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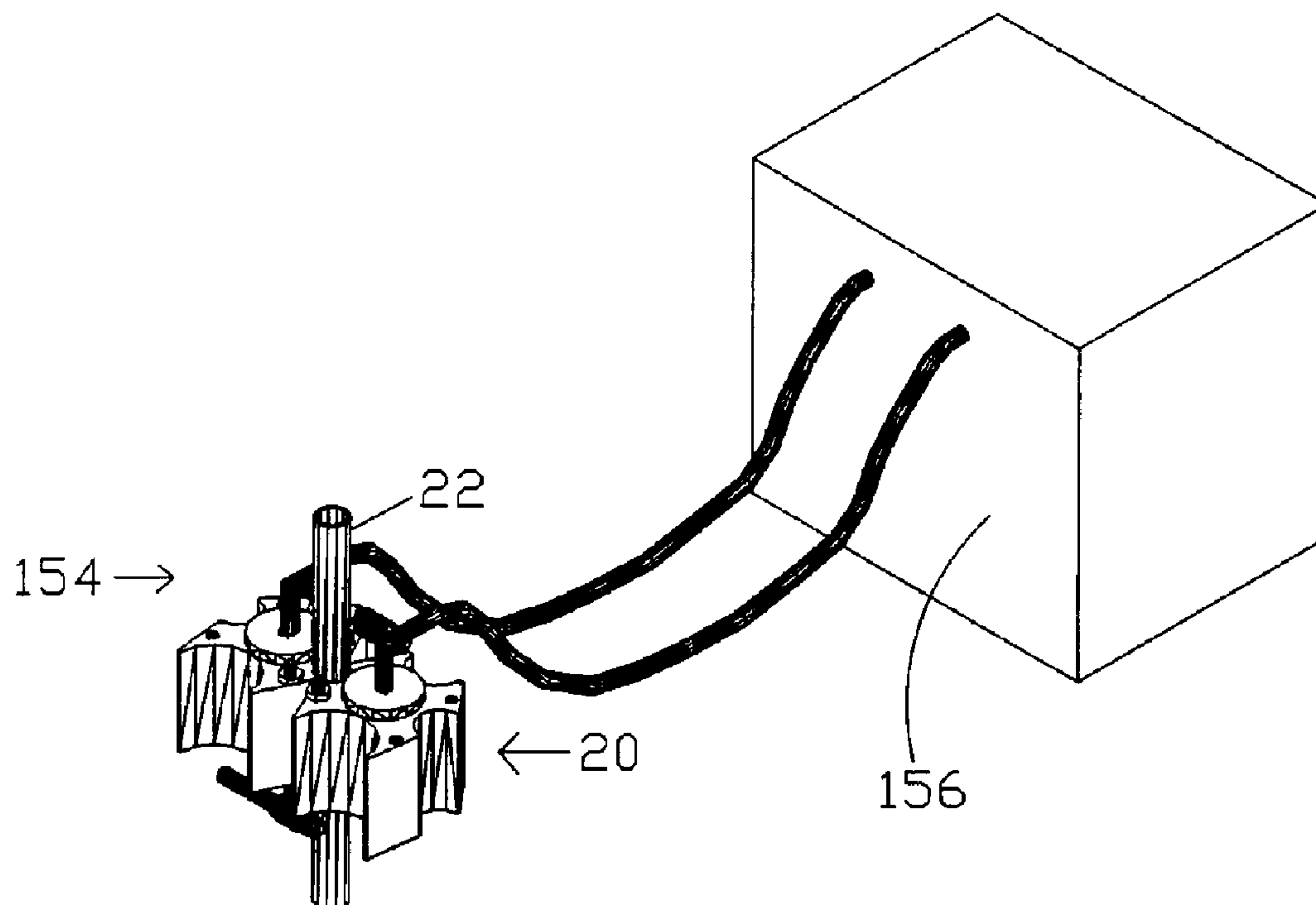
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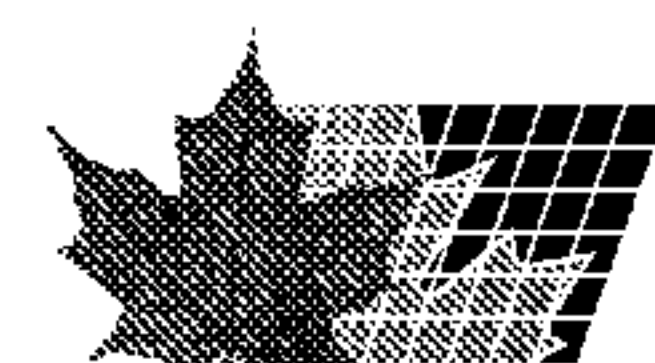
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(54) Title: PIPE FREEZER



(57) Abrégé/Abstract:

A pipe freezing apparatus comprises a multi-cavity adapter (20) and an evaporator (36) adapted to be fitted therein. The present invention uses a multi-cavity adapter having from two to eight cavities (42- 48) to fit standard plumbing pipes in copper, steel and plastic, metric and US standard. The refrigeration evaporator fits into a cylindrical bore (36) in the core of the radial multi-cavity array. The cavities are arrayed around the circumference of the bore. The adapter body that forms the array is of aluminum or the like. The coolant lines (132, 134) are elbowed at 90 degrees to the evaporator's longitudinal axis to facilitate attachment to the pipe in small or tight spaces and from the side of the pipe. The adapter body freely swivels around the evaporator thus reducing wear on the refrigeration tubes as the adapters are mounted on the section of pipe to be frozen. Thus any of the cavities can be lined up with the pipe. A set of special retainer mechanisms (90, 92) is used to tightly secure the adapter bodies to the section of pipe to be frozen, thus providing for close thermal contact.

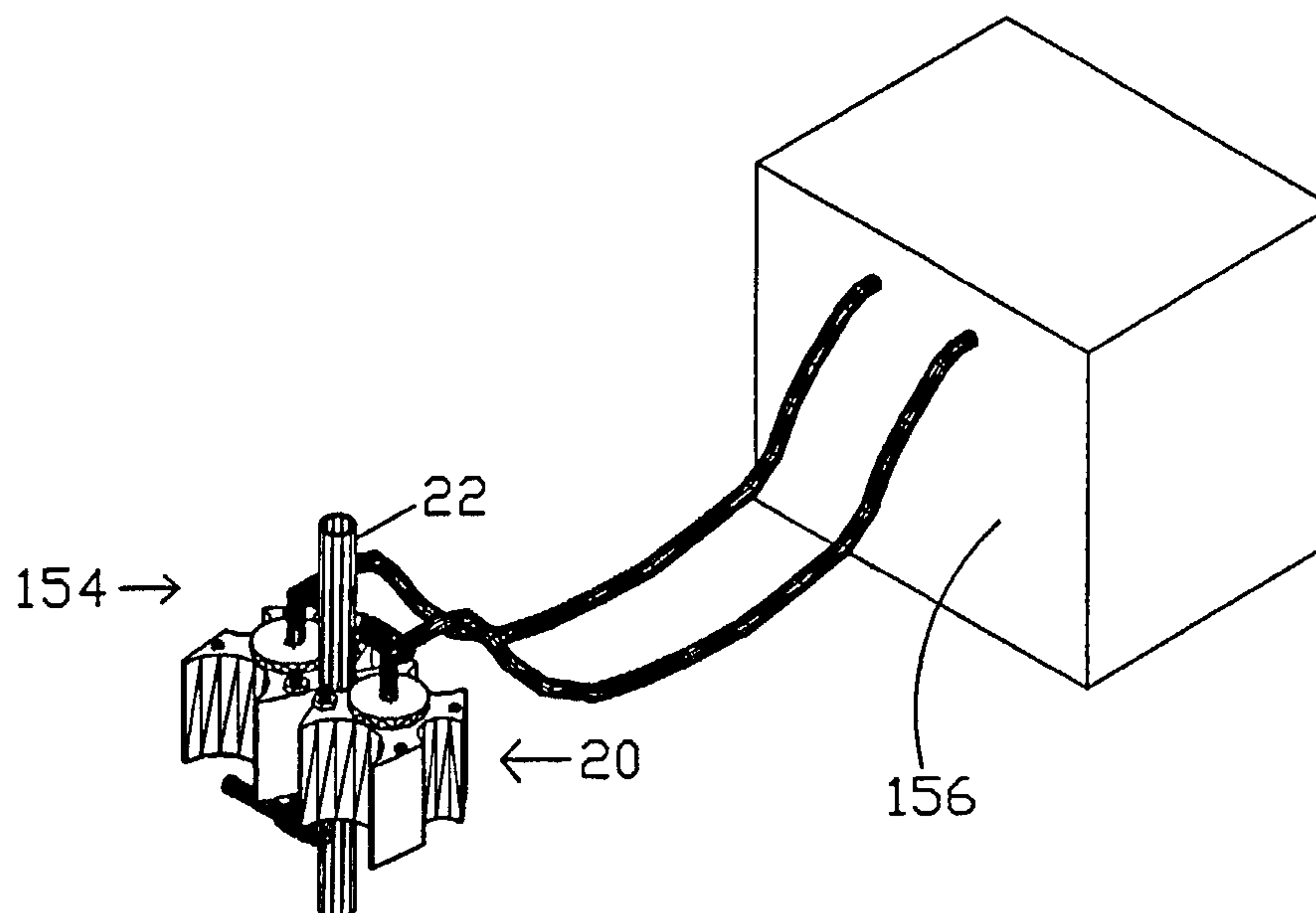


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(54) Title: PIPE FREEZER



(57) Abstract

A pipe freezing apparatus comprises a multi-cavity adapter (20) and an evaporator (36) adapted to be fitted therein. The present invention uses a multi-cavity adapter having from two to eight cavities (42-48) to fit standard plumbing pipes in copper, steel and plastic, metric and US standard. The refrigeration evaporator fits into a cylindrical bore (36) in the core of the radial multi-cavity array. The cavities are arrayed around the circumference of the bore. The adapter body that forms the array is of aluminum or the like. The coolant lines (132, 134) are elbowed at 90 degrees to the evaporator's longitudinal axis to facilitate attachment to the pipe in small or tight spaces and from the side of the pipe. The adapter body freely swivels around the evaporator thus reducing wear on the refrigeration tubes as the adapters are mounted on the section of pipe to be frozen. Thus any of the cavities can be lined up with the pipe. A set of special retainer mechanisms (90, 92) is used to tightly secure the adapter bodies to the section of pipe to be frozen, thus providing for close thermal contact.

1

Pipe Freezer

6 1.0 TECHNICAL FIELD

The present invention relates to an apparatus for freezing a plug of frozen liquid in a liquid-filled pipe, to plug said pipe at a point where there is no conventional valve, so that pipe repairs can be performed downstream of the plug.

2.0 BACKGROUND ART

A pipe freezer works by removing heat quickly enough from the liquid within a section of pipe that an ice plug forms in that section of pipe, thus effectively preventing the flow of liquid through that section of pipe. This ice plug acts as a temporary valve. When the ice plug is properly maintained (kept frozen), repairs can be performed on the pipe in the vicinity of the ice plug without the need to drain the piping system.

2.1 Two Primary Methods of Freezing Pipes

1. Expendable refrigerants sprayed directly onto the pipe and vented to the atmosphere.

2. Compression cycle refrigeration, which circulates the same refrigerant in a closed loop as a refrigerator does.

1. Expendable refrigerants: These are the traditional refrigerants for freezing the contents (in a small section of pipe 5.08 cm - 25.4 cm (2 in-10 in) in length) within plumbing piping or other fluid carrying conduits with a liquid that will freeze within the temperature range of the refrigerant being used.

36

1 The three more commonly used expendable refrigerants are listed
below with their refrigerant number and boiling point at sea
level (14.7PSIA).

1. Liquid Carbon Dioxide: R744, -109 F (-78 C)
- 6 2. Liquid Nitrogen: R728, -320 F (-196 C)
3. Liquid Helium: R707, -425 F (-269 C)

On pipes up to three 7.62 cm (three inches) of inner diameter
the refrigerant of choice is carbon dioxide. There are five or
11 more kits using carbon dioxide currently on the market in the
US. Liquid nitrogen and liquid helium are not as available, are
only packaged in large containers, and require additional safety
training. There are companies that specialize in pipe freezing
of pipes up to 152.4 cm (60 in) inside diameter. On pipes this
16 large, liquid nitrogen or liquid helium would be used depending
upon the application.

The current expendable refrigerant pipe freezing kits (for pipes
up to 7.62 cm (3 in) ID) employ bags or collars that wrap around
21 the pipe. The collars are hinged on one side and have a locking
screw. The bags are wrapped around the pipe and tied on each
end. Each type of kit has a spray head, which sprays the
refrigerant over the pipe. A high-pressure hose delivers the
liquid refrigerant to the spray heads from the tank.

26 As the liquid refrigerant is sprayed over the pipe within the
bag or collar, dry ice is being formed due to the containment of
the refrigerant (i.e., the refrigerant is not allowed to fully
evaporate into the atmosphere). When enough dry ice is formed,
31 the refrigerant valve on the tank is closed stopping the flow of
refrigerant in to the bag or collar. To conserve refrigerant,
heat is now removed from the pipe through the dry ice. The
ability of the dry ice to remove heat from the pipe is much less
than that of the denser liquid refrigerant. Throughout the
36 process, the liquid refrigerant is turned on and off to conserve

1 refrigerant, while depending on the dry ice, which was formed,
to remove heat from the pipe.

Draw backs of free flow systems over Applicant's Multi-Cavity
Adapter /Cartridge Evaporator

6

1. Requires longer freeze times.
2. Consumes more refrigerant
3. Cannot control vented gas location
4. Cost of equipment.

11 5. Danger of hose failure due to cold bending.

DESCRIPTION OF RELATED ART INCLUDING INFORMATION DISCLOSED UNDER
37 CFR 1.97 AND 37 CFR 1.98.

16 The present inventor invented United States Patent 4,309,875
issued to Radichio Jan, 12, 1982 for a Pipe Freezer or the Like,
in which a self contained freezing device forms a plug of ice
within a pipe section. A refrigeration unit supplies refrigerant
to a cradle-like freezer unit within which the section of pipe
21 to be frozen is held in spaced relation to the inner face of the
freezer. The space between the underside of the pipe and the
inner face of the freezer is filled with water, for example, by
spraying. As the water in contact with the cradle-like freezer
unit freezes, it covers the outer surface of the pipe section
26 with an ice jacket. Alternatively, a bag of freezable gel may be
substituted for the water spray and placed over the inside face
of the freezer; and then the pipe section is placed within the
fold of the bag. In the case of either alternative, the
refrigerant is maintained inside the freezer, and out of contact
31 with the pipe.

My United States Patent 5,548,965 to Chen and Radichio issued on
Aug. 27, 1996 for a Multi-cavity Evaporator which has an outer
surface and an inner chamber. The outer surface has at least two
36 pipe receiving surfaces and a pair of ends. The evaporator has a

1 bore extending from one of the ends to the inner chamber. A tube
extends into the bore sealing the chamber, such that a
refrigerant flows into the inner chamber through an inner tube
and out of the inner chamber through the outer tube. Each of the
pipe receiving surfaces has a distinct surface adapted for
6 receiving different size pipes.

- Patent EP 0 145 114 B1 issued to H. Ronald discloses a pipe
freezing device having collar and saddle arrangements.

- Patent 5,836,167 issued to S. D. Clouston et al discloses a
11 method and apparatus for freezing a large pipe. The apparatus
utilizes a hinge/latch combination to encircle and secure a
section of a large pipe.

- Patent 5,680,770 issued to R. M. Hall et al discloses an
apparatus for freezing liquid in a fluid conducting pipe. This
16 apparatus comprises a freeze jacket having two halves for
releasably surrounding a section of pipe.

- Patent WO 89/01110 issued to Laiho et al discloses a heat
transfer device comprising preformed grooves for different pipe
sizes and shapes.

21 3.0 DISCLOSURE OF INVENTION

3.1 Opening

26 The present invention uses a multi-cavity adapter having from
two to eight cavities to fit standard plumbing pipes in copper,
steel and plastic, metric and US standard. The refrigeration
evaporator fits into a cylindrical bore in the core of the
radial multi-cavity array. The cavities are arrayed around the
31 circumference of the bore. The extrusion that forms the array is
of aluminum or the like.

The coolant lines are elbowed at 90 degrees to the evaporator's
longitudinal axis to facilitate attachment to pipes in small or
36 tight spaces and from the side of the pipes. The central bore

1 in the adapter body has a diameter slightly larger than the
diameter of the evaporator which allows the evaporator to swivel
freely in the adapter body thus minimizing wear and tear on the
refrigeration lines to the evaporator when the evaporator is
inserted into the central bore of an adapter body of the multi
6 cavity adapter. Any of the cavities on the adapter body can be
lined up with the pipe. When a single adapter is being used, the
adapter is positioned on the pipe and secured with a strap
having hook and loop fastening material. Then the cartridge
evaporator is plugged into the adapter.

11 More preferably two units, a unit on either side of the
pipe, are strapped in place to fully surround the pipe. Most
preferably a special set of adjustable retainer mechanisms is
used to tightly secure the adapters to the section of pipe to be
16 frozen.

3.2 Contents

The above features are objects of this invention. Yet
21 further objects are as follows:

An object of the instant invention is to provide a pipe
freezer that is and sturdy, light weight, and easy to use.

26 A further object is to provide a pipe freezer that is
economical in cost to manufacture

A still further object is to provide a pipe freezer which
easily accommodates pipes of different outside diameters.

31 Still another object is to provide an evaporator specially
adapted to be used in applicant's pipe freezer.

A further object is to provide a retainer mechanism for
36 Applicant's pipe freezer which enables it to be quickly fastened

1 and tightened on pipes of various outside diameters.

Yet another object is to provide pipe freezing systems for both the use of expendable and nonexpendable refrigerants.

6 Still another object is to provide a pipe freezing system which can be used with pipes which have restricted access.

11 These and other objects, features, aspects, and advantages of the present invention will become better understood with regard to the following description, appended claims, and accompanying drawings and will be otherwise apparent to those skilled in the art.

16 For the purpose of illustration of this invention, several preferred embodiments are shown in the accompanying drawings. It is to be understood that this is for the purpose of example only and that the invention is not limited thereto.

4.0 BRIEF DESCRIPTION OF DRAWINGS

21 Fig. 1 is a perspective view of a pipe freezing system utilizing my multi cavity adapter and using nonexpendable refrigerants; Fig. 2 is a perspective view of one of the adapter bodies of the multi cavity adapter;

26 Fig. 3 is an enlarged perspective view of Figure 1 with most of the protective hose and the refrigeration system removed; Fig. 4 is a bottom view of the Fig. 3; Fig. 5A is a side perspective view of an adapter body with the cartridge evaporator removed;

31 Fig. 5B is an exploded view of Fig. 5A, and also shows a turned over evaporator cap to show its details; Fig. 6 shows an elevation in section of a pipe with frozen plug; Fig. 7 is a diagrammatic plan view of the refrigeration unit of Fig. 1;

36 Fig. 8 is an illustration of the fact that the secondary adapter

1 body is substantially a mirror image of the primary adapter
body;
Fig. 9 shows the adjustment settings of the special retainer
mechanism required to interconnect the adapter bodies around any
of the four standard pipe sizes that the adapter bodies can
6 accommodate;
Fig. 10 is an exploded view of the special retainer mechanisms;
Fig. 11 shows a single adapter strapped to a pipe;
Fig. 12 which shows two adapters strapped to a pipe;
Fig. 13A shows a perspective view of a pipe freezing system
11 having one evaporator utilizing expendable refrigerants which
utilizes my multi cavity adapter;
Fig. 13B shows a perspective view of a pipe freezing system
having two evaporators utilizing expendable refrigerants which
utilizes my multi cavity adapter;
16 Fig. 14 is an enlarged perspective view of Figure 13 with most
of the protective hose and the tank removed;
Fig. 15 is a diagrammatic plan view of the invention in use when
using an expendable refrigerant;
Fig. 16 is a diagrammatic plan view of the invention in use when
21 using an nonexpendable refrigerant;
Fig. 17 is a perspective view of the tight space of Fig. 16
showing the invention mounted upon the section of pipe to be
frozen;
Fig. 18 is a perspective view of the tight space of Fig. 16
26 showing the invention mounted upon the section of pipe to be
frozen;
Fig. 19 is a perspective view of Fig. 18;

31 5.0 BEST MODE FOR CARRYING OUT THE INVENTION

5.1 Detailed Description of the Elements

Turning now descriptively to the drawings, in which similar
reference characters denote similar elements throughout the
36 several views, Figure 1 illustrates a perspective view of a pipe

1 freezing system (utilizing non-expendable refrigerants)
utilizing my multi-cavity adapter. (Figure 13, described later,
illustrates a perspective view of a pipe freezing system
utilizing expendable refrigerants which utilizes my multi cavity
adapter.) The multi-cavity adapter, generally designated as 20
6 in fig. 1, is designed for the removal of heat from liquid
filled pipes, such as 22, to bring the liquid contents 24, as in
Figure 6, below the liquid's freezing point, and to cause an ice
blockage 26, as in fig. 6, within pipe 22. With ice plug 26 in
place, pipe 22 may now be cut open as at 28, to make plumbing
11 repairs without the need of a valve.

