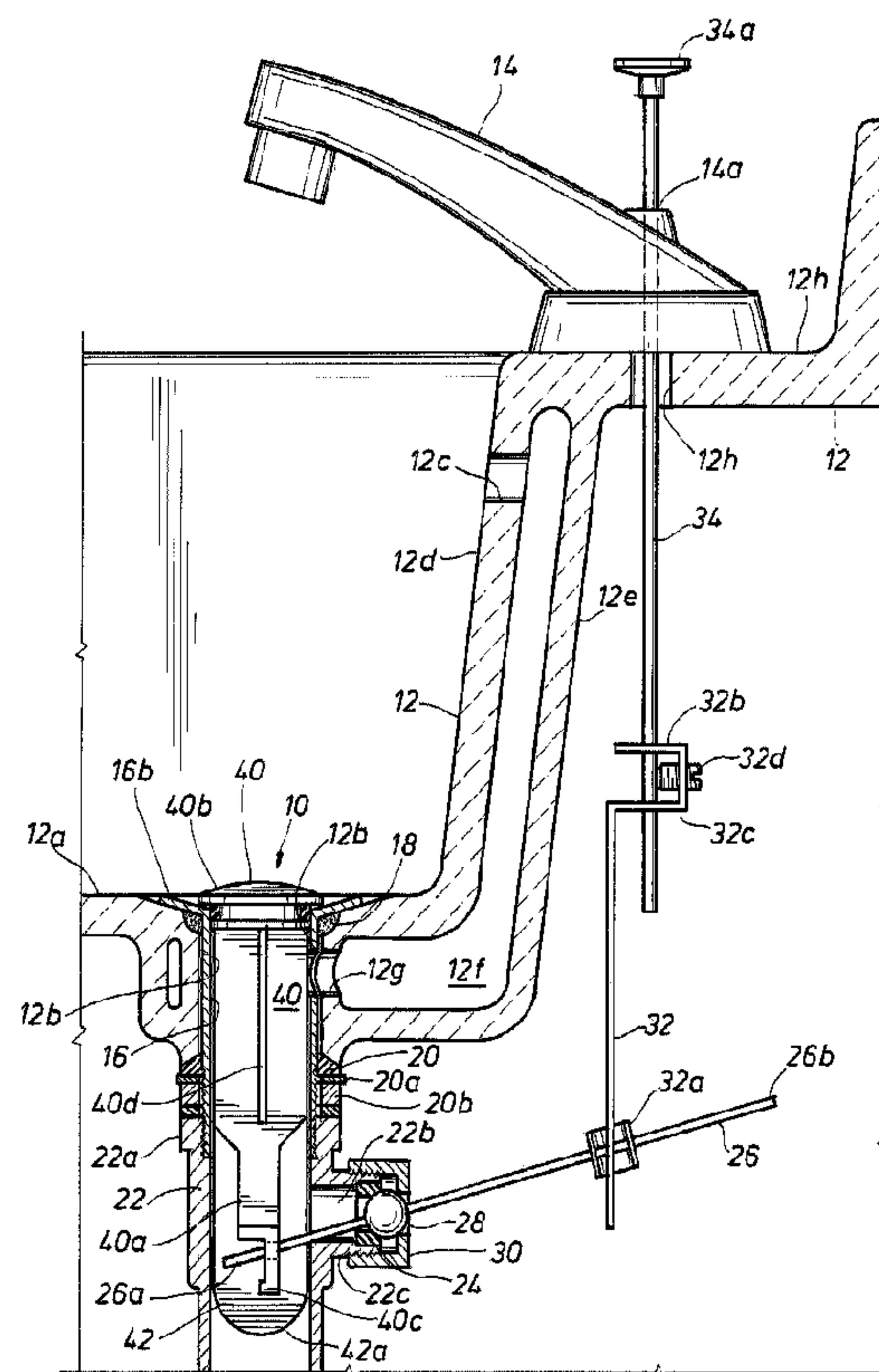




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(54) Title: POP-UP DRAIN ASSEMBLY



(57) Abrégé/Abstract:

A pop-up drain assembly for a sink has drain piping, a stopper in the drain piping, a pivot rod for opening and closing the stopper and tends not to clog because the pivot rod is not within a fluid flow path. In one embodiment the stopper has flow diverter plates that channel fluid flowing through the drain piping away from the pivot rod so that hair, waste and debris does not catch on and accumulate on the pivot rod. In another embodiment the stopper and the pivot rod are engaged through magnetic coupling, and the pivot rod does not protrude into the fluid flow path. The stopper is preferably variable in length for adjustment to fit different distances from the pivot rod to the top of the drain piping.

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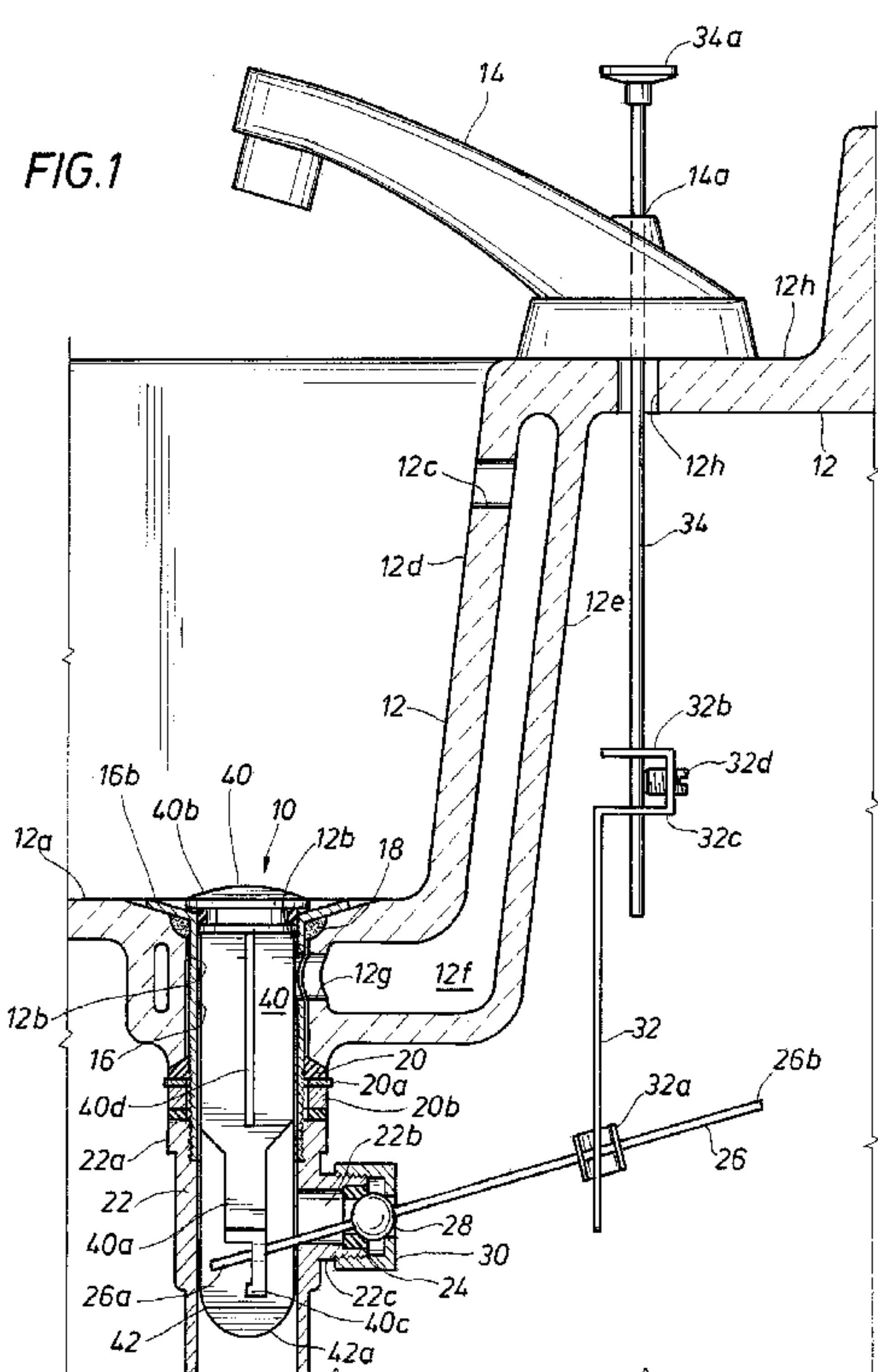
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(54) Title: POP-UP DRAIN ASSEMBLY



(57) Abstract: A pop-up drain assembly for a sink has drain piping, a stopper in the drain piping, a pivot rod for opening and closing the stopper and tends not to clog because the pivot rod is not within a fluid flow path. In one embodiment the stopper has flow diverter plates that channel fluid flowing through the drain piping away from the pivot rod so that hair, waste and debris does not catch on and accumulate on the pivot rod. In another embodiment the stopper and the pivot rod are engaged through magnetic coupling, and the pivot rod does not protrude into the fluid flow path. The stopper is preferably variable in length for adjustment to fit different distances from the pivot rod to the top of the drain piping.

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Pop-Up Drain Assembly

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

[0002] This present invention pertains to a pop-up drain assembly used to retain fluid in and release fluid from a sink or basin and more particularly to preventing debris such as hair from being caught in a drain pipe either by directing flow away from a pivot rod or by eliminating the pivot rod from within the drain pipe.

2. DESCRIPTION OF THE RELATED ART

[0003] In a lavatory or bathroom sink or basin equipped with a supply of running water for washing oneself, a pop-up drain assembly allows one to retain water in the sink or basin and then release the water to flow by gravity downwardly through a drain pipe. The sink or basin has an opening at a lowermost point, and a typical pop-up drain assembly comprises a drain conduit sealingly fastened to the sink or basin within the opening. A drain stopper is received in the drain conduit for sealing the opening and retaining water in the sink or basin. A pivot rod protrudes into the drain conduit and engages a bottom portion of the drain stopper. A lift rod is connected to the pivot rod. One can pull the lift rod up to pull the drain stopper down for sealing the opening in the bottom of the sink or basin for retaining water, and one can push the lift rod down to raise the drain stopper, which unseals the drain stopper and allows water to drain from the sink or basin. U.S. Patent No. 4,807,306, issued to Hayman et al., illustrates quite well the components in a typical prior art pop-up drain assembly and is incorporated by reference for all purposes.

[0004] As water drains from the sink, the water flows around and along the drain stopper and over the portion of the pivot rod that protrudes into the drain

conduit. Debris and/or waste in the water, such as soap, dirt, oils, toothpaste and particularly hair, catches on and clings to an end of the pivot rod, where the pivot rod protrudes into the drain conduit and engages with the bottom portion of the drain stopper. Accumulation of such debris and waste on the pivot rod and drain stopper clogs the drain conduit and causes water to not drain properly. To restore proper drainage through the drain conduit, one needs to remove and clean the pivot rod and the drain stopper. Removal of the pivot rod and drain stopper requires disassembly of a sealed connection of the pivot rod to the drain conduit, which is a messy and time-consuming task, and if a plumber is hired to provide the service, then it is also an expensive task. Improvements are needed in a pop-up drain assembly for reducing the accumulation of waste and debris in the drain assembly, and consequently, for reducing clogging in the drain assembly that slows or stops drainage through the drain conduit.

SUMMARY OF THE INVENTION

[0005] In one embodiment, the present invention provides a pop-up drain assembly for a sink or basin having a drain opening, which includes: drain piping, typically a drain flange and a drain body, which provides a fluid flow pathway from the sink or basin through the drain opening and through the piping; a stopper for retaining fluid in the sink or basin, which is received in the piping and which is moveable between an open position and a closed position; and a pivot rod for moving the stopper between the open position and the closed position, where the pivot rod is not in the fluid flow pathway. In one embodiment, fluid, typically water, draining through the drain piping is diverted around a pivot rod that extends into or protrudes inside the piping, which prevents hair, waste and debris from catching on the pivot rod. In another embodiment, the pivot rod does not protrude or extend into the piping significantly, and the pivot rod moves the stopper up and down through magnetic coupling between the stopper and the pivot rod, which also prevents hair, waste and debris from catching on the pivot rod.

[0006] In the embodiment where the pivot rod protrudes inside the drain piping, the pivot rod physically engages the stopper for moving the stopper up and down. In this embodiment, the stopper has a plug-type body with a central, longitudinal shaft. A pair of opposing, longitudinal plates are attached at an upper

end of the plates to the body of the stopper. The plates extend downwardly about the pivot rod such that the pivot rod is between the plates, and the plates extend about to or below the pivot rod. The plates are sized and designed with respect to the diameter of the drain piping so that fluid draining through the drain piping is diverted around the pivot rod, flowing along an outside surface of each plate while the pivot rod is on the inside of the plates. Hair, waste and debris flows on through the drain piping with the fluid and does not tend to get caught on or accumulate on the pivot rod or on the lower portion of the stopper that is engaged with the pivot rod. The stopper is preferably removeable from and attachable to the pivot rod, without needing to remove the pivot rod from the drain piping. The stopper is also preferably designed to provide more than one distance between the point where the pivot rod engages the stopper and a cap on an upper end of the stopper, which allows the stopper to fit drain assemblies made by different manufacturers.

[0007] In the embodiment in which magnetic coupling between the stopper and the pivot rod is used so that the pivot rod can move the stopper up and down, where the pivot rod terminates about flush with the inside wall of the drain piping, either a plug type or a tubular type stopper body can be used. A permanent magnet or magnetic material is fixed on the stopper body such that the magnet or magnetic material is adjacent to a pivot rod port in the drain piping. A distal end of a pivot rod terminates approximately flush with the inside wall of the drain piping in the pivot rod port adjacent to the magnet or magnetic material on the stopper body. The distal end of the pivot rod is made of magnetic material or a magnet that is opposite of the magnet or magnetic material on the stopper so that there is a magnetic attraction between the distal end of the pivot rod and the stopper for providing a magnetic coupling.

[0008] In another embodiment, a stopper is provided, and in one variation, the stopper preferably includes flow diverter plates for directing fluid flow away from a pivot rod holder. One preferred stopper has a pivot rod holder that has a notch, which allows the stopper to be installed and removed from a drain assembly that has a pivot rod protruding into the drain assembly, without needing to remove the pivot rod from the drain assembly, and the pivot rod holder can preferably receive the pivot rod in more than one vertically-spaced location for providing height adjustment. One preferred embodiment of a stopper provides a magnet or magnetic material on the

stopper for engagement with a pivot rod. The stopper is preferably adapted to accommodate drain assemblies from different manufacturers that have a different distance between the pivot rod and the top of the drain piping, which can be accomplished by using multiple magnets or sources of magnetic material spaced apart longitudinally and by a single longer, linear magnet or magnetic material. Another approach for adapting the stopper for different lengths is to alter the length of the stopper, such as through a connection of one portion of the stopper with another portion of the stopper, where the connection may be a threaded connection, or a friction-fit connection, a detent connection or a similar means of connection. This approach can be used with either the flow diverter guard plates or with the magnetically-coupled stopper. It is also preferable to be able to adjust the length of the pivot rod between the pivot ball and the distal end of the pivot rod that engages the stopper, such as by being able to move the pivot ball with respect to the pivot rod through a detent connection, a friction fit or by a threaded connection and/or by moving the distal end adjacent to the stopper by providing a tip that is biased outwardly by a spring or resilient material. In another embodiment, a stopper is fitted with screening means for trapping objects and debris, where the stopper is preferably removeable from and attachable to the pivot rod without removing the pivot rod, or the stopper is magnetically coupled to the pivot rod, so that the stopper can be removed, cleaned and replaced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] A better understanding of the invention can be obtained when the detailed description of exemplary embodiments set forth below is considered in conjunction with the attached drawings in which:

[0010] Fig. 1 is a cross-section of a side elevation of a sink or basin and a pop-up drain assembly, according to the present invention.

[0011] Fig. 2 is a cross-section of a side elevation of a pop-up drain assembly, according to the present invention.

[0012] Fig. 2A is a plan view of the pop-up drain assembly of Fig. 2 as seen from the bottom, according to the present invention.

[0013] Fig. 3 is a perspective view of a drain stopper, according to the present invention.

[0014] Fig. 4 is a side elevation of a drain stopper, according to the present invention.

[0015] Fig. 5 is a side elevation of the drain stopper of Fig. 4 rotated 90 degrees.

[0016] Fig. 6 is a perspective view of a drain stopper adapted to have different lengths, according to the present invention.

[0017] Fig. 7 is a side elevation of a drain stopper adapted to press onto a pivot rod transversely, according to the present invention.

[0018] Fig. 8A is a side elevation of a drain stopper adapted to press onto a pivot rod transversely, according to the present invention.

[0019] Fig. 8B is a side elevation of the drain stopper of Fig. 8A during assembly or disassembly, according to the present invention.

[0020] Fig. 9 is a side elevation of a drain stopper adapted to press onto a pivot rod transversely and to lock into engagement, according to the present invention.

[0021] Fig. 10 is a cross-section of a side elevation of a drain stopper that has a magnet or magnetic material for magnetically coupling with a pivot rod, according to the present invention.

[0022] Fig. 11 is a cross-section of a side elevation of a drain stopper that has a length of magnet or magnetic material for magnetically coupling with a pivot rod, according to the present invention.

[0023] Fig. 12 is a cross-section of a side elevation of a tubular drain stopper that has several magnets or discs of magnetic material for magnetically coupling with a pivot rod, according to the present invention.

[0024] Fig. 13 is a cross-section of a side elevation of a tubular drain stopper that has a magnets or a disc of magnetic material for magnetically coupling with a pivot rod, and the length of the tubular drain stopper is adjustable, according to the present invention.

