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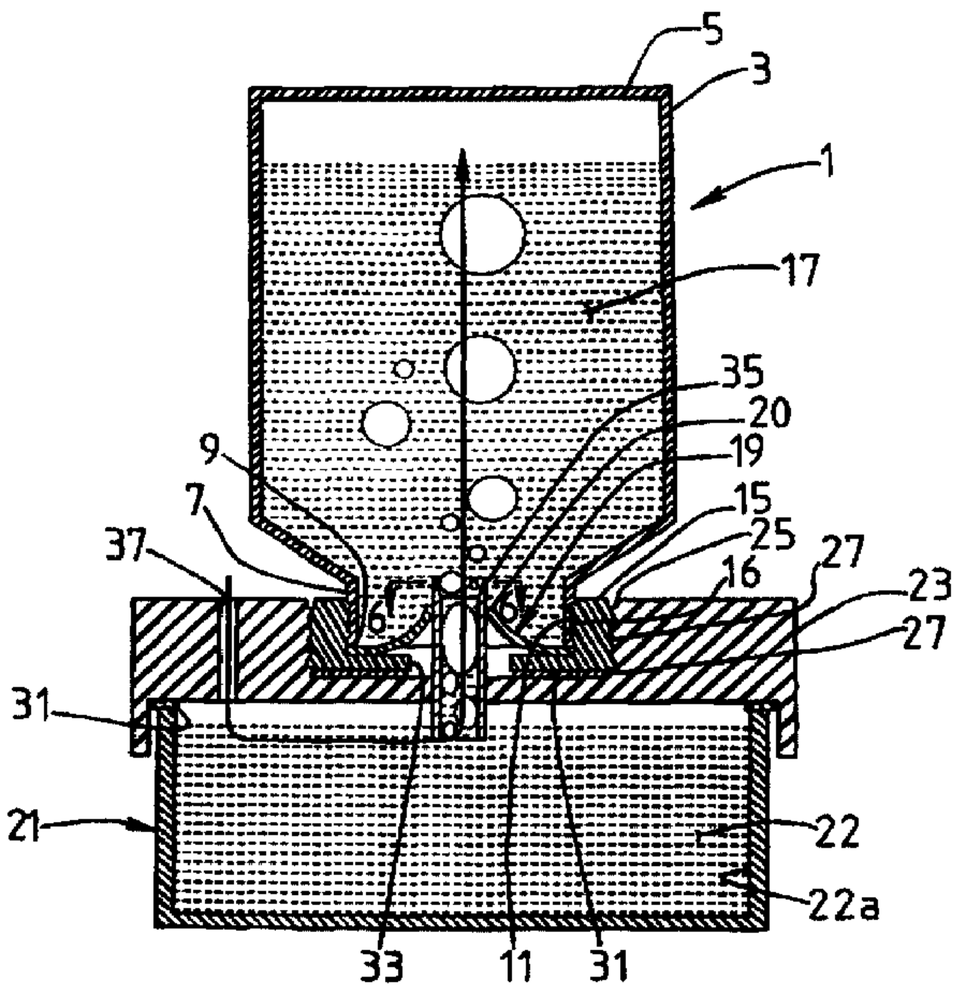
(54) **BOUTEILLE D'ENCRE A DIAPHRAGME DE FERMETURE PERFORABLE**

(54) **INK BOTTLE WITH PUNCTURABLE DIAPHRAGM CLOSURE**



(57) L'invention concerne un contenant ou une bouteille d'encre remplaçable (1) pour appareil d'impression à jet d'encre, dont l'orifice est fermé par un diaphragme perforable (19). Une pièce de perforation (35) supportée par le réservoir d'encre (21) de l'appareil d'impression à jet d'encre perce le diaphragme à l'installation du contenant dans l'appareil d'impression à jet d'encre. Au moment de la perforation du diaphragme (19) par la pièce prévue à cet effet (35), le diaphragme s'engage hermétiquement avec les côtés du tube de perforation proprement dit, de manière à empêcher sensiblement l'encre de s'échapper, et ledit tube met en communication l'encre du contenant et le réservoir d'encre, moyennant quoi l'encre s'écoule de la bouteille dans ce réservoir, via la pièce de perforation. Un trajet d'écoulement de l'air (37) est prévu pour mettre en relation l'atmosphère et le réservoir, de manière à permettre les échanges entre l'atmosphère et l'encre du contenant via la pièce de perforation: ainsi, l'encre s'écoule librement depuis le contenant dans le réservoir et la pression du contenant reste sensiblement équivalente à la pression atmosphérique.

