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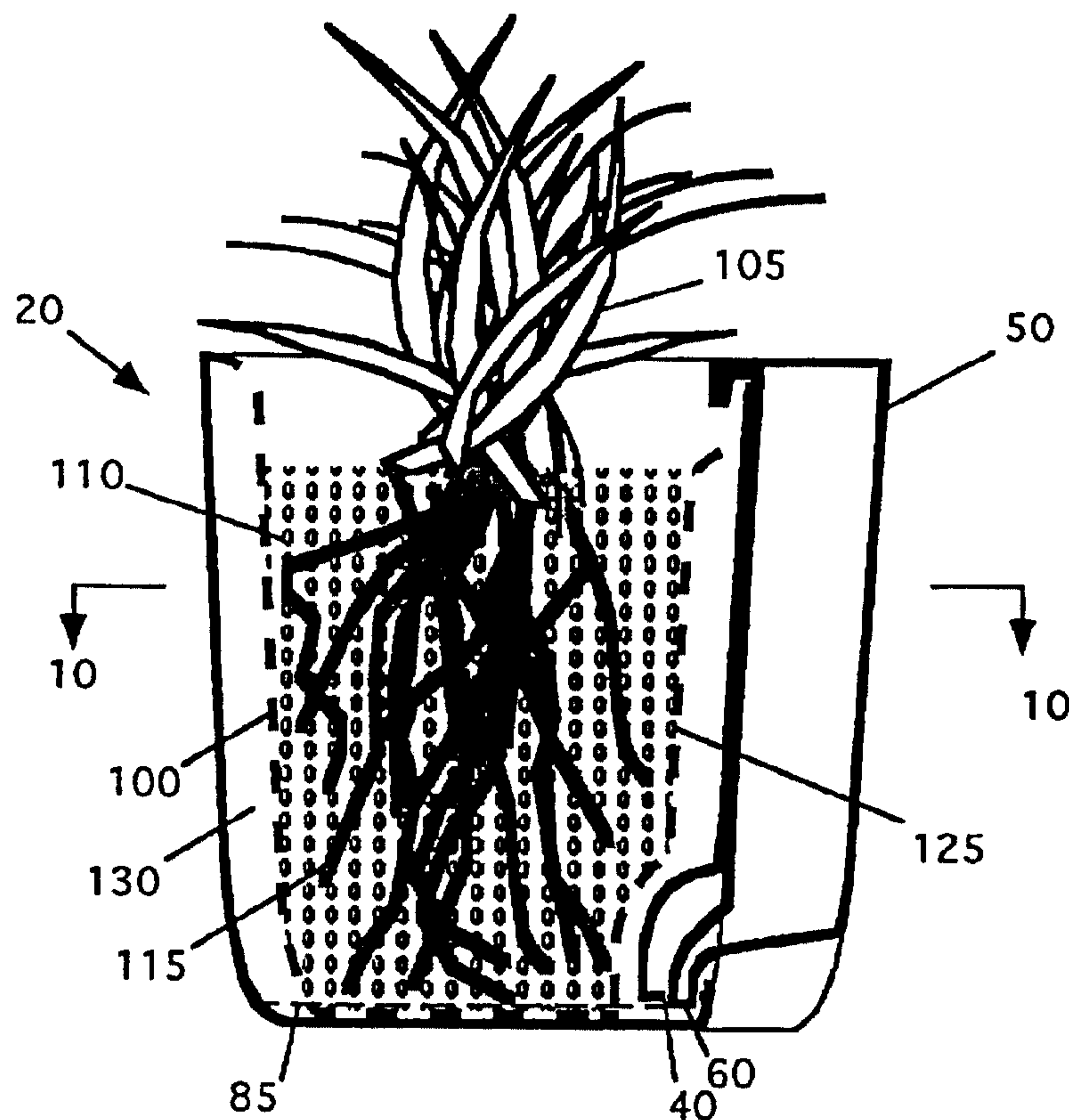
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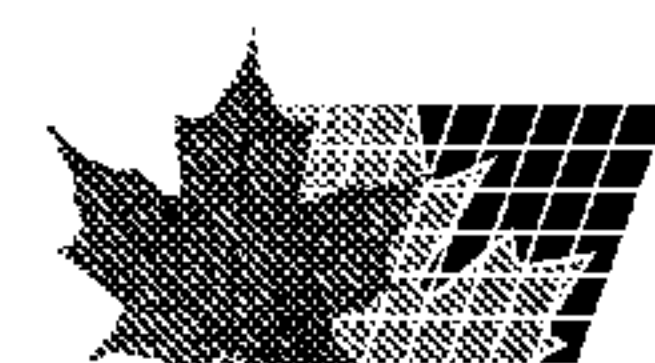
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(54) Title: SPILL-RESISTANT CONTAINER



(57) Abrégé/Abstract:

A spill-resistant container for storing and dispensing a liquid, the container having a curved neck which prevents the liquid from spilling when being poured out of the opening of the container. For example, the spill-resistant container may have a curved neck in the form of a number "7", a letter "Z" or a letter "S". When the spill-resistant container that is full of liquid is tilted such that the liquid level inside the container is higher than the liquid level at the opening of the container, no liquid flows out of the container. The



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liquid will start to flow out of the container only after the container is tilted beyond a predetermined start-to-pour angle. The start-to-pour angle is reached when the container is tilted enough so that the outside air starts to enter the container and the liquid inside the container starts to flow out of the container. This design makes pouring a liquid from a full container much less likely to spill. The curved passageway creates additional flow restriction in comparison with the ordinary containers without such design. This added flow restriction results in longer filling time and more "glugging" while pouring. A separate vent passageway of this disclosure is an improvement to overcome glugging due to the additional flow restriction in the curved passageway. This vent passageway provides a separate route for the release of inside air during filling process and allows ambient air to enter the container during pouring. Therefore, it improves the filling time and eliminates or greatly reduces the "glugging" of pouring. A special designed liquid level indicator is also provided to indicate liquid level within a small viewing area of the liquid container. The container finds particular application as a separate water container to be connected to planter inserts for self-watering planters.

ABSTRACT OF THE DISCLOSURE

A spill-resistant container for storing and dispensing a liquid, the container having a curved neck which prevents the liquid from spilling when being poured out of the opening of the container. For example, the spill-resistant container may have a curved neck in the form of a number "7", a letter "Z" or a letter "S". When the spill-resistant container that is full of liquid is tilted such that the liquid level inside the container is higher than the liquid level at the opening of the container, no liquid flows out of the container. The liquid will start to flow out of the container only after the container is tilted beyond a predetermined start-to-pour angle. The start-to-pour angle is reached when the container is tilted enough so that the outside air starts to enter the container and the liquid inside the container starts to flow out of the container. This design makes pouring a liquid from a full container much less likely to spill. The curved passageway creates additional flow restriction in comparison with the ordinary containers without such design. This added flow restriction results in longer filling time and more "glugging" while pouring. A separate vent passageway of this disclosure is an improvement to overcome glugging due to the additional flow restriction in the curved passageway. This vent passageway provides a separate route for the release of inside air during filling process and allows ambient air to enter the container during pouring. Therefore, it improves the filling time and eliminates or greatly reduces the "glugging" of pouring. A special designed liquid level indicator is also provided to indicate liquid level within a small viewing area of the liquid container. The container finds particular application as a separate water container to be connected to planter inserts for self-watering planters.

SPILL-RESISTANT CONTAINER

BACKGROUND OF THE INVENTION

5 It is well known that plants need air, water, and light for growth. It is also known that plants purify air. The purification of air through plant leaves is well known. However, the role of complex biological and bacterial process of plant's root system in breaking down air polluting chemicals and suppressing the growth of microbe has only become understood in recent years.

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 Since the energy crisis in the 1970's, new homes are being built with energy efficiency in mind. To achieve this, buildings tend to have less air circulation with the outside air and better seal around doors and windows. As a result of these changes in addition to wide spread use of plastics, paints and other synthetic materials and chemicals, the indoor
15 air pollution have become a serious health problem, which resulted in the so called sick air syndrome. Several air purification planters and apparatus were proposed by US patents, such as Patent Nos. 5,217,696; 5,269,094; 5,351,438; and 5,433,923. These patents suggest means to improve the interaction of air with the root system of the plants. A major deficit of these designs include 1) lack of sufficient water reservoir in the planter which increases the
20 work of maintaining the plants, 2) relatively large variation of water level within the planter which is, in many respects, an undesirable consequence of being unable to control a constant water level in the planter.

 On the market everywhere, there are many kinds of the so called "self watering"
25 planters available to the public. There is very little difference among these planters. The basic feature of these "self watering" planters is a small water reservoir at the bottom of the planter with a water filling opening near the bottom of the planter sidewall. A perforated divider separates soil from the water reservoir except that there are few studs or channels in the divider which extend down into the water reservoir and all the way to the bottom of the
30 planter so that soil in these studs or channels were able to be submerged in the water at any given water level in the water reservoir. Capillary action of the soil is able to lift water to the root system and support plant growth. The disadvantages of these "self watering" planters

include 1) the size of the water reservoir is usually small and the uncontrollable water level also changes with time, 2) the bottom exposed portion of the soil and the water reservoir are directly open to the ambient air through the water refill opening and thus mildew or microbe growth is a common problem.

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This invention relates to a planter with a removable spill-resistant container or separate water container to be connected to planter inserts for ordinary planters. The water container is capable of maintaining a constant water level in the planter. Because the spill-resistant container is separate to the planter and removable for refill, the size of the spill-resistant container may be made as big as one wish. For planter insert with very large water container, it is not practical to remove the water container for refill, a special design feature is provided to enable the refill of water container in place without spilling water. The neck of the spill-resistant container mouth "plugs" into the opening of the planter thus closes off the direct contact of water and potting medium in the container with the ambient air and thus reduced or eliminated the problem of mildew around water in the planter.

With different optional inserts the interface areas of ambient air with the potting medium and the root system is maximized, thus enhancing the effectiveness of air purification process by the root system. A lamp and a circulation fan are also provided. The location of the fan is imbedded within the potting medium and the water in the planter thus greatly reducing the vibration and noise level of the fan.

When inserting a full container of water to a drinking fountain stand, pouring a can of motor oil to the engine, pouring anti-freeze liquid into the radiator and in many other occasions, the liquid in the container is often too full and the receptacle spot has too small of an opening. Under these circumstances, one must act quickly or very often will spill the liquid all over the place. The extended curved neck of the spill-resistant container of this invention allows the container to be laid flat without spilling. The extended curved neck design even allows the user to raise the bottom of the container such that the liquid level inside the liquid container is higher than its mouth opening without spilling. This special feature makes the insertion and removal of water container from a drinking fountain extremely easy. In fact, this design simply makes the pouring of liquid from a container

much more manageable with less chance of spilling. The curved passageway of the extended curved neck have the shape of the number "7", the letter "Z" or the letter "S". The down side of this curved passageway also adds an undesired effect to an ordinary container of an additional flow restriction between the container and the ambient. When filling a container, the same volume of air must be released from the container as the liquid is filling in. The filling of liquid and the releasing of air take place simultaneously in the curved passageway. Any added resistance will make the process more difficult and therefore slowing down the filling process. By the same reason, when pouring liquid from the container, the same volume of air must enter the container to replace the liquid being poured out. A phenomenon call "glugging" appears when liquid is poured too quickly from the container. Glugging occurs when too much liquid tries to flow out of the container and not enough room is left in the curved passageway for air to enter into the container to replace the volume of the out-flowing liquid. When this happens, a partial vacuum is created inside the container that momentarily stops liquid from flowing out. Once the liquid flow stops, air starts to enter the container and eliminates the partial vacuum, thus resuming the liquid out flow. This intermittent and repeated liquid flowing and stopping is called "glugging" and makes the pouring unstable and undesirable.

On the market there are some container designs that have a hollow handle molded near the mouth opening of the container. A vent passageway is provided between the mouth opening and the hollow handle so that a separate air vent is provided. This allows the venting air from the mouth opening to travel down the vent passageway, through the hollow handle, and into the container to help eliminate or reduce the "glugging" condition.

The further improved spill-resistant container places a vent passageway along the curved passageway serves as an improvement to the basic spill-resistant container. To ensure the spill-resistant function, the vent passageway must also have the same shape of the number "7", the letter "Z" or the letter "S". This vent passageway serves a dual purpose of venting air out of the container while filling and venting air into the container during pouring, thus removing the shortcomings of the curved neck design described above.

The spill-resistant container invention may be applied to certain existing containers

by making the invented portion of the container as an adapter. The adapter will contain the above-described curved neck with the curved passageway with or without vent passageway. This adapter can then be threaded to or sealingly attached to the opening of an existing container. The combined existing container and the adapter will then form the integral part of
 5 an improved spill-resistant container.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved planter for plants or an
 10 improved planter insert for plants to be placed inside an existing ordinary or decorative planter.

It is another object of the present invention to provide a removable and refillable spill-resistant container for the planter to store water. The removable spill-resistant container
 15 is made of transparent material or with a strip of see through window so that the water level in the spill-resistant container is in clear view.

It is another object of the present invention to provide a separate water container for the planter insert. The bottom of the water container (when turned over and inserted into the
 20 planter becomes the top of the container) is provided with a small viewing area for a water level indicator so that water level inside the water container is in clear view.

It is another object of the present invention to provide and maintain a constant water level in the planter.
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It is another object of the present invention to provide and maintain constant water level in one or more planter insert(s) connected together and placed inside the same planter with a single water container.

30 It is another object of the present invention to increase the interface surface areas between ambient air with the potting medium and the root system. The improved air circulation and the inclusion of a lamp are all means of improving the effectiveness of air

purification and sterilization.

It is yet another object of the present invention to provide an improved spill-resistant container such that it is easier to turn over for insertion into the planter, water fountain or
5 other applications or just for pouring a liquid without a concern for spilling.

The present invention includes an improved planter insert, which has a shallow water well at the bottom of the planter insert. A water container with a curved neck can be seated at the opening of the shallow water well. A constant water level is maintained inside the planter
10 insert, which is achieved by the partial vacuum created within the water container and water surrounding the mouth opening of the water container.

The present invention includes an improved planter with a small opening near the bottom of the planter. A spill-resistant container with an extended curved neck can be
15 "plugged" into the opening of the planter and closes off the direct contact of water and potting medium in the planter with the ambient air. A constant level of water is maintained inside the planter. This constant water level is achieved by the upside down spill-resistant container and the partial vacuum created within the spill-resistant container.

20 Different version of optional inserts may be placed inside the planter. Each one serves different purposes and with different complexity. The simplest insert will help to increase the interface areas of ambient air with the potting medium and the root system thus improving the breathing or circulation of air in the root system and enhancing the air purification process by the root system. The second insert includes a circulation fan such that the
25 circulation of air is greatly increased. The third insert includes a lamp with or without a circulation fan. The lamp using either incandescent bulb or bulb with ultra violet feature will help to disinfect the air being circulated around the bulb. The inclusion of a fan will further enhance the air circulation.

30 For air purification purpose, hydroponically soil-less planting is the desired approach. Water absorbing pebbles such as expended clay and zeolite with or without activated carbon are ideal potting medium. This type of potting medium often leaves many void air spaces in

the potting medium and the root system and allows circulating air to be scrubbed by the damp pebble surfaces and the root system and maximizing the effect of air purification.

Conventional potting soil may also be used in this planter. The air purification
5 property does reduce considerably; nevertheless, it is still better than the regular planter is. Other advantages of the planter described earlier still apply.

The extended curved neck design of the spill-resistant container provides a unique
feature which allows the spill-resistant container to be laid flat after filling without spilling
10 any liquid. In fact, the bottom of the spill-resistant container can be lifted even higher with the liquid line inside being higher than the opening of the spill-resistant container without spilling any liquid. Container design with this feature could be applied to, in addition to the disclosed planter as described in this application, bottled water for drinking fountain, motor oil bottle, anti-freeze fluid bottle, cooking oil container and many other applications
15 whenever spillage is a concern when the container is turned for pouring.

In one aspect of the invention there is provided an improved planter with optional inserts for growing house plants in potting soil or hydroponically in pebbles or other potting medium for the purpose of improving the characteristics of purifying ambient air quality and
20 reducing the work of maintaining the plants. A removable see through spill-resistant container for storing water is attached to the planter such that the water level in the planter is maintained constant at all times. The watering frequency is reduced because of the large spill-resistant container. Three different types of inserts may be added to the planter to further enhance the effectiveness of air purification by the plants. A simple insert used to increase
25 the interface areas of ambient air with the potting medium and the root system. The second insert includes a circulation fan to increase the circulation of air through the potting medium and the root system. The third insert includes a lamp with or without a circulation fan. The addition of a lamp will help to sterilize the air. Another advantage of this improved planter is that water at the bottom of the planter does not in direct contact with the ambient air thus
30 greatly reduced or eliminated the growth of mildew or microbe which is a common problem in existing self watering planters on the market.

In a further aspect there is provided an improved planter insert to be used in conjunction with existing ordinary or decorative planters. Similar separate spill-resistant container for water is attached to the planter insert such that the water level in the planter insert is maintained constant at all times. Same additional features may also be added to the planter insert to further enhance the effectiveness of air purification by the plants. A simple planter insert used to increase the interface areas of ambient air with the potting medium and the root system. The second planter insert includes a circulation fan to increase the circulation of air through the potting medium and the root system. The third planter insert includes a lamp with or without a circulation fan. The addition of a lamp will help to sterilize the air.

According to one aspect of the present invention, there is provided a spill-resistant container comprising a body including a top region and a base located opposite the top region, the base being configured to rest on a horizontal surface, the body defining an interior volume in the container for storing a liquid, a neck connected to the top region of the body which defines and encloses a bent passageway having a first end and a second end, the bent passageway having a bent centerline, a first opening located at the first end of the bent passageway, the first opening coupling the bent passageway to the interior volume of the container, an unrestricted second opening located at the second end of the bent passageway, the second opening coupling the bent passageway to the exterior of the container and being sufficiently large to permit the pouring of the liquid out of the container, a first bend defined by the bent passageway and located between the first end and second end of the bent passageway, the first bend having an apex and the distance between the base and a point of the bent centerline of the bent passageway increasing or remaining the same as the point travels from the first opening to the apex of the first bend, wherein the bent passageway is configured to determine a start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the bent passageway, and if the container is tilted less than the start-to-pour angle, outside air can not enter the interior volume of the container and the liquid does not pour out of the second opening of the bent passageway even if the distance between

the level of the liquid inside the container and the horizontal surface is greater than the distance between the apex of the first bend and the horizontal surface, a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

According to a further aspect of the present invention, there is provided a spill-resistant container for a liquid comprising a body having a base and a first axis that intersects the base, the body defining an interior volume about the first axis for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is rotated to a start-to-pour angle relative to the horizontal surface, a neck located at a first portion of the body and defining a curved passageway and a parallel curved vent passageway having a first end and a second end, the first portion being opposite of the base, a first opening located at the first end of the curved passageway and vent passageway to couple the interior of the curved passageway and the vent passageway with the interior volume of the container, an unrestricted second opening located at the second end of the curved passageway and the vent passageway to couple the interior of the curved passageway and the vent passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container, a first curve located between the first end and the second end of the curved passageway and defining a two dimensional curved centerline within the curved passageway, the two dimensional curved centerline lying on a first plane which is substantially vertical with respect to the horizontal surface, the first curve having an apex and the distance between the base and a point of the curved centerline of the curved passageway increasing or remaining the same as the point travels from the first opening to the apex of the first curve, a second axis perpendicular to the first plane which defines a pivot for rotating the first plane, wherein the first plane is defined to be rotating in a counter-clockwise direction when the first plane is rotating about the second axis such that the first opening is rotated toward the

second opening along the two dimensional curved centerline while the first plane remains substantially vertical with respect to the horizontal surface, the curved passageway being configured to determine the start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the curved passageway when the container is rotated in the counter-clockwise direction, the curved passageway being further configured such that if the base is rotated relative to the horizontal surface at an angle less than the start-to-pour angle when the container is rotated in the counter-clockwise direction, outside air can not enter the interior volume of the container and the liquid in the container does not pour out of the second opening of the curved passageway nor the vent passageway even if the level of the liquid inside the container is higher than the second opening of the curved passageway, when the container is rotated further where larger amount of liquid pouring out from the container through the curved passageway, little or no room is left in the curved passageway for air to enter the container and the vent passageway provides the dedicated passageway for air to enter the container.

According to another aspect of the present invention, there is provided a liquid-storage container having an opening converted by adding a curved neck into a spill-resistant container, the container having a base configured to rest on a horizontal surface, the curved neck comprising a neck body defining a curved passageway and a parallel vent passageway having a first end plane, a second end plane and a first curve located between the first end plane and the second end plane the neck being adapted to be attached to the container at a side opposite of the base, the curved passageway having a first curve and defining a curved centerline within the curved passageway, the first curve having an apex and the distance between the base and a point of the curved centerline of the curved passageway increasing or remaining the same as the point travels from the first opening to the apex of the first curve, a first opening located at the first end plane of the curved passageway and vent passageway, a connector located at the first end plane of the curved passageway and the vent passageway which permits the first opening of the

curved passageway and the vent passageway to be sealingly connected to the opening of the container, an unrestricted second opening located at the second end plane of the curved passageway and vent passageway and being sufficiently large to permit the pouring of the liquid out of the container, when the curved neck is connected to the container to form a spill-resistant container, the curved passageway determines an angle wherein if the container is rotated equal to the angle, the liquid starts to pour out of the second opening of the curved passageway; if the container is rotated more than the angle, the liquid inside the container flows out of the second opening of the curved passageway, and if the container is rotated less than the angle, the liquid does not pour out of the second opening of the curved passageway even if the distance between the level of the liquid inside the container and the horizontal surface exceeds the distance between the second opening and the horizontal surface, a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

According to yet another aspect of the present invention, there is provided a spill-resistant container for a liquid comprising a body having a base and an axis that intersects the base, the body defining an interior volume around the axis in the container for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is tilted at a start-to-pour angle from the horizontal surface, a neck located at a first portion of the body and defining a bent passageway having a first end and a second end, the first portion being located opposite the base, a first opening located at the first end of the bent passageway to couple the bent passageway with the interior volume of the container, an unrestricted second opening located at the second end of the bent passageway to couple the bent passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container, a first bend located between the first end and the second end of the bent passageway, the bent

passageway having a bent centerline inside the bent passageway extending from the first opening through the first bend to the second opening of the bent passageway, the distance between the bent centerline and the base stays the same or increasing along the bent passageway starting from the first opening through the first bend to the second opening, the bent passageway further being configured to determine the start-to-pour angle between the base and the horizontal surface at which the liquid inside the container starts to flow out of the second opening of the bent passageway, wherein the bent passageway is configured such that if the base is tilted from the horizontal surface at an angle less than the start-to-pour angle, the liquid does not pour out of the second opening of the bent passageway even if the level of the liquid in the container is higher than the bent centerline, a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a top view of the planter of the present invention.

Figure 2 is a top view of the removable spill-resistant container of the present invention being laid flat.

Figure 3 is the cross-sectional view of Figure 2 along line 3 – 3.

Figure 4 is the side view of Figure 1 in the direction along line 4 – 4.

Figure 5 is the cross-sectional view of Figure 1 along line 5 – 5.

Figure 6 is the detailed view of the portion indicated in zone 6 of Figure 5.

Figure 7 is the detailed view of the portion indicated in zone 7 of Figure 5 with the spill-resistant container (partially shown) hung on the sidewall of the planter.

Figure 8 shows the same cross-sectional view of Figure 5 with spill-resistant container inserting to the opening of the planter in three progressive positions.

Figure 9 shows the same cross-sectional view of Figure 5 with first optional insert and spill-resistant container hung in place and plant potted with potting medium.

Figure 10 shows the cross-sectional view of Figure 9 along line 10 – 10.

Figure 11 shows the same cross-sectional view of Figure 5 with the second optional insert (including fan) and spill-resistant container hung in place and plant potted with potting medium.

5 Figure 12 shows the cross-sectional view of Figure 11 along line 12 – 12.

Figure 13 shows the same cross-sectional view of Figure 5 with the third optional insert (including lamp and optional fan) and spill-resistant container hung in place and plant

potted with potting medium.

Figure 14 shows the cross-sectional view of Figure 13 along line 14 -- 14.

Figure 15 shows the cross-sectional view of examples of spill-resistant container designs with the extended curved neck feature presented in this disclosure which may be used as a refillable water container or for many other applications.

Figure 16 is a top view of the planter insert of the present invention.

Figure 17 is a partial cross-sectional view of Figure 16 along line 117 - 117.

Figure 18 is the same cross-sectional view of Figure 17 showing the insertion of the spill-resistant water container of the present invention.

