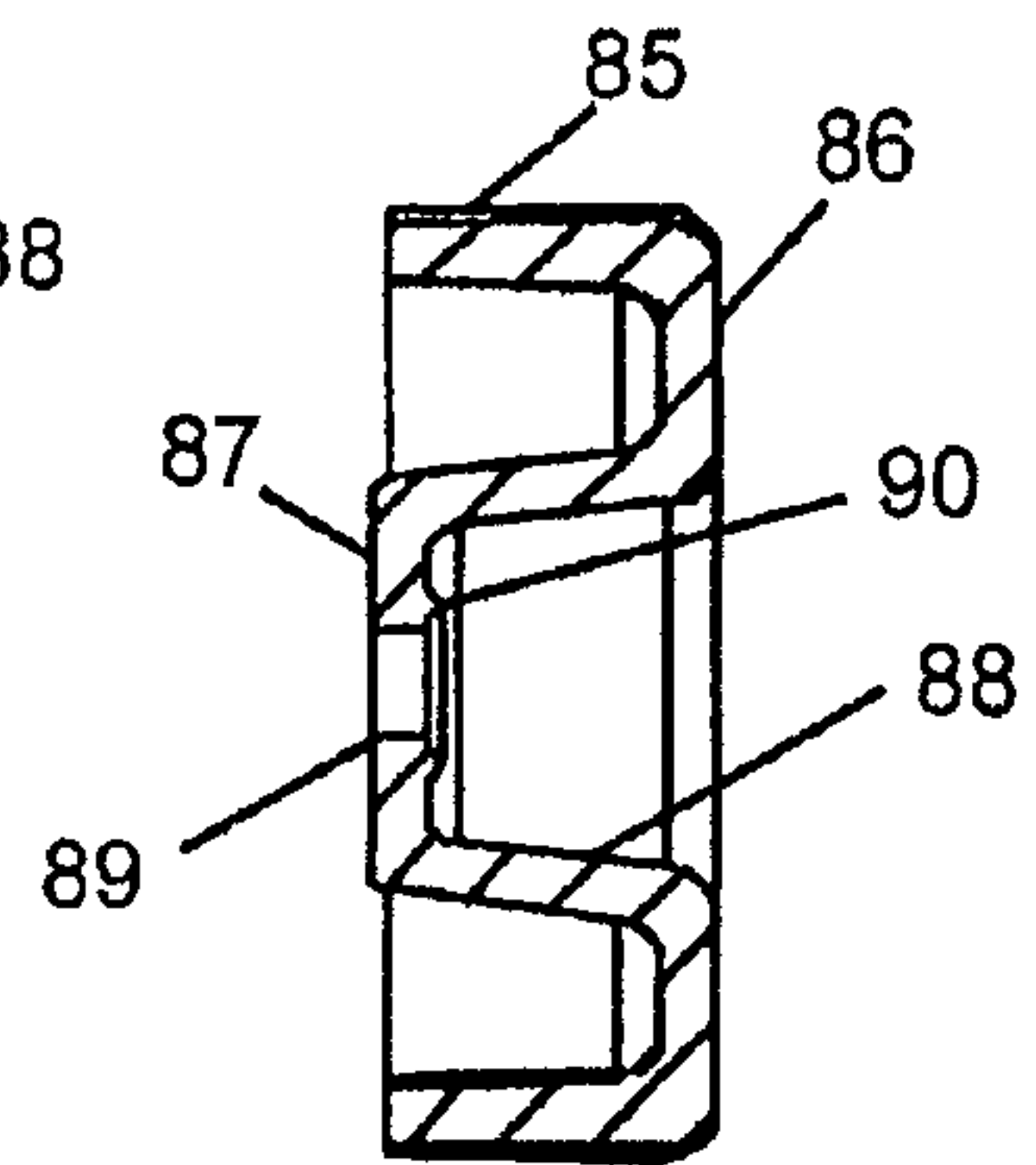


FIG. 9

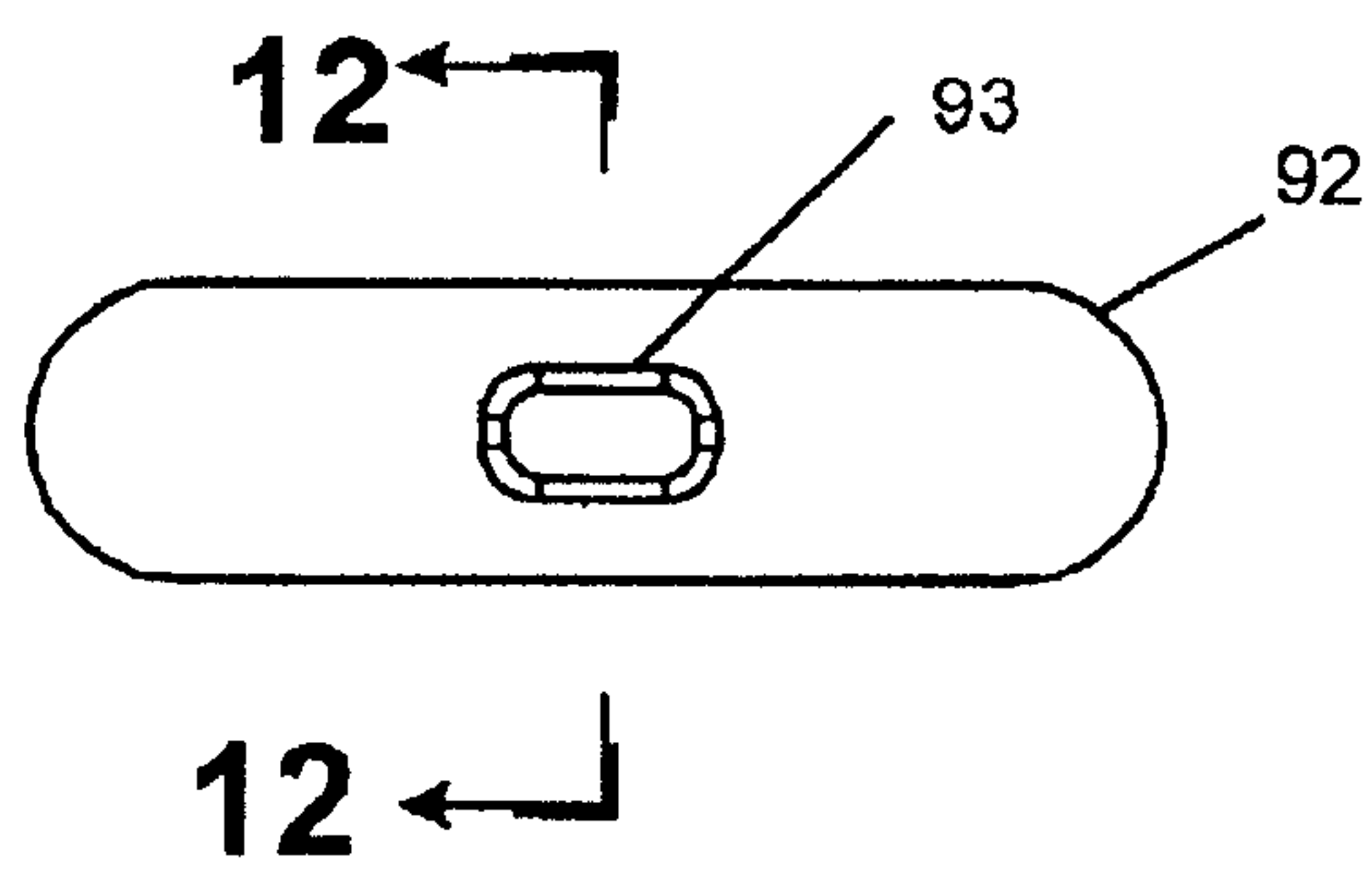


