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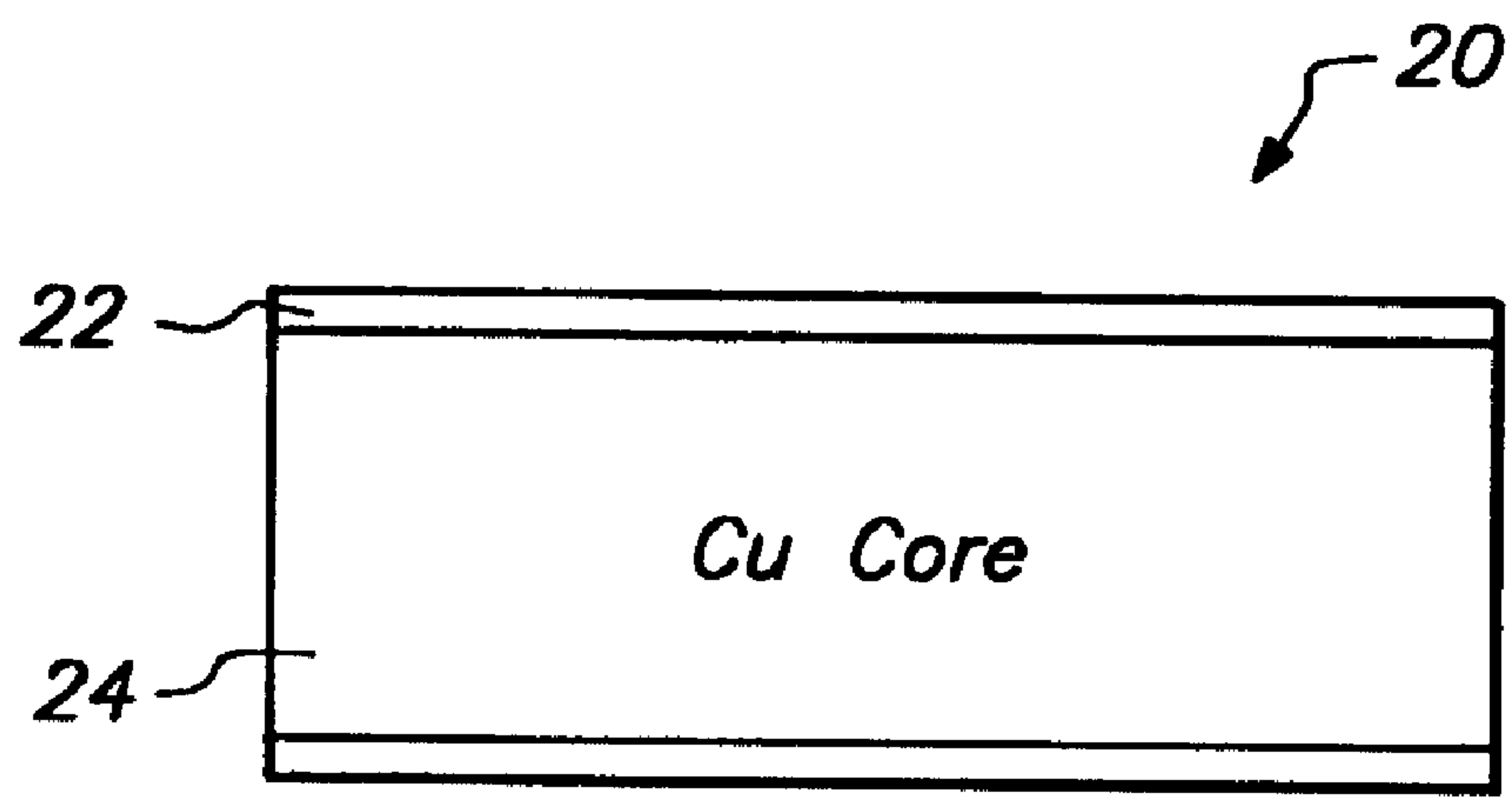
(54) **PANNE DE FER A SOUDER ET SON PROCEDE DE FABRICATION**

(54) **SOLDERING IRON TIP AND METHOD OF MAKING THE SAME**



(57) L'invention concerne une technique destinée à la production de pannes de fer à souder, qui comporte l'étape consistant à couper du fil métallique plaqué en plusieurs segments, chaque segment comportant un matériau d'âme (tel que du cuivre) et une couche extérieure de protection (telle que de l'acier inoxydable, Ni, Cr, ou un alliage de ceux-ci). Chaque segment de fil métallique plaqué est ensuite façonné en une panne de fer à souder par un procédé d'étirement à chaud ou à froid, ou par un autre procédé de formage de métaux. Dans la panne de fer finie, la couche extérieure de protection est placée à l'arrière de la surface de travail de

(57) A technique for producing soldering iron tips entails cutting clad wire into a plurality of segments, each segment comprising a core of material (such as copper) and an outer protective layer (such as stainless steel, Ni, Cr, or alloy thereof). Each clad wire segment is then shaped into a soldering iron tip by a cold or hot heading process, or other metal forming process. In the finished tip, the protective outer layer is disposed behind the working area of the tip, and serves to reduce the corrosion of the tip, and to improve the electrical conductivity between the tip and the soldering iron handle. A heater element can be formed at one end of the

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la panne, et sert à réduire la corrosion de la panne et à améliorer la conductivité électrique entre la panne et la poignée de fer à souder. Un élément chauffant peut être formé à une extrémité de la panne de fer à souder à partir du même segment de fil métallique plaqué utilisé pour produire la panne elle-même, ce qui permet d'assurer de bonnes propriétés de transfert de chaleur entre l'élément chauffant et la panne. L'invention concerne également une technique servant à former une couche extérieure de protection sur la surface de travail de la panne. Cette technique comporte l'étape consistant à découper des garnitures à partir d'une bande ou une feuille mince d'un matériau de protection, tel du fer. Plus spécifiquement, les garnitures sont découpées dans la feuille à l'aide d'une matrice dotée d'une forme ressemblant à la forme de la surface de travail de la panne à souder. Les garnitures ainsi formées sont ensuite insérées sur les extrémités des pannes, et fixées à celles-ci par application d'un matériau de brasage sur la garniture formée ou sur la bande de matériau avant formation de la garniture.

soldering iron tip from the same clad wire segment used to produce the tip itself, thereby ensuring good thermal transfer properties between the heater element and the tip. The invention also pertains to a technique for forming a protective outer layer on the working area of the tip. The technique comprises stamping caps from a thin strip or sheet of protective material, such as iron. More specifically, the caps are stamped out of the sheet using a die having a shape which resembles the shape of the working area of the soldering tip. The caps formed in this manner are then inserted over the ends of the tips, and attached thereto by applying brazing material to the formed cap or to the strip of material prior to forming the cap.

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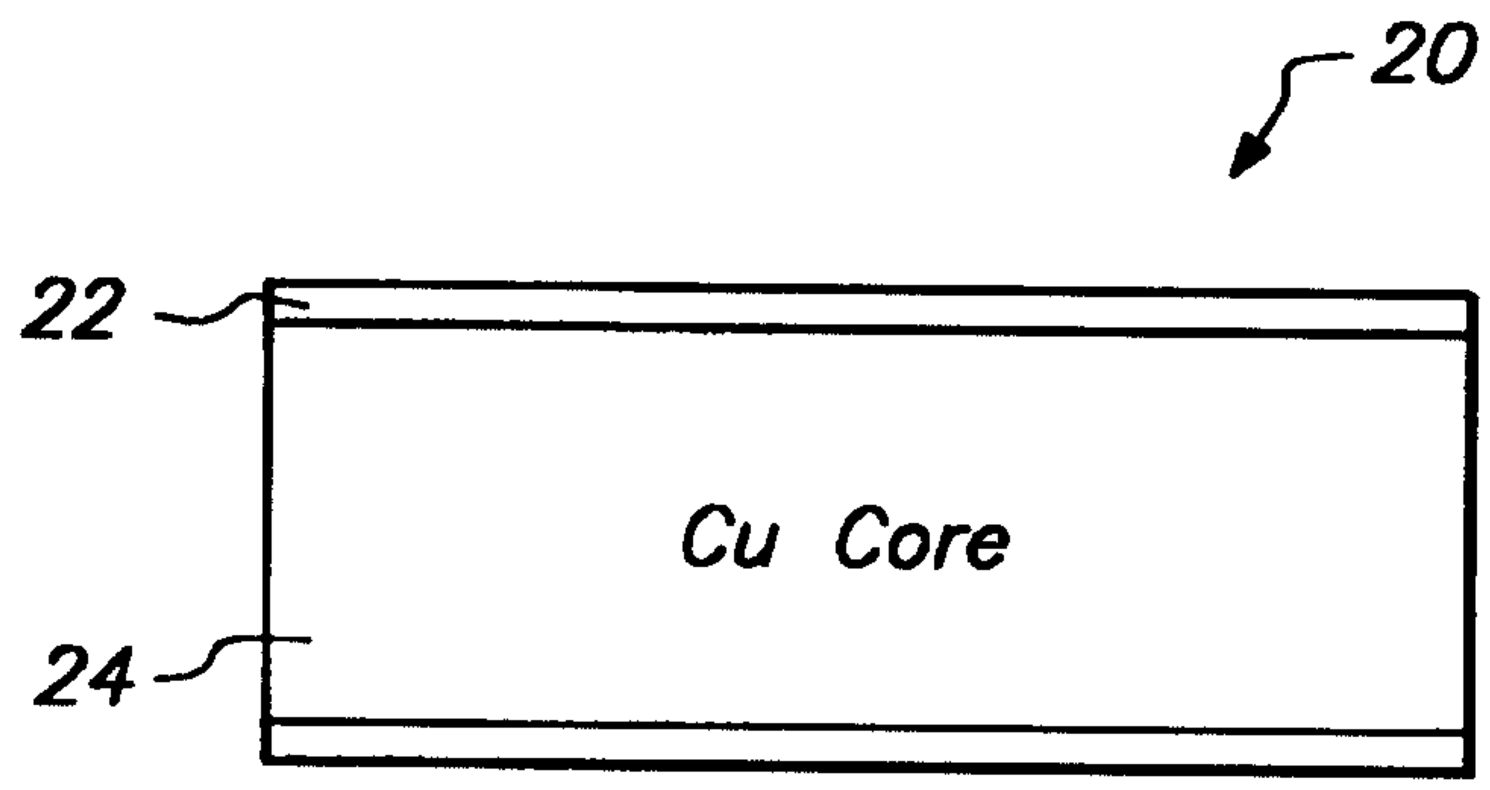
(57) Abstract



A technique for producing soldering iron tips entails cutting clad wire into a plurality of segments, each segment comprising a core of material (such as copper) and an outer protective layer (such as stainless steel, Ni, Cr, or alloy thereof). Each clad wire segment is then shaped into a soldering iron tip by a cold or hot heading process, or other metal forming process. In the finished tip, the protective outer layer is disposed behind the working area of the tip, and serves to reduce the corrosion of the tip, and to improve the electrical conductivity between the tip and the soldering iron handle. A heater element can be formed at one end of the soldering iron tip from the same clad wire segment used to produce the tip itself, thereby ensuring good thermal transfer properties between the heater element and the tip. The invention also pertains to a technique for forming a protective outer layer on the working area of the tip. The technique comprises stamping caps from a thin strip or sheet of protective material, such as iron. More specifically, the caps are stamped out of the sheet using a die having a shape which resembles the shape of the working area of the soldering tip. The caps formed in this manner are then inserted over the ends of the tips, and attached thereto by applying brazing material to the formed cap or to the strip of material prior to forming the cap.

Soldering Iron Tip and Method of Making the Same

BACKGROUND OF THE INVENTION

The present invention relates to techniques for making soldering iron tips having protective outer layers, and the tips produced thereby.

Manufacturers of soldering irons (as well as desoldering irons) typically use copper (Cu) or copper-based materials for the tip of the soldering iron. Copper offers high thermal conductivity at relatively low cost. Moreover, copper can be readily machined into the desired tip geometry. For example, Figure 1 illustrates an exemplary tip **1** formed by machining a monolithic rod of copper or a copper alloy **2**.