As best seen in Figures 2 and 3, the multi-cavity adapter
for a pipe freezer, generally shown by reference numeral 20,
consists of an elongated piece of thermally conductive material
16 30 which has a first end face 32, a second end face 34, and a
bore 36 passing through the piece of thermally conductive
material 30. This elongated piece of thermally conductive
material 30 will be referred to as an adapter body. The bore 36
serves as a cartridge evaporator receiving port for the
21 reception of a cartridge evaporator 38 therein. Figure 5A shows
a cartridge evaporator 38 removed from the cartridge evaporator
receiver port 36 of an adapter body 30. Figure 5B is an exploded
view of Figure 5A, and also shows a evaporator cap 136 upside
down to reveal its structure. The bore 36 extends from the first
26 end face 32 to the second end face 34 of the adapter body 30.
Preferably, the bore 30 is a central bore 30. The outer surface
40 of the adapter body 30 has a plurality of concave pipe
receiving surfaces 42-48. Preferably, each concave pipe-
receiving surface 42-48 has an arc of approximately 180 degrees.
31 Each concave pipe receiving surface 42-48 has a specific
distinct radius of curvature which is different than the radii
of curvature of the other pipe receiving surfaces 42-48. Thus,
pipes 22 with different outside diameters can be quickly and
easily accommodated. (Please see Figure 9.) The intersection of
36 each pipe receiving surface 42-48 and the outer surface 40

1 defines a first corner edge 50, 54, 58, 62 and a second corner
edge 52, 56, 60, 64 of each of the pipe receiving surfaces 42-
48. The intersection of each corner edge 50-64 with the first
end face 32 defines a corner point of the first end face. The
intersection of each corner edge with the second end face 34
6 defines a corner point of the second end face 34.

Applicant's preferred embodiment of a multi cavity adapter
20 has an adapter body 30 with at least four pipe receiving
surfaces 42-48 so that various sized pipes can be accommodated.
11 As shown in Figures 2 and 9, the four pipe receiving surfaces
42-48 of the adapter body can accommodate pipes with outside
diameters of 1.651 cm, 2.921 cm, 2.286 cm, and 4.191 cm (0.65,
1.15, 0.90, and 1.65 inches) respectively. The adapter body 30
of the multi cavity adapter 20 is thus designed to fit standard
16 plumbing pipes in copper, steel and plastic, in both metric and
US standard sizes. Occasionally, however, one will be required
to freeze a pipe with a diameter which is different from that of
the four pipe receiving surfaces 42-48. For this purpose
applicant's invention also includes a bushing adapter 70 (also
21 called a reducer bushing, or sleeve) for accommodating pipes
with other outside diameters. As shown in Figures 11-12, the
outer surface 72 of the bushing adapter 70 is convex and
complimentary to one of the concave pipe receiving surfaces 42-
48 of the adapter body 30. The inner surface 74 of the bushing
26 adapter 70 is concave and has a specific distinct radius
different from the pipe receiving surfaces 42-48 of the adapter
body 30 and is adapted to receive a pipe.

Preferably, as shown in Figure 3, Applicant's invention
31 includes a second elongated piece of thermally conductive
material 78 which will be referred to as the secondary adapter
body 78, and, in this case, the first elongated piece of
thermally conductive material 30 will be referred to as the
primary adapter body. The secondary adapter body 78 is
36 substantially a mirror image of the primary adapter body 30. (It

1 should be noted, as shown in Figure 8, that if one places two of
the primary adapter bodies 30,31 in a row 80 from left to right,
and the second one 31 in the row 80 is rotated about the central
axis of its central bore 36 by 180 degrees (as shown in row 82)
and then turned upside down (as in row 84), it is a mirror image
6 of the first one 30 in the row.)

Applicant's invention contemplates two ways of fastening
the multi cavity adapters 20 to the section of pipe 22 to be
frozen. In Applicant's preferred embodiment as shown in Figure
11 3, both the primary 30 and secondary 78 adapter bodies have
locking channels 86 which are substantially parallel to the axes
of the central bores 36 of the adapter bodies and extend from
the first end face 32 to the second end face 34 of each of the
adapter bodies 30, 78. As shown in Figure 1 there are four
16 locking channels 86 in each adapter body. Each locking channel
86 has a channel opening 88 in the first end face 32 and a
second channel opening 89 in the second end face 34. Preferably,
the circular edges of the channel openings 88, 89 of these
locking channels 86 are approximately 0.25 cm (0.1 inches) from
21 an edge of the adapter first end face 32 and situated between
the corner points of the first end face 32 at a position where
there will be no interference between the pipe section 22 to be
frozen and the retainer mechanisms 90, 92 when the retainer
mechanisms 90, 92 are inserted in those channels 86. Most
26 preferably as shown in Figure 9, the channel openings 88 of
these locking channels 86 are situated such that the number of
adjustment settings of the special retainer mechanism required
to interconnect the adapter bodies around any of the four
standard pipe sizes that the adapter bodies can accommodate are
31 minimized.

Special adjustable fastening mechanisms such as the
retainer mechanisms 90, 92 as shown in Figure 3 (and in greater
detail in Figure 10 which is an exploded view of these) are used

1 to fasten the primary 30 and secondary 78 adapter bodies to the
section of pipe 22 to be frozen. The first retainer mechanism 90
has a first prong 94 and a second prong 96. These prongs 94, 96
are threaded at their ends 98. The first prong 94 is adapted to
be received into a channel opening 88 of the primary adapter
6 body 30, and the second prong 96 is adapted to be received into
a channel opening 88 of the secondary adapter body 78, so that
when the primary 30 and secondary 78 adapter bodies are aligned
such that a pipe receiving surface 42-48 of the primary adapter
body 30 is facing a pipe receiving surface 42-48 of the
11 secondary adapter body which has the same radius of curvature as
the primary adapter body 30, the primary 30 and secondary 78
adapter bodies can be hingedly fastened together by the first
retainer mechanism 90, such that the primary 30 and secondary 78
adapter bodies can be draped around the section of pipe 22 which
16 is to be frozen. The first retainer mechanism 90 includes two
nuts 100, 100 for threading onto the ends 98, 98 of the threaded
prongs 94, 96 for securing the first retainer mechanism 90 in
the locking channels 86, 86.

21 The second retainer mechanism 92 is essentially similar to
the first retainer mechanism 90. It has a first prong 94 and a
second prong 96, and the prongs are threaded at their ends. The
first prong 94 is adapted to be received into a locking channel
86 of the primary adapter body 30, and the second prong 96 is
26 adapted to be received into a locking channel 86 of the
secondary adapter body 78, so that the primary 30 and secondary
78 adapter bodies can be fastened together, such that the
primary 30 and secondary 78 adapter bodies can tightly encompass
and secure the section of pipe 22 which is to be frozen.

31 In Applicant's preferred embodiment, special retainer
mechanisms 90, 92 as shown in Figure 3, are used to fasten the
multi-cavity adapters 20 to the section of pipe 22 to be frozen.
Each retainer mechanism 90, 92 consists of a first and second

locking pin 102, 104, a straight pin 116, which interconnects them, and a spring 118 under tension mounted on the straight pin 116 between the two locking pins 102, 104 to hold the locking pins 102, 104 apart from one another. As best seen in Figures 3 and 10, the first retainer mechanism generally shown by reference number 90 in Figure 10 consists of a first locking pin 102 whose first end 106 has a golf club-like head 108 which has a nonthreaded hole 110. The golf club-like head 108 is offset from the central axis of the locking pin 102 so that when the retainer mechanisms 90, 92 are inserted into the adapter bodies to be joined, the offsets will ensure that the straight pins 116, 116 of the retainer mechanisms 90, 92 will not come in contact with the section of pipe 22 to be frozen. These golf club-like heads 108, 110 are referred to as offset golf club-like heads. The second end 120 of the first locking pin 102 is threaded. The second locking pin 104, likewise, has a golf club-like head 110 which has a threaded hole 114. The diameter of this threaded hole 114 is smaller than the diameter of the nonthreaded hole 112 in the golf club-like head 108 of the first locking pin 102. The second end 120 of the second locking pin 104 is threaded. These two locking pins 102, 104 are connected via a straight pin 116. The straight pin 116 has a first end with an Allen head 122 with a diameter larger than the diameter of the nonthreaded hole 112 in the golf club-like head 108 of the first locking pin 102. The straight pin is threaded except for the Allen head end 122. The straight pin 116 is adapted to be inserted into the nonthreaded hole 112 of the offset golf club like head 108 of the first locking pin 102. It is then pushed through that hole 112 until it engages the threaded hole 114 of the offset golf club like head 110 of the second locking pin 104, and then is screwed into the threaded hole 114 of the second locking pin 104. A pair of nuts 110, 110 are screwed onto the second ends 120, 120 of each locking pin to secure the first retainer mechanism 90 in the locking channels 86, 86. The Allen head end 122 of the straight pin 116 is then turned to draw

1 together the golf club-like heads 108, 110 of the locking pins
102, 104 and thus tighten and secure the adapter bodies 30, 78 on
the section of pipe 22 to be frozen.

6 Preferably, a spring 118 under tension is mounted on the
straight pin 116 of each retainer mechanism 90, 92. This spring
118 serves to push apart and hold the first and second locking
pins 102, 104 in substantially parallel alignment to one
another, which enables one to simultaneously insert the locking
pins 102, 104 into corresponding locking channels 86, 86 of the
11 primary 30 and secondary 78 adapter bodies.

The second retainer mechanism 92 consists of a first
locking pin 102 whose first end 106 has a golf club-like head
108 which has a nonthreaded hole 110. Again, the golf club-like
16 head 108 is offset from the central axis of the locking pin 102
so that when the retainer mechanisms 90, 92 are inserted into
the adapter bodies to be joined, the offsets will ensure that
the straight pins 116, 116 of the retainer mechanisms 90, 92
will not come in contact with the section of pipe 22 to be
21 frozen. As mentioned above in the description of the first
retainer mechanism, these golf club-like heads 108, 110 are
referred to as offset golf club-like heads. The second end 120
of the first locking pin 102 is threaded. The second locking pin
104, likewise, has a golf club-like head 110 which has a
26 threaded hole 114. The diameter of this threaded hole 114 is
smaller than the diameter of the nonthreaded hole 112 in the
golf club-like head 108 of the first locking pin 102. The second
end 120 of the second locking pin 104 is threaded. These two
locking pins 102, 104 are connected via a straight pin 116. The
31 straight pin 116 has a first end with an Allen head 122 with a
diameter larger than the diameter of the nonthreaded hole 112 in
the golf club-like head 108 of the first locking pin 102. The
straight pin is threaded except for the Allen head end 122. The
straight pin 116 is adapted to be inserted into the nonthreaded

1 hole 112 of the offset golf club like head 108 of the first
locking pin 102. It is then pushed through that hole 112 until
it engages the threaded hole 114 of the offset golf club like
head 110 of the second locking pin 104, and then is screwed into
the threaded hole 114 of the second locking pin 104.

6
In use, the locking pins 102, 104 of the second retainer
mechanism 92 are not fully inserted into the locking channels
86, 86. Therefore, when the Allen head 122 of the straight pin
116 is tightened, thus pulling the upper parts of the locking
11 pins 102, 104 together, the lower tips 120, 120 of the locking
pins 102, 104 spread apart and contact the inner walls of the
locking channels 86, 86. Thus the locking pins 102, 104 bind in
the locking channels 86, 86, thus securing the locking pins 102,
104 in the locking channels 86, 86, and a second set of nuts is
16 not needed to hold the locking pins 102, 104 of the second
retainer mechanism in the locking channels 86, 86. In other
words, by tightening the Allen head 122 of the straight pin 116
interconnecting the two locking pins 102, 104, we can make the
distance between the two locking pins 102, 104 less than the
21 distance between the channel openings 88, 88 of the adapter
bodies 30, 78 we are fastening together around the section of
pipe 22 to be frozen, and thus the locking pins 102, 104 will
bind as you push them into their set of channel openings 88, 88.
The approximate distances between channel openings of the
26 adapter bodies to be joined by the retainer mechanisms 90, 92 in
Applicant's preferred embodiment are shown in Figure 9.

Applicant has found that if both retainer mechanisms 90, 92
are inserted in the same ends of the adapter bodies 30, 78, when
31 the Allen heads of the straight pins 116, 116 are turned to
tighten the locking pins 102, 104, the adapter bodies 30, 78 are
pulled together at that end and tend to spread apart at the
other end. The result is that there is not a good overall
contact of the adapter bodies 30, 78 on the section of pipe 22

1 to be frozen. Therefore, preferably, if the first retainer
mechanism 90 is inserted in channel openings 88, 88 of the first
end faces 32, 32 of the primary 30 and secondary 78 adapters,
the second retainer mechanism 92 should be inserted in channel
openings 89, 89 of the second end faces 34, 34 of the primary 30
6 and secondary 78 adapters. When this is done, the two adapter
bodies 30, 78 can be tightly secured to the section of pipe 22
to be frozen.

11 An alternate adjustable fastening mechanism for fastening a
multi cavity adapter 20 to the section of pipe 22 to be frozen
is a flexible strap with hook and loop fastener material such as
shown in Figure 11 which shows a single adapter 20 strapped to a
pipe 22 and Figure 12 which shows two adapters 20, 20 strapped
to a pipe. In use, pipe 22 is wet. Then two adaptors 20 and 20
16 are strapped by hook and loop (such as Velcro®) strap 124 around
pipe 22. Thus the two adaptors 20, 20 clamp to both sides of
pipe 22.

21 As shown in Figures 1, 3, and 4, a close fitting cartridge
type evaporator 38 is inserted in the central bore 36 of each
adapter body 30, 78. This type of cartridge evaporator provides
a way for using a refrigerant to freeze a pipe 22 for those
types of pipe freezers which use Applicant's multi cavity
adapter 20 to encompass the section of pipe 22 to be frozen.

26 As best seen in Figures 5A and 5B (which is an exploded
view of Fig. 5A), the cartridge evaporator 38 has an inner
chamber 126 and a bore 128 which extends from the first end
surface 130 of the cartridge evaporator to the inner chamber
31 126. A metering tube 132 extends into the bore 128 and protrudes
into the inner chamber 126 of the evaporator 38 for moving a
refrigerant into the inner chamber 126 of the evaporator 38 at a
predetermined rate. The metering tube 132 of Applicant's
invention is a capillary tube having an outside diameter of

1 1.778 mm (0.07 inches) and an inside diameter of 0.5588 mm
(0.022 inches). A return tube 134 extends out of the bore 128
for moving evaporated refrigerant out of the inner chamber 126
of the evaporator. In use, refrigerant flows into the inner
chamber 126 through the metering tube 132 and evaporated
6 refrigerant flows out of the inner chamber 126 through the
return tube 134. Preferably, as shown in Figures 5A and 5 B, the
metering tube 132 passes through and is surrounded by the return
tube 134, thus providing protection for the metering tube 132.

11 Preferably, the first end 138 of the cartridge evaporator
38 has a cap 136 which is fixedly fitted over the first end 138
of the cartridge evaporator 38. The cap 136 has a side wall 140
which extends along the outer surface 39 of the evaporator 38
for at least a portion of the length of the outer surface 39.
16 The cap 136 has a first end 144 which is closed, and a second
end 146 which has a face 150 with a sufficiently large bore 148
in it for the second end 146 of the cap 136 to fit over the
first end 138 of the evaporator 38. The face 150 of the second
end 146 of the cap 38 has an outside diameter which is greater
21 than the diameter of the central bore 36 of the adapter 38
serving as the cartridge evaporator receiving port 36. Thus,
when the second end 152 of the evaporator 38 having this cap 136
is inserted into the central bore 36 at one end of the adapter
body 30, 78 and pushed along the bore 36, the face of the cap
26 136 eventually comes to rest against the end face (32 or 34) of
that adapter 30, 78.

As shown in Figures 1 and 13, in which a nonexpendable
refrigerant is being used, Applicant's invention contemplates a
31 complete pipe freezing system 154 for freezing the contents of a
section of pipe 22. As shown in Figure 7 which shows the
interior details of the refrigeration unit, this pipe freezing
system 154 consists of a refrigeration unit 156 having a
compressor 158 for compressing the refrigerant from a low

1 pressure to a high pressure, a pair of condensers 160, 160
downstream of the compressor 158 for condensing the refrigerant
from a high temperature gas to a lower temperature liquid,
Applicant's multi-cavity adapter 20, fastened to the section of
pipe 22 which is to be frozen, and a cartridge type evaporator
6 38 inserted into a cartridge receiving port 36 of the multi-
cavity adapter 20. Metering tubes 132, 132 extend between the
condensers 160, 160 of the refrigeration unit 156 and the
evaporators 38, 38 for moving the refrigerant to the evaporators
38, 38. Return tubes 134, 134 extend between the evaporators 38,
11 38 and the compressor 158 of the refrigeration unit 156 for
moving refrigerant from the evaporators 38, 38 to the compressor
158.

Refrigerant enters each evaporator 38 through a metering
16 device such as capillary tube 132, or a thermostatic expansion
valve (not shown), or an automatic expansion valve (not shown),
or a fixed orifice (not shown). The pressure within the
evaporator chamber 126 is much lower than the liquid entering.
As shown in Figure 16, as the liquid enters the chamber 126, it
21 expands 170 into a saturated vapor, reducing its pressure and
temperature. Because higher temperature travels to cooler
temperature, this evaporation results in the removal of heat
from evaporators 38, 38. Then superheated refrigerant returns
via return suction tube 134 to the compressor 158 (fig. 7).

26
As in Figures 3 and 5, when the evaporators 38, 38 are
positioned within the central evaporator receiving ports 36, 36
of the adapter bodies 30, 78 of the multi cavity adapter 20, the
heat will flow from the adapter bodies 30, 78, and when the
31 adapter 20 is cradling a pipe 22, heat is removed from the pipe
22. For best thermal transfer, water, or any heat transfer
media, may be sprayed between pipe 22 and the adapter bodies 30,
78, and in the evaporator receiving ports 36, 36 of the adapter
bodies 30, 78 before placing the evaporators 38, 38 therein.