(57) A replaceable ink container or bottle (1) is disclosed for an ink jet printing apparatus in which the mouth of the bottle is closed by a puncturable diaphragm (19). A puncturing member (35) carried by the ink reservoir (21) of the ink jet printing apparatus pierces through the diaphragm upon the container being installed in the ink jet printing apparatus. Upon the puncturing member (35) puncturing through the diaphragm (19), the diaphragm sealingly engages the sides of the puncturing tube so as to substantially prevent the ink from leaking therepast, and the puncturing tube opens communication between the ink within the container and the ink reservoir thereby permitting ink to flow from the bottle into the ink reservoir via the puncturing member. An air path (37) is provided which is in communication with the atmosphere and with the reservoir so that ink from within the container and atmospheric air may be exchanged via the puncturing member so that ink is free to flow from the container into the reservoir, and so that the pressure within the container is maintained substantially at atmospheric pressure.

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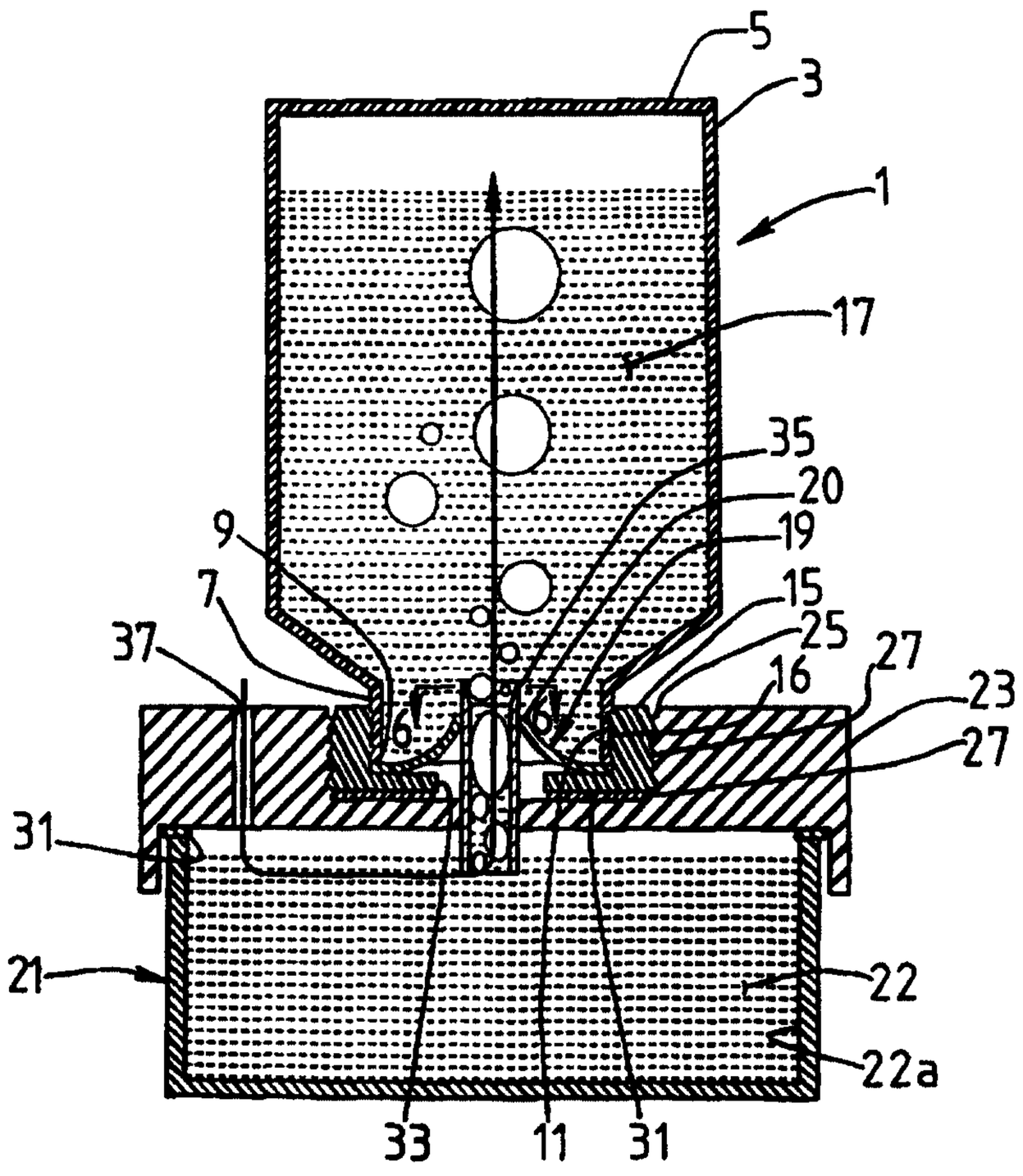
(54) Title: INK BOTTLE WITH PUNCTURABLE DIAPHRAGM CLOSURE