However, copper tips also have a number of undesirable properties. When heated to the high temperatures required for soldering, the tips may dissolve in the solder and/or corrode in air. Furthermore, the tips may deform when mechanical pressure is applied thereto. For this reason, simple copper-based soldering tips have a relatively low tip life.

The prior art has addressed this problem by coating the copper tips with one or more outer layers. More specifically, as illustrated in Figure 2, the end of the tapered portion of the tip **1** (referred to as the "working area") is coated with an outer layer **4** of iron (Fe). The iron coating **4** protects the softer copper core **2** from deformation during soldering operations, and from dissolving in the solder. Iron is also readily wettable by molten solder. The remainder of the soldering iron tip **1** is covered by other types of materials **6**, such as a layer of chromium (Cr) or a layer of chromium formed over a layer of nickel (Ni). These layers **6** provide a good electrical connection between the tip of the soldering iron and ground, thus ensuring a low tip-to-ground voltage potential and resistance. These layers **6** also protect the copper **2** from corroding in air. Furthermore, chromium offers poor wettability by the solder and thereby prevents the solder from creeping up the tip from the working area and degrading the performance of the soldering iron tip.

Typically, these materials are coated onto the copper tip by a deposition technique known as electroless plating or electroplating. Electroplating involves applying a voltage between the soldering iron tip (cathode), and pieces of the metal to be deposited (the anode), through an acid-based aqueous electrolyte. The soldering iron tip and the metal anode are both submersed in the electrolyte. The applied voltage causes metal ions to flow from the anode to the cathode (soldering iron tip) through the electrolyte, thus depositing the metal onto the tip of the soldering iron in a controlled fashion. For example, U.S. Patent No. 3,315,350 proposes a technique for electroplating a layer of iron on a copper tip, and then electroplating an additional layer of nickel and chromium on the iron layer. U.S. Patent No. 3,986,653 proposes electroplating an outer layer of osmium or ruthenium (or an alloy thereof) on a soldering iron tip.

Electroplating of copper soldering iron tips has disadvantages. First, electroplating sometimes produces a coating of uneven thickness on the tip, especially at regions where the contour of the tip abruptly changes. Second, the process itself is inherently unstable, resulting in differences in plating thickness and quality from one production batch to the next. Third, electroplating is relatively expensive, which is partially due to the large amount of manual labor required by the technique, and the need to dispose of the chemical solutions used in the process in an environmentally safe manner.

For these reasons, some manufacturers have looked to alternative ways of constructing tips having hardened outer layers. For example, U.S. Patent No. 4,055,744 discloses a technique for forming a hardened outer layer on the working area of a soldering tip by separately forming an iron cap, and then mechanically crimping the cap onto the soldering iron tip. The composite structure of the cap and the tip is further shaped by manually hammering the composite structure, or by using a swaging machine. While avoiding the problems associated with electroplating, crimping the cap to the copper tip may tightly bind the cap to the tip only at selective locations of the tip, such as at the base of the tip, thereby reducing the contact area between the tip and the cap. This, in turn, may reduce the transfer of heat from the tip to the cap, thus reducing the performance or the efficiency of the soldering iron.

Another problem addressed by the present invention pertains to soldering irons which include "heater" elements. As illustrated in Figures 3 and 4, a heater **8** is the component of the soldering iron which actually generates heat. That is, the electrical coils of the soldering iron (not shown) transfer energy to the heater **8**, which in turn transfers heat to the working area of the soldering iron tip **1**. In one tip design produced by the assignee of the present invention, the heater **8** element comprises a clad wire segment having an inner core **12** and an outer layer **10** formed thereon. The heater element **8** is press fit into a machined hole **14** located in the back of the tip **1**. The mechanical interface **16** (in Figure 4) between the heater **8** and the tip **1** impedes the transfer of heat from the heater **8** to the tip **1**.

It is therefore an exemplary objective of the present invention to provide a technique for making soldering iron tips that facilitates efficient and reliable large-scale production of the tips, preferably without the use of electroplating. It is a further exemplary objective of the present invention to provide a technique for making soldering iron tips which does not impose interfaces which impede the flow of heat from the heater to the tip.

SUMMARY OF THE INVENTION

These and other exemplary advantageous features are achieved according to a first aspect of the invention which entails producing a tip from a clad wire segment. The technique entails cutting a length of clad wire into a plurality of segments, where each segment comprises a core of material (such as copper) and an outer protective layer (such as stainless steel, nickel of high purity, chromium of high purity, Fe-Ni alloys such as Invar-type alloys, or other suitable material). Each clad wire segment is then shaped into a soldering iron tip by a cold heading process, or other metal forming process. In the finished tip, the outer protective layer is disposed "behind" the working area of the tip, and provides good electrical conductivity between the tip and ground, thus maintaining a low tip-to-ground voltage potential and resistance. The outer layer also protects the inner core (of copper) from oxidation, and offers poor wettability, which prevents solder from adhering thereto.

According to another aspect of the invention, the clad wire segment can be further shaped to form an integrated heater element located on one end of the tip.

Since the heater element is formed from the same segment of the clad wire segment as the tip itself, this technique ensures metallurgical continuity between the heater and the working area of the tip, and thereby improves the transfer of heat between the heater and the tip by eliminating the mechanical interface **16** shown in Figure 4.

According to another aspect of the invention, the above described metal forming steps can be performed on a wire (or rod) segment which does not include a protective outer layer.

According to still another aspect of the invention, a protective outer layer for the working area of the soldering iron tip can be formed by inserting a separately formed cap of iron (or like material) over the working area portion of the tip. More specifically, the technique entails producing a thin strip or sheet of protective layer material, such as iron. Tapered caps are then stamped out of the sheet using a die having a shape which resembles the shape of the soldering iron tip. The caps formed in this manner are then inserted over the working area of the soldering iron tips, and attached thereto by applying brazing material to the caps or the tips and then melting or sintering the brazing material. Alternatively, the brazing material can be applied directly to the strip of material (before stamping is performed) to further expedite the manufacturing process. In either event, the use of brazing, or like technique, improves the thermal conductivity between the tip and the cap by creating an intimate metallurgical bond between the tip and the cap, as compared with the prior art technique of crimping the cap to the tip.

According to another aspect of the present invention, a clad wire or rod segment is used to form a soldering tip including one or more protective outer layers on the working area of the soldering tip.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing, and other, objects, features and advantages of the present invention will be more readily understood upon reading the following detailed description in conjunction with the drawings in which:

Figure 1 shows a machined soldering iron tip according to the prior art;

Figure 2 shows a machined soldering iron tip with layers of material deposited thereon through the use of electroplating, according to the prior art;

Figure 3 shows a machined soldering iron tip including a machined hole in its back to receive a heater element, according to the prior art;

Figure 4 shows a machined soldering iron tip with a heater element press fit into a machined hole in the back of the tip, according to the prior art;

Figures 5-8 show the transformation of a clad wire segment to a soldering tip having a protective outer coating according to a first embodiment of the present invention;

Figure 9 shows an exemplary technique for shaping the clad wire segment;

Figure 10 shows an exemplary technique for making a soldering iron cap according to a second embodiment of the invention;

Figure 11 shows an exemplary perspective view of the soldering iron cap produced by the technique shown in Figure 10;

Figure 12 shows an exemplary manner of attaching the cap to the soldering iron tip;

Figures 13-14 show the transformation of a clad wire segment to a soldering tip having a protective outer coating on its working area according to another embodiment of the present invention; and

Figures 15-17 show the transformation of a clad wire segment having at least two outer layers to a soldering tip having a multilayered outer coating according to yet another embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation and not limitation, specific details are set forth in order to provide a thorough understanding of the invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods and devices are omitted so as not to obscure the description of the present invention with unnecessary detail.

Further, for the sake of brevity, the ensuing discussion is framed in the context of soldering irons. However, the principles disclosed herein are equally applicable to desoldering irons. Desoldering irons heat and remove previously applied solder.

1. Formation of a Soldering Iron Tip Using a Clad Wire Segment or Rod

A first exemplary embodiment produces the soldering iron tips (or desoldering iron tips) from clad wire or a clad rod. As shown in Figure 5 in a cross-section depiction, a clad wire (or rod) segment **20** comprises a core of material **24**, on which another electrically conductive protective layer **22** is metallurgically bonded. The core material **24** may comprise a metal such as copper of high purity, such as copper alloy Nos. C10100 or C10200 having copper contents of 99.99% Cu and 99.95% Cu, respectively. To promote machinability of the core, copper alloy containing tellurium can be used, such as copper alloy No. C14500 (comprised of 99.5% Cu, 0.5% Te and 0.008% P). The protective layer **22** can comprise, but is not limited to, high purity nickel, high purity chromium, or some alloy thereof, such as Fe-Ni (e.g. Invar-type alloys), Fe-Ni-Cr, or other suitable material. The layer **22** can also comprise stainless steel. According to one exemplary embodiment, clad wire produced by

Anomet Products, Inc. of Shrewsbury, Mass. can be used to produce soldering iron tips according to techniques disclosed herein.

A semi-finished tip produced by the clad wire segment **20** is shown in Figure 6 (in cross-section depiction), while a finished tip produced by the clad wire segment **20** is shown in Figure 7 (in cross-section depiction). Referring to Figure 7, the tip has a cylindrical portion **23** joined to a cylindrical portion **21** of smaller diameter. The portion **21** terminates in a tapered working area **28**. The outer layer **22** of the clad wire covers the underlying copper core **24**, except for the working area **28** of the tip.

In the finished soldering iron tip, the protective outer layer **22** serves a number of purposes. First, the layer **22** protects the underlying copper core **24** from corroding in the air. Second, the outer layer **22** provides a good electrical contact between the tip and ground, which, in turn, prevents a voltage from building up between the tip and ground which could discharge during soldering operations and damage the components to which solder is being applied. In the case of soldering electrical components, military specifications require a tip-to-ground voltage potential of no more than 2 millivolts (mv) and tip-to-ground resistance of no more than 2 ohms. Third, the outer layer **22** offers relatively poor wettability by solder, and thereby prevents solder from advancing past the working area of the soldering iron tip. Generally, the use of the clad wire or rod as a starting material eliminates the need to form the protective outer layer **22** by electroplating at a later stage in the production of the tip, and therefore eliminates the above-described drawbacks of electroplating.

2. Formation of an Integrated Heater Element

Another aspect of the invention involves the formation a heater element which is integral with the soldering iron tip. For example, as shown in Figure 8, the finished tip (or semi-finished tip) with an integral heater includes a cylindrical portion **23** sandwiched between the cylindrical portion **21** and a heater element **26** (as shown in cross-section depiction). The heater element **26** and the tip itself are formed from the same clad wire (or rod) segment **20**. As such, there is metallurgical continuity between the heater **26** and the tip, which facilitates the transfer of thermal energy from the heater **26** to the tip. The outer layer **22** from the clad wire covers the tip, including the heater **26**, but does not cover the tapered end portion **28** of the tip.

As mentioned above, the protective layer **22** can comprise, but is not limited to, stainless steel, high purity nickel, high purity chromium, or some alloy thereof, such as Fe-Ni (e.g. Invar-type alloys), Fe-Ni-Cr, or other suitable material. More specifically, Invar-type alloys of different compositions can be selected to provide different soldering iron power load capacities. For example, progressively greater power loads can be supplied by layers of: (1) 42% Ni, 6% Cr, 52% Fe; (2) 42% Ni, 58% Fe; (3) 44% Ni, 56% Fe; and (4) 52% Ni, 48% Fe.

3. Manufacture of a Soldering Iron Tip Using Metal Forming

Those skilled in the art will appreciate that there are many techniques for transforming the clad wire (or rod) segment **20** shown in Figure 5 into a desired tip geometry (such as the tip shapes shown in Figures 6, 7 or 8), including machining the wire or rod segment **20** into the desired shape. Alternatively, according to the present invention, a metal forming process, such as cold or hot heading can be used to manufacture the tip.

