OPIC
OFFICE DE LA PROPRIÉTÉ INTELLECTUELLE DU CANADA

CIPO
CANADIAN INTELLECTUAL PROPERTY OFFICE

(12) (19) (CA) Demande-Application

(21) (A1) 2,334,118

(86) 1999/06/16
(87) 1999/12/23

(72) VILLAFUERTE, JULIO, CA
(71) TREGASKISS LTD., CA
(51) Int.Cl.[6] B23K 9/26
(30) 1998/06/18 (60/089,752) US
(30) 1999/06/10 (09/329,510) US

(54) TUBE-CONTACT POUR SOUDAGE A L'ARC SOUS PROTECTION GAZEUSE

(54) GAS-METAL-ARC WELDING CONTACT TIP

(57) La présente invention concerne un tube contact pour chalumeau électrique qui comprend un élément ou un tube conducteur avec une extrémité montage et extrémité distale disposées sur un axe longitudinal d'alimentation du fil-électrode. L'élément conducteur est fait de cuivre, d'alliages de cuivre ou de mélanges de poudre de cuivre et de matières céramiques conductrices synthétisées selon des procédés relevant de la métallurgie des poudres. On a augmenté la taille de l'élément conducteur afin de réduire les températures de fonctionnement. L'extrémité montage de l'élément conducteur comporte un passage traversant qui présente une tronçon de grand diamètre du côté de l'extrémité montage et un tronçon de petit diamètre pour le guidage du fil de soudage, près de l'extrémité distale dans l'axe d'alimentation du fil. La sortie du tronçon de petit diamètre présente un bord circulaire net à angle droit, sans chambrage. Une chemise en céramique de forme allongée, à grande résistance à la température, est montée coaxialement dans le tronçon de grand diamètre de l'élément conducteur et comprend elle-même un passage traversant dont le diamètre est calculé pour assurer le guidage du fil-électrode. Le passage traversant de la chemise et le tronçon de petit diamètre de l'élément conducteur définissent un passage d'alimentation pour le fil-électrode.

(57) A contact tip for use in an electric welding torch includes an electrically conductive component or tube including a mounting end and a distal contact end extending along a longitudinal wire feed axis. The conductive component is made of copper, copper alloys or mixtures of copper powder and conductive ceramic materials synthesized by powder metallurgy methods. The size of the conductive component has been enlarged to minimize operating temperatures. The mounting end of the conductive component includes a high heat transfer mounting surface. The conductive component includes a through-bore having a large diameter portion extending from the mounting end and a small diameter portion, sized for guiding the welding wire, proximate to the distal end and extending along the wire feed axis. The outlet of the small diameter portion has no chamber but clean right-angle corners around the outlet. An elongated high temperature resistant, ceramic insert is coaxially mounted in the large diameter portion of the electrically conductive component and includes a corresponding through-bore also sized for guiding the welding wire. The insert through-bore and conductive component small diameter portion define a wire feed passageway for supporting the welding wire.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B23K 9/26

A1

(11) International Publication Number: WO 99/65635

(43) International Publication Date: 23 December 1999 (23.12.99)

(21) International Application Number: PCT/IB99/01122

(22) International Filing Date: 16 June 1999 (16.06.99)

(30) Priority Data:

60/089,752	18 June 1998 (18.06.98)	US
09/329,510	10 June 1999 (10.06.99)	US

(81) Designated States: BR, CA, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(71) Applicant: TREGASKISS LTD. [CA/CA]; 2570 North Talbot Road, Oldcastle, Ontario N0R 1L0 (CA).

(72) Inventor: VILLAFUERTE, Julio; 13116 Dillon Drive, Tecumseh, Ontario N8N 3X2 (CA).