1 As shown by Figure 13A, in the special case where an
expendable refrigerant is being supplied by a tank of
refrigerant, a complete pipe freezing system 200 will consist of
Applicant's multi-cavity adapter 20 fastened to the section of
pipe 22 which is to be frozen, and a cartridge evaporator 38 is
6 inserted into a cartridge receiving port 36 of one of the
adapter bodies 30, 78. A metering input tube 132 extends between
the tank 202 and the evaporator 38 for receiving refrigerant at
its first end 204 from the tank 202 and for moving the
refrigerant out of its second end 206 (see Figure 5B) to the
11 evaporator 38 at a predetermined rate. Preferably, the metering
input tube 132 extends into the evaporator 38, a distance which
is three quarters of the length of the evaporator 38. (Please
see Figures 5B and 15.) Evaporated refrigerant is expelled to
the atmosphere through the return tube 208 which, for expendable
16 refrigerants, is actually a discharge vent. Preferably, this
discharge vent 208 extends to a safe discharge area 210. (A
typical flow rate would be 0.675 kg (1.5 pounds) in 5 minutes
for a 3.81 cm (1.5 inch) ID copper pipe with an ambient
temperature of 70 F. The time to freeze the section of pipe 22
21 under these circumstances would be about 13 minutes.) The tank
202, of course, should be sufficiently charged with refrigerant
to freeze the contents of the section of pipe 22. Since the
metering tube 132 is somewhat fragile, Applicant's invention
utilizes a protective hose or tube 212 (which will be referred
26 to as the original protective tube) to encircle the metering
input tube 132 for at least a portion of the length of the
metering input tube 132.

Most preferably, as shown by Fig 13B, in the above pipe
31 freezing system using expendable refrigerants, a cartridge
evaporator 38 is inserted into the cartridge receiving ports 36,
36 of each of the adapter bodies 30, 78 of the multi-cavity
adapter 20. (Please see Figures 5A and 5B.) For this
configuration, as shown in Figures 13B-15, a metering input tube

1 132 extends outward from the tank 202 for receiving refrigerant
at its first end 204 from the tank 202 and for moving the
refrigerant out of its second end 206 (Fig. 15) at a
predetermined rate. Preferably this metering input tube 132 is a
capillary tube. An input tee 214 is situated between the second
6 end of this metering input tube 132 and the two evaporators 38,
38. This input tee 214 has an input port 216 and two output
ports 218, 218. This tee 214 receives refrigerant from the
second end 206 of the metering input tube 132 through the tee's
input port 216 and supplies refrigerant out of each of the tee's
11 two output ports 218, 218. An additional metering input tube
220, 220 is situated between each of the two output ports 218,
218 of the tee 214 and each of the two evaporators 38, 38. These
additional metering input tubes 220, 220 receive refrigerant
from each of the two output ports 218, 218 of the input tee 214
16 at their reception ends 222, 222 and supply this refrigerant out
of their supply ends 224, 224 to each of the two evaporators 38,
38. Preferably, these additional metering input tubes 220, 220
are capillary tubes as well. An additional protective tube (220
with 226) extends from each evaporator 38, 38. An additional
21 protective tube (220 with 226) encircles each of the two
additional metering input tubes 220 for at least a portion of
the length of each additional metering input tube 220. Discharge
vents 208, 208 extend from the bore 128, 128 of each evaporator
38, 38 so that evaporated refrigerant can flow from the inner
26 chamber 126 of each evaporator 38, 38 and be expelled to a safe
environment 210, 210. Preferably, as shown in Figures 13A-15,
each of the evaporators 38, 38 is equipped with a
supply/discharge tee 228, 228. These supply/discharge tees 228,
228 are mounted on the evaporators 38, 38 such that the central
31 axes of their straight through legs 230, 230 are collinear with
the central axes of the respective evaporators 38, 38. The
supply ends 232, 232 of these supply/discharge tees 228, 228 are
mounted directly in the central bores 128, 128 in the evaporator
caps 136, 136. The reception ends 234, 234 of each

1 supply/discharge tee 228, 228 are blocked off 236 (except for a
hole through which one of the additional metering tubes 230, 230
passes). The bull end 238, 238 of each supply/discharge tee 228,
228 has an opening 240 to the atmosphere. With this
configuration, the supply ends 224, 224 of each of the additional
6 metering input tubes 220, 220 enter the reception ends 234, 234
of the straight through legs 230, 230 of the supply/discharge
tees 228, 228, pass through the straight through legs 230, 230,
and exit the supply ends 232, 232 of the straight through legs
230, 230 of the supply/discharge tees 228, 228 on their way into
11 the cartridge evaporators 38, 38. (Preferably, as noted above,
these additional metering input tubes 220, 220 extend into each
evaporator 38, 38 a distance which is three quarters of the
length of each cartridge evaporator 38, 38.) In this preferred
configuration, the return 242 from the cartridge evaporators 38,
16 38 is directly into the supply ends 232, 232 of the
supply/discharge tees 228, 228. Since the reception ends are
blocked off 234, 234 (except for the additional metering tubes
132, 132 which pass through those blockages 236, 236),
expendable refrigerant passing into the supply ends 232, 232 of
21 these supply/discharge tees 228, 228 is shunted out the bull
ends 238, 238 (which function as a discharge vent) of the
supply/discharge tees 228, 228, and thus is discharged into the
atmosphere.

26 As shown in Figure 15, refrigerant enters the evaporators
38, 38 through a metering device such as capillary tube 220, or
a thermostatic expansion valve (not shown), or an automatic
expansion valve (not shown), or a fixed orifice (not shown). The
pressure within the evaporator chamber 126 is much lower than
31 the liquid entering. As the liquid enters the chamber 126, it
expands 246 into a saturated vapor, reducing its pressure and
temperature. Because higher temperature travels to cooler
temperature, this evaporation 246 results in the removal of heat
from evaporator 38, 38. Then the used refrigerant is shunted out

1 the bull ends 238, 238 of the supply/discharge tees 228, 228,
and thus is discharged into the atmosphere.(Fig. 15).

6 As in Figures 3 and 4, when the evaporators 38, 38 are
positioned within the central evaporator receiving ports 36, 36
of the adapter bodies 30, 78 of multi cavity adapter 20, the
heat will flow from the adapter bodies 30, 78, and when the
adapter bodies 30, 78 of the multi cavity adapter 20 are
cradling a pipe 22, heat is removed from the pipe 22. For best
thermal transfer, water, or any heat transfer media, may be
11 sprayed on the pipe section 22 to be frozen and the selected
pipe receiving surfaces of the adapter bodies 30, 78, and also
in the evaporator receiving ports 36, 36 of the adapter bodies
30, 78 before placing the cartridge evaporators 38, 38 therein.

16 It is preferred that the inside diameter of the capillary
tubes used for the various metering tubes would compliment the
evaporator by optimizing the freeze time versus refrigerant use.
By properly metering the refrigerant through a fixed orifice,
refrigerant usage can be minimized.

21 Fig. 17 shows a space in which the invention may be used.
Limited access space 174 is available around pipe 22. Water is
sprayed onto pipe 22 for good thermal contact. As in Figures 18
and 19, the pipe receiving surfaces 42-48 of each adapter body
26 30, 78 that best fit the pipe 22 to be frozen are selected, and
the adapter bodies 30, 78 are oriented so that they encompass
the pipe 22 to be frozen with the selected pipe receiving
surfaces of the adapter bodies 30, 78 contacting the pipe 22.
The water which was sprayed on the pipe section 22 and the
31 selected pipe receiving surfaces acts as a thermal transfer
medium.

As shown in Figures 18 and 19, the right angle elbow 176 in
additional protective hose 226, 226 which surrounds the

1 additional metering input tubes 220, 220 allows the unit to fit
into the tight space without bending the additional protective
hose 226, 226, thereby reducing wear-and-tear on the protective
hose 226, 226 and the additional metering input tubes 220, 220
which are encircled by that protective hose 226, 226.

6 Below is an overview of the steps for freezing the contents
of a pipe using a pipe freezing system which has a refrigeration
system having a compressor, a condenser, a cartridge evaporator,
and a multi-cavity adapter having a single adapter body which
has a plurality of concave pipe receiving surfaces on its
11 adapter body:

- (a) based on the diameter of the section of pipe to be frozen,
select the proper concave pipe receiving surface of the
adapter body.
- (b) align and secure the adapter to the pipe such that the
16 proper concave surface engages the pipe.
- (c) insert a cartridge evaporator in the evaporator receiving
port of the adapter body of the multi cavity adapter.
- (d) circulate a refrigerant through the refrigeration system
thereby reducing the temperature of the evaporator and the
21 adapter within which it is inserted. As a result, the
temperature of the pipe is reduced which causes the
contents of the pipe to freeze.

Following is a more detailed view of the steps of
26 Applicant's preferred method for mounting a single multi-cavity
adapter on the section of pipe to be frozen and installing a
cartridge evaporator into the evaporator cartridge receiving
bore of the multi-cavity adapter:

- (a) wet the outer surface of the section of pipe to be frozen.
- 31 (b) select the pipe receiving surface of the adapter which has
a diameter equal to the outside diameter of the pipe to be
frozen.
- (c) wet the pipe-receiving surface.
- (d) hold the elongated cylindrically shaped piece of thermally

- 1 conductive material against the pipe to be frozen such that
the pipe rests in the pipe receiving surface.
- (e) strap the adapter to the pipe with an adjustable strap, and
tighten the adjustable strap.
- (f) wet the evaporator receiving surface of the bore of the
6 adapter.
- (g) insert a cartridge evaporator into the cartridge receiving
bore of the adapter.

- 11 Following is an overview of the steps for freezing the
contents of a pipe using a pipe freezing system which has a
refrigeration system having a compressor, a condenser, two
cartridge evaporators, and two multi-cavity adapters, the
adapter bodies of each of which have a plurality of concave pipe
receiving surfaces on their adapter body:
- 16 (a) based on the diameter of the section of pipe to be frozen,
select the proper concave pipe receiving surfaces of the
adapter bodies.
- (b) align and secure each adapter to the pipe such that the
proper concave surface of each adapter engages the pipe and
21 the concave pipe receiving surface of each adapter is
aligned with and facing the concave pipe receiving surface
of the other adapter.
- (c) insert a cartridge evaporator in the evaporator receiving
port of the adapter body of the multi cavity adapter.
- 26 (d) circulate a refrigerant through the refrigeration system
thereby reducing the temperature of the evaporator and the
adapter within which it is inserted. As a result, the
temperature of the pipe is reduced which causes the
contents of the pipe to freeze.

- 31 Following is a more detailed view of the steps of
Applicant's preferred method for mounting two multi-cavity
adapters on the section of pipe to be frozen and installing the
cartridge evaporators into each multi-cavity adapter:

- 1 (a) position the primary and secondary adapter bodies such that the pipe receiving surface of the first adapter body which has a diameter equal to the outside diameter of the pipe to be frozen is facing and aligned with the pipe receiving surface of the second adapter having that same.
- 6 (b) orient the first retainer mechanism with respect to a first side of the section of pipe to be frozen such that the central axes of the pin bodies of the first retainer mechanism are substantially parallel to the central axis of the section of pipe to be frozen.
- 11 (c) turn the offset golf club-like heads of the first retainer mechanism such that the offset golf club-like heads are oriented away from the section of pipe.
- 16 (d) simultaneously insert the second ends of the first and second locking pins of the first retainer mechanism into corresponding locking channels of the primary and secondary adapter bodies, thus forming a hinge. Now the primary and secondary adapter bodies are swivelable with respect to each other.
- 21 (e) secure the ends of the first and second locking pins of the first retainer mechanism with nuts.
- (f) swivel the primary and secondary adapter bodies outward with respect to each other.
- (g) wet the outer surface of the section of pipe to be frozen.
- 26 (h) wet those pipe-receiving surfaces of the multi-cavity adapter which are to receive the section of pipe to be frozen.
- (i) drape the hinged primary and secondary adapter bodies around the pipe to be frozen.
- 31 (j) swivel the primary and secondary adapter bodies toward each other.
- (k) orient the second retainer mechanism with respect to the side opposite the first side of the section of pipe to be frozen such that the central axes of the pin bodies of the second retainer mechanism are substantially parallel to the

- 1 central axis of the section of pipe to be frozen.
- (l) turn the offset golf club-like heads of the second retainer mechanism such that the offset golf club-like heads are oriented away from the section of pipe to be frozen.
- (m) simultaneously insert the second ends of the first and
6 second locking pins of a second retainer mechanism into corresponding locking channels of the primary and secondary adapter bodies, thus securing the section of pipe to be frozen.
- (n) wet the evaporator receiving surface of the bore of the
11 adapter.
- (o) insert cartridge evaporators into the evaporator receiving ports of each of the adapter bodies.

5.3 Advantages of the Invention

16 The previously described multi cavity adapter has many advantages, including:

- (a) Rather than have many individual adapters (Eight for a four
21 cavity adapter), only two are required.
- (b) The evaporator can swivel within the adapter body of a multi cavity adapter reducing stress on the protective hose and the input metering tube contained therein.
- (c) Angle adapters are not required, because the evaporator is
26 angled at 90 degrees from the hoses.
- (d) The adapters can be exchanged for different sizes to go from metric to US standard sizes.
- (e) If any pipe receiving surface is damaged, the adapter body can be replaced without entering the sealed system.
- 31 (f) The evaporator is protected by the adapter body of the Multi-Cavity Adapter.

The chance of refrigerant leakage is reduced, because the number of welded areas are reduced, and, when ported within the

- 1 adapter, evaporator damage due to rough handling is less likely, because the evaporator is sheltered by the adapter body of the multi cavity adapter.

1	5.5	<u>LIST OF REFERENCE NUMBERS</u>
	20	multi cavity adapter
	22	liquid filled pipe
6	24	liquid contents of pipe
	26	ice blockage in pipe
11	28	cut in pipe
	30	elongated piece of thermally conductive material (primary adapter body)
16	31	second primary adapter in row in Figure 7
	32	first end face of adapter body
	34	second end face of adapter body
21	36	bore for reception of a cartridge evaporator
	38	cartridge evaporator
26	39	outer surface of cartridge evaporator
	40	outer surface of adapter body
	42	pipe receiving surface #1 (for pipes with an outside diameter of 1.651 cm (0.65 in))
31	44	pipe receiving surface #2 (for pipes with an outside diameter of 2.286 cm (0.90 in))

- 1 46 pipe receiving surface #3 (for pipes with an outside
 diameter of 2.921 cm (1.15 in))
- 48 pipe receiving surface #4 (for pipes with an outside
 diameter of 4.191 cm (1.65 in))
- 6 50 first corner edge of pipe receiving surface #1
- 52 second corner edge of pipe receiving surface #1
- 11 54 first corner edge of pipe receiving surface #2
- 56 second corner edge of pipe receiving surface #2
- 58 first corner edge of pipe receiving surface #3
- 16 60 second corner edge of pipe receiving surface #3
- 62 first corner edge of pipe receiving surface #4
- 21 64 second corner edge of pipe receiving surface #4
- 66 a corner point of the first end face
- 68 a corner point of the second end face
- 26 70 bushing adapter
- 72 outer surface of bushing adapter
- 31 74 inner surface of bushing adapter
- 78 second elongated piece of thermally conductive
 material (secondary adapter body)

1 80 row of two primary adapters 30, 31

 82 row after primary adapter 31 is rotated by 180
 degrees

6 84 row after primary adapter 31 is turned upside down

 86 locking channel

 88 channel opening in first end face

11 89 channel opening in second end face

 90 first retainer mechanism

16 92 second retainer mechanism

 94 first prong

 96 second prong

21 98 end of prong

 100 nut

26 102 first locking pin

 104 second locking pin

 106 first end of retainer mechanism

31 108 golf club-like head with a nonthreaded hole

 110 golf club-like head with a threaded hole

- 1 112 nonthreaded hole
- 114 threaded hole
- 116 straight pin
- 6 118 spring under tension
- 120 threaded second end of locking pin
- 11 122 first end of straight pin with an Allen head
- 124 strap with hook and loop material at the ends thereof
- 126 inner chamber of cartridge evaporator
- 16 128 bore of cartridge evaporator
- 130 first end surface of cartridge evaporator
- 21 132 metering input tube
- 134 return tube
- 136 evaporator cap
- 26 138 first end of cartridge evaporator
- 140 side wall of evaporator cap
- 31 142 an evaporator cap turned upside down to show details
- 144 first end of evaporator cap
- 146 second end of evaporator cap

- 1 148 bore in second end of evaporator cap
- 150 face of second end of evaporator cap
- 152 second end of evaporator
- 6 154 complete pipe freezing system using nonexpendable refrigerants
- 156 refrigeration unit
- 11 158 compressor
- 160 condenser
- 16 162 discharge vent
- 164 first end of metering input tube
- 166 second end of metering input tube
- 21 168 return from the cartridge evaporator
- 170 expansion of liquid entering the evaporator chamber
- 26 172 supply end of metering input tube
- 174 limited access space
- 176 right angle elbow in return tube surrounding metering
- 31 input tube
- 200 pipe freezing system utilizing expendable refrigerants
- 202 tank containing expendable refrigerant

- 1 204 first end of metering input tube
- 206 second end of metering input tube
- 208 discharge tube or vent
- 6 210 safe discharge area
- 212 protective hose or tube
- 11 214 input tee
- 216 input port of tee
- 218 output port of tee
- 16 220 additional metering input tube
- 222 reception end of additional metering input tube
- 21 224 supply end of additional metering input tube
- 226 additional protective tube
- 228 supply/discharge tee
- 26 230 straight through leg of supply/discharge tee
- 232 supply end of straight through leg of
 supply/discharge tee
- 31 234 reception end of supply/discharge tee
- 236 blocked off portion of supply/discharge tee

- 1 238 bull end of supply/discharge tee
- 240 opening in bull end of supply/discharge tee
- 242 return from the cartridge evaporator
- 6 246 expansion of liquid entering the evaporator chamber

1 It will be understood that each of the elements described
above, or two or more together may also find a useful application
in other types of devices and methods differing from those types
described above.

6 5.6 Alternatives and the Closing

 Thus the reader will see that my multi cavity adapter
supplies a long felt need for a simple, economical, easy to use
means for freezing a plug of ice in a section of pipe. If one
11 should aver that my multi cavity adapter is obvious, then one is
hard put to explain why users of pipe freezers continue to use
pipe freezing methods without the advantages of Applicant's
invention.

16 Although the present invention has been described in
considerable detail with reference to certain preferred versions
thereof, other versions are possible which will be apparent to
those who are skilled in the art. While certain novel features
of this invention have been shown and described and are pointed
21 out in the annexed claims, it is not intended to be limited to
the details above, since it will be understood that various
omissions, modifications, substitutions and changes in the forms
and details of the device illustrated and in its operation can be
made by those skilled in the art without departing in any way
26 from the spirit of the present invention. Therefore, the spirit
and scope of the appended claims should not be limited to the
description of the preferred versions contained herein, but by
the appended claims and their legal equivalents.

1 CLAIMS: What is claimed is:

1. A multi-cavity adapter for a pipe freezer, said adapter comprising an adapter body, said adapter body being an elongated piece of thermally conductive material having a predetermined length, said adapter body comprising:
- 6 (a) a first end face;
 - (b) a second face;
 - 11 (c) a bore passing through said adapter body, said bore serving as a cartridge evaporator receiving port for the reception of a cartridge evaporator therein, said bore having a predetermined diameter, said bore having an inner surface, said bore extending from the first end face to the second end face of said adapter body;
 - 16 (d) an outer surface having a plurality of concave pipe receiving surfaces, each concave pipe receiving surface having a specific distinct radius of curvature, whereby pipes with different outside diameters can be accommodated, the intersection of each said pipe receiving surface and said outer surface defining a first corner edge and a second corner edge of each
 - 21 said pipe receiving surface, the intersection of each corner edge with said first end face defining a corner point of said first end face, the intersection of each corner edge with said second end face defining a
 - 26 corner point of said second end face; and
 - (e) a first locking channel and a second locking channel situated near the corner points of each pipe receiving surface, said locking channels passing through said adapter body, said locking channels extending from the
 - 31 first end face to the second end face of said adapter body, said first locking channel having a first channel opening in the first end face and a second channel opening in the second end face, said second locking channel having a first channel opening in the
 - 36 first end face and a second channel opening in the second end face.