Figure 9 illustrates one exemplary technique employing a cold heading process for transforming a wire segment into a finished or semi-finished tip. The exemplary technique begins by feeding a length of clad wire from a spool of wire to a cutter (step **S1**), which cuts off a segment of the wire of prescribed length (step **S2**). Following the cutting operation, the segment is then transported to a first die chamber (step **S3**), where one or more dies deliver one or more blows to taper one end of the segment (step **S4**) to shape a portion **21** having a reduced diameter, as shown in Figure 6, which is then further processed to shape a tapered working area **28**, as shown in Figure 7. Cold heading per se is well understood in the art and thus the details of such a process will be evident to those skilled in this art. By way of example, U.S. Patent Nos. 3,669,334, 3,934,293, 4,058,865, and 5,146,668 provide exemplary details of typical cold heading machinery and techniques for shaping wire segments. These patents are incorporated by reference herein.

The process can skip steps **S5** and **S6**, upon which the part is dispensed in step **S7**. At this stage in the manufacture of the tip, the protective layer **22** can be removed from the working area **28** of the tip by machining or like technique. A protective layer can be added to the working area **28** at some later stage of production using any suitable technique, such as by using electroplating, or by fitting a cap onto the working area **28** (to be discussed later).

If an integral heater is desired, the tip shown in Figure 7 can be transported to a second die chamber (step **S5**), where another die delivers one or more blows to form the heater element **26** at one end of the tip (step **S6**), as shown in Figure 8, thus producing the finished tip with an integrated heater **26**. The finished tip is dispensed in step **S7**. Steps **S5** and **S6** are enclosed in a broken-line box to illustrate that they can be omitted to produce a tip without an integrated heater, if desired.

Alternative methods for constructing the tip include using a hot heading process (instead of a cold heading process), or forming the heater **26** prior to forming the portions **21**, **28**, or forming the heater **26** at the same time as the portions **21**, **28** (e.g. through the simultaneous application of plural blows from plural dies). The exemplary steps shown in Figure 9 can be fully automated, or may require manipulation of parts and/or machinery by a human operator. Furthermore, the tip portions (e.g. portions **21**, **23**) can be formed having any desired geometry.

The process discussed above shapes the clad wire segment **20** shown in Figure 5. However, the technique can also be used to shape wire segments which do not have an outer protective layer **22**. In this embodiment, the protective layer **22** could be subsequently formed on the shaped tips through electroplating or like technique.

4. Formation of an Outer Layer Cap on the Working Area of the Tip

Figures 10-12 illustrate another aspect of the present invention for forming a hardened outer layer on the working area of the tip. The technique shown in Figures 10 through 12 has wide applicability to many types of tips produced by various techniques. For example, the technique shown in Figures 10 through 12 can be used to supply a hardened outer layer on the exposed end **28** of the soldering iron tip produced by the method described with reference to Figures 5 through 9, or can be used to supply a hardened outer layer for machined copper cores, such as the machined core **2** shown in Figure 1.

As shown in Figure 10, a continuous thin strip of material **30** is produced (e.g. a strip having a thickness of about 5 mils). According to exemplary embodiments, the material can comprise iron of high purity (e.g. iron having a purity of 99.5% in one exemplary embodiment), nickel, or other material or alloy. Thereafter, a plurality of caps **34** are stamped out using die **32** which mates with die **35**. Only one pair of dies (**32**, **35**) has been shown to facilitate discussion, although plural pairs of dies (**32**, **35**) can be used. The die **32** has an outer contour **37** which defines the inner contour of the cap **34**, while the die **35** has a recess having a contour **39** which defines the outer geometrical shape of the cap **34**. Figure 11 shows one such exemplary shaped cap **34**, having a tapered end **38** and a cylindrical portion **36**. The cap **34** can alternatively be formed by other techniques such as, but not limited to, a deep drawing process.

The cap **34** is then inserted over the working area **33** of a tip **41** in the manner shown in Figure 12. The cap **34** is preferably secured to the tip **41** by a metallurgical bonding technique such as brazing, or like technique. For example, a small amount (e.g. about 0.2 mils) of high purity silver or "CUSIL" (72% Ag, 28%Cu) can be applied to a mating surface of either the stamped cap **34** or the tip **41**, and then melted or sintered to metallurgically bond the cap to the tip. Alternatively, to further promote efficiency in production, the brazing material can be applied to the strip of material **30** before stamping. During melting, the silver and copper form a CuAg eutectic which bonds the cap to the tip.

As an alternative to stamping the cap **34** from a sheet of material such as iron, the cap may be produced by cold heading or forming segments of wire or metal shapes (e.g. spheres) into the desired tapered shape. The details of such a process will be evident to those having skill in this art, and thus will not be discussed in further detail. By way of example, U.S. Patent No. 3,669,334 discloses one such technique.

The finished soldering iron tip **41** shown in cross-section depiction in Figure 12 comprises a copper core **40** having a tapered working area end **33**. The cap **34** is inserted over the working area end **33**. The cap **34** can contact another layer **42** (or series of layers). These additional layers **42** can be formed by any suitable technique. For instance, these layers **42** can be formed by the technique shown in Figures 5-9, or via electroplating. Alternatively, these layers **42** can themselves be separately formed as caps and inserted over the core **40** prior to inserting the cap **34**, such that the tip has a plurality of overlapping caps. In any event, these layers **42** preferably have low wettability by solder and provide low tip-to-ground potential, as previously described. Finally, while the tip **41** shown in Figure 12 does not include an integrated heater, this technique can be used to furnish caps **34** for tips which include integrated heaters (such as the tip shown in Figure 8).

According to the exemplary embodiment shown in Figure 12, the outer contour of the working area **33** generally matches the inner contour of the cap **34**. Alternatively, the terminal end of the tip need not match the inner contour of the cap **34**. For example, the terminal end of the tip can be truncated along the line **61**, thereby forming an intermediary region between the end of the tip and the cap **34**. This intermediary region is filled with a brazing composition (or other metallic substance) to improve the thermal conductivity between the tip and the cap **34**.

More specifically, in one embodiment, an amount of brazing material is added to the inside **63** of the cap **34** before fitting the cap **34** onto the end of the tip. The brazing material can be applied to the interior of the cap in a paste, solid or powder form, or some other form. Once applied, the cap **34** (with brazing material disposed therein) is heated to melt or sinter the brazing material, thereby bonding the brazing material to the inside of the cap at its distal end. After the cap **34** cools, the cap is inserted over the end the tip, and attached thereto by a suitable technique, such as brazing or sintering.

In yet another embodiment, the cap **34** can be secured to the end of the tip before the brazing material cools, such that the brazing material is still in a melted form, or at least still soft. This technique further ensures that the junction between the end of the tip and the cap does not contain air gaps. Still other forms of the invention entail securing the cap **34** to the end of the tip and then adding the brazing material to the interior cavity between the cap **34** and the tip through a hole in the cap (not shown), for example.

5. Formation of the Outer Layer on the Working Area Using Clad Wire

Another exemplary embodiment entails producing the soldering iron tips (or desoldering iron tips) having an outer layer on the working area of the tip from a clad wire segment or a clad rod segment. As shown in Figure 13 in cross-section depiction, in this embodiment, the clad wire (or rod) segment comprises a core of material **70** made of copper or a copper alloy. The protective layer **71** can comprise, but is not limited to, high purity iron, nickel, or like material or alloy.

This segment can be shaped or formed according to any of the techniques discussed above into a desired tip geometry, such as the exemplary tip geometry shown in Figure 14 in cross-section depiction. As shown in Figure 14, the tip includes a copper core **70** having an outer layer **71** (e.g. comprising iron) covering substantially the entire surface of the tip, including the working area **72**. The outer layer **71** can be joined at the distal end of the working area **72** by any suitable technique, such as by crimping the distal end of the working area **72**. Furthermore, although not shown, additional layers can be formed on the outer layer **71**, such as a layer having the properties discussed above in the context of Figure 5 (including, but not limited to high purity nickel, high purity chromium, or some alloy thereof, such as Fe-Ni or other Invar-type alloys, Fe-Ni-Cr, stainless steels or other suitable material). These additional layers can be formed on the outer layer **71** by any suitable technique, such as electroplating.

Instead of electroplating additional layers onto the layer **71**, yet another embodiment of the present invention entails forming a tip having two or more outer layers by shaping or forming a clad wire segment having two or more outer layers, as shown in Figure 15 in cross-section depiction. More specifically, the clad wire (or rod) segment shown in Figure 15 comprises a core of material **80** made of a metal such as copper or a copper alloy. A first clad layer **82** comprises, but is not limited to, high purity iron, nickel, or like material or alloy. A second outer clad layer **84** can comprise, but is not limited to, high purity nickel, high purity chromium, or some alloy thereof, such as Fe-Ni or other Invar-type alloys, Fe-Ni-Cr, stainless steels or other suitable material.

This segment can be shaped or formed according to any of the techniques discussed above into a desired tip geometry, such as the exemplary tip geometry shown in Figure 16. As shown in Figure 16 in cross-section depiction, the tip includes the copper core **80** having outer layers **82** and **84** covering substantially the entire surface of the tip, including the working area **86**. The outer layer **84** can be removed to reveal the outer layer **82** (formed of, for example, iron) at the working area **86**, as shown in Figure 17 in cross-section depiction. The outer layer **84** can be removed by any suitable technique, such as machining.

The above-described exemplary embodiments are intended to be illustrative in all respects, rather than restrictive, of the present invention. Thus, the present invention is capable of variations in detailed implementation that can be derived from the description contained herein by a person skilled in the art. All such variations and modifications are considered to be within the scope and spirit of the present invention as defined by the following claims.

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WHAT IS CLAIMED IS:

1. A process for making a soldering tip having a protective outer layer, comprising steps of:

cutting a length of clad wire to form a clad wire segment, said wire including a core material surrounded by a protective outer layer which is metallurgically bonded to said core material; and

deforming said clad wire segment to form a working end, thereby forming said soldering tip having said protective outer layer.

2. The process of claim 1, further including a step of shaping said clad wire segment to form a heater element at an end opposite to said working end.

3. The process of claim 1, wherein said shaping step comprises cold or hot heading.

4. The process of claim 2, wherein said shaping steps comprise cold or hot heading.

5. The process of claim 1, wherein said core material comprises copper or a copper alloy.

6. The process of claim 1, wherein said protective outer layer is located behind a working area of said soldering tip, and provides low tip-to-ground potential or resistance, and protects said soldering tip from corrosion in air or dissolution by solder.

7. The process of claim 1, wherein said protective outer layer consists essentially of stainless steel, nickel, chromium, a nickel alloy, an iron-nickel alloy, or a chromium alloy.

AMENDED SHEET

8. The process of claim 6, wherein said protective outer layer consists essentially of stainless steel, nickel, chromium, a nickel alloy, an iron-nickel alloy, or a chromium alloy.

9. The process of claim 1, wherein said protective outer layer is located at least on a working area of said soldering tip.

10. The process of claim 1, wherein said protective outer layer consists essentially of iron, or an iron alloy.

11. The process of claim 9, wherein said protective outer layer consists essentially of iron, or an iron alloy.

12. The process of claim 1, wherein said protective outer layer on said clad wire segment comprises at least a first outer layer and a second outer layer.

13. The process of claim 12, wherein, in a finished or semi-finished soldering tip, said first outer layer is located on a working area of said soldering iron tip, and said second outer layer is located behind said working area of said soldering tip, further wherein said second outer layer provides low tip-to-ground potential or resistance, and protects said soldering tip from corrosion in air or dissolution by solder.

14. The process of claim 2, further comprising shaping a cylindrical middle section positioned between said heater element and said working end.

15. The process of claim 14, where said cylindrical middle section has a first diameter, and said heater element has a second diameter, wherein said first diameter is larger than said second diameter.

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16. A soldering tip produced by the process of claim 1.

17. A soldering tip produced by the process of claim 2.

18. A soldering tip produced by the process of claim 12.

19. A process for making a soldering tip comprising steps of:

cutting a length of wire to form a wire segment;

shaping said wire segment to form a working end using a metal forming process, thereby forming said soldering tip; and

deforming said wire segment to form a heater element component at an end opposite to said working end.

20. A process of claim 19, further including a step of forming a protective layer on said soldering tip after said shaping steps.