[0025] Fig. 14 is a side elevation of a drain stopper that has a magnet or magnetic material, and the length of the tubular drain stopper is adjustable, according to the present invention.

[0026] Fig. 15 is a side elevation of a pivot rod magnetically coupled to a drain stopper, wherein the pivot rod has a tip that is pressed against the drain stopper by a spring, according to the present invention.

[0027] Fig. 16 is a side view of a pivot rod and a pivot ball shown in cross-section, where the pivot ball is fixed to the pivot rod by a detent mechanism, according to the present invention.

[0028] Fig. 16A is a side view of a pivot rod and a pivot ball shown in cross-section, where the pivot ball is connected to the pivot rod by a threaded connection, according to the present invention.

[0029] Fig. 17 is a cross-section of the tubular drain stopper shown in a side elevation with a magnet or a piece of magnetic material, according to the present invention.

[0030] Fig. 18 is a side elevation of a drain stopper having an extension and magnets or magnetic material in the extension and a basket screen attached to the extension, according to the present invention.

[0031] Fig. 19 is a cross-section of a side elevation of a sink or basin and a pop-up drain assembly, according to the present invention.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

[0032] The present invention provides a pop-up drain assembly for a sink or basin for receiving and retaining a fluid, which is typically water, and a drain opening is provided in a lowermost portion of the sink or basin for draining the fluid. The pop-up drain assembly includes piping that can be placed through the drain opening and fastened to the sink or basin. The piping is typically connected to a drain pipe, and the piping provides a fluid flow pathway from the sink or basin through the drain opening and through the piping to the drain pipe for conveying fluid from the sink or basin to the drain pipe and away for disposal and/or treatment. After the drain assembly is installed on a sink, a drain stopper is received in the piping and is moveable between an open position and a closed position. In the closed position, the stopper provides a seal with the piping for retaining fluid in the sink or basin, and in the open position, fluid can enter the piping and drain away through the drain pipe. A pivot rod is used to move the stopper between the open position and the closed position. The pivot rod pivots about a generally horizontal position and engages the

stopper, raising the stopper to the open position and lowering the stopper to the closed position.

[0033] In the drain assembly of the present invention, the pivot rod is not in the fluid flow pathway while in operation. The pivot rod either protrudes inside the piping for moving the stopper and fluid flow is diverted around the pivot rod for preventing hair and other debris from catching on the pivot rod or the pivot rod does not protrude significantly inside the piping and is magnetically coupled to the stopper for moving the stopper. In a prior art pop-up drain assembly, the pivot rod was typically in the fluid flow pathway, and hair and debris caught on the pivot rod and stopper, which clogged the drain assembly. The present invention provides a pop-up drain assembly in which the pivot rod is not in the fluid flow pathway, so clogging in the drain assembly should be reduced.

[0034] Turning now to the drawings and with reference to Fig. 1, a pop-up drain assembly 10 is shown according to the present invention. Drain assembly 10 is received in a sink or basin 12, such as is typically used in a lavatory. Sink 12 has a lower surface 12a that drains into a drain opening 12b. Sink 12 has an overflow port 12c in a side wall 12d, which is an optional feature. An outer wall 12e and side wall 12d define an overflow channel 12f, and side wall 12d has an overflow drain port 12g for draining overflow fluid into a port in drain assembly 10. A faucet 14 is mounted on a top deck 12h of sink 12 for supplying water or other fluid to sink 12.

[0035] A number of different manufacturers make and sell pop-up drain assemblies, which can be retrofitted to provide a pop-up drain assembly according to the present invention. In the embodiment depicted in Fig. 1, pop-up drain assembly 10 comprises a drain flange 16 that fits down through drain opening 12b in sink 12. Preferably, drain flange 16 has a threaded tubular portion 16a extending essentially throughout its full length and a flange 16b extends radially outwardly on a top end. A gasket or plumber's putty 18 provides a seal between the lower surface 12a of the sink 12 and the flange 16b of drain flange 16. A flexible gasket 20 and a washer 20a are placed around a bottom portion of drain flange 16 and then pressed tightly against a bottom surface of sink 12 with a threaded nut 20b. A drain body 22 is threaded onto a lower end of drain flange 16. Drain body 22 has a wrench flange 22a for receiving a wrench for tightening and loosening drain body 22 with respect to drain flange 16.

Drain body 22 has a pivot rod port 22b, and a threaded tubular stub 22c projects radially outwardly from drain body 22. A pivot rod seal 24 is received in stub 22c.

[0036] A pivot rod 26 has a stopper end 26a and an outer end 26b. A pivot ball 28 is sealingly received on pivot rod 26 closer to stopper end 26a than outer end 26b. Pivot rod 26 is received in stub 22c such that stopper end 26a is inside the drain body 22, and the stopper ball 28 rests against pivot rod seal 24. A pivot rod cap 30 is threaded onto stub 22c sufficiently tightly to seal pivot ball 28 against pivot rod seal 24, but loose enough to allow pivot ball 28 and pivot rod 26 to pivot. An extension rod 32 having a plurality of holes, which are not shown, is received on outer end 26b of pivot rod 26 and held in place by a clip 32a. Extension rod 32 is bent so as to have two parallel portions 32b and 32c that are perpendicular to the longitudinal axis of the extension rod 32, and each of the two parallel portions has a hole through which a control rod 34 is received. Control rod 34 passes through a faucet port 14a and a sink control rod port 12h. Control rod 34 has a knob 34a at an upper end, and control rod 34 is fastened to extension rod 32 by a set screw 32d. There are various ways to connect a control rod to a pivot rod, and there are alternative means for controlling the pivot rod and the stopper, including a cable such as described in U.S. Patent No. 5,822,812, issued to Worthington et al, and U.S. Patent No. 4,596,057, issued to Ohta et al., and electronic means, which may include a solenoid, an electronic actuator and/or a motor.

[0037] A stopper 40 is received in drain flange 16 and drain body 22. Stopper 40 has an elongate shaft 40a running its length, which has a longitudinal axis through the center of stopper 40. A cap 40b is located on an upper end while the drain assembly 10 is installed and operational, and a pivot rod receiving member 40c is located on an opposing lower end. The pivot rod receiving member 40c defines an opening through which stopper end 26a of pivot rod 26 protrudes for engaging and moving stopper 40, and pivot rod receiving member 40c may be referred to as open member 40c. Four flanges or fins, referred to collectively as fins 40d, extend longitudinally along shaft 40a and project radially, and fins 40d lie in two perpendicular and intersecting planes. The fins provide structural support for the shaft and center the stopper in the drain pipe. A suitable number of fins can be used, including 2, 3, 4, 5, 6, 7, 8, 9, or 10 fins. The cap may be a separate piece that is received on the shaft, or the cap may be formed integral with the shaft. In one

embodiment, the cap and shaft are formed of an integral piece of plastic, and the cap is coated with a metal such as chrome, nickel or brass. The stopper may also be made of a combination of metal and plastic.

[0038] A debris-guard flow diverter 42 is attached at an upper end to shaft 40a and fins 40d. Debris-guard flow diverter 42 has a lower free end 42a that extends below end 26a of pivot rod 26, although free end 42a may terminate above end 26a of pivot rod 26. If water is in sink 12, one can drain the water by pushing down on knob 34a of control rod 34, which pivots stopper end 26a of pivot rod 26 upward about pivot ball 28, raising stopper cap 40b. With cap 40b raised into an open position, water flows into drain flange 16. Debris-guard flow diverter 42 directs the water to flow between the debris-guard flow diverter 42 and the inside wall of drain flange 16 and drain body 22. Consequently, water does not readily flow over stopper end 26a of pivot rod 26 or over open member 40c on the lower end of stopper 40, which results in less hair, soap, toothpaste and debris being caught on and accumulating on stopper end 26a of pivot rod 26 or on pivot rod receiving member 40c. Pop-up drain assembly 10 is less likely to become clogged, particularly by accumulation of hair on pivot rod 26, than conventional prior art drain assemblies. Debris-guard flow diverter 42 may be referred to as a hair guard because it is particularly useful for preventing strands of hair from being caught and retained on the pivot rod and the lower end of the stopper.

[0039] Turning now to Fig. 2, a pop-up drain assembly 10a is shown in a cross-section of a side elevation, according to the present invention. Fig. 2A is a plan view of pop-up drain assembly 10a as seen from the bottom looking up. Drain assembly 10a is installed in sink 12 in the same manner as described with reference to Fig. 1. A stopper 44 is received in a drain flange 46. Drain flange 46 is connected to a drain body 48, which has an inside wall 48a, by a nut 48b. Stopper 44 has a body comprising longitudinal fins 44a that project radially outwardly at right angles to one another. A cap 44b is located on an upper end for sealing drain flange 46 and a notched open member 44c is located on a lower end of stopper 44. End 26a of pivot rod 26 is received in notched open member 44c, which has a notch or cut 44d. Notch or cut 44d allows stopper 44 to be pressed onto pivot rod 26 transversely, which allows stopper 44 to be installed and removed without the need to uninstall pivot rod 26 in order to engage pivot rod 26 with stopper 44. Debris-guard shields 50a and 50b

are attached at an upper end to fins 44a of stopper 44 at a point 44e. Any suitable method can be used to connect debris-guard shields 50a and 50b to fins 44a of stopper 44, including integral plastic molding, gluing and spot welding.

[0040] Debris-guard shields 50a and 50b have a lower end 50c and 50d, respectively, that is free in that it is not secured to anything. Debris-guard shields 50a and 50b have a width that is nearly as great as the diameter of drain flange 46 and drain body 48. Debris-guard shields 50a and 50b are not completely rigid, but rather are somewhat stiff, but flexible. Debris-guard shields 50a and 50b can be described in one embodiment as resilient. Debris-guard shields 50a and 50b flex outwardly from connection point 44e around the notched open member 44c, and thus around pivot rod 26. Because debris-guard shields 50a and 50b have a width essentially equal to the diameter of drain flange 46 and drain body 48 and because flow diverters 50a and 50b are sufficiently stiff, flow diverters 50a and 50b press against the inside wall of the drain body 48 at an intermediate point between the pivot rod 26 and the radius of the drain body 48 in the plane of the image of Fig. 2.

[0041] As can be seen in Fig. 2, drain body 48 has a radius r in the plane of the image shown in Fig. 2. Debris-guard flow diverter 50b presses against the inside wall 48a of drain body 48 at an intermediate point such that a gap x is defined between an outside surface of debris guard 50b and inside wall 48a at the full radius r in the plane of the image shown in Fig. 2. In the cross-sectional side elevation shown in Fig. 2, pivot rod 26 is shown as lying in a longitudinal centerline, which is a distance r from the inside wall 48a in the plane of the image. The lower free end 50d of the hair guard 50b presses against the inside wall 48a at a distance of r minus x from the centerline in the plane of the image, and consequently a flow path is defined between an outside surface of the hair guard 50b and the inside wall 48a of drain body 48. The plan view in Fig. 2A shows the flow path in the gap x is defined by the debris guard 50b and the inside wall 48a of drain body 48. The lower end 50d of debris guard 50b is bent into the shape of a circular arc because its edges are pressed against the inside wall 48a of drain body 48 while the center portion is pressed further outwardly by notched open member 44c. The inside wall 48a of drain body 48 defines a circular arc that has a greater diameter than the circular arc shape of debris guard 50b. Consequently, the flow path in gap x has a crescent shape in this embodiment. All that has been described with reference to debris guard 50b is also

the same for debris guard 50a, and consequently, a flow path is provided inside drain body 48 on each side of pivot rod 26, but not over pivot rod 26 or notched open member 44c, which retards accumulation of hair and other debris on pivot rod 26 and notched open member 44c. The result is reduced frequency of clogging of pop-up drain assembly 10a.

[0042] Fig. 3 shows a side elevation of a stopper 60 in a perspective view. Stopper 60 has a central, elongate shaft from which fins 60a, 60b, 60c and 60d, which is not shown as it is hidden behind fins 60a and 60b. Stopper 60 has a cap 60e on an upper end, which has an outermost and uppermost domed flange 60f, lowermost and innermost flange 60g and a seal 60h between the flanges for sealing with a drain flange and retaining water in a sink. A pivot rod receiving element 60i is formed integral with the central shaft on a lower end opposite the cap 60e and has an opening 60j through which a pivot rod can be received so that the pivot rod can move the stopper 60 up and down between an open and a closed position, respectively. Pivot rod receiving element 60i could be notched as shown in Fig. 2 so that it could be pressed transversely onto the pivot rod. Another alternative is that the pivot rod holder could have the shape of the letter “J” such that there is a hooked end in which the pivot rod can be received. A pair of flow diverters or debris shields 60k and 60m are fastened onto the central shaft. While stopper 60 can be made of metal or plastic or a combination of metal and plastic, in this embodiment, the central shaft, the fins 60a, 60b, 60c and 60d, and the pivot rod receiving member 60i are formed by injection molding of a plastic such as polyethylene, polypropylene, polystyrene, polyvinylchloride or a copolymer of suitable monomers. Although shown as two separate pieces in other embodiments, in this embodiment, debris guards 60k and 60m are formed of a single integral piece of stiff, resilient plastic, such as polypropylene. A slot is formed or cut along a longitudinal centerline and extends about the half of the length of the debris guard, but is longitudinally centered. The width and length of the slot in the debris guard is determined by the need to fit over the fins 60a and 60c. The debris guard is folded at a longitudinal centerline and placed on the central shaft, receiving fins 60a and 60c through the slot in the debris guard. An adhesive is preferably used to fasten the debris guard to the central shaft at an upper end near the cap 60e, but if an adhesive fails, such as due to an incompatibility of materials, other

mechanical and/or chemical means can be used to fix the debris guard on the central shaft defined by fins 60a, 60b, 60c and 60d.

[0043] Continuing to reference Fig. 3, the cap's lower flange 60g and seal 60f are sized to fit snugly in a drain flange for a sealing engagement that will hold fluid in a receptacle. The width of the debris guard 60k, 60m is about the same as the diameter of cap flange 60g and cap seal 60f, probably slightly smaller, but greater than the radius of the cap flange 60g and cap seal 60f. If the radius of the cap flange 60g and cap seal 60f is R , then the width of the debris guard ranges between $1.1R$ and $1.9R$, preferably between $1.3R$ and $1.9R$, more preferably between $1.5R$ and $1.8R$. Some experimentation will likely be required, and a width of $1.75R$ may be a good starting point. The width should be such that fluid flow around stopper 60 is directed along an outside surface 60k' and 60m' of debris guards 60k and 60m, respectively. Debris guards 60k and 60m have a lower free-end portion 60k'' and 60m'', which may flex into an essentially vertical position while installed in a drain assembly, leaving a flow path along outer surfaces 60k' and 60m', while shielding pivot rod receiving element 60i from fluid and debris in the fluid, such as hair, toothpaste, oil and soap. The length and width of the debris guard relative to the diameter of the drain assembly will determine how the debris guard lies against the inside wall of the drain assembly. A longer debris guard will more likely flex into a vertical position in a lower end portion. A shorter debris guard may bend such that its lower edge is adjacent to the inside wall of the drain assembly. If a short debris guard is used, which does not flex into a vertical position in its lower end, one may wish to use a squared-off lower end rather than a rounded lower end, because if the lower end of the debris guards is squared off, this should ensure a larger semi-circular flow path as compared to a smaller crescent-shaped flow path that may result from a rounded bottom. A stopper with debris guards rounded at the bottom is easier to install in a drain, and debris guards that are long enough to flex into a vertical position around the pivot rod may be preferred.

[0044] The width of the debris guard or flow diverter is more appropriately compared to the inside diameter of the piping in which the stopper is received. A purpose for using a pair of opposing flow diverters on a stopper is to form somewhat of a seal between the flow diverters and the inside wall of the piping so that fluid flow is diverted away from the lower end of the stopper. The flow

diverters provide a partial dam in the fluid flow path in the drain piping, and fluid flowing downwardly through the drain piping is directed toward the inside wall of the drain pipe and away from the lower end of the stopper. There is preferably a minimal clearance between the side edges of the flow diverters and the inside wall of the piping for providing somewhat of a seal between the flow diverters and the inside wall of the piping. The width, w , of the flow diverters could be as great as (or possibly greater than) the inside diameter of the piping, which is the drain flange and drain body in Fig. 1. It is believed that the width of the flow diverters should be at least as great as half the inside diameter of the piping, which is its radius, r . Then, the width of the flow diverters should range between about r and about $2r$ or so and is probably in the range of $1.4r$ to $1.8r$. The length, L , of the flow diverter plates will likely be related to the length of the stopper, particularly the length below the cap. If the stopper has a body length of BL , then the length of the flow diverters will likely be as least as long as about $0.25BL$ and probably not longer than about $2BL$. If a pivot rod holder, such as in Figs. 6 and 7, is included as part of the body of the stopper, then L will be likely less than or equal to about $1.25BL$ and more likely to be less than or equal to $1.75BL$, and preferably $0.5BL$ is less than or equal to L , which is less than or equal to $1.5BL$. The thickness of the flow diverters will depend on the material of which the flow diverter is made. The flow diverter should form a seal with the inside wall of the piping. A sheet of standard copier paper is believed to be less than about 0.004 inches thick, which a sheet of cardstock is believed to be about 0.0175 inches thick. If a thin, stiff, flexible and resilient metal or plastic material is used, the thickness may be about 0.01 inch or about 0.25 mm. On the other hand, a thicker plate could be used, such as another plastic with a higher content of elastomeric material, which may be as much as one-eighth of an inch thick or about 3 mm, but probably no more than about one-sixteenth of an inch or about 1.5 mm thick. The thickness may be about 0.01 to 0.02 inches in one embodiment and may be from about 0.2 mm to about 1 mm, preferably to about 0.5 mm in another embodiment. The thickness of cardstock may be about right, depending on the material of construction. An example of a flow diverter is a rectangular plate having a length of from about 3 to 6 inches, and width of from about 0.75 to about 1.5 inches and a thickness of from about 0.01 to about 0.02 inches, where the plate is made of a material that will flex into an arc along a transverse section that has a radius of

curvature equal to about the width of the plate, but is sufficiently stiff so that it will not readily flex into an arc having a radius of curvature of about half the width of the plate, and where the material is resilient so that it will return to the shape of a planar plate after a flexing force is removed.

