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**ABSTRACT**

A valve gated injection nozzle providing a nozzle tip removably connected to a nozzle body with a nozzle seal. A melt channel is defined through said nozzle body and nozzle tip and a valve pin is  
5 disposed in the melt channel. A bearing surface is defined on the valve pin for bearing against a guiding surface defined by the nozzle.

**Title: VALVE GATED INJECTION NOZZLE****FIELD OF THE INVENTION**

This invention relates generally to injection molding and more particularly to a valve gated injection nozzle.

**5 BACKGROUND OF THE INVENTION**

Valve gated injection nozzles are well known for use in controlling the flow of a molten material (melt) in an injection molding machine towards a mold cavity through a mold gate. Examples of such nozzles are disclosed in U.S. Patents No. 5,695,793 (Bauer) and 5,811,140  
10 (Manner) as well as additional patents referred to below.

A problem with valve gated injection nozzles is that the valve pin that is located within the melt channel tends to become misaligned with the mold gate due to the extreme pressures exerted on the valve pin by the melt. As a result, the end of the valve pin becomes  
15 damaged over numerous cycles as it continuously engages the wall of the mold gate. The damage to the end of the pin results in imperfections in the molded parts.

Other problems associated with the molding of precision parts using valve gated injection nozzles include restricted backflow  
20 between the end of the valve pin and the mold gate, inadequate transfer of heat from the heated nozzle to the melt and inadequate change over times in cases where maintenance or colour changes are required. All of the problems can contribute to flaws in the molded parts and delays in production.

25 Attempts have been made in the past to address these problems. U.S. Patents No. 4,412,807 (York), 5,254,305 (Fernandes), and 5,700,499 (Bauer) disclose various arrangements of guide surfaces defined on a valve pin and a melt channel to align the end of the valve pin within a mold gate. These devices do not adequately address backflow and  
30 thermal conductivity problems as discussed above, nor do they address the

need for quick change over times to conduct maintenance or colour changes. U.S. Patents No. 3,716,318 (Erik) and 5,849,343 (Gellert), German Patent DE3245571 (Manner) and European Patent 638407 (Krummenacher) disclose various arrangements of guide elements having apertures for conducting the melt. A problem associated with these devices is the formation of flow lines in the molded parts due to the splitting of melt in the melt channel. The devices also suffer from the thermal conductivity and change over problems as noted with the patents described above. U.S. Patent No. 2,865,050 (Strauss) discloses a valve gated injection nozzle for a cold runner system. The valve pin includes flattened surfaces to encourage backflow during closing of the valve pin. Strauss is not suitable for hot runner applications where freezing of the melt in the melt channel is unacceptable. Strauss of course also does not address thermal conductivity problems and also does not permit rapid change overs.

There is a need for an improved device that overcomes the above described problems.

### **SUMMARY OF THE INVENTION**

In one aspect, the invention provides A valve gated injection nozzle comprising:

- a nozzle body defining a first portion of a melt channel;
- a bore defined in said nozzle body;
- a nozzle tip defining a second portion of said melt channel, said nozzle tip being formed of a material having a high resistance to wear and said nozzle tip being sized to fit within said bore of said nozzle body;
- a nozzle seal having a first connector for removably engaging a second connector defined on said nozzle body for connecting said nozzle tip within said bore of said nozzle body with said first portion and said second portion of said melt channel being fluidly connected;
- an electric heater disposed in said nozzle body around said nozzle tip;

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a valve pin disposed in said melt channel for moving between an open position and a closed position, said valve pin having a stem extending through said melt channel and a head disposed on an end of said stem for sealingly engaging a gate to a mold cavity; and

5 a bearing surface defined on said stem for engaging a guiding surface defining a portion of said melt channel for guiding said head into alignment with said gate when said valve pin moves from said open position to said closed position.

#### 10 **BRIEF DESCRIPTION OF THE DRAWINGS**

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made by way of example to the accompanying drawings. The drawings show preferred embodiments of the present invention, in which:

15 Fig. 1 is a split sectional view of a portion of a valve gated injection apparatus in accordance with the present invention, the left hand side of Fig. 1 showing the valve pin of the apparatus in an open position and the right hand side of Fig. 1 showing the valve pin in a near closed position;

20 Fig. 2 is a plan view of the valve pin for the apparatus of Fig. 1;

Fig. 3 is an enlarged view of the end of the valve pin of Fig. 2;

Fig. 4 is a sectional view of the valve pin as viewed along lines 4-4 of Fig. 3;

25 Fig. 5 is a sectional view of a portion of a valve gated injection apparatus according to a second embodiment of the present invention showing the valve pin in a closed position;

Fig. 6 is a sectional view of the second embodiment of apparatus as viewed along lines 6-6 of Fig. 5;

30 Fig. 7 is a sectional view of the second embodiment of the apparatus as viewed along lines 7-7 of Fig. 5;

Figs. 8-13 are split sectional views of the valve gated injection apparatus in accordance with further embodiments of the present invention.

## 5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The structure of an injection molding apparatus having a multi cavity injection molding system is well known to those skilled in the art. A detailed description of the structure may be found in U.S. Patents 5695793 (Gellert) and 5849343 (Bauer) which are incorporated herein by  
10 reference.

A valve gated injection apparatus in accordance with the present invention is shown generally at 20 in Fig. 1. Apparatus 20 comprises a nozzle 22 defining a melt channel 24. A valve pin 26 is disposed in melt channel 24. Nozzle 22 is disposed in a melt distribution  
15 manifold 25. Valve pin 26 is mounted to a piston (not shown) for reciprocating valve pin between an open position and a closed position relative to a gate 28 defined in melt distribution manifold 25 leading to a mold cavity (not shown). A gathering space 29 is defined between the end of nozzle 22 and melt distribution manifold 25 for receiving and heating  
20 melt that has not passed through gate 28.

Nozzle 22 includes a nozzle body 30 having a cylindrical bore 32 for receiving a nozzle tip 34. An electrical heating element 36 extends about the outer circumference of nozzle body 30. A thermocouple 38 is disposed in an opening defined in nozzle body 30 adjacent to nozzle tip 34.

25 Nozzle tip 34 is removably secured within bore 32 with a nozzle seal 40. Nozzle seal 40 depicted in Fig. 1 has an externally threaded portion (not shown) that engages an internally threaded portion (not shown) of nozzle body 30 to secure the parts together. Nozzle seal 40 abuts a shoulder 42 defined in nozzle tip 34 to urge nozzle tip 34 into sealed  
30 engagement with the end of bore 32. Alternative arrangements for securing nozzle tip 34 to nozzle body 30 are described further below and shown in Figs. 8-13.

Nozzle 22 is made of materials having relatively high thermal conductivity and a high degree of wear resistance. Nozzle body 30 and nozzle seal 40 are preferably formed from titanium, H-13 or other suitable materials that may be obtained and manufactured at reasonable costs. Nozzle tip 34 is preferably formed of tungsten carbide due to its superior heat transfer properties although other thermally conductive materials may be utilized.

Referring to Fig. 1, melt channel 24 has a first portion 44 defined through nozzle tip 34 and a second portion 46 defined through nozzle body 30. First portion 44 and second portion 46 are aligned along a centre axis 48 for gate 28. First portion 44 includes a guiding surface 50 that is arranged coaxially with gate axis 48 to guide valve pin 26 into alignment with gate 28 as it moves from an open position to a closed position. First portion 44 also includes a channel surface 52 extending in a gradual outward curve from guiding surface 50 for encouraging melt to flow around valve pin 26 to and from gate 28 in a manner that places reduced stress on the melt.