21. The process of claim 20, wherein said protective layer consists essentially of stainless steel, nickel, chromium, a nickel alloy, an iron-nickel alloy, or a chromium alloy

22. The process of claim 19, wherein said shaping steps comprise cold or hot heading.

23. The process of claim 19, wherein said wire segment is formed from copper or a copper alloy.

24. A soldering tip produced by the process of claim 19.

25. A soldering tip produced by the process of claim 20.

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26. A soldering tip comprising:

a metal core member made of material having a high thermal conductivity, said metal core member having a first tapered working end, and a second end, opposite to the first end, forming a heater element; and

an outer protective layer, metallurgically bonded to portions of said metal core member including the heater element, the heater element and said first tapered working end of said metal core member being arranged so as to promote thermal transfer of energy between said heater element and said first tapered working end of said metal core member.

27. The soldering iron tip of claim 26, wherein said protective outer layer is located behind a working area of said soldering tip, and provides low tip-to-ground potential or resistance, and protects said soldering tip from corrosion in air or dissolution by solder.

28. The soldering iron tip of claim 26, wherein said protective outer layer consists essentially of stainless steel, nickel, chromium, a nickel alloy, an iron-nickel alloy, or a chromium alloy.

29. The soldering iron tip of claim 27, wherein said protective outer layer consists essentially of stainless steel, nickel, chromium, a nickel alloy, an iron-nickel alloy, or a chromium alloy.

30. The soldering iron tip of claim 26, wherein said protective outer layer is disposed over said heater element but not over said first tapered working end.

31. The soldering iron tip of claim 26, wherein said protective outer layer is disposed over at least said working end.

32. The soldering iron tip of claim 26, wherein said protective outer layer consists essentially of iron, or an iron alloy.

33. The process of claim 31, wherein said protective outer layer consists essentially of iron, or an iron alloy.

34. A process for applying a protective cap on a soldering tip, comprising steps of:

forming a cap from a sheet of metallic material, said cap having an inner contour which generally matches an outer contour of a soldering tip;

fitting said cap over said soldering tip; and

securing said cap to said soldering tip by metallurgically bonding said cap to said soldering tip.

35. The process of claim 34, further comprising a step of applying a brazing composition to said cap following said step of fitting, wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

36. The process of claim 34, further comprising a step of applying a brazing composition to said sheet of material before said step of forming, wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

37. The process of claim 34, wherein said sheet of metallic material comprises iron, or an iron alloy.

38. The process of claim 34, wherein said tip includes a core formed from copper or a copper alloy.

39. The process of claim 34, wherein said forming step forms a tapered end portion and a cylindrical portion on said cap.

40. The process of claim 34, wherein said step of forming comprises stamping or deep drawing a plurality of caps from said sheet of metallic material.

41. A process for making a soldering tip having protective outer layers, comprising steps of:

cutting a length of clad wire to form a clad wire segment, said wire including a core material surrounded by a first protective outer layer;

shaping said clad wire segment to form a tapered end of said soldering tip;

forming a cap from a sheet of a second protective material;

fitting said cap over said tapered end of said soldering tip; and

securing said cap to said soldering tip by metallurgically bonding said cap to said soldering tip.

42. A process for applying a protective cap on a soldering tip, comprising steps of:

forming a cap from a sheet of metallic material;

fitting said cap over an end of said soldering tip; and

securing said cap to said soldering tip by metallurgically bonding said cap to said soldering tip.

43. The process of claim 42, further comprising a step of applying a brazing composition to said cap following said step of fitting, wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

44. The process of claim 42, further comprising a step of applying a brazing composition to said sheet of material before said step of forming,

wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

45. The process of claim 42, wherein said sheet of metallic material comprises iron, or an iron alloy.

46. The process of claim 42, wherein said tip includes a core formed from copper or a copper alloy.

47. The process of claim 42, wherein said forming step forms a tapered end portion and a cylindrical portion on said cap.

48. The process of claim 42, wherein said step of forming comprises stamping or deep drawing a plurality of caps from said sheet of metallic material.

49. The process of claim 42, further including steps of:

before said step of fitting, applying a brazing composition inside said cap to fill at least a portion of an interior cavity of said cap; and

heating said brazing composition.

50. The process of claim 49, wherein said brazing composition is applied in the form of a paste.

51. The process of claim 49, wherein said brazing composition is applied in the form of a powder.

52. The process of claim 49, wherein said brazing composition is applied in the form of a solid.

53. A soldering iron tip, comprising:

a metal core member made of material having a high thermal conductivity;

a protective cap secured over one end of said metal core member, wherein said cap and said metal core member define at least one intermediary region between said cap and said metal core member;

a brazing composition which fills said at least one intermediary region.

54. The process of claim 1, further including the steps of:

forming a cap from a sheet of metallic material, said cap having an inner contour which generally matches an outer contour of said working end;

fitting said cap over said working end; and

securing said cap to said soldering tip by metallurgically bonding said cap to said working end.

55. The process of claim 54, further comprising a step of applying a brazing composition to said cap following said step of fitting, wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

56. The process of claim 54, further comprising a step of applying a brazing composition to said sheet of material before said step of forming, wherein said step of metallurgically bonding comprises melting or sintering said brazing composition.

57. The process of claim 54, further including steps of:

before said step of fitting, applying a brazing composition inside said cap to fill at least a portion of an interior cavity of said cap; and

heating said brazing composition.

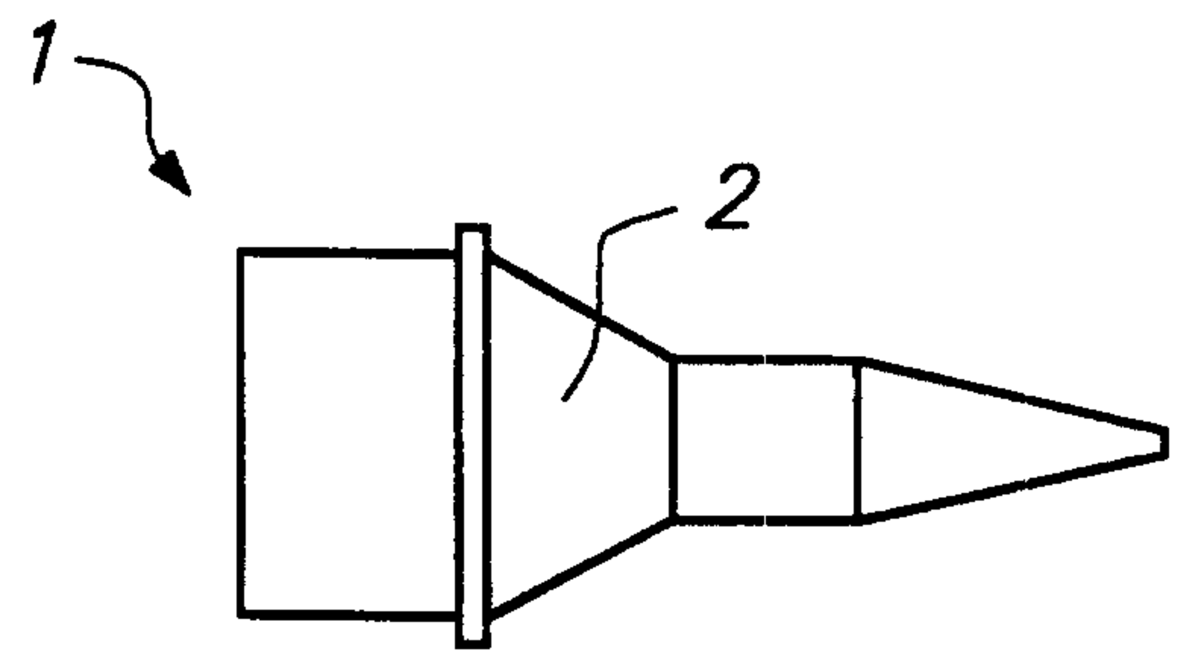

FIG. 1
(PRIOR ART)

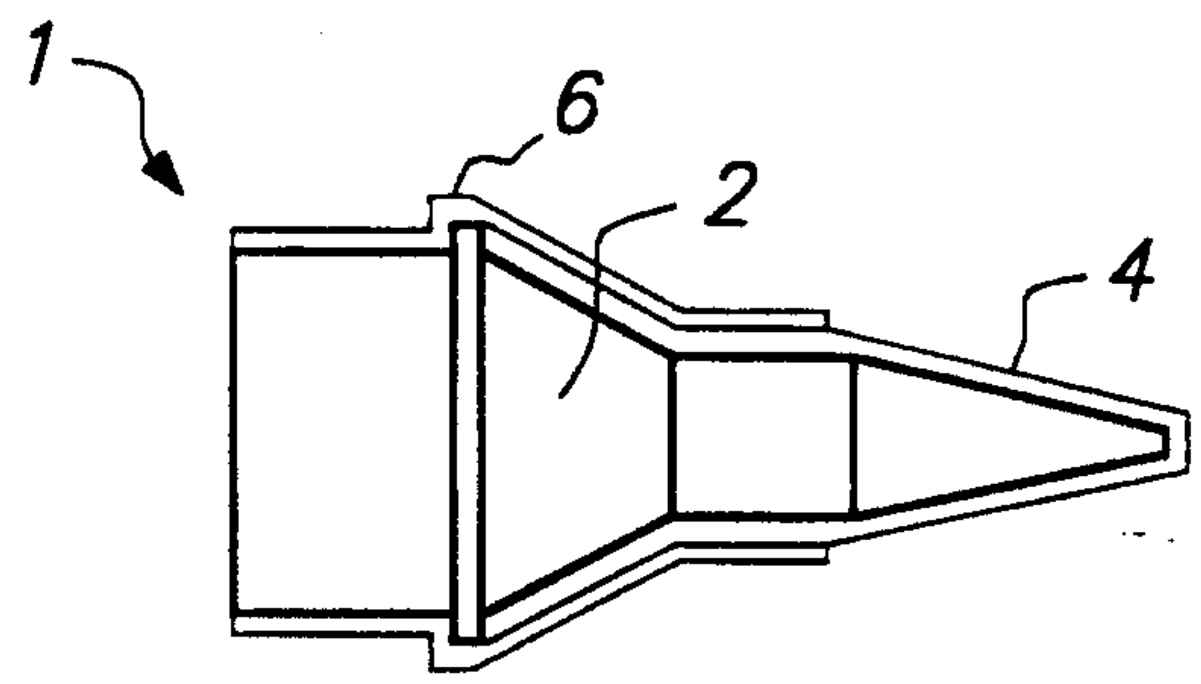

FIG. 2
(PRIOR ART)

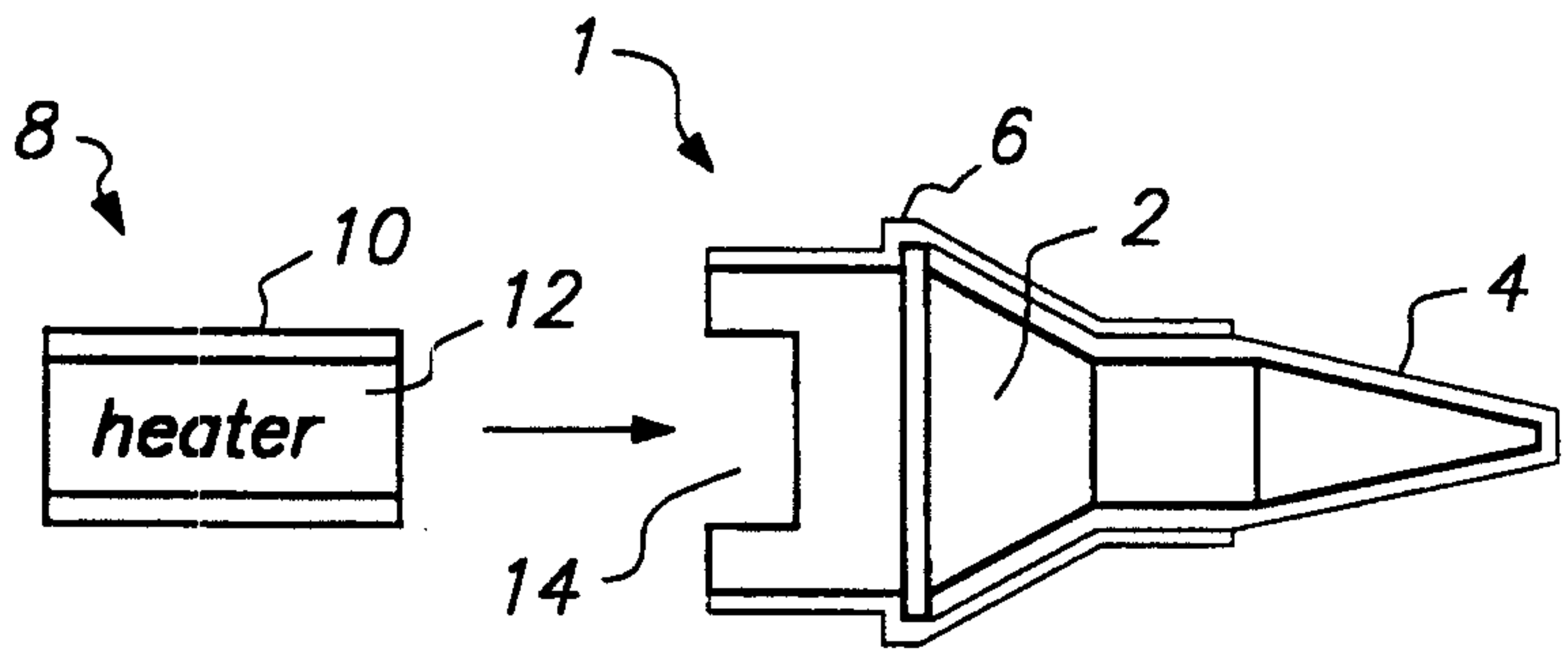

FIG. 3
(PRIOR ART)