(54) Title: GAS-METAL-ARC WELDING CONTACT TIP

(57) Abstract

A contact tip for use in an electric welding torch includes an electrically conductive component or tube including a mounting end and a distal contact end extending along a longitudinal wire feed axis. The conductive component is made of copper, copper alloys or mixtures of copper powder and conductive ceramic materials synthesized by powder metallurgy methods. The size of the conductive component has been enlarged to minimize operating temperatures. The mounting end of the conductive component includes a high heat transfer mounting surface. The conductive component includes a through-bore having a large diameter portion extending from the mounting end and a small diameter portion, sized for guiding the welding wire, proximate to the distal end and extending along the wire feed axis. The outlet of the small diameter portion has no chamber but clean right-angle corners around the outlet. An elongated high temperature resistant, ceramic insert is coaxially mounted in the large diameter portion of the electrically conductive component and includes a corresponding through-bore also sized for guiding the welding wire. The insert through-bore and conductive component small diameter portion define a wire feed passageway for supporting the welding wire.

GAS-METAL-ARC WELDING CONTACT TIP

Cross Reference to Related Applications

This application claims the benefit of U.S. Provisional Application No. 60/089,752, filed June 18, 1998.

Field of the Invention

This invention relates to electric welding torch tips and more particularly to a contact tip formed of mixtures of copper and conductive-ceramic powders using powder metallurgy processes which may have a non-conductive ceramic insert therein through which a continuous metal wire electrode is passed and charged with enough current to become filler metal on a workpiece.

Background of the Invention

In a conventional welding operation, a wire of filler metal or welding wire is continuously fed and charged through a welding torch contact tip having a wire feed aperture with a receiving end through which the filler wire enters the contact tip and a contact end through which a short length of the filler wire projects to be presented in a suitable position next to the weld zone. An electric arc is formed between the charged end of the wire and an oppositely charged workpiece which provides heat to form a weld puddle. In many methods and apparati, a welding machine further includes a nozzle for blowing an inert or active gas over the weld puddle to keep it under a controlled atmosphere. This avoids unwanted reactions of the molten metal with the surrounding air which result in poor weld quality.

In welding methods of this general category, the welding wire is unwound from a spool and automatically fed into the welding assembly as the welding wire is consumed. The welding wire has a cast, which is arcuate in nature, as it is formed and wound on the spool. It is desirable to maintain good electrical continuity between the wire and the contact tip. Drive rollers are often used to feed the wire off the spool and into the welding torch. The wire must be moved through the wire feed aperture smoothly, without jerking, for accurate and high performance welding to be satisfactorily achieved.

Welding methods of this type, measure process efficiency by the percentage of arc-on time during production. Manual, mechanized, automatic or robotic systems using these welding methods often deliver efficiencies of less than 50%. The time during which a laborer or machine is not welding is generally attributable to operational difficulty of the welding apparatus which is often related to the performance of the contact tip.

Contact tips are traditionally fabricated as cylindrical tubes made of pure copper or high copper content alloys which have high electrical and thermal conductivity. Under normal service conditions, contact tips may be exposed to operating temperatures well above 400°C (752°F). Operating temperature is critical in determining the performance of contact tips. Higher temperatures degrade the material properties and accelerate failure of contact tips. Heat is mainly transferred by conduction from the contact tip to the welding torch.

Under normal service conditions, contact tips are subject to systematic accumulation of debris carried by the wire surface into the contact tip wire feed aperture. These debris are burnt during the welding operation leaving refractory non-conductive byproducts. Contact tip wire feed apertures are fabricated with a dimensional tolerance to minimize friction to the passage of the welding wire. In such contact tips, true electrical contact is only possible at discrete points along the wire feed aperture, and depends on wire feed aperture tolerance and the cast in the welding wire. The presence of non-conductive material inside the wire feed aperture causes electrical contact to become unstable, which results in contact tip failure. Also, the presence of additional material inside the wire feed aperture increases the likelihood of wire choking due to repetitive expansion and contraction cycles which may prevent regular feeding causing bad weld starts or burnback, a condition in which the wire melts to the end of the contact tip.

