



(11) (21) (C) **2,030,287**
(22) 1990/11/19
(43) 1992/05/20
(45) 2000/12/19

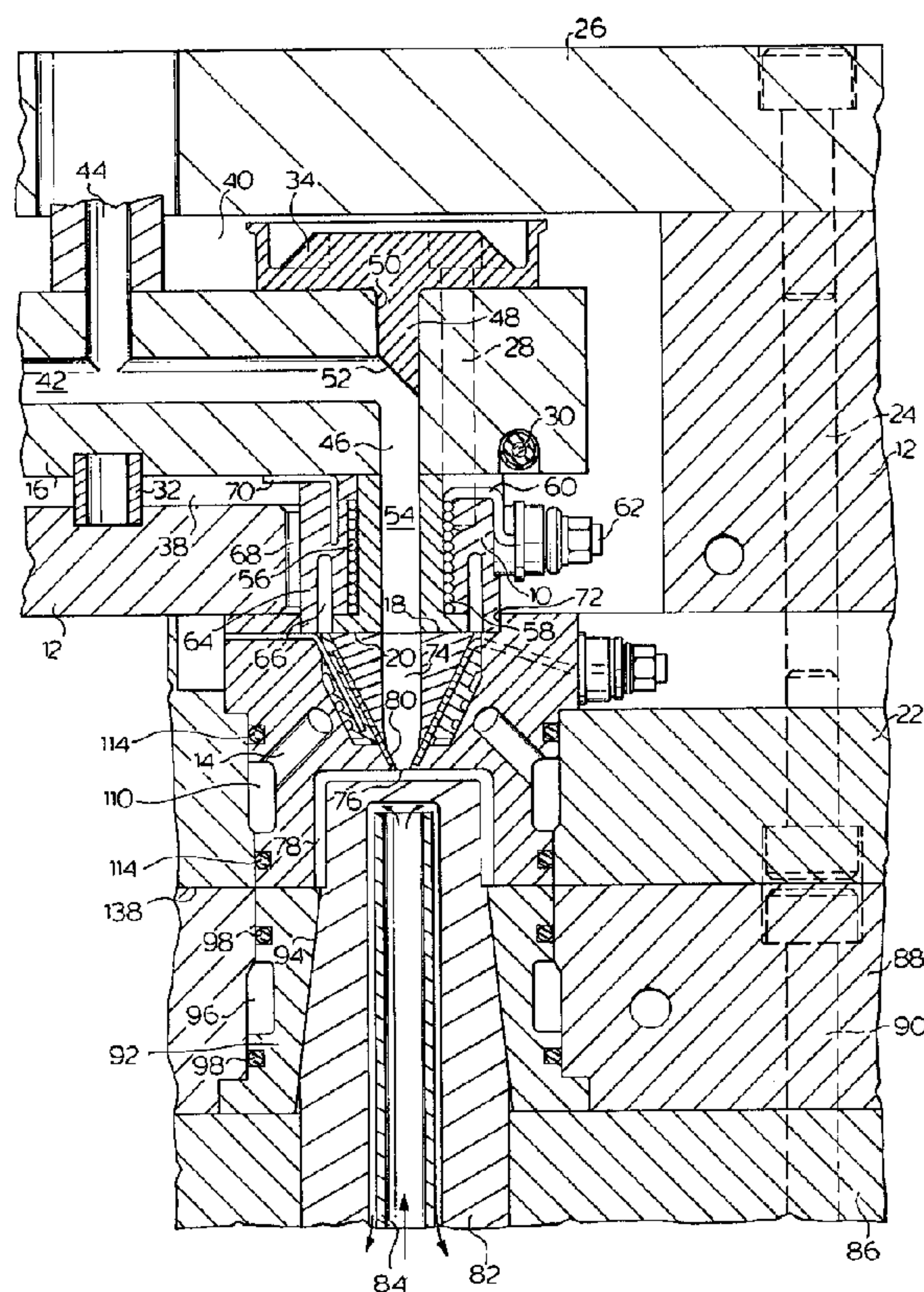
(72) GELLERT, JOBST ULRICH, CA

(73) GELLERT, JOBST ULRICH, CA

(51) Int.Cl.⁵ B29C 45/74

(54) **MACHINE POUR MOULAGE PAR INJECTION, AVEC
ELEMENT CHAUFFANT DISTINCT, LOGE DANS UN
ELEMENT RAPPORTE FORMANT UNE CAVITE**

(54) **INJECTION MOLDING APPARATUS HAVING SEPARATE
HEATING ELEMENT IN THE CAVITY FORMING INSERT**



(57) Apparatus for thermal gated injection molding having a cavity forming insert separate from the heated nozzle. The cavity forming insert has a combination of heating and cooling extending around a central melt bore leading to a gate. The cavity forming insert has an integral electric heating element with an inner portion having a number of adjacent coils near the gate. Power to the heating element is switched on and off during the thermal gated cycle, and the combination of heating and cooling in the cavity forming insert improves the thermal response and shortens the cycle time.