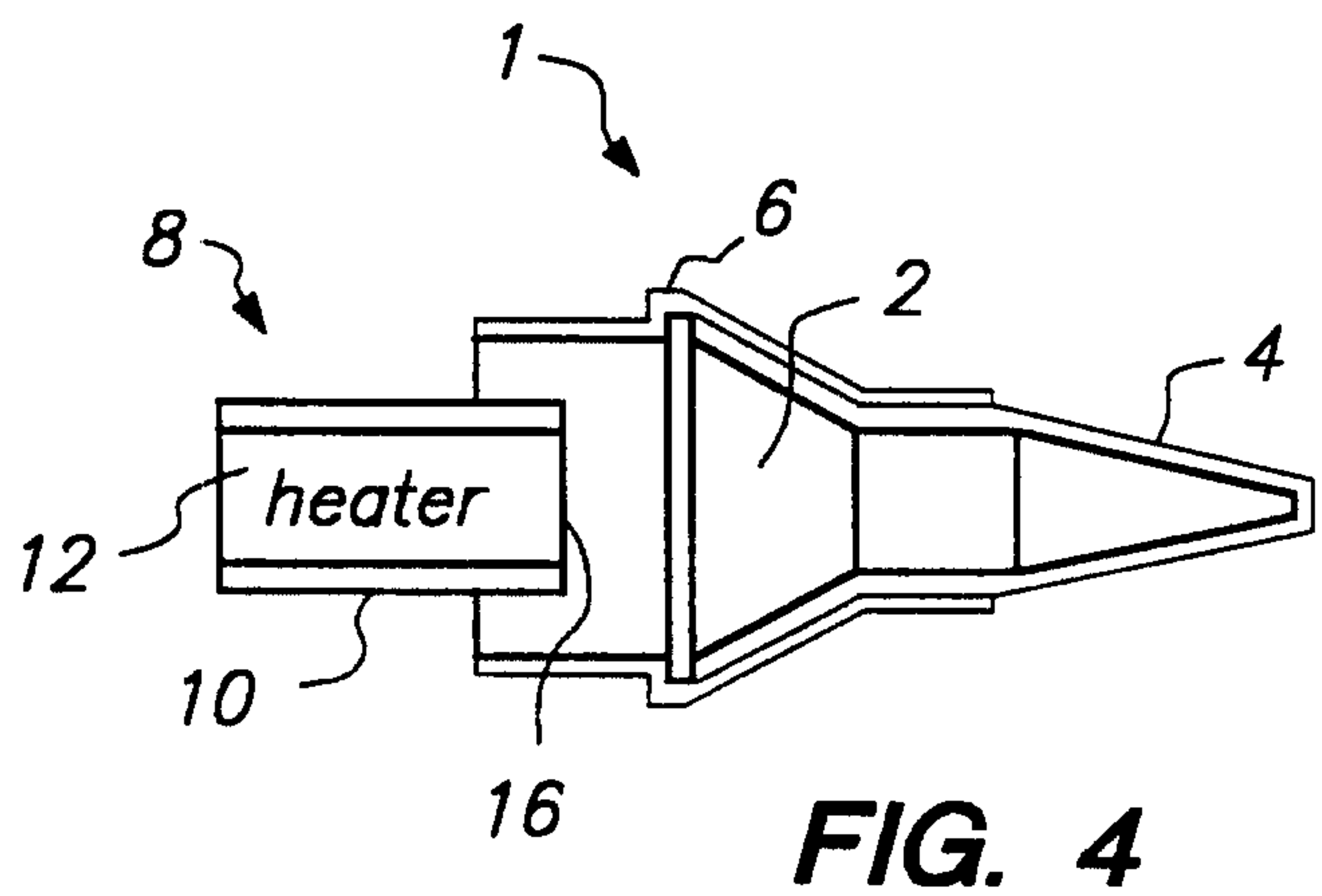

FIG. 4
(PRIOR ART)