Figure 19 is the cross-sectional views of spill-resistant container of the present invention.

Figure 20 is a top view of an alternate embodiment of the present invention.

Figure 21 is a cross-sectional view of another alternate embodiment of the present invention.

Figure 22 is the cross-sectional view of Figure 21 along line 122 - 122.

Figure 23 is a cross-sectional view of another alternate embodiment of the present invention.

Figure 24 is the cross-sectional view of Figure 23 along line 124 - 124.

Figure 25 is a top view of another alternate embodiment of the present invention.

Figure 26 is the cross-sectional view of Figure 25 along line 126 - 126.

Figure 27 shows the operation of check valve used in the embodiment shown in Figures 25 and 26.

Figure 28 shows the operation of an alternate check valve used in the embodiment shown in Figures 25 and 26.

Figure 29 shows a water level indicator to be used in all water containers of the present invention.

Figure 30 shows a cross-sectional view of an improved spill-resistant container.

Figure 31 shows the same improved spill-resistant container of Figure 30 at two rotated pouring position.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows the top view of the planter 20 of the present invention. Which has four sidewalls 25, 26, 27, and 28 and a bottom 29. The rectangular shaped planter shown is for example only; many other shapes may also be suitable. One of the sidewall 28 has an indentation 30. Near the bottom of the planter at the indentation 30, the sidewall 28 has a further cavity 35 (may be seen better in Figures 4 and 5 and is partially detailed in Figure 6). There is an opening 40 at the bottom of the cavity 35. A spill-resistant container 50 shown in Figures 2 and 3 is shaped to match the indentation 30.

Figure 2 shows the top view of the spill-resistant container 50 which is being laid flat. The spill-resistant container 50 is made of transparent material or at least a portion of the sidewall (the bottom wall as shown in Figure 2) is transparent and is marked with a scale 51. The amount of water remaining in the spill-resistant container 50 will be clearly visible while inserted to the planter.

Figure 3 is the cross-sectional view of the spill-resistant container 50 along line 3 -- 3 in Figure 2. The heavy bold lines shown in Figure 3 as well as other figures described later represent the thickness of the cross-sectional walls. The spill-resistant container 50 has an extended curved neck 55 and a mouth opening 60. A passageway 61 connects the mouth opening to the container chamber 62 where water is stored. It also has a hanging hook 65, and a refill opening with a cap 70.

Figure 4 is the side view of the planter 20 along line 4 -- 4 in Figure 1. The indented portion of the sidewall 28 has lower sidewall at edge 75 where the hanging hook 65 of the spill-resistant container 50 will hang. The cavity 35 allows the opening 40 to be further set back into the planter (better seen in Figures 5 and 6). This arrangement plus all the sidewalls of the planter being tilted inward with the bottom of the planter being smaller than the top so that the stacking of planters to save space for shipping and storage becomes possible. A raised edge 80 surround the opening 40 will catch any water spill during the insertion or removal of the spill-resistant container 50.

Figure 5 shows the cross-sectional view of the planter along line 5 -- 5 in Figure 1. A detailed cross-sectional view for the portion of region 6 is shown in Figure 6.

Figure 6 includes a section of the extended curved neck 55 of the spill-resistant container 50 when plugged in place to the planter 20. The tip of the neck 55 fits snug with the opening 40.

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Figure 7 is a detailed partial cross-sectional view of the region 7 shown in Figure 5 with the spill-resistant container 50 (only a small portion is shown) already hung on sidewall 28 at the lowered edge 75.

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Figure 8 is the same cross-sectional view of Figure 5 showing how the spill-resistant container 50 is inserted into the planter 20 with the spill-resistant container shown in three progressive positions. When the spill-resistant container 50 is filled and the refill cap 70 closed tight, the spill-resistant container may be laid flat in position A. The specially designed extended curved neck 55 allows the spill-resistant container to be laid flat without spilling any water. In fact, the spill-resistant container could be lifted to an angle well beyond position B as shown in Figure 8 before water will start to flow out. The extended curved neck 55 also allows the mouth opening 60 to be aimed toward the cavity 35 at the opening 40 easily. The insertion of spill-resistant container 50 into the planter 20 from position A through position B to the final hung position C becomes easy and less likely that any water will spill outside the planter. Due to a partial vacuum created within the spill-resistant container 50, the water level line 85 in the planter will be automatically maintained at the mouth opening 60 of the spill-resistant container 50 for as long as there is water remaining in the spill-resistant container. The indentation 30 shown in the figures and described in this disclosure is not a necessary feature. The inclusion of this indentation is for better visual appearance of the planter. After the spill-resistant container is filled with water and hung to the planter, the spill-resistant container fits well with the indentation and the planter appears square again on the outside. If the planter is rectangular in shape, the spill-resistant container may very well have the same width of the planter without indentation and still have a pleasant appearance.

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Figure 9 shows the same cross-sectional view of Figure 5 along line 5 -- 5 in Figure 1 with spill-resistant container 50 inserted. Figure 9 also shows the first optional insert 100

along with plant 105 potted using potting medium 110.

Figure 10 shows the cross-sectional view along line 10 -- 10 in Figure 9. The purpose of this insert 100 is to provide a maximized interface areas of ambient air with the potting medium 110 and the root system 115 of the plant 105. It is achieved by utilizing any suitable form of wavy sidewalls 120 of the insert 100 against the inside surfaces of the planter sidewalls such that narrow air passageways 130 are formed. The wavy sidewalls have small holes or perforations 125 (shown in Figure 9). These holes allow the breathing of the root system with ambient air in the air passageways 130. Potting medium 110 fill the insert where the plant 105 is potted. The bottom layers of the potting medium are submerged under the water level line 85. Capillary action along with the suction of the root system 115 carry water to the upper portion of the potting medium and therefore support the plant growth. The tip of the extended curved neck 55 of the spill-resistant container 50 closes off the opening 40 in the planter and isolates ambient air from direct contact with the water in the planter. Any contact of air must pass through the potting medium and the root system or through the narrow air passageways 130. The ability of the root system in suppressing microbe growth in the vicinity of the root system including the air passageways 130 will help reduce or eliminate mildew growth near the water line 85, which has always been a major problem in the ordinary "self watering" planter. The biological and bacterial processes of the root system along with the increased interface areas with ambient air will greatly enhance the air purification process compared to the same plant growing in an ordinary planter.

Figure 11 shows the same cross-sectional view of Figure 5 along line 5 -- 5 in Figure 1 with spill-resistant container 50 inserted. Figure 11 also shows the second optional insert 200 along with plant 205 potted using potting medium 210.

Figure 12 shows the cross-sectional view along line 12 -- 12 in Figure 11. The purpose of this insert 200 is the inclusion of a circulation fan 235 to enhance the airflow in addition to maximize the interface areas of ambient air with the potting medium 210 and the root system 215 of the plant 205. The wavy sidewalls 220 of the insert 200 against the inside surfaces of the planter sidewalls formed narrow air passageways 230. The wavy sidewalls 220 have small holes or perforations 225 for air to pass through. A circulation fan 235 is

located at the bottom center of the insert 200 slightly above the water level line 85. The use of circulation fan helps to increase airflow through the potting medium and the root system. The circulating air is then passed through the small holes or perforations 225 of the insert and down through the air passageways 230 to the bottom of the planter. Partition walls at the bottom of the insert form air inlet ducting 240, which guide the circulation air toward the suction side 245 of the fan 235. Discharge duct 250 guides the exhaust air to the ambient. Potting medium 210 fills the insert where the plant 205 is potted. The bottom layers of the potting medium are submerged under the water level line 85. Capillary action along with the suction of the root system 215 carries water to the upper portion of the potting medium and therefore supports the plant growth.

Figure 13 shows the same cross-sectional view of Figure 5 along line 5 -- 5 in Figure 1 with spill-resistant container 50 inserted. Figure 13 also shows the third optional insert 300 along with plants 305 potted using potting medium 310.

Figure 14 shows the cross-sectional view along line 14 -- 14 in Figure 13. The purpose of this insert 300 is to include a lamp 360 attached to the discharge duct 350 along with a glass shield 365 and a lamp shade 370 in addition to maximize the interface areas of ambient air with the potting medium 310 and the root system 315 of the plants 305. The wavy sidewalls 320 of the insert 300 against the inside surfaces of the planter sidewalls form narrow air passageways 330. The heat of the lamp will heat the air and cause the air to rise and pass through the air gap 375 between light bulb 380 and the glass shield 365. This rise of air creates a suction at the discharge duct 350 which in turn pulls ambient air to pass through potting medium 310 and the root system 315 then through holes or perforations 325 and down the air passageways 330, the air inlet ducting 340 to the discharge duct 350. An optional circulation fan 335 is located at the bottom of the discharge duct 350 and above the water level line 85. Some enhancement of air circulation by fan is helpful but too much airflow may cause the light bulb 380 being unable to heat the air hot enough for sterilization. Potting medium 310 fills the insert where the plant is potted. The bottom layers of the potting medium submerged under the water level line 85. Capillary action along with the suction of the root system 315 carries water to the upper portion of the potting medium and therefore supports the plant growth.

Figure 15 shows the cross-sectional views of examples of various versions of spill-resistant container 400 with the extended curved neck feature incorporated into the design. The spill-resistant container 400 may be of any shape or size. It generally has sidewalls 405, top wall 410, and bottom wall 415. If desirable, one sidewall 406 may be flat to allow the liquid container to lay flat after filling. A major axis 16 -- 16 generally defines the centerline of the spill-resistant container. The spill-resistant container is in its upright position when the major axis is vertical and the top wall 410 is facing up. The extended curved neck 425 could be in the form of a number "7" (as shown in Figure 15-1), or in the form of a letter "Z", or "S" (as shown in Figures 15-2, 15-3) with at least one bent or curve having an apex 470. A mouth opening 430 is located at the end of the extended curved neck. A minor axis 17 -- 17 perpendicular to the plane of the mouth opening. In general, the minor axis 17 -- 17 is parallel with the major axis 16 -- 16. However, it is not necessary to do so, and the two axes may be intersected with a small angle. The extended curved neck 425 may start from almost anywhere on the spill-resistant container 400 but usually starts from the top wall 410 or from the sidewall near the top wall and on the opposite side of the flat sidewall 406. A passageway 435 along a two dimensional curved centerline 475 of the extended curved neck connects the mouth opening 430 at one end to the inner chamber 420 of the spill-resistant container 400 at the other end 431. The distance 480 from the two dimensional curved centerline 475 to the bottom of the container 415 is generally increasing or remain the same from the inner chamber at 431 to the apex 470 of the curved neck. After the spill-resistant container is filled with liquid in the upright position, it can be laid flat on the sidewall 406 and the liquid inside the chamber 420 will not flow out even if the liquid level line 445 inside the chamber 420 is higher than the liquid level line 450 at the mouth opening as long as it is oriented correctly with the "7", "Z" or "S" shaped curved neck in the upright position where the mouth opening 430 end of the curved neck is on the upper most location when the spill-resistant container is laid down flat before tilting as shown in Figure 15 with angle A at zero degree. The bottom wall 415 is lifted further to pour the liquid. The liquid will not start to flow until the angle "A" reaches a pouring angle, which can be anywhere between zero (0) to nearly ninety (90) degrees. This angle "A" is determined by the shape, size, curvature, and restrictions of the passageway 435. When this angle "A" reaches the pouring angle, outside air will start to enter the inner chamber at the liquid level line 450 in the extended curved neck 425 and at

the same time liquid inside the inner chamber will start to flow out. Describe it in a different way, after the spill-resistant container is filled with liquid in the upright position, it can be laid flat on the sidewall 406 and the liquid inside the chamber 420 will not flow out even if the liquid level line 445 inside the chamber 420 is higher than the liquid level line 450 at the mouth opening as long as it is being rotated in the counter-clockwise direction where the counter-clockwise direction is defined as follows:

A two dimensional curved centerline 475 of the curved passageway lying on a cross-sectional plane. A pivoting axis 485 perpendicular to the cross-sectional plane which defines the rotating axis of the container, wherein the container is said to be rotated in a counter-clockwise direction when the angle A as shown in Fig 15 is increasing while the cross-sectional plane remains vertical. The container is rotated further to pour the liquid. The liquid will not start to flow until the angle " A " reaches a pouring angle, which can be anywhere between zero (0) to nearly ninety (90) degrees.

The extended curved neck feature may be built-in with the spill-resistant container (as shown in Figures 15-1, and 15-2) or built into a cap 455 by then attaching the cap to any existing container with a gasket 460 for leak proofing (as shown in Figure 15-3). Optional closing cap or plug 465 may be used to enclose the spill-resistant container mouth opening when the container is not in use or during transportation.

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Figure 16 shows the top view of a planter 510, which could be any ordinary existing planter. As an example, Figure 16 shows a rectangular planter 510 with three planter inserts 515 inside, the shape of this planter can be square, circular, rectangular or any other shape and size. Depending on the shape and size of the planter 510, one or more planter insert(s) 515 can be inserted into the planter. Regardless of the number of planter inserts in planter 510 there is only one spill-resistant container 520 needed. All planter insert(s) 515 will be sharing water supply from this common spill-resistant container 520. The planter insert has an exterior shallow water well 525 at the bottom of the planter insert to receive the discharge opening mouth 530 of the spill-resistant container 520 (better shown in Figure 17). Partial vacuum inside the spill-resistant container 520 and the height of the discharge opening mouth 530 will control the water line 535 in the shallow water well 525 at a constant level for as long as there is water in the spill-resistant container 520. Connecting tubes 540 connect all

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shallow water wells 525 together. Since all planter inserts are at the same elevation, water from spill-resistant container 520 can be distributed to every planter insert's shallow water well 525 and maintain all water lines 535 to the same level. Small opening 545 (shown in Figure 17) on the sidewall of the planter insert 515 communicates shallow water well 525 with the interior of the planter insert thus allowing water to enter the planter insert 515 to feed the potting medium 550 and plants 555 in each planter insert 515. Usually the sidewall of planter 510 is made of material that is opaque; water level inside spill-resistant container 520 is hard to determine. The exposed upper end of the spill-resistant container 520 (the bottom of the spill-resistant container after turned over and inserted to the planter becomes the top exposed surface) will not have a good clear view of the full depth of spill-resistant container. A specially designed water level indicator can be attached to the spill-resistant container requiring only a relatively small transparent viewing area 560 to show the entire range of water level. The design and its operation of this water level indicator will be described later in Figure 29.

As an alternate, one single shallow water well that is large enough to receive all the planter insert(s) and the spill-resistant container may be used in stead of individual shallow water wells and connected with connecting tubes. The planter itself could also be acted as shallow water well as long as the drain holes (if any) in the planter are located above the desired water level line.

Figure 17 is a cut away partial cross-sectional view of Figure 16 along line 117 - 117 with potting medium and plants omitted from the planter insert. All planter inserts 515 in Figure 16 are placed at the same elevation (only one planter insert is shown) and are connected through connecting tube 540 at shallow water wells. This assures that the water level line 535 at each and every planter inserts be at the same level and is maintained by spill-resistant container 520 at the discharge opening mouth 530. Potting medium and plants inside each planter insert (omitted from the figure) is therefore supported with proper water supply for plant growth.

Figure 18 shows the same cross-sectional view of figure 17 except that this figure shows how the spill-resistant container is inserted into the planter after water is refilled and

the container is partially turned over almost 180 degrees. Because of the extended curved neck feature incorporated into the design, the spill-resistant container 520 is capable of turning over with water level inside the spill-resistant container being above the discharge mouth opening without spilling any water.

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Figure 19 shows five cross-sectional views of the spill-resistant container 520 at different stages of refilling and inserting into the planter. Figure 19 - A shows that the spill-resistant container is turned right side up with the cap 565 removed from the body of the container 570 for refilling. A hook 575 is provided for hanging onto the planter insert. It is shown as part of the container but can be a separate piece and attached to the container. The cap 565 has a supporting stand 580 used to support the spill-resistant container and maintains the proper height of the discharge mouth opening 530 while inserted into the planter 510. The extended curved neck 585 is also attached to the cap in this example. Figure 19 - B shows that the water is refilled and the cap 565 is attached to the spill-resistant container body 570 with a sealing gasket 590. Figures 19 - C and 19 - D show the spill-resistant container is turned over for insertion into the planter. Because the extended curved neck 585 has the form of a number "7", or in the form of a letter "Z" or "S" and it is oriented correctly with the "7", "Z" or "S" shaped curved neck in the upright position where the mouth opening end 530 of the curved neck 585 is on the upper most location when the spill-resistant container is laid down flat (as shown in Figure 19 - C) before tilting further (as shown in Figure 19 - D), water inside this spill-resistant container will not start to flow out as long as the tilting angle A (shown in Figure 19 - D) is less than the predetermined tilting angle. After insertion, the spill-resistant container is hooked to the planter insert and seated inside the planter (as shown in Figure 17). And the spill-resistant container 520 is positioned upright as shown in Figure 19 - E where the angle B is greater than the predetermined tilting angle. Water will start to flow out and control the proper water level line 535 inside the shallow water well 525. Spill-resistant container shown in Figure 19 is just an exemplary configuration. The container body 570 and the cap 565 could be an integral single piece with a simple refill hole for refilling or without any hole other than the discharge-opening hole 530. In this case, the refilling will be accomplished through the discharge-opening hole 530.

Figure 20 shows the top view of an alternate embodiment of the present invention.

The planter insert 515 has wavy sidewalls 595 against the interior of the planter sidewall 600. In this example, only one planter insert 515 is fitted inside the planter 510. Spill-resistant container 520 hangs to the sidewall of the planter insert with its hook 575 and its discharge opening mouth 530 received by the shallow water well 525. The purpose of this planter insert

5 515 is to provide a maximized interface areas of ambient air with the potting medium and the root system of the plant (not shown and omitted from the figure). This is achieved by utilizing any suitable forms of wavy sidewalls 595 of the planter insert 515 against the inside surfaces of the planter sidewalls 600 such that narrow air passageways 605 are formed. The wavy sidewalls 595 have small holes or perforations 610 (shown in Figures 21 and 23).

10 These holes allow the breathing of the root system with ambient air in the air passageways 605. Potting medium fill the planter insert where plant is potted (not shown). The bottom layer of the potting medium submerged under the water level line. Capillary action along with the suction of the root system carries water to the upper portion of the potting medium and therefore supports the plant growth. A small transparent area 560 on the spill-resistant

15 container 520 is also shown where the water level indicator may be attached.

Figure 21 shows the cross-sectional view of another alternate embodiment of the present invention. This embodiment has basically the same construction of Figure 20 except that additional air passage partitions and an air circulation fan 620 is added.

20 Figure 22 is the cross-sectional view of Figure 21 along line 122 - 122. The purpose of this planter insert 515 is the inclusion of a circulation fan 620 to enhance airflow in addition to maximize the interface areas of ambient air with the potting medium and the root system of the plant (not shown). The wavy sidewalls 595 of the planter insert 515 against the

25 inside surfaces of the planter sidewalls 600 formed narrow air passageways 605. The wavy sidewalls 595 have small holes or perforations 610 for air to pass through. A circulation fan 620 is located at the bottom center of the planter insert 515 slightly above the water level line 535. The use of circulation fan helps to increase airflow through the potting medium and the root system. The circulating air is then passed through the small holes or perforation 610 of

30 the planter insert and down through the air passageways 605 to the bottom of the planter. Partition walls 615 at the bottom of the planter insert forms air inlet ducting 625, which guides the circulating air toward the suction side 630 of the fan 620. Discharge duct 635

guides the exhaust air to the ambient through the gaps of spill-resistant container 520 and the planter 510. Potting medium fill the planter insert where the plant is potted (not shown). The bottom layer of the potting medium submerged under the water level line 535. Capillary action along with the suction of the root system carries water to the upper portion of the potting medium and therefore supports the plant growth. A small transparent area 560 on the spill-resistant container is also shown where the water level indicator may be attached.

Figure 23 is a cross-sectional view of another alternate embodiment of the present invention. This embodiment has basically the same construction of Figure 21 except that the discharge air from air circulation fan 620 is directed upward to include a lamp 640 through the discharge duct 635 along with a glass shield 645 and a lamp shade 650 in addition to maximize the interface areas of ambient air with the potting medium and the root system of the plants (not shown).

Figure 24 is the cross-sectional view of Figure 23 along line 124 - 124. The wavy sidewalls 595 of the planter insert 515 against the inside surfaces of the planter sidewalls 600 formed narrow air passageways 605. The heat of the lamp will heat the air and cause the air to rise and pass through the air gap 655 between light bulb 640 and the glass shield 645. This rise of air creates a suction at the discharge duct 635 which in turn pulls ambient air to pass through potting medium and the root system than through holes or perforation 610 and down the air passageways 605, the air inlet ducting 625 to the discharge duct 635. The circulation fan 620 located at the bottom of the discharge duct 635 and above the water level line 535 will enhance air circulation further. Too much airflow may cause the light bulb 640 being unable to heat the air hot enough for sterilization. Potting medium (not shown) fills the insert where the plant is potted. The bottom layer of the potting medium submerged under the water level line 535. Capillary action along with the suction of the root system carries water to the upper portion of the potting medium and therefore supports the plant growth. A small transparent area 560 on the spill-resistant container 520 is also shown where the water level indicator may be attached.

Figure 25 shows yet another alternate embodiment of the present invention. The planter insert 515 can be in the form of any one of the pre-mentioned designs as shown in

Figures 16, 17, and 20 - 24 however, the water container 521 is very large and will be set in place and not to be removed for refilling. The shape of the water container 521 as shown in figure 25 is in the form of a donut but can be in the forms of a rectangular, semi circular or any other suitable shape.

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Figure 26 shows the cross-sectional view of Figure 25 along line 126 - 126. When water in the water container 521 is exhausted, a refill cap 660 is removed from the refill opening 665 for refill. At this time, the partial vacuum inside the water container is no longer exist and any water filled into the water container will immediately tend to flow out from the discharge mouth opening 531 and flood the planter insert 515 to cause the water line 535 to rise. A special design as shown in Figure 27 will prevent it from happening.

Figure 27 - A is a simple assembly 670 to be inserted into the water container 521 (Figure 27 - B, and 27 - C) at the refill opening 665. This simple assembly 670 has a small insert 675 in the form of an inverted cup which slide fitted and covers the discharge mouth opening 531 as shown in Figure 27 - B and 27 - C. A flapper 680 with a bent arm 685 is attached to the small insert 675 at the hinge 690. At the other end of the bent arm 685 is hinge mounted with a push rod 695. The upper end of the push rod will be anchored to the refill opening 665 with any suitable means and allow it to slide up and down. A new discharge opening 700 is made on the small insert 675. The flapper 680 is heavier than the total weight of the bent arm 685 and the push rod 695 and therefore tend to flip down while raising the bent arm 685 and push up the push rod 695 as shown in Figure 27 - B when the refill cap 660 is removed from the refill opening 665. When the flapper 680 drops down, it covers and seals the new discharge opening 700 and stops the water from flowing out of the water container during refilling. Figure 27 - C shows that when the water is refilled and the refill cap 660 is attached to the refill opening 665. At the same time, the refill cap also pushes down the push rod 695 and tilting the bent arm to lift the flapper 680. The lifting of the flapper uncovers the discharge opening 700 thereby allows water to flow out. Otherwise, the operation of the planter insert and the water container is the same as those described in Figures 16, 17, and 20-24. A small transparent area 560 on the water container 521 is also shown where the water level indicator may be attached.

Figure 28 shows an alternate design of Figure 27 to control water flow during water container refill. Figure 28 - A shows the refill cap 660 is removed from the refill opening 665 for water refill. A three armed rock arm 705 is attached near the refill opening allowing to pivot the third arm of the three armed rock arm between two up and down positions as shown in figure 28 - A and 28 - B. The refill cap 660 has a concave shaped plug 710 (as shown in Figure 28 - B) which will trigger the pivoting of the three armed rock arm to pivot. When the refill cap 660 is removed from the refill opening 665, the concave shaped plug 710 will cause the three armed rock arm to turn clockwise to the position as shown in Figure 28 - A. At this position, the third arm 715 of the three armed rock arm 705 is in the down position which lowers the stopper flapper 720 by lowering the string 725 connecting them. The stopper flapper 720 at the down position covers the discharge mouth opening 531 and therefore prevented water from flowing out of the water container 521 during refill. After the water container 521 is refilled and the refill cap 660 is replaced to the water container, the concave shaped plug 710 will push the three armed rock arm 705 to rotate in the counter-clockwise direction to the position shown in Figure 28 - B. In this case the third arm 715 of the rock arm 705 is in the upper position and lifting the string 725 and stopper flapper 720. In this position, the stopper flapper uncovers the discharge mouth opening 531 and allows water to flow. The water level in the planter insert is controlled the same way as that described earlier.