Referring to Figs. 2-4, valve pin 26 has a cylindrical stem 54 with a frusto-conical head 56 ending in a cylindrical tip 58. Flow surfaces 60 are defined in frusto-conical head 56 and in cylindrical stem 54 of valve pin 26 to define flow channels 62 between valve pin 26 and channel surface 52. Flow surfaces 60 extend between stem 54 and frusto-conical head 56 to permit backflow of melt when frusto-conical head 56 is becoming seated in gate 28. Flow surfaces 60 have a generally planar portion 64 and a tapered end portion 66 to encourage backflow of melt in a manner that is not overly stressful to the melt. It is contemplated that flow surfaces 60 may instead have non-planar surfaces (such as rounded flutes) to accommodate an increased volume of backflow.

Bearing surfaces 68 are defined between flow surfaces 60 for bearing against guiding surface 50 to guide valve pin 26 into alignment with gate 28. Fig. 3 shows an embodiment in which three generally rounded bearing surfaces 68 are defined between three generally planar

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flow surfaces 60. It is contemplated that at least three bearing surfaces 68 would be defined in stem 54 to permit precise alignment of valve pin 26 within gate 28.

In use, valve pin 26 is first retracted to an open position as shown on the left side of Fig. 1 to permit flow of melt through melt channel 24 and through gate 28 to fill mold cavity (not shown). Heat is transferred to melt from electrical heating element 36 in nozzle body 30 via highly thermally conductive nozzle tip 34. Once mold cavity is filled, valve pin 26 is moved from an open position to a closed position to seal gate 28. As valve pin 26 moves to a closed position it is guided by bearing surfaces 68 slidably bearing against guiding surface 50. As frusto-conical head 56 of valve pin 26 approaches a closed position in gate 28 as shown on the right side of Fig. 1, excess melt is guided away from gate 28 into gathering space 29 and along flow channels 62 into melt channel 24. Advantageously, if maintenance or a colour change in melt is required then nozzle tip 34 may be quickly removed from nozzle body 30 by removing threaded nozzle seal 40.

Referring to Figs. 5-7, a second embodiment of valve gated injection apparatus in accordance with the present invention is shown at 20. The same reference numerals are used to identify elements corresponding to elements of the earlier described embodiment.

Fig. 5 shows valve pin 26 disposed in a closed position within gate 28. First portion 44 of melt channel 24 defines guiding surface 50 for guiding valve pin 26. Gate 28 has a frusto-conical surface 70 and a cylindrical surface 72 for receiving tip 58. Valve pin 26 has a cylindrical stem 54 above frusto-conical head 56 that defines bearing surface 68 (ie there are no flow surfaces 60 other than bearing surface 68 itself).

Referring to Figs. 6 and 7, a first tolerance gap G1 is defined between tip 58 and cylindrical surface 72 and a second tolerance gap G2 is defined between bearing surface 68 and guiding surface 50. Gap G1 is greater than gap G2. In this manner, minute variances in alignment of bearing surface 68 relative to guiding surface 50 will not be sufficient to

cause tip 58 to become damaged by engaging frusto-conical surface 70. It should be noted that bearing surface 68 does not bear immediately upon guiding surface 50 and tip 58 does not bear against surface 72. Instead, a small amount of melt is forced into gaps G1 and G2 by back pressure. Melt  
5 acts as a lubricant to reduce wear on valve pin 26 and melt channel 24.

Referring to Figs. 8-13, further embodiments of the valve gated injection apparatus in accordance with the present invention are shown. Once again, corresponding reference numbers are used to refer to corresponding elements of earlier described embodiments.

10 Fig. 8 shows an apparatus with a hot valve with a nozzle seal 40 having an internal thread (not shown) engaging a corresponding external thread (not shown) defined on nozzle body 30.

Fig. 9 shows an apparatus 20 having a cylindrical valve gate 28 and a nozzle seal 30 similar to the embodiment of Fig. 8.

15 Fig. 10 shows an apparatus 20 with a hot valve having a nozzle tip 34 and nozzle seal 40 integrally formed as one piece.

Fig. 11 shows an apparatus 20 having a cylindrical valve gate 28 with a one piece integral nozzle tip 34 and nozzle body 40 similar to the embodiment of Fig. 10.

20 Fig. 12 shows an apparatus 20 with a hot valve having a nozzle seal 40 having an external thread (not shown) for engaging a corresponding internal thread (not shown) defined on nozzle body 30.

Fig. 13 shows an apparatus 20 with a cylindrical valve gate 28 and a nozzle seal similar to Fig. 1.

25 It is to be understood that what has been described is a preferred embodiment to the invention. If the invention nonetheless is susceptible to certain changes and alternative embodiments fully comprehended by the spirit of the invention as described above, and the scope of the claims set out below.

**WE CLAIM:**

1. A valve gated injection nozzle comprising:  
a nozzle body defining a first portion of a melt channel;  
a bore defined in said nozzle body;  
5 a nozzle tip defining a second portion of said melt channel,  
said nozzle tip being formed of a material having a high resistance to wear  
and said nozzle tip being sized to fit within said bore of said nozzle body;  
a nozzle seal having a first connector for removably engaging  
a second connector defined on said nozzle body for connecting said nozzle  
10 tip within said bore of said nozzle body with said first portion and said  
second portion of said melt channel being fluidly connected;  
an electric heater disposed in said nozzle body around said  
nozzle tip;  
a valve pin disposed in said melt channel for moving  
15 between an open position and a closed position, said valve pin having a  
stem extending through said melt channel and a head disposed on an end  
of said stem for sealingly engaging a gate to a mold cavity; and  
a bearing surface defined on said stem for engaging a guiding  
surface defining a portion of said melt channel for guiding said head into  
20 alignment with said gate when said valve pin moves from said open  
position to said closed position.
2. A nozzle as claimed in claim 1 wherein at least one flow  
surface is defined in said valve pin to facilitate a backflow of melt when  
said valve pin moves to said closed position, said flow surface being  
25 defined in portions of said head and said stem of said valve pin.
3. A nozzle as claimed in claim 2 wherein a plurality of said  
flow surfaces are defined in said valve pin.

4. A nozzle as claimed in claim 3 wherein a plurality of said bearing surfaces are defined on said valve stem, each said bearing surface being disposed between a pair of said flow surfaces.
5. A nozzle as claimed in claim 2 wherein said flow surface has a planar portion and a tapered portion.
6. A nozzle as claimed in claim 1 wherein a channel surface defines a portion of said melt channel in said nozzle tip upstream of said guiding surface, said channel surface extending in an outward curve relative to said guiding surface for channelling melt around said valve pin.
7. A nozzle as claimed in claim 1 wherein a first tolerance gap is defined between said head and the walls of said gate and a second tolerance gap is defined between said bearing surface and said guiding surface, said second tolerance gap being narrower than said first tolerance gap.
8. A nozzle as claimed in claim 1 wherein a sufficient gap is defined between said bearing surface and said guiding surface to receive a layer of melt for lubricating the relative movement between said valve pin and said nozzle tip.
9. A nozzle as claimed in claim 1 wherein said nozzle tip material has a high thermal conductivity.
10. A nozzle as claimed in claim 1 wherein said nozzle tip and said nozzle seal are integrally connected.