ABSTRACT OF THE DISCLOSURE

1 Apparatus for thermal gated injection molding
having a cavity forming insert separate from the heated
nozzle. The cavity forming insert has a combination of
heating and cooling extending around a central melt bore
5 leading to a gate. The cavity forming insert has an
integral electric heating element with an inner portion
having a number of adjacent coils near the gate. Power to
the heating element is switched on and off during the
thermal gated cycle, and the combination of heating and
10 cooling in the cavity forming insert improves the thermal
response and shortens the cycle time.

15

20

25

INJECTION MOLDING APPARATUS HAVING SEPARATE
HEATING ELEMENT IN THE CAVITY FORMING INSERT

BACKGROUND OF THE INVENTION

1 This invention relates generally to injection
molding and more particularly to thermal gated injection
molding apparatus having a cavity forming insert with a
combination of heating and cooling extending around a
5 central bore leading to a gate.

 For clarification, reference herein to a "cavity
forming insert" shall include both a cavity insert as seen
in the first embodiment and a core insert as seen in the
second embodiment.

10 Thermal gating which is also referred to as
temperature assisted gating involves changing the

2030287

temperature of the melt in the gate area during each cycle to assist in controlling flow to the cavity. This is known in the art such as in U.S. patent number 4,768,945 to Schmidt et al. which issued September 6, 1988 which describes the heating element having a forward portion extending diagonally into a nose portion of the nozzle. In the applicant's U.S. patent numbers 4,911,636 which issued March 27, 1990 and 4,941,249 which issued July 17, 1990, thermal gating is described using a nozzle with an integral heating element having a circular portion which encircles the melt bore in a forward nose portion of the nozzle. The applicant's U.S. patent number 4,875,848 which issued October 24, 1989 discloses a tapered gate insert which is mounted in the forward end of a nozzle and is heated by an integral helical heating element.

It is known in the art to use a separate cavity insert rather than a cavity plate in which the nozzle is seated to form the rearward side of the cavity. For instance, the applicant's U.S. patent number 4,911,636 which issued March 27, 1990 show a heated nozzle extending through a support or nozzle plate into a cooled cavity insert. However, the gate and the entire melt passage leading to it are part of the nozzle and all of the heating is provided by the single heating element in the nozzle. Thus, the nozzle must project through the cavity insert to the cavity.

1 These previous systems have the disadvantage for
thermal gating temperature sensitive materials that
thermal response is delayed by the cooling being in the
cavity insert and the heating in the nozzle.

5

SUMMARY OF THE INVENTION

 Accordingly, it is an object of the present
invention to at least partially overcome the disadvantages
of the prior art by providing thermal gated injection
10 molding apparatus having a cavity forming insert with a
combination of heating and cooling extending around a
central bore leading to a gate.

 To this end, in one of its aspects, the
invention provides an injection molding apparatus to
15 convey pressurized melt from a source to a cavity having a
cooled cavity forming insert with a rear end, a heated
nozzle with a forward end, the heated nozzle being
received in a nozzle plate with the forward end of the
heated nozzle abutting against the rear end of the cavity
20 forming insert, the nozzle having at least one melt
passage extending therethrough, the improvement wherein;
the cavity forming insert has a gate leading to the
cavity, a central bore to convey melt from the melt
passage in the nozzle to the gate, and an integral
25 electrically insulated heating element, the heating

1 element having an outer terminal portion extending
outwardly to an external terminal and an inner portion
having a generally uniform rectangular cross section, the
inner portion of the heating element having a plurality of
5 adjacent coils which form an inner surface, the heating
element being integrally mounted in the cavity forming
insert with the inner portion extending around the central
bore leading to the gate whereby at least part of the
inner surface formed by the adjacent coils of the inner
10 portion of the heating element form a tapered portion of
the central bore leading to the gate.

Further objects and advantages will appear from
the following description taken together with the
accompanying drawings.