In welding methods of this kind, there are sporadic liquid metal bursts originated at regular disruptions of the molten wire/puddle bridge or by regular perturbations to the puddle surface. Bursts of this nature result on liquid metal being regularly expelled from the weld zone as miniature droplets or spatter which binds and builds up on the contact end of the contact tip on the inside of the wire feed aperture around the outlet. Excessive spatter accumulation at the front of the contact tip creates a metal bridge between the moving welding wire and the contact tip which eventually causes feeding fluctuations and may bring the process to a halt. Also, spatter buildup in and around the wire feed aperture outlet produces choking of the filler wire leading to similar feeding problems. Feeding instability leads to contact tip failure by burnback or bad weld starts.

Furthermore, the contact wire feed aperture is subject to wear damage by abrasion or electrical erosion caused by the sliding friction between the charged wire feed aperture surface and the moving welding wire. Excessive unidirectional wearing of the wire feed aperture outlet or "keyholing" causes the wire to miss the target seam resulting in misplaced welds. This is critical to robotic welding in which program schedules are not designed to compensate for such source of variation.

It is known in the art relating to continuous feed welding torches to use replaceable contact tips that have an insert disposed in the contact tip distal end proximate the workpiece. Typically these inserts are of a harder material than the copper of the tip. These inserts are claimed to extend the contact tip life by reducing wear as the welding wire is fed through the tip. However, these inserts, and other inserts so positioned, inhibit current transfer close to the arc where it is more efficient for arc stability and welding soundness.

Copper-carbon "alloys" have been suggested to improve lubricity and reduce coefficient of expansion of the contact tip wire feed aperture. This previous art also refers to copper-carbon "alloys" that provide high electrical conductivity while having low thermal conductivity and high melting point. This art refers to the fabrication of cylindrical contact tips by injection molding or traditional machining.

Copper-carbon "alloys" are not possible since carbon is immiscible in copper. However, copper and carbon can be integrated into a single material by powder metallurgy methods which involve pressure-die molding followed by controlled sintering. Carbon comes in many different crystallographic groups including diamond, graphite, amorphous and buckyballs. Each one of these groups exhibits contrasting mechanical and physical properties. Furthermore, within each group specific mechanical and physical properties depend on the level of impurities and orientation of the crystal structure with respect to applied external forces. Diamond exhibits the highest thermal conductivity and hardness of any material while possessing the lowest electrical conductivity of any material. Graphite exhibit limited electrical and thermal conductivity depending on crystal orientation. The good lubricity of graphite results from the hexagonal arrangement of layer planes. Each plane is free to slip or slide past one another. Amorphous carbons have smaller monoplanes piled in turbostatic stacks which have a variety of properties including small expansion coefficient with a variety of thermal and electrical conductivities. Buckyballs are special "soccer-ball" configurations of carbon which exhibit special electrical and other properties.

Powder metallurgy (P/M) materials have certain percentage of undesirable porosity which is inherent to the P/M process. A challenge of every P/M process is to minimize porosity so that the density of the P/M material is as close as possible to its theoretical density.

Summary of the Invention

The present invention provides an improved contact tip for gas-metal-arc welding wherein a continuous wire of filler metal or welding wire is passed through an electrically charged contact tip which passes its charge to the welding wire while the workpiece is oppositely charged.

As is hereinafter more fully described, the contact tip that minimizes friction in its wire feed aperture, display high thermal diffusivity, possess high electrical conductivity, provide permanent anti-spatter protection, stabilizes the location of the current transfer point (insert), minimizes operating temperatures and eliminate excessive wearing of the wire feed aperture.

More specifically, the present invention provides a contact tip for use in a welding torch that guides a welding wire toward a workpiece and transfers welding current from a torch to the welding wire. The contact tip comprises an electrically conductive component including a mounting end and a distal contact end extending along a longitudinal wire feed axis. The conductive component includes a through-bore or wire feed aperture that may have a large diameter portion extending from a mounting, wire receiving, end and a small diameter portion, sized for guiding the welding wire and transferring the welding current, proximate to the distal end and extending along the wire feed axis.