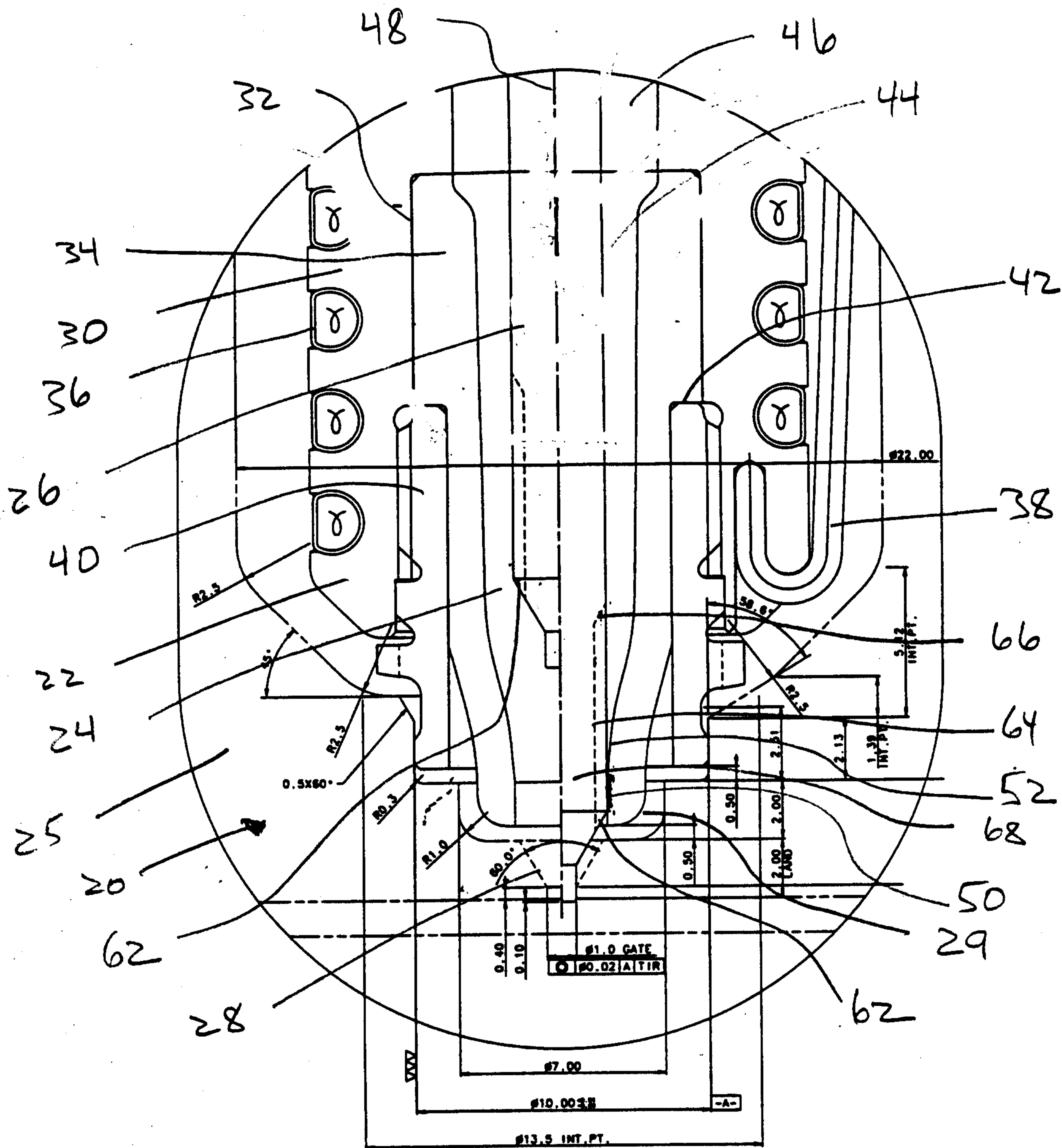


FIG. 1

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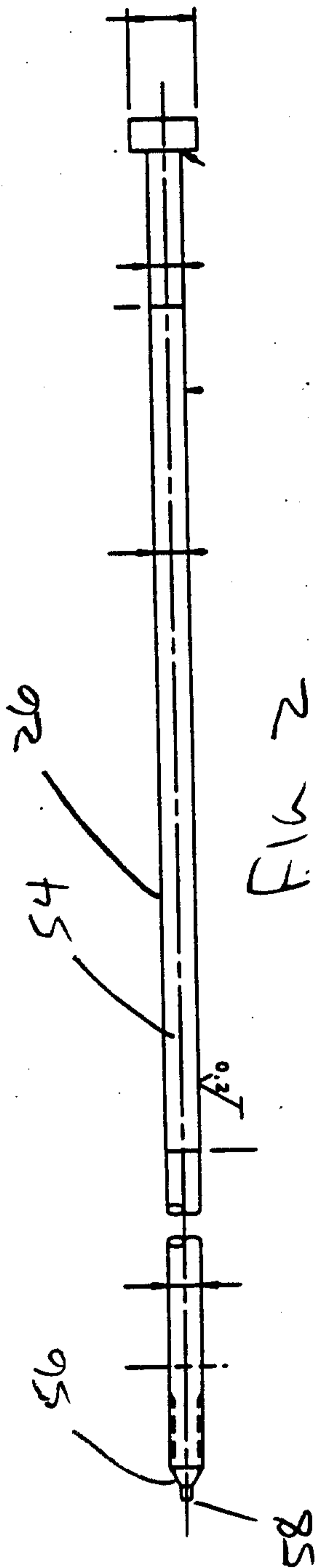