FIG. 11

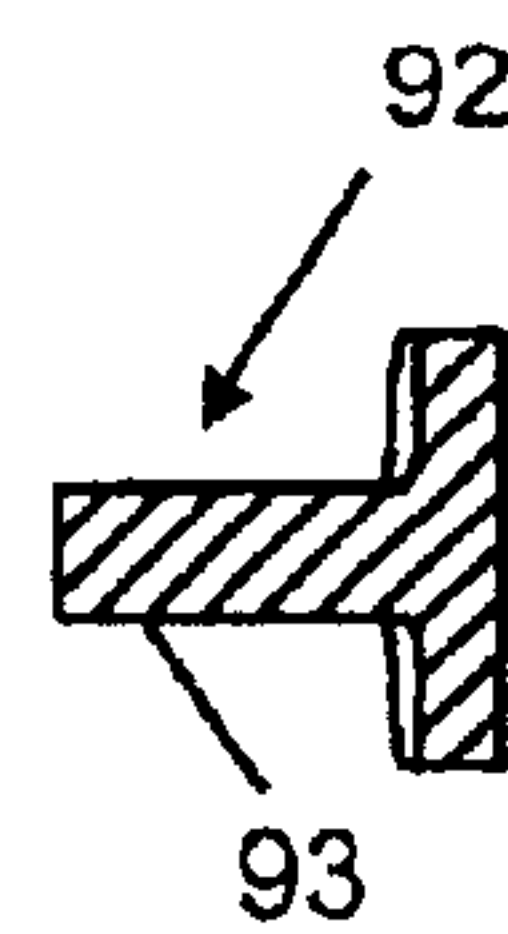


FIG. 12