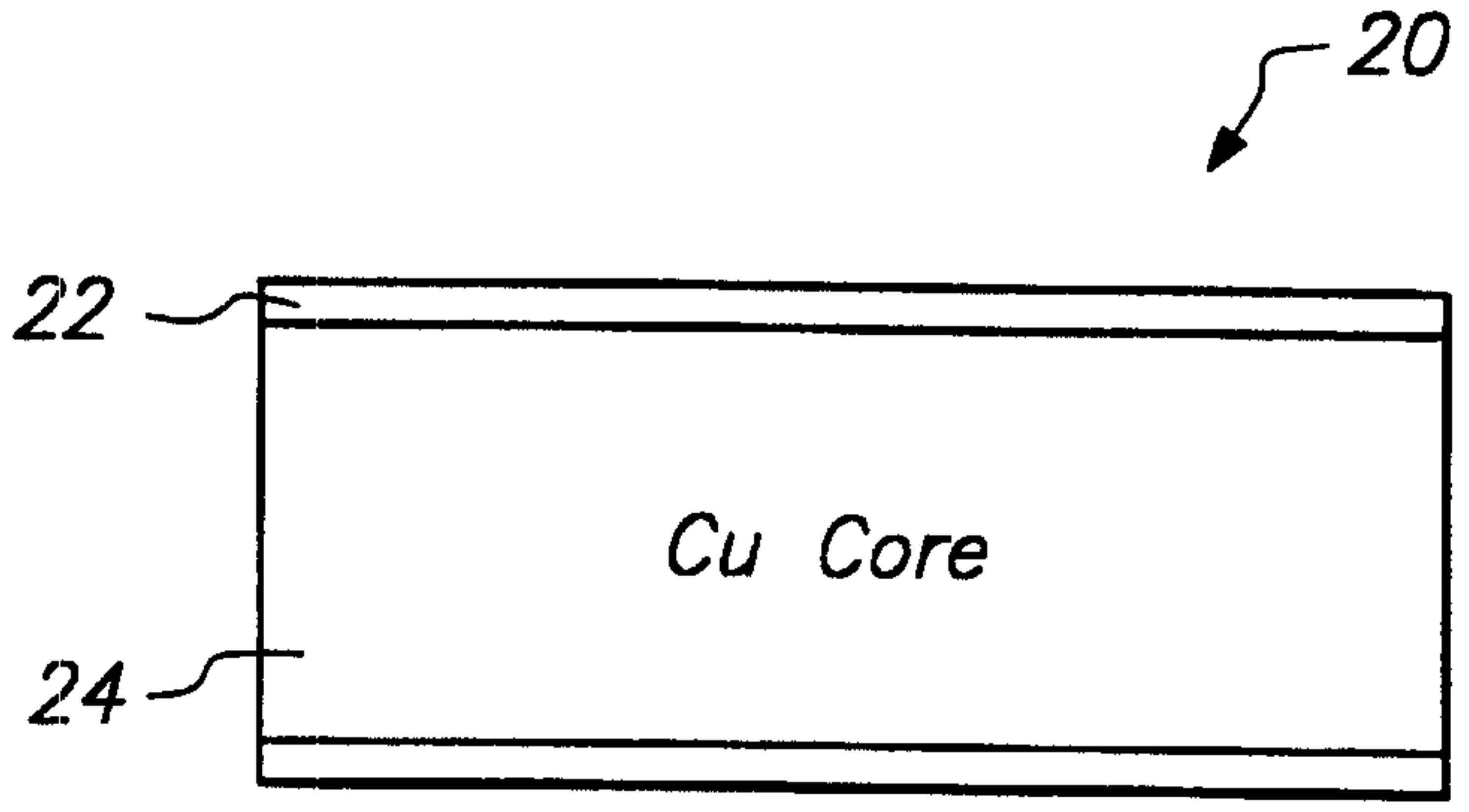

FIG. 5

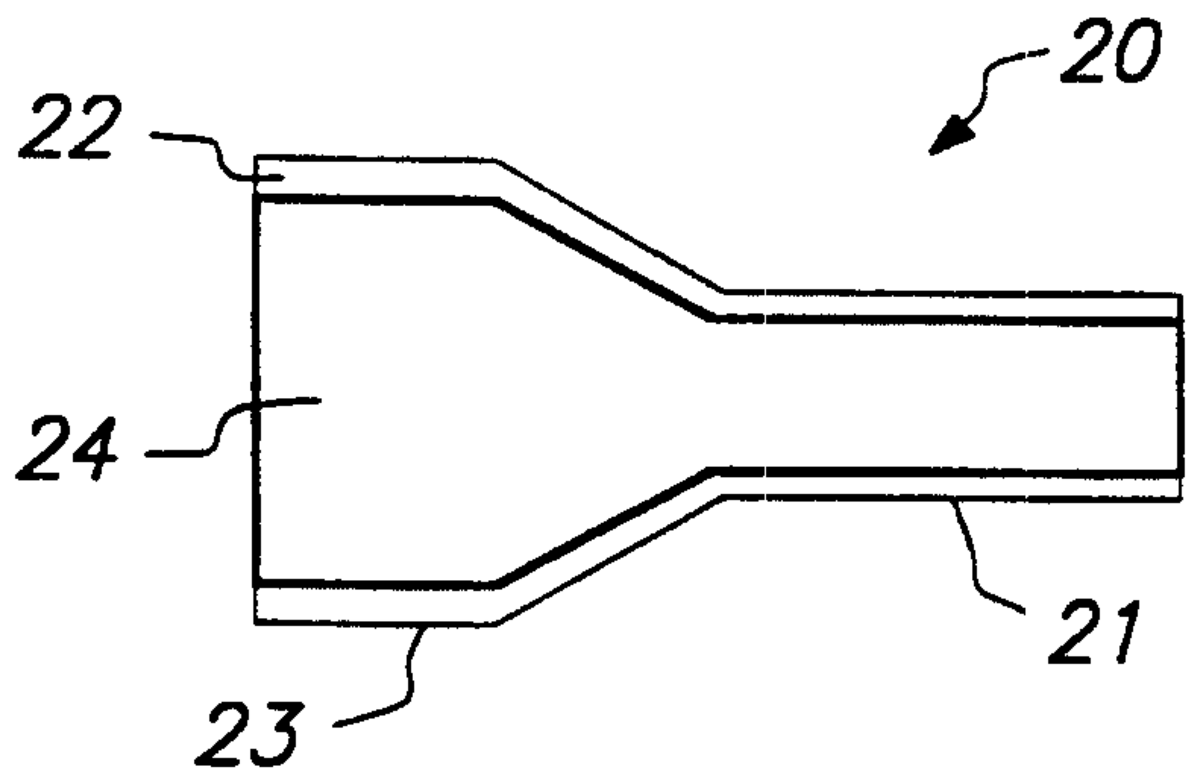

FIG. 6

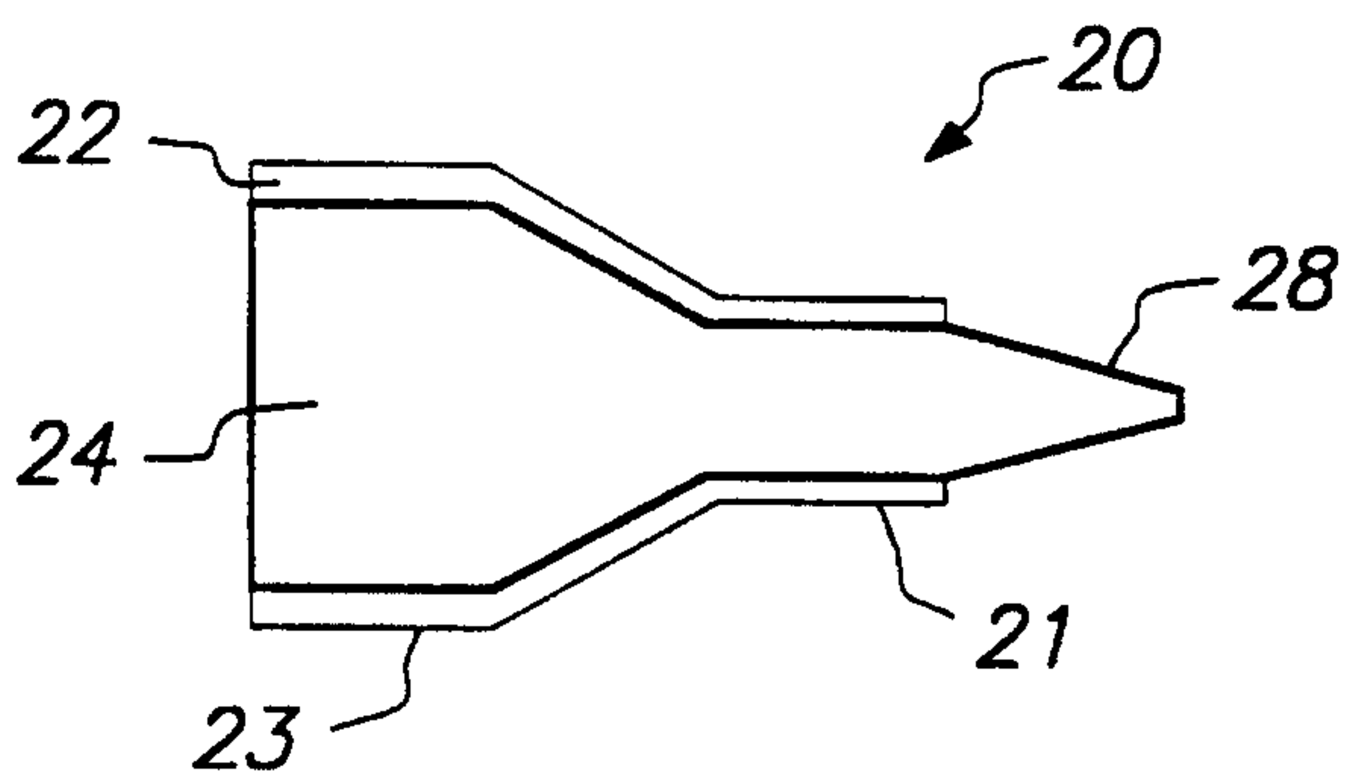

FIG. 7

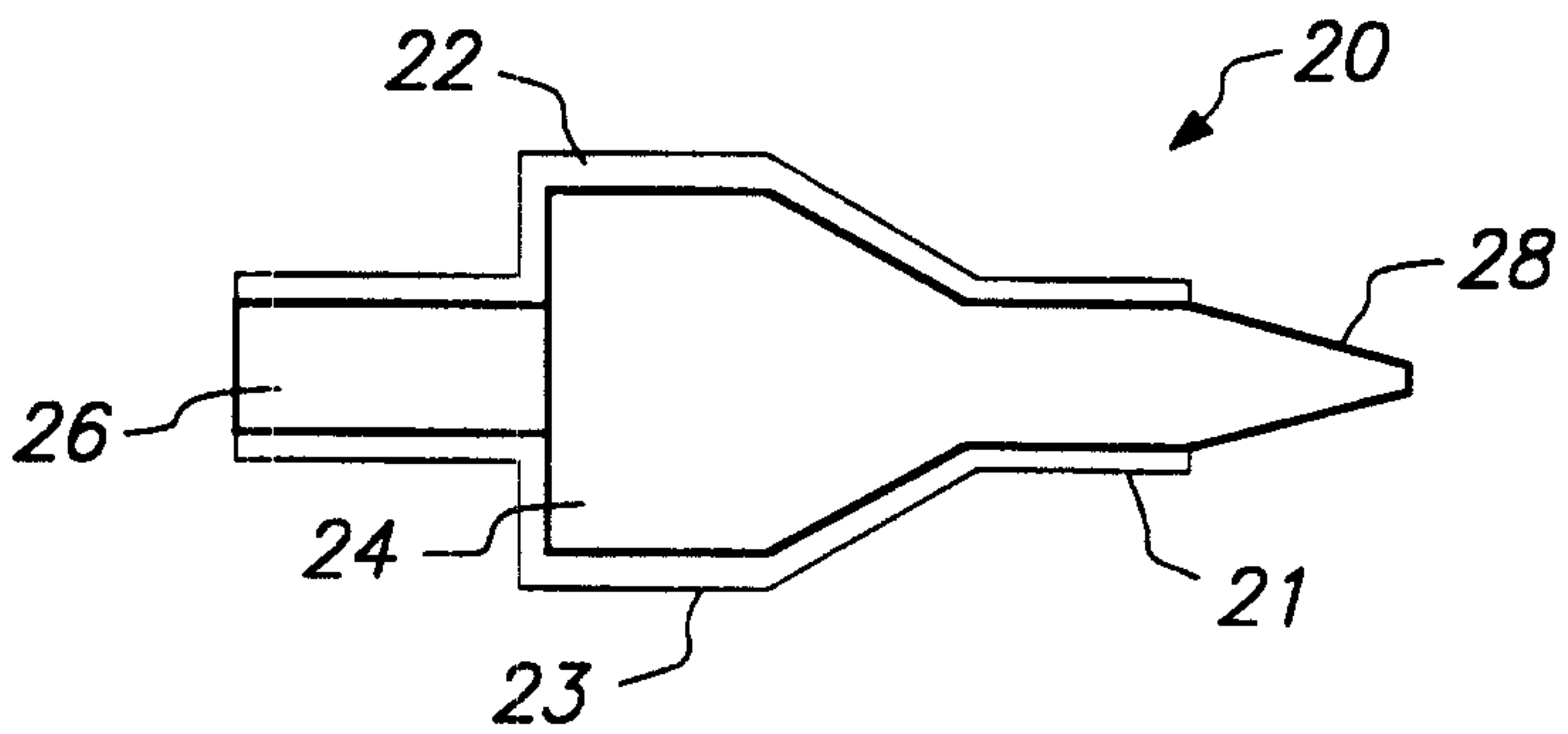

FIG. 8

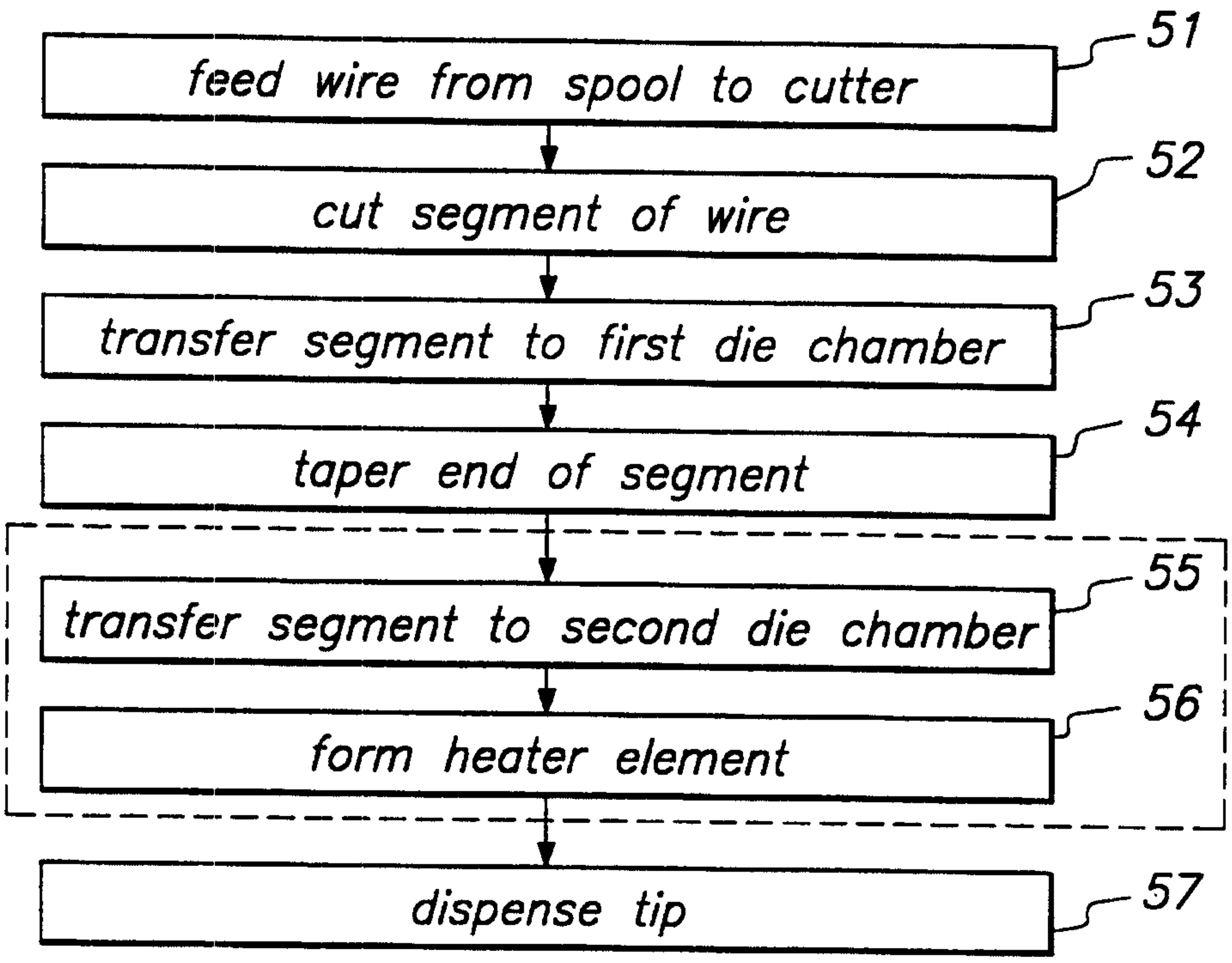
feed wire from spool to cutter
51
cut segment of wire
52
transfer segment to first die chamber
53
taper end of segment
54
transfer segment to second die chamber
55
form heater element
56
dispense tip
57