(57) Abstract

A replaceable ink container or bottle (1) is disclosed for an ink jet printing apparatus in which the mouth of the bottle is closed by a puncturable diaphragm (19). A puncturing member (35) carried by the ink reservoir (21) of the ink jet printing apparatus pierces through the diaphragm upon the container being installed in the ink jet printing apparatus. Upon the puncturing member (35) puncturing through the diaphragm (19), the diaphragm sealingly engages the sides of the puncturing tube so as to substantially prevent the ink from leaking therepast, and the puncturing tube opens communication between the ink within the container and the ink reservoir thereby permitting ink to flow from the bottle into the ink reservoir via the puncturing member. An air path (37) is provided which is in communication with the atmosphere and with the reservoir so that ink from within the container and atmospheric air may be exchanged via the puncturing member so that ink is free to flow from the container into the reservoir, and so that the pressure within the container is maintained substantially at atmospheric pressure.



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Ink Bottle with Puncturable Diaphragm Closure

This invention relates to an ink bottle (or other container) for containing a supply of ink for an ink jet printing system. The ink jet printing apparatus for which the ink bottle of the present invention is intended for use is generally referred to as an industrial type ink jet printing system (as opposed to an office ink jet printer) which typically is used to print indicia on packaging or on secondary packaging of products conveyed past the ink jet printhead of this system as the products in their packages are conveyed past the printhead on a conveyor belt or the like. Such ink jet printing systems are shown in U. S. Patent Application No. 08/728,774 filed October 11, 1996, assigned to Marsh Company of Belleville, Illinois. It will be appreciated that such industrial ink jet printing systems typically use considerably more ink in a given time than office ink jet printers because the area printed by such industrial printers is greater and the industrial printing systems operate continuously. Thus, it is desirable to provide a relatively large supply of ink for such industrial ink jet printers, as compared to office ink jet printers.

Heretofore, ink was supplied to such commercial ink jet printing systems by means of a disposable ink bottle holding a desired quantity of ink, e.g. a pint (0.4732 litres) or a litre. One such ink bottle is shown in U. S. Patent 5,343,226 entitled "Ink Jet Ink Supply Apparatus," which has a spring biased poppet valve incorporated in a screw on cap such that when the bottle is inverted and threaded into a receptacle in the ink jet printing apparatus, a finger will engage the normally closed spring biased valve in the cap, and will force the valve to open, thus allowing ink from within the bottle to fill a reservoir of the ink jet printing apparatus. Upon removal of the ink bottle from the ink jet printing apparatus, the valve will close under the bias of the spring, and thus the valve will prevent the flow of ink from the bottle as it is removed. While such bottles worked well for their intended purpose, the necessity of including the spring biased valve in the cap of each bottle is expensive.

Reference also may be made to U. S. Patents 4,531,656 and 4,678,101 which disclose the use of a puncturable closure for a bottle from which a liquid is to be pressure dispensed.

EP-A-0322131 discloses a process and system for supplying ink to an ink jet pen wherein an off board ink supply is provided remote from the pen, and ink is fed from this supply to the pen by capillary action created during an ink jet printing operation. The pen includes a porous storage medium which is initially filled with ink at a slightly negative head. However, this negative head increases during ink depletion from the storage medium and provides the capillary forces necessary to pull ink into the storage medium from the off board ink supply. The driving energy for this action is provided by current drive to a thin film printhead of the pen, thus rendering the printhead multi-functional in purpose and simplifying the ink supply apparatus therefor. The use of an intermediate porous storage medium enables the ink supply system to accommodate large rates of changes in ink demand from the pen while still affording the user with a large ink capacity system in which disposable pens may be readily and easily replaced in a userfriendly operation.