Figure 29 shows a water level indicator 730 of the present invention. The objective of this indicator is to show the full range of water level inside a water container from a relatively small viewing area 560, a small transparent piece of mounting surface. Attached to this small piece of surface are two guide tubes 735 and 740 (can be guide rails or any other suitable guiding structures), one for the float 745 and the other for the weight 750. There are also a number of hoops or clamps 755 on the mounting surface 560. A string divided into two colored sections say red section 760 and white section 765 and connected at the junction 770. The string connects the float 745 and the weight 750 at the two ends. The string loops around the hoops or clamps 755 in a zigzag path 775 as shown in Figure 29 in a very small area. If the water container has transparent surfaces, this water level indicator can be attached to the inside surface of the water container. Otherwise, the water container can have a cut opening and replaced it with the transparent piece of this water level indicator and the joint line sealed. After the water container is inserted into the planter, the transparent piece 560 of the

water level indicator is on the top as indicated in Figure 29. When the water in the water container is full, the float 745 will be floated to the top and the weight 750 will sink to the bottom of the water container. As water gradually leave the water container and the water level start to drop, the float 745 will follow the water level and start to drop as well. The weight 750 on the other end of the string is lighter than the weight of the float and thus being pulled up and hanging in the air. The length of the string is (the combined length of red 760 and white 765 strings) properly measured so that it is always in tension between the float 745 and the weight 750. The up and down movement of the float 745 due to the water level change also cause the junction point 770 of the two colored string to move along the zigzag path 775. When water is full, the float is up and the red string will be showing in the zigzag path 765. When water is nearly empty as shown in Figure 29, the float will be near the bottom and more white string will be showing in the zigzag path. Calibration marking 780 can thus be placed on the transparent piece to indicate the true water level for the entire range of the water container. This water level indicator can be applied to any one of the previously described water containers 520 and 521 where only the viewing areas 560 were depicted while the detailed water level indicator structures were omitted in those views. It can also be applied to any other liquid container where the viewing area is limited to a small area at one end of the container.

Figure 30 shows the vertical cross-sectional view of the present improved spill-resistant container 810 invention. The horizontal cross-sectional view along line 201 – 201 (the sectional view is not shown), the main body of the container, may be circular, square, rectangular, oval or any other desired shape. The carrying handle 820 as shown is desirable for larger size containers but not essential and could be located at different locations on the container. A major axis 202 – 202 generally defines the vertical centerline of the container. The container is in its upright position when the major axis is vertical with the upper end of the container on the top. The curved neck 830 provides the spill-resistant feature of the invention and is generally located at the top end region of the container. This curved neck could be in the shape of the number “7”, the letter “Z” or the letter “S” with at least one bent or curve having an apex 835. A mouth opening 840 is located at one end of the curved neck and a curved passageway 850 as defined by a two dimensional curved centerline 855 of the curved neck. The mouth opening 840 portion of the curved neck is at the upper portion of the

number "7", letter "Z", or letter "S". A minor axis 203 – 203 perpendicular to the plane of the mouth opening 840 is generally parallel with the major axis 202 – 202. However, it is not necessary to be so, and the two axes could be intersected with a small angle. The curved passageway 850 connects the mouth opening 840 with the inner chamber 860 of the improved spill-resistant container 810 at the other end of the curved passageway 845. A vent passageway 870 next to the curved passageway 850 having the same shape of the number "7", the letter "Z" or the letter "S" also connects from near the top of the mouth opening 840 to the inner chamber 860 of the improved spill-resistant container 810 at the end of the curved vent passageway 846.

During the filling process of the improved spill-resistant container, liquid is filled from the mouth opening 840 through the curved passageway 850 into the inner chamber 860. At the same time, air inside the chamber 860 is vented through the vent passageway 870 to the ambient. Using a high speed filling machine, the vent passageway may be connected to a vacuum chamber where lower pressure is maintained so that air inside the improved spill-resistant container is drawn out at a higher rate thus allowing the filling to be accomplished at a faster rate.

When pouring liquid from the improved spill-resistant container, especially when the container is full at the full line 880, liquid will not flow out or spill from the container if the improved spill-resistant container is turned correctly with the "7", "Z" or "S" shaped curved neck turned to the upright position where the mouth opening 840 of the curved neck 830 is on the upper portion of the number "7", or letter "Z", or letter "S" when the container is laid down (as shown in Figure 31 – A) where the major axis 202 – 202 is in the substantially horizontal position. This is due to the fact that a partial vacuum is created inside the inner chamber which prevents the liquid from flowing out. As shown in Figure 31 – A, when the improved spill-resistant container is in the laid down position, the liquid level inside the inner chamber is shown at line 890 and the liquid level at the curved passageway is shown at line 900. When the improved spill-resistant container is tilted further (as shown in Figure 31 - B) and the tilting angle A is equal to or greater than the starting angle, liquid inside will flow out from the inner chamber. When the tilting angle A equals the starting angle, the liquid line inside the inner chamber becomes line 890' and the liquid line at the curved passageway

becomes line 900'. The starting angle is the minimum tilting angle where air from outside will start to enter the improved spill-resistant container at location 910 at the end of the curved passageway 850 and the liquid level line 900' as shown in Figure 31 – B. As soon as air starts to enter the inner chamber, the vacuum inside the inner chamber is lost and liquid
5 will start to flow. The vent passageway 870 next to the curved passageway 850 has the same “7”, “Z” or “S” shaped curvature also preventing liquid from flowing out of the inner chamber when the tilting angle is less than the starting angle. When the tilting angle is much greater than the starting angle, more liquid flows out through the curved passageway 850 and leaves no room in the curved passageway 850 for air to enter if there is no vent passageway
10 870. This will cause the interior of the inner chamber to have a partial vacuum and temporarily stop liquid from flowing out. As soon as liquid stops to flow out, air will reenter the inner chamber and eliminate the vacuum inside and resume the liquid flow again. This intermittent and repeated liquid flowing out and air flowing in makes the flow of liquid very unstable and is commonly called “glugging”. With a vent passageway 870 beside the curved
15 passageway 850, the entire curved passageway 850 may be dedicated to the flowing of liquid and the venting of air is accomplished by the vent passageway 870, thus eliminating or greatly improved the very undesirable “glugging” condition.

Various modifications to the depicted and described apparatus will be apparent to
20 those skilled in the art. Accordingly, the forgoing detailed description of the preferred embodiment should be considered exemplary in nature and not as limiting to the scope and spirit of the invention as set forth in the appended claims.

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

1. A liquid bottle comprising;

a container for the storage of liquid with a major axis along the center line of the container; and

a curved neck at the top end region of the container; and

a curved passageway along the center line of the said curved neck with a mouth opening communicating the said container with the ambient; and

the said curved passageway has the basic form of a number “ 7 ”, a letter “ Z ” or a letter “ S ”; and

the said mouth opening is located at a terminating end of an upper portion of the curved neck having the form of the number “ 7 ” or letters “ Z ” or “ S ”; and

after filling the container with liquid, the said container may be laid down with the bottom end of the container being higher than the top end of the container and the liquid level line inside the container being higher than the liquid level line at the mouth opening of the curved neck without spilling liquid as long as the “ 7 ” or “ Z ” or “ S ” shaped curved neck is positioned such that the number “ 7 ” or letters “ Z ” or “ S ” is oriented in the upright direction when the container is laid down (the major axis is in the substantially horizontal direction) and the mouth opening of the curved neck is on the upper most position; and

the size, shape, and the curvature of the curved passageway determine the starting angle where the liquid inside the container will begin to flow out from the container, and

the starting angle is a tilting angle of the container when the outside air starts to enter the container and liquid starts to flow out from the container.

2. A liquid bottle comprising;

a container for the storage of liquid with a major axis along the center line of the container; and

an extended curved neck at the top end region of the container; and

a curved passageway along the center line of the said extended curved neck with a mouth opening communicating the said container with the ambient; and

the said curved passageway has the basic form of a number “ 7 ” a letter “ Z ” or a letter “ S ”; and

the said mouth opening is located at a terminating end of an upper portion of the extended curved neck having the form of the number “ 7 ” or letters “ Z ” or “ S ”; and

after filling the container with liquid, the said container may be laid down with the bottom end of the container at higher than the top end of the container as long as the “ 7 ” or “ Z ” or “ S ” shaped extended curved neck is positioned such that the number “ 7 ” or letters “ Z ” or “ S ” is oriented in the upright direction when the container is laid down (the major axis is in the substantially horizontal direction) and the mouth opening of the extended curved neck is on the upper most position; and

vacuum created inside the container allows the tilting of the container further such that the liquid level line inside the container is higher than the liquid level line at the mouth opening of the curved neck and prevents the flowing of liquid from the container until a tilting angle is greater than a predetermined starting angle; and

the said container is substantially rigid such that the container walls are capable of withstand the vacuum created inside the bottle without being deflexed appreciably; and

the size, shape, and the curvature of the said extended curved passageway determine the starting angle which is the tilting angle of the container when outside air starts to enter the container and liquid inside the container will begin to flow out from the container.

3. A liquid bottle comprising;

an existing container with an opening at the top for the storage of liquid; and

a mating piece having a mating end threaded to or plugged into the opening of the said existing container using a gasket or sealant for preventing leakage when needed; and

a curved neck at a far end region of the mating end of the said mating piece; and

a curved passageway along the center line of the said curved neck with a mouth opening communicating the said container with the ambient; and

the said curved passageway has the basic form of a number “ 7 ” a letter “ Z ” and a letter “ S ”; and

the said mouth opening is located at a terminating end of an upper portion of the curved neck having the form of the number “ 7 ” or letters “ Z ” or “ S ”; and

after filling the container with liquid, the said container may be laid down with the bottom end of the container being higher than the top end of the container and the liquid level line inside the container being higher than the liquid level line at the mouth opening of the curved neck without spilling liquid as long as the “ 7 ” or “ Z ” or “ S ” shaped curved neck is positioned such that the number “ 7 ” or letters “ Z ” or “ S ” is oriented in the upright direction when the container is laid down (the major axis is in the substantially horizontal direction) and the mouth opening of the curved neck is on the upper most position; and

the size, shape, and the curvature of the curved passageway determine the starting angle where the liquid inside the container will begin to flow out from the container, and

the said starting angle is a tilting angle of the container when outside air starts to enter the container and liquid starts to flow out from the container.

4. A spill-resistant container comprising:

a body including a top region and a base located opposite the top region, the base being configured to rest on a horizontal surface, the body defining an interior volume in the container for storing a liquid;

a neck connected to the top region of the body which defines and encloses a bent passageway having a first end and a second end, the bent passageway having a bent centerline;

a first opening located at the first end of the bent passageway, the first opening coupling the bent passageway to the interior volume of the container;

an unrestricted second opening located at the second end of the bent passageway, the second opening coupling the bent passageway to the exterior of the container and being sufficiently large to permit the pouring of the liquid out of the container;

a first bend defined by the bent passageway and located between the first end and second end of the bent passageway, the first bend having an apex and the distance between the base and a point of the bent centerline of the bent passageway increasing or remaining the same as the point travels from the first opening to the apex of the first bend;

wherein the bent passageway is configured to determine a start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the bent passageway, and if the container is tilted less than the start-to-pour angle, outside air can not

enter the interior volume of the container and the liquid does not pour out of the second opening of the bent passageway even if the distance between the level of the liquid inside the container and the horizontal surface is greater than the distance between the apex of the first bend and the horizontal surface;

a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

5. The spill-resistant container of claim 4 wherein the first bend is a curve having a radius.
6. The spill-resistant container of claim 4 wherein the first bend is an angled junction between two arcs, or two straight sections.
7. The spill-resistant container of one of claims 4 to 6 wherein the body forms a rectangularly shaped container.
8. The spill-resistant container of one of claims 4 to 6 wherein the body forms a spherically, elliptically, or other irregularly shaped container.
9. The spill-resistant container of one of claims 4 to 8 wherein the container is semi-rigid.
10. The spill-resistant container of one of claims 4 to 9 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees.
11. The spill-resistant container of one of claims 4 to 9 wherein the start-to-pour angle is approximately 90 degrees.
12. The spill-resistant container of one of claims 4 to 11 wherein as the container is tilted and the liquid starts to pour from the body, a partial vacuum is created inside the container which

establishes the start-to-pour angle at which outside air begins to enter the interior volume of the container and the liquid starts to flow out of the second opening of the bent passageway.

13. The spill-resistant container of one of claims 4 to 12 wherein the bent passageway and the vent passageway include a second bend located between the first bend and the first opening.

14. The spill-resistant container of claim 13 wherein the bent passageway defines a bent centerline inside the bent passageway extending from the first opening through the first and second bends and to the second opening, the distance between a point of the bent centerline and the base increasing or being equal as the point travels from the first opening to the second opening.

15. The spill-resistant container of any one of claims 4 to 14 wherein at least a portion of the neck is detachable from the container.

16. A spill-resistant container for a liquid comprising:

a body having a base and a first axis that intersects the base, the body defining an interior volume about the first axis for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is rotated to a start-to-pour angle relative to the horizontal surface;

a neck located at a first portion of the body and defining a curved passageway and a parallel curved vent passageway having a first end and a second end, the first portion being opposite of the base;

a first opening located at the first end of the curved passageway and vent passageway to couple the interior of the curved passageway and the vent passageway with the interior volume of the container;

an unrestricted second opening located at the second end of the curved passageway and the vent passageway to couple the interior of the curved passageway and the vent passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container;

a first curve located between the first end and the second end of the curved passageway and defining a two dimensional curved centerline within the curved passageway, the two dimensional curved centerline lying on a first plane which is substantially vertical with respect to the horizontal surface, the first curve having an apex and the distance between the base and a point of the curved centerline of the curved passageway increasing or remaining the same as the point travels from the first opening to the apex of the first curve;

a second axis perpendicular to the first plane which defines a pivot for rotating the first plane, wherein the first plane is defined to be rotating in a counter-clockwise direction when the first plane is rotating about the second axis such that the first opening is rotated toward the second opening along the two dimensional curved centerline while the first plane remains substantially vertical with respect to the horizontal surface;

the curved passageway being configured to determine the start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the curved passageway when the container is rotated in the counter-clockwise direction, the curved passageway being further configured such that if the base is rotated relative to the horizontal surface at an angle less than the start-to-pour angle when the container is rotated in the counter-clockwise direction, outside air can not enter the interior volume of the container and the liquid in the container does not pour out of the second opening of the curved passageway nor the vent passageway even if the level of the liquid inside the container is higher than the second opening of the curved passageway;

when the container is rotated further where larger amount of liquid pouring out from the container through the curved passageway, little or no room is left in the curved passageway for air to enter the container and the vent passageway provides the dedicated passageway for air to enter the container.

17. The spill-resistant container of claim 16 wherein the body forms a rectangularly shaped container.

18. The spill-resistant container of claim 16 wherein the body forms a spherically, elliptically, or other irregularly shaped container.

19. The spill-resistant container of any one of claims 16 to 18 wherein the container is semi-rigid.
20. The spill-resistant container of any one of claims 16 to 19 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees.
21. The spill-resistant container of any one of claims 16 to 19 wherein the start-to-pour angle is approximately 90 degrees.
22. The spill-resistant container of any one of claims 16 to 21 wherein as the container is rotated and the liquid starts to flow from the first opening toward the second opening, a partial vacuum is created inside the container which establishes the start-to-pour angle at which outside air starts to enter the interior volume of the container and the liquid starts to flow out of the second opening of the curved passageway.
23. The spill-resistant container of any one of claims 16 to 22 wherein the curved passageway and the vent passageway include a second curve.
24. The spill-resistant container of claim 23 wherein the second curve is located between the first curve and the first opening.
25. The spill-resistant container of any one of claims 16 to 24 wherein at least a portion of the neck is detachable from the container.
26. A liquid-storage container having an opening converted by adding a curved neck into a spill-resistant container, the container having a base configured to rest on a horizontal surface, the curved neck comprising:
 - a neck body defining a curved passageway and a parallel vent passageway having a first end plane, a second end plane and a first curve located between the first end plane and the second end plane the neck being adapted to be attached to the container at a side opposite of the

base, the curved passageway having a first curve and defining a curved centerline within the curved passageway, the first curve having an apex and the distance between the base and a point of the curved centerline of the curved passageway increasing or remaining the same as the point travels from the first opening to the apex of the first curve;

a first opening located at the first end plane of the curved passageway and vent passageway;

a connector located at the first end plane of the curved passageway and the vent passageway which permits the first opening of the curved passageway and the vent passageway to be sealingly connected to the opening of the container;

an unrestricted second opening located at the second end plane of the curved passageway and vent passageway and being sufficiently large to permit the pouring of the liquid out of the container;

when the curved neck is connected to the container to form a spill-resistant container, the curved passageway determines an angle wherein if the container is rotated equal to the angle, the liquid starts to pour out of the second opening of the curved passageway; if the container is rotated more than the angle, the liquid inside the container flows out of the second opening of the curved passageway, and if the container is rotated less than the angle, the liquid does not pour out of the second opening of the curved passageway even if the distance between the level of the liquid inside the container and the horizontal surface exceeds the distance between the second opening and the horizontal surface;

a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

27. The liquid-storage container of claim 26 wherein the connector is sealingly mateable to the opening of the container.

28. The liquid-storage container of claim 26 wherein the connector is permanently attachable to the opening of the container.

29. The liquid-storage container of any one of claims 26 to 28 wherein the curved passageway and the vent passageway include two curves.
30. The liquid-storage container of any one of claims 26 to 29 wherein the angle is greater than approximately 90 degrees and less than 180 degrees.
31. A spill-resistant container for a liquid comprising:
- a body having a base and an axis that intersects the base, the body defining an interior volume around the axis in the container for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is tilted at a start-to-pour angle from the horizontal surface;
 - a neck located at a first portion of the body and defining a bent passageway having a first end and a second end, the first portion being located opposite the base;
 - a first opening located at the first end of the bent passageway to couple the bent passageway with the interior volume of the container;
 - an unrestricted second opening located at the second end of the bent passageway to couple the bent passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container;
 - a first bend located between the first end and the second end of the bent passageway;
 - the bent passageway having a bent centerline inside the bent passageway extending from the first opening through the first bend to the second opening of the bent passageway, the distance between the bent centerline and the base stays the same or increasing along the bent passageway starting from the first opening through the first bend to the second opening;
 - the bent passageway further being configured to determine the start-to-pour angle between the base and the horizontal surface at which the liquid inside the container starts to flow out of the second opening of the bent passageway;
 - wherein the bent passageway is configured such that if the base is tilted from the horizontal surface at an angle less than the start-to-pour angle, the liquid does not pour out of the second opening of the bent passageway even if the level of the liquid in the container is higher than the bent centerline;

a smaller vent passageway parallel to the bent passageway located within the same curved neck and having the same form of curvature as the bent passageway, coupling the vent passageway to the interior volume of the container at one end and the exterior of the container on the other end in a parallel path as the bent passageway.

32. The spill-resistant container of claim 31 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees.

33. The spill-resistant container of claim 31 wherein the start-to-pour angle is approximately 90 degrees.

34. The spill-resistant container of any one of claims 31 to 33 wherein the bent passageway and the vent passageway include a second bend.

35. The spill-resistant container of any one of claims 31 to 34 wherein the first bend having an apex and the distance between the base and a point of the bent centerline of the bent passageway increasing or remaining the same as the point travels from the first opening to the apex of the first bend.

36. A spill-resistant container comprising:

a body including a top region and a base located opposite the top region, the base being configured to rest on a horizontal surface, the body defining an interior volume in the container for storing a liquid;

a neck connected to the top region of the body which defines and encloses a bent passageway having a first end and a second end, the bent passageway having a bent centerline;

a first opening located at the first end of the bent passageway, the first opening coupling the bent passageway to the interior volume of the container;

an unrestricted second opening located at the second end of the bent passageway, the second opening coupling the bent passageway to the exterior of the container and being sufficiently large to permit the pouring of the liquid out of the container;

a first bend defined by the bent passageway and located between the first end and second

end of the bent passageway, the first bend having an apex and the distance between the base and a point of the bent centerline of the bent passageway increasing or remaining the same as the point travels from the first opening to the apex of the first bend;

wherein the bent passageway is configured to determine a start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the bent passageway, and if the container is tilted less than the start-to-pour angle, outside air can not enter the interior volume of the container and the liquid does not pour out of the second opening of the bent passageway even if the distance between the level of the liquid inside the container and the horizontal surface is greater than the distance between the apex of the first bend and the horizontal surface;

where the start-to-pour angle is greater than 45 degrees and less than 180 degrees.

37. The spill-resistant container of claim 36 wherein the first bend is a curve having a radius.

38. The spill-resistant container of claim 36 wherein the first bend is an angled junction between two arcs, or two straight sections.

39. The spill-resistant container of any one of claims 36 to 38 wherein the body forms a rectangularly shaped container.

40. The spill-resistant container of any one of claims 36 to 38 wherein the body forms a spherically, elliptically, or other irregularly shaped container.

41. The spill-resistant container of any one of claims 36 to 40 wherein the container is semi-rigid

42. The spill-resistant container of any one of claims 36 to 41 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees

43. The spill-resistant container of any one of claims 36 to 41 wherein the start-to-pour angle

is approximately 90 degrees

44. The spill-resistant container of any one of claims 36 to 43 wherein as the container is tilted and the liquid starts to pour from the body, a partial vacuum is created inside the container which establishes the start-to-pour angle at which outside air begins to enter the interior volume of the container and the liquid starts to flow out of the second opening of the bent passageway.

45. The spill-resistant container of any one of claims 36 to 44 wherein the bent passageway includes a second bend located between the first bend and the first opening.

46. The spill-resistant container of claim 45 wherein the bent passageway defines a bent centerline inside the bent passageway extending from the first opening through the first and second bends and to the second opening, the distance between a point of the bent centerline and the base increasing or being equal as the point travels from the first opening to the second opening.

47. The spill-resistant container of any one of claims 36 to 46 wherein at least a portion of the neck is detachable from the container.

48. A spill-resistant container for a liquid comprising:

a body having a base and a first axis that intersects the base, the body defining an interior volume about the first axis for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is rotated to a start-to-pour angle relative to the horizontal surface;

a neck located at a first portion of the body and defining a curved passageway having a first end and a second end;

a first opening located at the first end of the curved passageway to couple the interior of the curved passageway with the interior volume of the container;

an unrestricted second opening located at the second end of the curved passageway to couple the interior of the curved passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container;

a first curve located between the first end and the second end of the curved passageway and defining a two dimensional curved centerline within the curved passageway, the two dimensional curved centerline lying on a first plane which is substantially vertical with respect to the horizontal surface;

a second axis perpendicular to the first plane which defines a pivot for rotating the first plane, wherein the first plane is defined to be rotating in a counter-clockwise direction when the first plane is rotating about the second axis such that the first opening is rotated toward the second opening along the two dimensional curved centerline while the first plane remains substantially vertical with respect to the horizontal surface;

the curved passageway being configured to determine the start-to-pour angle between the base and the horizontal surface at which outside air starts to enter the interior volume of the container and the liquid inside the container starts to flow out of the second opening of the curved passageway when the container is rotated in the counter-clockwise direction, the curved passageway being further configured such that if the base is rotated relative to the horizontal surface at an angle less than the start-to-pour angle when the container is rotated in the counter-clockwise direction, outside air can not enter the interior volume of the container and the liquid in the container does not pour out of the second opening of the curved passageway even if the level of the liquid inside the container is higher than the second opening of the curved passageway;

where the start-to-pour angle is greater than 45 degrees and less than 180 degrees.

49. The spill-resistant container of claim 48 wherein the body forms a rectangularly shaped container.

50. The spill-resistant container of claim 48 wherein the body forms a spherically, elliptically, or other irregularly shaped container.

51. The spill-resistant container of any one of claims 48 to 50 wherein the container is semi-rigid.

52. The spill-resistant container of any one of claims 48 to 51 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees.

53. The spill-resistant container of any one of claims 48 to 51 wherein the start-to-pour angle is approximately 90 degrees.

54. The spill-resistant container of any one of claims 48 to 53 wherein as the container is rotated and the liquid starts to flow from the first opening toward the second opening, a partial vacuum is created inside the container which establishes the start-to-pour angle at which outside air starts to enter the interior volume of the container and the liquid starts to flow out of the second opening of the curved passageway.

55. The spill-resistant container of any one of claims 48 to 54 wherein the curved passageway includes a second curve;

56. The spill-resistant container of claim 55 wherein the second curve is located between the first curve and the first opening.