FIG 2

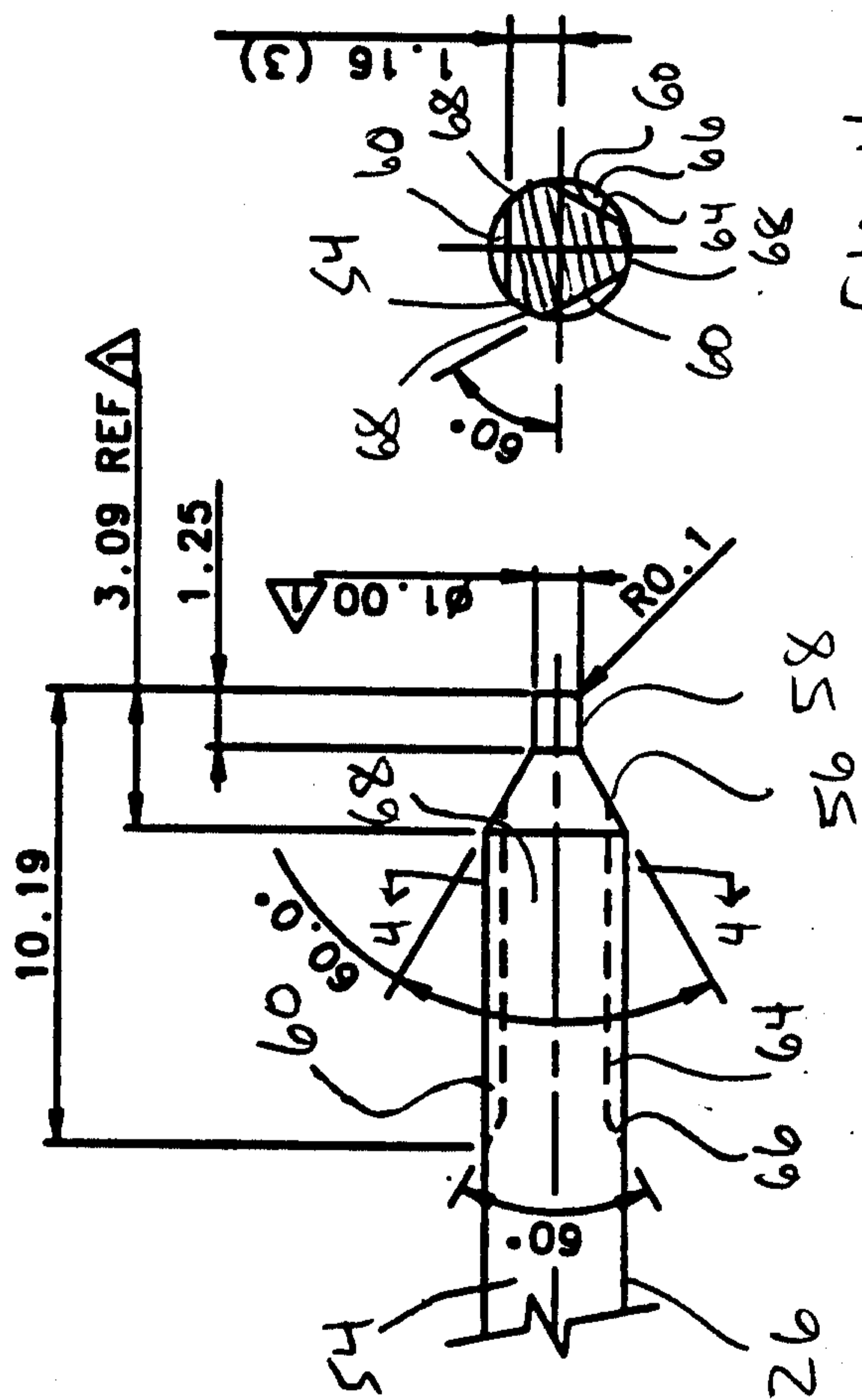


FIG 3

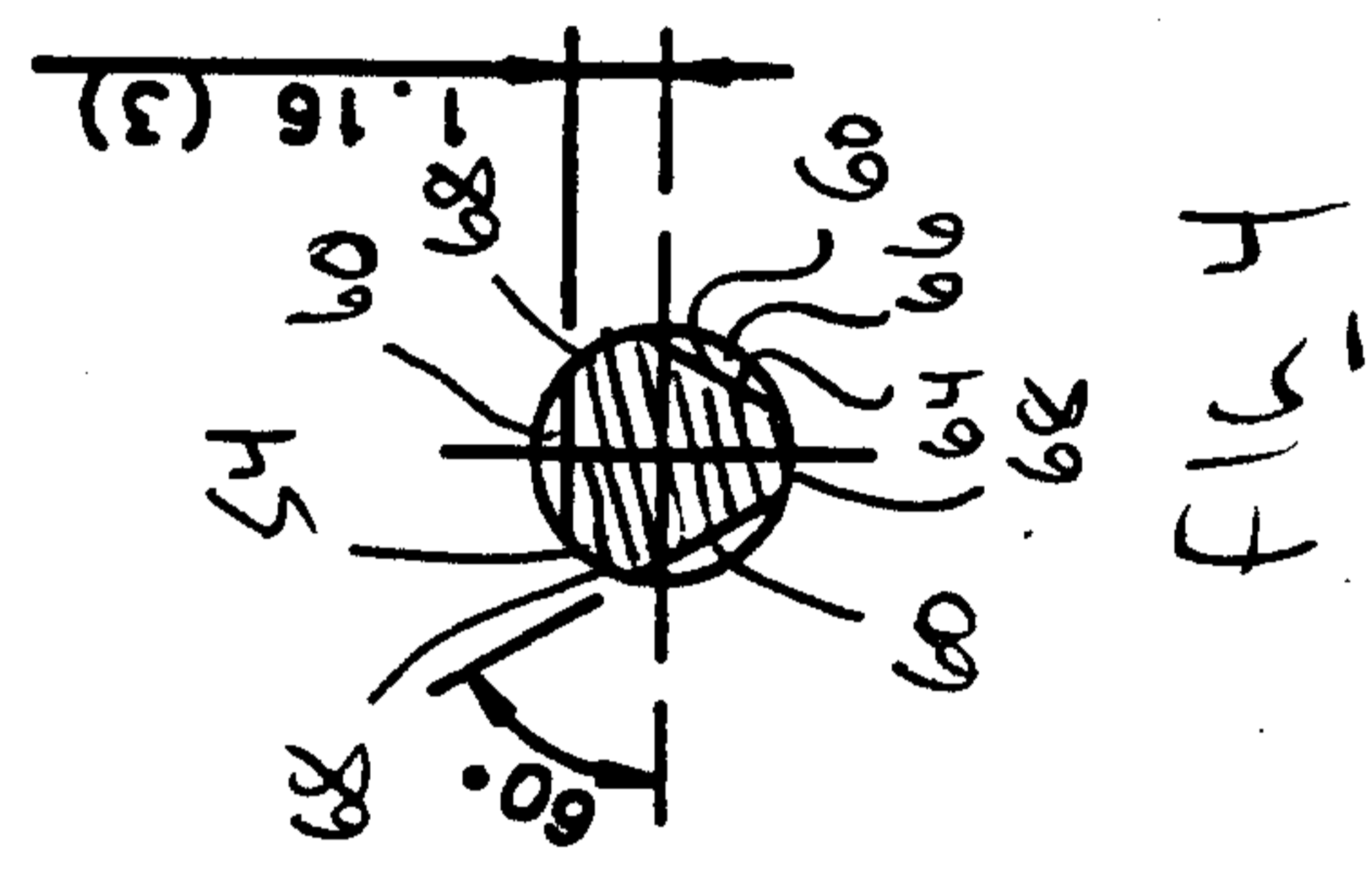
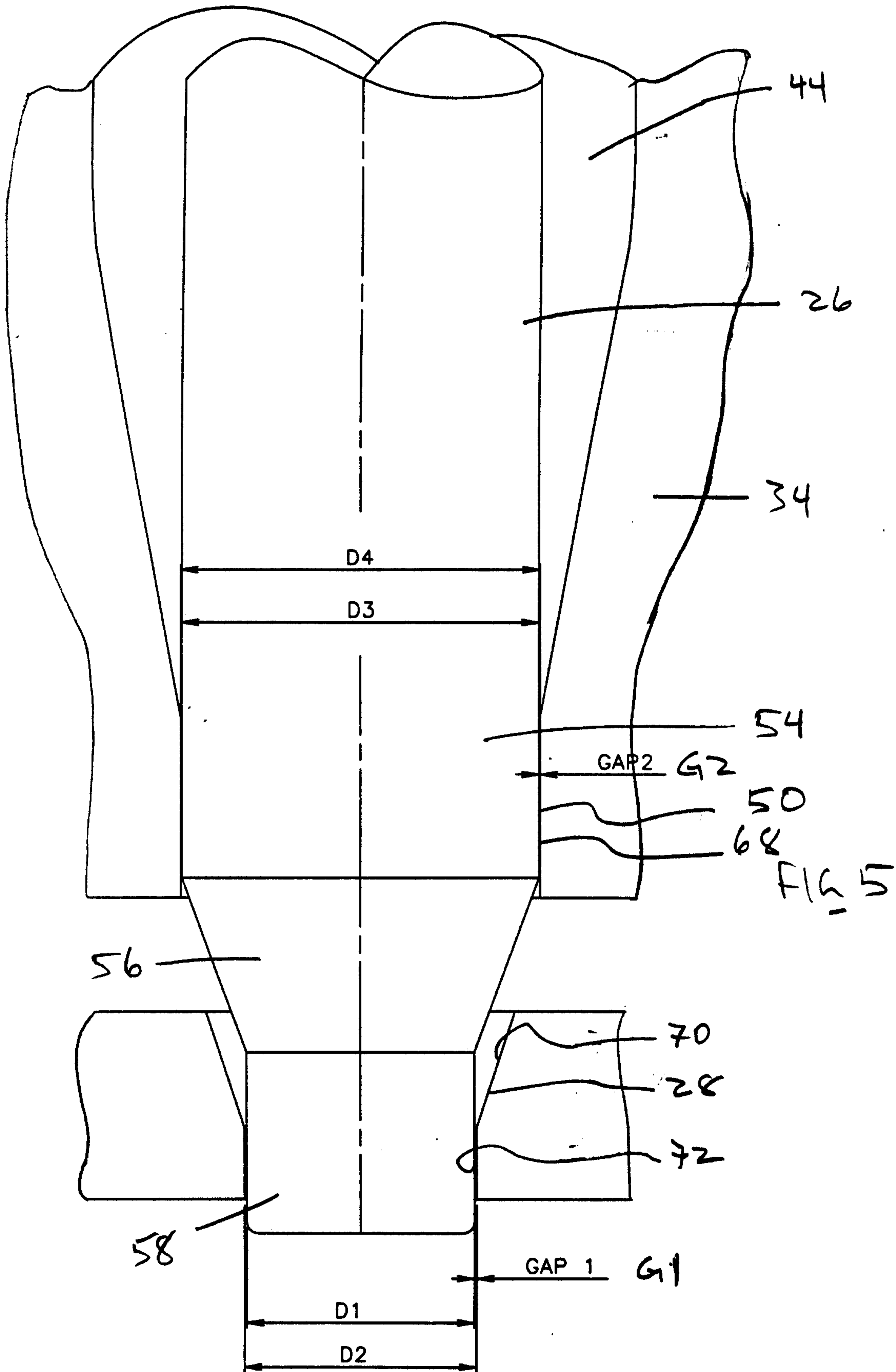