15

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of a portion of a
thermal gated multi-cavity injection molding system or
apparatus showing a cavity insert according to a first
20 embodiment of the invention;

Figure 2 is a similar view showing the nozzles
and cavity insert in the open position;

Figure 3 is an enlarged sectional view of the
cavity insert shown in Figures 1 and 2;

25

Figure 4 is a partially cut-away view of the cavity insert seen in Figure 3 to show the cooling conduit configuration in this embodiment; and

Figure 5 is a sectional view of a portion of an injection molding system showing a core insert according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference is a first made to Figures 1 and 2 which show a portion of a multi-cavity thermal gated injection molding system having a number of heated nozzles 10, each of which is received in a nozzle plate 12 between a cavity insert 14 and a common elongated manifold 16. As seen in Figure 1, the cavity insert 14 is secured in position with its rear end 18 abutting against the forward end 20 of the nozzle 10 by a cavity insert retainer plate 22. The cavity insert retainer plate 22 is held by bolts 24 which extend through the nozzle plate 12 to a backplate 26.

Each nozzle 10 is attached by bolts 28 to the manifold 16 which is heated by an electric heating element 30 which is integrally cast into it as described in the applicant's U.S. patent number 4,688,622 which issued August 25, 1987. The manifold 16 is securely located in place between the nozzle plate 12 and the backplate 26 by

2030287

1 a central locating ring 32 and a number of spacer rings
34. The nozzle plate 12 and the backplate 26 are cooled
by pumping cooling water through cooling conduits 36. The
locating ring 32 provides an insulative air space 38
5 between the heated manifold 16 and the cooled nozzle plate
12. The spacer rings 34 provide another insulative air
space 40 between the heated manifold 16 and the cooled
backplate 26.

The manifold 16 has a melt passage 42 which
10 branches from a common inlet 44 to a number of outlets
46. Each spacer ring 34 has a stem portion 48 which
extends into a hole 50 in the manifold 16. The stem
portion 48 has a diagonal face 52 which avoids a sharp
corner in the melt passage 42.

15 In this embodiment, each nozzle 10 has a central
melt passage 54 extending therethrough in alignment with
one of the outlets 46 from the melt passage 42 in the
manifold 16. The nozzle 10 is heated by an integral
electrically insulated heating element 56 which has a
20 helical portion 58 which encircles the central melt
passage 54 and a terminal portion 60 which extends
outwardly to an external terminal 62. The heated nozzle
10 has a circular outer collar portion 64 which forms an
air gap 66 extending around the helical portion 58 of the
25 heating element 56 to reduce heat loss to the cavity

1 insert retainer plate 22. An insulative air space 68 is
also provide around the nozzle 10 to reduce heat loss to
the surrounding nozzle plate 12. Each nozzle 10 also has
a thermocouple 70 to monitor the operating temperature
5 adjacent the heating element 56. The nozzle 10 is located
by the collar portion 64 being received in a matching
circular seat 72 in cavity insert retainer plate 22 so the
melt passage 42 through the nozzle 10 is accurately
aligned with a central bore 74 which extends through the
10 cavity insert 14. The cavity insert 14 also has a gate 76
leading to a cavity 78, and the central bore 74 has a
tapered portion 80 adjacent the gate 76. In other
embodiments, a number of melt passages can extend through
each nozzle to a bore in the cavity insert 14.

15 As described in more detail below, the cavity
insert 14 and the adjacent core insert 82 are made to form
the cavity 78 between them of a described shape and
size. The core insert 82 is cooled by cooling water which
flows through a central cooling tube 84. The core insert
20 82 is located by a surrounding core insert retainer plate
86. A stripper ring retaining plate 88 is secured to the
core insert retainer plate 86 by bolts 90 to secure a
stripper ring 92 around a tapered portion 94 of the core
insert 82. A water cooling ring 96 with sealing O-rings
25 98 extends around between the stripper ring 92 and the

2030287

1 stripper ring retaining plate 88. Figure 2 is a similar
view to Figure 1 showing the apparatus partially assembled
to clearly illustrate how the separate nozzle 10 and
cavity insert 14 fit together.

5 Reference is now made to Figures 3 and 4 to
describe the cavity insert 14 in more detail. In this
embodiment, it has a generally cylindrical shape with a
tapered central portion 100 extending between an inner
portion 102 and an outer portion 104, all of which are
10 made of steel. The outer portion 104 is cooled by pumping
cooling water through a cooling channel 106 which extends
around the tapered central portion 100. The cooling
channel 106 has a number of pie-shaped portions 108 which
extend inwardly from outer circumferential portions 110,
15 one of which is connected to a cooling water inlet 112 and
an adjacent one of which is connected to a cooling water
outlet 113. O-rings 114 extend around between the outer
portion 104 of the cavity insert 14 and the surrounding
cavity insert retainer plate 22 to prevent leakage of the
20 cooling water. The central portion 100 has a number of
outer circumferential grooves 116 which provide air
insulation between it and the cooled outer portion 104.