[0045] Fig. 4 is a side elevation of a drain stopper 64, and Fig. 5 is another side view of drain stopper 64 after a 90-degree rotation about its longitudinal axis. Stopper 64 comprises two plates that intersect at a right angle to provide longitudinal flanges or fins 64a, 64b, 64c and 64d, which attach to a plate 64e on a lower end. Two downwardly projecting elements 64f and 64g are attached at an upper end to a lower surface of plate 64e, and the downwardly projecting elements 64f and 64g each have a free end that curves one towards the other so that together, the downwardly projecting elements 64f and 64g form a shape that resembles a semi-circle that is cut to leave a gap 64h in the center of its arc. Downwardly projecting elements 64f and 64g are stiff and resilient so that stopper 64 can be pressed onto a pivot rod from the side, and consequently, stopper 64 can be removed from a drain assembly for cleaning without needing to remove the pivot rod. Stopper 64 can be reinstalled by pressing the stopper downwardly while the gap 64h is aligned over the side of the pivot rod. Downwardly projecting elements 64f and 64g flex outwardly to accommodate the full diameter of the pivot rod in the gap 64h and then return to their normal state to retain the pivot rod in an interior opening 64i defined by the downwardly projecting elements 64f and 64g and plate 64e. Flow diverter plates 66 and 68 have an upper end portion 66a and 68a that is adhered to fins 64a and 64c. Flow diverter plates 66 and 68 flex outwardly through a central portion 66b and 68b in order to accommodate the width of lower plate 64e. Flow diverter plates 66 and 68 have a lower portion 66c and 68c and a lower end 66d and 68d. The flow diverter plates 66 and 68 are preferably of a stiffness, length and width such that the lower portion 66c and 68c is forced into an essentially vertical position. The flow diverter plates 66 and 68 have an outer surface 66e and 68e.

[0046] While stopper 64 is installed and in operation, two fluid flow pathways should be defined by flow diverter plates 66 and 68 and the inside wall of the drain assembly. The inside wall of the drain assembly is circular in a transverse cross-section and has a diameter of twice its radius or $2R$. If the width of flow diverter plates 66 and 68 is about $1.4R$ to about $1.8R$, then lower portions 66c and

68c will press against the inside wall of the drain assembly and orient essentially vertically, provided the flow diverter plates 66 and 68 are sufficiently long. In this case, one fluid flow path will be defined as a semi-circular shape by outside surface 66e and the inside wall of the drain assembly, and another fluid flow path will be defined between outer surface 68e of diverter plate 68 and the inside wall of the drain assembly, which flow path will also have a semi-circular shape in a transverse cross-section.

[0047] Drain stopper 64 in Figs. 4 and 5 further includes a cap portion 64j that includes a top plate 64k, which is attached to the top of the central shaft and the fins 64a, 64b, 64c and 64d, a cap shaft 64m extending upwardly from top plate 64k, and a domed flange 64n is affixed to or integral with an upper end of cap shaft 64m. A gasket or seal 64p is received around cap shaft 64m between top plate 64k and domed flange 64n. Gasket or seal 64p is typically made of an elastomeric material and provides a seal with a drain flange for retaining fluid in a receptacle. Gasket or seal 64p is shown in cross-section in Fig. 5.

[0048] Fig. 6 is a side elevation of a drain stopper 70 in a perspective view. Stopper 70 has a cap 70a and fins 70b, 70c, 70d and 70e, but fins 70d and 70e are not visible in Fig. 6. Flow diverter debris shields 70f and 70g are attached to fins 70c and 70e about midway along the length of the fins. The debris shields 66 and 68 in Figs. 4 and 5 were attached to a lower end of the fins and shaft, while in Fig. 7 the debris shields are attached to an upper end of the stopper body. Stopper 70 has a pivot rod retainer 72, which is shown as being about as long as the fins 70b and 70c but may be longer or shorter. Pivot rod retainer 72 is attached to or formed integral with a lower end of the shaft from which the fins 70b and 70c emanate radially. Pivot rod retainer 72 has an upper end 72a, where it is attached to or formed integral with the central elongate body of the stopper, and a lower end 72b. Pivot rod retainer 72 has an open slot 72c on lower end 72b, which extends upwardly for nearly the entire length of the pivot rod retainer 72. The body of the pivot rod retainer 72 defines the slot 72c and multiple circular openings sized to have a diameter only slightly larger than the diameter of a pivot rod. Stopper 70 and pivot rod retainer 72 can be pressed and forced onto a pivot rod transversely, and the multiple circular openings provide different distances between a pivot rod and the bottom of the cap 70a, which allows stopper 70 to fit different drain assemblies from different manufacturers. In this

embodiment, pivot rod retainer 72 has openings 72d, 72e, 72f, 72g, 72h and 72i stacked one above the other along slotted opening 72c, which provides six different vertical distances between the bottom of a lavatory basin and a pivot rod in a drain assembly. The openings in the pivot rod retainer can be circular, oval, rectangular and/or triangular. Thus, stopper 70 can be used to retrofit an existing drain assembly with a stopper that reduces the likelihood of flow stoppage or clogging in the drain assembly.

[0049] Fig. 7 is another embodiment of a drain stopper according to the present invention. A side elevation of a drain stopper 76 is shown in Fig. 7, which has flow diverter debris shields 76a and 76b attached to an upper end of a radial flange 76c. An opposing radial flange can not be seen in this view. Opposing radial flanges 76d and 76e extend radially outwardly perpendicular to radial flange 76c, and the longitudinal intersection of the radial flanges define a central longitudinal shaft. Radial flange or fin 76d extends downwardly into a first prong 76f, and radial flange 76e extends downwardly into a second prong 76g. First and second prongs 76f and 76g are spaced apart and a slot 76h is defined between first and second prongs 76f and 76g. First and second prongs 76f and 76g have inside edges 76f' and 76g', respectively, and a layer of rubbery, elastomeric material 76i is bonded to the inside edges 76f' and 76g'. A gap remains within slot 76h between the elastomeric material 76i on first prong 76f and the elastomeric material 76i on the second prong 76g, and a pivot rod can be received in this gap by forcing stopper 76 transversely over a pivot rod that is extending or protruding into a drain assembly. The width of the gap between the elastomeric material is slightly less than the width or diameter of the pivot rod, while the width of slot 76h between first and second prongs 76f and 76g is slightly greater than the width or diameter of the pivot rod, which results in a snug or tight friction fit between the stopper 76 and the pivot rod. First and second prongs 76f and 76g and slot 76h can have different lengths relative to the central longitudinal shaft such as 0.25, 0.50, 0.75, 1.0, 1.25, 1.50, 1.75 and 2.0 times the length of the central longitudinal shaft. Slot 76h and the gap between the elastomeric material 76i within slot 76h have a length equal to essentially the length of first and second prongs 76f and 76g, which is from 1 to about 10 times the diameter of a pivot rod, preferably 1 to 6 times and more preferably 1 to 3 times the diameter of a conventional pivot rod that has a circular cross-section. A conventional pivot rod may range in size of from

about 6 to about 12 inches in length, more typically from about 8 to about 10 inches in length, with a diameter ranging from about 0.125 inches to about 0.375 inches, where the diameter is typically about 0.25 inches.

[0050] Figs. 8 and 9 illustrate an alternative design for a pivot rod and a pivot rod retainer on a drain stopper. Fig. 8A shows a cross-section side elevation of a drain assembly 78, and a side elevation of the lower portion of a drain plug 80. Drain plug 80 is fitted with a pair of clog preventers 80a and 80b. Drain assembly 78 has an inside wall 78a for which a horizontal cross-section would be circular, assuming drain assembly 78 is installed in a vertical position. Clog preventers 80a and 80b have a lower, vertical portion 80a' and 80b', respectively, while installed in a vertical drain assembly, due to the width and flexibility of the clog preventers, which causes the lower portions 80a' and 80b' of the clog preventers 80a and 80b to press against and rest against inside wall 78a of drain assembly 78. Clog preventers 80a and 80b have an outside surface 80a'' and 80b'', respectively, on a side opposite of where a pivot rod is received. A first flow pathway 80c is defined between the outer surface 80a'' of debris shield or clog preventer 80a, and a second flow pathway 80d is defined between the outer surface 80b'' of flow diverter or clog preventer 80b.

[0051] Fig. 8A shows a side elevation of a pivot rod holder 80e attached to a lower end of a plug body 80f. Pivot rod holder 80e has two parallel prongs 80g and 80h, which are spaced apart to provide a gap 80i. The inside walls of prongs 80g and 80h, which define gap 80i, have a series of notches 80j, and between a pair of adjacent notches 80j is a projection 80k. A pivot rod 82 having a pair of opposing longitudinal flanges 82a and 82b that project radially is received in a detent relationship in gap 80i. Fig. 8b shows the stopper and drain assembly of Fig. 8A, while stopper 80 is pushed into detent engagement with pivot rod 82. Pivot rod flanges 82a and 82b are in longitudinal alignment with the longitudinal centerline of gap 80i between prongs 80g and 80h while stopper 80 is pushed onto pivot rod 82. Projections 80k on prong 80g are opposite and facing projections 80k on prong 80h and are spaced apart a distance that is slightly less than the diameter of pivot rod 82, which requires that prongs 80g and 80h be forced apart somewhat while stopper 80 is pressed into engagement with pivot rod 82. Fig. 8A shows pivot rod 82 at rest between a pair of opposing notches 80j and between adjacent projections 80k. A pair of adjacent projections on first prong 80g opposes a pair of adjacent projections on

second prong 80h and surround pivot rod 82 to hold and retain pivot rod 82 within pivot rod holder 80e in a detent relationship. A detent relationship is one in which one part is kept in a certain position relative to that of another, where one part can be released by applying force to one of the parts. Fig. 9 shows a portion of the pivot rod holder 80e of Fig. 8A and pivot rod 82. In Fig. 9 the pivot rod 82 has been rotated 90 degrees relative to the position of pivot rod 82 in Fig. 8A. Consequently, pivot rod flanges 82a and 82b are perpendicular to the longitudinal axis of slot 80i. Flanges 82a and 82b project sufficiently to force prongs 80g and 80h apart slightly, which provides a tighter engagement of pivot rod holder 80e with pivot rod 82 as compared to the arrangement in Fig. 8A. In Fig. 8A, the pivot flanges are 82a and 82b are aligned with the centerline of slot 80i, and in Fig. 9, the pivot flanges are 82a and 82b are transverse to the centerline of slot 80i, so the parallel alignment in Fig. 8A can be said to provide a soft detent hold on the pivot rod, and the transverse alignment in Fig. 9 can be said to provide pivot rod holder 80e a firm detent hold on pivot rod 82.

[0052] Turning now to Fig. 10, an embodiment of the present invention is shown in which a pivot rod and a stopper are magnetically coupled rather than physically engaged, where the pivot rod does not protrude significantly inside a drain assembly. A pop-up drain assembly 100 is shown according to the present invention, which is received in a basin, receptacle or sink 102 through a drain hole 102a. Drain assembly 100 comprises a drain flange 104 that fits down through drain opening 102a in sink 102. As described with reference to Fig. 1, drain flange 104 has a threaded tubular portion that extends essentially throughout its full length and a flange 106 extends radially outwardly on a top end. A gasket or plumber's putty provides a seal between a lower surface of flange 106 and the sink 102. A rubber gasket 108 and a washer 108a are placed around a bottom portion of drain flange 104 and then pressed tightly against a bottom surface of sink 102 with a threaded nut 110. A drain body 112 is threaded onto a lower end of drain flange 104. Drain flange 104 has an inside wall 104a, and drain body 112 each has an inside wall 112a, and these two inside walls define circular cylindrical spaces 104b and 112b, respectively. Drain body 112 has a wrench flange 112a for receiving a wrench for tightening and loosening drain body 112 with respect to drain flange 104. Drain body 112 has a pivot rod port 116, and a threaded tubular stub 118 projects radially outwardly from drain body 112. A pivot ball seal 120 is received in stub 118.

[0053] A pivot rod 122 has a stopper end 122a and an outer end 122b, which is not shown. A pivot ball 124 is sealingly received on pivot rod 26 closer to stopper end 122a than outer end 122b. Pivot rod 122 is received in stub 116 such that stopper end 122a does not protrude into the interior space 112b defined by the inside wall 112a of the drain body 112 or only protrudes slightly inside of inside wall 112a. The pivot rod ball 124 rests against pivot rod seal 120. A pivot rod cap 126 is threaded onto stub 118 sufficiently tightly to seal pivot ball 124 against pivot rod seal 120, but loose enough to allow pivot ball 124 and pivot rod 122 to pivot. The positioning of pivot ball 124 on pivot rod 122 may be made adjustable so that the end of pivot rod tip 122a is located flush with the inside wall 112a of drain body 112.

[0054] A drain stopper 130 is received in drain flange 104 and drain body 112. Stopper 130 has a cap 132 with a gasket 134 (shown in cross-section) for sealing with flange 106 of drain flange 104 to retain fluid in sink 102. Stopper 130 has a plug-type body as described above with radial flanges 130a, 130b, 130c and 130d extending the length of the body. A bottom horizontal plate 136 is adhered to or formed integral with the lower end of the body of stopper 136. A holder 138 (shown in partial cross-section) is bonded to or formed integral with the bottom horizontal plate 136 and extends downwardly along the inside wall 112a of drain body 112 in alignment with pivot rod port 116. Holder 138 has a recess 138a, and a magnet or magnetic material 140 is received in recess 138a. Pivot rod end 122a is made of a magnetic material or is a magnet also, and pivot rod end 122a is magnetically coupled or linked to or engaged with magnet or magnetic material 140, such that there is a magnetic attraction between pivot rod end 122a and magnet or magnetic material 140. Only one of magnet or magnetic material 140 and pivot rod end 122a needs to be a magnet, while the other may be magnetic material, but a stronger magnetic coupling will be achieved if both are magnets. Stopper 130 is shown in the open position in Fig. 10, and pivoting of pivot rod 122 such that pivot rod end 122a is lowered will move stopper 130 into a closed position. Pivoting of pivot rod 122 about pivot ball 124 such that pivot rod end 122a is raised (into the position shown in Fig. 10) will move stopper 130 into an open position. Consequently, drain assembly 100 is less likely to become clogged than a conventional pop-up drain assembly because the pivot rod is not in the fluid flow path, which coincides with much of the space 104b and 112b inside drain flange 104 and drain body 112, respectively. Hair and other

debris cannot readily catch on and/or adhere to pivot rod end 122a because pivot rod end 122a does not protrude inside of inside wall 112a of drain body 112. In a preferred embodiment, a permanent magnet is received in recess 138a in holder 138, while end 122a of the pivot rod 122 is made of magnetic material that is attracted to the permanent magnet, but the reverse arrangement can be used. The stopper 130 is open and closed by pivoting pivot rod 122 up and down, while the end 122a of the pivot rod 122 is not physically engaged with stopper 130, but is instead magnetically engaged with stopper 130.

[0055] Fig. 11 shows a pop-up drain assembly 150 much like the drain assembly 100 in Fig. 10. The sink, drain flange, drain body and pivot rod are the same as described for Fig. 10 and have been given the same element numbers as described above with reference to Fig. 10. A stopper 152 is received in the drain flange and drain body shown in Fig. 11. The stopper 152 in Fig. 11 is not the same as the stopper 130 in Fig. 10. Stopper 152 has an elongate central shaft from which four fins 154, 156, 158 and 160 project radially outwardly. Stopper 152 could be made, such as by plastic injection molding, with 3, 4, 5, 6, 7, 8, 9 or 10 fins or flanges. Fin 154 tapers inwardly through a lower section 154a in a manner similar to the stoppers shown in Figs. 2-7. Fin 158 does not taper inwardly and inside has an outside edge that remains adjacent to the inside wall 104a and 112a throughout its length. A lower plate 162 is bonded to or formed integral with the bottom edges of fins 154, 156, 158 and 160, as well as to a central shaft at the intersection of the fins. A holder 164 is bonded to or formed integral with lower plate 162 and possibly to fin 158. Holder 164 has a recess 164a, and holder 164 and recess 164a are preferably from about 2 to about 10 times as long as the diameter of pivot rod 122, preferably 3 to 8 times as long and more preferably 4 to 7 times as long. Stopper 152 in Fig. 11 differs from stopper 130 in Fig. 10 primarily in that holder 164 and recess 164a are longer than holder 138 and recess 138a in Fig. 10. This allows stopper 152 to fit drain assemblies of different lengths. The distance between the flange 106 at the surface of the sink 102 and the pivot rod 122 is different in drain assemblies from different manufacturers and between different models from the same manufacturer. The stopper 152 should be designed to fit many, if not all, of these different configurations. Either a permanent magnet or magnetic material 166 can be placed in recess 164a, and end 122a of pivot rod 122 can be either magnetic material or a

permanent magnet, respectively, such that there should be a magnetic attraction between end 122a of pivot rod 122 and the magnet or magnetic material in recess 164a in holder 164 on stopper 152. A stronger magnetic coupling will be obtained if both are magnets and neither is merely a magnetic material. Pivoting of pivot rod 122 such that pivot rod end 122a moves up and down should correspondingly move stopper 152 up and down between an open position and a closed position, respectively. For further information, see U.S. Patent Application Pub. Nos. 2010/0154114 published June 24, 2010, for inventors Van Zeeland and Sims entitled "Magnetic Drain Assembly" and 2009/0255041 published October 15, 2009, for inventor Duncan entitled "Magnetically Actuated Drain Stopper Apparatus".