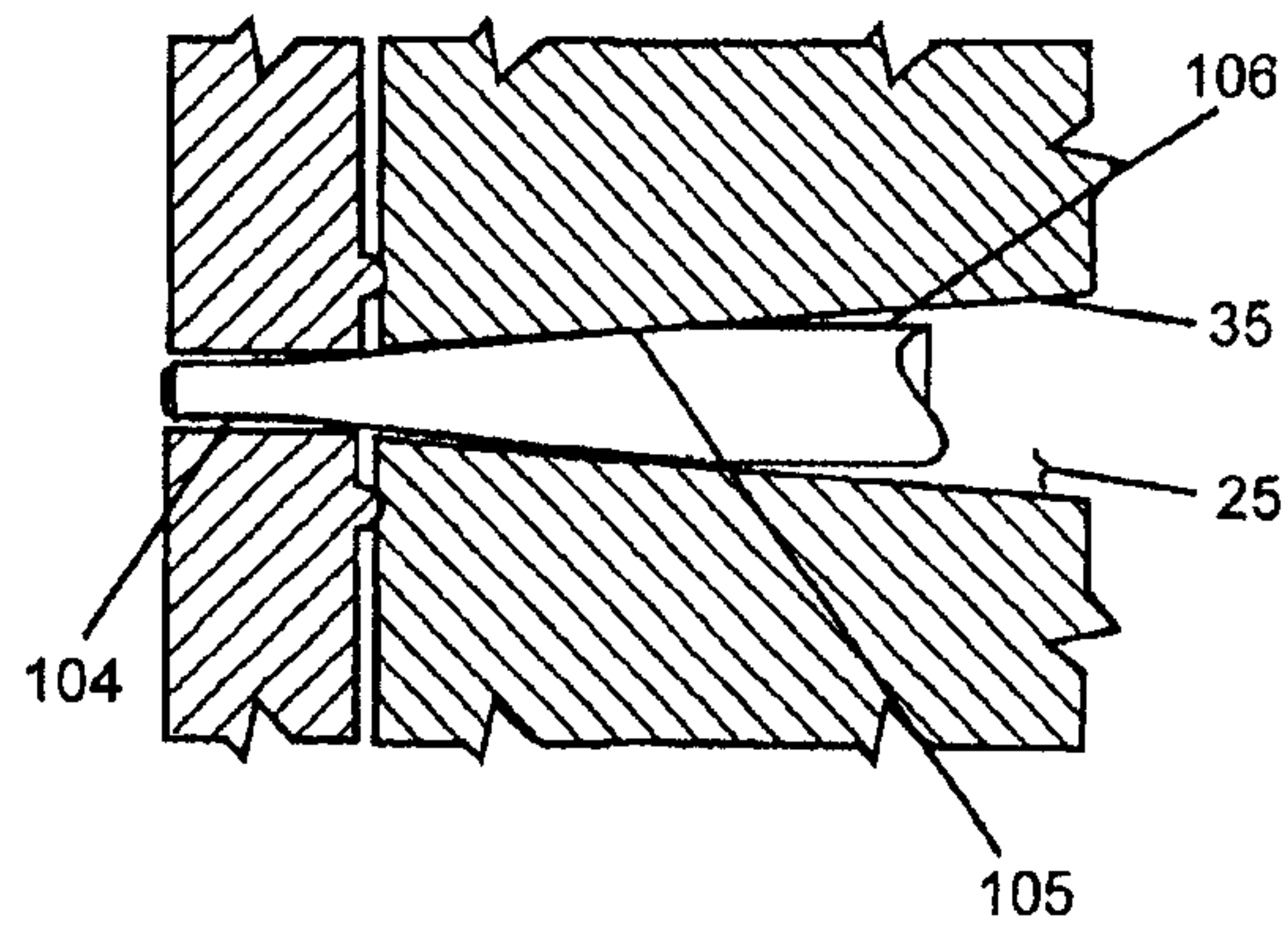


FIG. 13A

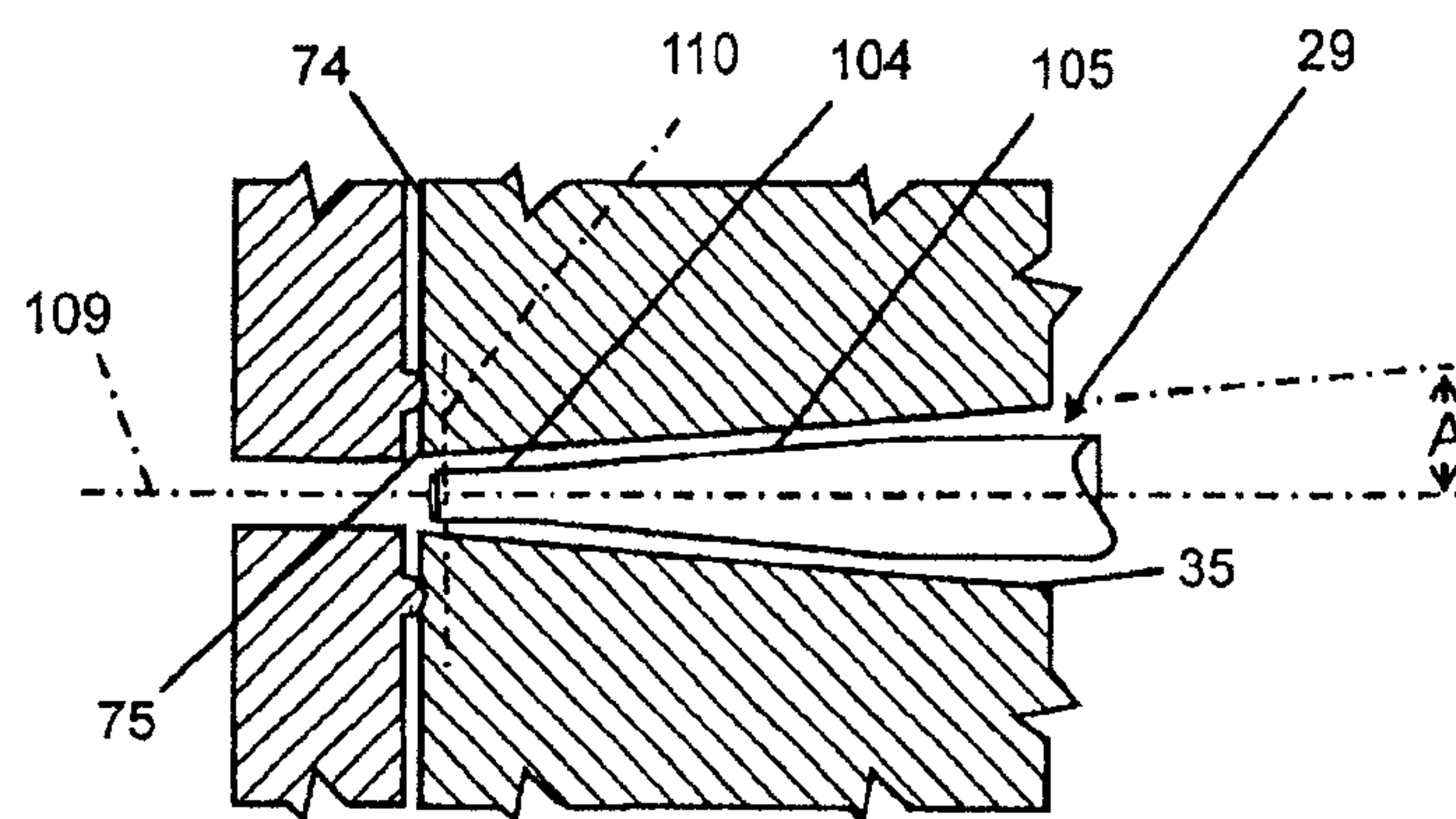