FIG. 9

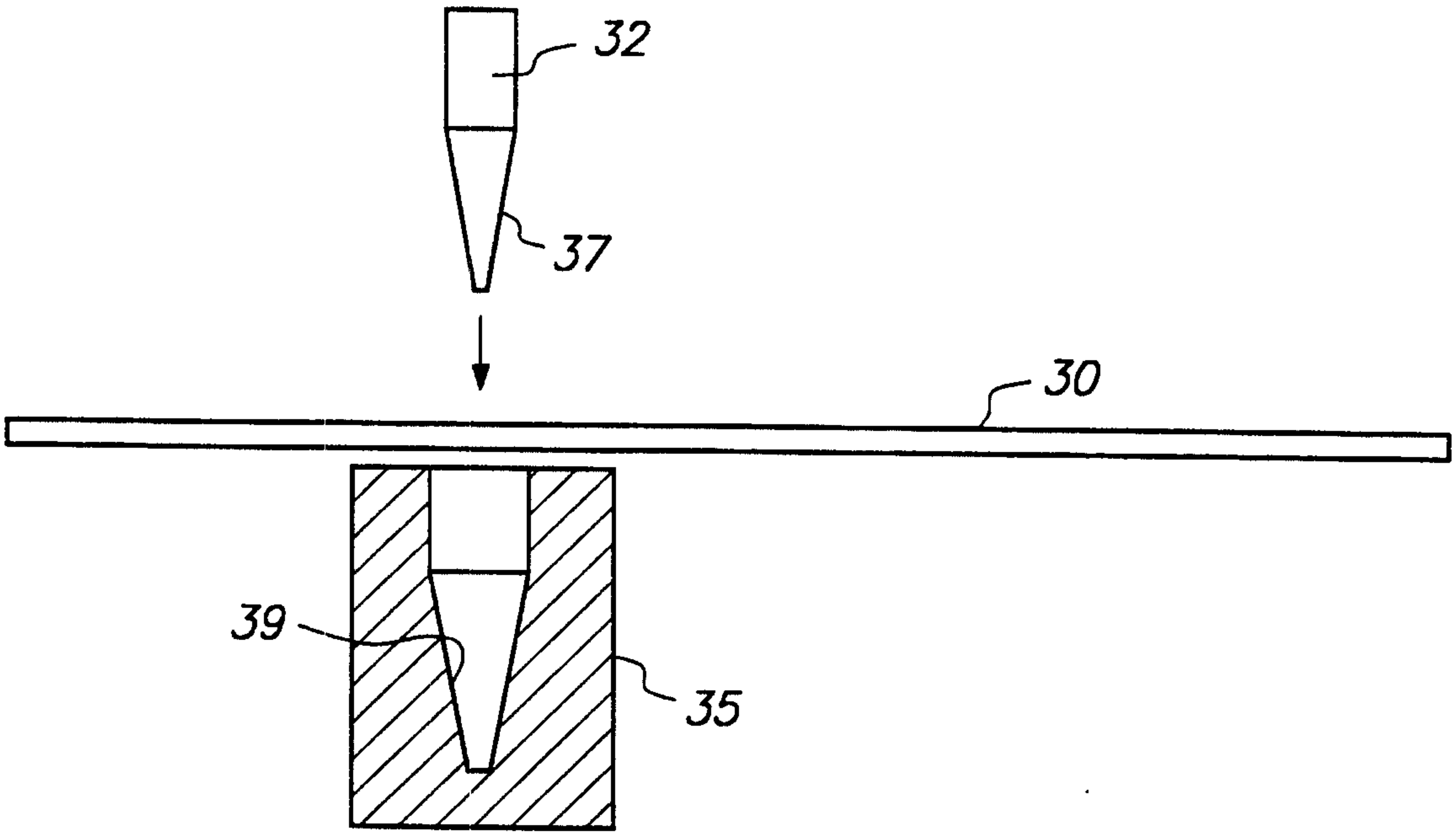
32
37
30
39
35

FIG. 10

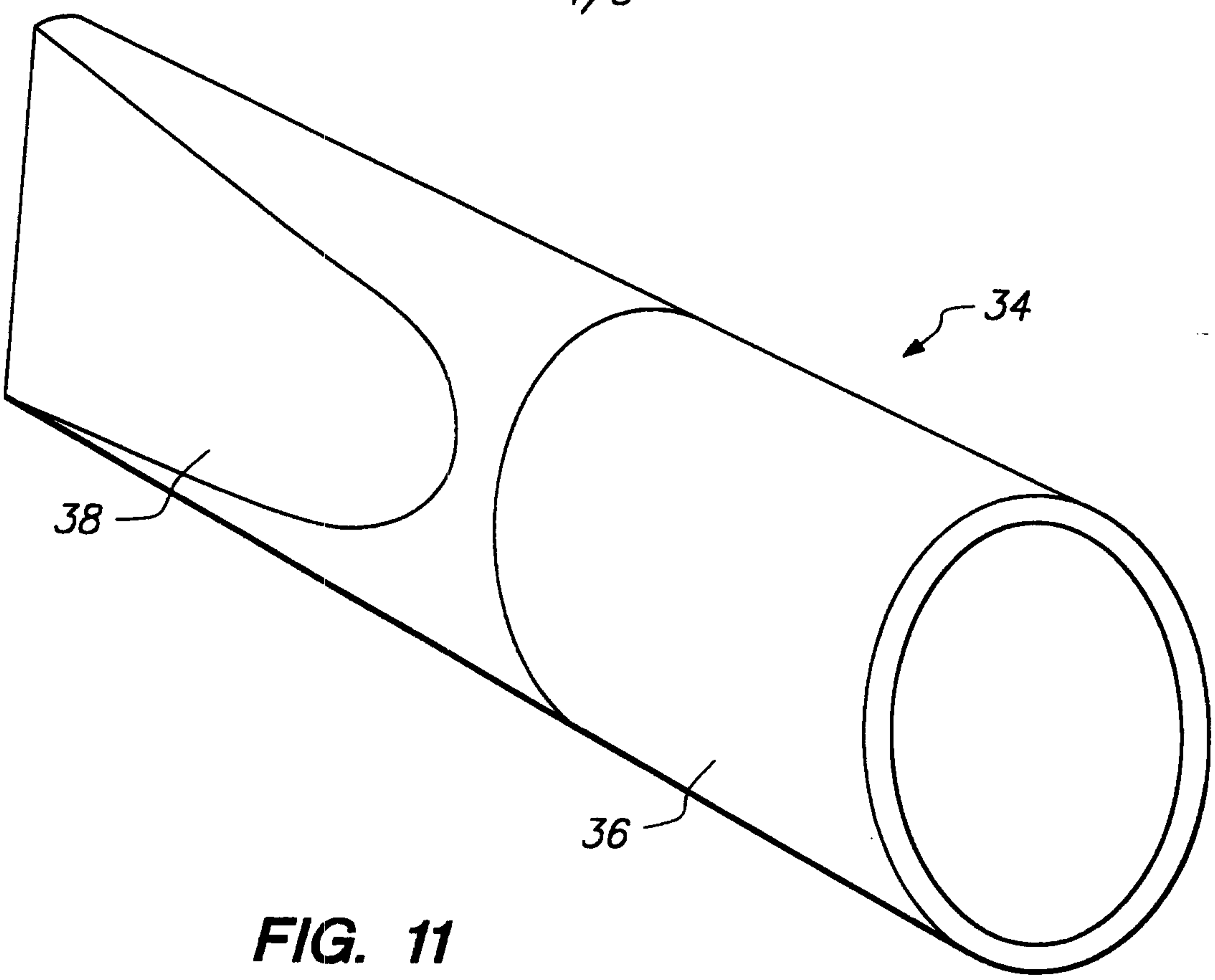

FIG. 11

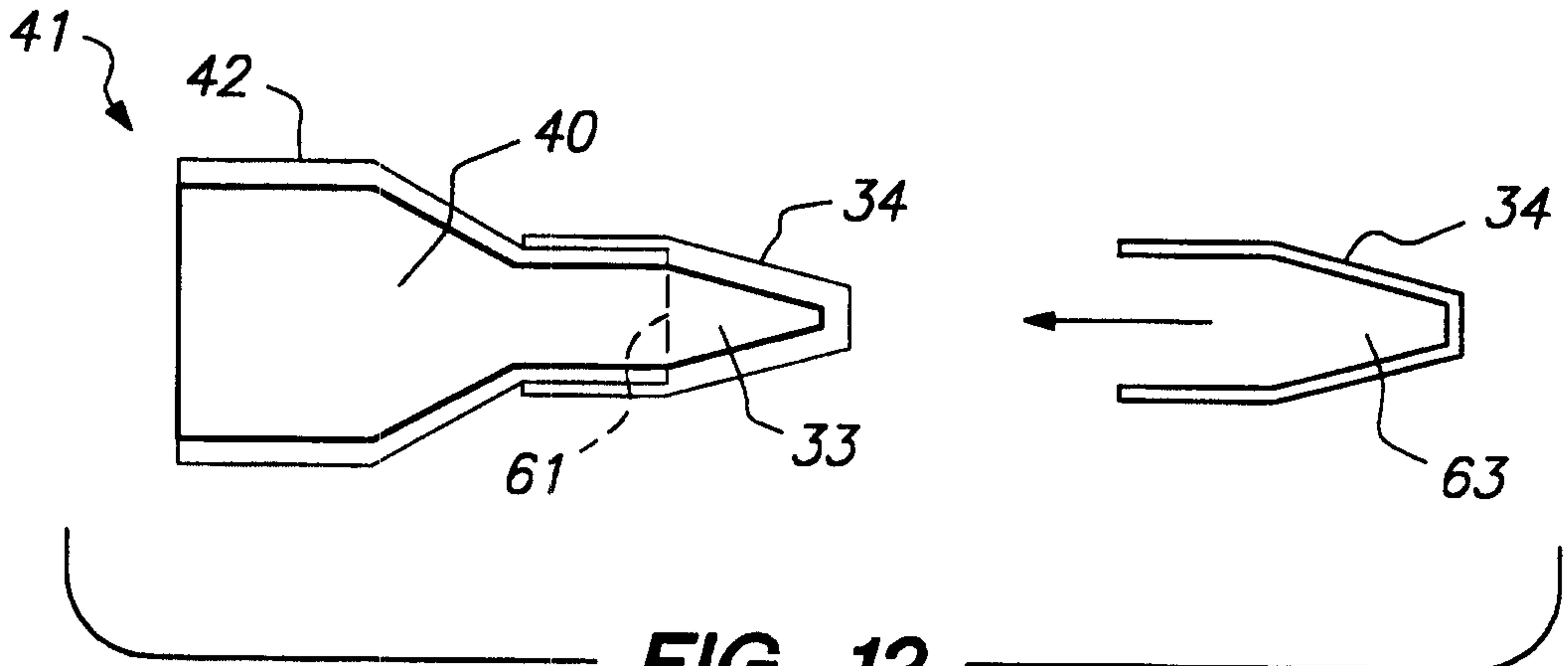

FIG. 12

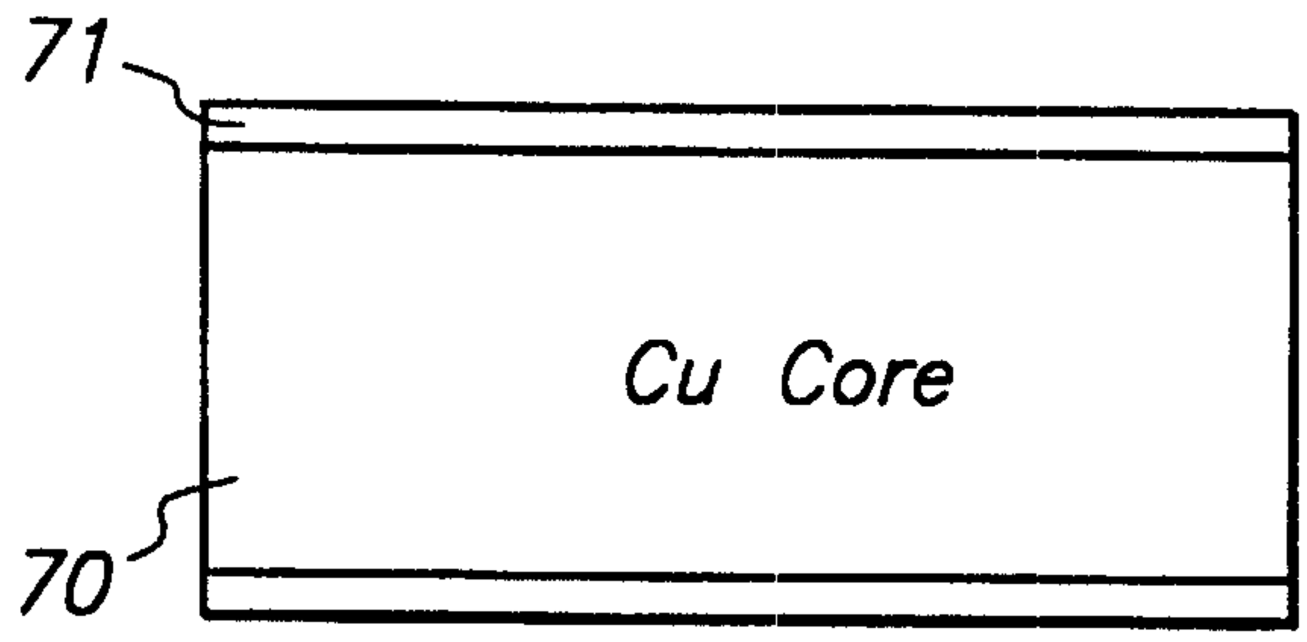