In one embodiment of the invention, an elongated high temperature resistant, ceramic insert including a corresponding through-bore sized for guiding the welding wire, is coaxially mounted in the large diameter portion of the electrically conductive component. Therein, the insert through-bore and conductive component small diameter portion define a wire feed passageway for supporting the welding wire.

Preferably the small diameter portion of the conductive component proximate its distal end extends less than 100% the length of the through-bore extending through the tip. The small diameter portion of the conductive component exhibits a smaller tolerance between wire size and bore size so that true electrical contact is improved.

One end of the insert through-bore may be tapered. This tapered end is the end mounted adjacent the conductive component mounting end to facilitate introduction of welding wire through the insert portion of the contact tip. Preferably the tapered end includes a sidewall disposed generally at an angle of about 30 degrees to the longitudinal wire feed axis.

The front-end outside geometry of the tip comprises an enlarged outside diameter at the front end which enhances the ability of the tip to diffuse heat thus lowering operating temperatures.

Another feature of the front-end geometry is the lack of chamfer at the outlet part of the wire feed aperture. A right angle corner edge provides enhanced current transfer, lowers operating temperature and prevents microspatter from entering the wire feed aperture.

Another feature of the tip front-end geometry comprises an enlarged radius of curvature and bulbous shape which maximizes metal mass at the front end lowering operating temperatures at the wire feed aperture.

Another feature of the front-end may be a coating of an extra-hard protective film of diamond-like carbon which enhances the ability to reject spatter buildup.

The mounting end of the contact tip includes a connector that provides high heat transfer. In one embodiment, the mounting end comprises a frusto-conical surface and taper-lock thread arrangement which enhances the ability of conducting heat transfer away from the contact tip.

In one embodiment of the invention, the conductive component comprises copper or a high copper content alloy. The invention also comprises a conductive component made of a composite material consisting of sintered powders of high purity copper and conductive ceramic particles. Conductive ceramic particles include special crystalline forms of carbon including but not limited to graphite. Specially oriented graphite particles in sufficient density enhance anti-spatter properties of the material and increase lubricity in the wire feed aperture. P/M Copper-graphite composites exhibit lower electrical and thermal conductivity than pure copper. Therefore excessive amounts of graphite (above 20%) may preclude the principal function of the contact tip leading to catastrophic failure. P/M Copper-graphite composites must have a density higher than 80% of the ideal densities of their solid counterparts.

In another embodiment of the invention, the conductive component may comprise a cylindrical insert made of a ceramic material including, but not limited to, aluminum oxide, boron carbide, silicon carbide, silicon oxide, aluminum nitride, zirconium oxide, boron nitride or any mixture of these substances. The ceramic insert limits current transfer to the front end of the contact tip which minimizes burnback occurrences.

These and other features and advantages of the invention will be more fully understood from the following detailed description of the invention taken together with the accompanying drawings.

Brief Description of the Drawings

In the drawings:

FIG. 1 is a sectional view of a welding torch contact tip constructed in accordance with the present invention; and

FIG. 2 is a sectional view of a welding torch contact tip constructed in accordance with the present invention and including a ceramic insert at a welding wire receiving end.

Detailed Description of the Invention

Referring now to FIGS. 1-2 in detail, numeral 10 generally indicates a contact tip for use in a continuous feed welding torch, not shown. Contact tip 10 feedingly guides a welding wire, as is known, toward a workpiece and transfers welding current from the torch to the wire.