FIG. 13B

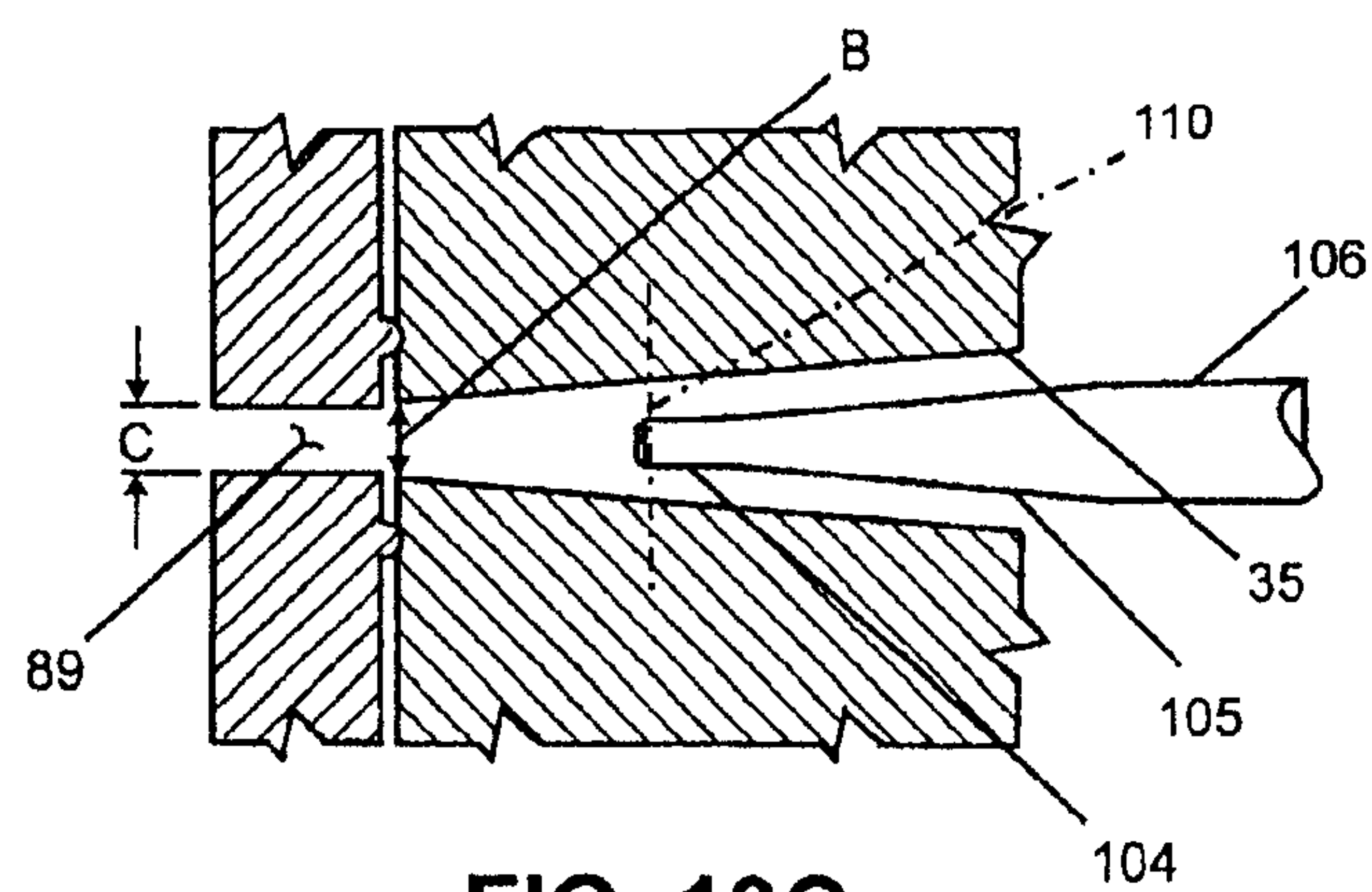


FIG. 13C

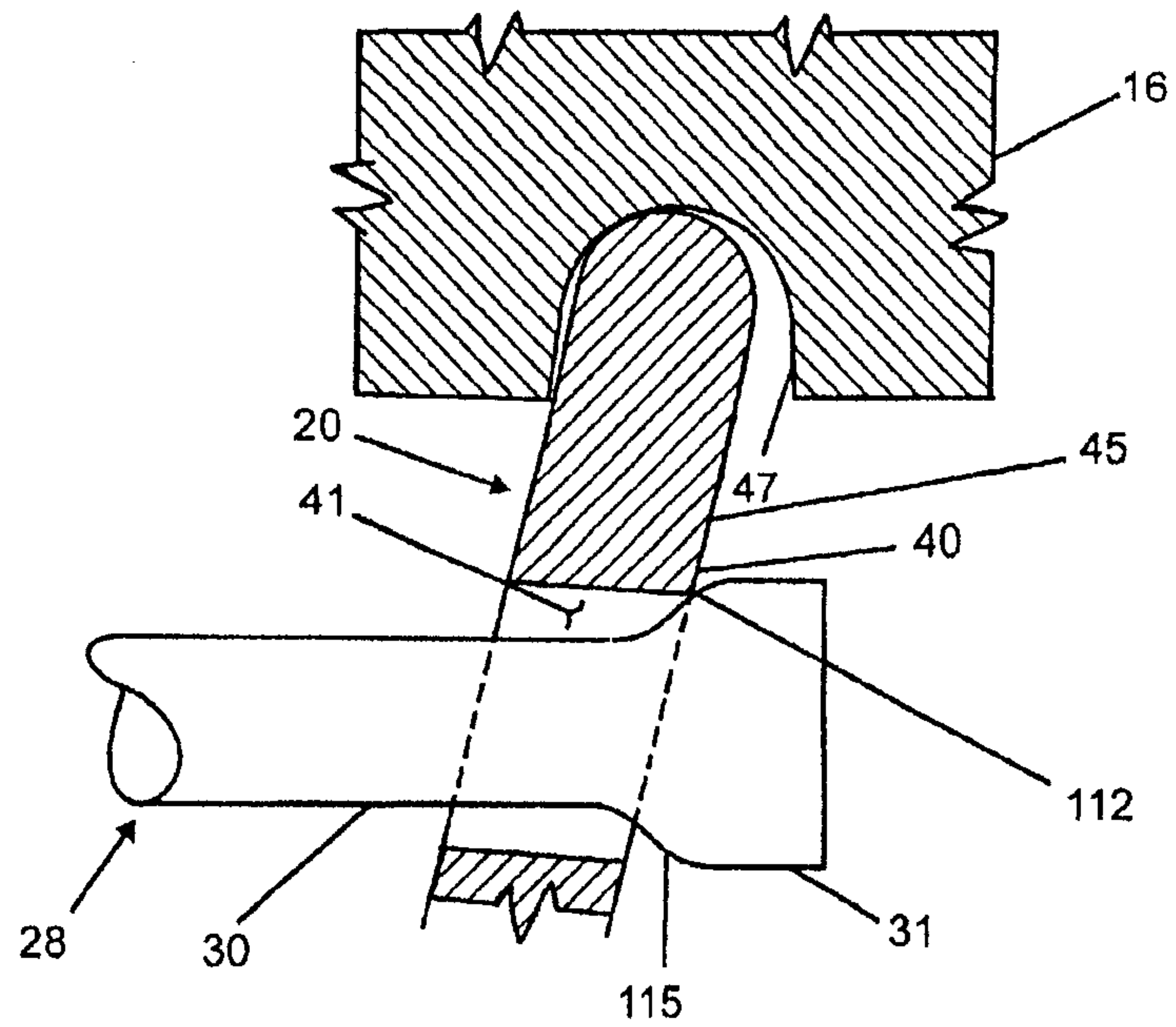