- 1 2. The multi-cavity adapter of claim 1, wherein the concave
pipe-receiving surfaces have arcs of approximately 180°.
- 6 3. The multi-cavity adapter of claim 2, further comprising a
bushing adapter having an outer surface and an inner
surface, the outer surface being convex and complimentary
to one of the concave pipe receiving surfaces of the
adapter and the inner surface being concave and having a
specific distinct radius different from those of the
adapter and adapted to receive a pipe.
- 11 4. The multi-cavity adapter of claim 1, further comprising a
fastening mechanism for securing the adapter to the pipe.
- 16 5. The multi-cavity adapter of claim 1, wherein the bore is a
central bore.
- 21 6. The multi-cavity adapter of claim 4, further comprising a
second adapter body, which is substantially a mirror image
of the first adapter body, whereby when a hollow concavity
of the first adapter body is aligned, caused to face, and
brought into contact with the hollow concavity of the
second adapter body which has the same radius of curvature
as the aligned hollow concavity of the first adapter body,
a cylindrical channel is formed for the reception of a pipe
to be frozen.
- 26 7. The multi-cavity adapter of claim 6, wherein said fastening
mechanism comprises:
(a) a first retainer mechanism having a first prong and a
31 second prong, said first prong being adapted to be
received into a channel opening of the first adapter
body, and said second prong being adapted to be
received into a channel opening of the second adapter
body, so that when the first and second adapter bodies
36 are aligned such that a pipe receiving surface of the
first adapter body is facing the pipe receiving

1 surface of the second adapter body which has the same
radius of curvature as the pipe receiving surface of
the first adapter body, the first and second adapter
bodies can be hingedly fastened together by the first
retainer mechanism, such that the first and second
6 adapter bodies can be draped around the section of
pipe which is to be frozen; and
(b) a second retainer mechanism having a first prong and a
second prong, said first prong being adapted to be
received into a channel opening of the first adapter
11 body, and said second prong being adapted to be
received into a channel opening of the second adapter
body, so that the first and second adapter bodies can
be fastened together, such that the first and second
adapter bodies can tightly encompass and secure the
16 section of pipe which is to be frozen.

8. The multi-cavity adapter of claim 7, wherein:

- (a) said prongs of said retainer mechanisms are threaded
at the ends thereof; and
21 (b) said first retainer mechanism further comprises nuts
for threading onto the ends of said threaded prongs
for securing the first retainer mechanism in the
locking channels.

26 9. The multi-cavity adapter of claim 6, wherein said fastening
mechanism comprises:

- (a) a first retainer mechanism comprising:
(i) a first locking pin having a first end and a second
end, said first end having an offset golf club-like
31 head having a nonthreaded hole of first
predetermined diameter therein, said second end
being threaded;
(ii) a second locking pin having a first end and a second
end, said first end having an offset golf club-like
36 head having a threaded hole of second predetermined
diameter therein, said second predetermined diameter

- 1 being smaller than said first predetermined
diameter, said second end of said second locking pin
being threaded;
- 6 (iii) a straight pin of said second predetermined
diameter, said straight pin having a first end with
an Allen head with a diameter larger than said first
predetermined diameter, and a second end which is
threaded, said straight pin being adapted to be
11 inserted into the nonthreaded hole of the offset
golf club like head of first locking pin, pushed
through that hole until it engages the threaded hole
of said offset golf club like head of said second
locking pin, and screwed into said threaded hole of
said second locking pin; and
- 16 (iv) nuts for the second end of each locking pin for
securing the first retainer mechanism in the locking
channels,
- 21 wherein said first locking pin is adapted to be received
into a channel opening of the first adapter body, and
said second locking pin is adapted to be received into a
channel opening of the second adapter body, so that when
the first and second adapter bodies are aligned such that
a pipe receiving surface of the first adapter body is
facing the pipe receiving surface of the second adapter
26 body which has the same radius of curvature as the pipe
receiving surface of the first adapter body, the first
and second adapter bodies can be hingedly fastened
together by the first retainer mechanism, such that the
first and second adapter bodies can be draped around the
section of pipe which is to be frozen;
- 31 (b) a second retainer mechanism comprising:
- 36 (i) a first locking pin having a first end and a second
end, said first end having an offset golf club like
head having a nonthreaded hole of said first
predetermined diameter therein;
- (ii) a second locking pin having a first end and a second
end, said first end having an offset golf club like

1 head having a threaded hole of said second
predetermined diameter therein, said second
predetermined diameter being smaller than said first
predetermined diameter; and
(iii) a straight pin of said second predetermined
6 diameter, said straight pin having a first end with
an Allen head with a diameter larger than said first
pre-determined diameter, and a second end which is
threaded, said straight pin being adapted to be
11 inserted into the nonthreaded hole of the offset
golf club like head of first locking pin, pushed
through that hole until it engages the threaded hole
of said golf club like head of said second locking
pin, and screwed into said threaded hole of said
second locking pin;

16 wherein said first locking pin is adapted to be received
into a channel opening of the first adapter body, and
said second locking pin is adapted to be received into a
channel opening of the second adapter body, so that the
first and second adapter bodies can be fastened together,
21 such that the first and second adapter bodies can tightly
encompass and secure the section of pipe which is to be
frozen.

26 10. The multi-cavity adapter of claim 9, wherein a spring under
tension is mounted on the straight pin of each retainer
mechanism, said spring serving to push apart and hold the
first and second locking pins in substantially parallel
alignment to one another, whereby said pins can be inserted
simultaneously into said locking channels.

31 11. An apparatus for freezing the contents of a section of pipe
using a refrigerant, the apparatus comprising:

(a) a refrigeration unit comprising:

(i) a compressor for compressing the refrigerant from
36 a low pressure to a high pressure;

(ii) a condenser downstream of the compressor for

- 1 condensing the refrigerant from a high
 temperature gas to a lower temperature liquid;
- (b) the multi-cavity adapter of claim 7, draped around the
 section of pipe which is to be frozen.
- (c) a cartridge evaporator having a predetermined length
6 and a predetermined outside diameter, said evaporator
 comprising:
- (i) an outer surface, a first end having a surface,
 and a second end having a surface;
- (ii) an inner chamber;
- 11 (iii) a bore extending from the first end surface to
 the inner chamber;
- (iv) a metering tube extending into the bore and
 protruding into the inner chamber of the
 evaporator for moving a refrigerant into the
16 inner chamber of the evaporator at a
 predetermined rate; and
- (v) a return tube extending out of the bore for
 moving evaporated refrigerant out of the inner
 chamber of the evaporator;
- 21 said cartridge evaporator being inserted into a
 cartridge receiving port of said multi-cavity adapter,
 and wherein:
- (i) the metering tube extends between the con-denser
 of the refrigeration unit and the evaporator for
 moving the refrigerant to the evaporator; and
- 26 (ii) the return tube extends between the evaporator
 and the compressor of the refrigeration unit for
 moving refrigerant from the evaporator to the
 compressor.
- 31
12. The apparatus of claim 11 wherein the first end surface of
 the cartridge evaporator comprises a cap which is fitted
 over the first end of the cartridge evaporator, said cap
 having a side wall which extends along the outer surface of
36 the evaporator for at least a portion of the length of the
 outer surface, said cap having a first end which is closed,

1 and a second end having a face with a sufficiently large
bore therein for the second end to fit over the first end
of the evaporator, said face having an outside diameter
which is greater than the diameter of the bore serving as
the cartridge evaporator receiving port, whereby when said
6 second end of said evaporator is inserted into the bore at
one end of said adapter and pushed along said bore, said
face of said cap eventually comes to rest against the end
face of that adapter.

11 13. The apparatus of claim 11, wherein said metering tube
extends into the evaporator, a distance which is three
quarters of the length of the evaporator.

16 14. An apparatus for freezing the contents of a section of pipe
using an expendable refrigerant, the apparatus comprising:

- 21 (a) a tank having an adequate amount of liquid refrigerant
to freeze the contents of the section of pipe;
- (b) the multi-cavity adapter of claim 7, draped around the
section of pipe which is to be frozen;
- 26 (c) a cartridge evaporator having a predetermined length
and a predetermined outside diameter, said evaporator
comprising:
- (i) an outer surface, a first end having a surface,
and a second end having a surface;
- (ii) an inner chamber;
- (iii) a bore extending from the first end surface to
the inner chamber;
- (iv) a metering tube extending into the bore and
protruding into the inner chamber of the
31 evaporator for moving a refrigerant into the
inner chamber of the evaporator at a
predetermined rate; and
- (v) a return tube extending out of the bore for
moving evaporated refrigerant out of the inner
36 chamber of the evaporator; and
- (vi) an original protective tube encircling the

- 1 metering tube for at least a portion of the
length of the metering tube;
said cartridge evaporator being inserted into a
cartridge receiving port of said multi-cavity adapter,
and wherein
- 6 (i) the metering tube has a first end and a second
end, and said metering tube extends between the
tank and the evaporator for receiving refrigerant
at its first end from the tank and for moving the
refrigerant out of its second end into the
11 evaporator at a predetermined rate; and
(ii) the return tube is a discharge vent and
evaporated refrigerant is expelled to the
atmosphere through said discharge vent.
- 16 15. The apparatus of claim 14 wherein the first end surface of
the cartridge evaporator comprises a cap which is fitted
over the first end of the cartridge evaporator, said cap
having a side wall which extends along the outer surface of
the evaporator for at least a portion of the length of the
21 outer surface, said cap having a first end which is closed,
and a second end having a face with a sufficiently large
bore therein for the second end to fit over the first end
of the evaporator, said face having an outside diameter
which is greater than the diameter of the bore serving as
26 the cartridge evaporator receiving port, whereby when said
second end of said evaporator is inserted into the bore at
one end of said adapter and pushed along said bore, said
face of said cap eventually comes to rest against the end
face of that adapter.
- 31 16. The apparatus of claim 14, wherein said metering tube
extends into the evaporator, a distance which is three
quarters of the length of the evaporator.
- 36 17. The apparatus of claim 14, wherein said discharge vent
extends to a safe discharge area.

- 1 18. The apparatus of claim 14, further comprising a second
cartridge evaporator, and wherein:
- 6 (a) a cartridge evaporator is inserted into each of the
two cartridge receiving ports of said multi-cavity
adapter;
- (b) the metering tube has a first end and a second end,
and said metering tube extends outward from the tank
for receiving refrigerant at its first end from the
tank and for moving the refrigerant out of its second
end at a predetermined rate; and
- 11 (c) the discharge vents extending from the bore of each
evaporator are for moving evaporated refrigerant from
the inner chamber of each evaporator to a safe
environment;
- 16 and the apparatus further comprises:
- (a) a tee situated between the second end of the metering
tube and the evaporator, said tee having an input port
and two output ports, said tee receiving refrigerant
21 from the second end of said metering tube through the
tee's input port and supplying refrigerant out of each
of its two output ports;
- (b) an additional metering tube situated between each of
the two output ports of the tee and each of the two
26 evaporators for receiving refrigerant from each of the
two output ports of the tee and supplying this
refrigerant to each of the two evaporators; and
- (c) an additional protective tube extending from the
31 second evaporator, wherein both the original
protective tube and the additional protective tube
encircle each of said two additional metering tubes
for at least a portion of the length of each
additional metering tube.
- 36 19. The apparatus of claim 11, wherein the metering tube is a
capillary tube.

- 1 20. The apparatus of claim 18, wherein the metering tube and
the two additional metering tubes are capillary tubes.
21. A method of freezing the contents of a pipe having an
outside diameter, said method comprising the following
6 steps:
- (a) providing a refrigeration system having a compressor,
a condenser, a cartridge evaporator, and the multi-
cavity adapter of claim 7;
- 11 (b) selecting the concave pipe receiving surfaces of the
first and second adapter bodies which correspond to
the outside diameter of the pipe;
- (c) aligning and securing the adapter bodies to one another
and to the pipe utilizing the first and second
16 retainer mechanisms such that the proper concave
surface of each adapter body engages the pipe and the
concave pipe receiving surface of each adapter body is
aligned with and facing the proper concave pipe
receiving surface of the other adapter body;
- (d) inserting a cartridge evaporator in the evaporator
21 receiving port of at least one of the adapters;
- (e) circulating a refrigerant through the refrigeration
system thereby reducing the temperature of the
evaporator and the adapter within which it is inserted,
which then reduces the temperature of the pipe, thus
26 causing the contents of the pipe to freeze.
22. A method of mounting the multi-cavity adapter of claim 9 on
a section of pipe to be frozen and installing the cartridge
evaporator of claim 11 into said multi-cavity adapter, said
31 method comprising the steps of:
- (a) positioning the first and second adapter bodies such
that the pipe receiving surface of the first adapter
body having a diameter equal to the outside diameter
36 of the pipe to be frozen is facing and aligned with

- 1 the pipe receiving surface of the second adapter body
having the same said diameter equal to the outside
diameter of the pipe;
- 6 (b) orienting the first retainer mechanism with respect to
a first side of the section of pipe to be frozen such
that the pin bodies of the first retainer mechanism
are substantially parallel to the section of pipe to
be frozen;
- 11 (c) turning the offset golf club-like heads of said first
retainer mechanism such that said offset golf club-like
heads are oriented away from said section of pipe;
- 16 (d) inserting the second end of the first locking pin of a
first retainer mechanism into a locking channel of the
first adapter body, and inserting the second end of
the second locking pin of a first retainer mechanism
into a locking channel of the second adapter body,
thus forming a hinge, whereby the first and second
adapter bodies are swivelable with respect to each
other;
- 21 (e) securing the ends of the first and second locking pins
of the first retainer mechanism with said nuts;
- (f) swiveling first and second adapter bodies outward with
respect to each other;
- (g) wetting the outer surface of the section of pipe to be
frozen;
- 26 (h) wetting those pipe-receiving surfaces of the adapter
bodies which surfaces are to receive the section of
pipe to be frozen;
- (i) draping the hinged first and second adapter bodies
around the pipe to be frozen;
- 31 (j) swiveling first and second adapter bodies toward each
other;
- (k) orienting the second retainer mechanism with respect
to the side opposite the first side of the section of
pipe to be frozen such that the pin bodies of the
36 second retainer mechanism are substantially parallel

- 1 to the section of pipe to be frozen;
- (l) turning the offset golf club-like heads of said second
retainer mechanism such that said offset golf club-
like heads are oriented away from said section of pipe;
- (m) inserting the second end of the first locking pin of a
6 second retainer mechanism into a locking channel of
the first adapter body, and inserting the second end
of the second locking pin of the second retainer
mechanism into a locking channel of the second adapter
body, thus securing the section of pipe to be frozen;
- 11 (n) wetting the evaporator receiving surface of the bore
of the adapter; and
- (o) inserting a cartridge evaporator into the bore for
receiving an evaporator therein.
- 16 23. A method of mounting the multi-cavity adapter of claim 7 on
a section of pipe to be frozen and installing the cartridge
evaporator of claim 11 into said multi-cavity adapter, said
method comprising the steps of:
- 21 (a) positioning the first and second adapter bodies such
that the pipe receiving surface of the first adapter
having a diameter equal to the outside diameter of the
pipe to be frozen is facing and aligned with the pipe
receiving surface of the second adapter having the
26 same said diameter equal to the outside diameter of
the pipe;
- (b) orienting the first retainer mechanism with respect to
a first side of the section of pipe to be frozen such
that the prongs of the first retainer mechanism are
31 substantially parallel to the section of pipe to be
frozen;
- (c) inserting a prong of the first retainer mechanism into
a locking channel of the first adapter body, and
inserting the other prong of the first retainer
36 mechanism into a locking channel of the second adapter

- 1 body, thus forming a hinge, whereby the first and second adapter bodies are swivelable with respect to each other;
- (d) swiveling first and second adapter bodies outward with respect to each other;
- 6 (e) wetting the outer surface of the section of pipe to be frozen;
- (f) wetting those pipe-receiving surfaces of the multi-cavity adapter which surfaces are to receive the section of pipe to be frozen;
- 11 (g) draping the hinged first and second adapter bodies around the pipe to be frozen;
- (h) swiveling first and second adapter bodies toward each other;
- (i) orienting the second retainer mechanism with respect to the side opposite the first side of the section of pipe to be frozen such that the prongs of the second retainer mechanism are substantially parallel to the section of pipe to be frozen;
- 16 (j) inserting a prong of the second retainer mechanism into a locking channel of the first adapter body, and inserting the other prong of the second retainer mechanism into a locking channel of the second adapter body, thus securing the section of pipe to be frozen;
- 21 (k) wetting the evaporator receiving surface of the bore of the adapter; and
- 26 (l) inserting a cartridge evaporator into the bore for receiving an evaporator therein.
- 31