57. The spill-resistant container of claim 16 wherein at least a portion of the neck is detachable from the container.

58. A liquid-storage container having an opening converted by adding a curved neck into a spill-resistant container, the container having a base configured to rest on a horizontal surface, the curved neck comprising:

a neck body defining a curved passageway having a first end plane, a second end plane and a first curve located between the first end plane and the second end plane;

a first opening located at the first end plane of the curved passageway;

a connector located at the first end plane of the curved passageway which permits the first opening of the curved passageway to be sealingly connected to the opening of the container;

an unrestricted second opening located at the second end plane of the curved passageway and being sufficiently large to permit the pouring of the liquid out of the container;

when the curved neck is connected to the container to form a spill-resistant container, the curved passageway determines an angle wherein if the container is rotated equal to the angle, the liquid starts to pour out of the second opening of the curved passageway; if the container is rotated more than the angle, the liquid inside the container flows out of the second opening of the curved passageway, and if the container is rotated less than the angle, the liquid does not pour out of the second opening of the curved passageway even if the distance between the level of the liquid inside the container and the horizontal surface exceeds the distance between the second opening and the horizontal surface;

where the angle is greater than 45 degrees and less than 180 degrees.

59. The liquid-storage container of claim 58 wherein the connector is sealingly mateable to the opening of the container.

60. The liquid-storage container of claim 58 wherein the connector is permanently attachable to the opening of the container.

61. The liquid-storage container of any one of claims 58 to 60 wherein the curved passageway includes two curves.

62. The liquid-storage container of any one of claims 58 to 61 wherein the angle is greater than approximately 90 degrees and less than 180 degrees.

63. A spill-resistant container for a liquid comprising:

a body having a base and an axis that intersects the base, the body defining an interior volume around the axis in the container for storing a liquid such that the container has an upright position when the base is parallel to a horizontal surface and the container has a start-to-pour position when the base is tilted at a start-to-pour angle from the horizontal surface;

a neck located at a first portion of the body and defining a bent passageway having a first end and a second end;

a first opening located at the first end of the bent passageway to couple the bent passageway with the interior volume of the container;

an unrestricted second opening located at the second end of the bent passageway to couple the bent passageway with the exterior of the container and the second opening being sufficiently large to permit the pouring of the liquid out of the container;

a first bend located between the first end and the second end of the bent passageway;

the bent passageway having a bent centerline inside the bent passageway extending from the first opening through the first bend to the second opening of the bent passageway, the distance between the bent centerline and the base stays the same or increasing along the bent passageway starting from the first opening through the first bend to the second opening;

the bent passageway further being configured to determine the start-to-pour angle between the base and the horizontal surface at which the liquid inside the container starts to flow out of the second opening of the bent passageway;

where the start-to-pour angle is greater than 45 degrees and less than 180 degrees; and;

wherein the bent passageway is configured such that if the base is tilted from the horizontal surface at an angle less than the start-to-pour angle, the liquid does not pour out of the second opening of the bent passageway even if the level of the liquid in the container is higher than the bent centerline.

64. The spill-resistant container of claim 63 wherein the start-to-pour angle is between approximately 90 degrees and 180 degrees, but less than 180 degrees

65. The spill-resistant container of claim 63 wherein the start-to-pour angle is approximately 90 degrees.

66. The spill-resistant container of any one of claims 63 to 65 wherein the bent passageway includes a second bend.

67. The spill-resistant container of any one of claims 63 to 66 wherein the first bend having an apex and the distance between the base and a point of the bent centerline of the bent passageway increasing or remaining the same as the point travels from the first opening to the apex of the first bend.

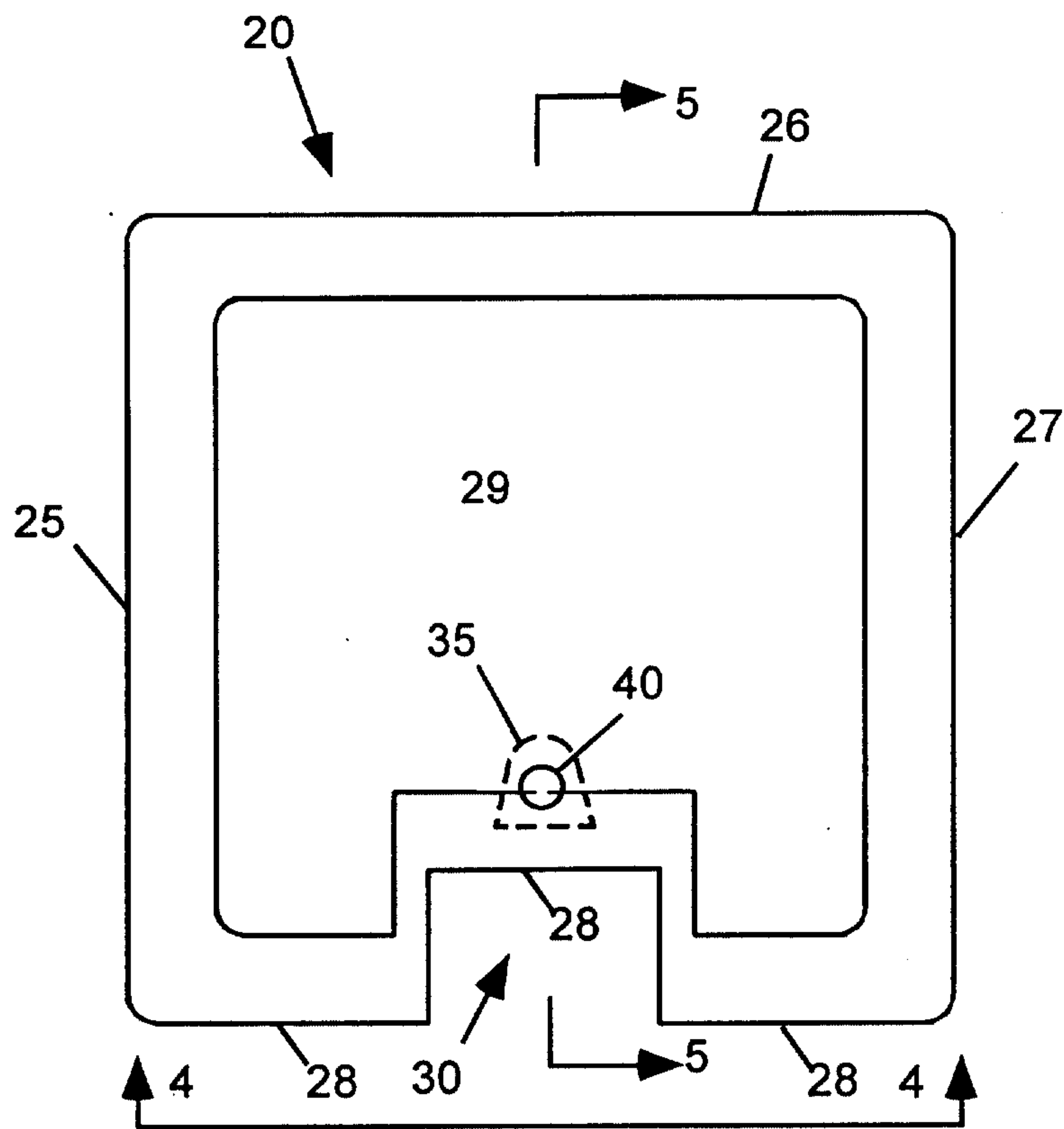


Figure 1

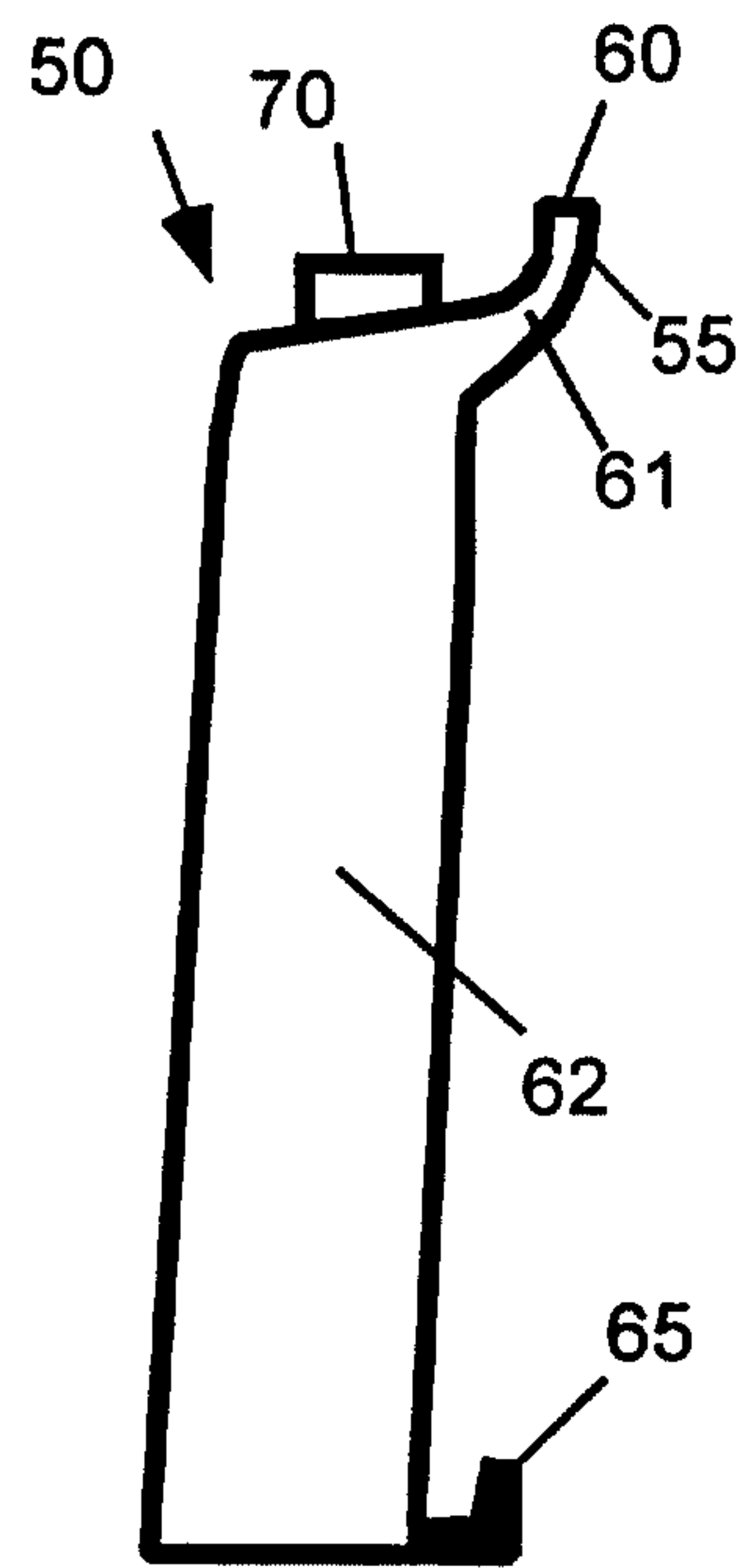


Figure 3

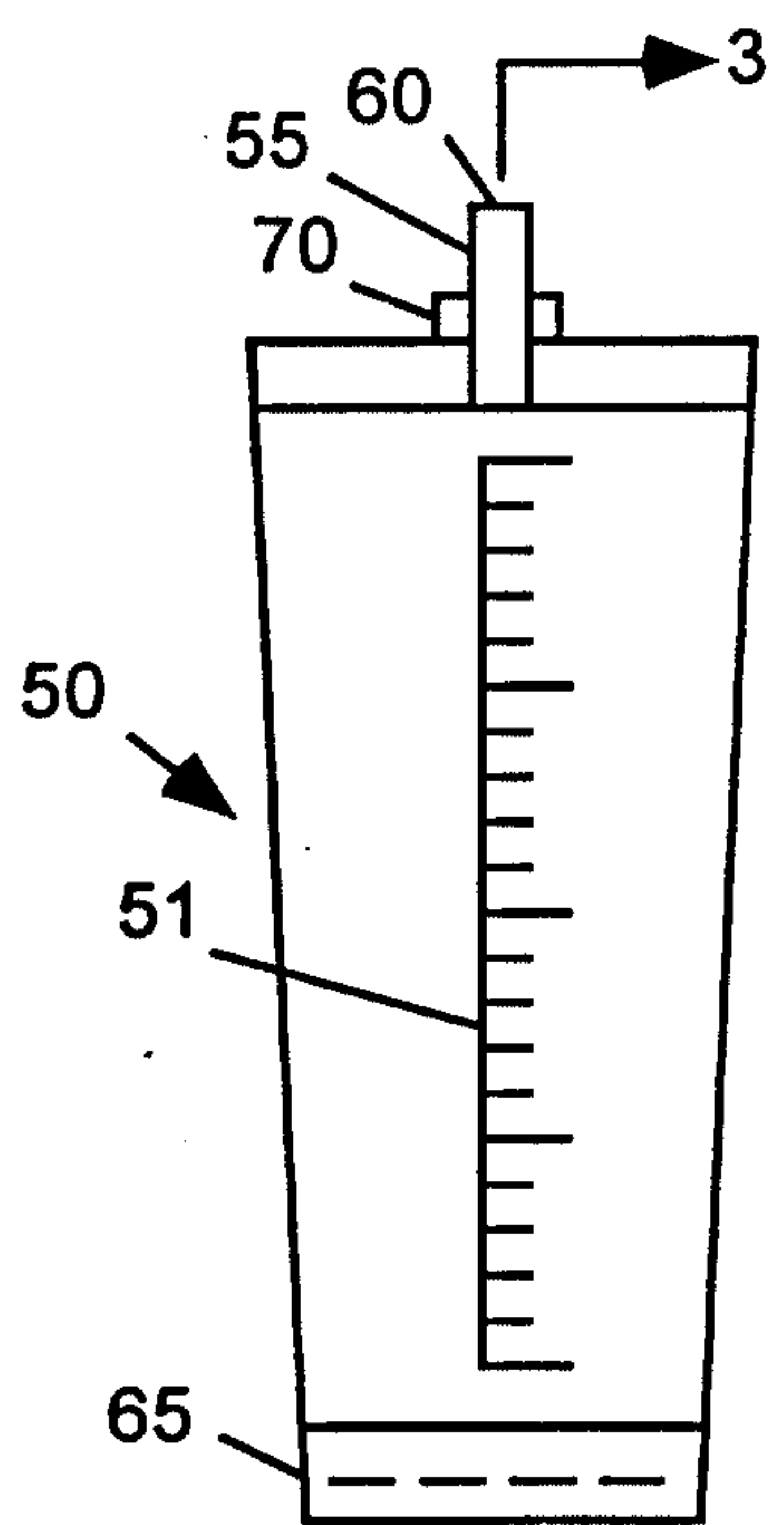


Figure 2

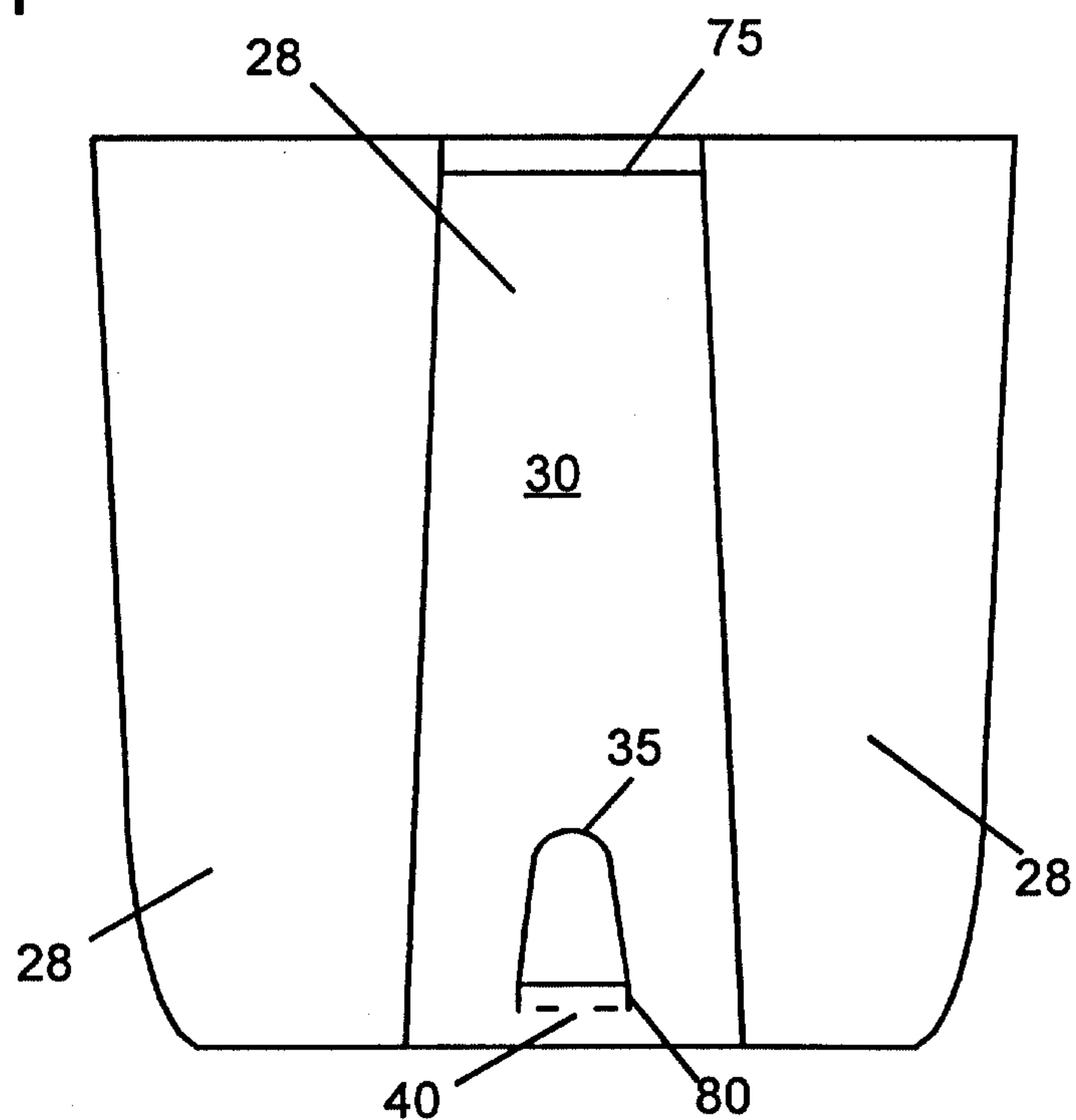


Figure 4

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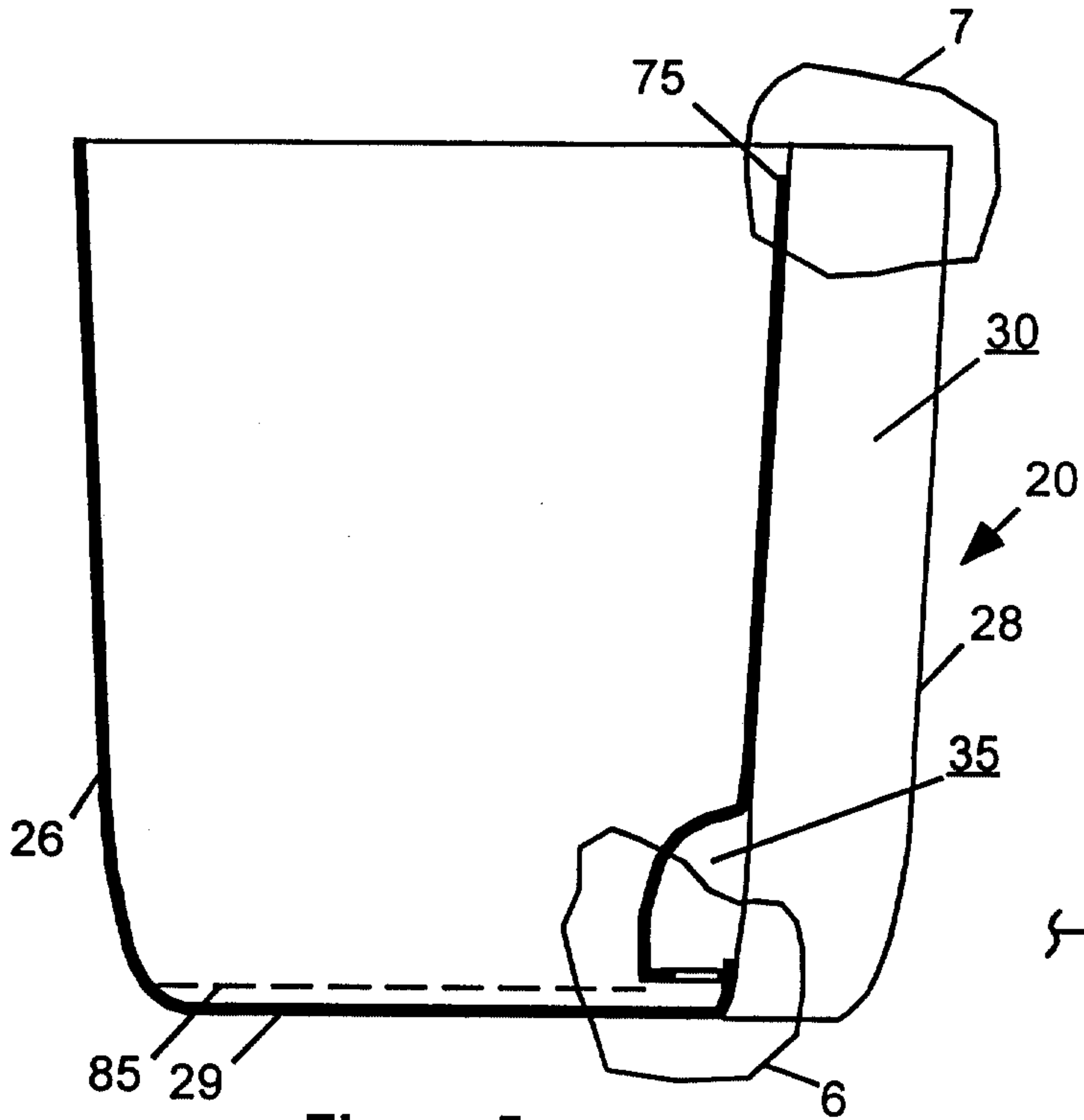