[0056] Fig. 12 is a cross-section of a side elevation of a pop-up drain assembly 180, according to the present invention. A basin 182 has a drain opening 182a. A drain flange 184 is received in drain opening 182a and held in place by a threaded nut 186, which presses against a gasket 188. A drain body 190 extends below drain flange 184 and has an inside wall 190a. Drain flange 184 and drain body 190 together form a piping that defines a circular cylindrical flow path for draining water or another fluid from basin 182. Drain body 190 has a pivot rod port and a stub 192 projects radially outwardly from drain body 190. A pivot ball seal 194 is received in stub 192. A pivot rod 196 and a pivot ball 198, which is in a sealing engagement with pivot rod 196, is received within stub 192 such that pivot ball 198 sealingly and moveably rests against pivot ball seal 194. A pivot assembly cap 200 holds pivot ball 198 against pivot ball seal 194. Pivot rod 196 has a tip 202 that is inside stub 192. A distal end 202a (with respect to pivot ball 198) extends inside stub 192 and terminates essentially flush with drain body inside wall 190a. Drain body inside wall 190a defines a circular cylindrical volume or space 190b. Distal end 202a may extend into drain body space 190b by as much as 10 mm, preferably no more than 50 mm, and more preferably no more than 3 mm, but is preferably flush plus or minus about 1 or 2 mm, although a large drain body may require tip 202a to extend further within space 190b.

[0057] A stopper 204 is received in drain assembly 184 and drain body 190. Stopper 204 has a stopper body 204a that is tubular in shape such that the wall of the body defines a circular, cylindrical, empty space 204b within the body 204a. A

cap 204c having a gasket 204d is received on an upper end of tubular body 204a. An upper body tube 204e has two, three or four or more ports or openings 204f (which could be slots or a screen) located at an upper end just below cap 204c through which fluid in basin 182 can drain. Upper body tube 204e has an opposing lower end, which is threaded, and a lower body tube 204g has an upper end that is threadedly engaged with the lower end of upper body tube 204e such that the upper and lower body tubes thread together to form a unified piece of pipe or tubing. Lower body tube 204g is open at its lower end 204h. Lower body tube 204g has several recesses 204i, 204j, 204k and 204m spaced apart radially and longitudinally such that a line passing through the recess traces a spiral shape on an outer surface of lower body tube 204g.

[0058] A permanent magnet or magnetic material 206 is received in recess 204i on lower body tube 204g. The permanent magnet or magnetic material 206 is located in close proximity to distal end 202a of tip 202 on pivot rod 196. Tip 202 on pivot rod 196 is made of magnetic material or is a permanent magnet so as to be opposite of permanent magnet or magnetic material 206 such that there is a magnetic attraction between tip 202 and permanent magnet or magnetic material 206, which provides a magnetic coupling or engagement between pivot rod 196 and stopper 204. Through this magnetic coupling, one can pivot pivot-rod 196 down and up to move stopper 204 up and down to open and close the seal between gasket 204d and drain flange 184. Additional permanent magnets or magnetic material 206a, 206b and 206c is received in recesses 204j, 204k and 204m, respectively. Several magnets or magnetic material at different longitudinal locations allows stopper 204 to fit different manufacturer's drain assemblies, where there may be a difference in the distance between the center of pivot rod port and stub 192 (and hence the pivot rod 196) and the upper end of drain flange 184, which is flush with a drain surface of basin 182. The threaded engagement of upper body tube 204e and lower body tube 204g provides further adjustability to fit different manufacturer's drain assemblies, but the threaded engagement is optional, and a single piece of pipe or tubing could be used instead.

[0059] Fig. 13 is a side elevation of a pop-up drain assembly 210, according to the present invention. The sink, drain flange, drain body, pivot rod assembly and pivot rod are the same as for pop-up drain assembly 180 in Fig. 12, and like elements bear like numbers. Pop-up drain assembly 210 has a drain stopper 212

that is different from stopper 204 in Fig. 12, although it is similar. Stopper 212 has an upper tubular body 212a, which is threaded at a lower end 212b and which has one or more ports or openings 212c at an upper end through which water or fluid can pass into the inside of stopper 212. A cap 212d having a gasket 212e, which is shown in cross-section, is fixed to an upper end of upper tubular body 212a. A lower tubular body 212f having a threaded upper end 212g (shown partially without cross-section) is threaded onto the lower end upper tubular body 212f, although a single unified body could be used. Lower tubular body 212f is open at a lower end 212h so that fluid retained in basin 182 can flow into openings 212c, through the interior of upper tubular body 212a, lower tubular body 212f and out the open end 212h. Lower tubular body 212f has a circumferential recess or groove 212i, which is proximate to the pivot rod port in the drain body 190 while the stopper 212 is installed and operational. Either a ring of magnetic material or permanent magnet 212j or a plurality of discrete portions of magnetic material or permanent magnet 212j is received in groove 212i. The ring of magnetic material or permanent magnet 212j or a plurality of discrete portions of magnetic material or permanent magnet 212j is magnetically coupled to or engaged with tip 202 of pivot rod 196 so that pivot rod 196 can lift stopper 212 up and pull it down. The ring 212j allows stopper 212 to rotate about a longitudinal axis, while remaining magnetically engaged with or coupled to distal end 202a of tip 202 of pivot rod 196.

[0060] Fig. 14 is a side elevation in partial cross-section of a stopper 220, according to the present invention. Stopper 220 has a central longitudinal shaft 222 and four longitudinal fins 224, 226, 228 and 230 (hidden in back) radiate outwardly from shaft 222 forming two intersecting, perpendicular planes in a transverse cross-section. The longitudinal fins have a top portion and a bottom portion, which is not as wide as the top portion because each fin tapers inwardly through a curved arc in the bottom portion. A bottom plate 232 is bonded to or formed integral with a bottom edge of shaft 222 and fins 224, 226, 228 and 230. A holder 234 is bonded to or formed integral with plate 232 at an outer edge of plate 232. Holder 234 has a longitudinal axis that is parallel to the longitudinal axis of the shaft 222. A recess 236 is provided in holder 234, and a magnet or magnetic material 238 is received in recess 236 for magnetic engagement with a pivot rod as described above. The central longitudinal shaft 222 has a bore 240, and an inside wall 242 that defines bore hole

240 is threaded. A fully threaded rod or stud 244 has male threads threaded into the female threads in the wall 242. A cap 246, which would have a gasket that is not shown, is secured to the upper end of threaded rod 244, such as by threading, integral formation, welding or gluing. Rod 244 can be screwed to a desired depth to give stopper 220 a desired length so that stopper 220 will fit different manufacturer's drain assembly. Alternatively or additionally, bottom plate 232 (and holder 234) can be attached to the bottom edge of shaft 222 and fins 224, 226, 228 and 230 by a similar threaded rod and threaded borehole arrangement for providing a variable length for stopper 220. The means for adjusting the length of a stopper body described in reference to Figs. 12-14 can also be incorporated in the stoppers described in reference to Figs. 1-9, including having a two-piece, threaded shaft in which the length of the shaft can be adjusted.

[0061] Fig. 15 shows a side elevation in partial cross-section of a magnetic coupling assembly 250, according to the present invention. A cross-section of a small portion of a stopper 252 has a recess 254 in which is received a magnet or magnetic material 256. A drain body with a pivot rod port, pivot rod stub and pivot ball holder assembly is not shown for simplification. A side elevation in partial cross-section of a pivot rod 258 is shown, and a pivot ball 260 having a central bore is received on pivot rod 258. A seal is formed between pivot ball 260 and pivot rod 258. Pivot rod 258 has an end portion 262, which is a hollow, tubular portion. The remainder of pivot rod 258 may be a hollow tube or may be solid. A tip 264 has a bulbous head 266 formed integral with a shaft 268. A distal end 270 of end portion 262 has a shoulder 272 that projects inwardly about the circumference of the end 270 of pivot rod 258. Shaft 268 has a longitudinal slot 274 on an end 276 distal to head 266 and a radially outwardly projecting shoulder 278 about the circumference. Tip 264 can be pressed into engagement with end portion 262 of pivot rod 258. End 276 of shaft 268 of tip 264 is pushed inside distal end 270 of end portion 262 of pivot rod 258. Slot 274 allows shaft 268 of tip 264 to compress sufficiently so that outwardly projecting shoulder 278 passes through inwardly projecting shoulder 272, after which shaft 268 expands back to its normal diameter. After shoulder 278 of shaft 268 has passed to the interior of shoulder 272 of end portion 262 of pivot rod 258, tip 264 is locked into engagement with end portion 262 of pivot rod 258 because shoulder 272 on end portion 262 blocks the exit of shoulder 278 on tip 264. A spring (or resilient material)

280 is retained inside end portion 262. Spring 280 pushes against a solid portion within pivot rod 258 to push tip 264 outwardly so that head 266 remains adjacent to and/or is in contact with magnet or magnetic material 256 on stopper 252. Moving pivot rod 258 up and down moves stopper 252 down and up through magnetic coupling between tip 264 and stopper 252. Tip 264 is made of either magnetic material or a permanent magnet, opposite of the magnet or magnetic material 256 so that there is a magnetic attraction between tip 264 and stopper 252.

[0062] Fig. 16 is a side elevation of a pivot ball 290 (in cross-section) received on a pivot rod 292. Pivot ball 290 has a bore 294 through it and a hollow cylindrical extension 296. Pivot ball 290 has a shoulder 298 that projects inwardly into bore 294 and extends around the interior circumference of the wall that defines bore 294. Pivot rod 292 has circumferential grooves 300, 302 and 304 that can matingly receive shoulder 298 in a detent relationship. Pivot rod 292 has a distal end 306 for magnet coupling with a stopper. The detent fastening of pivot ball 290 onto pivot rod 292, where the pivot rod has multiple grooves spaced longitudinally apart for receiving the shoulder 298, allows the distance between the pivot ball 290 and distal end 306 of pivot rod 292 to be adjusted to fit different spacings that different manufacturers may have between a pivot ball and the inside wall of a drain body. The hollow cylindrical extension 296 on pivot ball 290 is optional. Alternative means for adjusting the distance between a pivot ball and the adjacent distal end of a pivot rod is a threaded connection, a friction fit and an easy slip-on ball with a set screw connection.

[0063] Fig. 16A is very similar to Fig. 16, but instead depicts a threaded connection between pivot rod 292 and pivot ball 290. Pivot rod 292 has a spiral groove 292a on at least a portion of its surface, which provides threads, and pivot ball 290 has internal threads 290a for engagement with the threads on the pivot rod. Distal end 306 has a smaller diameter than the threaded portion of the pivot rod 292 for passing through the pivot ball 290. The extension 296 is optional, but useful for providing an O-ring seal between the pivot rod and the pivot ball, in which case the pivot rod has a circumferential groove 292b in which is received an O-ring 293, which forms a seal with an unthreaded, smooth-walled extension 306. An alternative to threading pivot ball 290 and extension 206 is to use a material and to have an inside

diameter in the pivot ball and extension that will allow threads to be created while the threaded rod is threaded into the pivot ball 290.

[0064] Fig. 17 is a side elevation of a stopper 310 in partial cross-section. Stopper 310 has a hollow, cylindrical tubular body 312, which has an upper end 314 and a lower end 316. A cap 318 is fixed to upper end 314, and tubular body 312 has a hole, recess or indentation 320 for receiving a magnet or magnetic material 322. The upper end 314 of the tubular body 312 has a plurality of slotted openings 324 spaced together closely through which fluid, typically water, may pass, but which screens out debris, waster and objects that are too large to pass through the slotted openings 324. Slotted openings 324 are located around the entire circumference of the upper end 314 of tubular body 312. If a person's ring is dropped in a sink in which stopper 310 is installed, the upper end 314 serves as a screen to block entry of the ring into the interior of the tubular body 312. Long hair that falls into the sink may be caught in slotted upper end 314 as water flows into tubular body 312. Alternatively, a mesh screen can be used instead of the slotted openings 324. Alternative means for screening includes installing a horizontal mesh screen in a transverse cross-section of the lower end 316 of tubular body 312 or along the open end of lower end 316, in which case tubular body 312 becomes a basket for catching things such as hair that enter stopper 310, and in which case large ports would be provided in upper end 314 rather than slots 324.

[0065] Fig. 18 is a side elevation of a drain stopper 330, according to the present invention, which is similar to stopper 152 shown in Fig. 11 and described above. Stopper 152 in Fig. 11 was described as having a single linear magnet or magnetic material, but a plurality of magnets or magnetic material can be used. Stopper 330 has a plug-type body 332 comprised of a central shaft from which longitudinal flanges 334, 336, 338 and 340 (hidden) project radially. A top plate 342 is attached to the upper end of the central shaft and the longitudinal flanges 334, 336, 338 and 340. A cap 344 is received on the top plate 342. A bottom plate 346 is attached to the lower end of the central shaft and the longitudinal flanges 334, 336, 338 and 340. A receptacle member 348 extends downwardly from bottom plate 346 for a distance of about 0.25 to about 20, preferably about 0.5 to about 12 and more preferably from about 0.75 to about 5 times the diameter of the body 332. Receptacle member 348 has a plurality of recesses 350, and each recess 350 contains a permanent

magnet or magnetic material 352. Alternatively, a single linear magnet or magnet material having approximately the length of the receptacle member 348 can be used. A cylindrical ring 354 is attached to or formed integral with the lower end of the receptacle member 348. A mesh basket 356 is attached to a lower end of ring 354. Mesh basket 356 provides a screen for catching objects, debris, hair and waste. Since stopper 330 will be magnetically coupled to a pivot rod, stopper 330 can be easily removed from a drain, cleaned and reinstalled. Alternatively, a screening mechanism can be used on an upper end of stopper body 332.

[0066] Fig. 19 shows an alternative means for opening and closing a stopper. The present invention has been described with reference to a pop-up drain in which a pivot rod is used to open and close the stopper. However, one skilled in this art would know a number of alternative means for opening and closing the stopper. Fig. 19 is a side elevation in partial cross-section showing a drain assembly 370, according to the present invention. Fig. 19 shows a prior art drain assembly disclosed in U.S. Patent No. 3,002,196, issued to Mackey, Jr., as modified according to the present invention. In Fig. 19, a lavatory bowl 372 has a drain opening 374 and piping 376 is received in bowl 372 through opening 374. A stopper 378 has an elongate body from which a plurality of elongate fins 380 extend radially. A lower end of a flow diverter 382 is visible in the drawing.. Debris-guard, debris shield, or flow diverter 382 is made, attached to stopper 378 and used as described above with reference to Figs. 1-9. However, stopper 378 is not opened and closed by a pivot rod. Each of the fins 380 of stopper 378 have a split end 384, and a wedge-shaped cam 386 is received in one of the split ends 384. Cam 386 slides within a neck 388, and a cable 390 connects a control knob 392 to cam 386. As cam 386 is pushed inwardly by pressing downwardly on control knob 392, cam 386 slides into split end 384 of stopper 378 and lifts stopper 378 into an open position. As cam 386 is pulled outwardly by pulling upwardly on control knob 392, cam 386 slides out of split end 384 of stopper 378, and stopper 378 falls by gravity into a closed position. A pair of opposing guard shield flow diverters 382 divert water from bowl 372 around cam 386 and the lower split ends 384 to prevent debris, particularly hair, from accumulating on cam 386 and lower ends 384. Other means for opening and closing a stopper include electromechanical means, electric and magnetic means, and a spring-loaded detent mechanism. The

following patents and patent applications describe various drain and stopper arrangements, different means for opening and closing stoppers and different means for controlling a pivot rods: U.S. Patent Nos. 773,408, issued to Moore; 1,980,250, issued to Baxter; 6,219,861, issued to Chen; and 6,308,351, issued to Franke; and U.S. Patent Application Publication Nos. 2003/0041374, listing Franke as inventor; and 2006/0179564, listing Jacobs as inventor. Means for moving a stopper in a drain include a pivot rod, a cam system, an electromechanical system, an electric-magnetic system, a human-manual system, a detent mechanism or a spring-loaded detent mechanism. The human-manual system is one in which a person holds the stopper and moves it between an open position and a closed position.

[0067] Additionally, the debris guard flow diverters described with reference to Figs. 1 to 9 can be used in conjunction with the magnetic coupling described with reference to Figs. 10, 11, 14 and 18 for stoppers having plug-type bodies. The various embodiments of the present invention are believed to effectively address a problem of clogging in sink and basin pop-up drain assemblies, particularly in that the pivot rod is not in the fluid flow pathway in the drain assembly. Fluid flow is diverted around the pivot rod that protrudes into the fluid flow path using debris shield flow diverter plates, or the pivot rod does not protrude significantly into the fluid flow path and is magnetically coupled to the stopper. An electromagnet could be used instead of a permanent magnet, along with a suitable control mechanism.

[0068] Having described the invention above, various modifications of the techniques, procedures, materials, and equipment will be apparent to those skilled in the art.