The cavity insert 14 also has an electrically
insulated heating element 118. In this embodiment, the
25 heating element 118 has a nickel chrome resistant wire 120

1 extending through a refractory powder electrical
insulating material 122, such as magnesium oxide, in a
steel casing 124. The heating element 118 has an outer
terminal portion 126 which extends outwardly from an inner
5 portion 128 to an external terminal 130. The outer
terminal portion 126 has a generally uniform circular
cross section, while the inner portion 128 has a generally
uniform rectangular cross section. The inner portion 128
of the heating element 118 is formed of a number of
10 adjacent coils 132. As described in detail in the
applicant's Canadian patent application serial
number filed November 19, 1990 entitled
"Injection Molding Nozzle having Tapered Heating Element
Adjacent the Bore", the inner portion 128 is made by
15 coiling a portion of a heating element and then
compressing it in an opening in a tapered die. Thus, the
adjacent coils 132 with the rectangular cross section form
a tapered inner surface 134. After the central portion
100 of the cavity insert 14 is inserted into the outer
20 portion 104, the heating element 118 is mounted with its
central inner portion 128 between the central and inner
portions 100,102 of the cavity insert 14 and its outer
terminal portion 126 extending out through a slot (not
shown) in the outer portion 104. The assembly is then
25 brazed together in a vacuum furnace which provides a

1 metallurgical bonding of the parts into an integral unit.
The central portion 128 of the heating element 118
encircles the central bore 74 leading to the gate 76. In
fact, in this embodiment of the invention, the tapered
5 portion 80 of the central bore 74 extending through the
cavity insert 14 to the gate 74 is provided by part 136 of
the inner surface 134 formed by the tapered adjacent coils
132 of the inner portion 128 of the heating element 118.
The cavity insert 14 also has a thermocouple 137 to
10 monitor the operating temperature adjacent the heating
element 118.

In use, the system is assembled as shown in
Figures 1 and 2 and electrical power is applied to the
heating element of the manifold 16, the heating elements
15 56 of the nozzles 10, and the heating elements 118 of the
cavity inserts 14 to heat them to a predetermined
operating temperature. Pressurized melt is injected from
a molding machine (not shown) through the inlet 44 into
the melt passage 42 in the manifold 16 according to a
20 predetermined operating cycle. In order to provide
thermal or temperature assisted gating, the power to the
heating elements 118 of the cavity plates 14 is controlled
in conjunction with the melt injection pressure. The
pressurized melt flows through the melt channel 42, the
25 melt passages in each nozzle 10 and cavity insert 14, and

1 the gates 76, and fills the cavities 78. After the
cavities 78 are filled, the injection pressure is held
momentarily to pack and then released. Following a short
cooling period, the mold is opened along the parting line
5 138 to eject the molded products. The power to the
heating elements 118 is switched off just before the mold
is opened. The heat in the gate and cavity areas is
quickly dissipated by the water flowing through the
cooling channel 106 and the gates 76 freeze off. Power is
10 reapplied to the heating elements 118 as the mold is
closed following ejection. This instantly heats the
solidified melt in the gates 76 so they open immediately
when melt injection pressure is reapplied. This cycle is
repeated continuously as rapidly as several times per
15 minute in some instances. The combination of both the
cooling channel 106 and the heating element 118 extending
around the tapered bore 74 of the cavity insert 14
improves thermal response and thus reduces cycle time.
This is particularly true when part of the inner surface
20 134 formed by the adjacent coils 132 of the inner portion
128 of the heating element 118 provides the tapered
portion 80 of the central bore 74 of the cavity insert 14.

Reference is now made to Figure 5 to describe a
second embodiment of the invention. As many of the
25 elements in this embodiment are similar to those of the

1 first embodiment, elements common to both embodiments are
described and illustrated using the same reference
numerals. As can be seen, in this embodiment the cavity
140 has a different shape than the cavity 78 of the first
5 embodiment. Thus, a core insert 142 is required, rather
than a cavity insert. As mentioned above, the generic
term "cavity forming insert" is used herein to include
both a cavity insert 14 as described in the first
embodiment and a core insert 142 as described in this
10 embodiment. The core insert 142 is secured in place with
its rear end 144 abutting against the forward end 20 of
the nozzle 10 by a core insert retainer plate 146 which is
secured by bolts (not shown) which extend to the backplate
26.