Figure 5

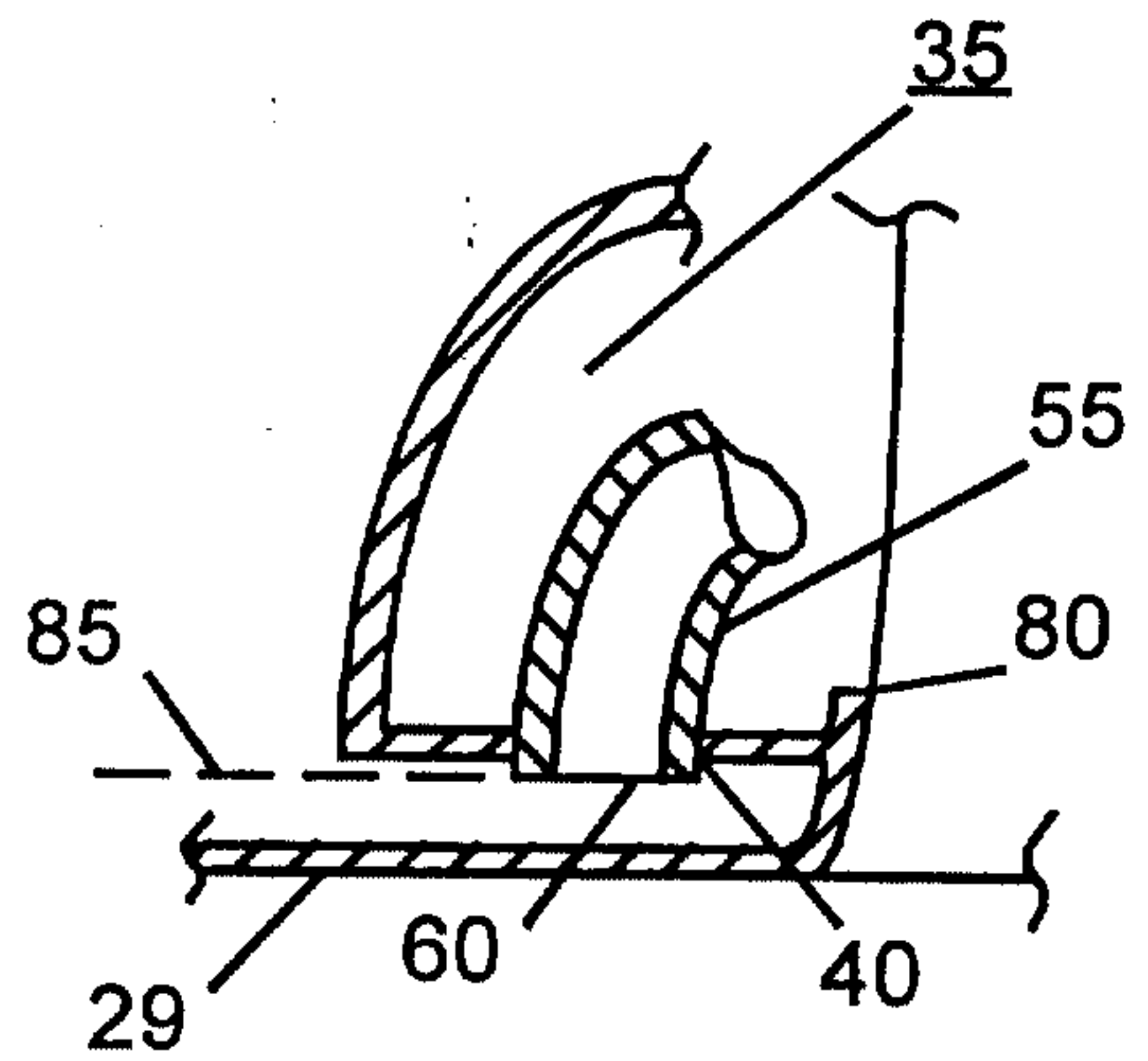


Figure 6

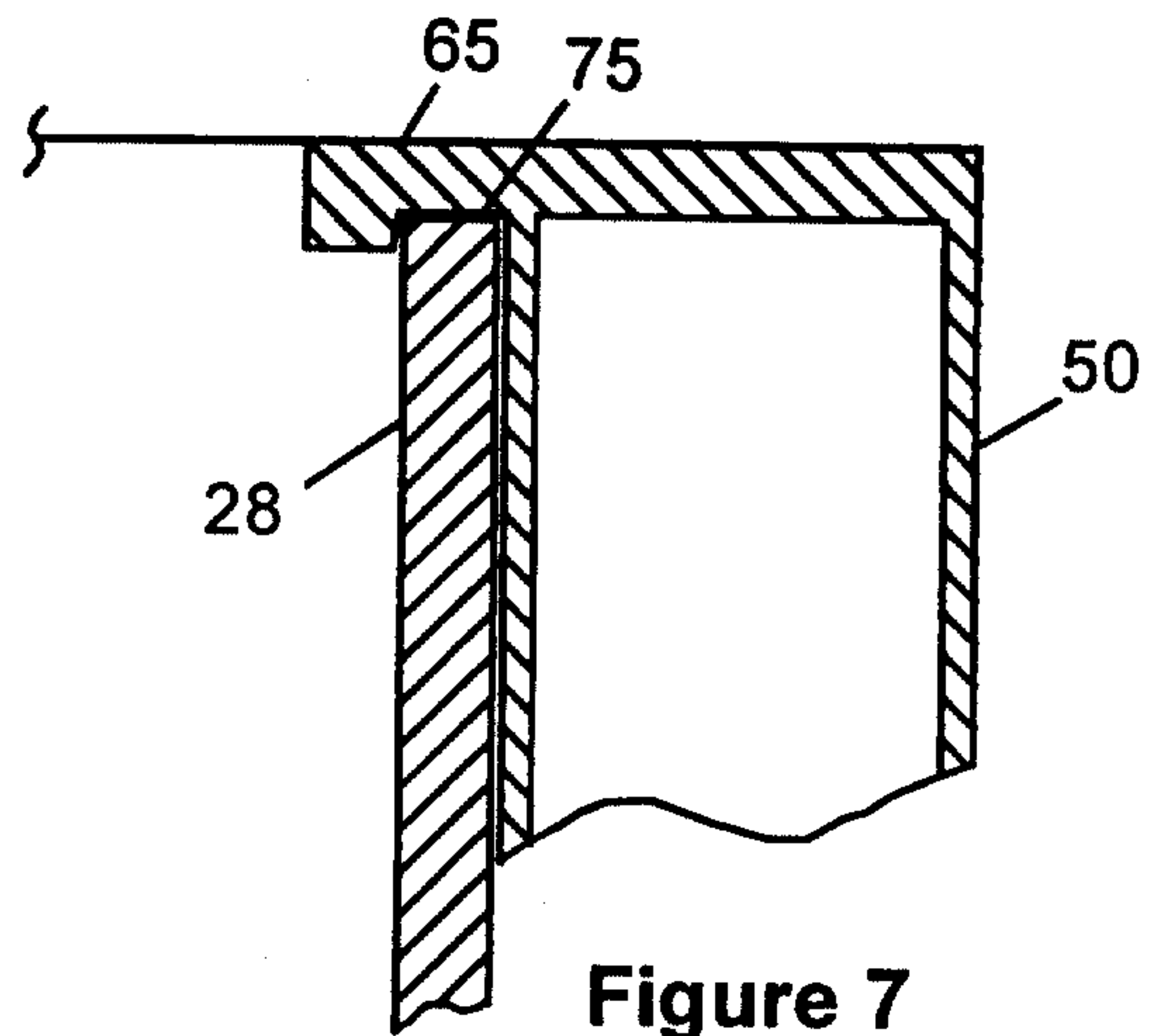


Figure 7

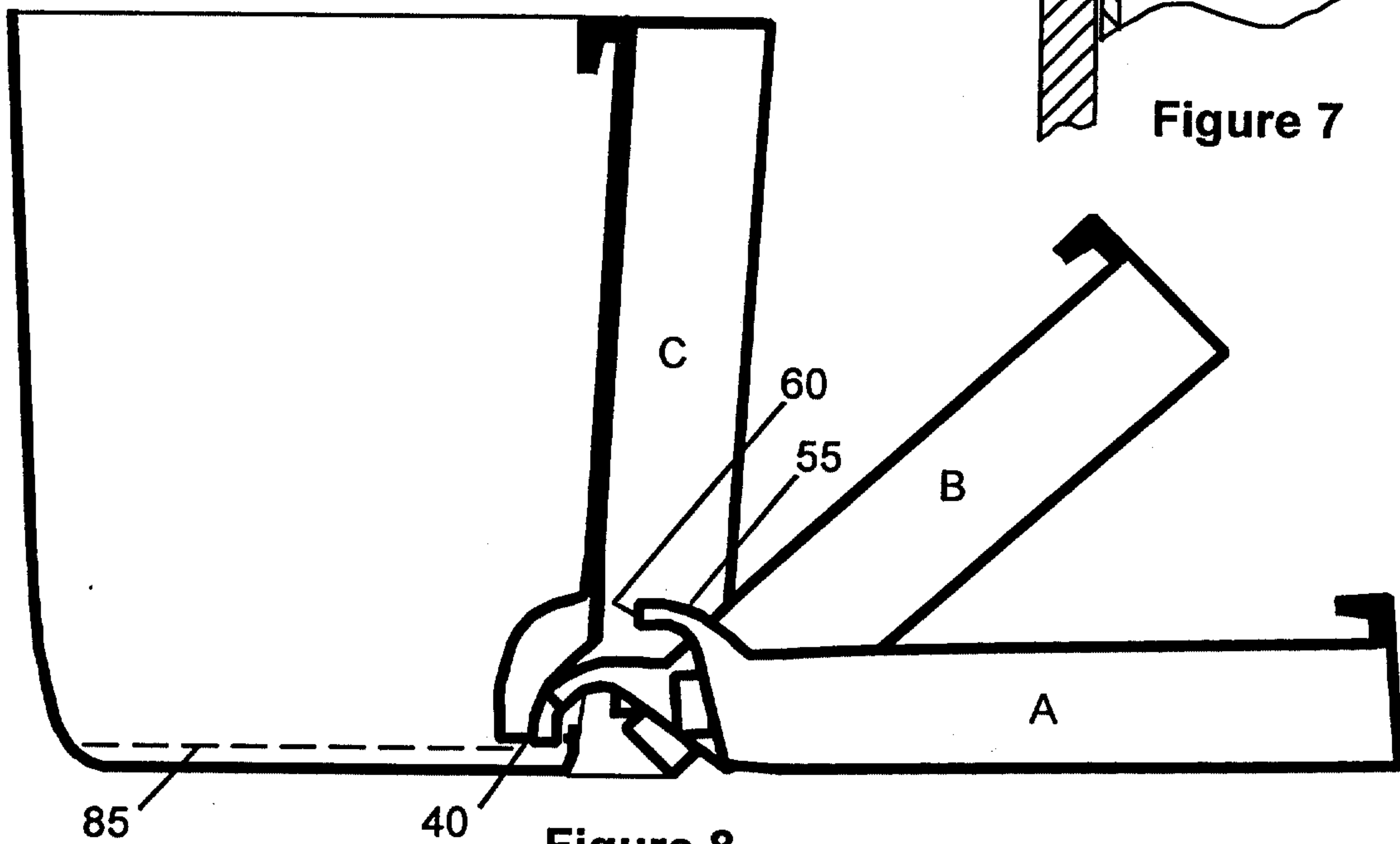


Figure 8

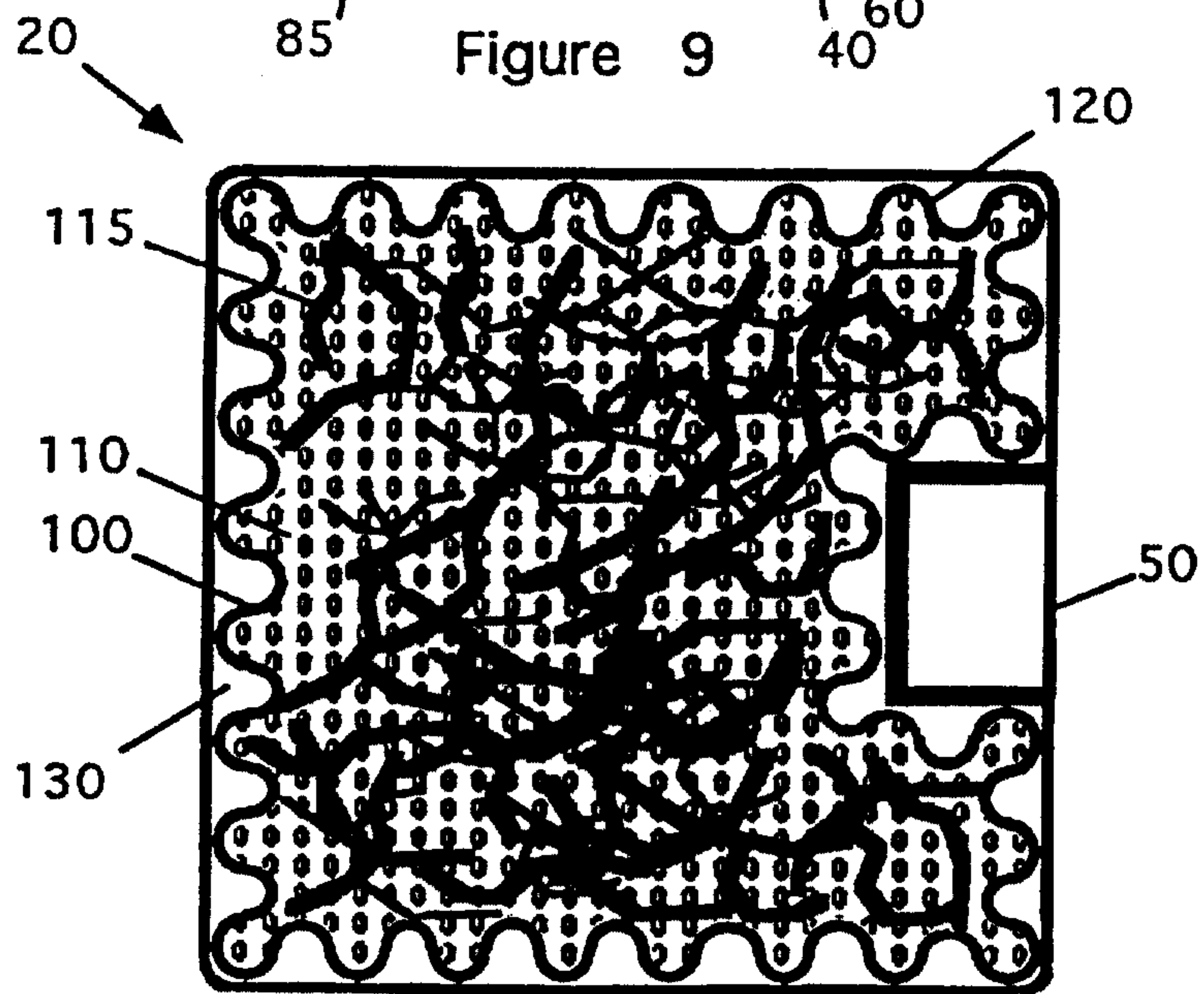
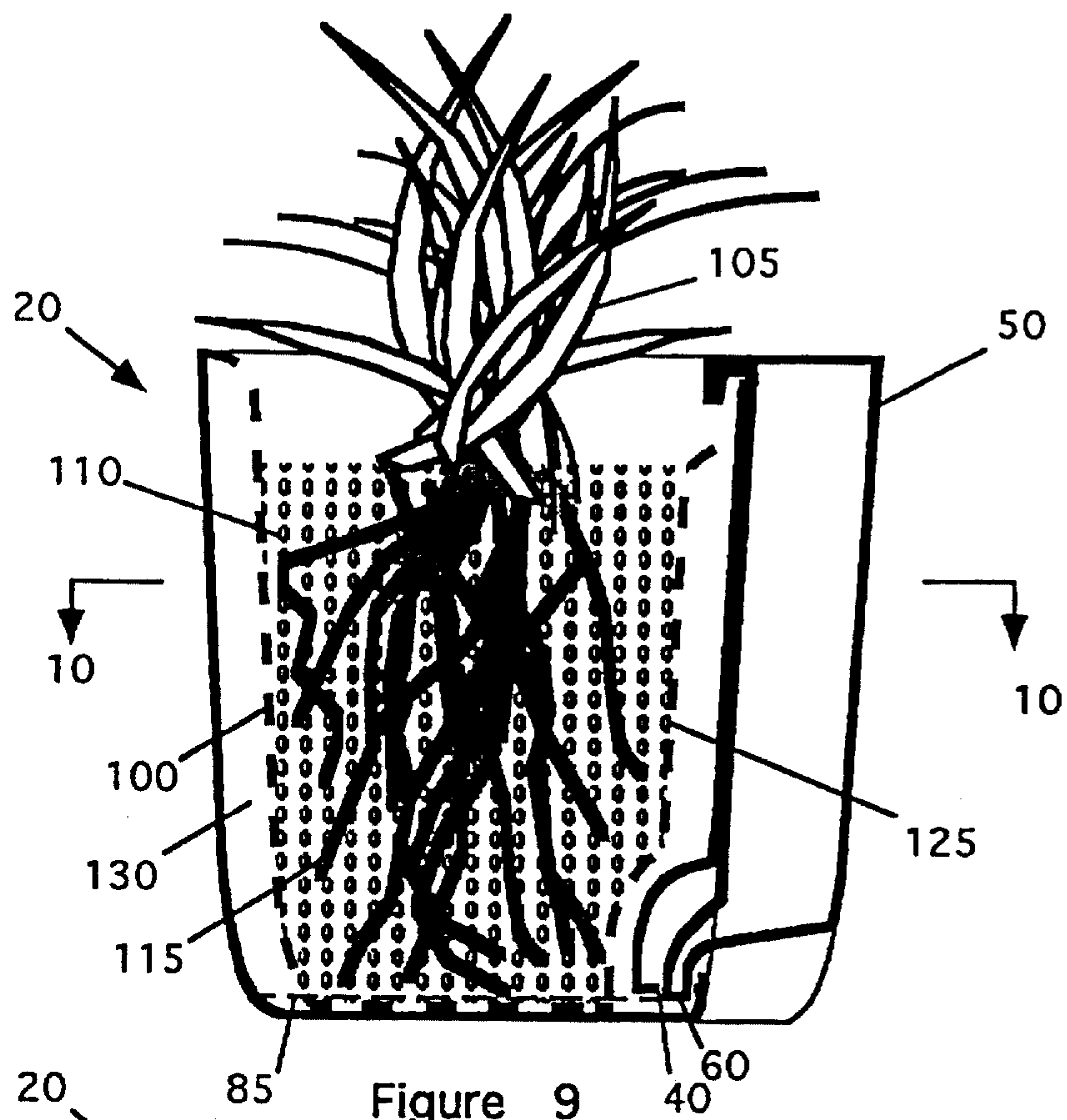
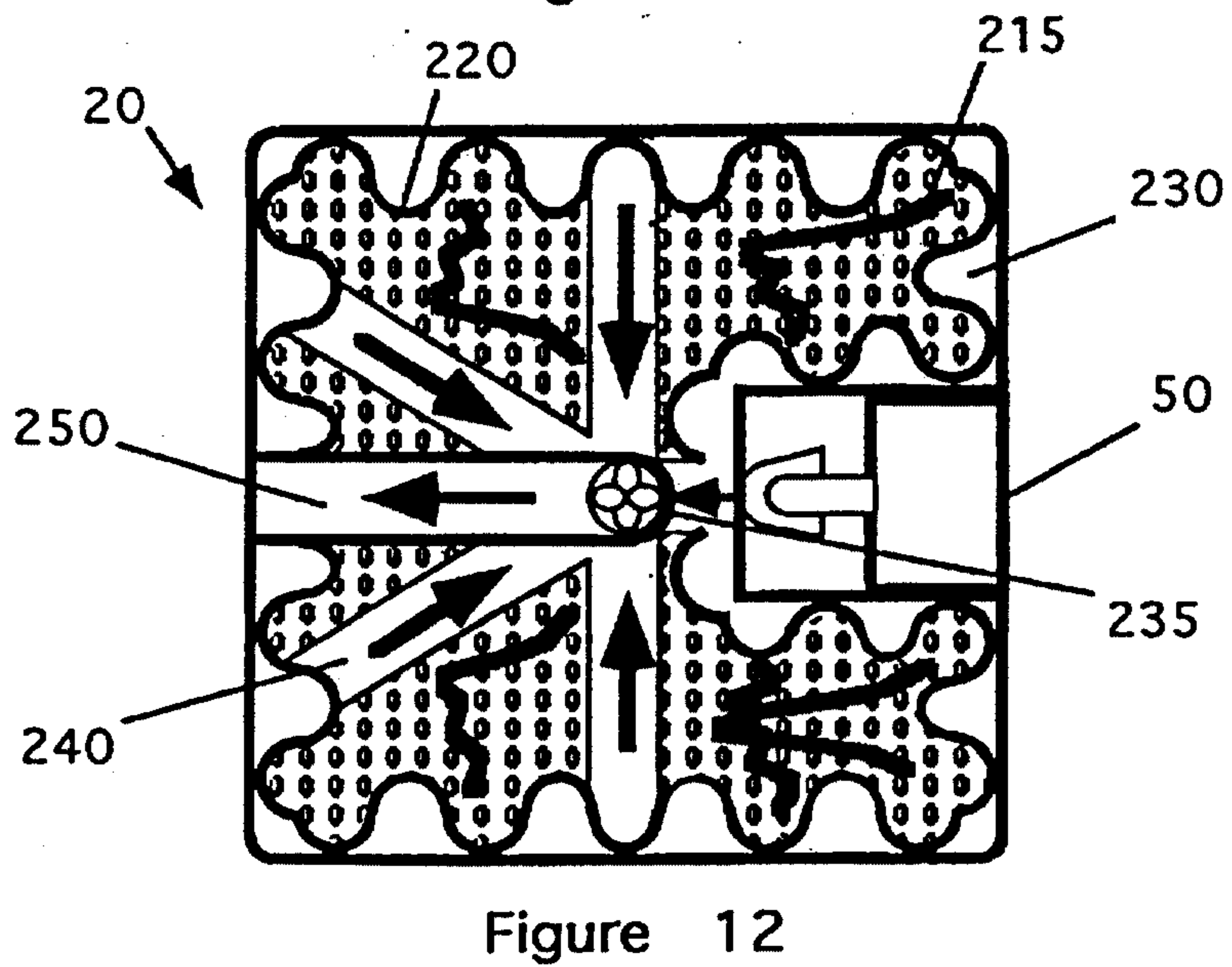
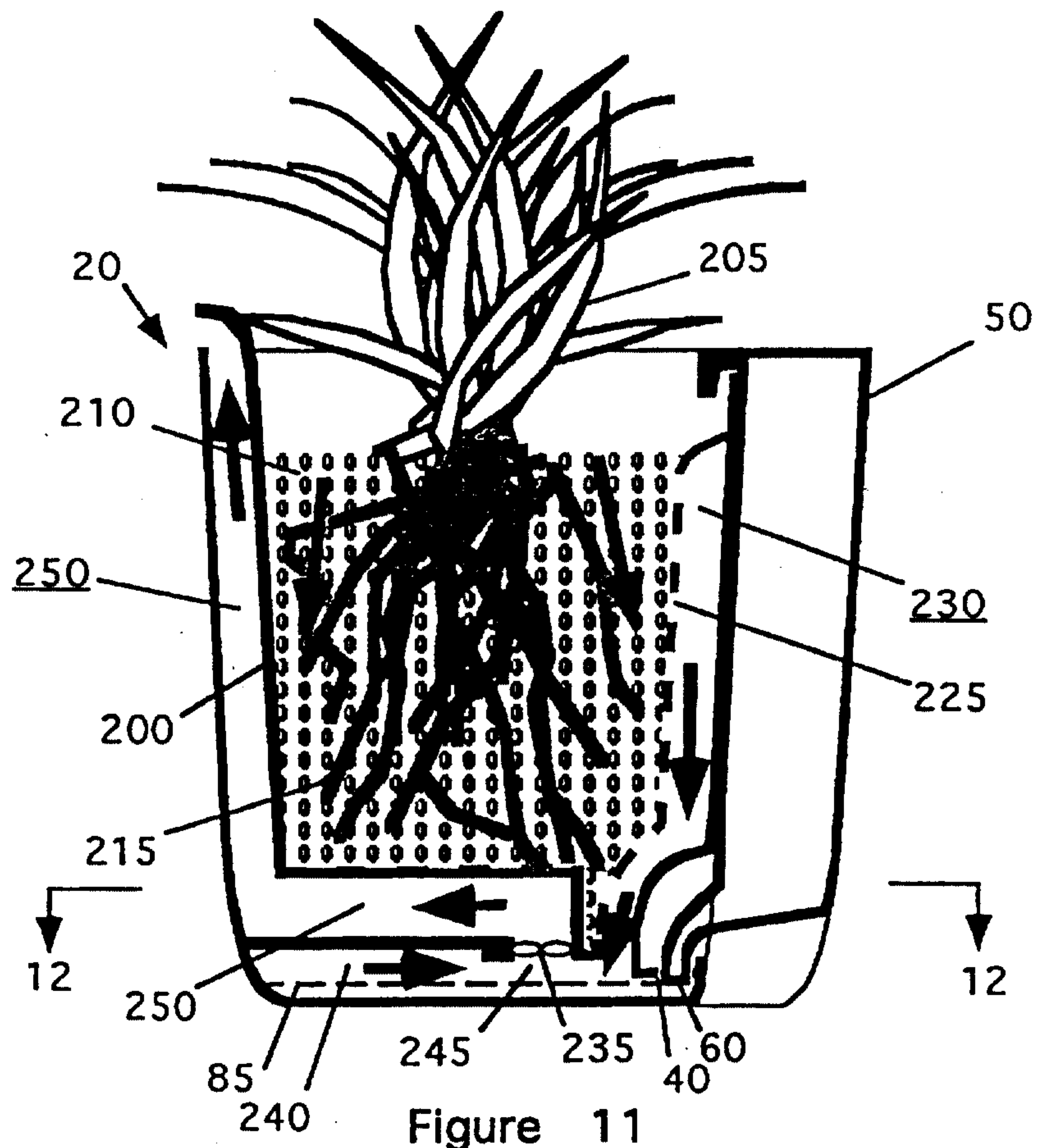