Fig. 1

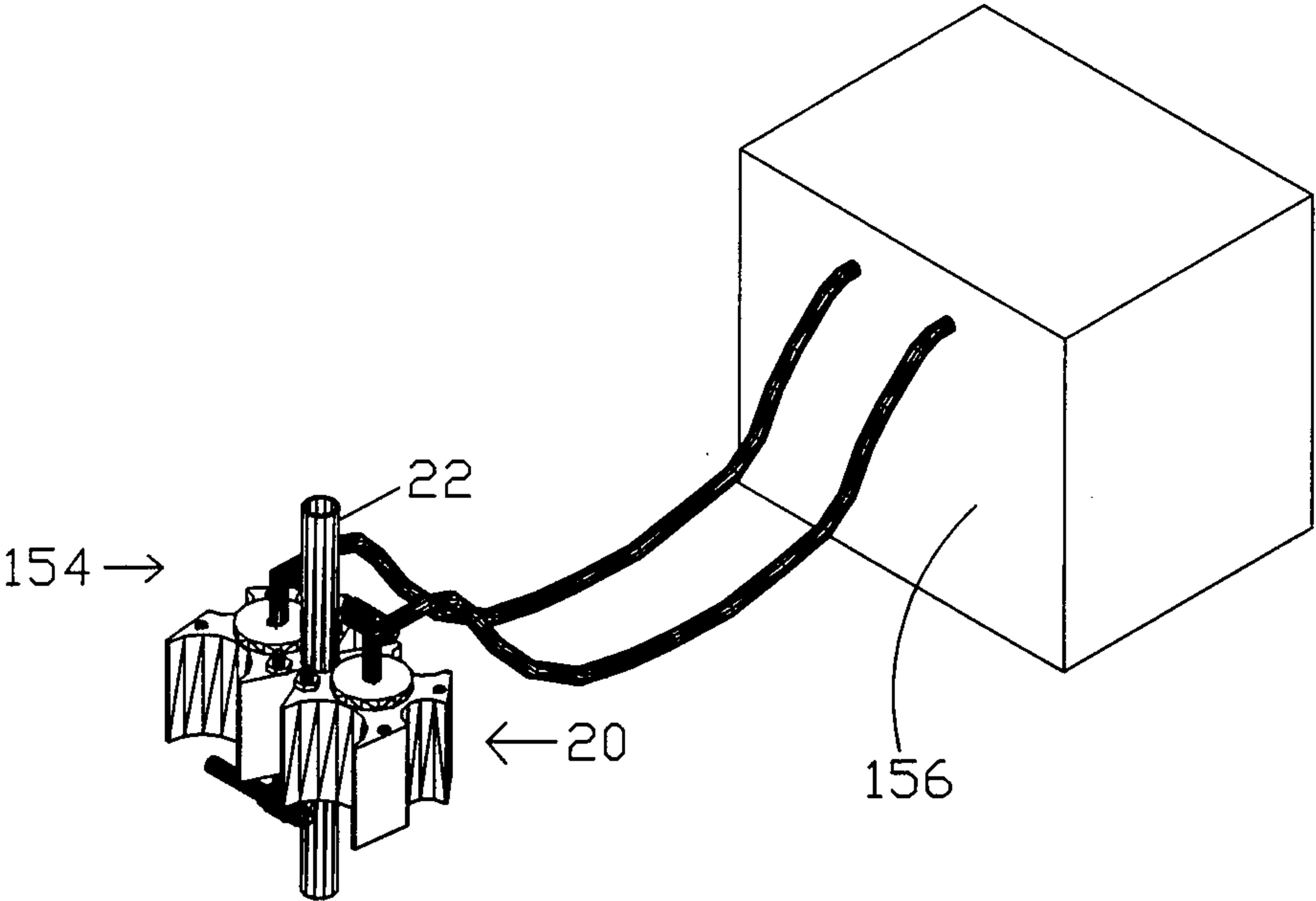


Fig. 2

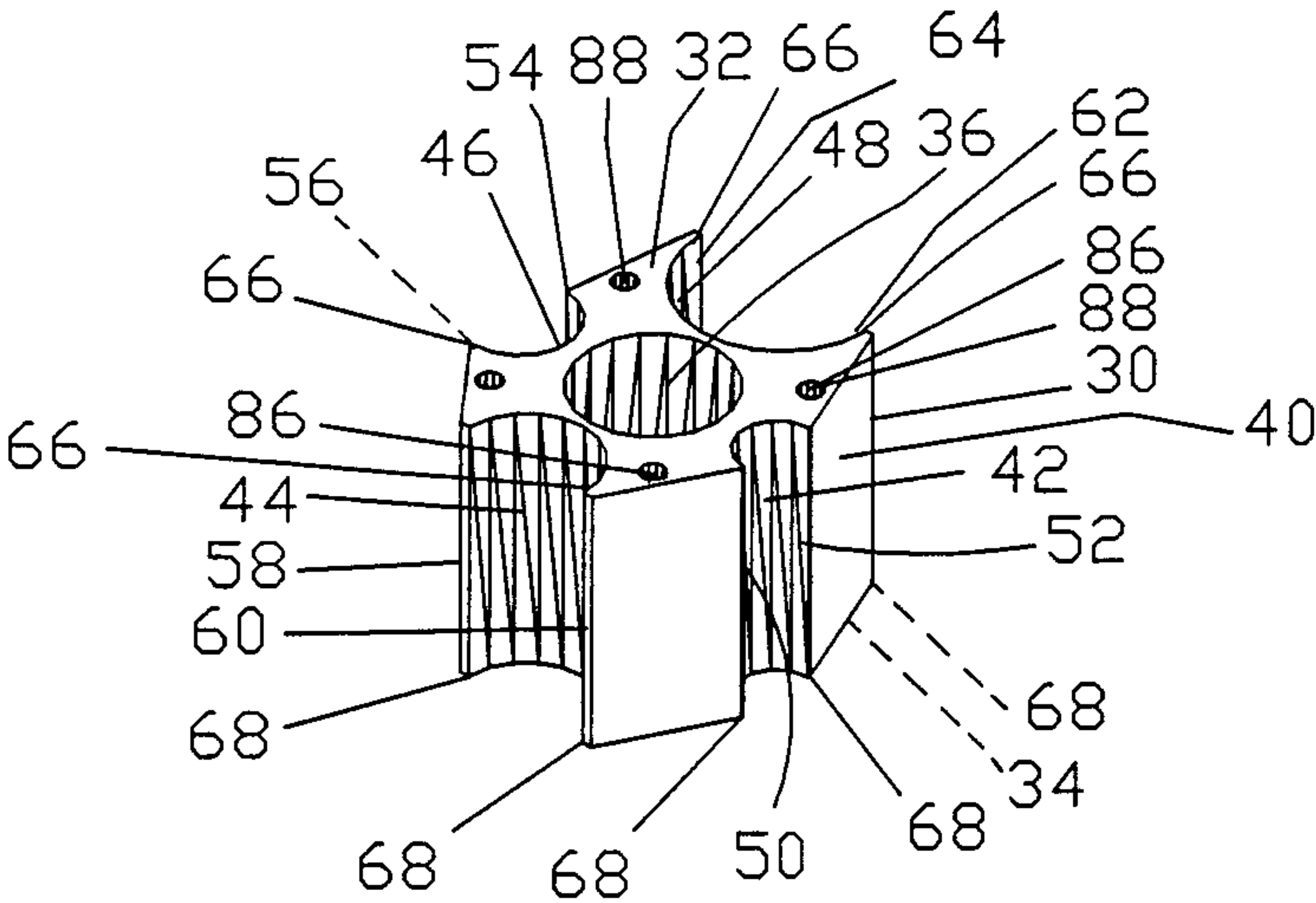


Fig. 3

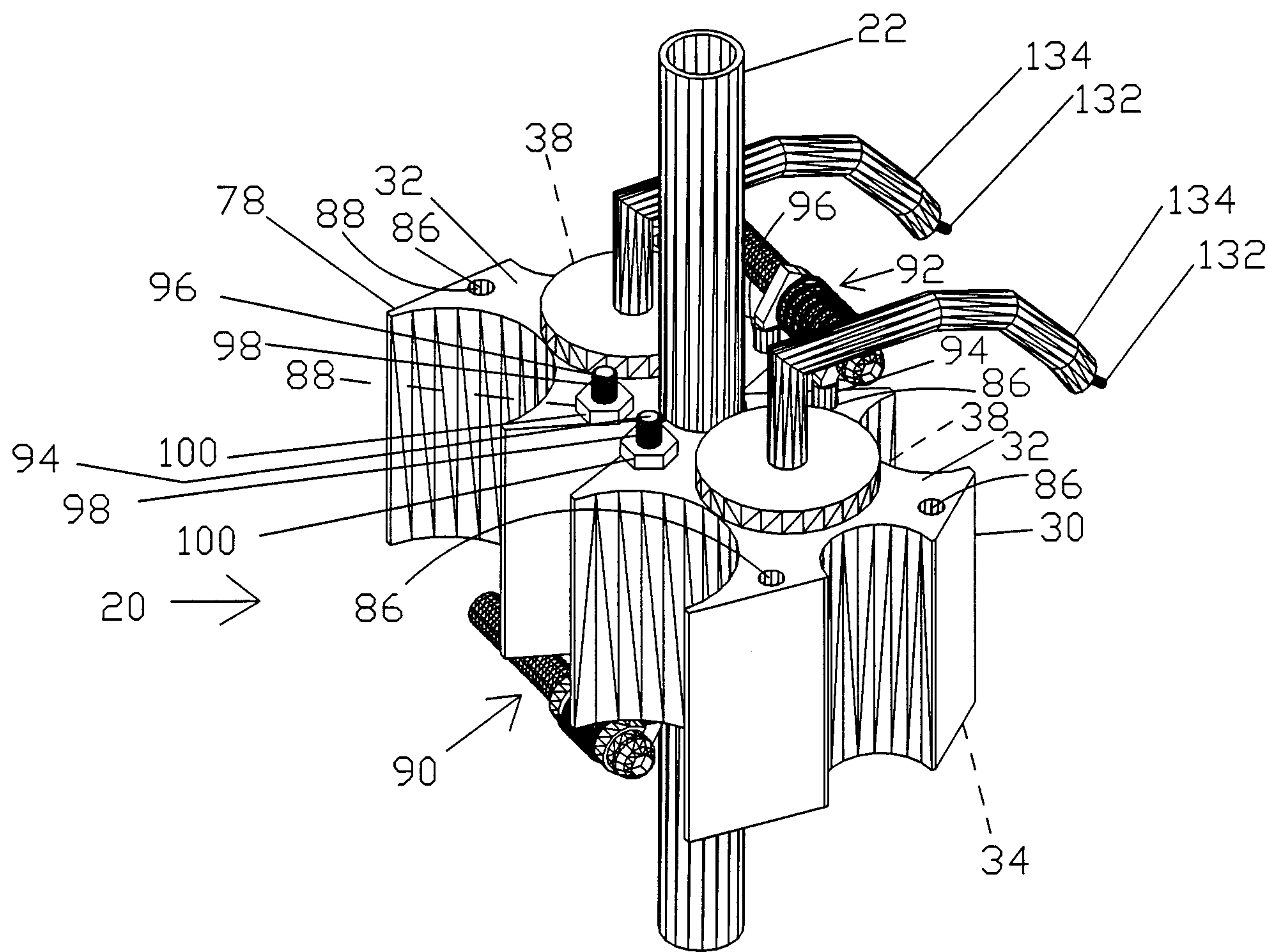


Fig. 4

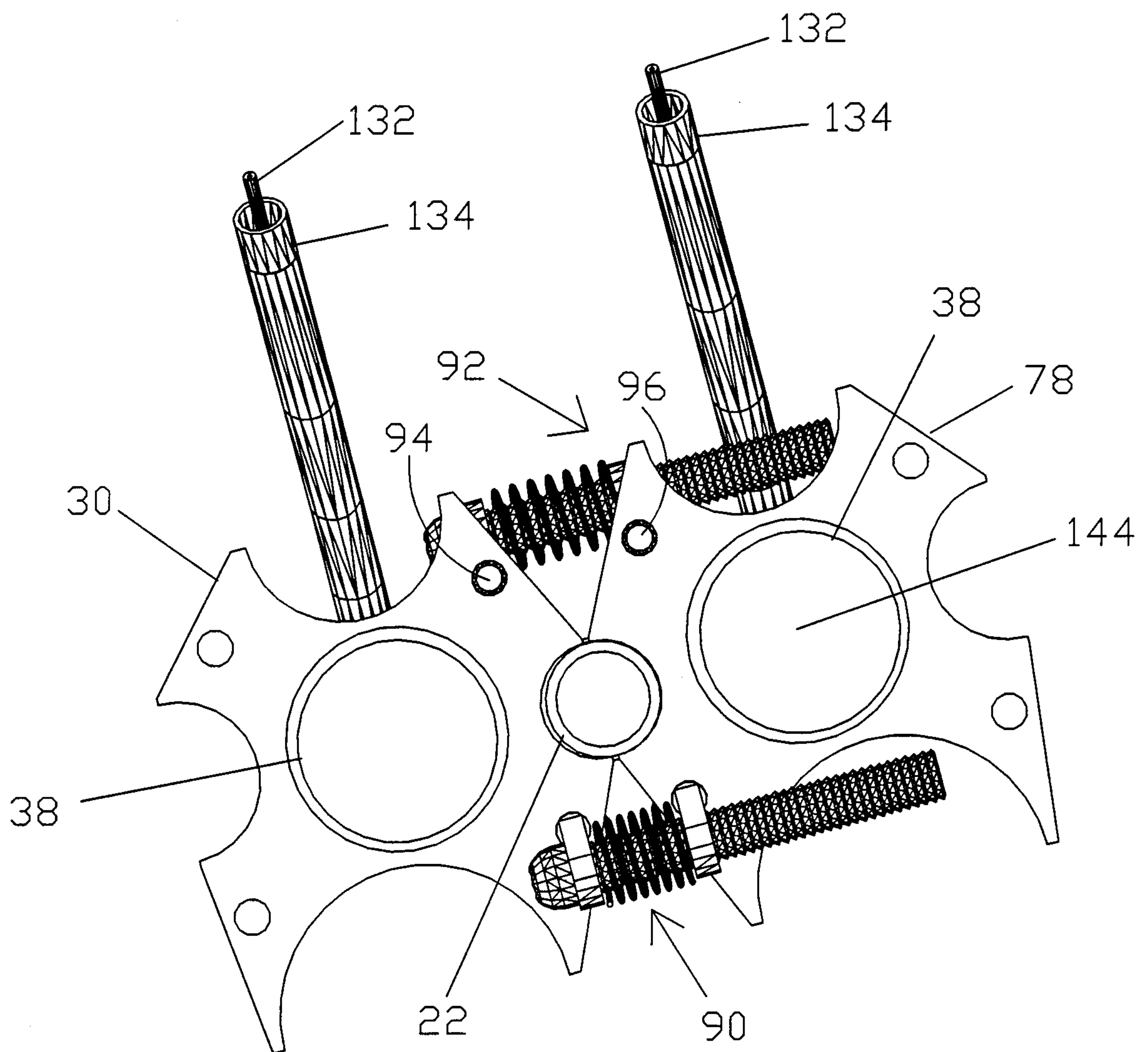


Fig. 5A

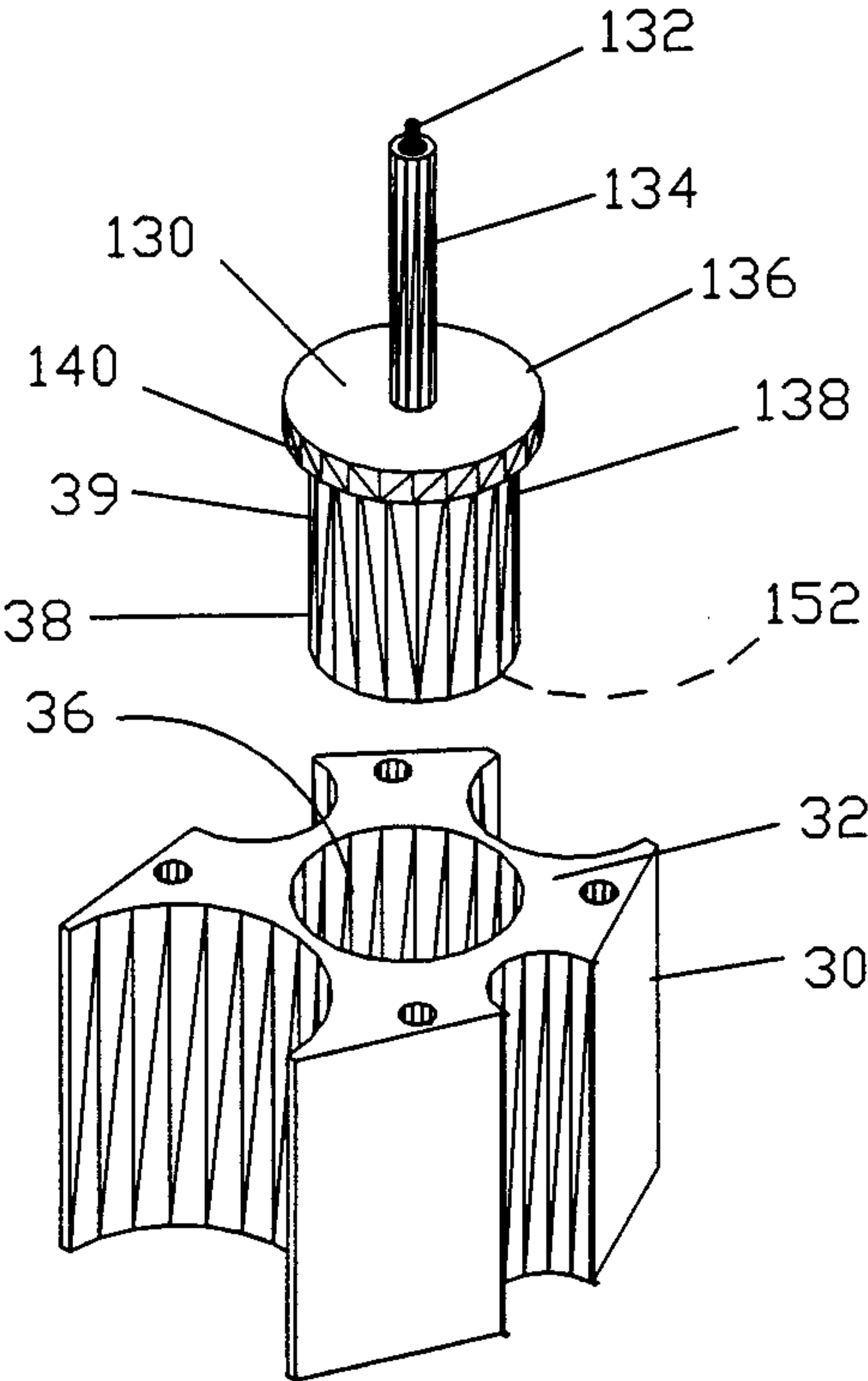


Fig. 5B