FIG 4



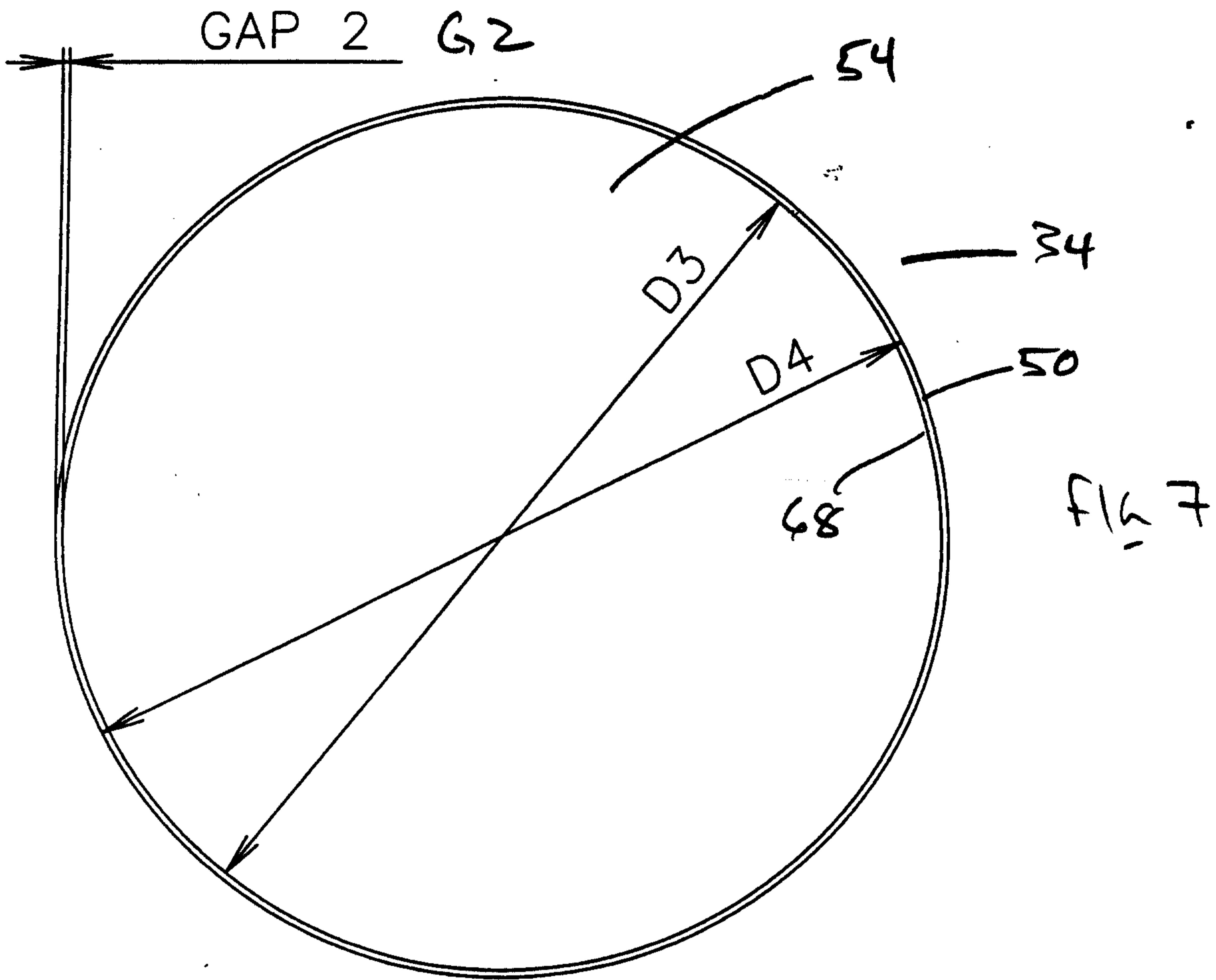


FIG 7

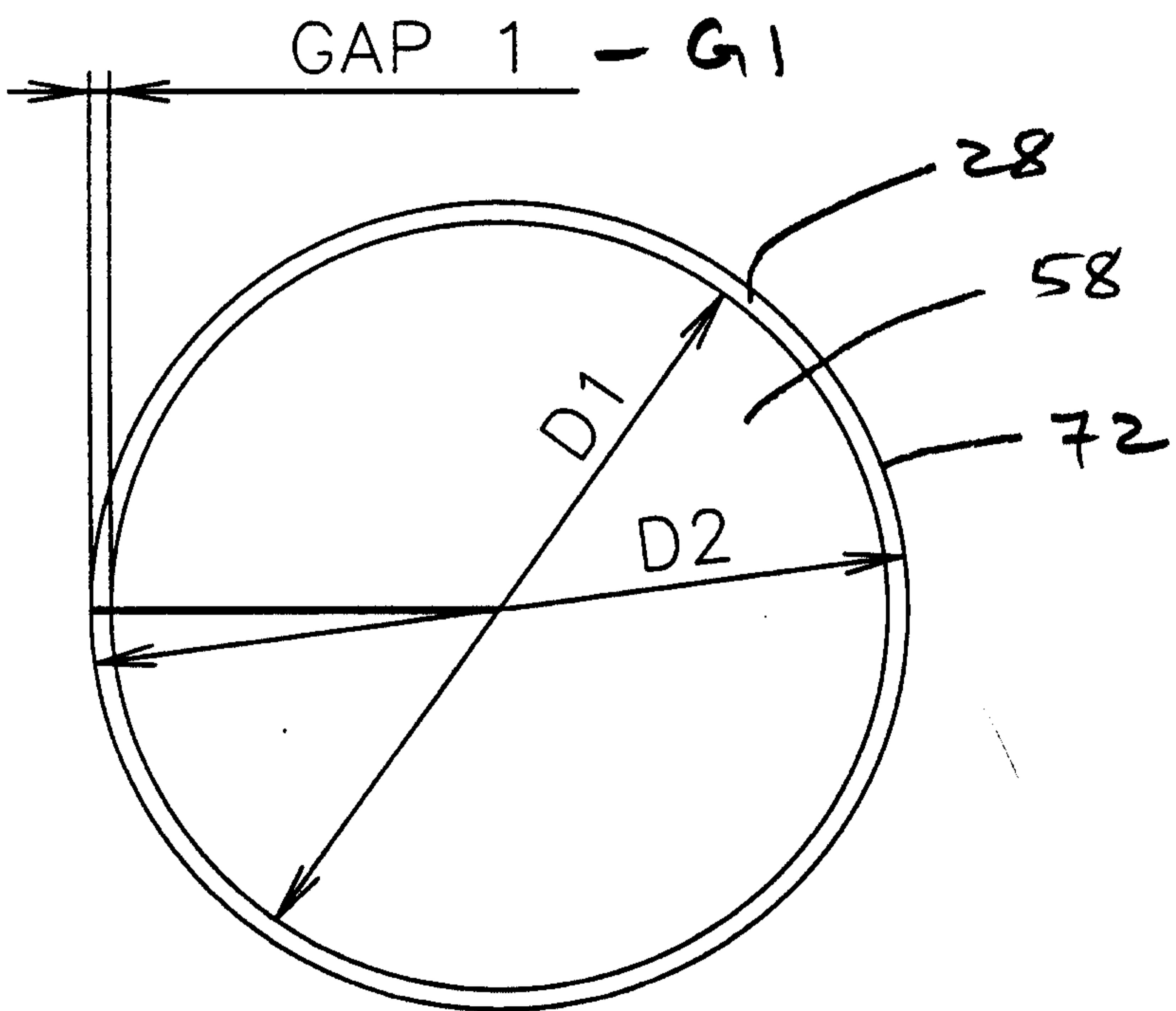