Figure 10



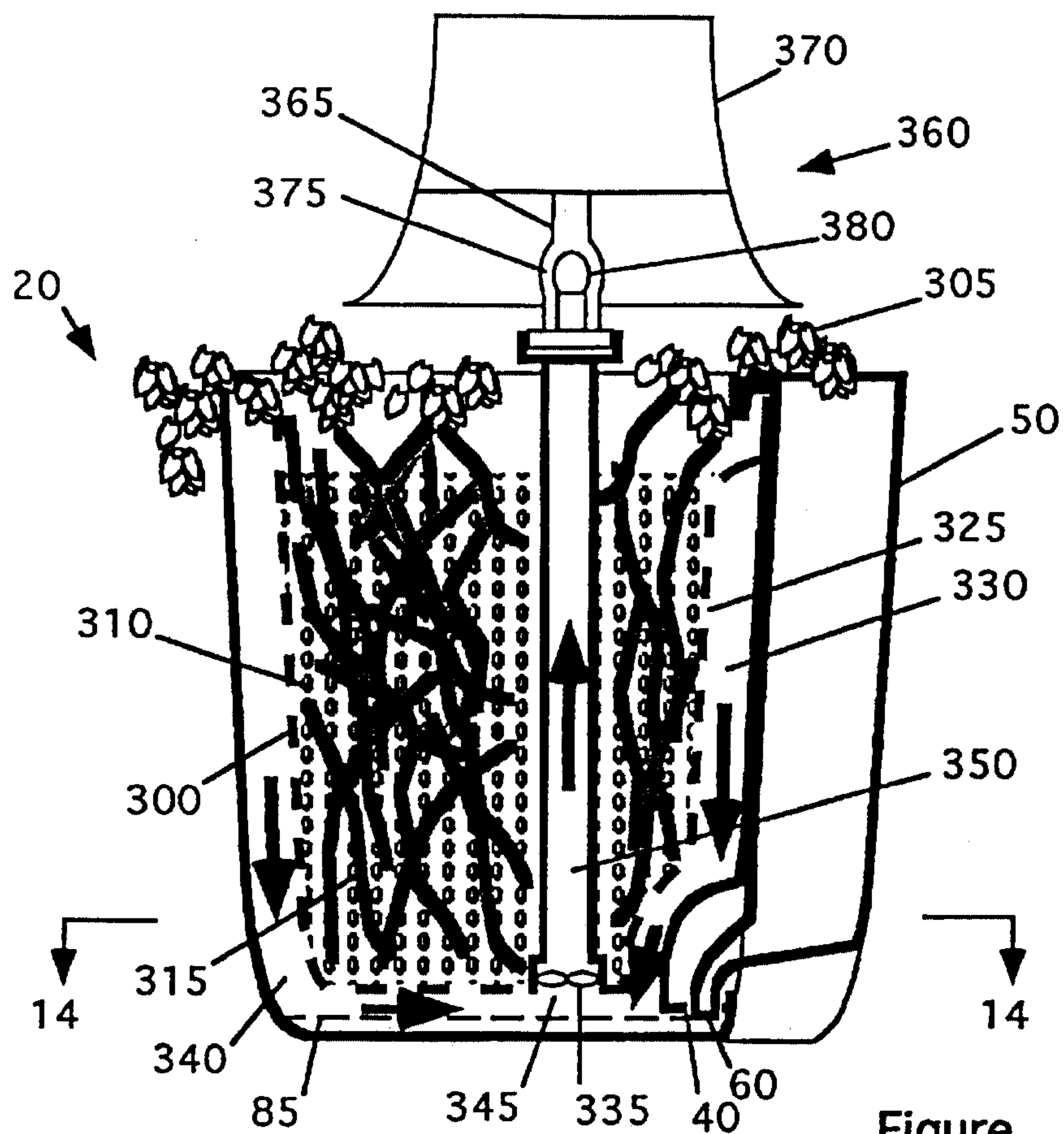


Figure 13

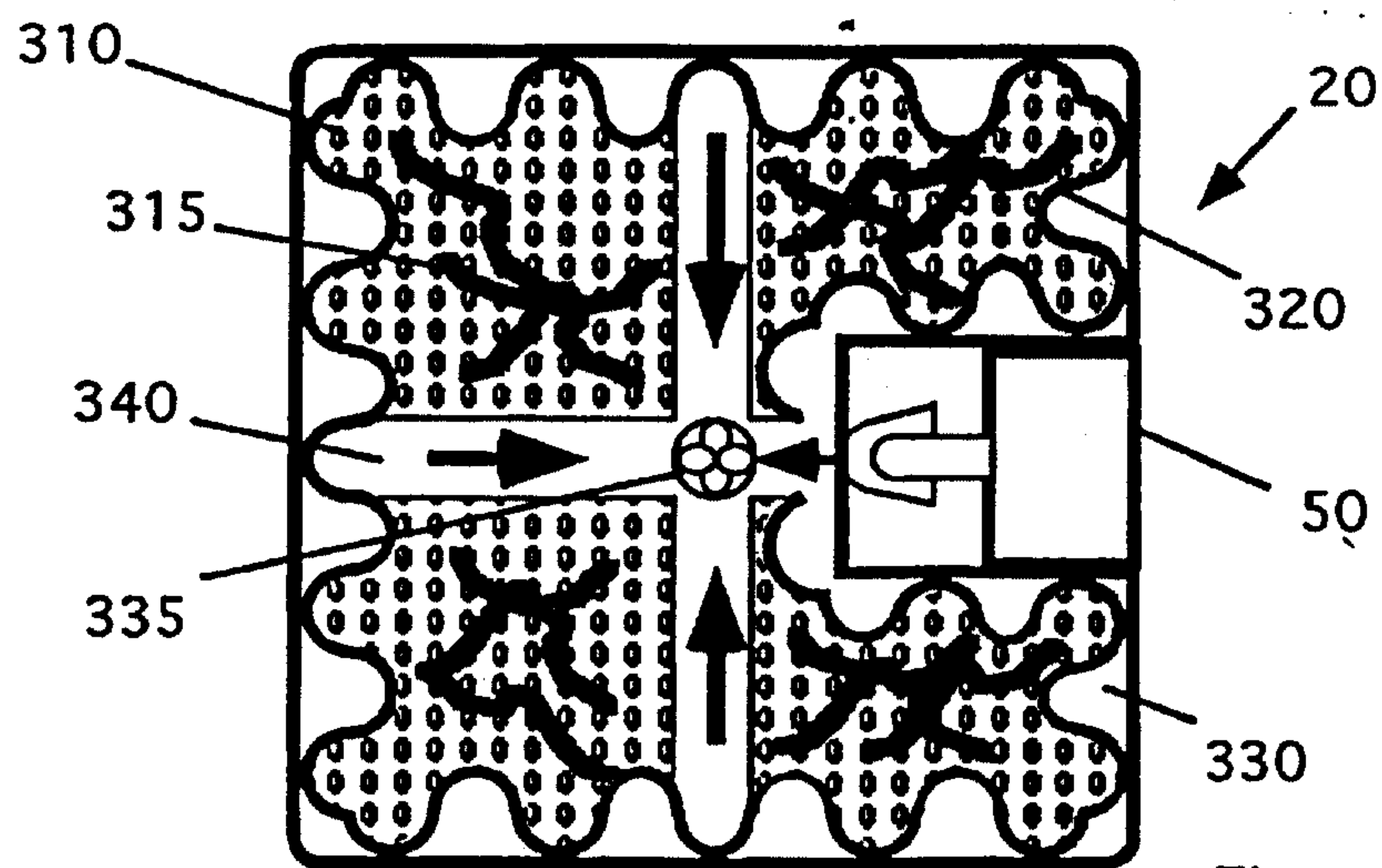


Figure 14

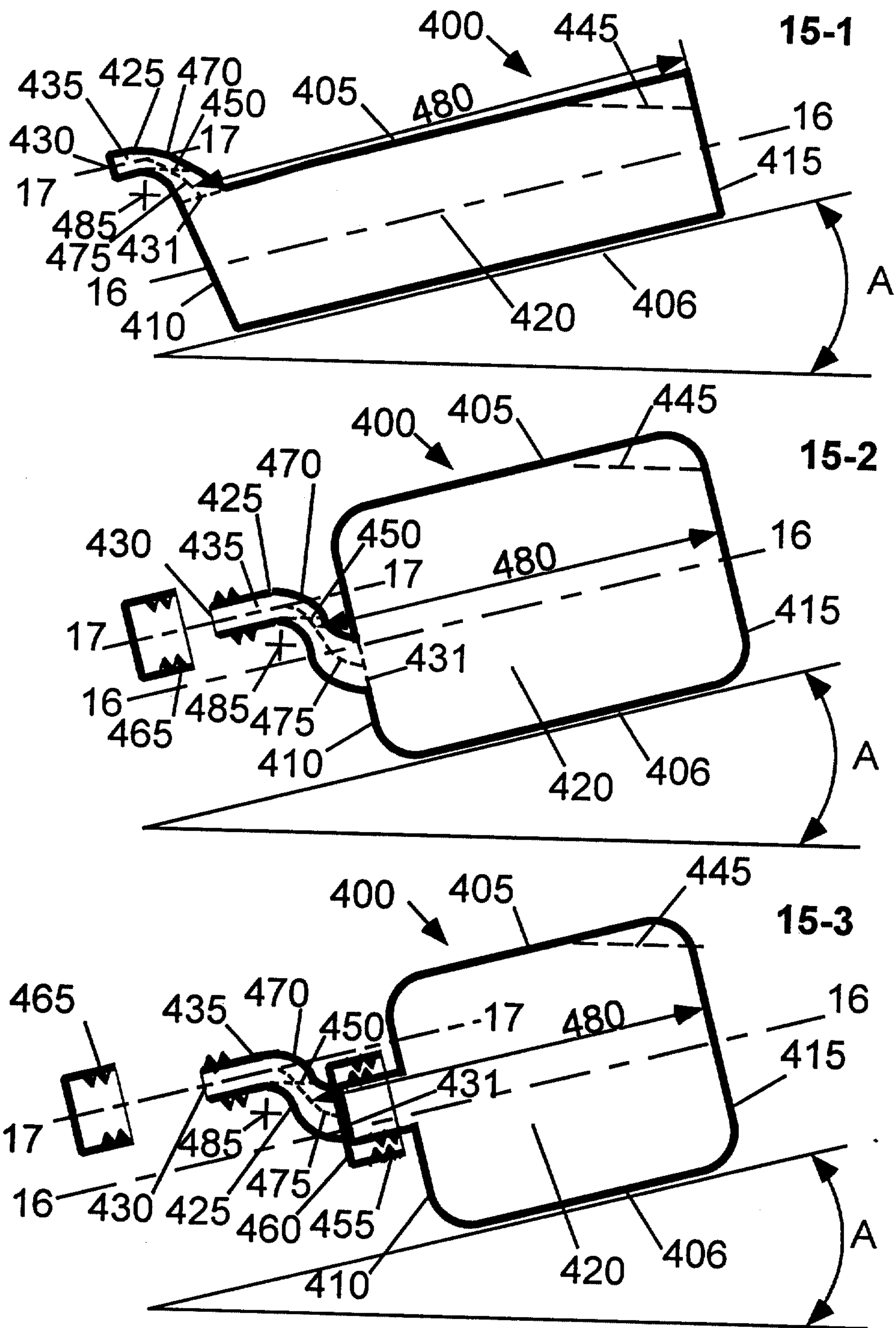


Figure 15

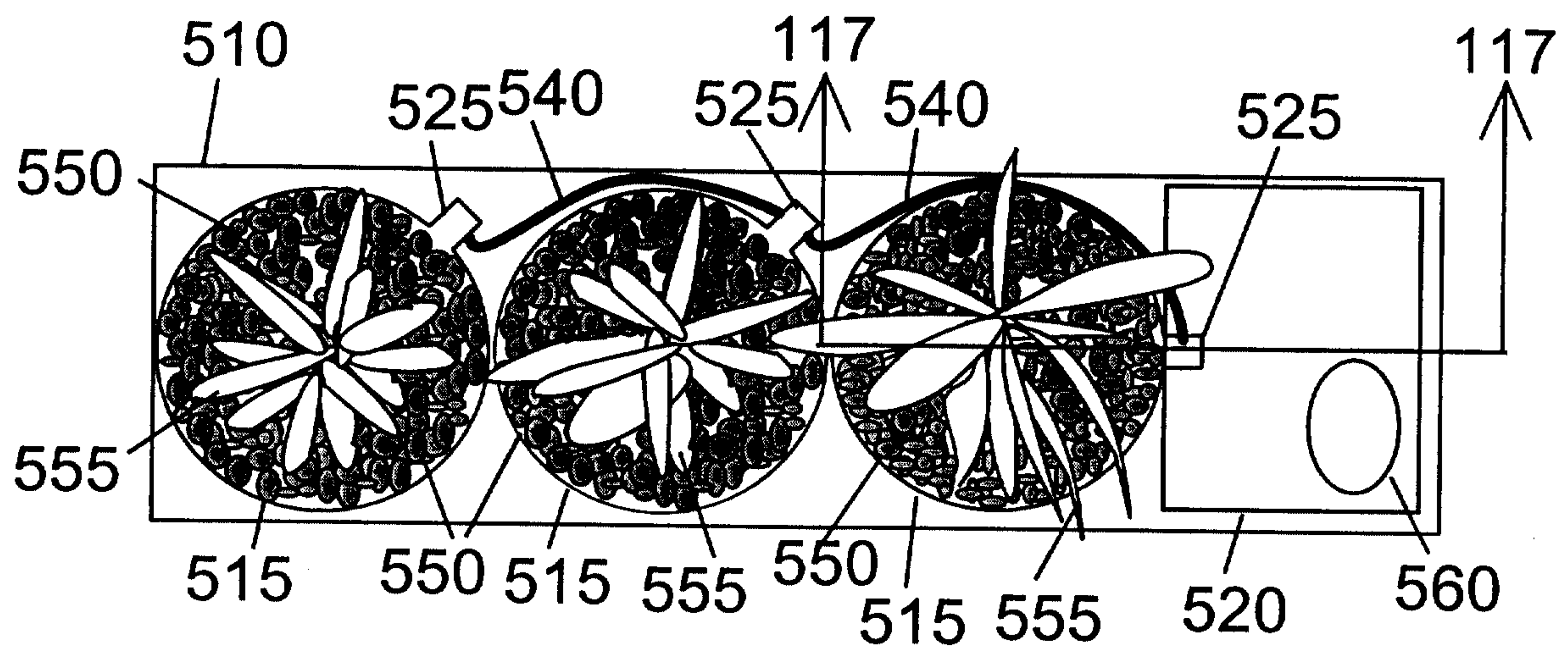


Figure 16

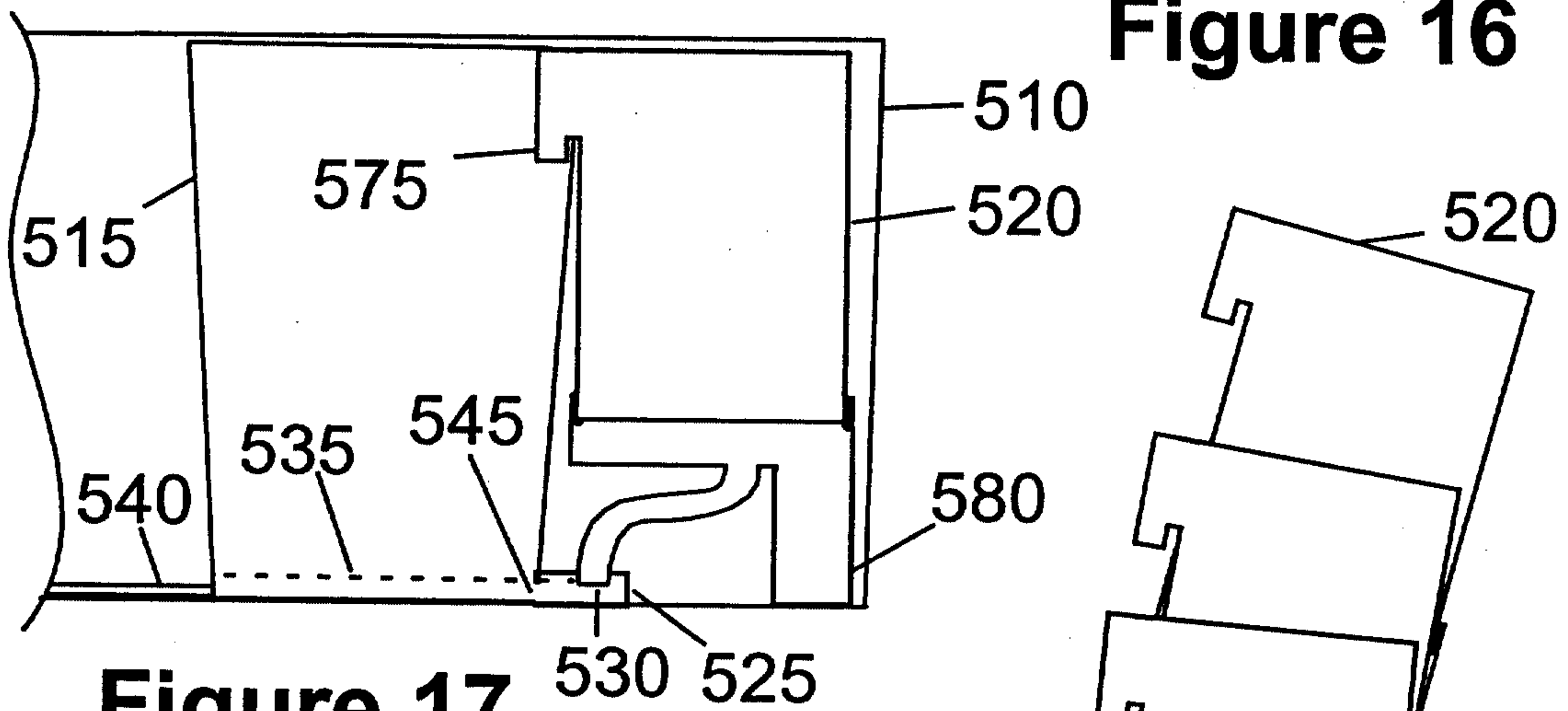
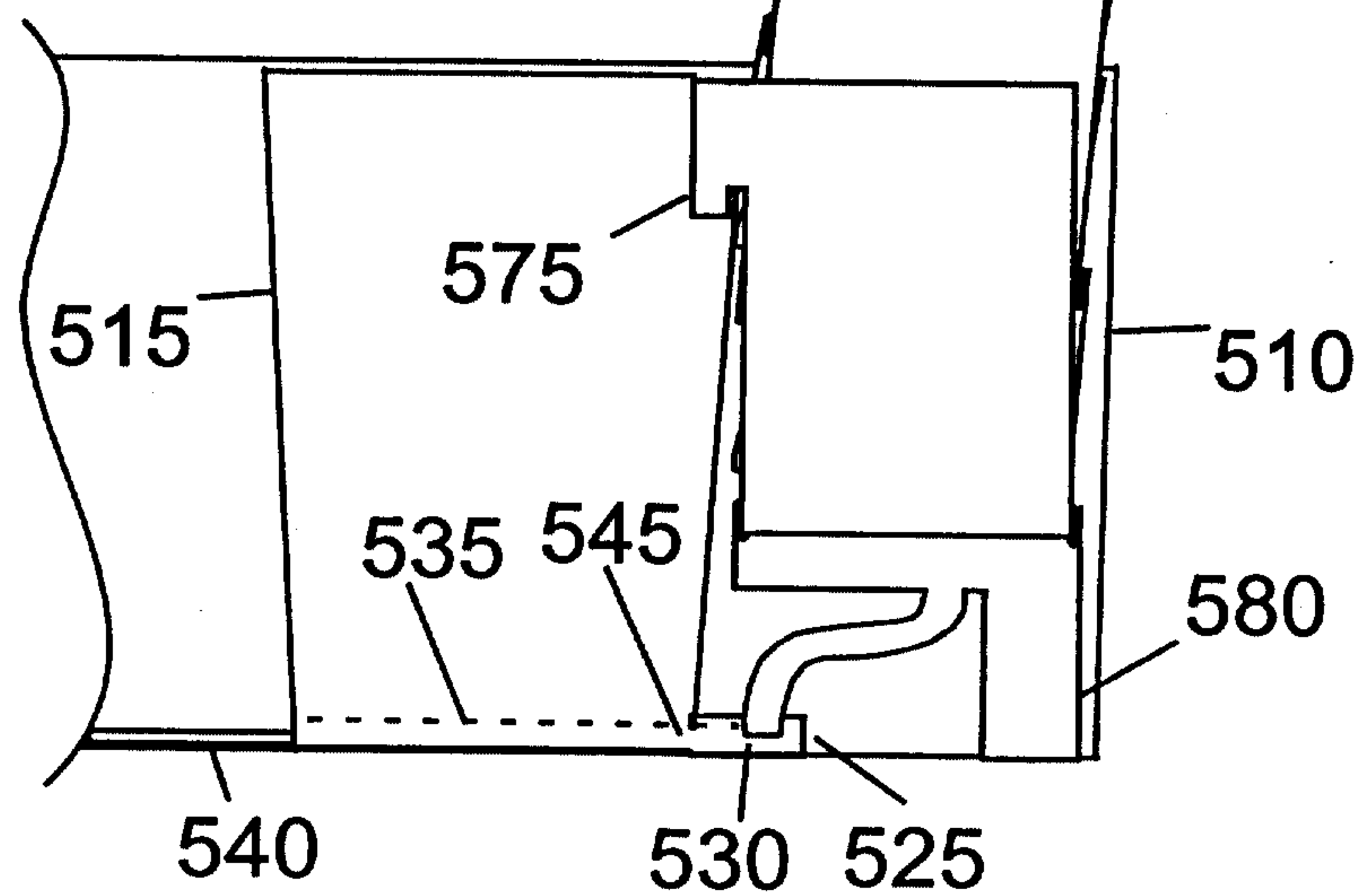