CLAIMS

What is claimed is:

1. A pop-up drain assembly for a sink or basin having a drain opening, comprising:
 - piping for providing a fluid flow pathway from the sink or basin through the drain opening and through the piping, wherein the piping has a pivot rod port;
 - a stopper for retaining fluid in the sink or basin, wherein the stopper is received in the piping while in operation and is moveable between an open position and a closed position; and
 - a pivot rod for moving the stopper between the open position and the closed position, wherein the pivot rod is attached to the piping at the pivot rod port, wherein the pivot rod is pivotable between upward and downward positions and is in a generally horizontal position while in operation,
 - wherein the pivot rod is not in the fluid flow pathway while in operation, and while in operation,
 - wherein the pivot rod either:
 - (1) protrudes inside the piping through the pivot rod port for moving the stopper and the stopper has a flow diverter for diverting fluid flow around the pivot rod for preventing hair from catching on the pivot rod, or
 - (2) the pivot rod does not protrude significantly inside the piping and is magnetically coupled to the stopper through the pivot rod port for moving the stopper.
2. The pop-up drain assembly of claim 1, wherein the pivot rod protrudes inside the piping through the pivot rod port and engages the stopper, and wherein the flow diverter is fixed to the stopper for diverting flow away from the pivot rod while in operation.
3. The pop-up drain assembly of claim 2, wherein the flow diverter comprises two opposing plates that extend below the pivot rod while in operation.

4. The pop-up drain assembly of claim 3, wherein the flow diverter creates two fluid flow paths while in operation, one path being between one plate and an inside wall of the piping and another path being between the other plate and an inside wall of the piping, and wherein the pivot rod is between the two plates.
5. The pop-up drain assembly of claim 4, wherein the stopper has a central, longitudinal shaft, a cap on one end of the shaft and an open member on the other end for receiving the pivot rod, and wherein the two opposing plates are fixed to the shaft proximate to the cap.
6. The pop-up drain assembly of claim 4, wherein the stopper has a central, longitudinal shaft, a cap on one end of the shaft and an open member on the other end for receiving the pivot rod, and wherein the two opposing plates are fixed to the shaft proximate to the open member.
7. The pop-up drain assembly of claim 1, wherein the stopper has a central, longitudinal shaft, wherein the flow diverter is fixed to the shaft for diverting flow away from the pivot rod while in operation, wherein the flow diverter comprises two opposing rigid, flexible and/or resilient plates that extend toward, to or past the pivot rod while in operation, wherein the plates are generally rectangular with opposing longitudinal edges, wherein at least a portion of the longitudinal edges is adjacent to the inside wall of the piping for forming a flow channel between each plate and the inside wall of the piping.
8. The pop-up drain assembly of claim 7, wherein a transverse cross-section of the shaft of the stopper has the general shape of a circular central portion with at least two opposing fins extending radially outwardly, and wherein each plate has a notch through which one of the fins extends.
9. The pop-up drain assembly of claim 8, wherein each plate has a fixed end that is fixed to the shaft and an opposing free end.

10. The pop-up drain assembly of claim 1, wherein the flow diverter is fixed to the stopper for diverting flow away from the pivot rod while in operation, wherein the stopper has a shaft and an open member attached to or integral with an end of the shaft for receiving the pivot rod, and wherein the open member is a solid ring through which the pivot rod may only be inserted or the open member is a cut ring through which the pivot rod may be inserted or which may be pressed onto the pivot rod.

11. The pop-up drain assembly of claim 1, wherein the flow diverter is fixed to the stopper for diverting flow away from the pivot rod while in operation, wherein the stopper has a shaft and an open member attached to or integral with an end of the shaft for receiving the pivot rod, wherein the open member has a slot in its longitudinal axis for receiving the pivot rod, and wherein the slot is long enough to accommodate more than one distance between the pivot rod and the drain opening in the sink or basin.

12. The pop-up drain assembly of claim 11, wherein the open member has a longitudinal slot that provides an opening for receiving the pivot rod in an orientation transverse to the longitudinal axis of the open member, and wherein the slot is defined to appear as a circle attached to another circle by a line.

13. The pop-up drain assembly of claim 12, wherein the pivot rod has a pair of opposing longitudinal fins, wherein the pivot rod may be received in the open member such that the fins on the pivot rod are received within a circle in the slot in the open member.

14. The pop-up drain assembly of claim 11, wherein the open member comprises two opposing prongs spaced apart, wherein the slot is defined between the two prongs, and wherein each prong has an elastomeric material that extends into the slot for engaging the pivot rod in a friction fit.

15. The pop-up drain assembly of claim 1, wherein the stopper comprises a longitudinal shaft, a cap on one end of the shaft and a pivot-rod-receiving element, wherein the pivot-rod-

receiving element has more than one opening for providing different distances between the pivot rod and the cap while in operation.

16. The pop-up drain assembly of claim 15, wherein the flow diverter is fixed to the stopper for diverting flow away from the pivot rod while in operation, wherein the flow diverter comprises two opposing plates that extend below the pivot rod while in operation.

17. The pop-up drain assembly of claim 16, wherein the stopper can be engaged with and disengaged from the pivot rod while the pivot rod is sealingly connected to the piping.

18. The pop-up drain assembly of claim 1, wherein the pivot rod does not protrude significantly inside the piping, wherein the pivot rod is magnetically coupled to the stopper for moving the stopper, wherein the stopper comprises a magnet or magnetic material, wherein the pivot rod comprises a magnet or magnetic material, and wherein at least one of the stopper and the pivot rod comprises a magnet.

19. The pop-up drain assembly of claim 18, wherein the stopper comprises a shaft, a cap on one end of the shaft for providing a seal to prevent fluid from flowing into the piping while in operation, and a magnet (or magnetic material) mounted to the shaft on the opposing end.

20. The pop-up drain assembly of claim 18, wherein the stopper comprises a shaft, a cap on one end of the shaft for providing a seal to prevent fluid from flowing into the piping while in operation, and an extension fastened to or formed integral with the shaft on the opposing end, and wherein two or more magnets (or magnetic material) are fixed to the extension for providing two or more distances between the cap and the pivot rod.

21. The pop-up drain assembly of claim 18, wherein the stopper comprises a shaft, a cap on one end of the shaft for providing a seal to prevent fluid from flowing into the piping while in operation, and an extension fastened to or formed integral with the shaft on the opposing end, wherein a magnet (or magnetic material) having a length is fixed to the extension for accommodating more than one distance between the cap and the pivot rod.

22. The pop-up drain assembly of claim 1, wherein the stopper comprises a hollow tube having an outer wall, and wherein a magnet (or magnetic material) is fixed to and/or embedded in the outer wall for magnetically coupling with the pivot rod.
23. The pop-up drain assembly of claim 22, wherein two or more magnets (or magnetic material) are fixed to and/or embedded in the outer wall for magnetically coupling with the pivot rod, and wherein the two or more magnets (or magnetic material) are spaced apart longitudinally.
24. The pop-up drain assembly of claim 1, wherein the stopper comprises a magnetic material, and wherein the pivot rod comprises a magnet for moving the stopper between the open position and the closed position.
25. The pop-up drain assembly of claim 24, wherein the stopper comprises an elongated hollow tube having a cap on one end.
26. The pop-up drain assembly of claim 1, wherein the stopper comprises an elongate shaft having a longitudinal axis, a cap on an upper end while installed and an opposing lower end, wherein an extension plate having a longitudinal axis protrudes from the lower end, wherein the longitudinal axis of the extension plate is essentially parallel to the longitudinal axis of the shaft, and wherein the extension plate has one or more magnets or is comprised of a magnetic material.
27. The pop-up drain assembly of claim 26, further comprising a flow diverter fixed to the stopper for diverting flow away from the extension plate.
28. The pop-up drain assembly of claim 1, wherein the pivot rod has a tip on one end that is a magnet or a magnetic material.
29. The pop-up drain assembly of claim 28, wherein the tip is moveable with respect to the pivot rod.

30. The pop-up drain assembly of claim 29, further comprising a spring or a resilient material for moving the tip longitudinally outwardly with respect to the pivot rod.

31. The pop-up drain assembly of claim 1, further comprising a pivot ball mounted on the pivot rod, wherein the distance between an end of the pivot rod and the pivot ball can be adjusted while installing the pivot rod.

32. The pop-up drain assembly of claim 1, wherein the stopper comprises a hollow tube having an outer wall, the outer wall having an opening through which fluid in the sink or basin can pass while the stopper is in the open position, and wherein a magnet is fixed to and/or embedded in the outer wall or the outer wall comprises a magnetic material, further comprising a gasket or seal around the outer wall for sealingly engaging the piping while in operation.

33. The pop-up drain assembly of claim 1, wherein the stopper has a cap on one end and an opposing end, and wherein the distance between the cap and the opposing end is adjustable.

34. The pop-up drain assembly of claim 1, further comprising means for screening fluid that flows through the piping.

35. The pop-up drain assembly of claim 34, wherein the stopper incorporates the means for screening fluid.

36. A drain stopper for a sink or basin, comprising:

- a shaft having an upper end and an opposing lower end;

- a cap received on the upper end for providing a seal to retain fluid in the sink or basin;

- a first plate having a length and opposing upper and lower ends for diverting flow away from the lower end of the shaft, wherein the upper end of the first plate is fixed to or formed integral with the shaft, and wherein the lower end of the plate is free; and

a second plate fixed to or formed integral with the shaft opposite of the first plate for diverting flow away from the lower end of the shaft, the second plate having a length and opposing upper and lower ends, wherein the lower end of the plate is free.

37. The drain stopper of claim 36, further comprising pivot rod engagement means fixed to and/or formed integral with the lower end of the shaft.

38. The drain stopper of claim 37, wherein the pivot rod engagement means is a pivot rod holder for physical engagement with a pivot rod.

39. The drain stopper of claim 38, wherein the pivot rod holder has an open slot so that the drain stopper can be pressed onto a pivot rod transverse to the longitudinal axis of the pivot rod.

40. The drain stopper of claim 38, wherein the pivot rod holder has more than one location for receiving the pivot rod so that the drain stopper can provide more than one distance between the upper end of the shaft and the location where the pivot rod will be received.

41. The drain stopper of claim 40, wherein the pivot rod holder has two parallel members that each have an edge, and wherein a slot is defined between the edges of the two parallel members.

42. The drain stopper of claim 39, wherein each edge has more than one recess, and wherein a recess on one edge opposes a recess on the other edge to form an opening for receiving the pivot rod.

43. The drain stopper of claim 41, further comprising a layer of an elastomeric material on each edge for receiving the pivot rod in a friction fit.

44. The drain stopper of claim 41, wherein the edge of one member has at least two indentations separated by a protuberance, wherein the edge of the other member has at least two indentations separated by a protuberance, and wherein the indentations and protuberance on one

member opposes the indentations and protuberance on the other member, respectively, for providing a detent mechanism for holding the pivot rod.

45. The drain stopper of claim 44, further comprising a flanged pivot rod for moving the stopper, wherein the flanged pivot rod comprises a cylinder and a pair of opposing longitudinal flanges sized to fit the detent mechanism.

46. The drain stopper of any one of claims 36 to 45, wherein the distance between the lower end of the shaft and the cap is adjustable.

47. The drain stopper of claim 36, further comprising pivot rod engagement means fixed to and/or formed integral with the lower end of the shaft and screening means fixed to and/or formed integral with the shaft.

48. The drain stopper of claim 36, further comprising pivot rod engagement means fixed to and/or formed integral with the lower end of the shaft and a magnet or magnetic material received on or in the pivot rod engagement means for magnetic coupling with a pivot rod.

49. A pop-up drain assembly for a sink or basin having a drain opening, comprising:

- piping for providing a fluid flow pathway from the sink or basin through the drain opening and through the piping;
- a stopper for retaining fluid in the sink or basin, wherein the stopper has a body that has an upper end and a lower end, wherein the stopper is received in the piping while in operation and is moveable between an open position and a closed position;
- a pair of opposing flow diverter plates, wherein each flow diverter plate has a fixed end, which is fixed to the body of the stopper between the upper and lower ends of the stopper, and a free end that extends toward, to or past the lower end of the stopper, which is not fixed, wherein the stopper body is between the flow diverter plates; and
- means for moving the stopper between the open position and the closed position, wherein

the flow diverter plates fit in the piping in a manner such that fluid flowing through the piping tends to be diverted away from the lower end of the body of the stopper.

50. The pop-up drain assembly of claim 49, wherein the means for moving the stopper is a pivot rod, a cam system, an electromechanical system, an electric-magnetic system, a human-manual system, a detent mechanism or a spring-loaded detent mechanism.

51. The pop-up drain assembly of claim 49 or 50, wherein each flow diverter plate has a width W , wherein the piping has an inside diameter of twice its radius or $2R$, and wherein R is less than or equal to W and W is less than or equal to $2R$.

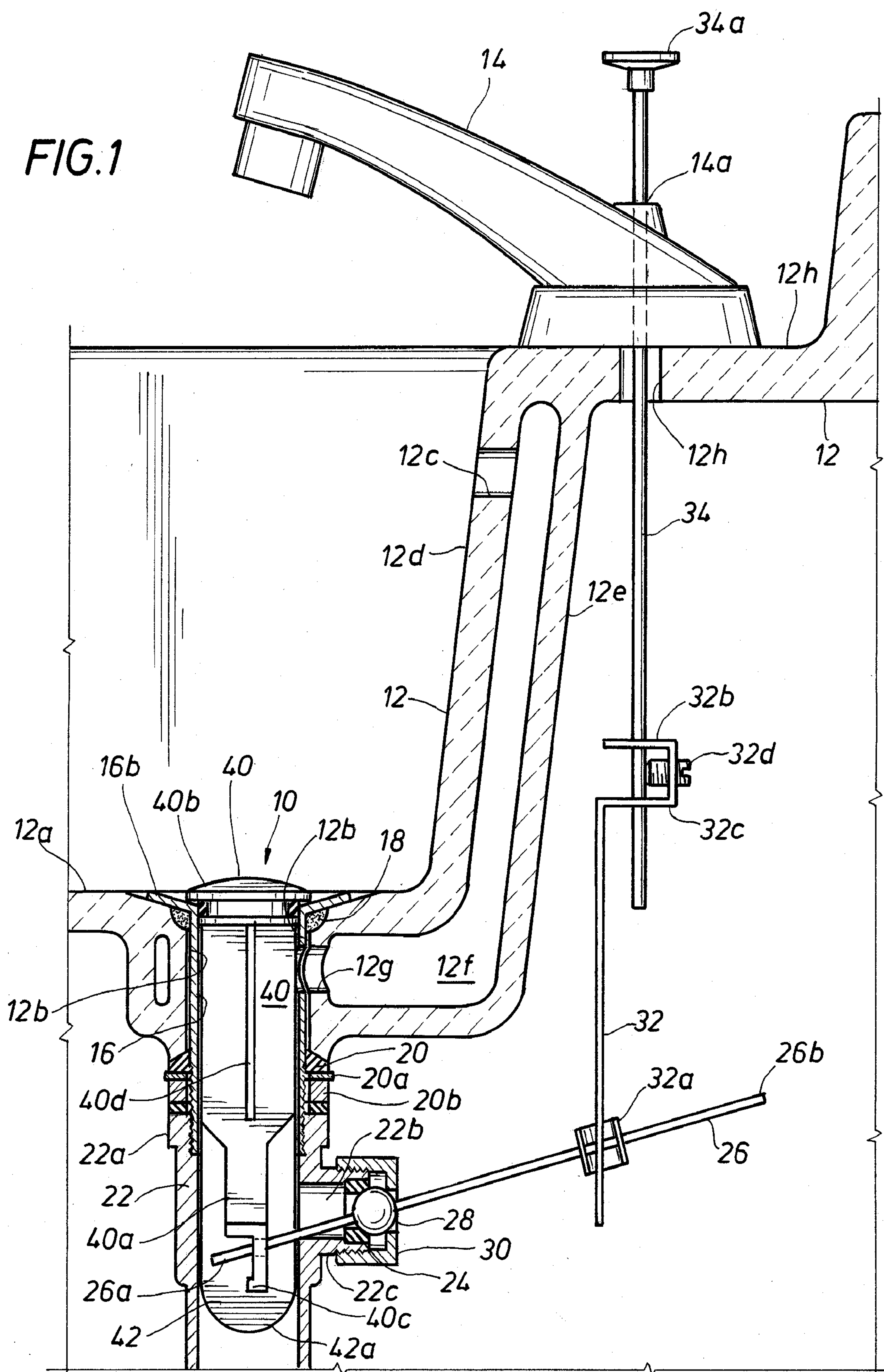
52. A retrofit kit for a pop-up drain assembly, comprising:

a stopper comprising a shaft, a cap on one end of the shaft for providing a seal and a magnet or a magnetic material mounted to or formed integral with the shaft on the opposing end;

a pivot rod having external threads and a stopper end proximate to the external threads, wherein the stopper end comprises a magnet or a magnetic material for forming a magnetic coupling with the magnet or magnetic material mounted to or formed integral with the shaft of the stopper; and

a pivot ball having a bore extending through the pivot ball and internal threads that define the bore, wherein the internal threads in the pivot ball matingly engage the external threads on the pivot rod for screwing the pivot ball onto the pivot rod for providing an adjustable distance between the pivot ball on the pivot rod and the stopper end of the pivot rod,

wherein after installation in a pop-up drain assembly that has a drain pipe that provides a fluid flow pathway, the pivot rod does not protrude significantly inside the drain pipe and is magnetically coupled to the stopper so that the pivot rod is not in the fluid flow pathway while in operation.