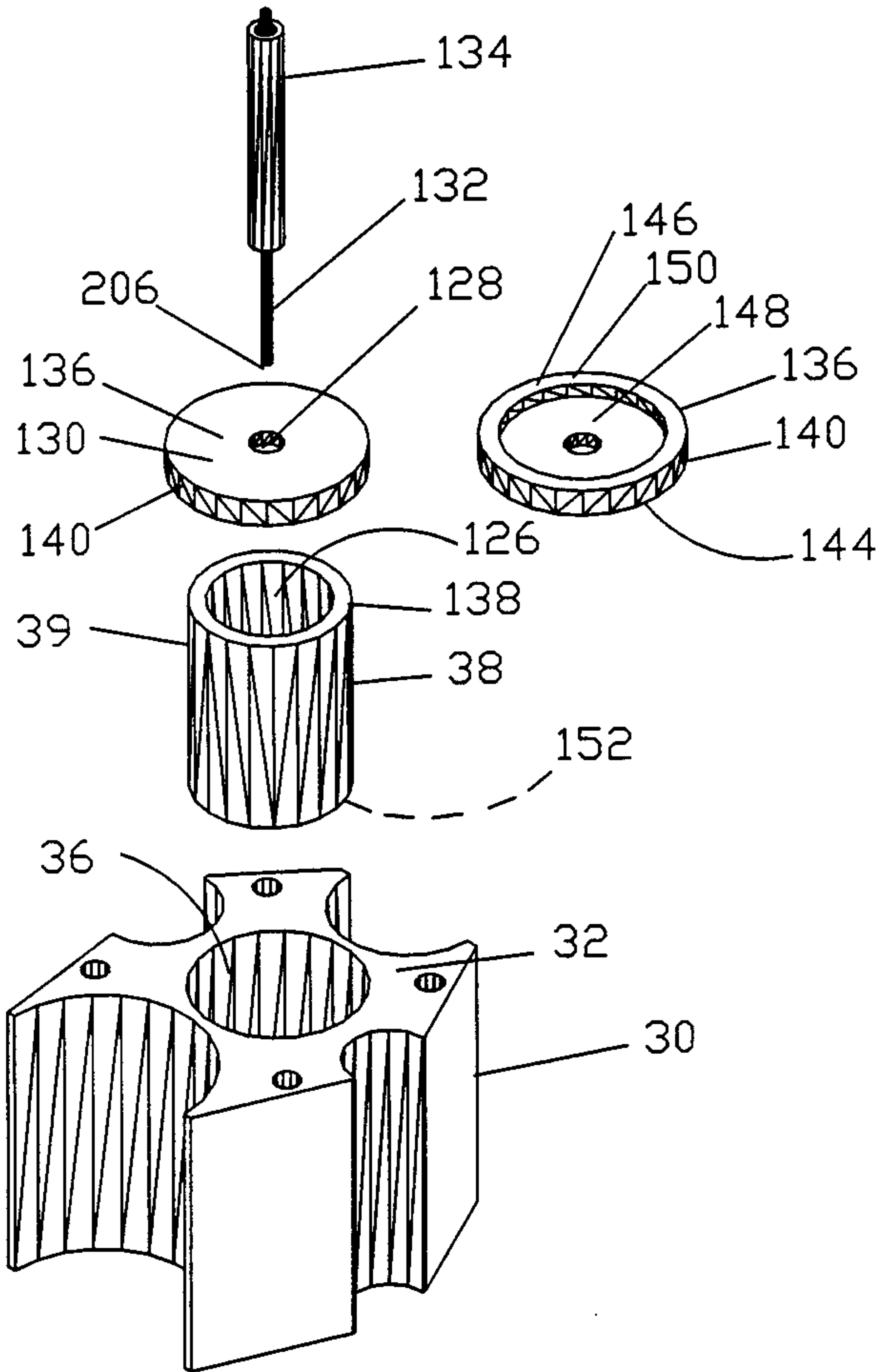


FIG. 6

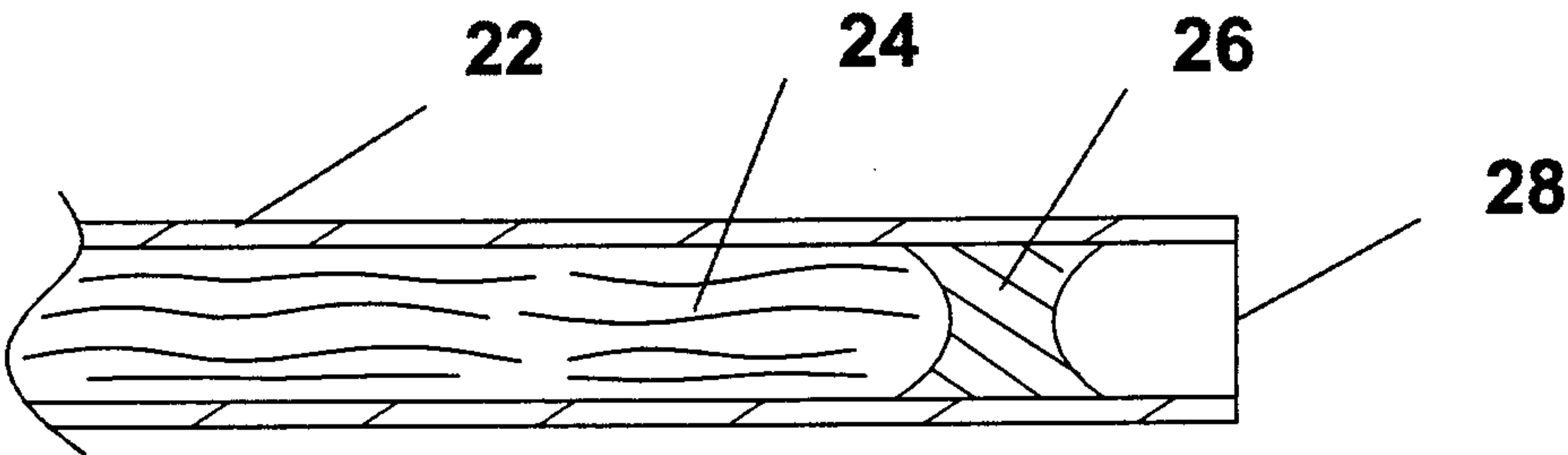


FIG. 7

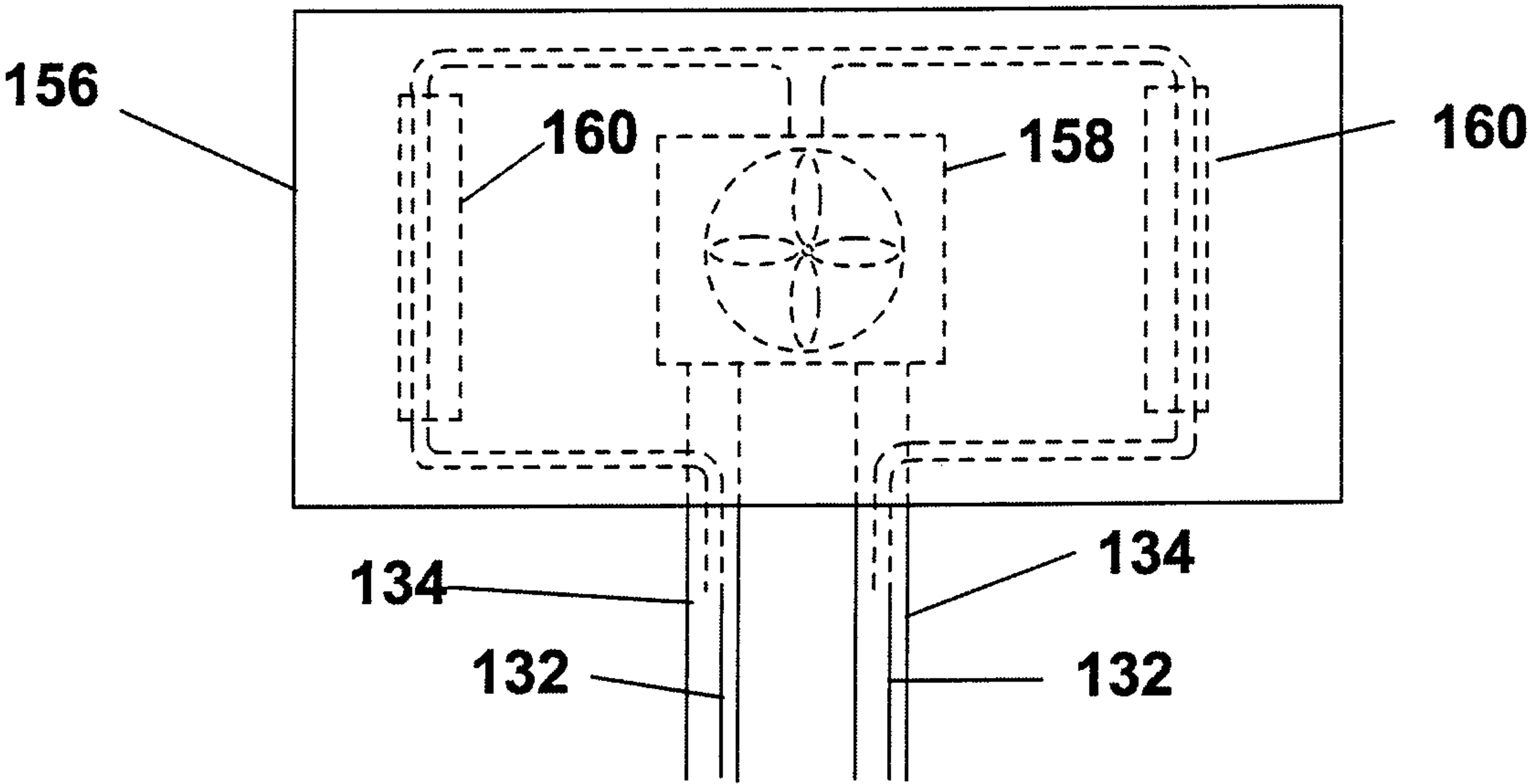


Fig. 8

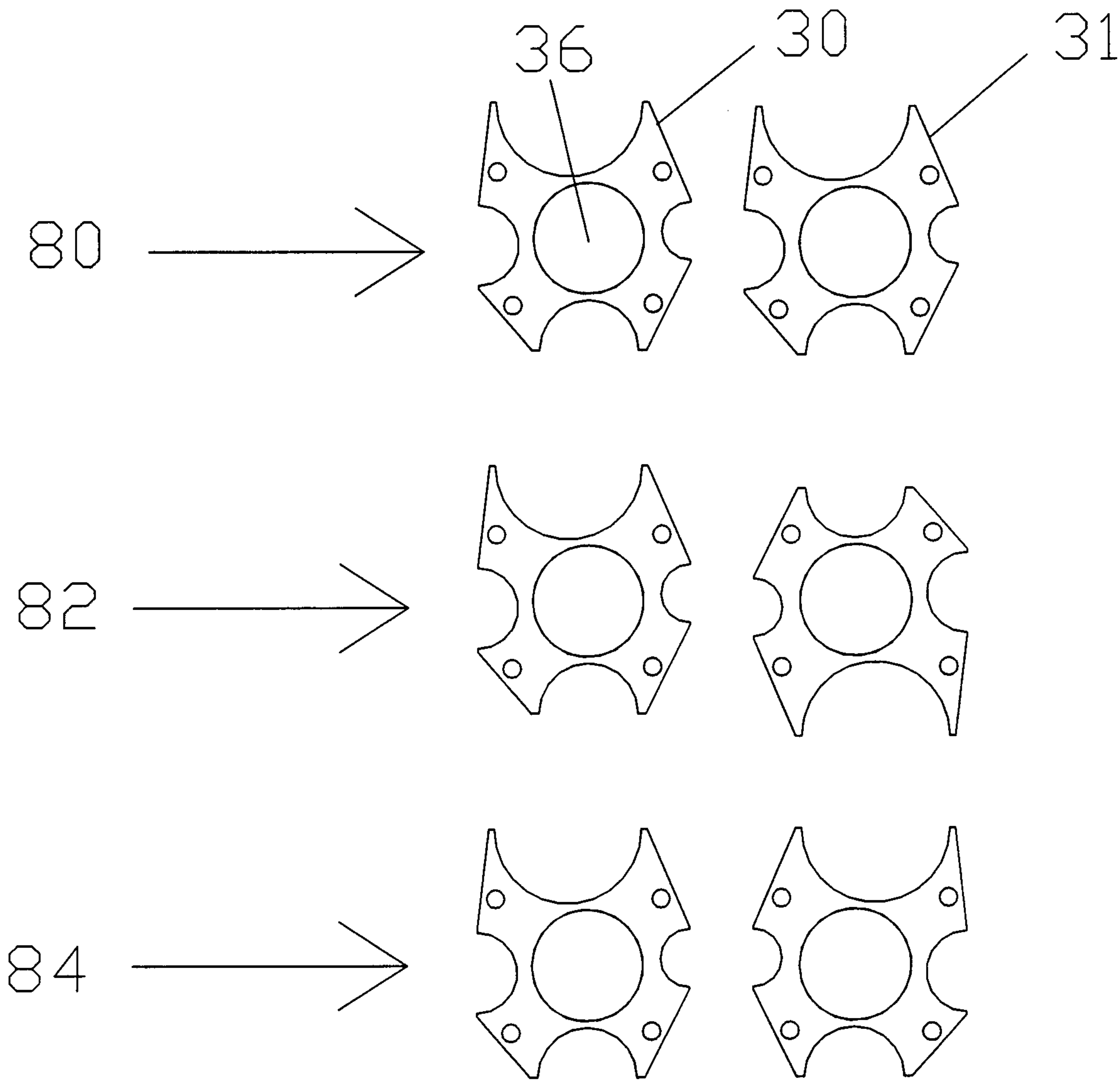
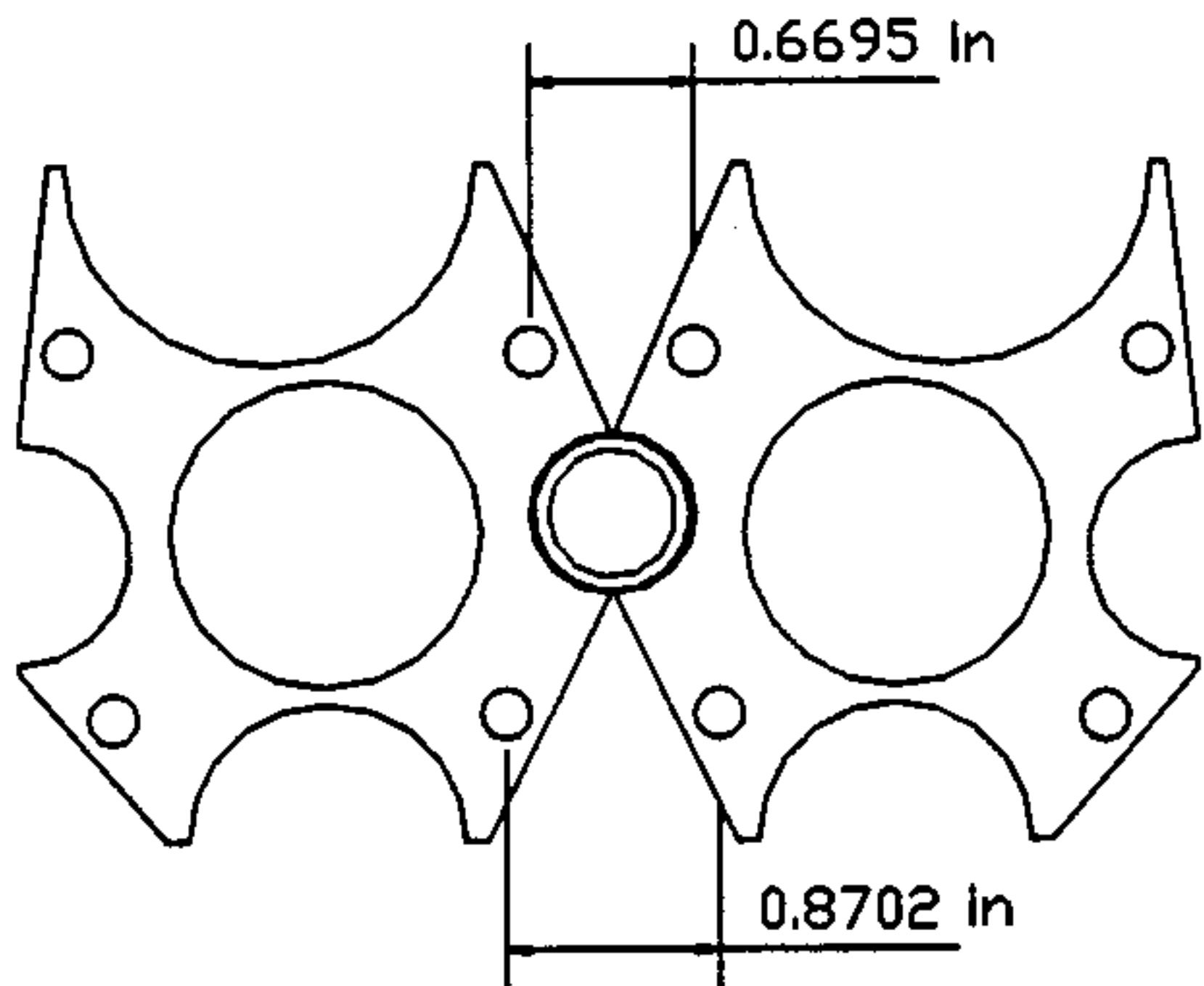
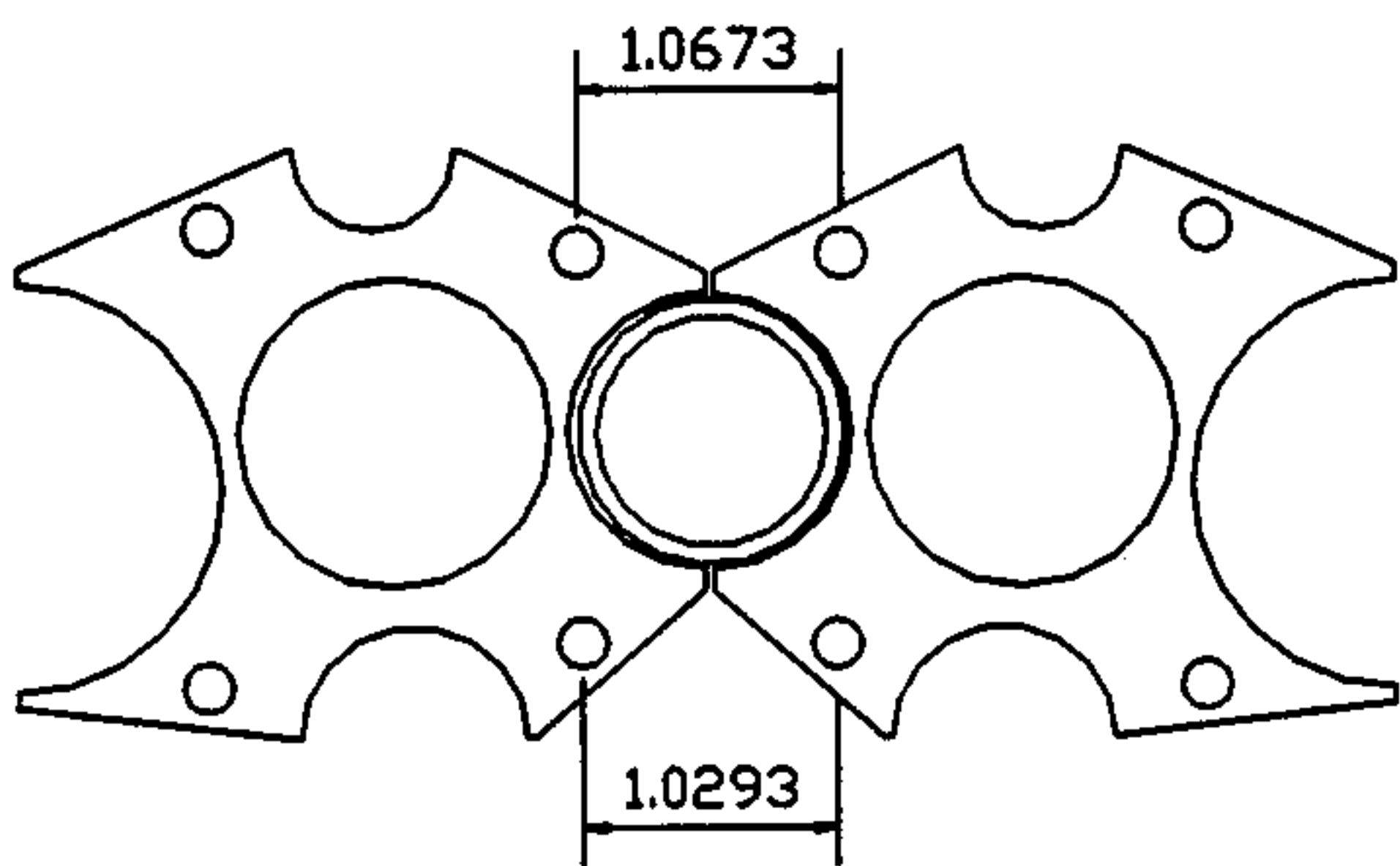