Referring to FIGS. 1-2, the contact tip 10 includes an electrically conductive component 12 including a mounting end 14 and a distal contact end 16 extending along a longitudinal wire feed axis 18. The conductive component 12 includes a through-bore 20 having a large diameter portion 22 extending from the mounting end 14 and a small diameter portion 24 sized for guiding welding wire, proximate the distal end 16 and extending along the wire feed axis. Mounting end 14 includes a connector that provides high heat transfer. In the embodiments shown, mounting end 14 is a frusto-conical surface and taper-lock thread arrangement for attaching the tip 10 to a cooperating surface on a welding torch.

Outlet 30 of the small diameter portion 24 contains no chamfer and the edge around the outlet and forms generally a right angle with no metal debris or inconsistent sharp edges. As illustrated, the radius of curvature of the front end 32 or contact end of the tip is increased and has a bulbous shape which lowers operating temperatures around the outlet 30 of the small diameter portion 24.

Where applicable, an elongated high temperature resistant ceramic insert 26 is coaxially mounted in the large diameter 22 of the conductive component 12. Insert 26 includes a through-bore 28 corresponding to the small diameter portion 24 and is sized for guiding welding wire therethrough. The insert through-bore 28 and conductive component small diameter portion 24 define the wire feed passageway for supporting the welding wire.

In the embodiment illustrated, the conductive component 12 comprises copper, a high copper content alloy, or sintered mixtures of copper and conductive ceramic particles including composite materials made of copper and certain forms of graphite with final density higher than 80%. The ceramic insert 26 comprises ceramic material including but not limited to one of aluminum oxide, boron carbide, silicon carbide, silicon oxide, aluminum nitride, zirconium oxide, boron nitride or any mixture of these substances.

With continuing reference to FIG. 1, the small diameter portion of the conductive component 12 proximate the conductive component distal end 16 has a length in the range of 100% the length of the contact tip wire feed aperture. It is at this portion 24 that the welding current is transferred from the welding torch to the welding wire.

In FIG. 2, the small diameter portion 24 of the conductive component 12 proximate the conductive component distal end 16 has a length of 50% the length of the contact tip through-bore. The limited length of the small diameter portion 24 provides for better arc stability during the transfer of the welding current from the torch to the wire and thereby keeps the tip 10 cleaner and reduces the occurrence of burnback. The ceramic insert 26 confines the arcing to the small diameter portion 24 of the conductive component 12.

Preferably, the insert through-bore 28 is tapered at one end 31 adjacent the conductive component or contact tip mounting end to facilitate the feed of welding wire into the insert portion of the tip 10. Preferably the tapered end 31 is defined by a sidewall disposed generally at an angle of about 30 degrees to the longitudinal wire feed axis.

In the embodiment illustrated, an optional diamond-like thin coating 34 of carbon has been applied to further enhance anti-spatter properties.

Although the invention has been described by reference to specific embodiments, it should be understood that numerous changes may be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the described embodiment, but that it have the full scope defined by the language of the following claims.

Reference Numerals

10. contact tip	54.
12. conductive component	56.
14. mounting end	58.
16. distal contact end	60.
17.	62.
18. wire feed axis	64.
20. through-bore	66.
22. large diameter	68.
24. small diam. portion	70.
26. ceramic insert	72.
28. through-bore	74.
30. outlet	76.
32. front outside corner	78.
34.	80.
36.	82.
38.	84.
40.	86.
42.	88.
44.	90.
46.	92.
48.	94.
50.	96.
52.	98.

M 3·05·00

D

Claims

What is claimed is:

1. A contact tip for use in a welding torch that feedingly guides a welding wire toward a workpiece and transfers welding current from the torch to the wire, the contact tip including:

an electrically conductive tube having a tube outside diameter and including a mounting end and a distal contact end spaced from said mounting end along a longitudinally extending wire feed axis;

said conductive tube including a through-bore extending along said axis through which said welding wire is fed; characterized in that:

said conductive tube comprises copper, a high copper content alloy or conductive composite material consisting of sintered powders of high purity copper and conductive ceramic particles;

said conductive tube distal contact end has a bulbous shape and an outside diameter that exceeds the outside diameter of said conductive tube between the mounting end and distal end.