Figure 17

Figure 18



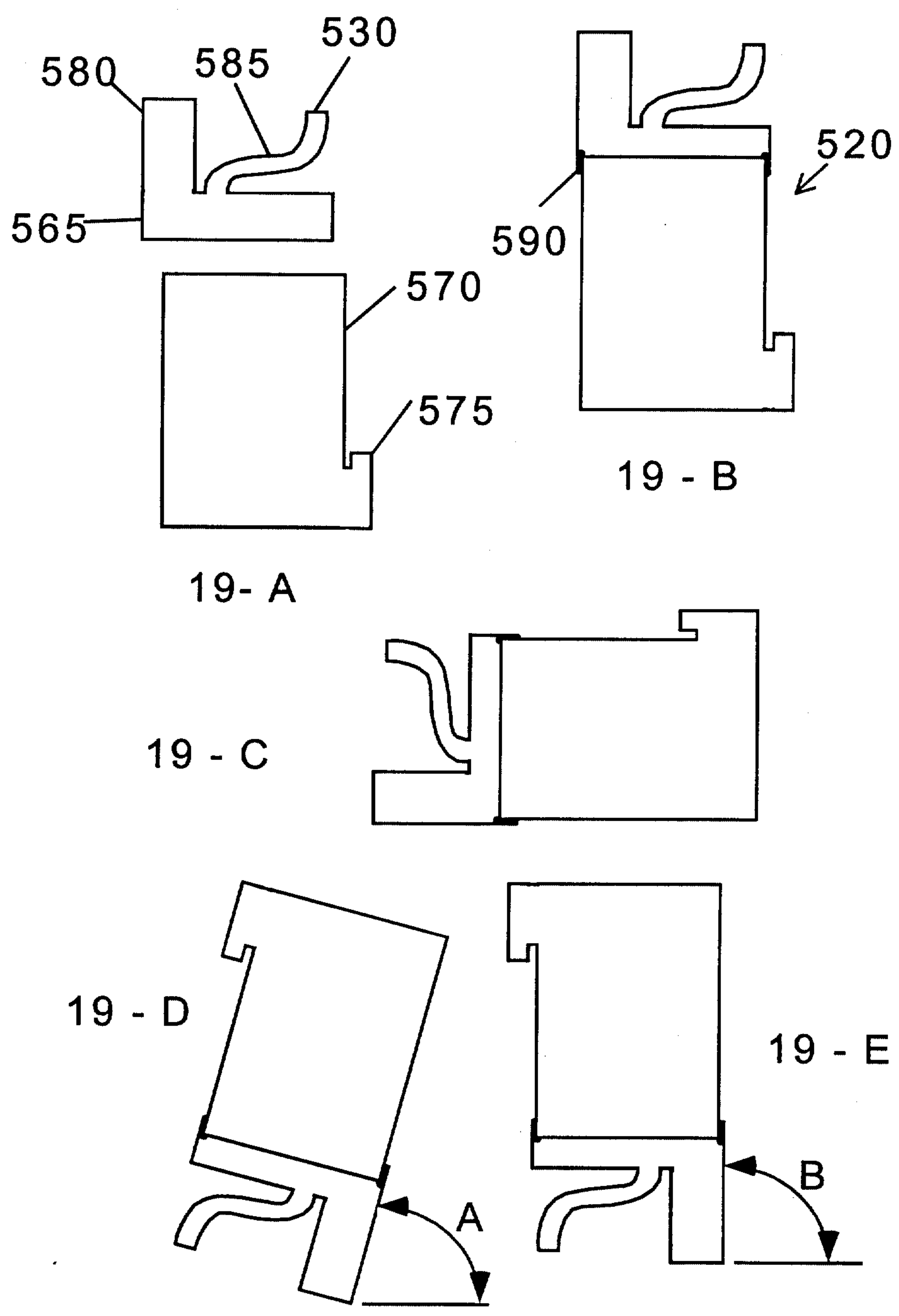


Figure 19

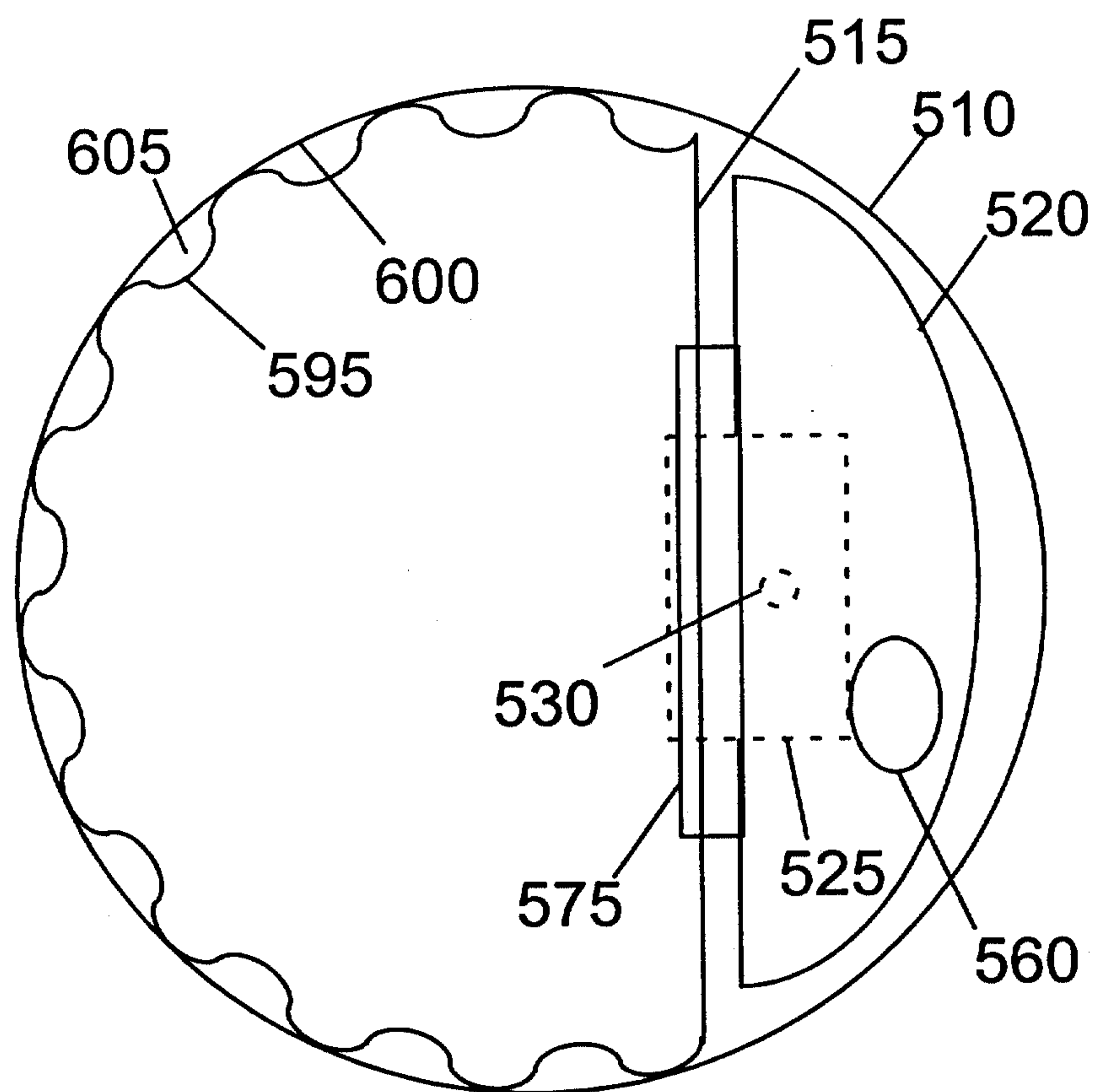


Figure 20

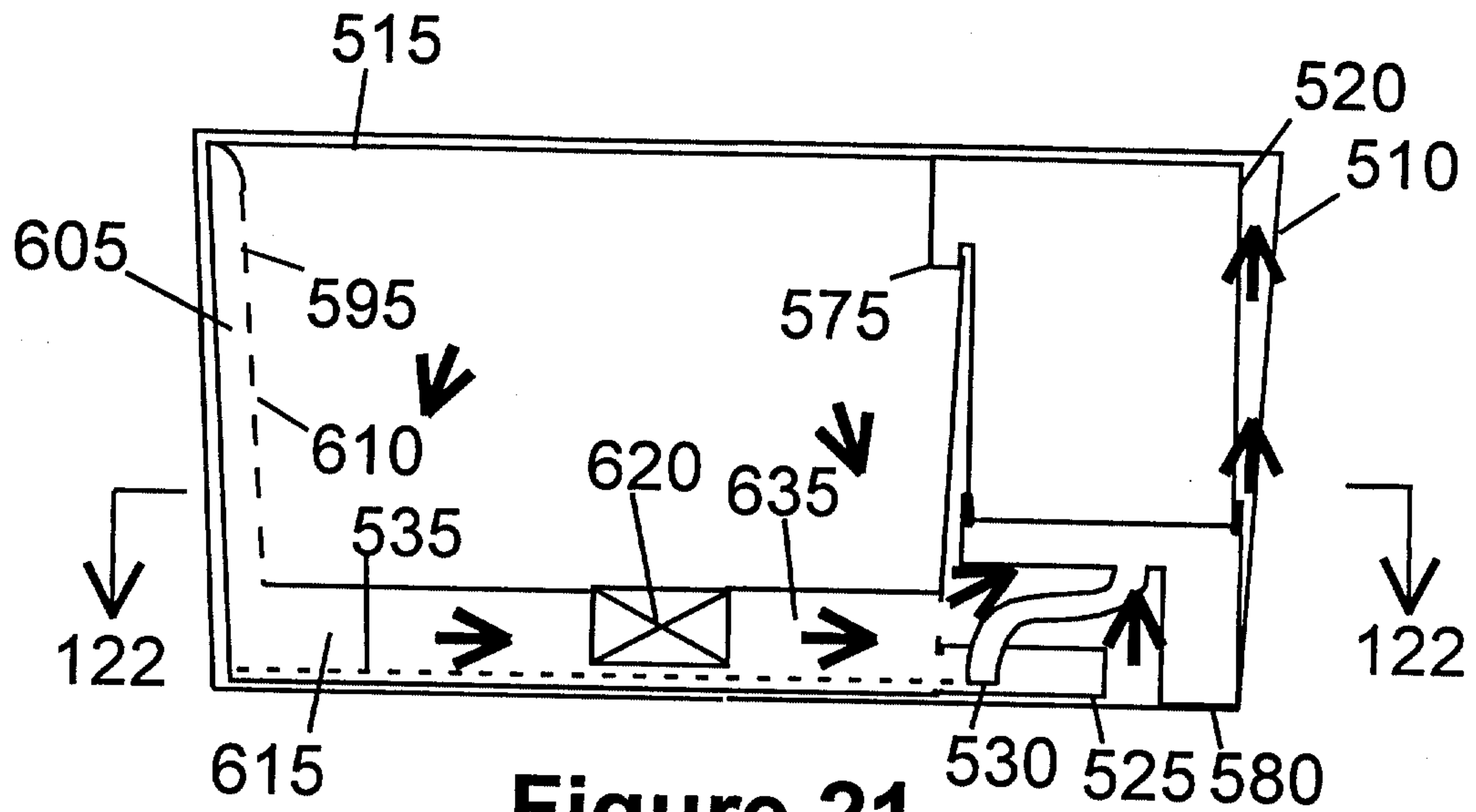


Figure 21

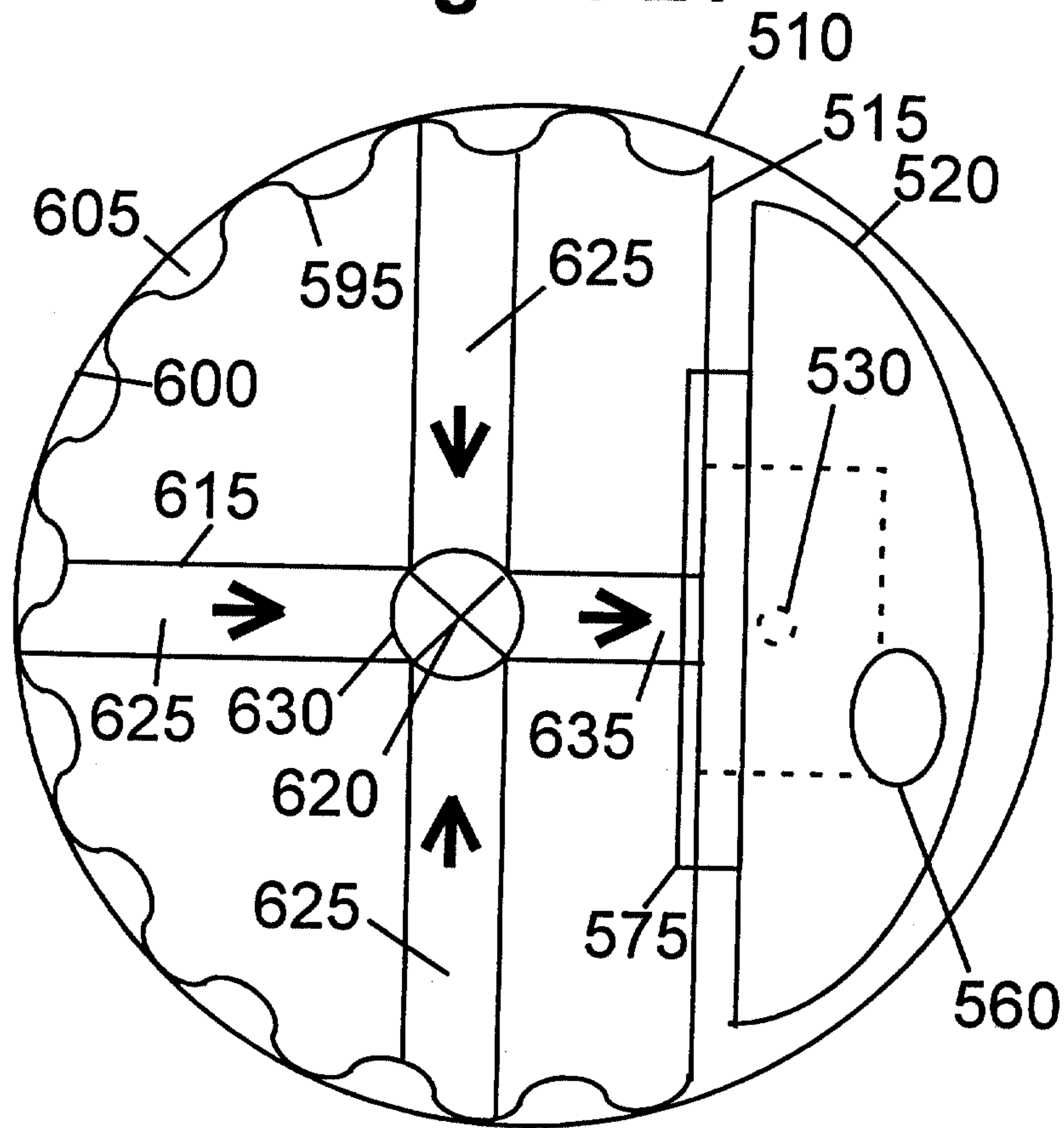
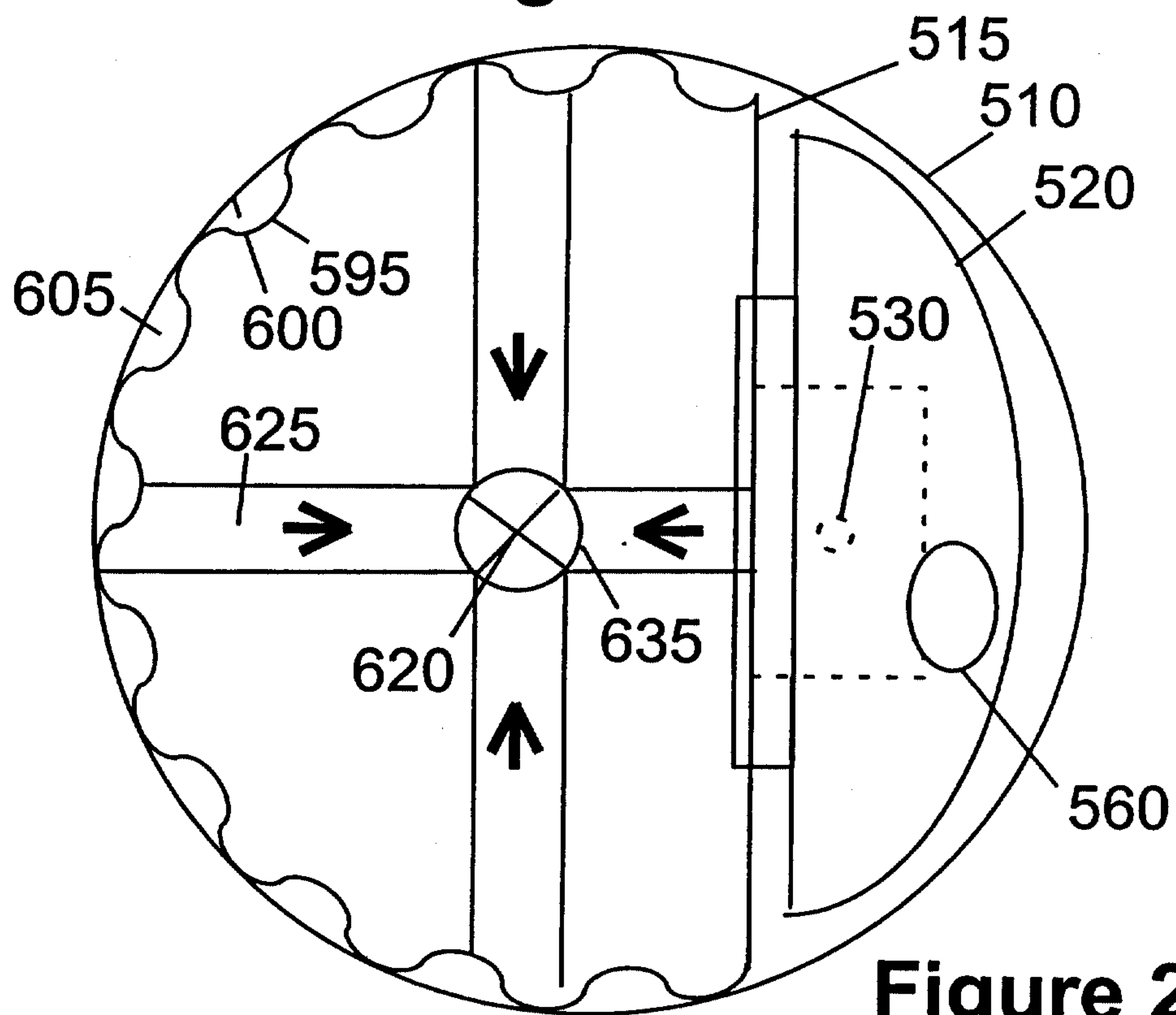
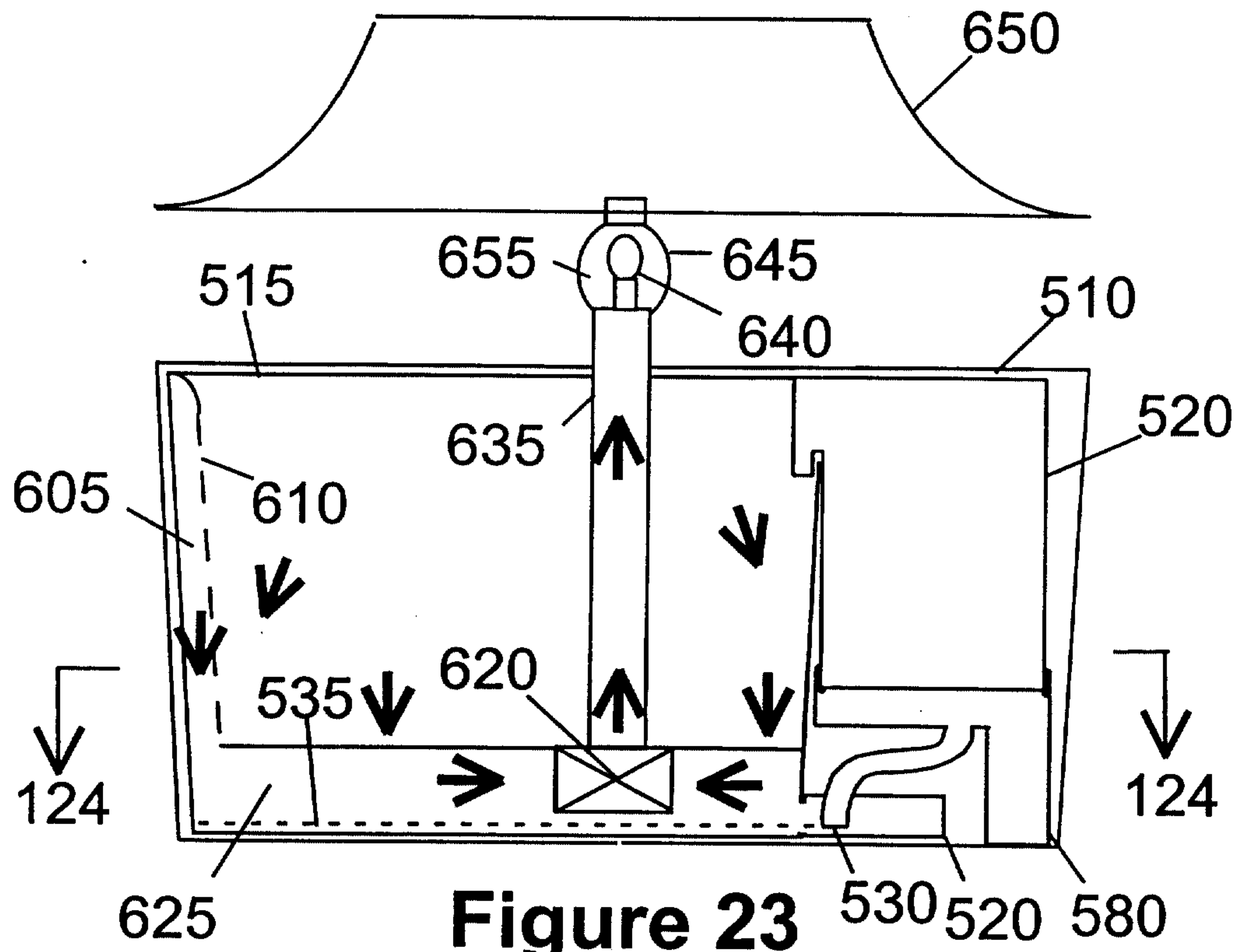