15 The core insert 142 has a similar heating
element 148 with an outer terminal portion 150 and an
inner portion 152 which extends around a central bore 154
leading to a gate 156. The outer terminal portion 150 has
a generally uniform circular cross section, whereas the
20 cross section of the inner portion 152 is generally
rectangular. As described above, the inner portion 152 of
the heating element 148 is formed of a number of adjacent
coils 158, which form an inner surface 160. In this
embodiment, this inner surface 160 forms most of the
25 central bore 154 through the core insert 142 to provide

1 immediate thermal response for thermal gating. The core
insert 142 also has interconnected cooling bores 162
extending around the central bore 154 through which
cooling water is pumped to provide cooling.

5 In use, heating and melt injection pressure are
applied according to a predetermined thermal gating cycle
similar to that described above, and the mold is opened
along parting line 164. The combination of heating and
cooling in the core insert 142 again improves thermal
10 response and reduces cycle time.

While the description of the injection molding
apparatus having a cavity forming insert 14 with a
combination of heating and cooling extending around the
central bore 74 has been given with respect to preferred
15 embodiments, it is not to be construed in a limiting
sense. Variations will readily occur to those skilled in
the art. For instance, it is apparent that the size and
shape of the central bore and the size, shape and location
of the cooling channel and heating element extending
20 around it can be different for different applications.
Reference is made to the appended claims for a definition
of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an injection molding apparatus to convey pressurized melt from a source to a cavity having a cooled cavity forming insert with a rear end, a heated nozzle with a forward end, the heated nozzle being received in a nozzle plate with the forward end of the heated nozzle abutting against the rear end of the cavity forming insert, the nozzle having at least one melt passage extending therethrough, the improvement wherein;

the cavity forming insert has a gate leading to the cavity, a central bore to convey melt from the melt passage in the nozzle to the gate, and an integral electrically insulated heating element, the heating element having an outer terminal portion extending outwardly to an external terminal and an inner portion having a generally uniform rectangular cross section, the inner portion of the heating element having a plurality of adjacent coils which form an inner surface, the heating element being integrally mounted in the cavity forming insert with the inner portion extending around the central bore leading to the gate whereby at least part of the inner surface formed by the adjacent coils of the inner portion of the heating element form a tapered portion of the central bore leading to the gate.

2. An injection molding apparatus as claimed in claim 1 wherein at least part of the inner surface formed by the adjacent coils of the tapered portion of the heating element form a portion of the tapered bore leading to the gate.

FIG.1.