2. The tip of claim 1 characterized in that said conductive composite material consisting of sintered powders of high purity copper and conductive ceramic particles comprises 99.5 to 80% Cu and 0.5 to 20% ceramics.

3. The tip of claim 1 characterized in that said conductive composite material consisting of sintered powders of high purity copper and conductive ceramic particles comprises 95.0 to 90% Cu and 5.0 to 10% ceramics.

4. The tip of claim 1 characterized in that said conductive composite material consisting of sintered powders of high purity copper and conductive ceramic particles comprises 99.0 to 85% Cu and 1.0 to 15% ceramics.

5. The tip of claim 1 characterized in that said conductive composite material consisting of sintered powders of high purity copper and conductive ceramic particles comprises 85% Cu and 15% ceramics.

6. The tip of claim 1 characterized in that said bulbous distal end includes an anti-spatter coating.

7. The tip of claim 6 characterized in that said coating comprises a diamond-like carbon material.

8. The tip of claim 1 characterized in that said through-bore has a large diameter portion extending from said mounting end and a stepped down small diameter portion, sized for guiding said welding wire, proximate said distal end; and

an elongated high temperature resistant, non-conductive insert including a through-bore corresponding in diameter to said small diameter portion and also sized for guiding said welding wire, coaxially mounted in said large diameter portion of said tube;

said non-conductive insert not extending to said distal end;

said insert through-bore and conductive tube small diameter portion defining a wire feed passageway for supporting the welding wire.

9. The tip of claim 8 characterized in that said insert comprises ceramics material.

10. The tip of claim 9 characterized in that said ceramics material comprises one of aluminum oxide, boron carbide, silicon carbide, silicon oxide, aluminum nitride, zirconium oxide and boron nitride.

11. The tip of claim 10 characterized in that said stepped down small diameter portion proximate said conductive tube distal end extends less than 100 percent of the length of said through-bore.

12. The tip of claim 8 characterized in that said insert through-bore includes a tapered end at one end adjacent said conductive tube mounting end.

13. The tip of claim 12 characterized in that said tapered end is defined by a sidewall disposed generally at an angle of about 30 degrees to the longitudinal wire feed axis.