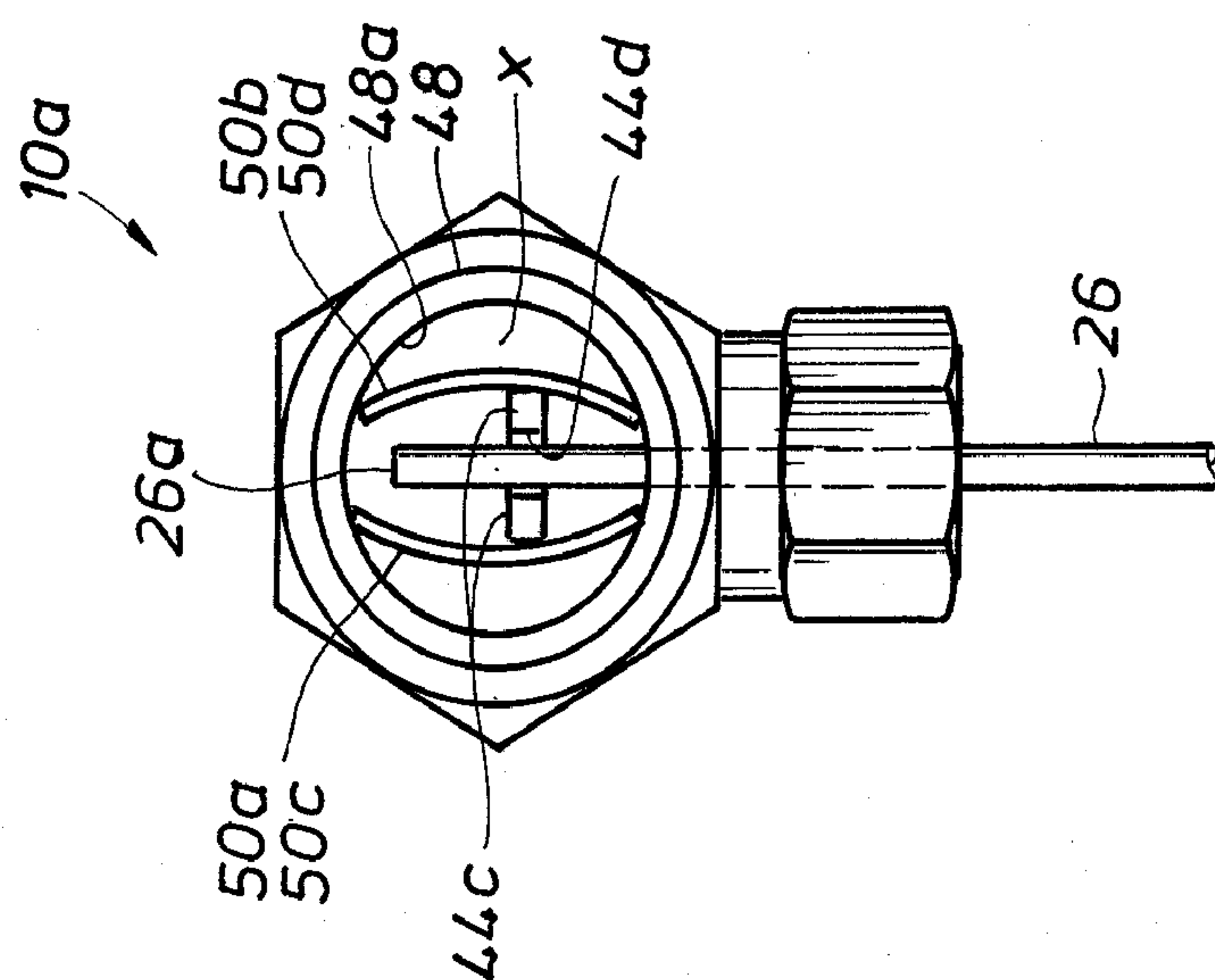
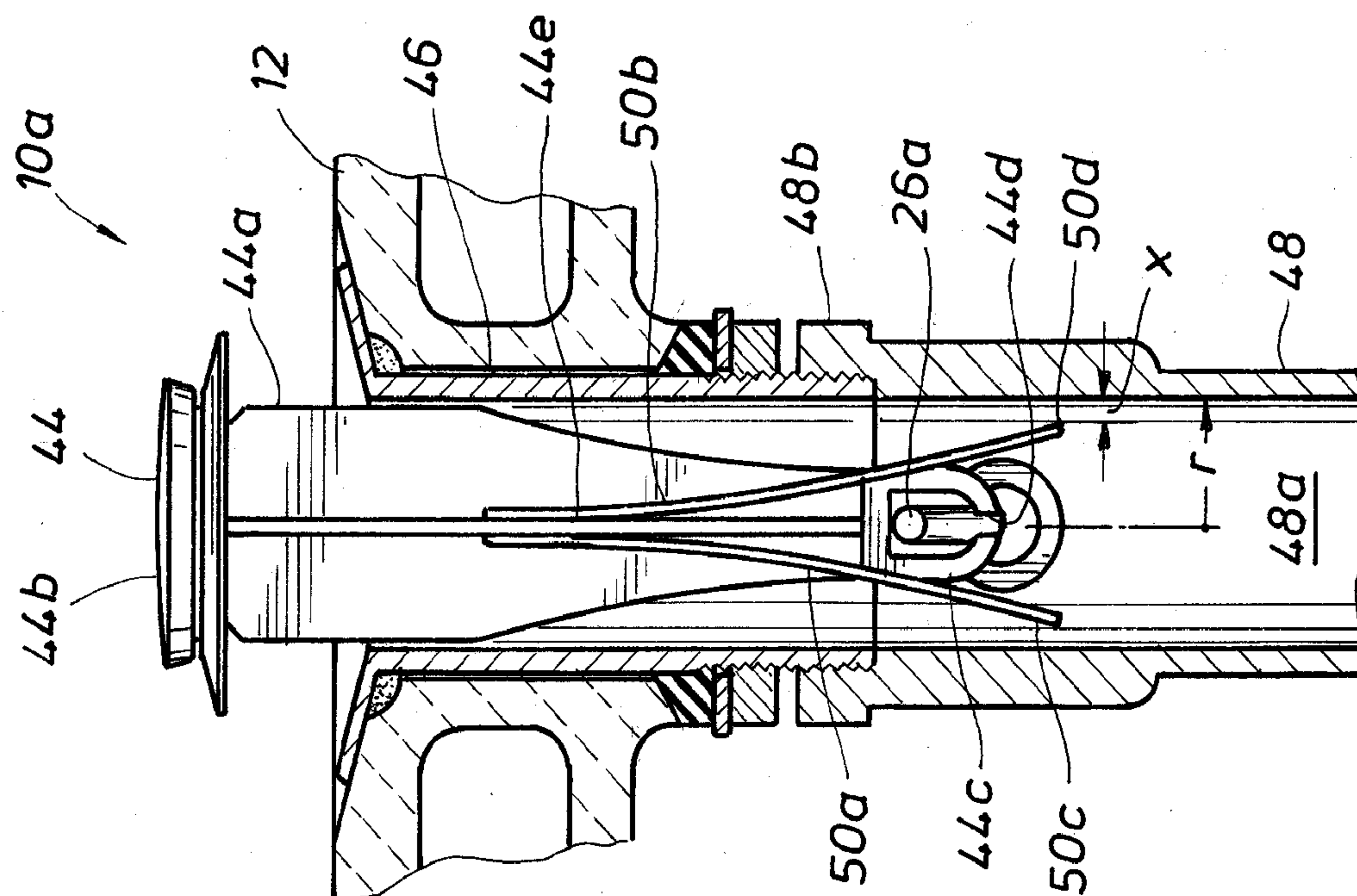


FIG. 2A

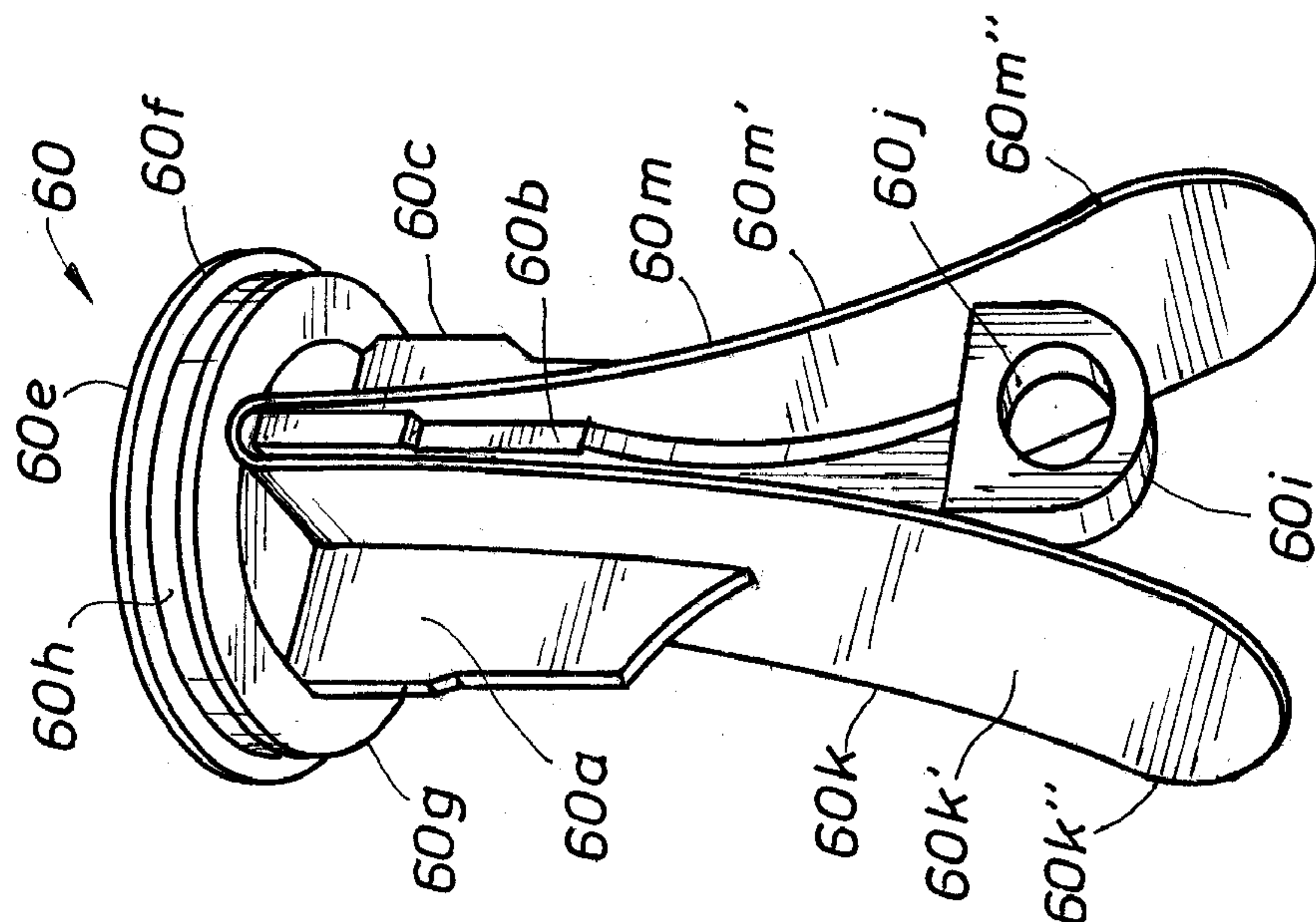
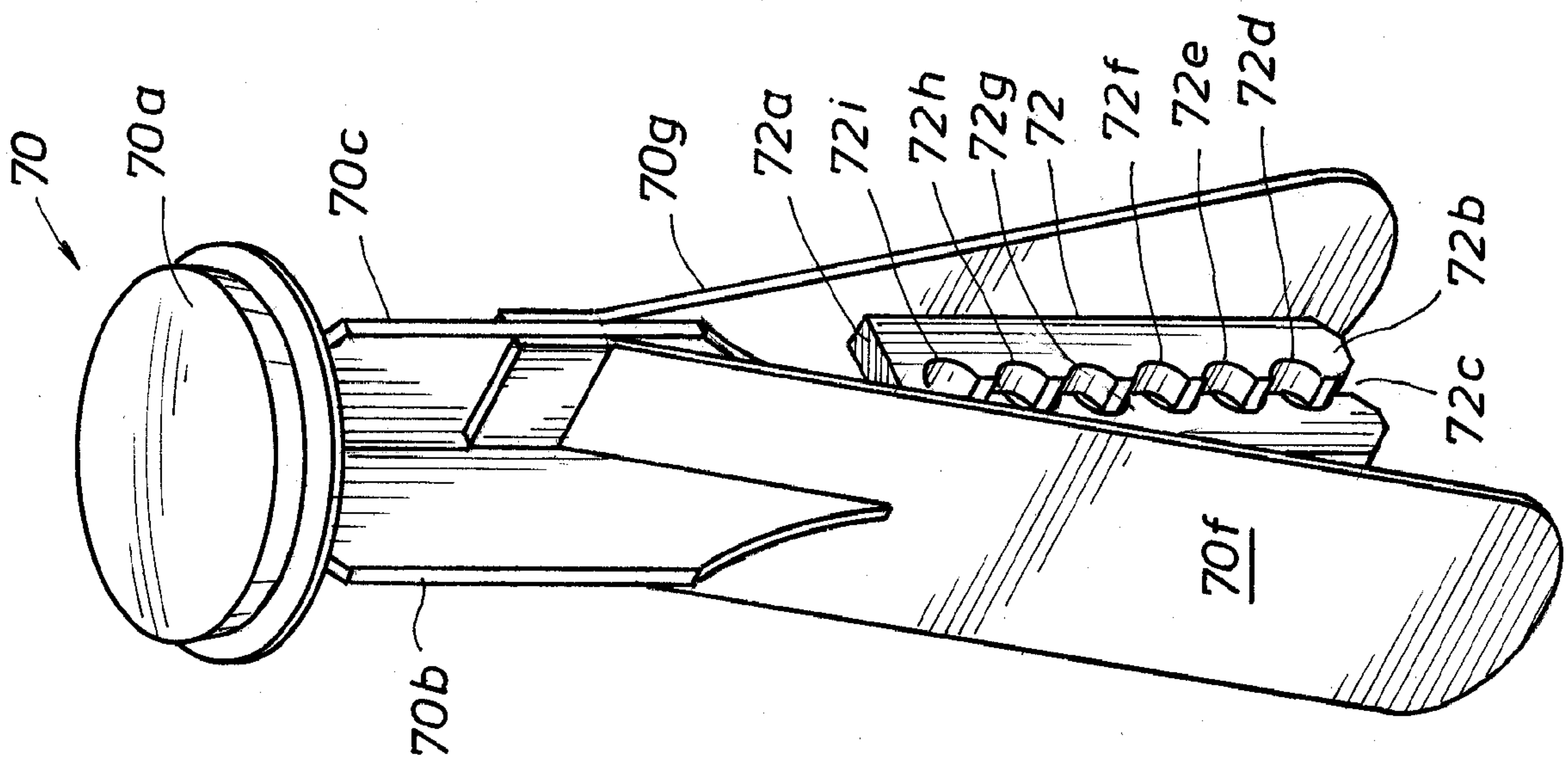
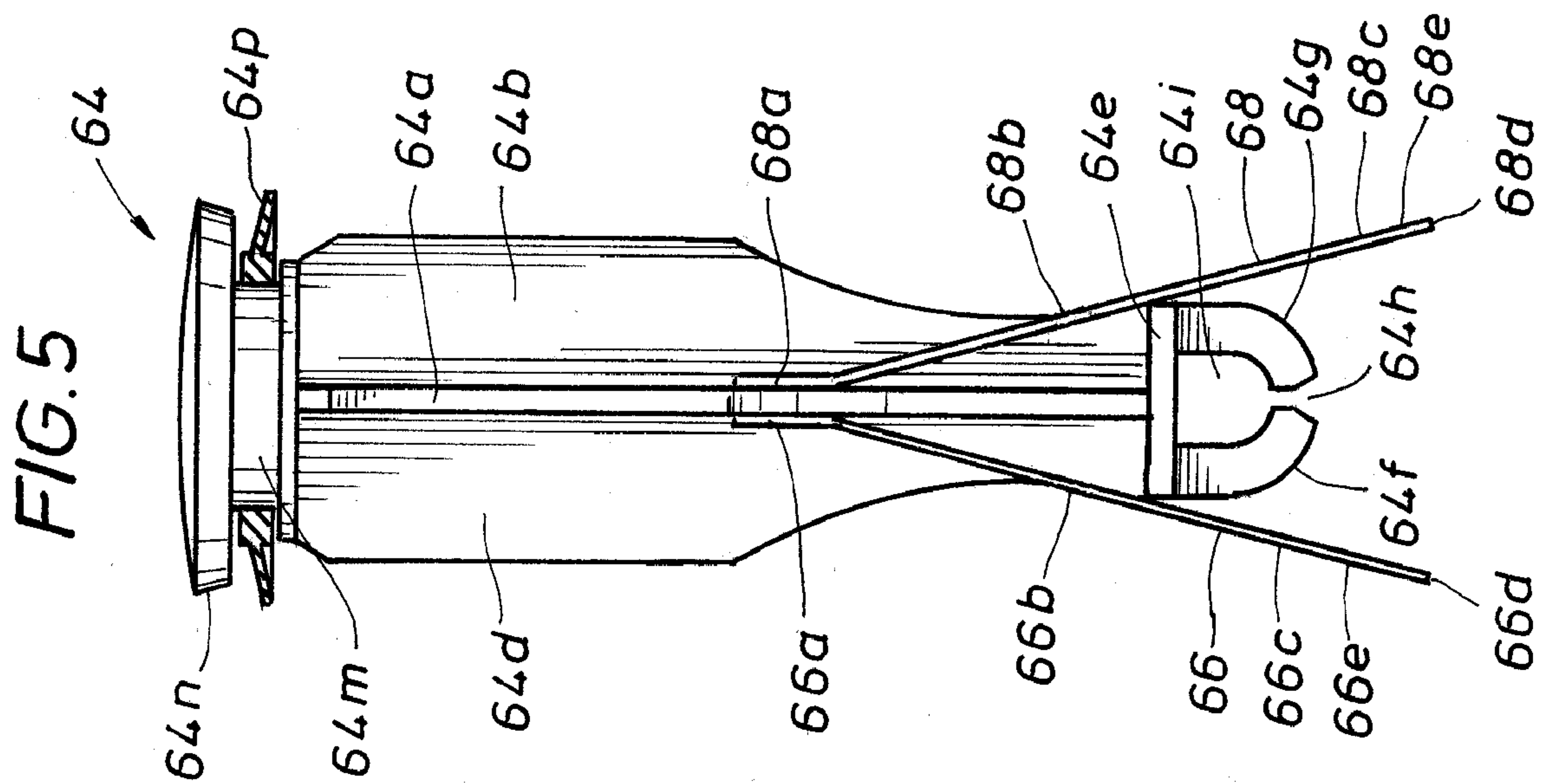
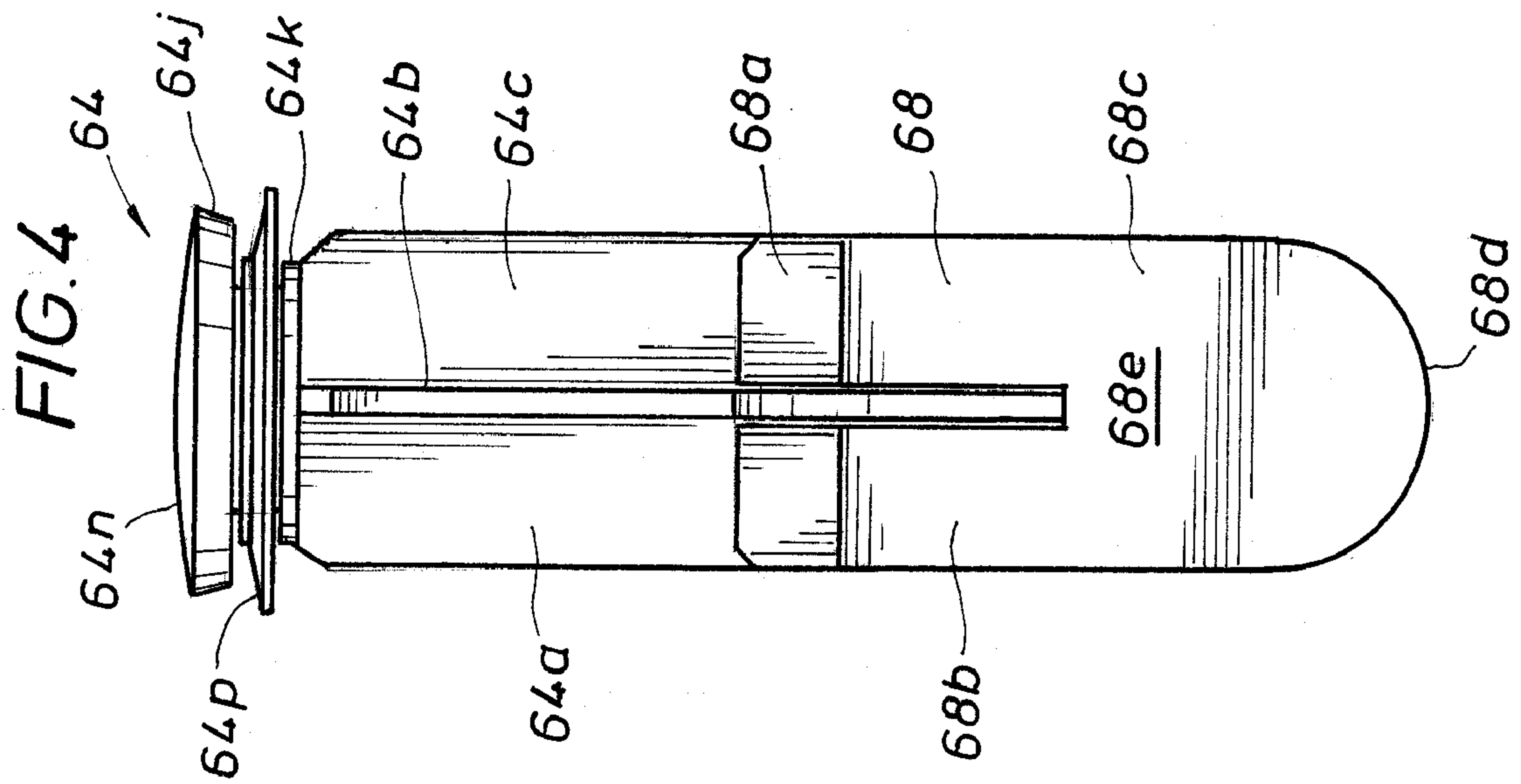