FIG. 14A

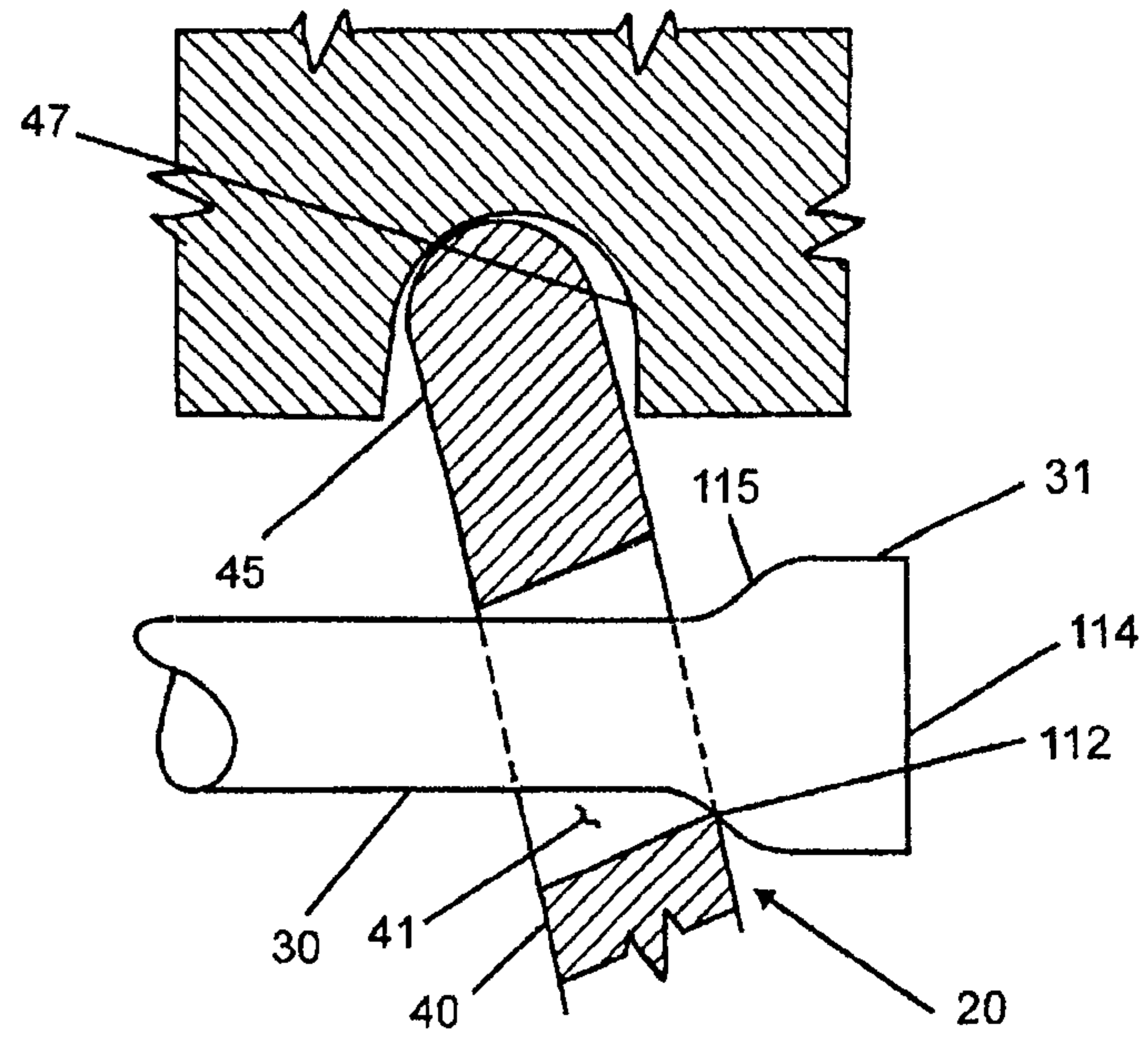


FIG. 14B