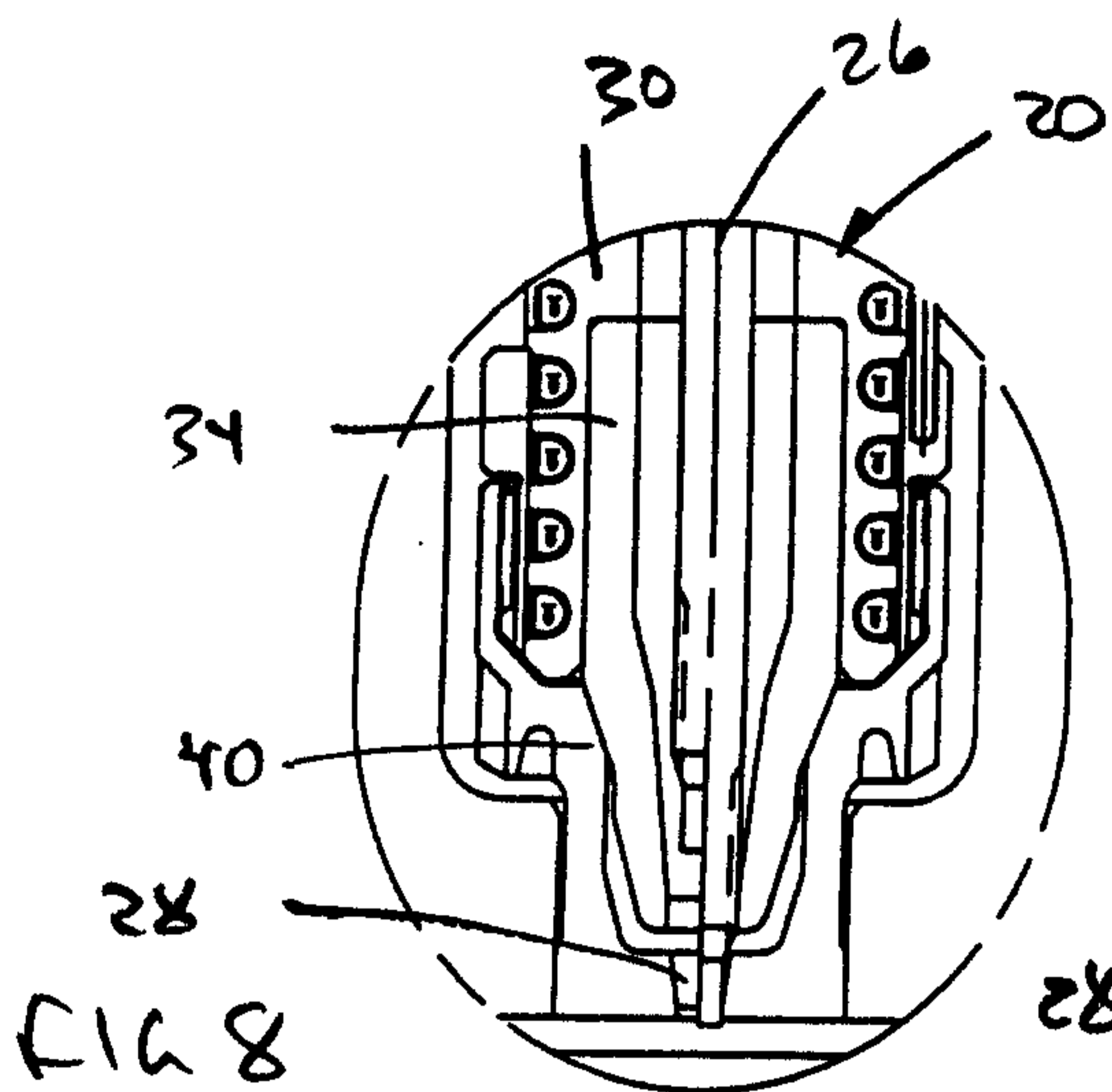
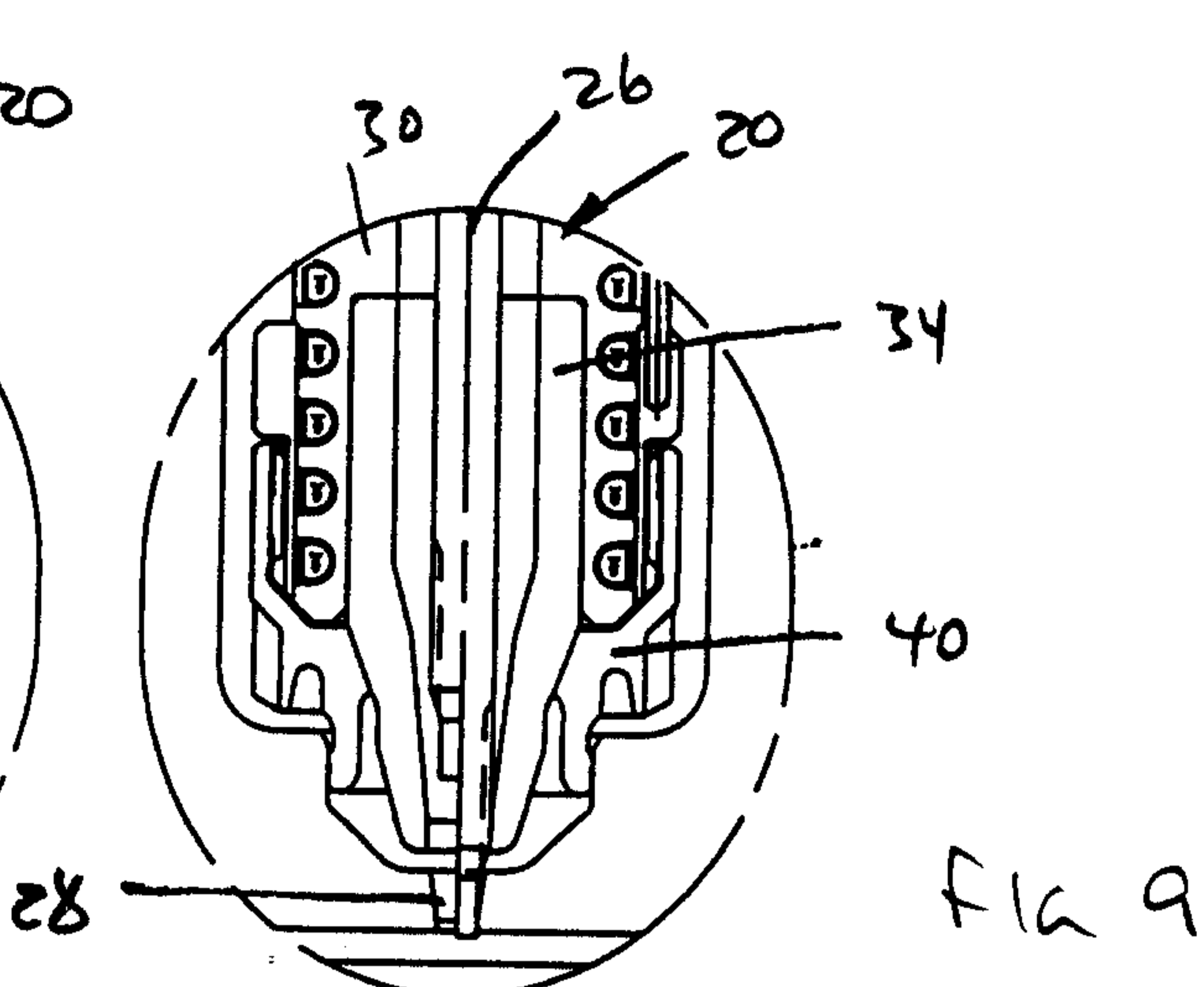