14. The tip of claim 8 characterized in that said bulbous distal end includes an anti-spatter coating.

15. The tip of claim 14 characterized in that said coating comprises a diamond-like carbon material.

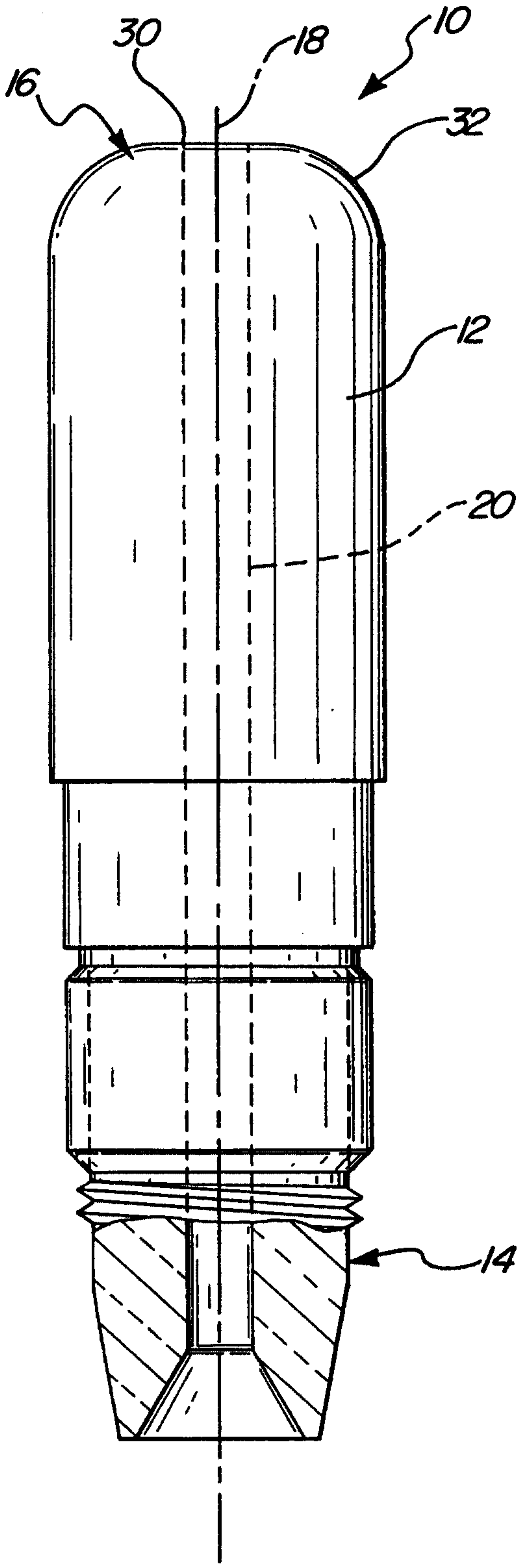

FIG-1

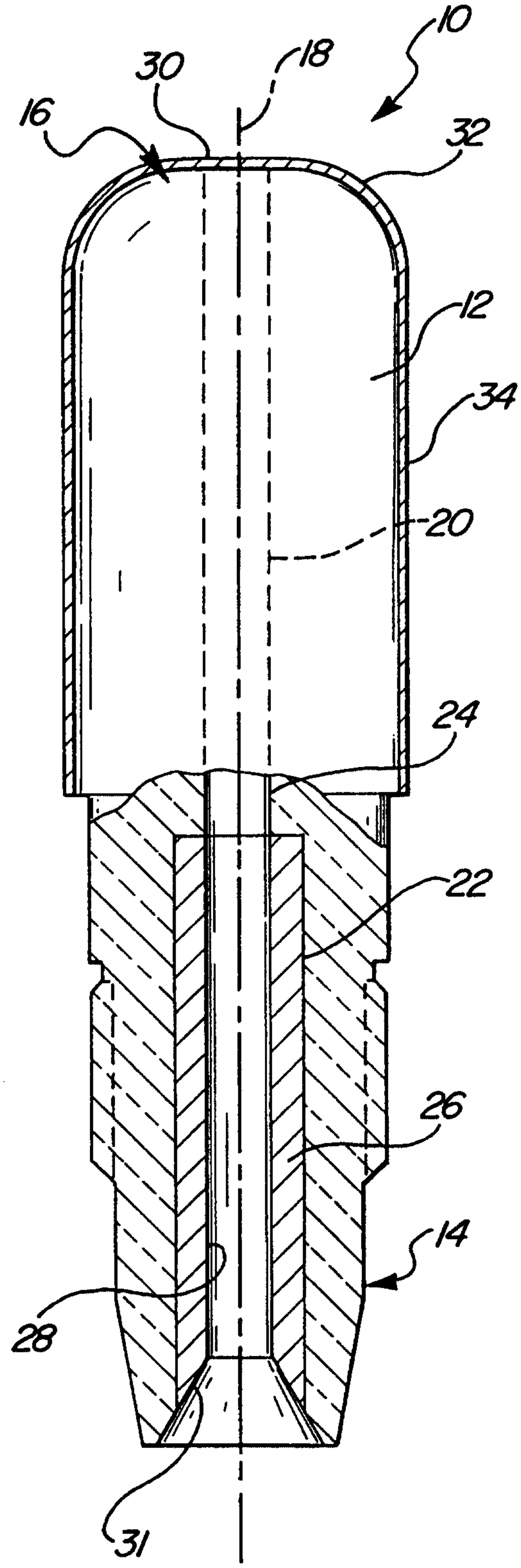

FIG-2