According to a first aspect of the present invention there is provided an ink jet printing apparatus comprising: an ink reservoir; a replaceable ink container for supplying ink to said reservoir, said container having a supply of ink therein; a puncturable diaphragm closing said container; a puncturing member carried by said ink reservoir and having a passage therethrough via which ink in said container can be exchanged for air, said puncturing member being engageable with said diaphragm upon said diaphragm facing said puncturing member, upon said container and said diaphragm being moved toward said puncturing member said puncturing member piercing through said diaphragm and said diaphragm engaging the sides of said puncturing member so as to substantially prevent ink from leaking between said puncturing member and said diaphragm, said puncturing member opening communication between the ink within said container and said ink reservoir thereby permitting ink to flow through said passage in the puncturing member from said

container into said ink reservoir; and an air path in communication with the atmosphere and said reservoir so that ink from within said container and atmospheric air may be exchanged within said container via said passage in said puncturing member so that ink is free to flow from said container into said reservoir and so that the pressure within said container is maintained substantially at atmospheric pressure.

According to a second aspect of the present invention there is provided an ink bottle for an ink jet printing system, the latter having an ink reservoir for holding a supply of ink for said ink jet printing system, said bottle having a closed container body having a mouth at one end thereof, a puncturable diaphragm sealingly secured to said mouth closing the bottle, said diaphragm being a sheet of resilient elastomeric material, a cap secured to said mouth and overlying said diaphragm, said cap having an opening therethrough exposing a portion of said diaphragm so as to be pierced by a puncturing member when the bottle is installed in said ink jet printing system in inverted position with the mouth facing downwardly such that ink from within said bottle and atmospheric air are exchanged via a passage through said puncturing member, said diaphragm engaging the sides of said puncturing member so as to substantially prevent ink from leaking between said puncturing member and said diaphragm.

According to a third aspect of the present invention there is provided an ink supply system for an ink jet printing apparatus comprising an ink reservoir for containing a supply of ink which is supplied to an ink jet printing head or the like, a replaceable ink bottle for containing a supply of ink for said ink reservoir, an ink bottle diaphragm carried by said ink bottle, a puncturing member carried by said ink reservoir and having a passage therethrough via which ink in said bottle can be exchanged for air, said puncturing member being engageable with said diaphragm upon said ink bottle being moved toward said puncturing member so that said puncturing member punctures through said diaphragm, said puncturing member being sealingly engageable with said diaphragm

so as to substantially prevent the leakage of ink between said puncturing member and the region of said diaphragm in engagement with said puncturing member, and an air path between the outside atmosphere and said reservoir enabling the exchange of air and ink within said ink bottle via said passage through said puncturing member.

According to a fourth aspect of the present invention there is provided a method of supplying ink to an ink jet printing system, the latter having a closed ink reservoir, a puncturing tube extending above the reservoir and providing via the passage therethrough communication to the interior of said reservoir with said puncturing tube extending downwardly within said reservoir to a predetermined level, an air passageway extending from the atmosphere exteriorly of said reservoir to said reservoir, and an ink bottle having a puncturable diaphragm, said method comprising the steps of: orienting said ink bottle such that said diaphragm faces said puncturing tube; causing said puncturing tube to pierce through said diaphragm thereby to open communication via the passage through the tube between the interior of said ink bottle and said reservoir such that ink from within said ink bottle may flow into said reservoir, said diaphragm engaging the sides of said puncturing tube so as to substantially prevent ink from leaking between said puncturing tube and said diaphragm; and allowing the exchange of ink from said bottle into said reservoir and of atmospheric air into said bottle as the ink flows therefrom via the passage of said puncturing tube.