FIG. 13

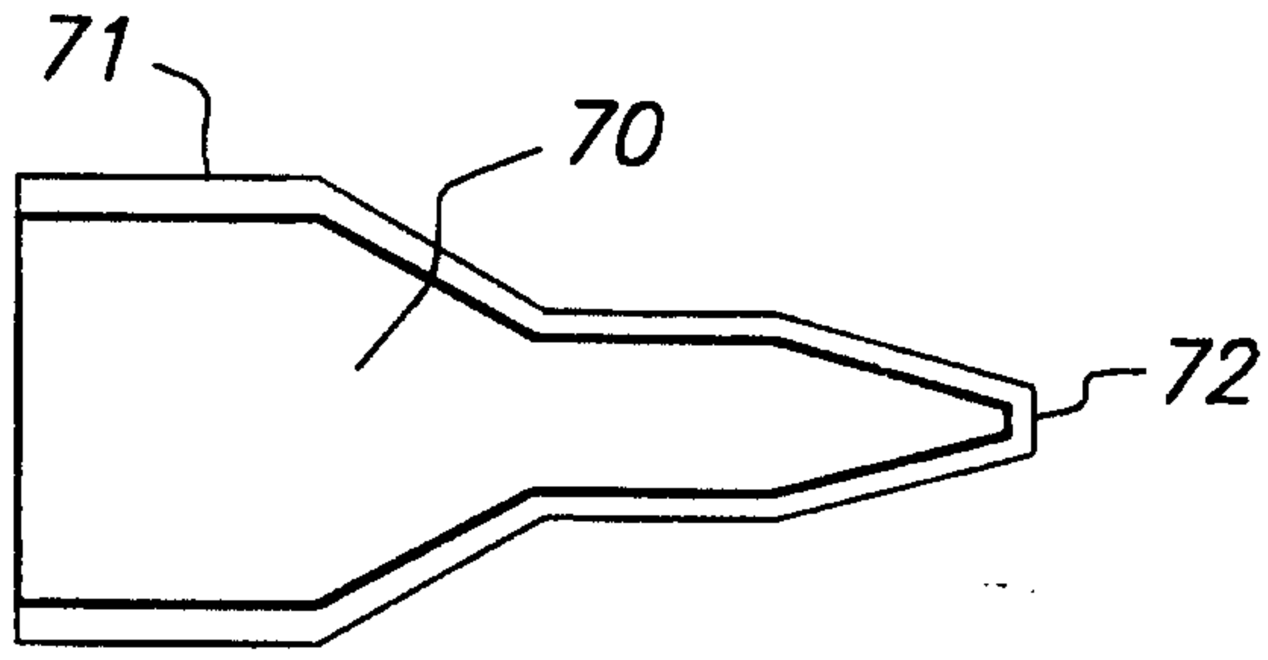

FIG. 14

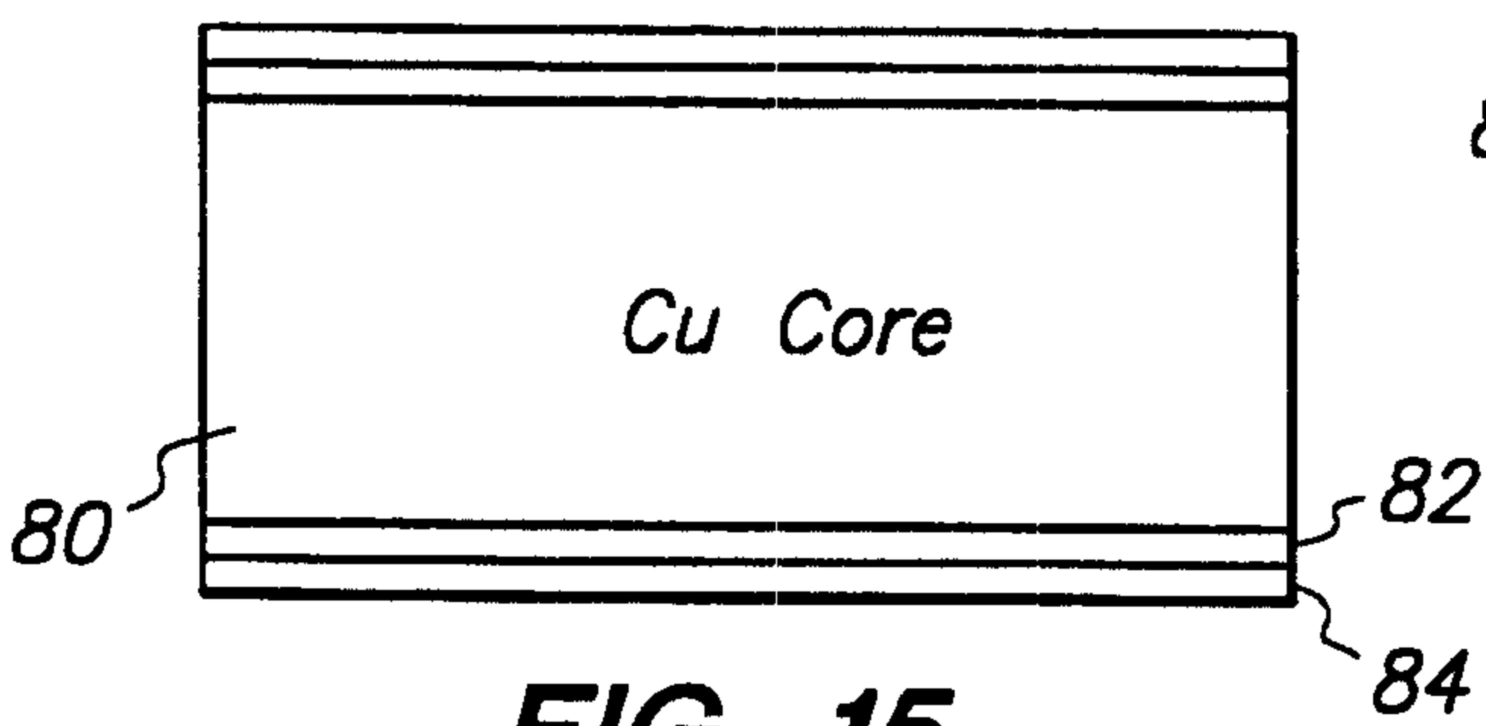

FIG. 15

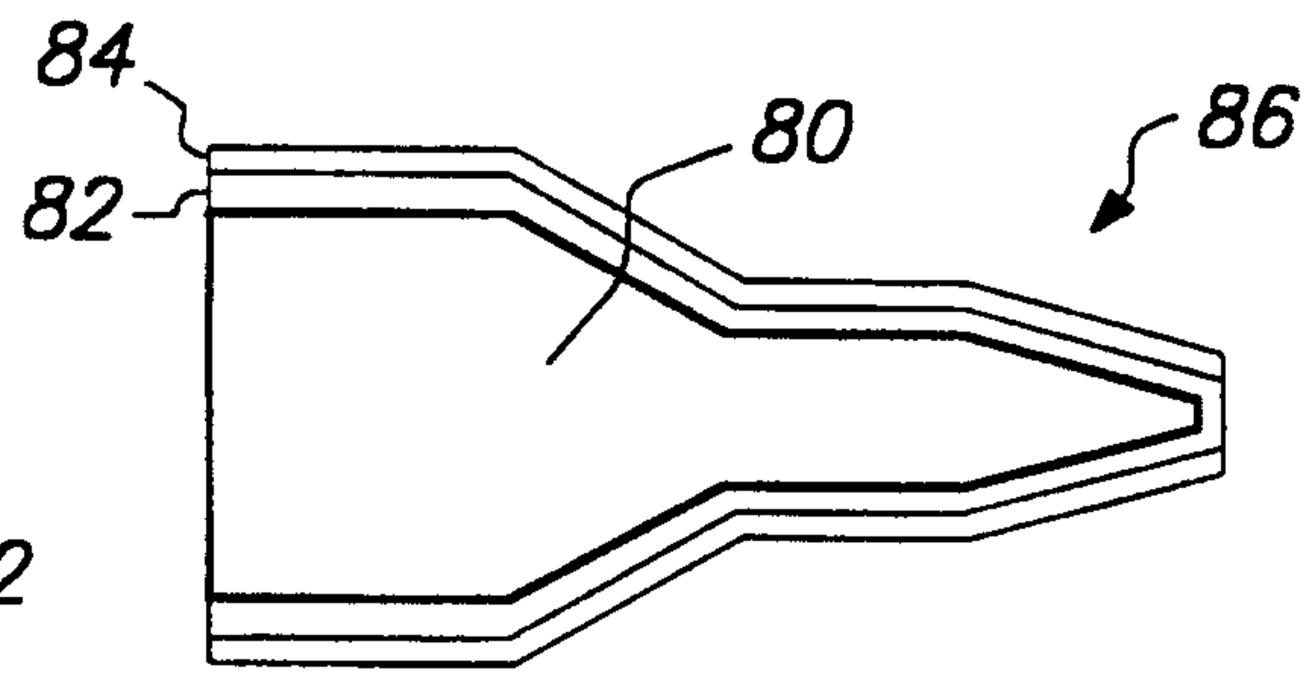

FIG. 16

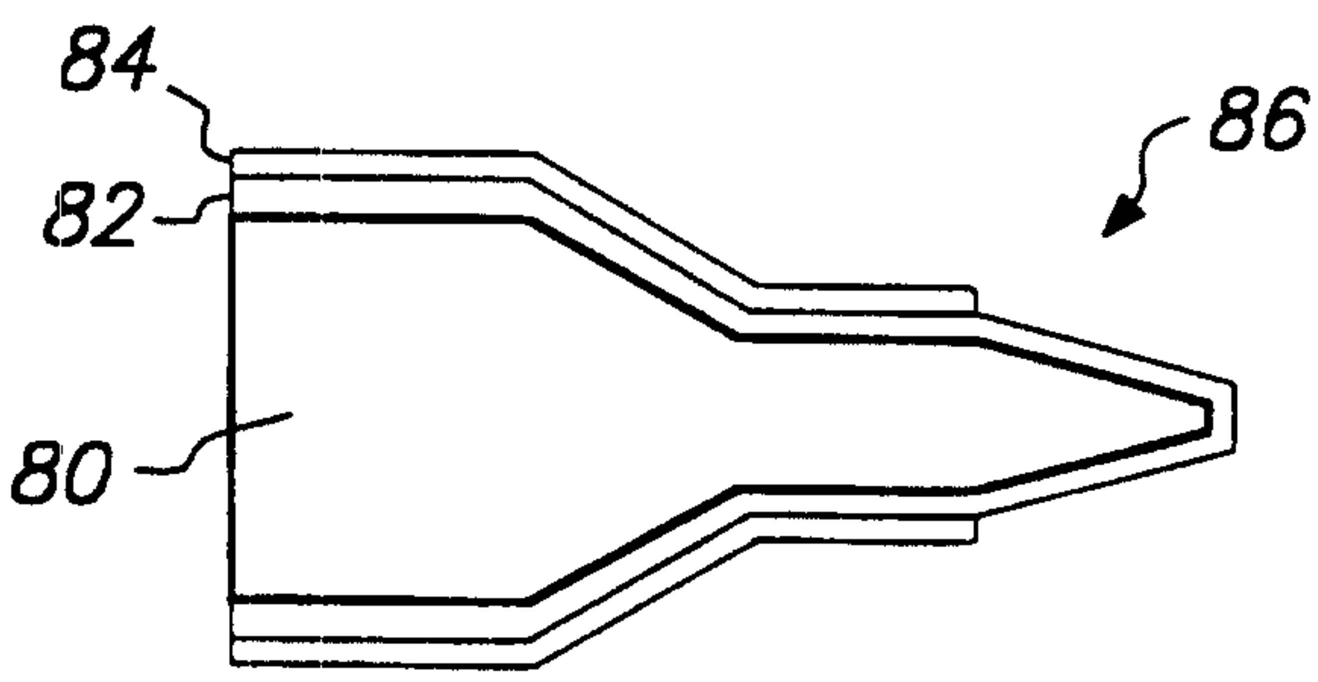

FIG. 17