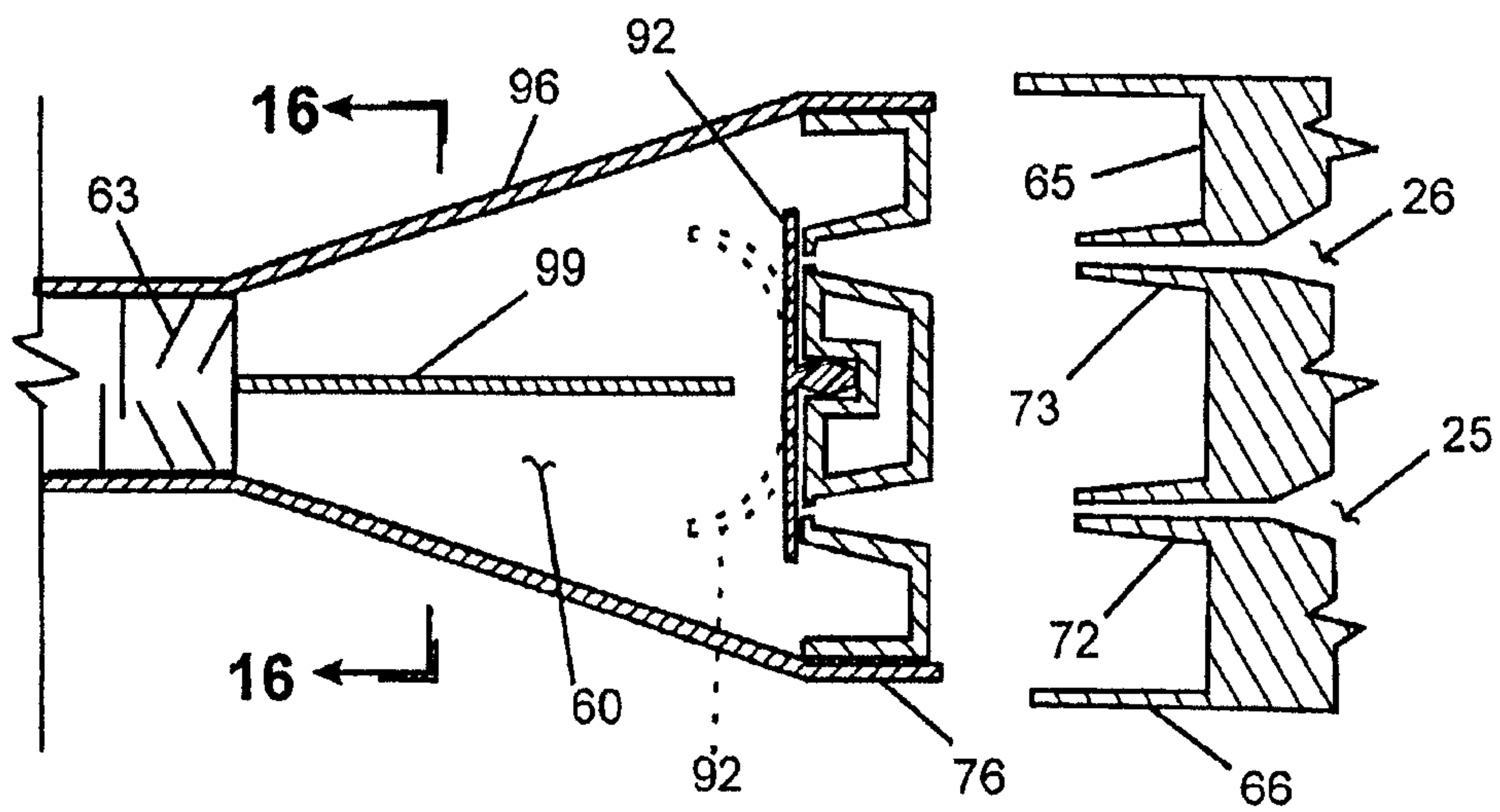


FIG. 15

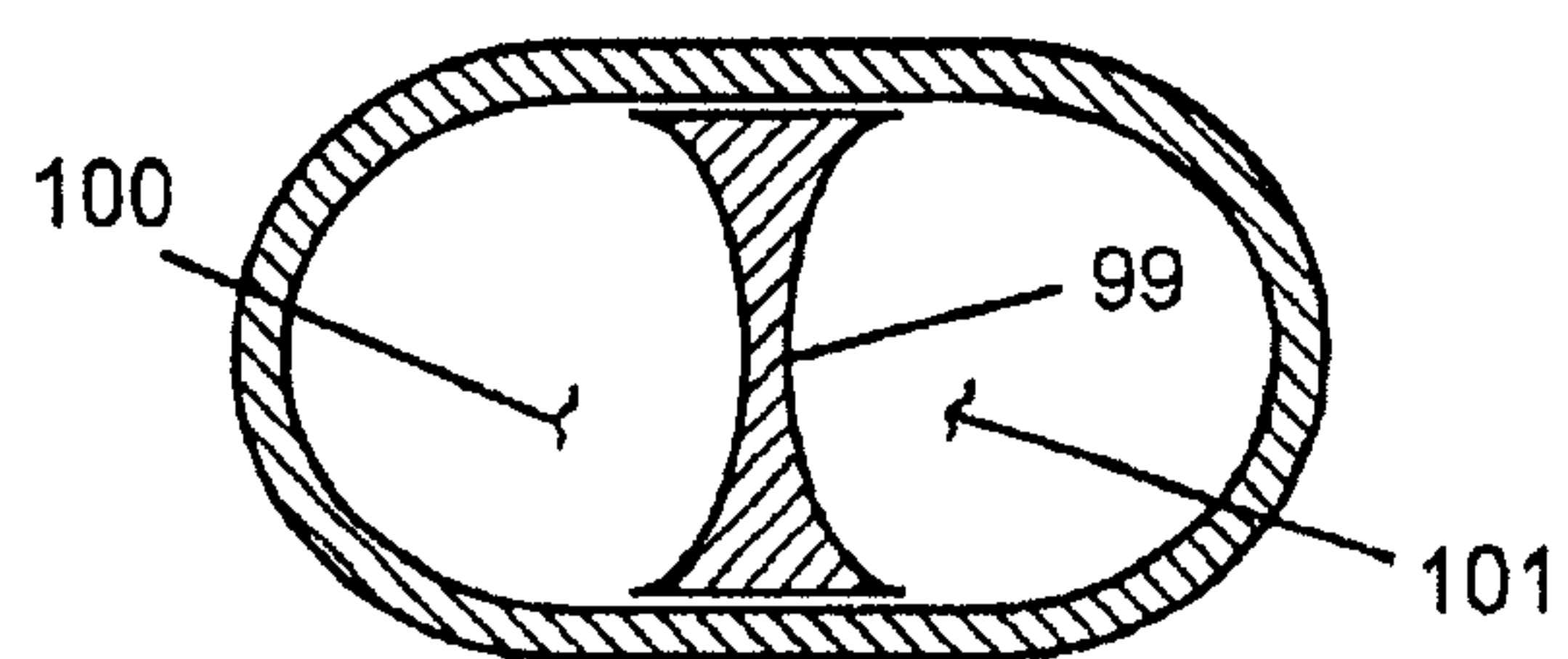