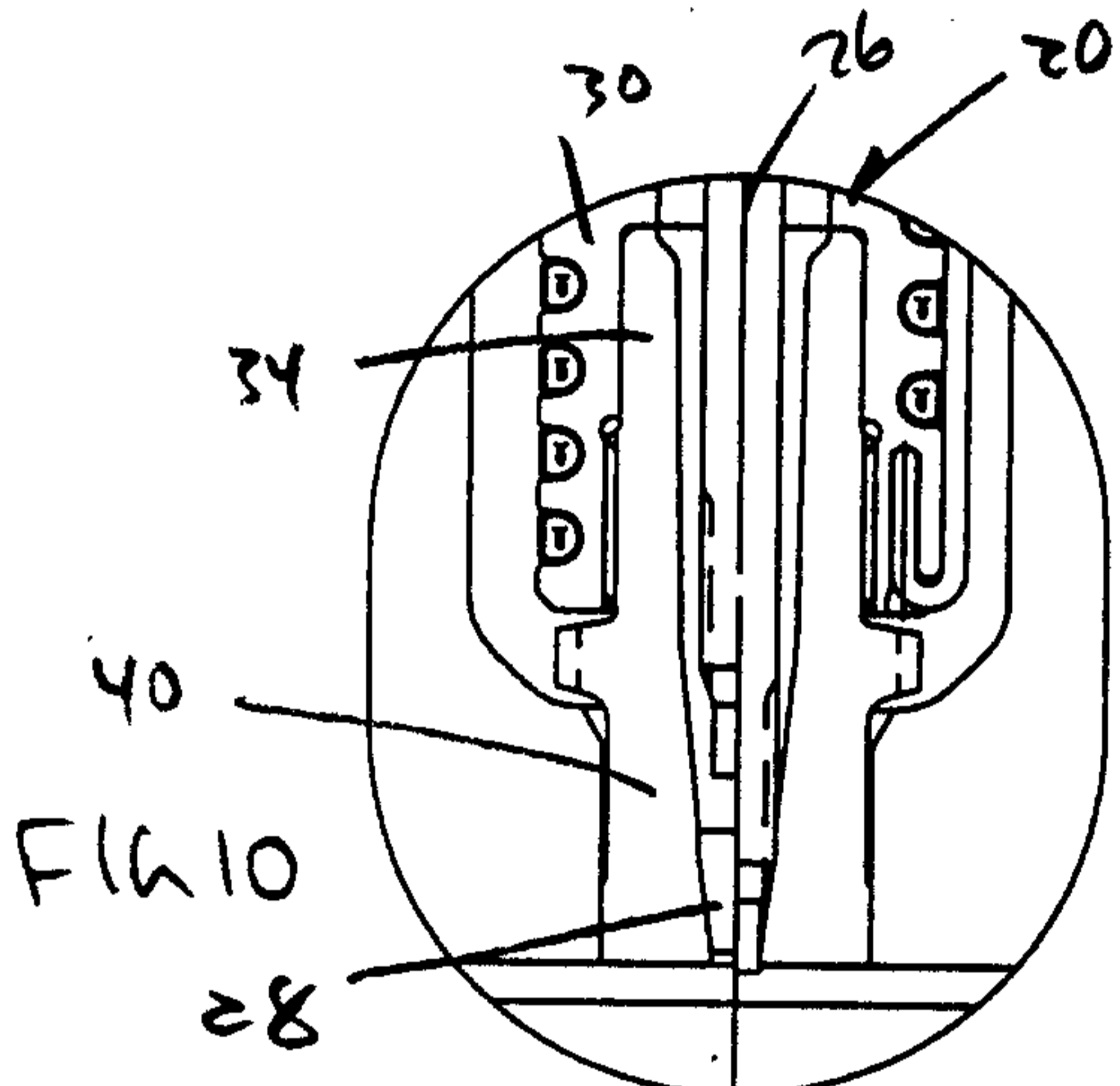
FIG 6



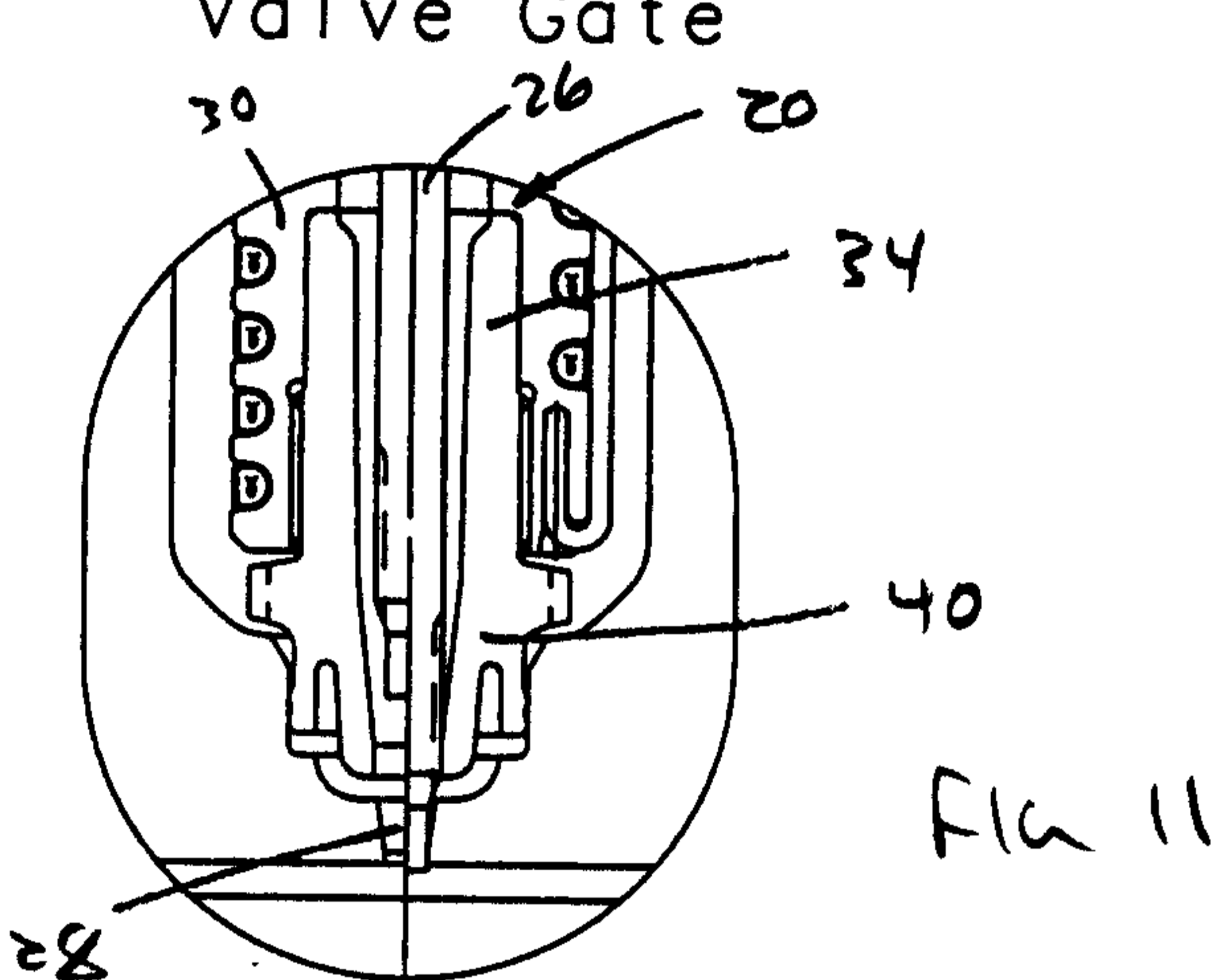
O.T.I.R.  
Hot Valve



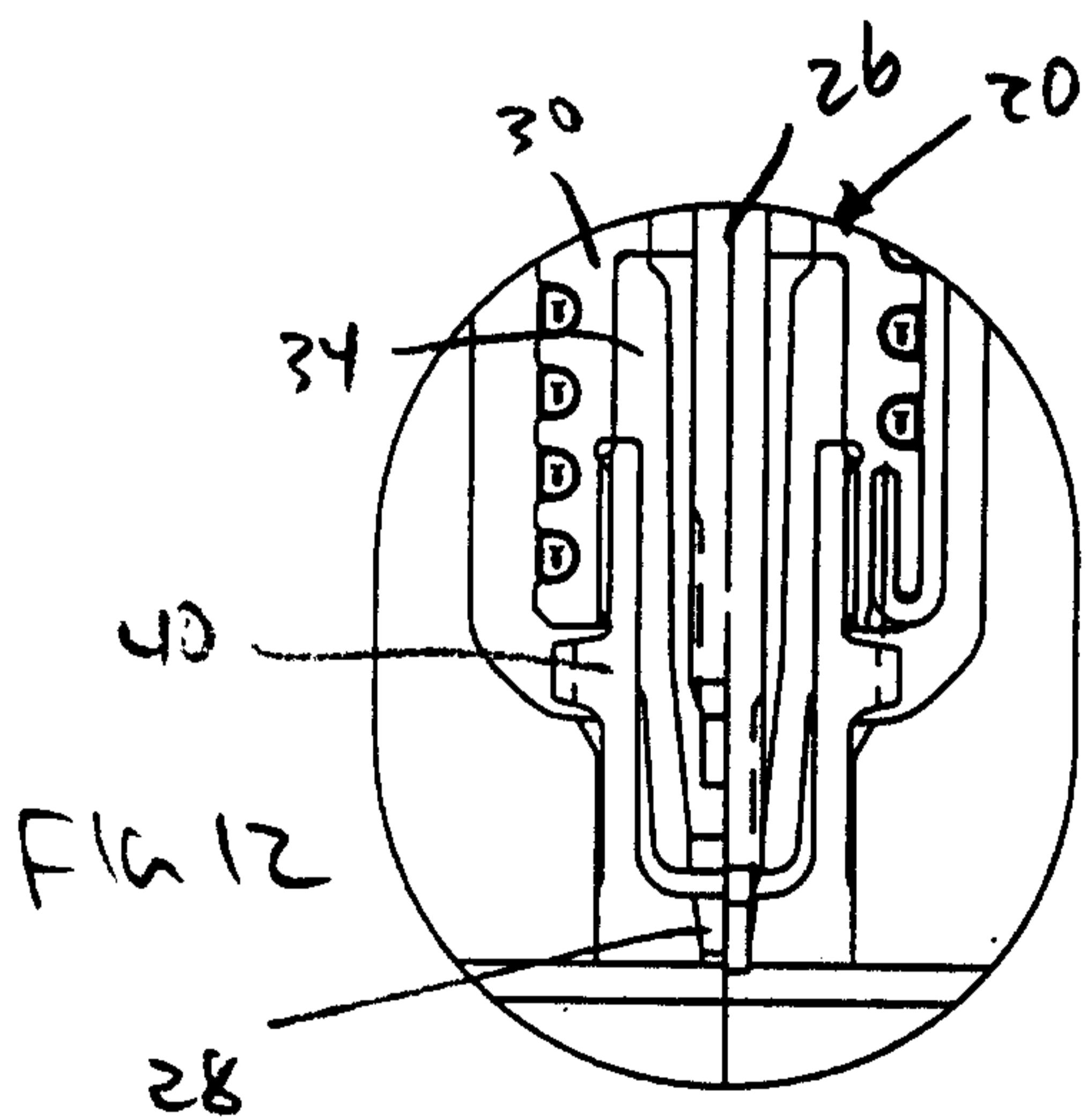
O.T.I.R.  
Cylindrical  