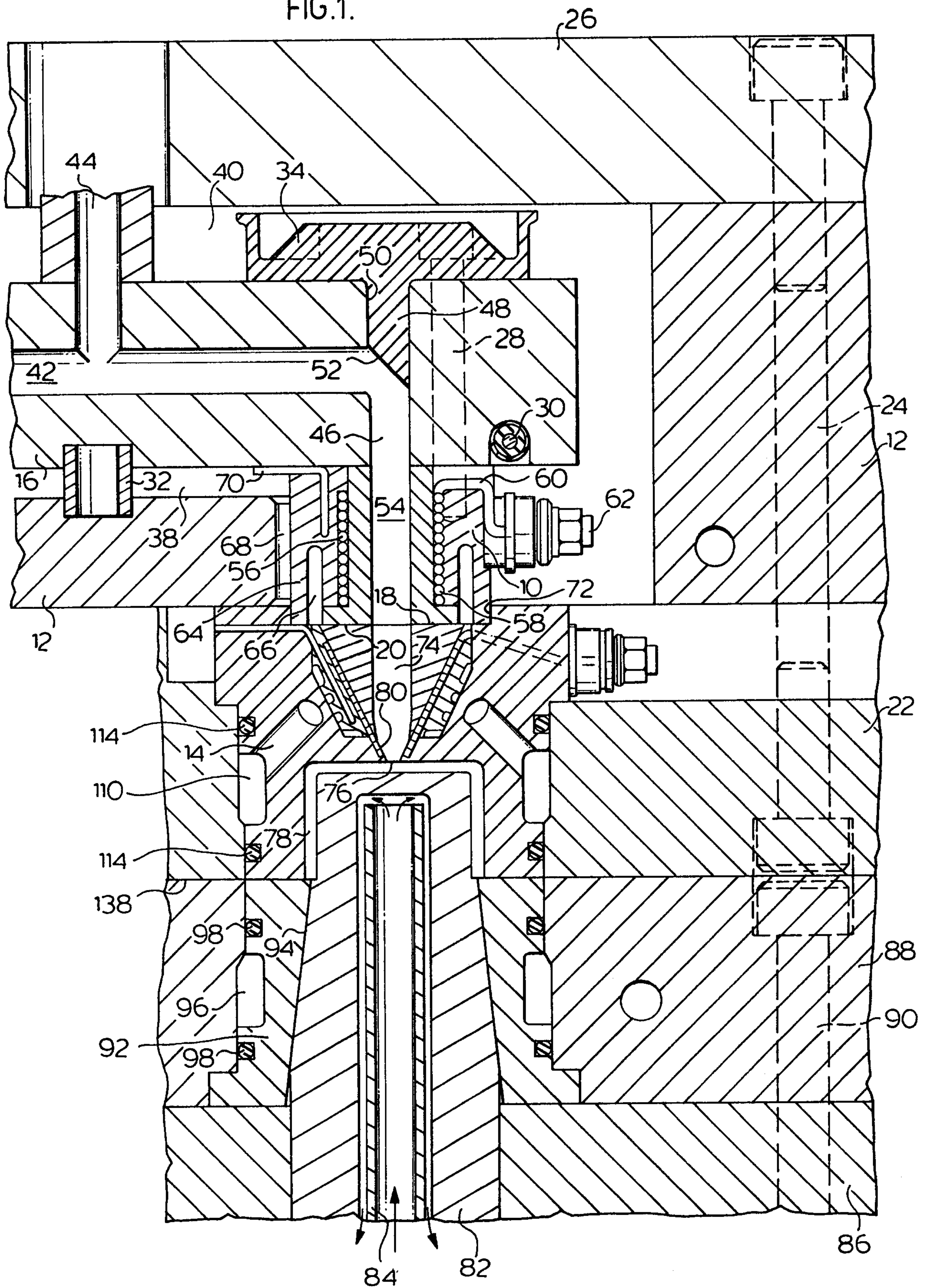
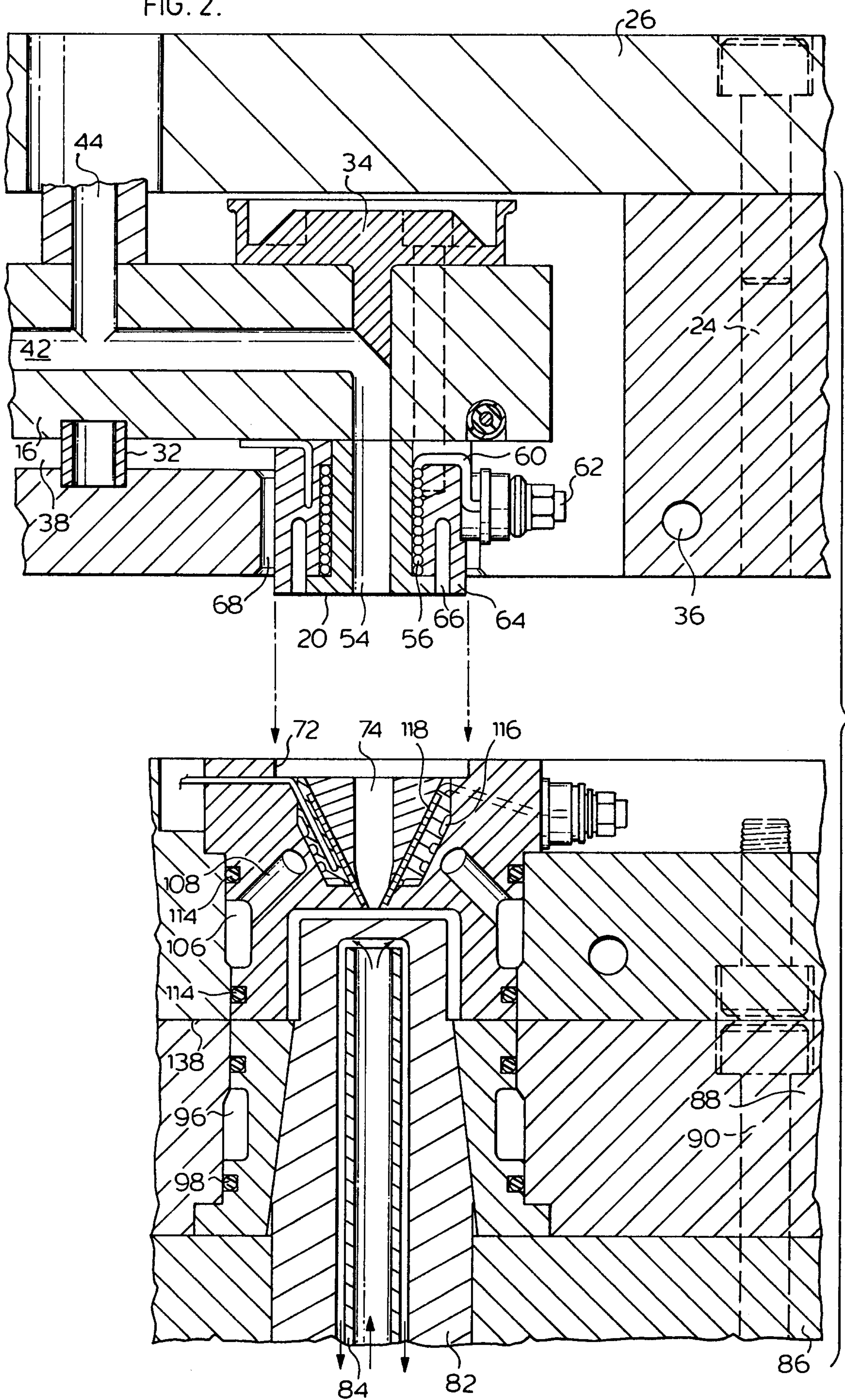