Among the various features of the embodiment of the present invention, it will be noted:

the provision of a container or a bottle for holding a supply of ink for an ink jet printing apparatus in which the mouth of the bottle is closed by a puncturable diaphragm sealed with respect to the mouth of the bottle such that upon installation of the bottle in an inverted position within the ink jet printing apparatus, a hollow piercing member will pierce through the diaphragm and open communication with the ink inside the bottle, thus allowing the ink to flow by gravity through the piercing member into a reservoir of the ink jet printing system, and such that atmospheric air may enter the bottle through the piercing member to replace the ink as it flows from the bottle into the ink jet printing apparatus;

the provision of such a container or bottle in which the diaphragm has a pre-formed, but still sealed, area (line) of weakness therein which is broken open upon the piercing member being inserted therethrough with the edges of such area of weakness being at least in part in sealing engagement with the sides of the piercing member so as to substantially prevent undesired leakage of the ink;

the provision of such a container in which the diaphragm is of elastomer sheet material having sufficient resiliency and memory such that as the piercing member is withdrawn from the diaphragm, the opening formed by the piercing member will close, thus effectively re-closing (and in some instance re-sealing) the opening and preventing leakage of the ink;

the provision of such a container in which the material from which the diaphragm is made has a surface energy relative to the surface tension of the ink such that upon re-closing of the line of weakness or slit in the diaphragm, the ink will bridge across the slit such that leakage of the ink through the slit is substantially prevented; and

the provision of such a container which is of simple and economical construction, which may be readily filled with ink, which may be readily sealed with such diaphragm, which is easy

to use, and which requires little in the way of special instructions for use, and which is of rugged construction.

Briefly stated, the embodiment of the invention is intended for use with an ink jet printing apparatus having an ink reservoir for receiving a supply of ink from a replaceable ink container, the latter having a mouth and a supply of ink within the container, the ink reservoir having an ink well for containing a supply of ink. The embodiment includes a resilient, puncturable diaphragm closing the mouth of the container. A puncturing member is carried by the ink reservoir of the ink jet printing apparatus. The puncturing member is engageable with the diaphragm upon the container being inverted such that the diaphragm faces downwardly as the container and the diaphragm are moved downwardly on the puncturing member so that the puncturing member pierces through the diaphragm. Upon the puncturing member puncturing through the diaphragm, the latter sealingly engages the sides of the puncturing tube so as to substantially prevent the ink from leaking therepast. The puncturing member opens communication between the ink within the container and the ink reservoir thereby permitting ink to flow from the bottle into the ink reservoir via the puncturing member. An air path is provided which is in communication with the atmosphere and with the reservoir so that ink from within the container and atmospheric air may be exchanged via the puncturing member so that ink is free to flow from the container into the reservoir and so that the pressure within the container is maintained substantially at atmospheric pressure.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a top perspective view of an ink reservoir of a commercial ink jet printing apparatus having two disposable ink bottles according to the present invention installed in the ink reservoir so as to supply ink thereto;

Fig. 2 is vertical cross sectional view of one of the ink bottles (containers) of Fig. 1 containing ink in its inverted, installed position as it is installed in the ink reservoir, illustrating a supply of ink within the container, and further illustrating a puncturing member which has pieced through a flexible, elastomeric diaphragm closing the mouth of the container, and further illustrating the manner in which atmospheric air may be vented into the container upon the level of the ink within the reservoir falling below a predetermined level such that the air and ink are exchanged in the bottle via the puncturing member;

Fig. 3 is a perspective view of the elastomeric diaphragm or membrane closing the mouth of the bottle having a pre-formed partial slit (i.e., an area of weakness) therein;

Fig. 4 is a cross sectional view of a cap to be threadably installed on the threaded neck of the ink bottle with the cap having external threads formed thereon for threadably engaging internal female threads within a socket in the ink reservoir;

Fig. 5 is an enlarged exploded view of a portion of the ink bottle and of the ink reservoir, illustrating the installation of the ink bottle into a threaded socket in the ink reservoir and further illustrating a piercing member for piercing through the puncturable membrane in the cap of the ink bottle so as to open communication between the ink within the bottle;

Fig. 6 is a cross-section taken along line 6 -- 6 of Fig. 2 illustrating the piercing tube or septum passing through the slit in the diaphragm;

Fig. 7 is a plan view of the diaphragm showing drops of ink thereon;