Valve Gate



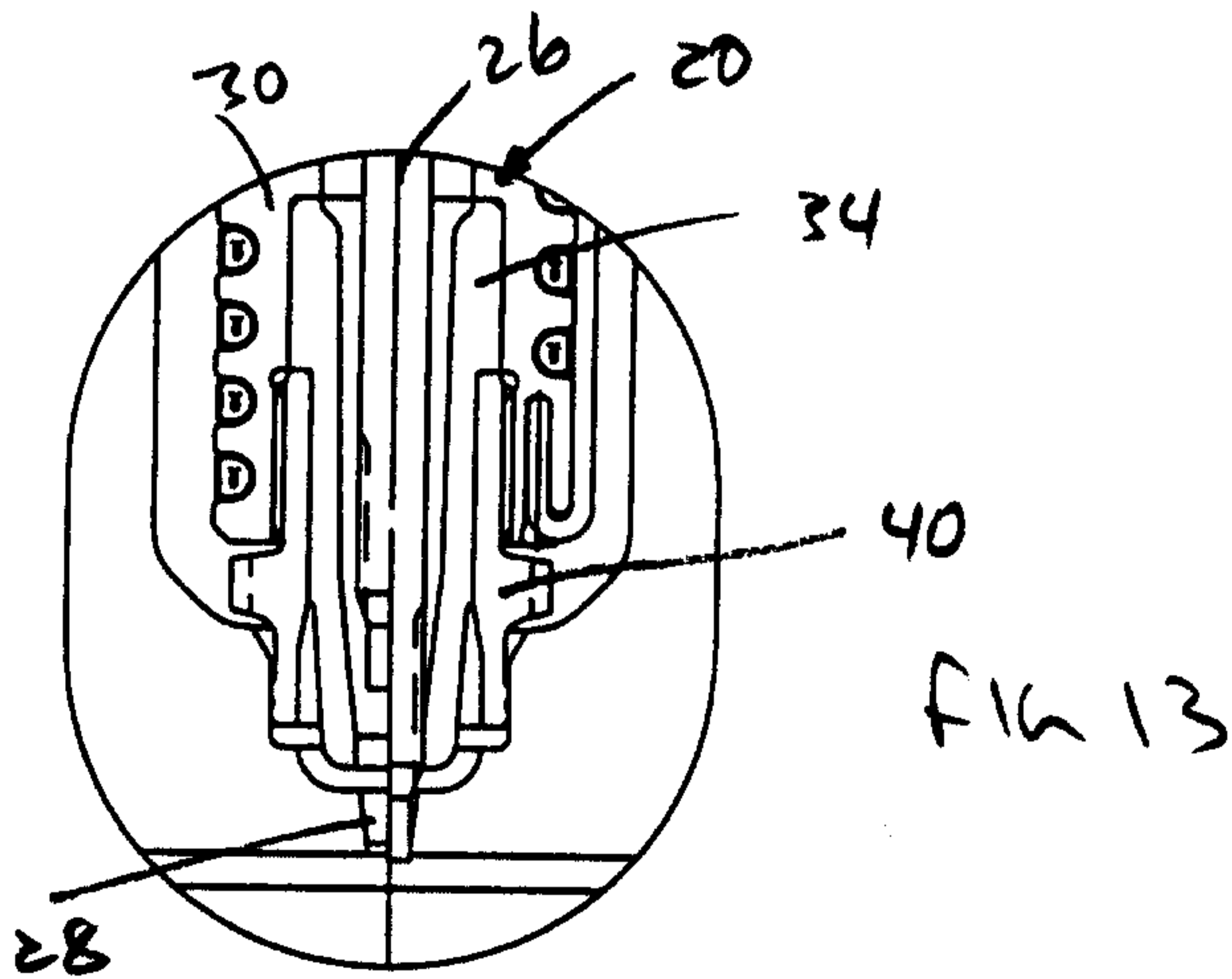
Hot Valve  
One Piece



Cylindrical  
Valve Gate  
One Piece



Hot Valve  
Two Piece



Cylindrical  
Valve Gate  
Two Piece