FIG. 2.



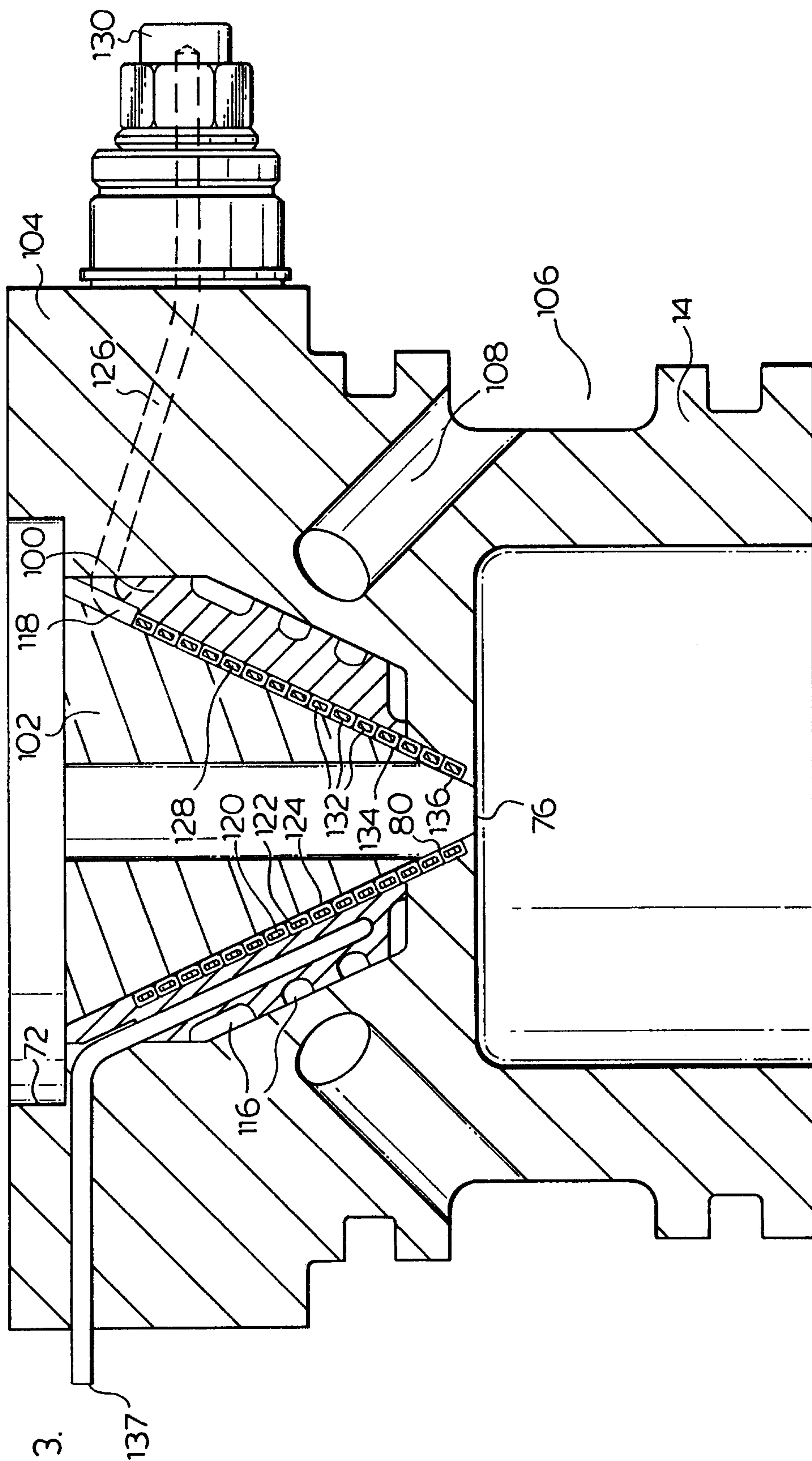


FIG. 3.