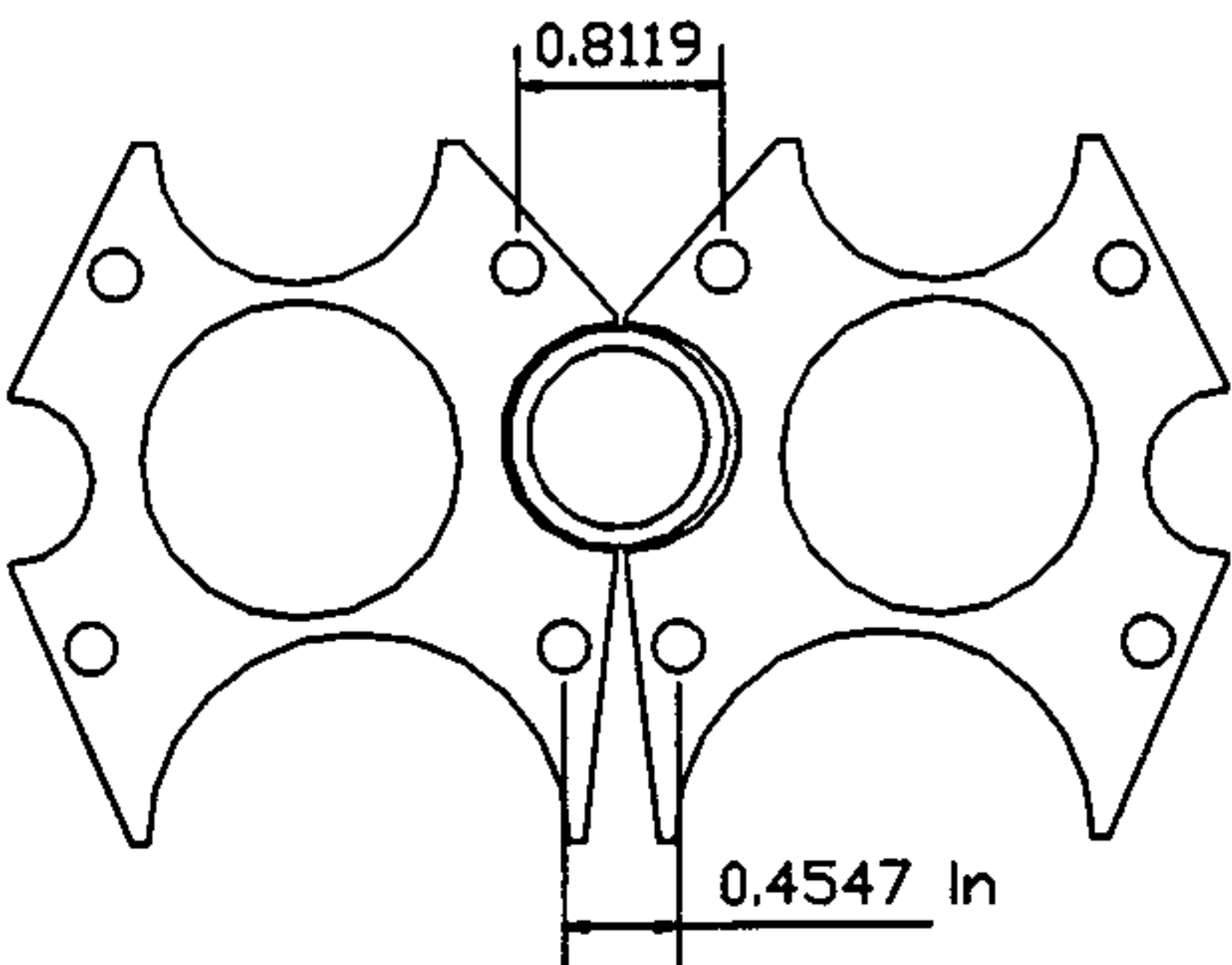
Fig. 9



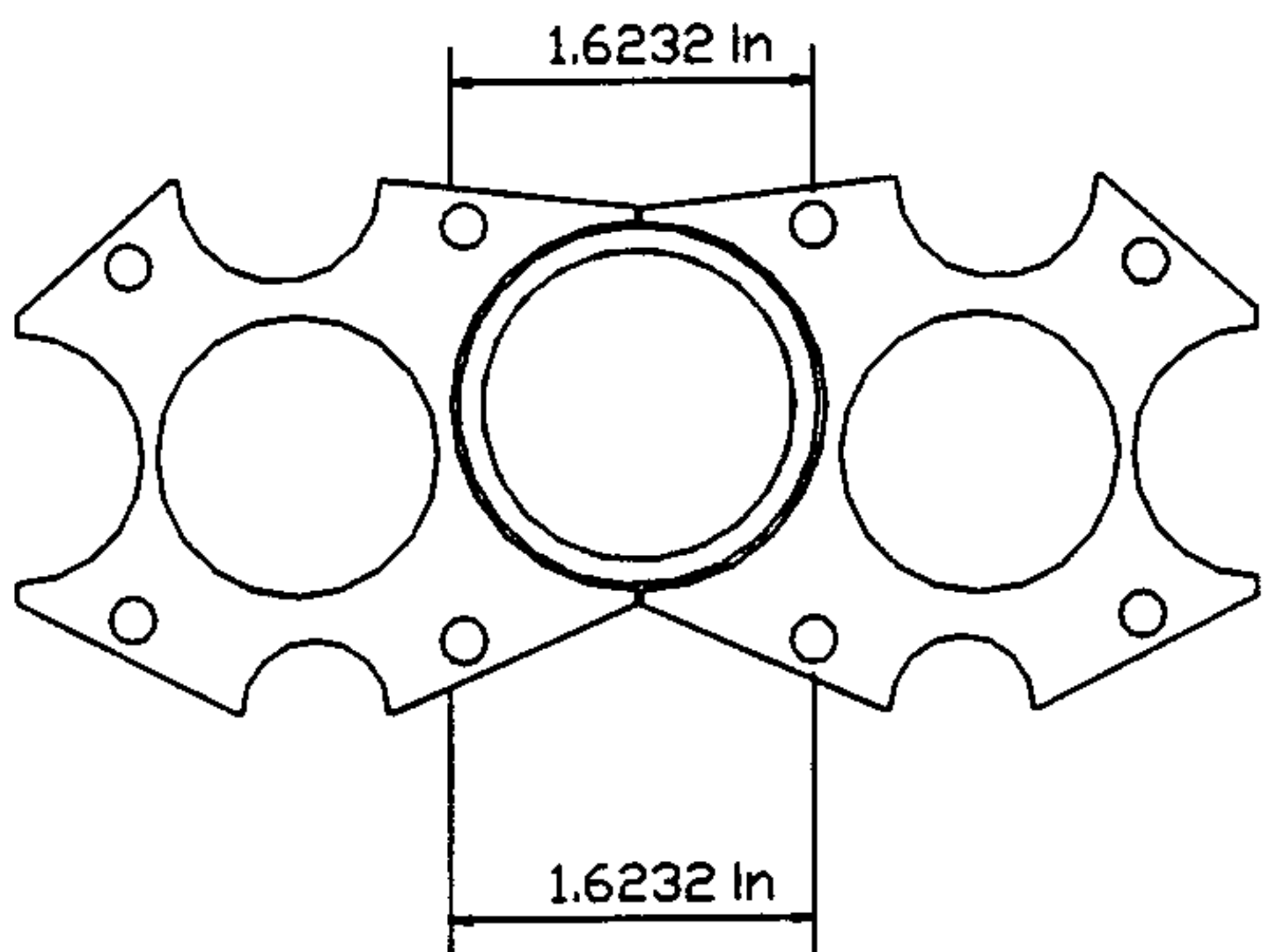
Pipe OD = 1.65 cm (0.65 in)



Pipe OD = 2.92 cm (1.15 in)



Pipe OD = 2.29 cm (0.90 in)



Pipe OD = 4.19 cm (1.65 cm)