Fig. 8 is a cross-section taken along line 8 -- 8 of Fig. 7 showing a preferred construction of the diaphragm wherein the surface energy of the diaphragm is less than the surface tension of the ink such that a drop of ink on the surface of the diaphragm and opening of the re-closed slit will not wick through the slit; and

Fig. 9 is a view similar to Fig. 8, but where the surface energy of the diaphragm is somewhat greater than the surface tension of the ink such that at least some of the ink such that at least some of the ink is drawn by capillary action (wicks) through the re-closed slit.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring now to the drawings, an ink supply system for an ink jet printing apparatus is shown in which an ink bottle or container 1 supplies ink to the printhead of the ink jet printing apparatus, such as is disclosed in U. S. Patent Application No.08/728,774. For the sake of brevity, only the ink bottle 1 and such structure from the ink jet printing apparatus as is needed to interface with and to receive the ink from the bottle 1 are herein described.

As shown in Fig. 2, ink bottle 1 is in an inverted position when it is installed in the ink jet printing apparatus. Bottle 1 has a bottle body 3 having a closed bottom 5, a neck 7, and a mouth 9. The neck 7 of the bottle 1 has suitable external screw threads 11 (see Fig. 5) formed on the outer surface thereof and a suitable over cap 15 having internal threads 16 (see Fig. 5) is threaded onto threads 11 on neck 7 of bottle 1. As shown in Fig.2, bottle 1 contains a supply of ink 17. Preferably, bottle 1 is a semi-rigid bottle blow molded of a suitable synthetic resin, such as a suitable high density polyethylene (HDPE) or the like, which is compatible with ink 17 contained within the bottle. Of course, those skilled in the art will recognize that the bottle 1 should have sufficient barrier properties and the like so as to insure an adequate shelf life for the ink.

In accordance with this invention, a resilient, elastomeric diaphragm or membrane 19 covering the open mouth of the bottle 1 is sealably secured to the mouth 9 of the bottle so as to seal the ink within the bottle. Preferably, diaphragm 19 is of a suitable elastomeric sheet material, such as natural rubber or sheet silicone material. However, other materials, such as low density polyethylene (LDPE), may be used. The elastomeric material from which diaphragm 19 is formed

preferably has sufficient memory that after being deformed, the diaphragm will quickly and resiliently return to its flat position, as shown in Fig. 2. As shown in Fig.'s 2 and 5, diaphragm 19 is interposed between the underside of cap 15 and the edge of bottle mouth 9 such that when the cap is tightly screwed in place on the neck of the bottle, the diaphragm will be tightly gripped between the bottle mouth and the cap, thereby sealing it therebetween. The diaphragm also may be sealing secured by the mouth of the bottle as by ultrasonically welding or the like.

As shown in Fig. 3, elastomeric diaphragm 19 may have an optional, pre-formed slit 20 therein. Slit 20 is preferably not fully through the thickness of the diaphragm, but instead is a line (area) of weakness which will open or tear upon installation of bottle 1 in the ink jet printing apparatus as will be more fully described hereinafter. However, within the broader aspects of this invention, slit 20 is not required, as the piercing member, as will be hereinafter described, may puncture the diaphragm without the pre-formed area of weakness. Further, while slit 20 is shown to be a single slit, multiple star shaped or pie slice shaped slits (or other area of weakness) also may be used.

As further shown in Fig. 2, an ink reservoir of the ink jet printing apparatus, as indicated generally at 21, has an ink well 22a which holds a supply 22 of ink dispensed from bottle 1 for use by the ink jet printing apparatus. Ink from reservoir 21 is conveyed to the printhead (not shown) of the ink jet printing apparatus so as to print desired indicia on objects in the manner well known to those skilled in the art. For the sake of simplicity and brevity, the ink supply tube from reservoir 21 to the printhead is not shown. Reservoir 21 has a reservoir lid 23 enclosing the ink within the reservoir.

Reservoir lid 23 has two recesses or sockets 25 formed in the upper portion thereof for receiving the cap 15 of a respective bottle 1. Preferably, each recess 25 has female threads 27 (see Figs. 2 and 5) on its vertical sides and cap 15 has mating male threads 29 on its outer sides

engageable with female threads 27. A gasket 31 having a center opening 32 (see Fig. 5) is interposed between the cap 15 and the base of recess 25 so that upon screwing cap 15 into recess 25, the cap will sealingly engage gasket 31 and seal the cap to the reservoir lid 23. Preferably cap 15, in addition to being screwed onto the bottle neck 7, is adhesively bonded (or otherwise secured) to the bottle such that the cap will not unscrew. As shown in Figs. 2, 4 and 5, cap 15 has a center opening 33 which exposes a portion of diaphragm 19 through gasket 31.