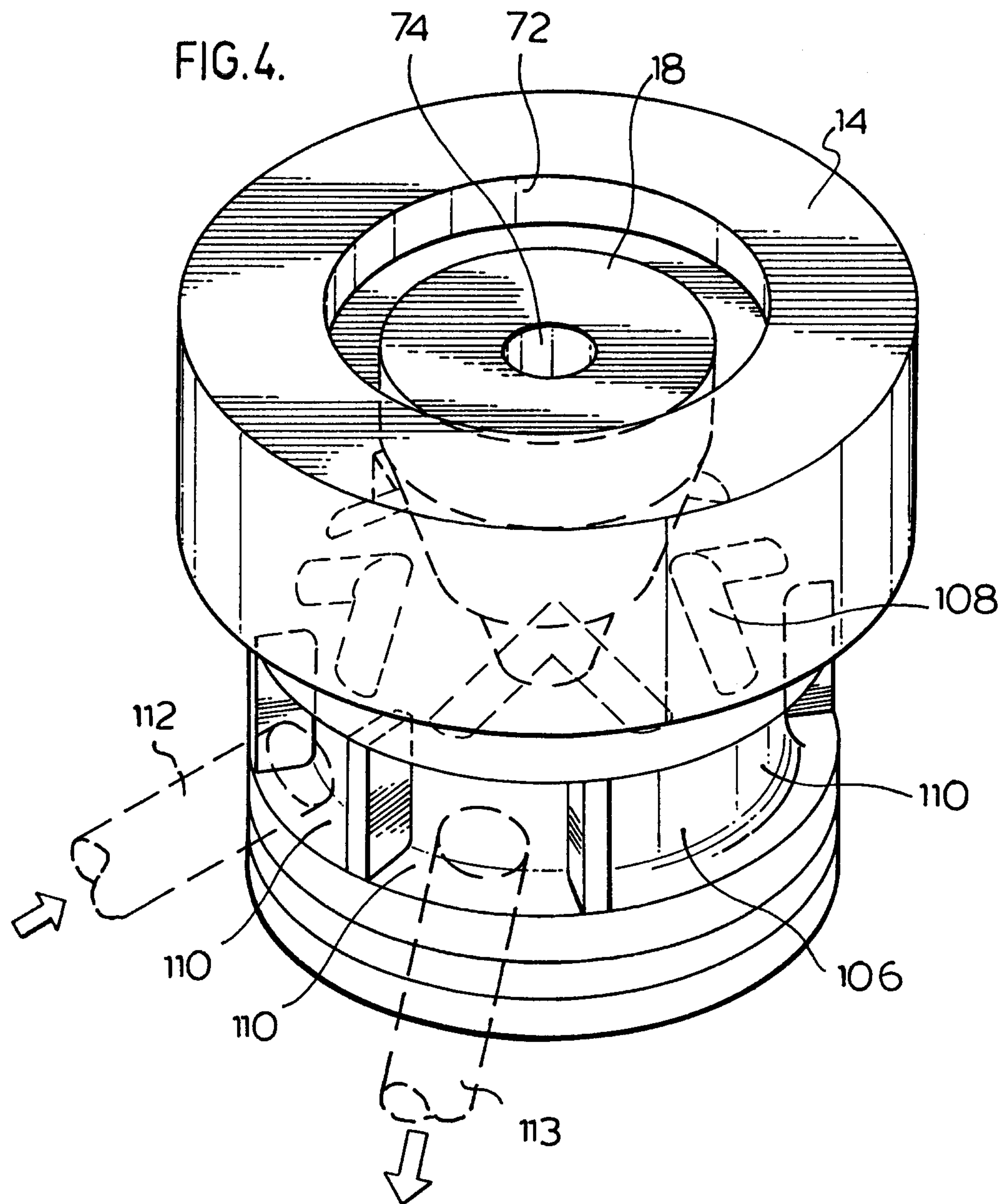


FIG. 5.