FIG. 3



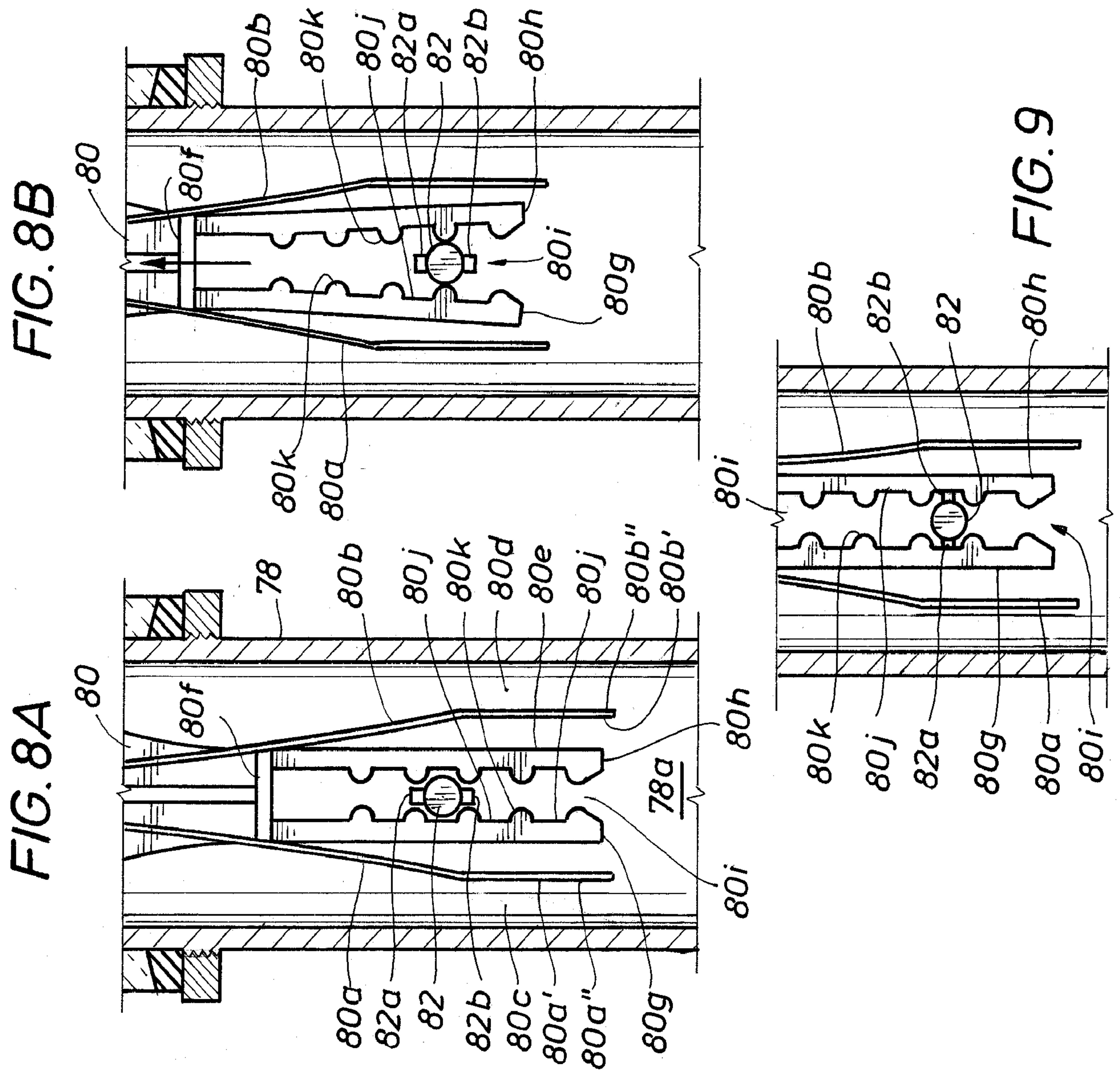
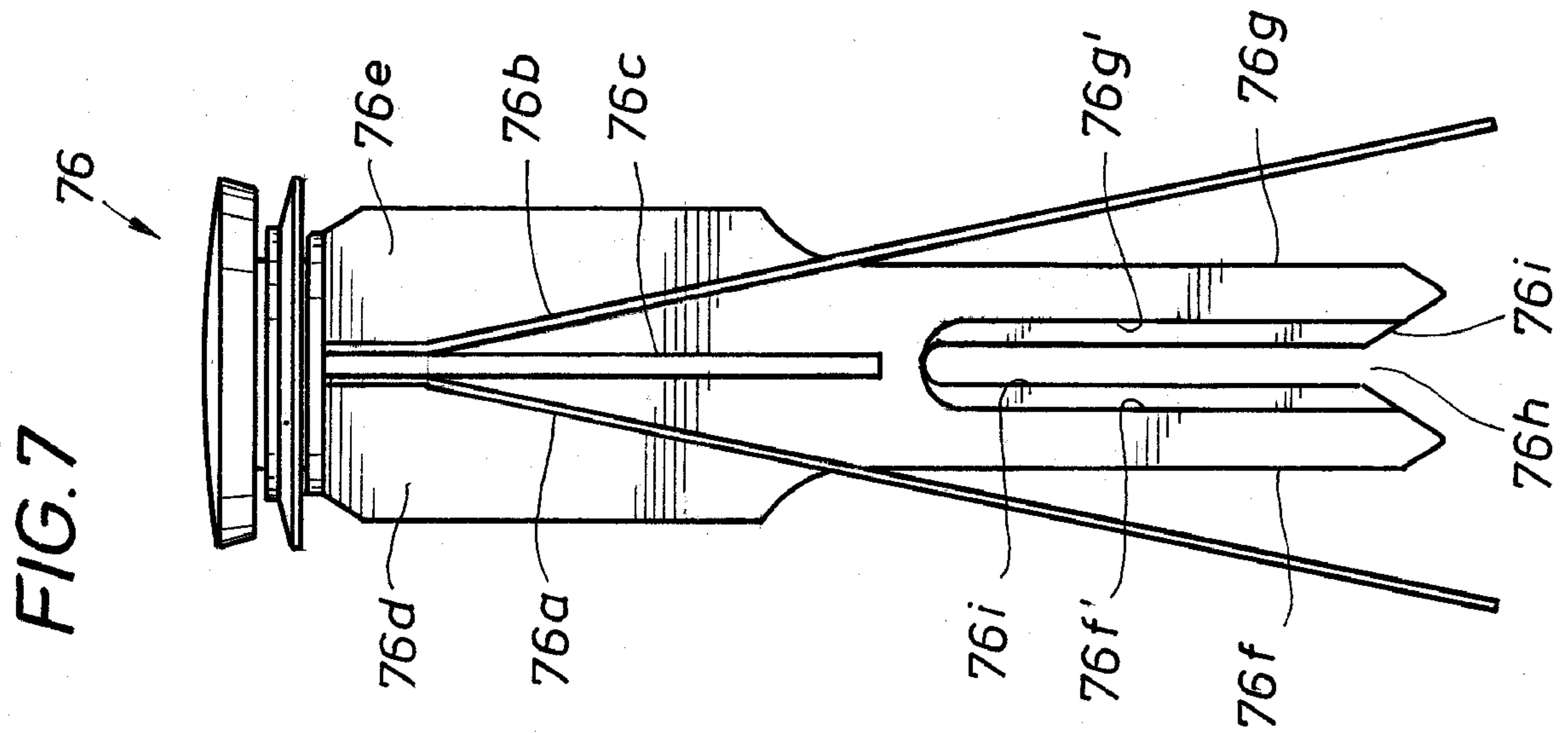