Figure 22



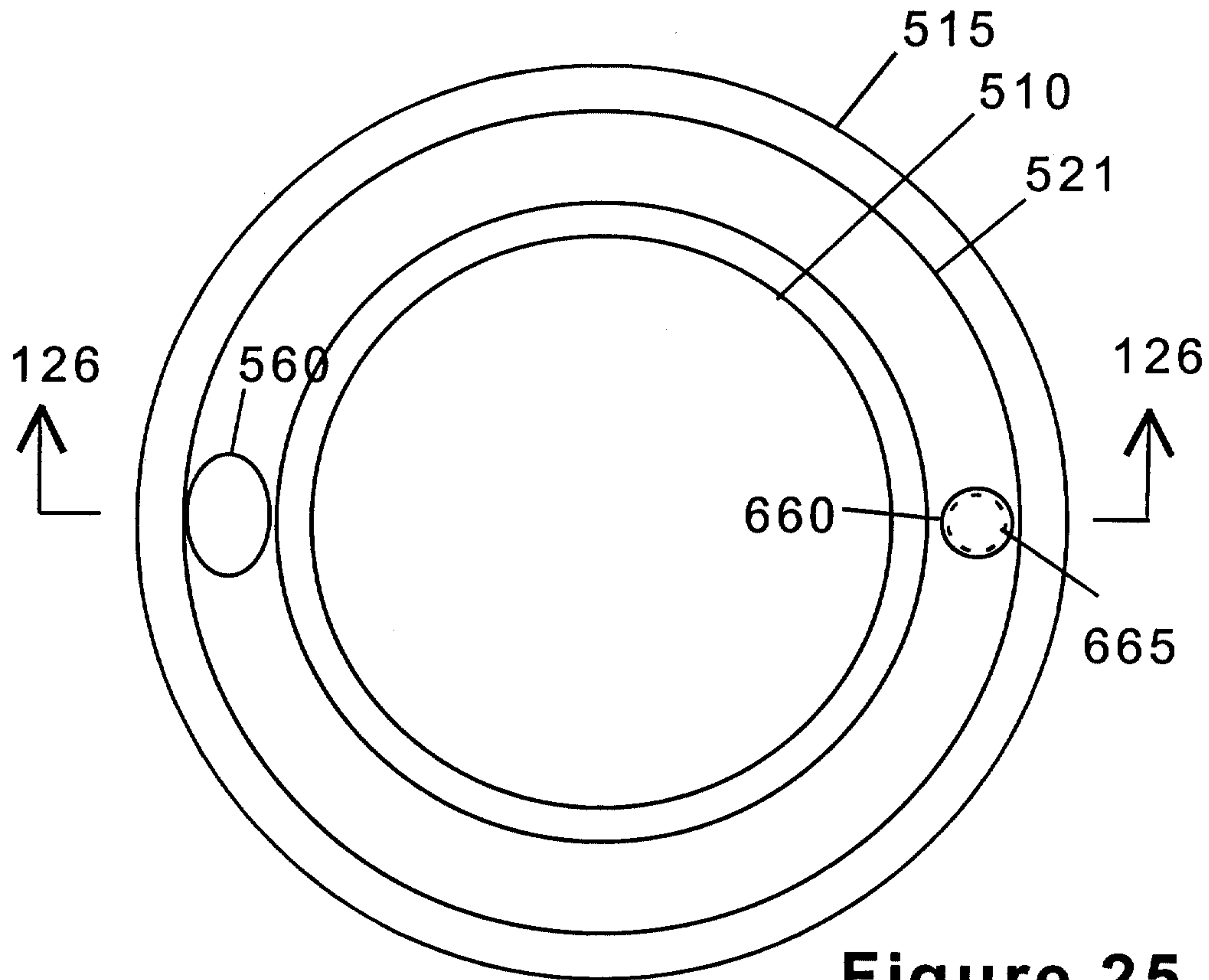


Figure 25

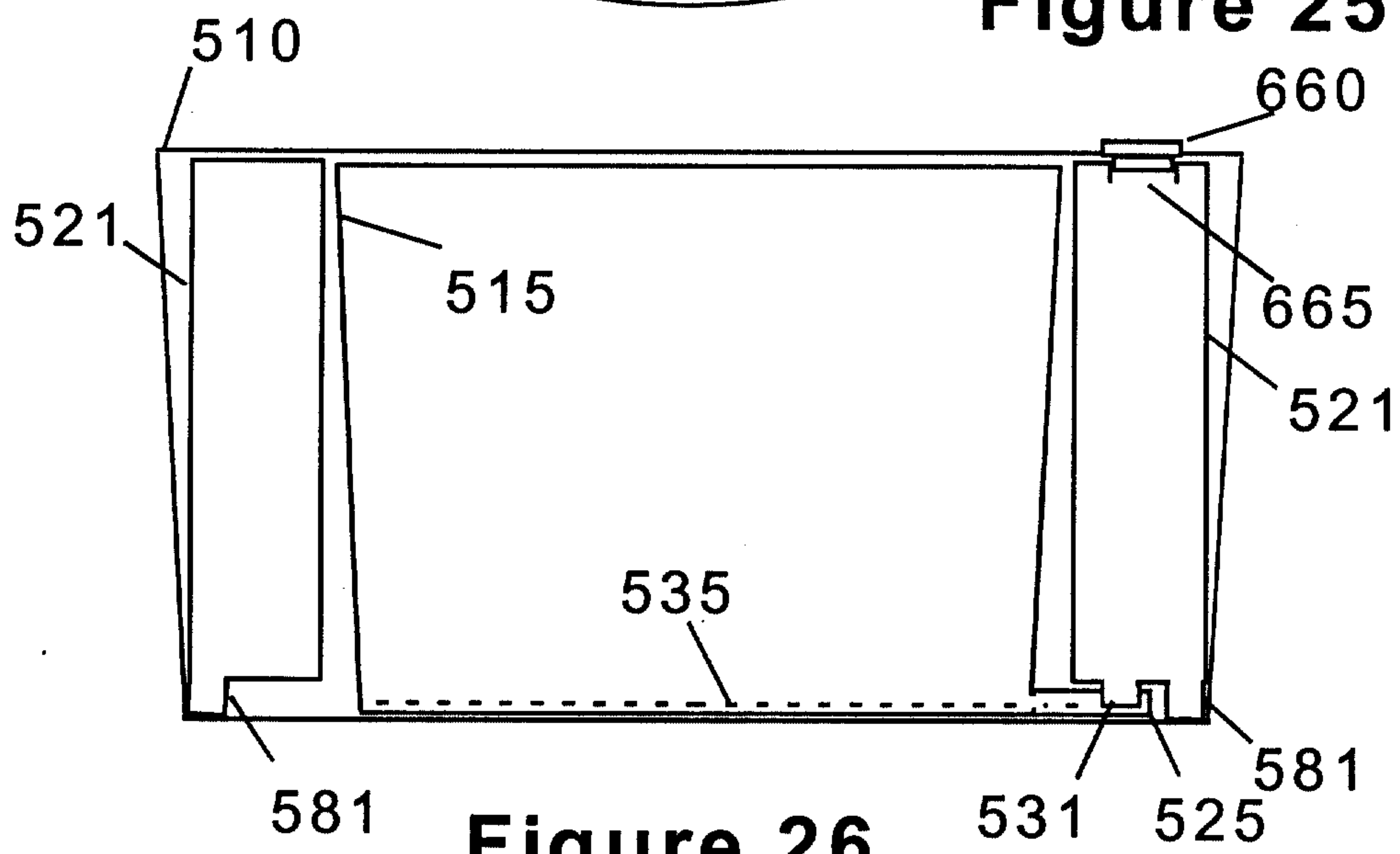


Figure 26

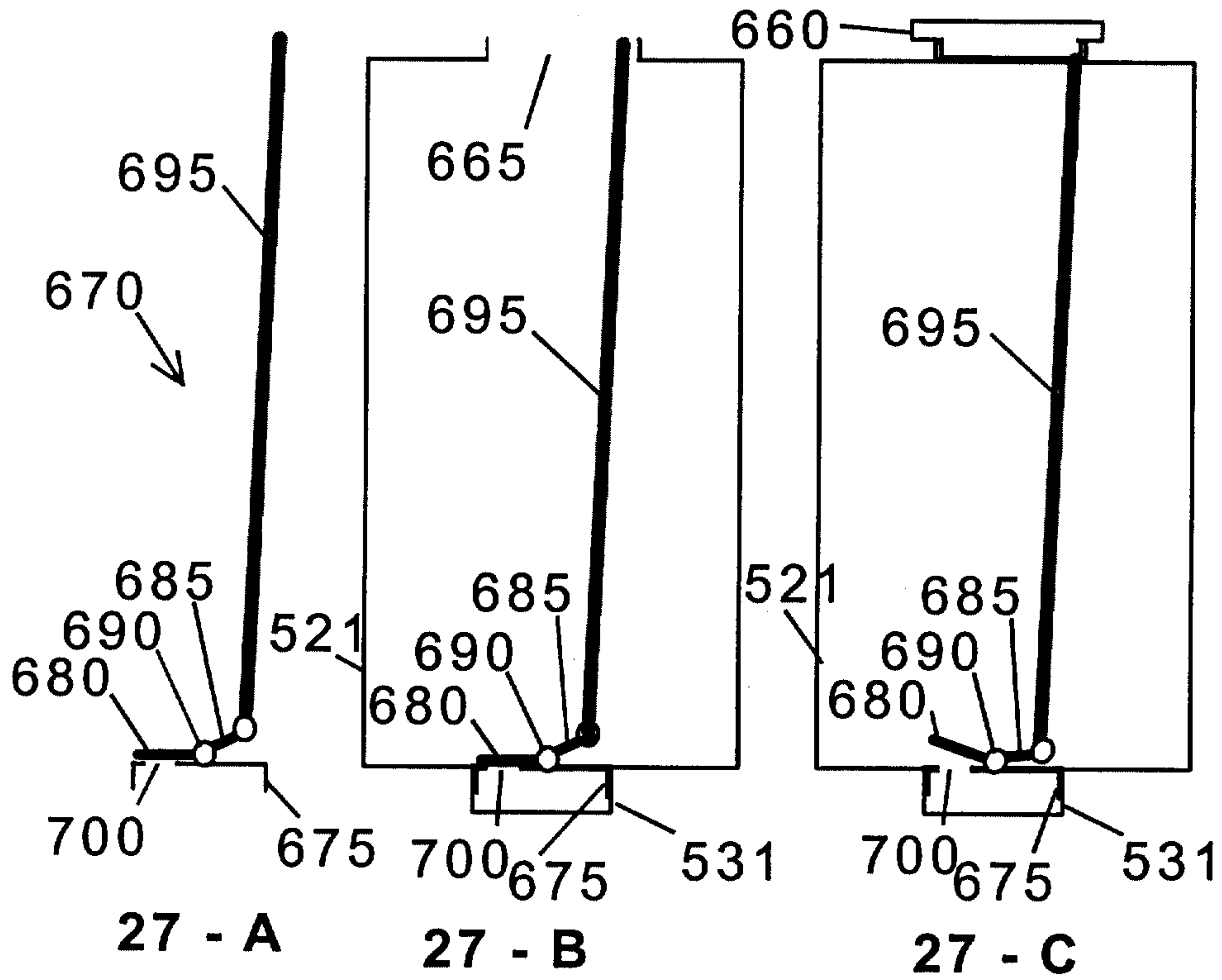
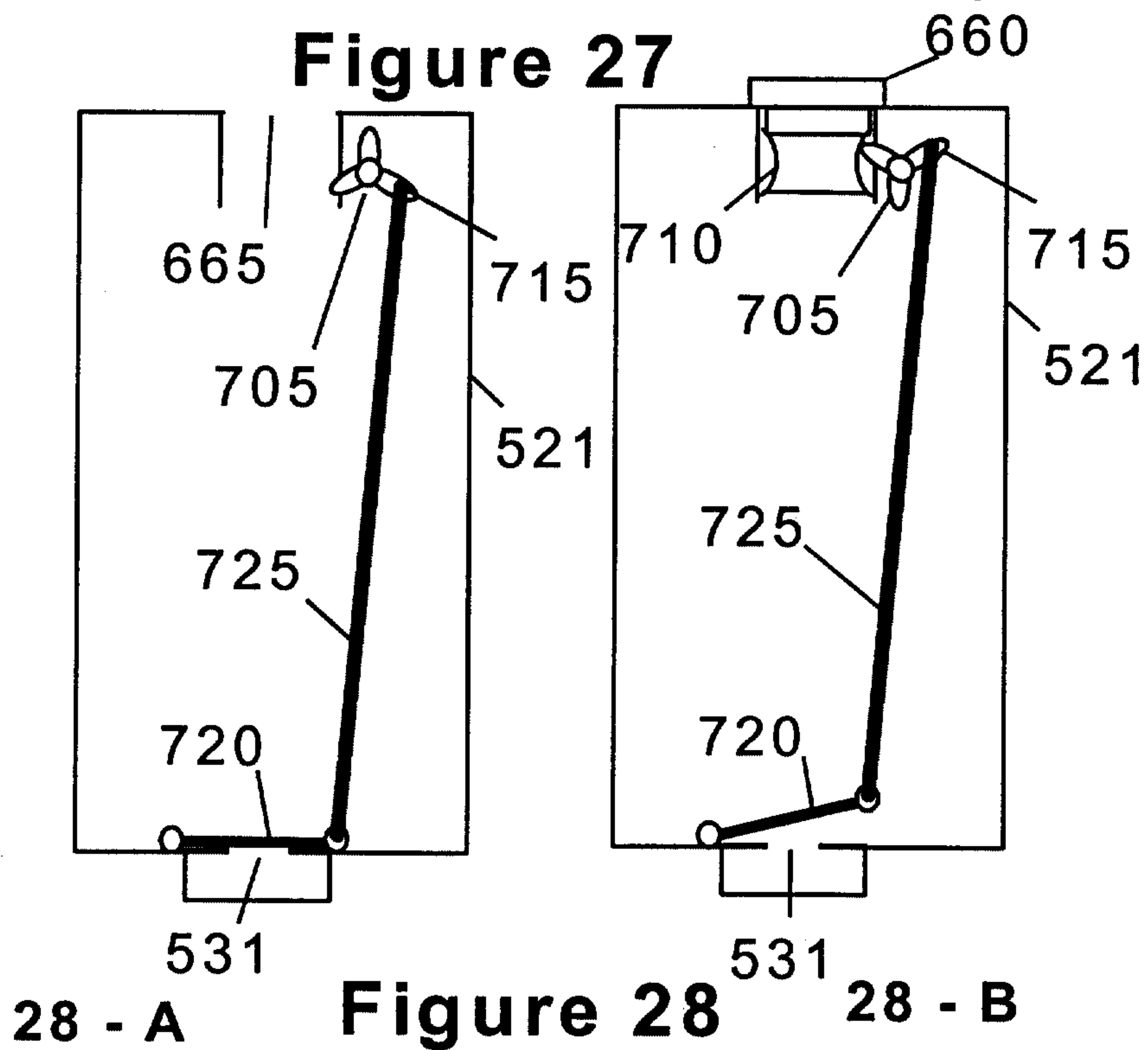
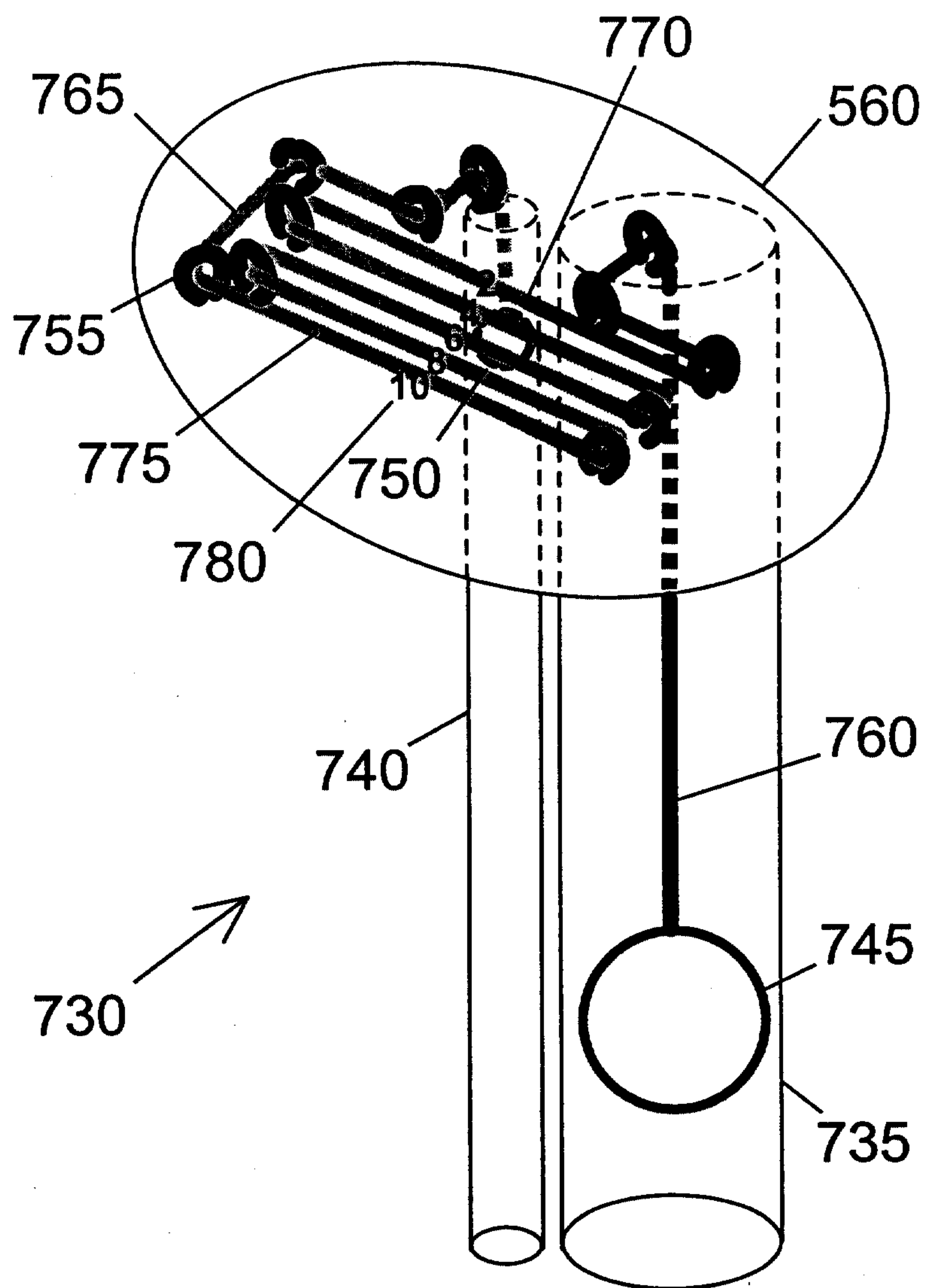


Figure 27



**Figure 29**

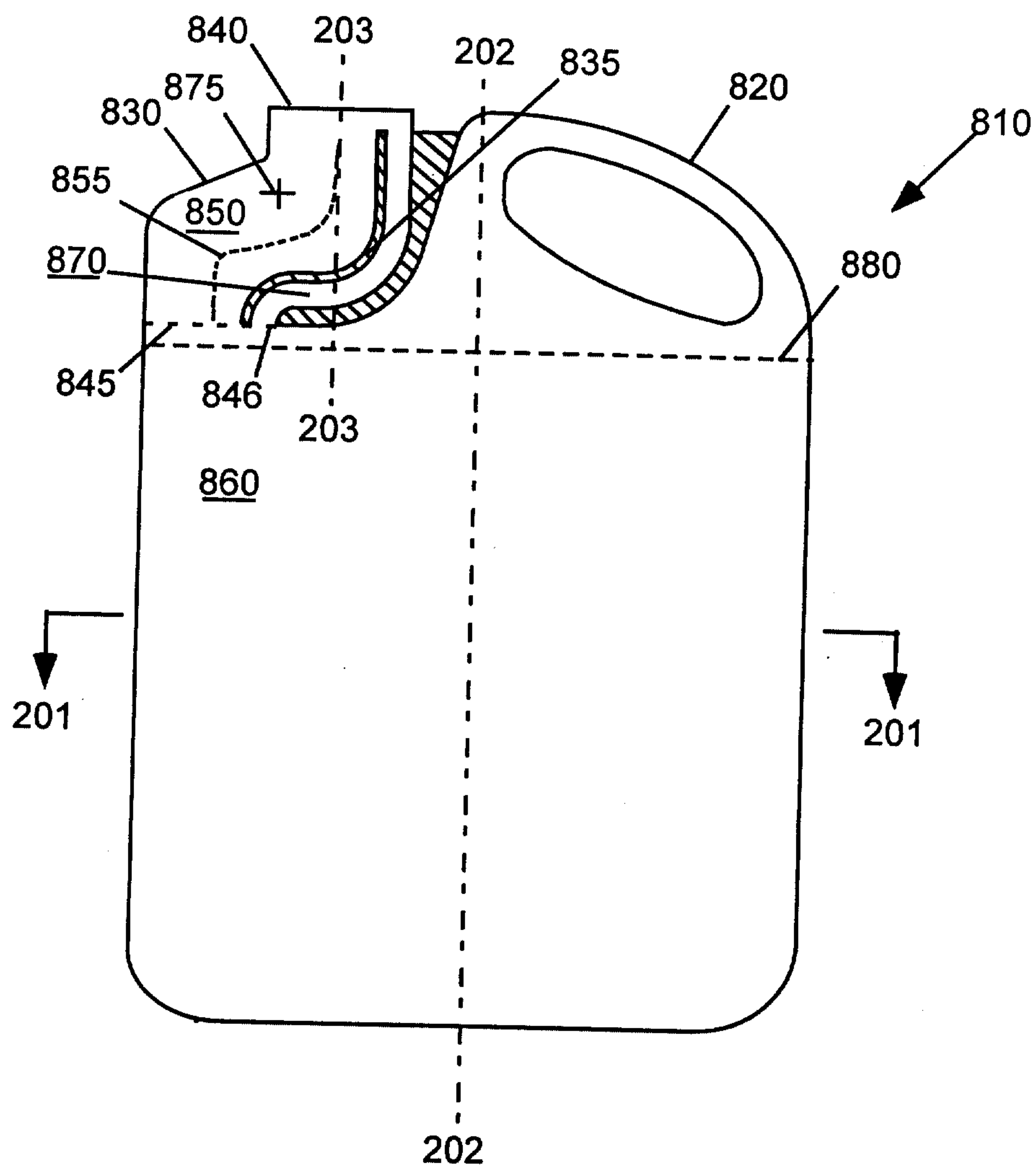


Figure 30

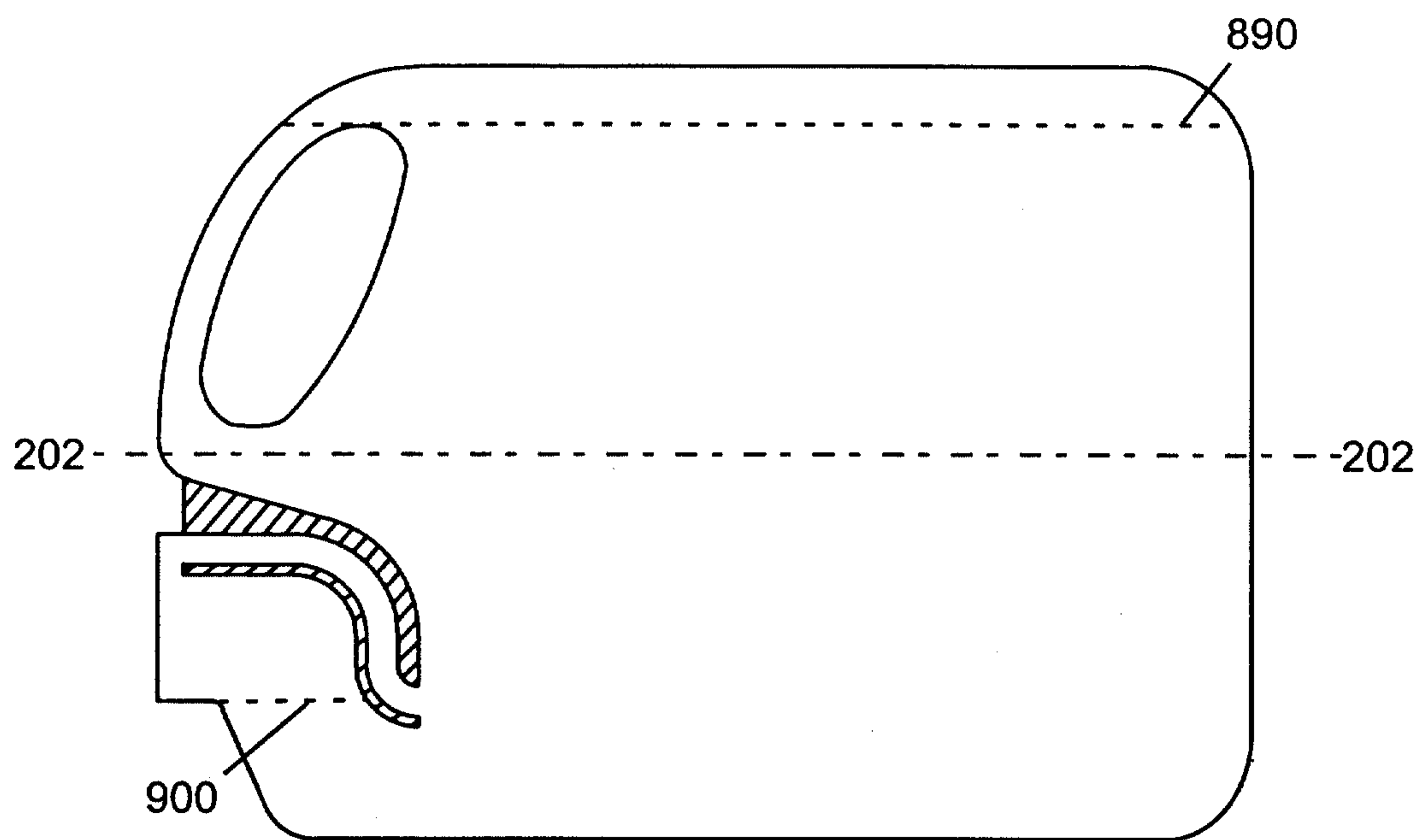


Figure 31 - A

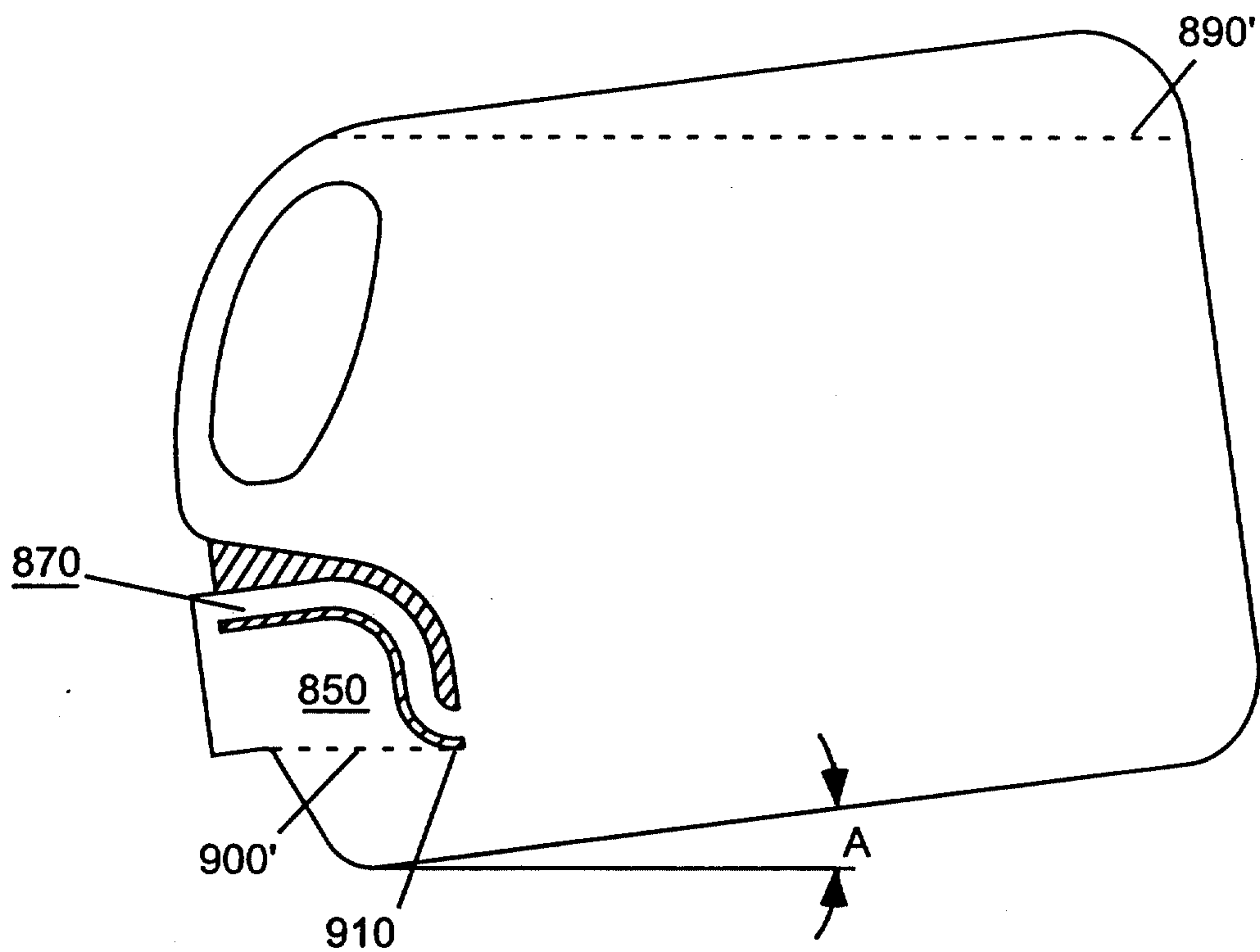


Figure 31 - B