FIG. 16

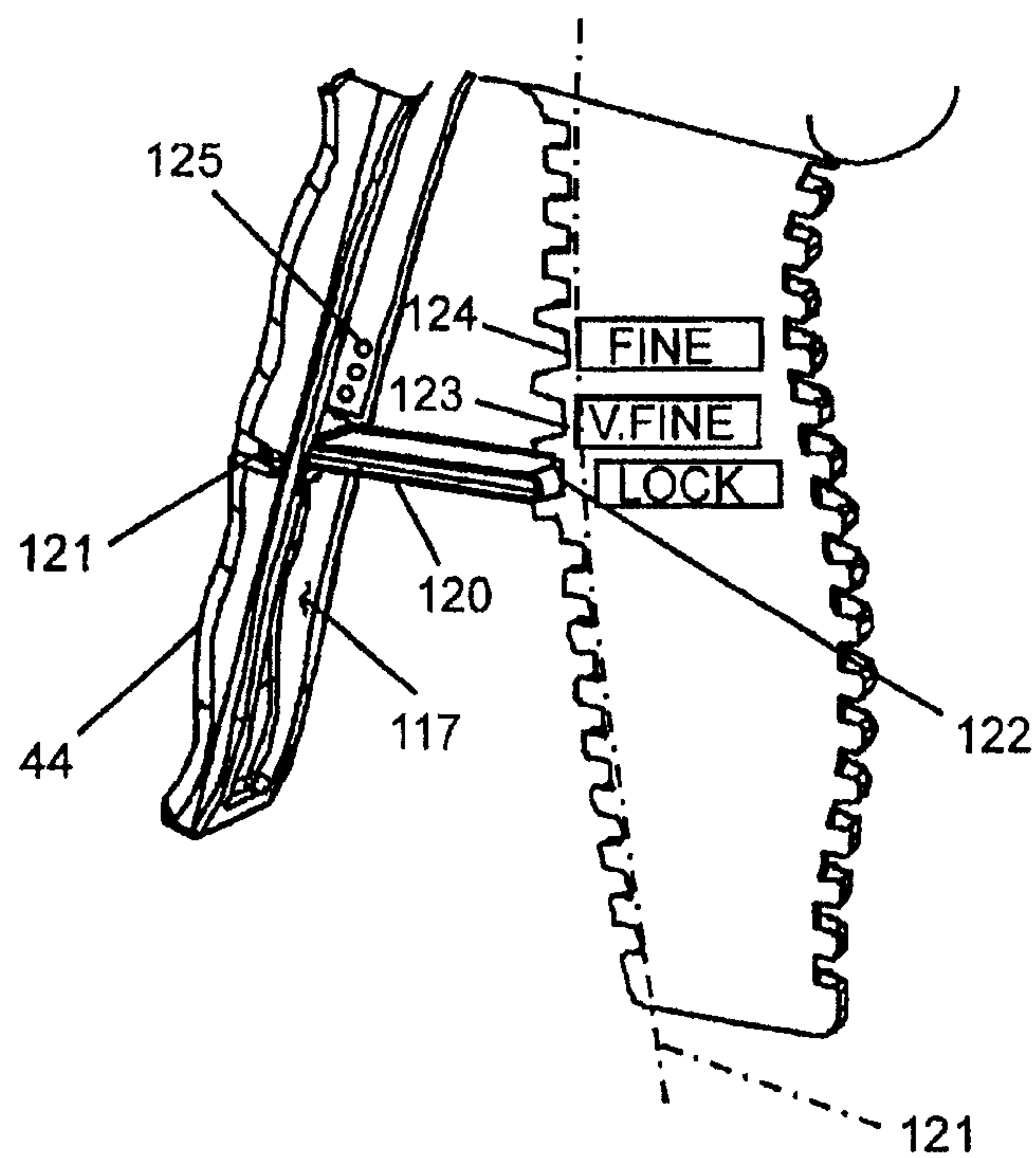


FIG. 17