FIG. 10

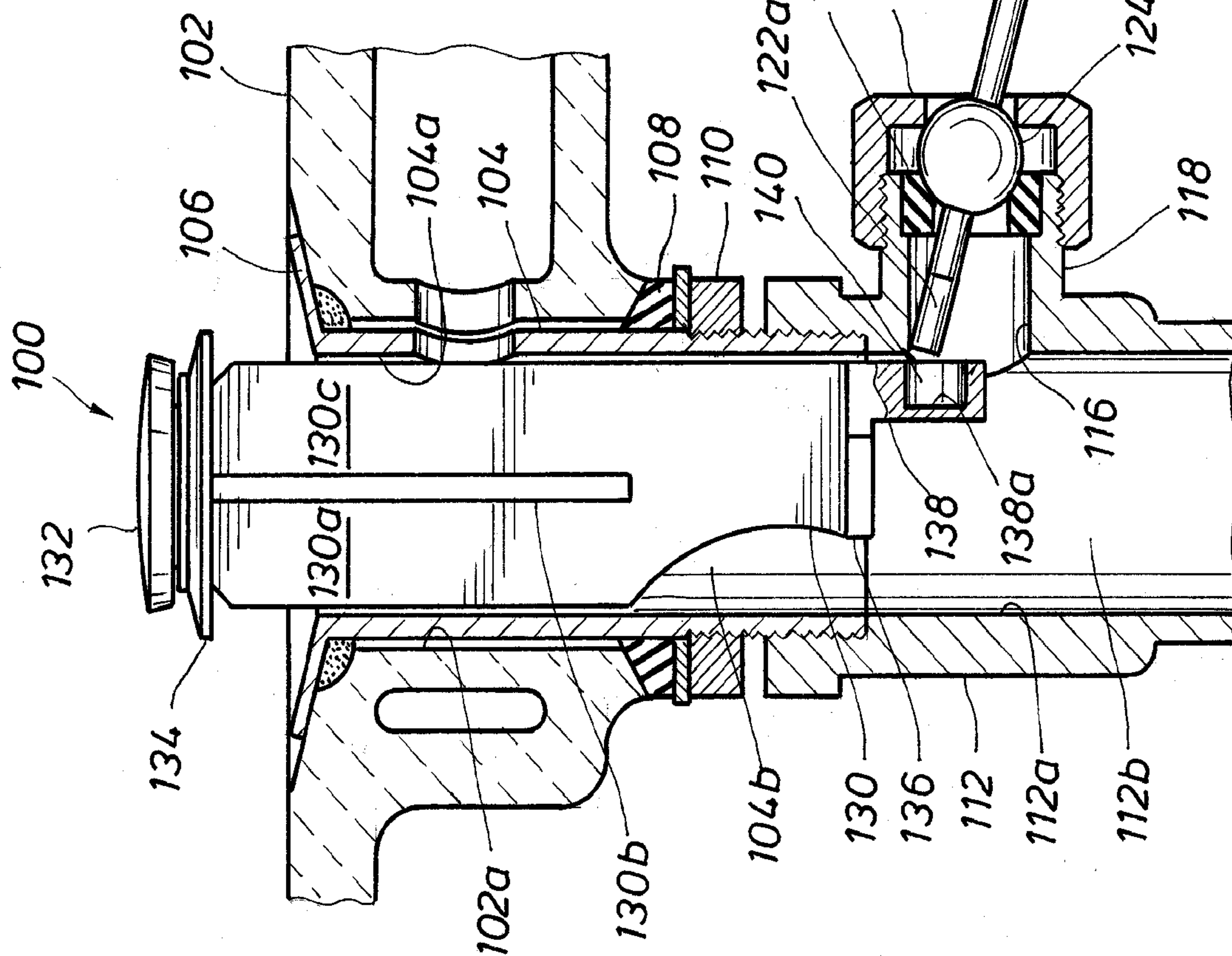
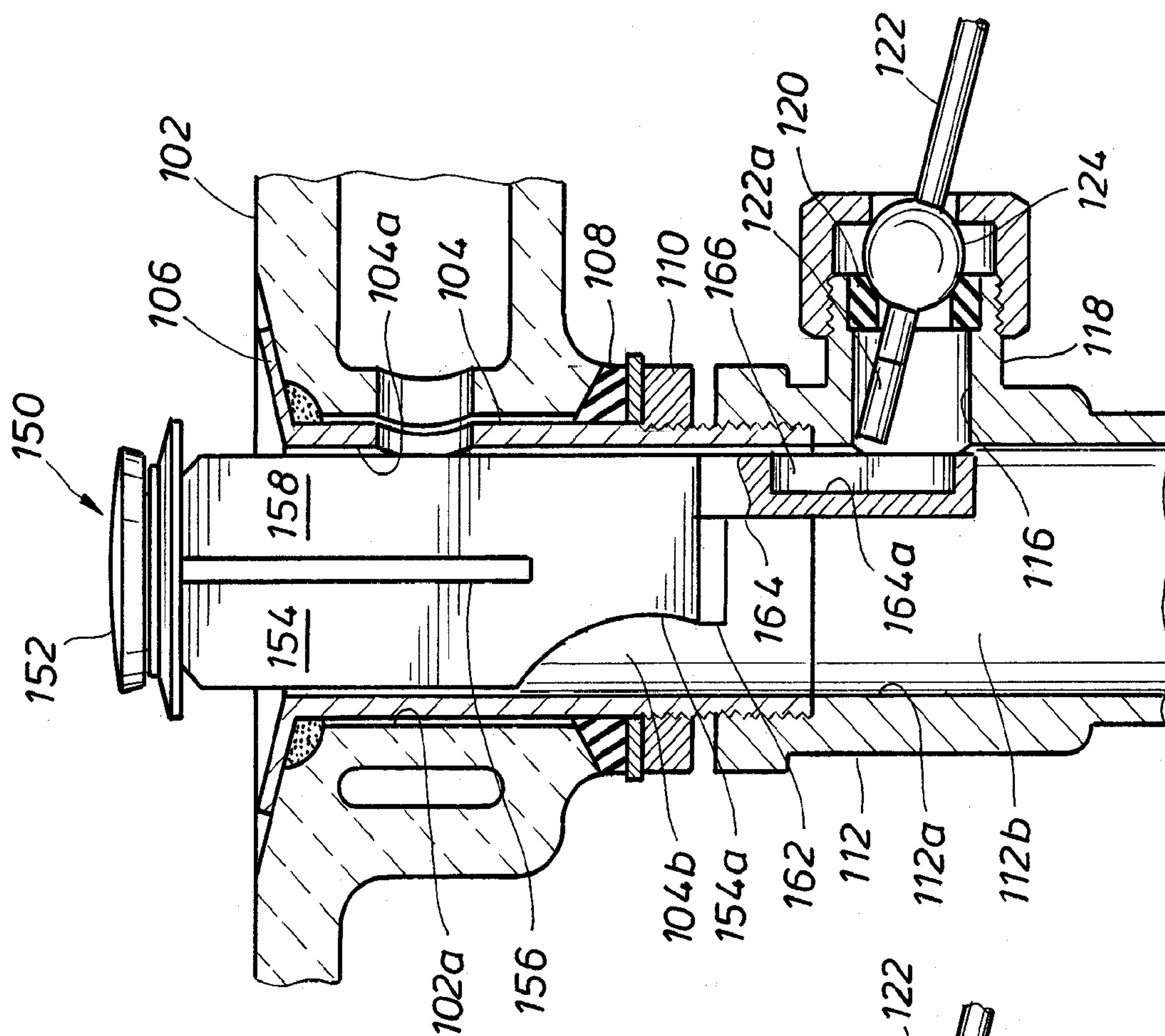
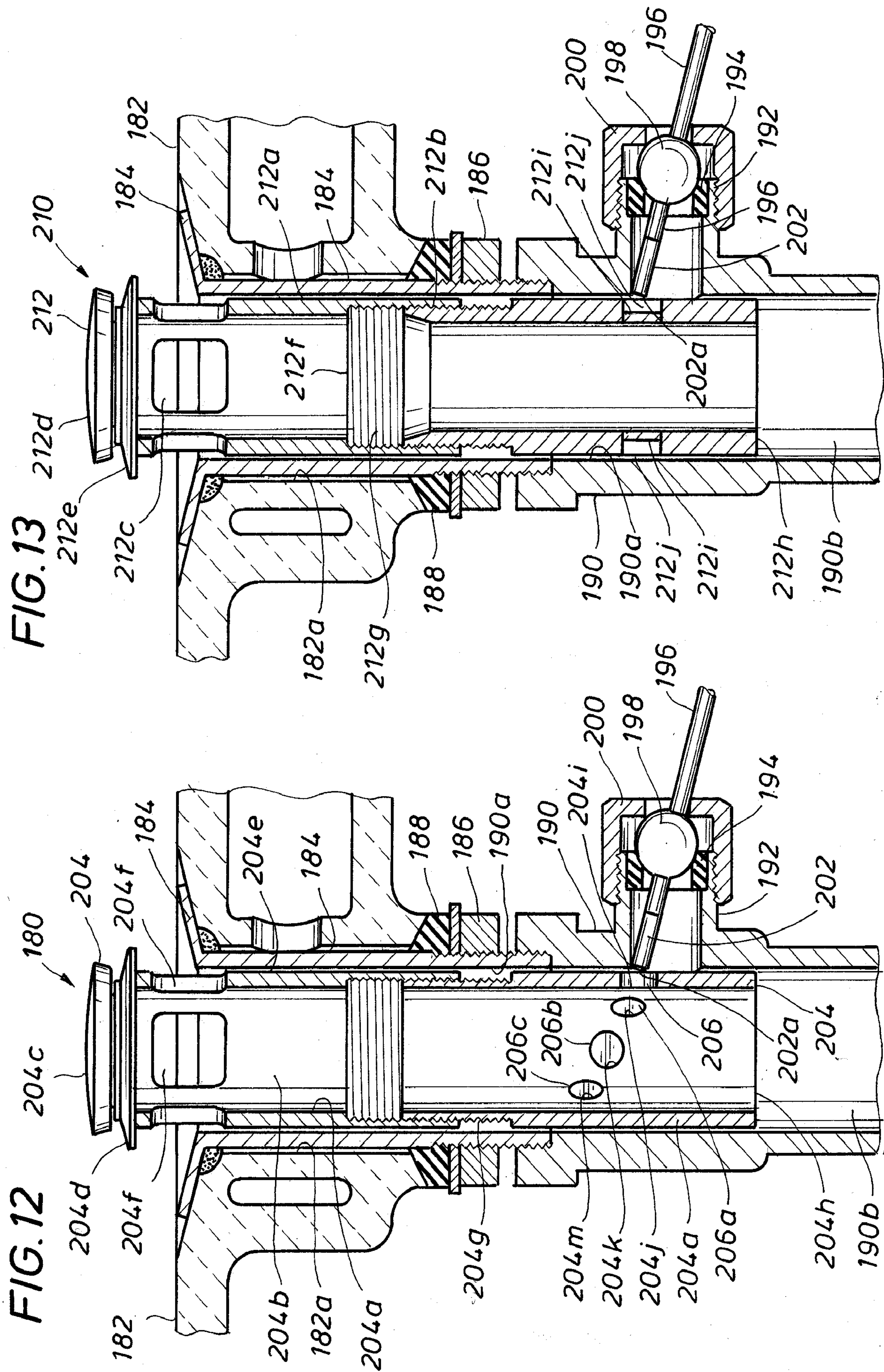


FIG. 11





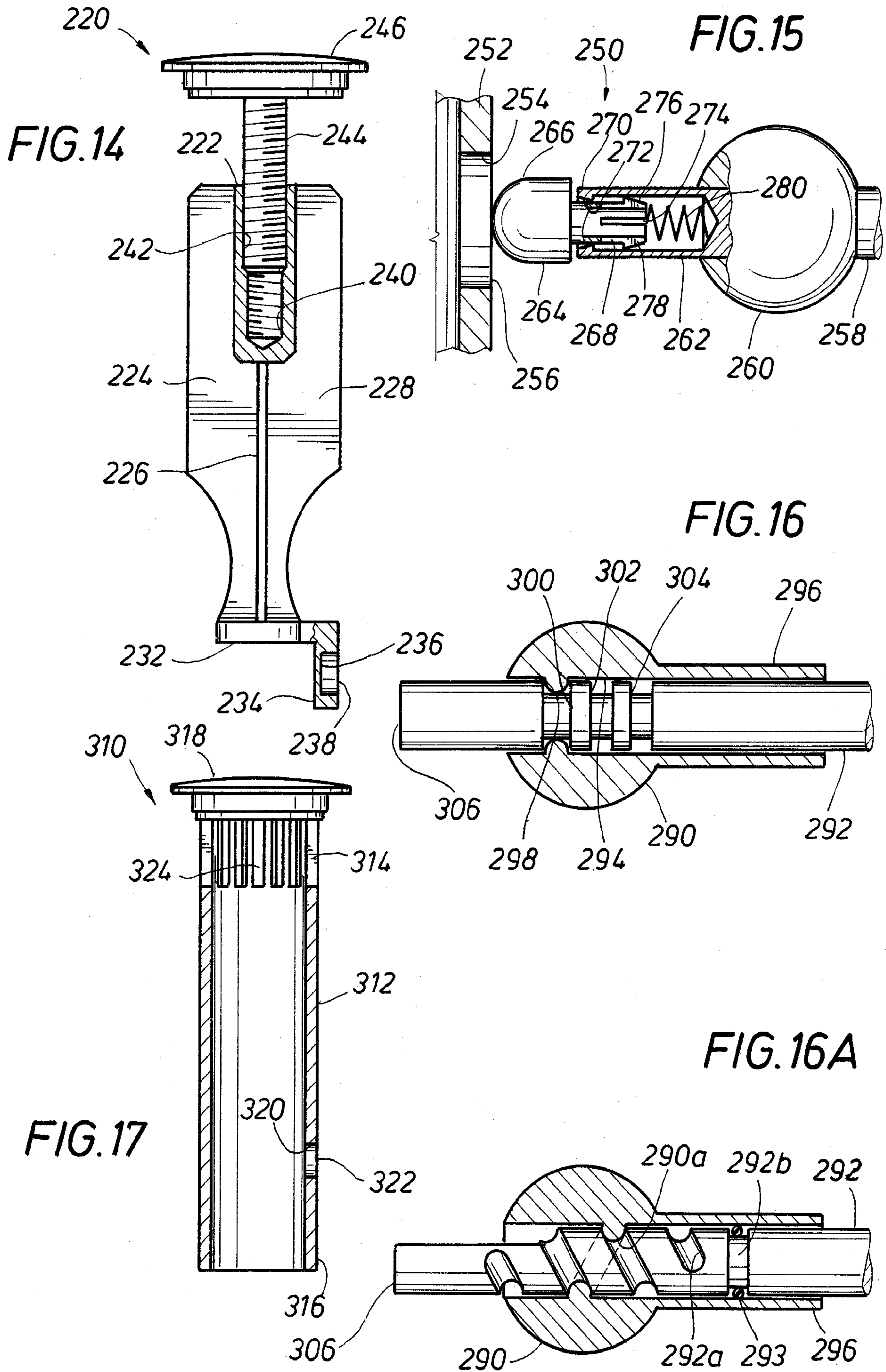


FIG. 18

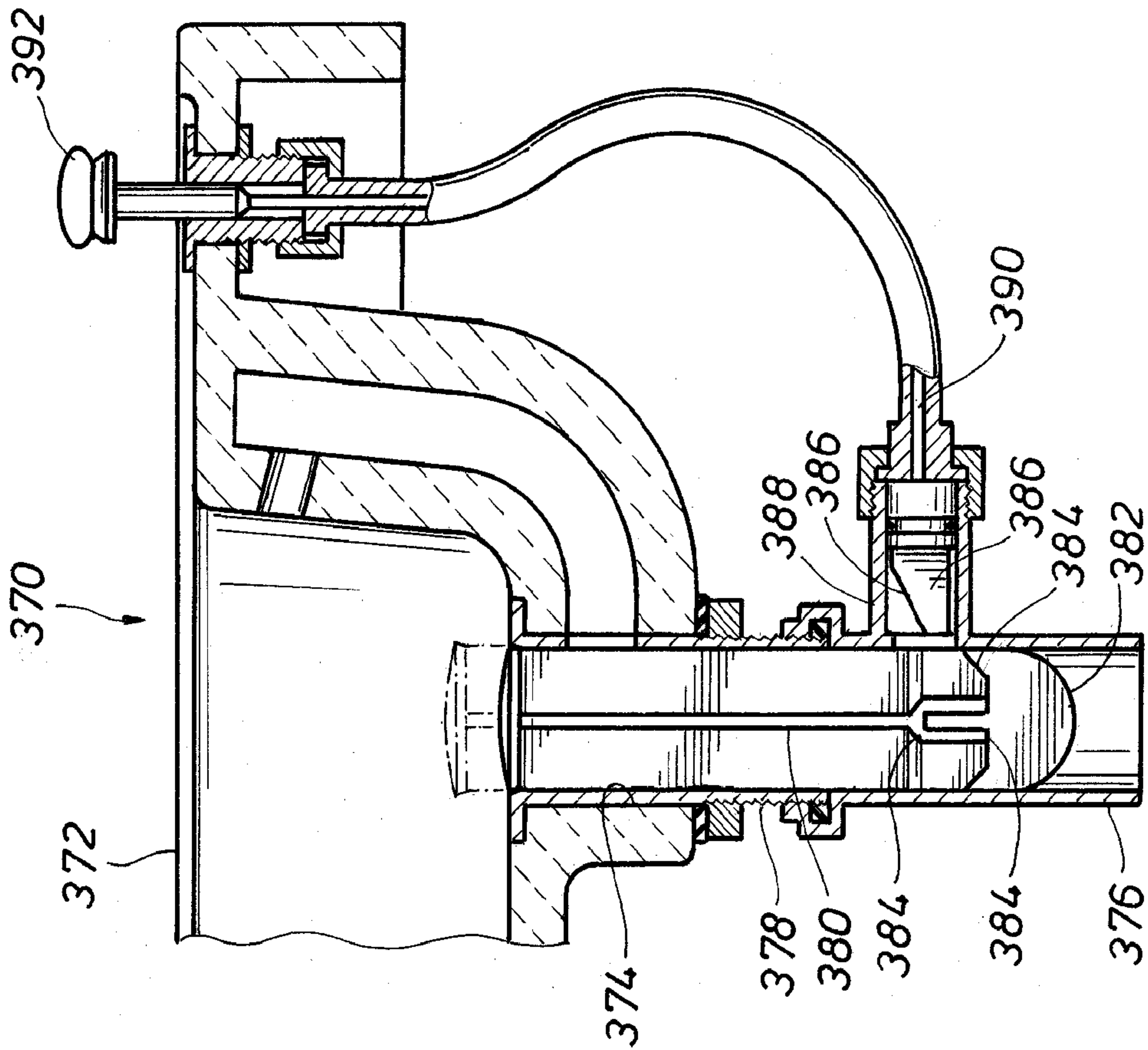
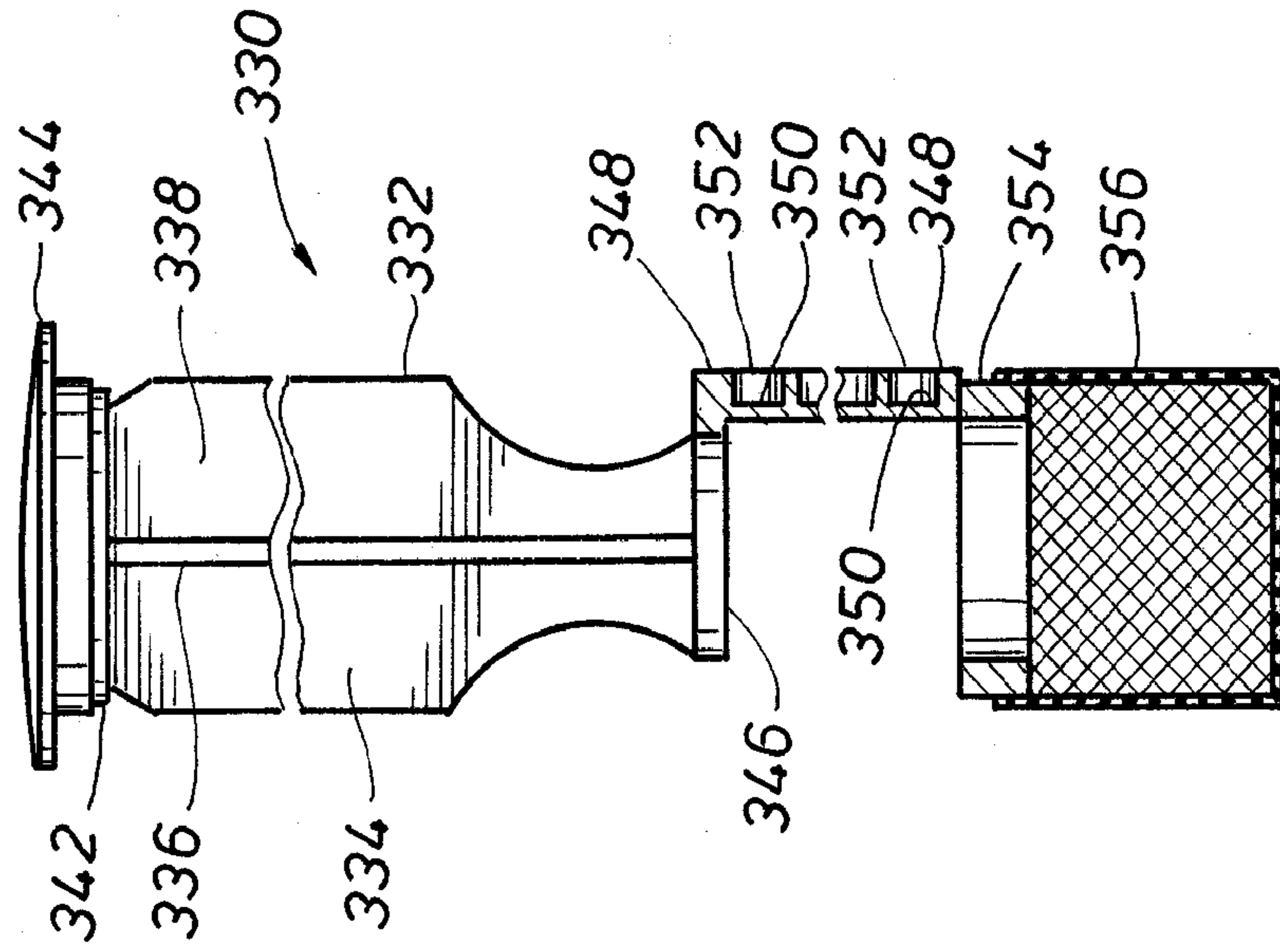


FIG. 19