Fig. 10

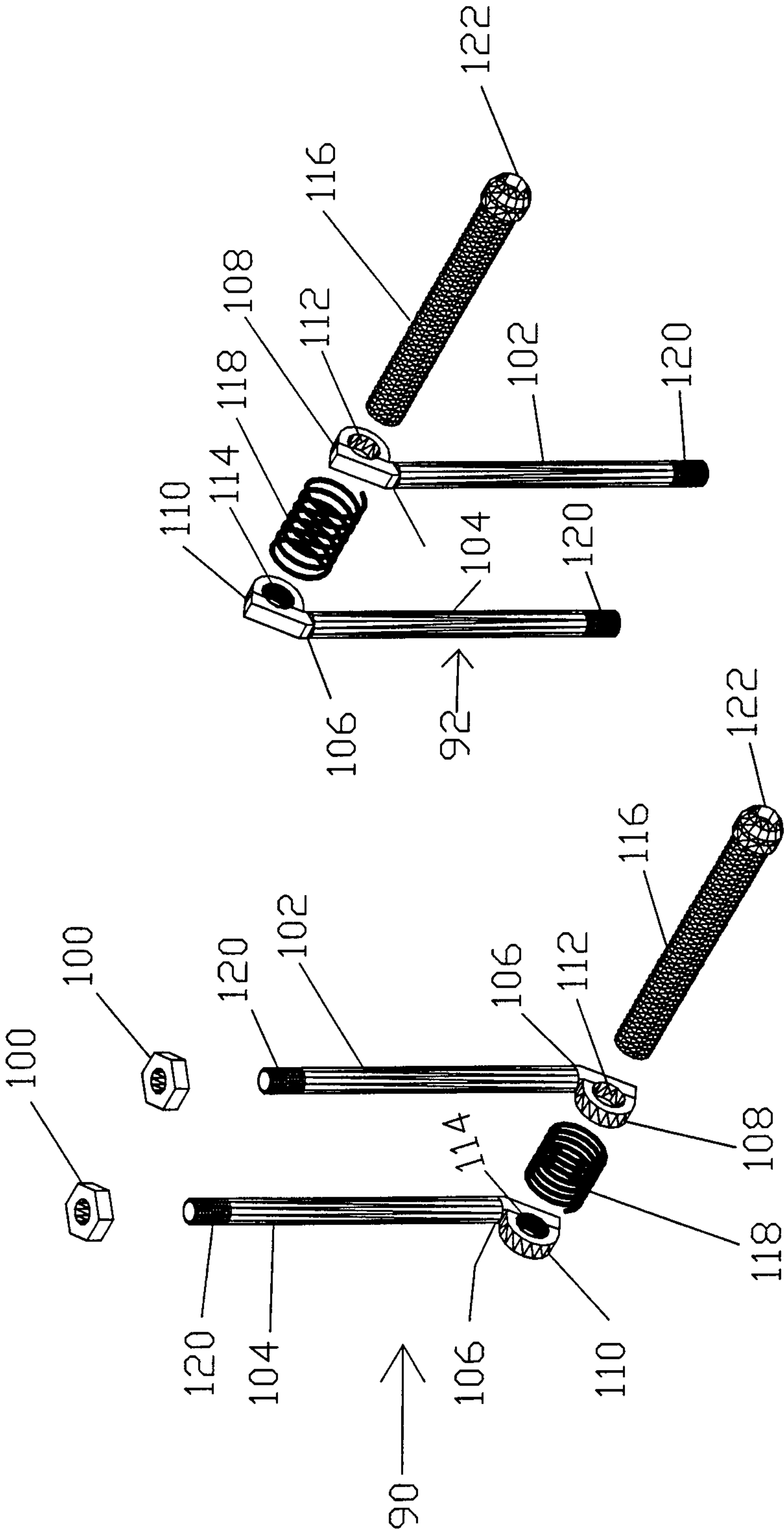


Fig. 11

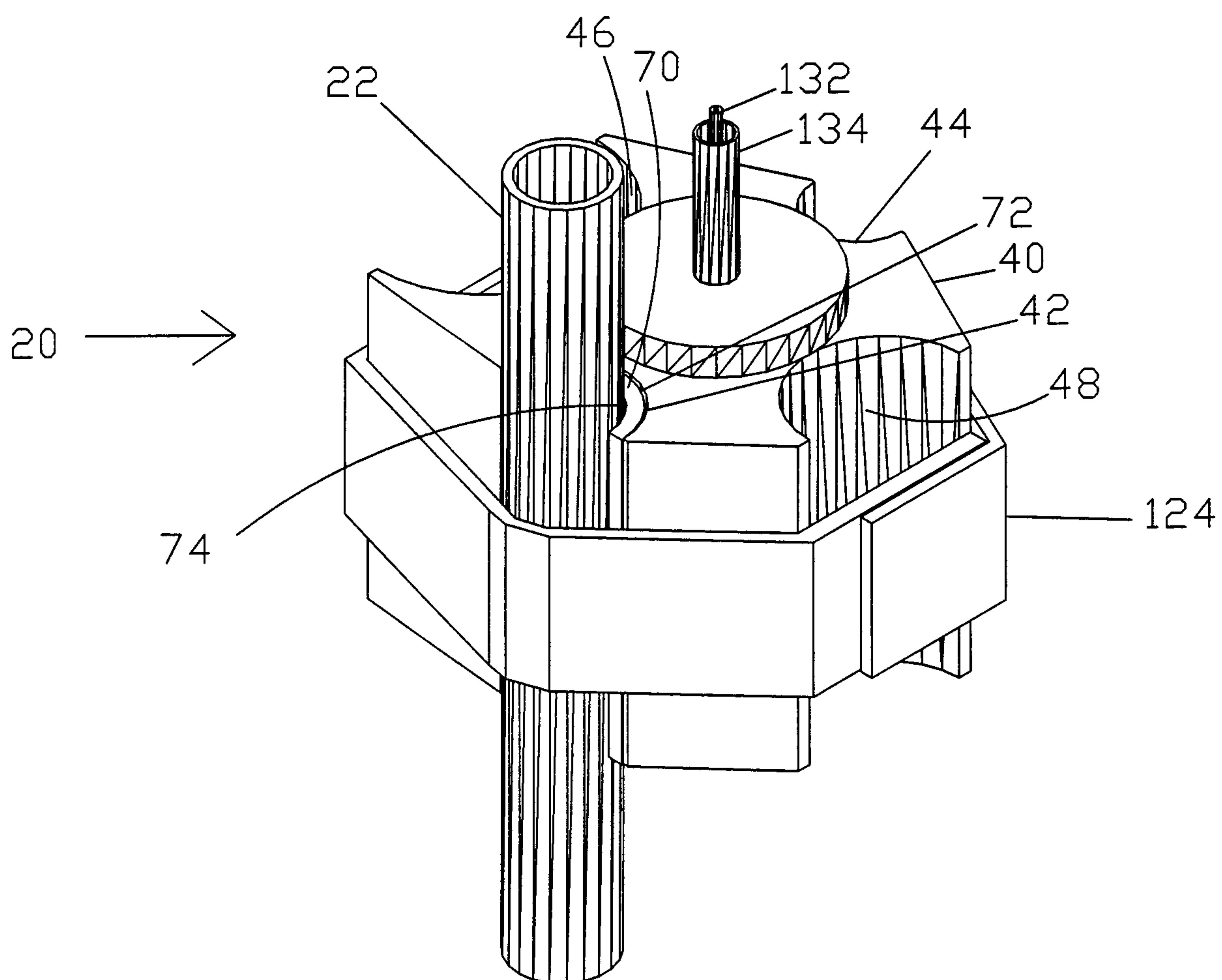


Fig. 12

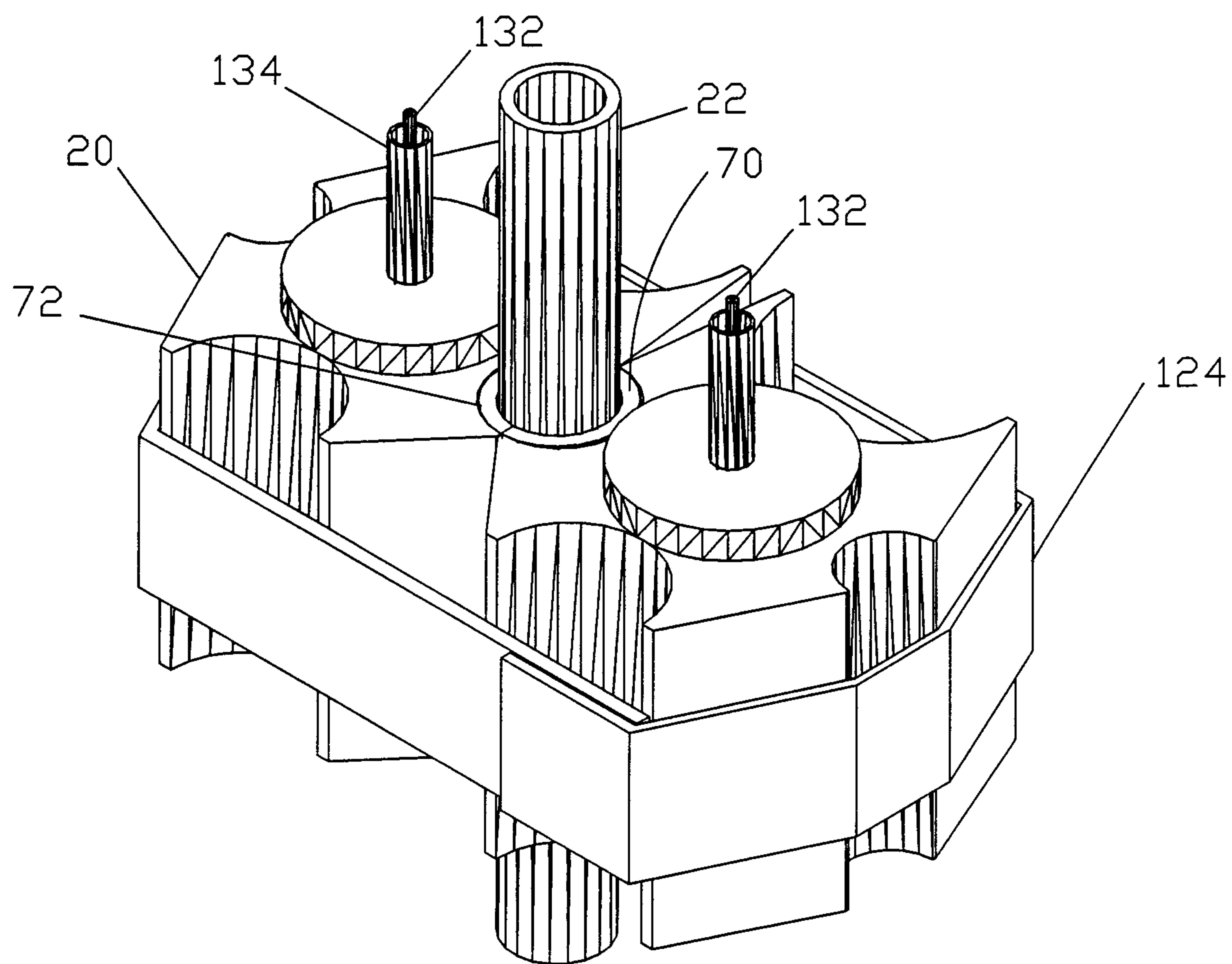


Fig. 13A

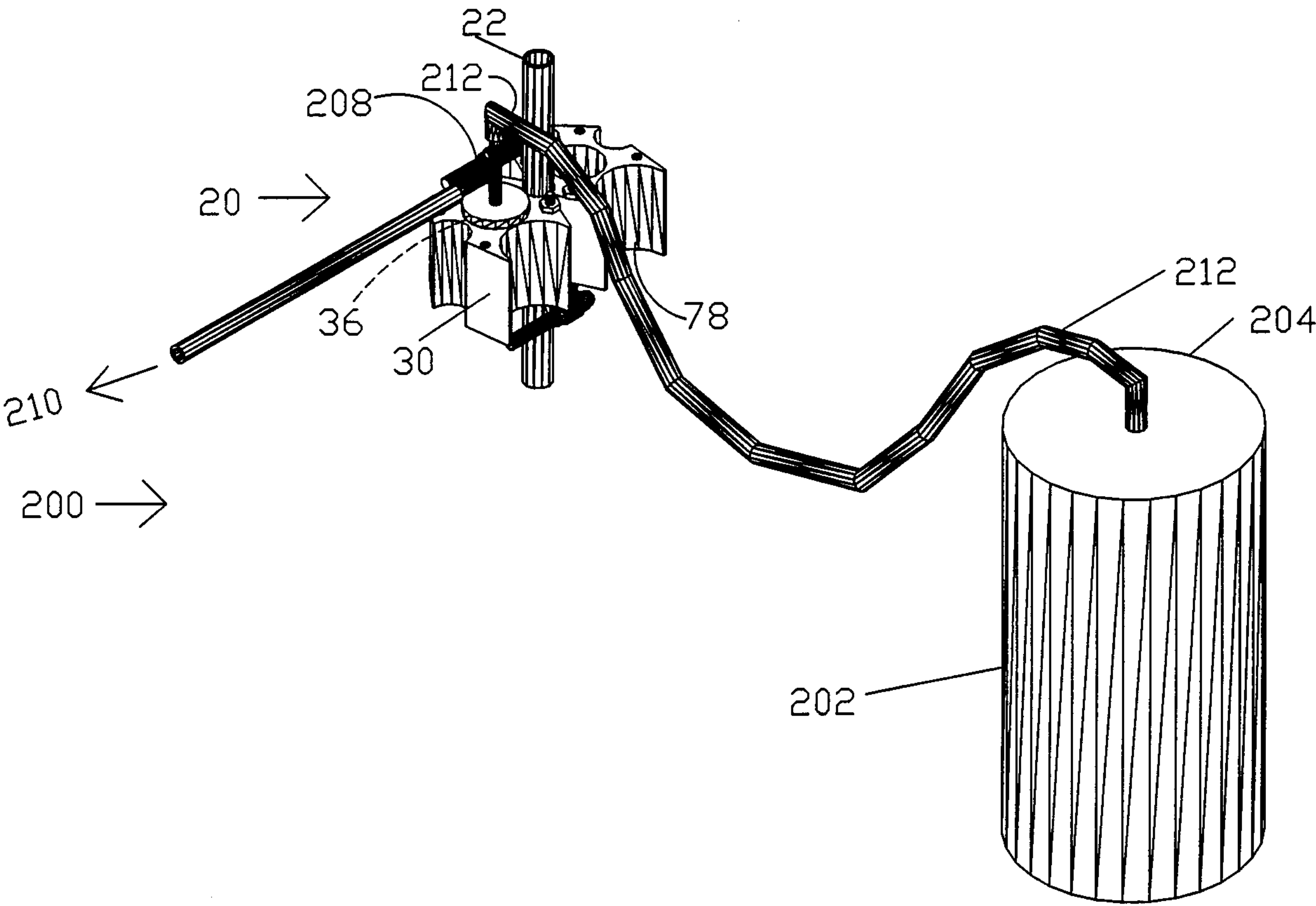


Fig. 14

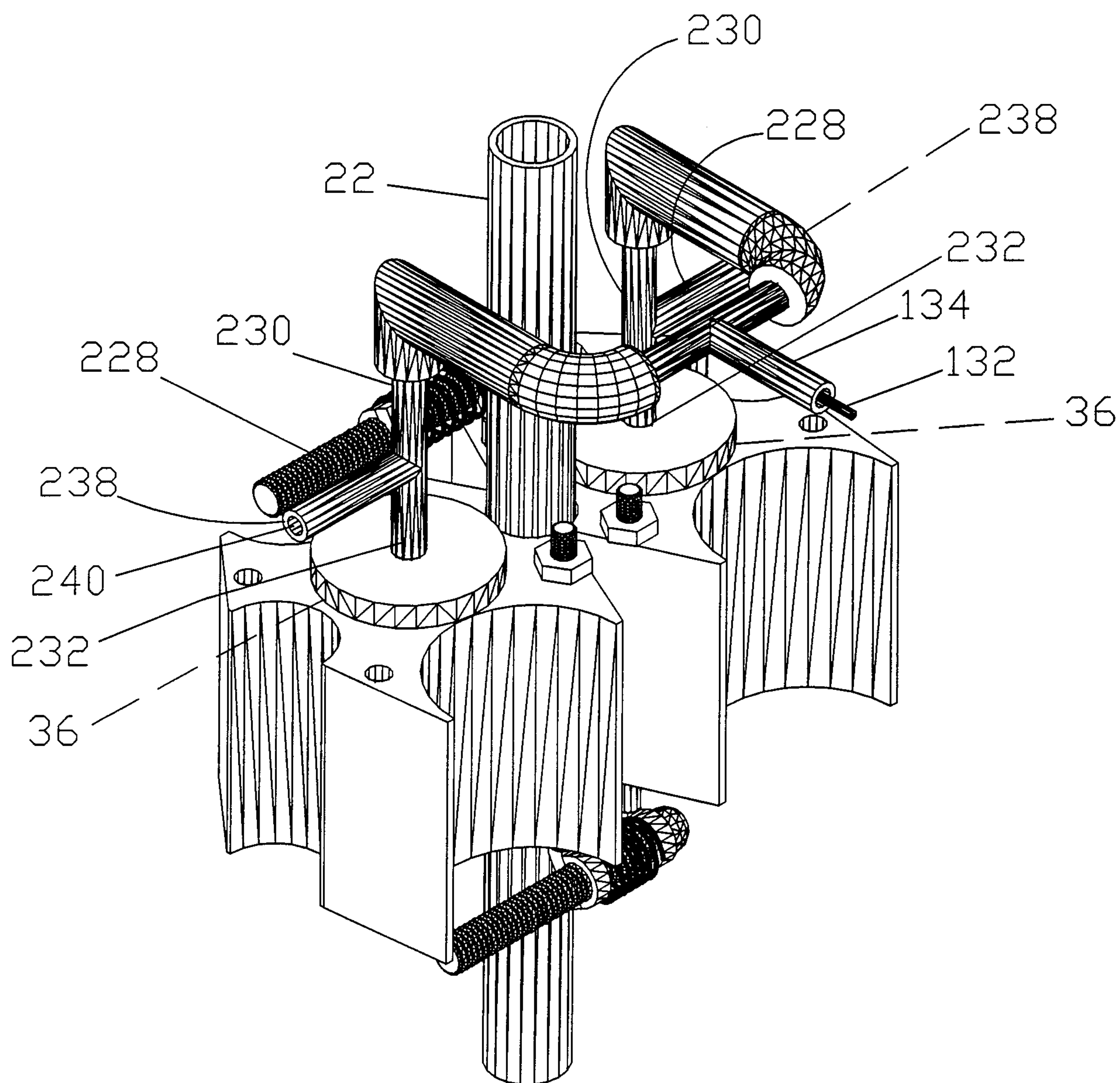


FIG. 15

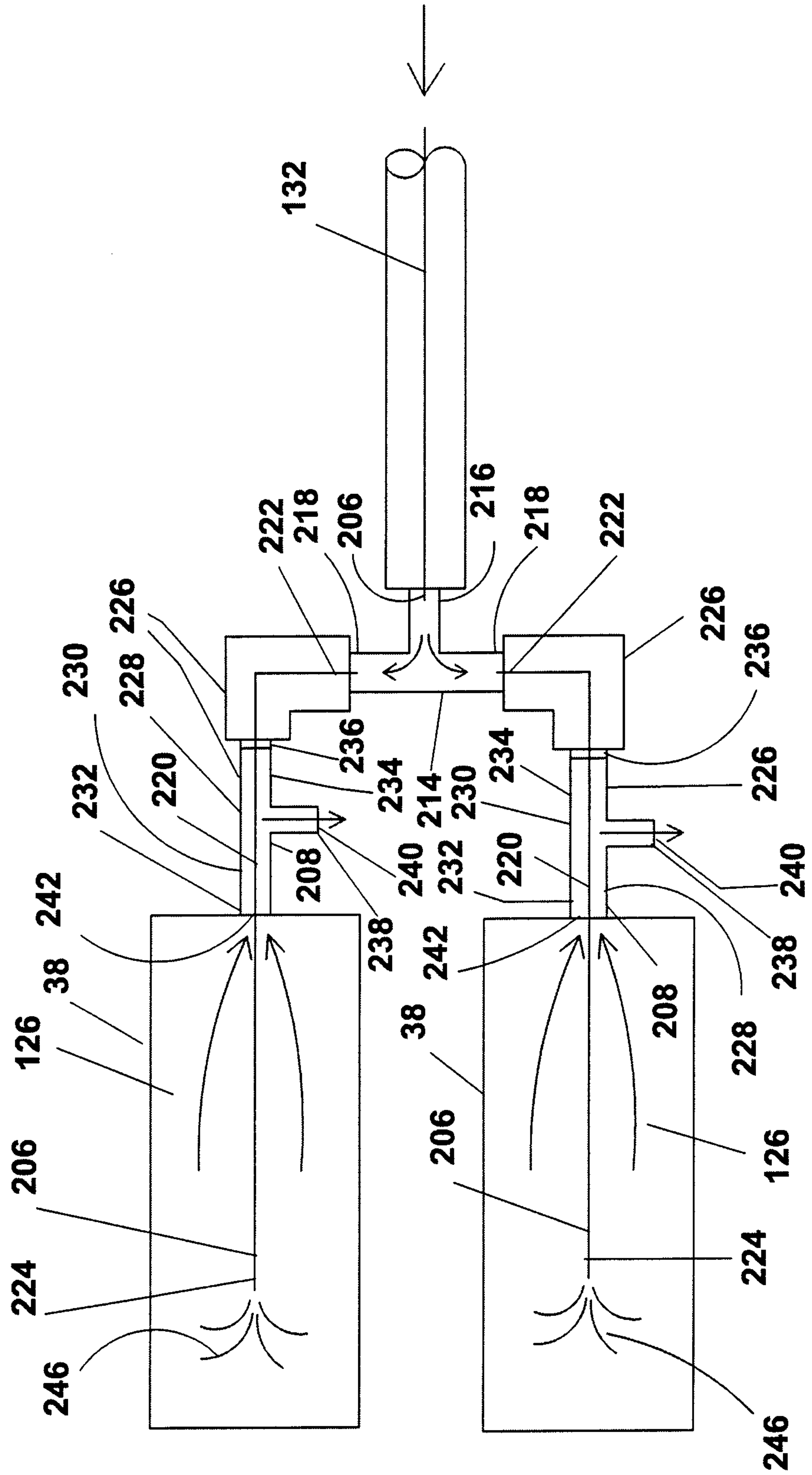


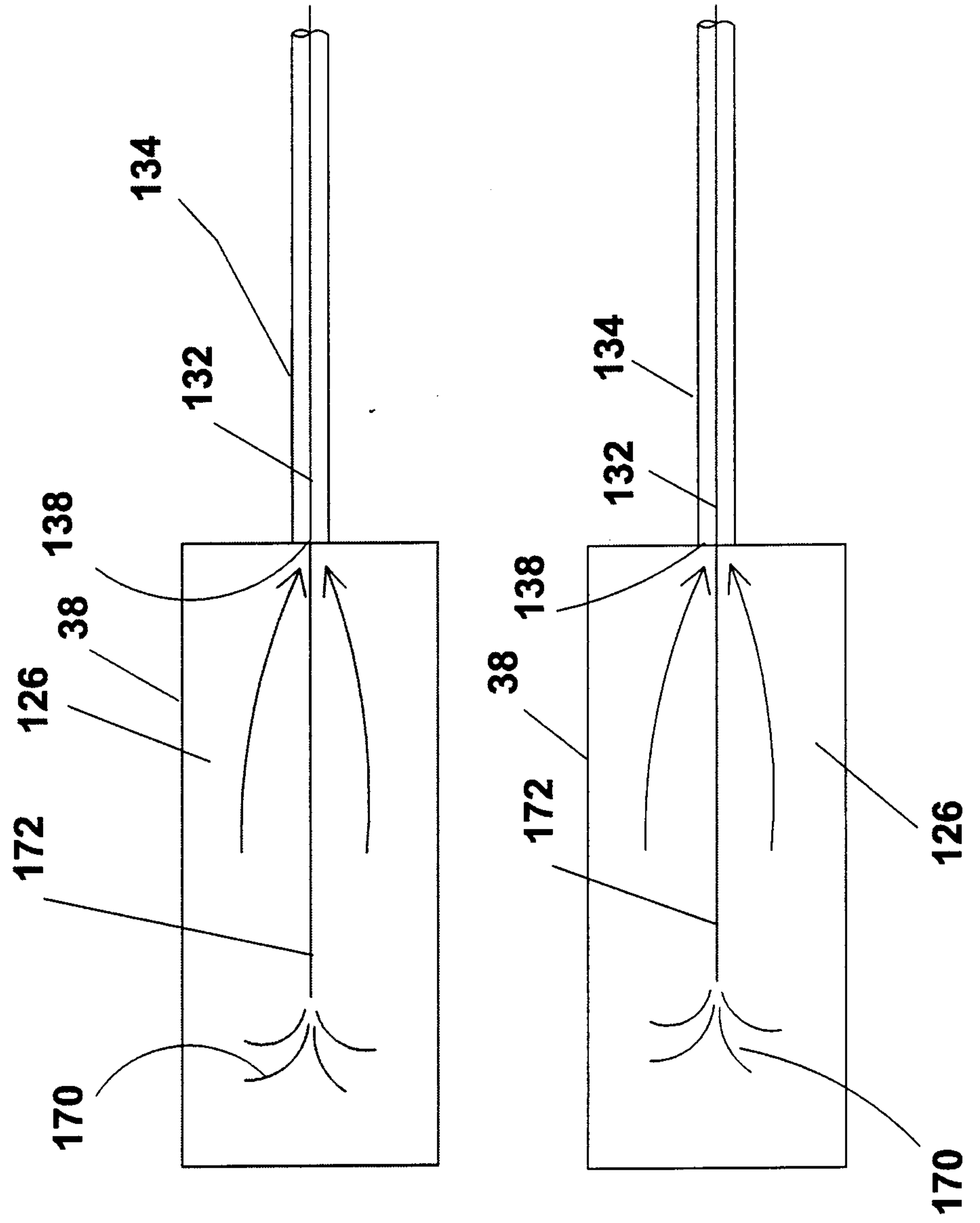
FIG. 16

Fig. 17

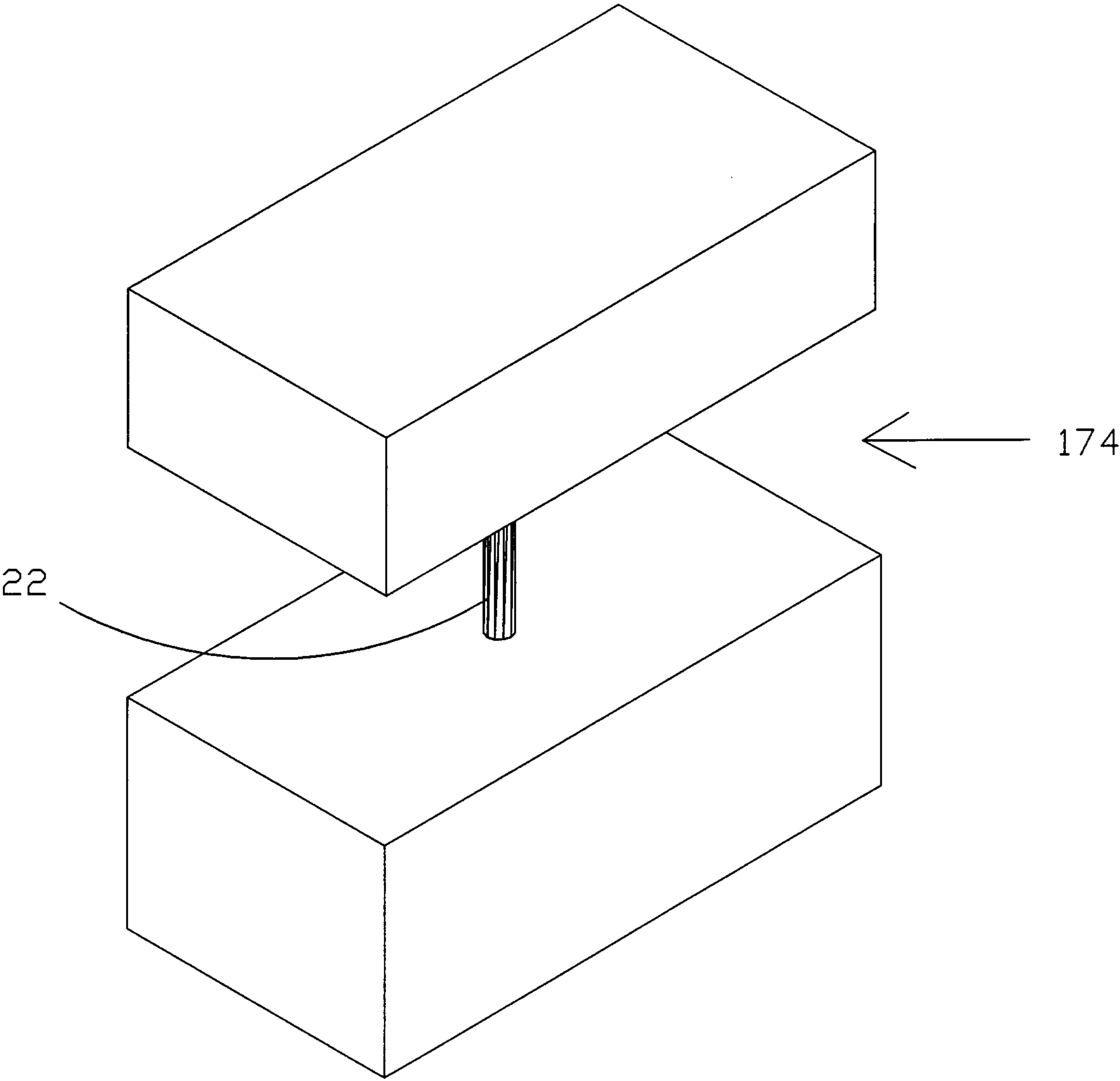


Fig. 18

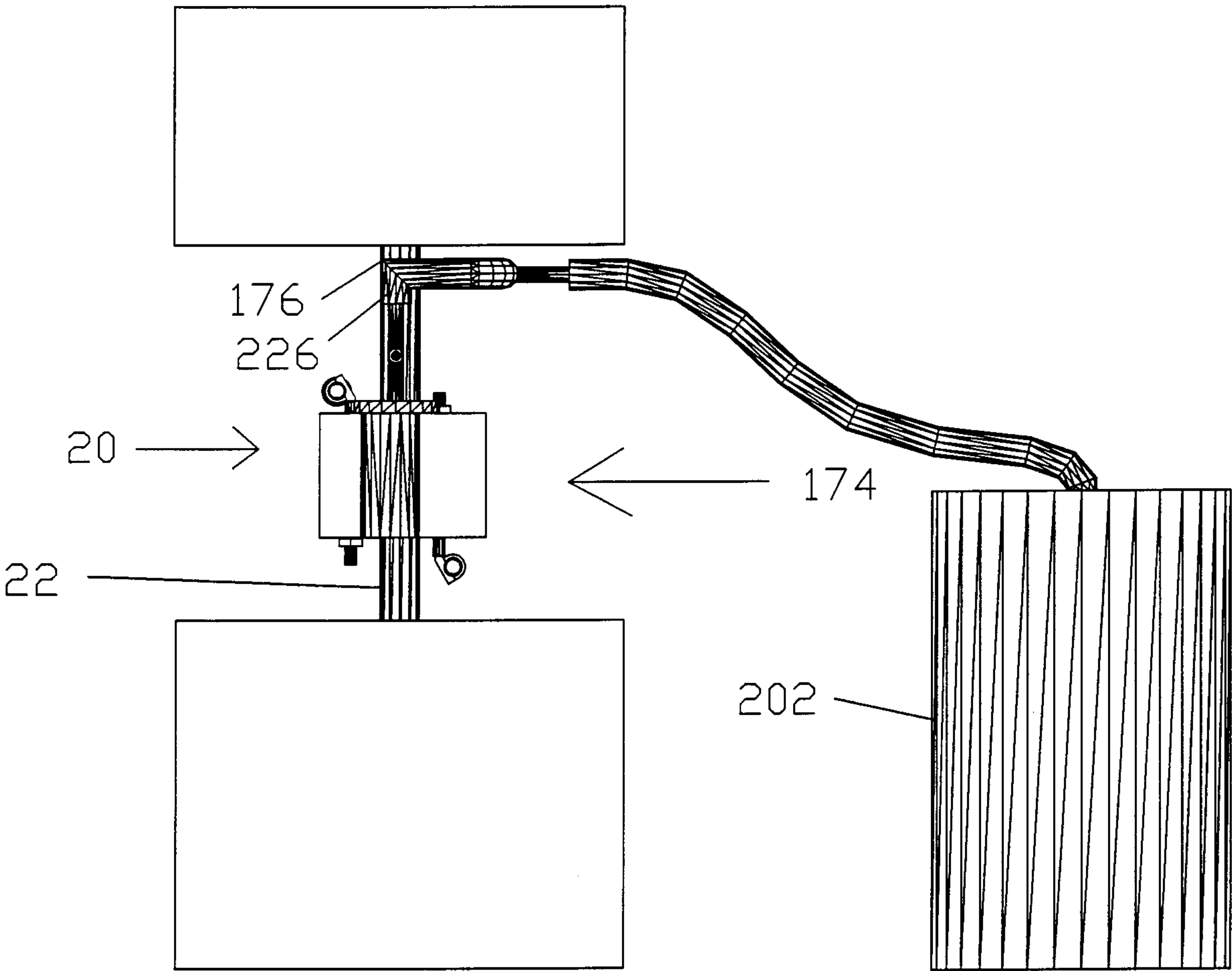


Fig. 19