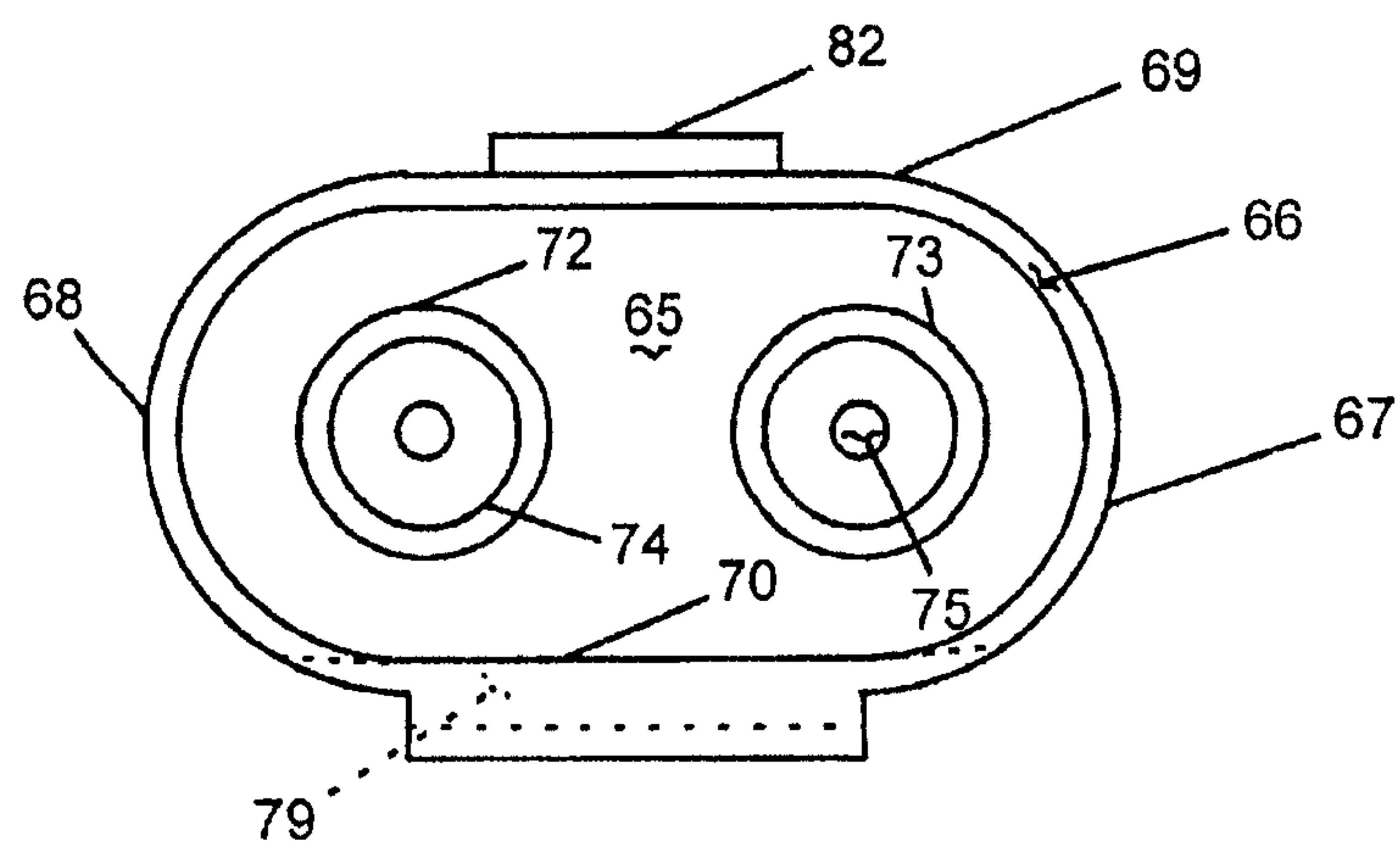


FIG. 18

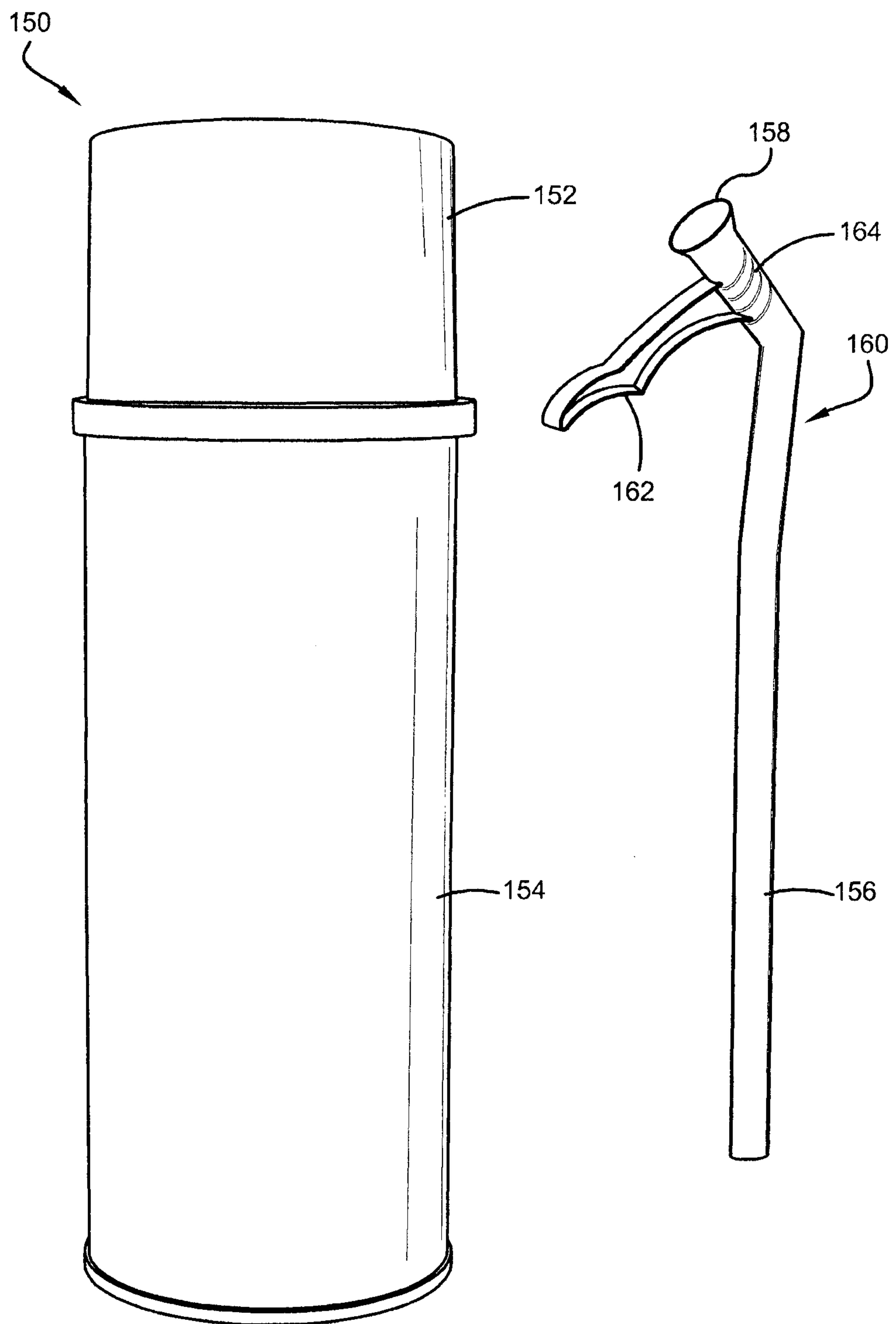


FIG. 19