Reservoir lid 23 has a puncturing or piercing member or septum 35 fixed with respect to the reservoir lid 23 and extending upwardly within center of recess 25. Preferably, puncturing member 35 is a hollow, tubular member which, as will be herein described in detail, allows air and ink exchange therethrough. The diameter of piercing tube 35 is sized relative to the density and viscosity of the ink and relative to the resilient and elastomeric properties of the diaphragm 19 such that the piercing tube will readily pierce the diaphragm and leak past the diaphragm will be minimized.

As shown in Fig. 5, piercing tube 35 is supported by an open spider structure 39 having one or more passages 41 extending from the area below gasket 33 downwardly into reservoir 21. In this manner, any ink that seeps or leaks between slit 20 of diaphragm 19 and piercing tube 35 drains into the reservoir and is not wasted.

By way of example, a typical ink used for ink jet printing may have a surface tension of about 35 dyne/cm. and a viscosity as high as about 350 centipoise. Diaphragm 19 may be of sheet silicone elastomer commercially available from SFS Industries of Santa Fe Springs, California having a thickness of 2.38mm (3/32 inches) and a Shore hardness of about 70A. The diameter of the mouth 9 of bottle 1 is about 37.59mm (1.48 inches) and the length of pre-formed slit 20 in diaphragm 19 is about 20.32mm (0.8 inches). Piercing tube 35 is a length of stainless steel tubing having an outer diameter of about 9.525mm (0.375 inches).

The above example illustrates one size bottle and diaphragm thickness. It will be understood by those skilled in the art that the material from which the membrane is made, the diameter of the piercing member, the diameter of the mouth of the bottle, and other factors may vary widely in accordance with this invention.

In addition to the above noted physical properties of diaphragm 19, it is preferred that diaphragm 19 have a surface energy less than the surface tension of ink 17 such that droplets D of ink (as shown in Fig. 8) will bead up on the surface of diaphragm 19 and will bridge a re-closed slit 20 such that ink will not wick through the slit by capillary action. Thus, upon removal of a partially filled bottle 3 from piercing tube 35, the resilient nature of the diaphragm will cause slit 20 to re-close and the lower surface energy of the diaphragm material will prevent loss of ink. For example, for the above-noted ink having a surface tension of about 35 dyne/cm., the elastomeric material of diaphragm 19 should have a lower surface energy of about 20 dyne/cm. to yield the ink beading as shown in Fig. 8. The surface energy is greater than the surface tension of the ink, the ink droplet D', as shown in Fig. 9, will not bridge re-closed slit 20 and will wick through or leak through the slit.

By the way of example, the filled ink bottle 1 is inverted such that its cap 15 faces downwardly. The cap 15 is inserted into socket 25 and the male threads 29 on the outer surface of the cap 15 are threaded into female threads 27 in socket 25. As the cap 15 is threaded downwardly into the recess 25, the upper end of piercing member 35 engages the pre-formed area of weakness (slit 20) and punctures through the membrane 19 along the pre-formed slit (or line of weakness) 20. As the piercing member 35 punctures through the membrane 19, the membrane 19 resiliently grips the outer surface of the piercing member 35 and seals the outer surface of the piercing member 35 relative to the membrane 19 thereby to substantially prevent ink from leaking from the interface of the piercing member 35 and the membrane 19. Of course, once communication is

opened between the interior of bottle 1 and ink reservoir 21, ink will flow from the bottle 1 into the reservoir 21.

Further, as shown in Fig. 2, reservoir lid 23 has an air path 37 therethrough which allows atmospheric air to enter reservoir 21 and to permit the exchange of air and ink within bottle 1 via piercing tube 35 as ink flows from the bottle, into ink reservoir 21. As shown in Fig. 2, the level of the ink 22 in reservoir 21 is at the level of the lower end of the piercing tube 35. Upon the ink level in the reservoir 21 falling below the lower end of the piercing tube 35, air from air path 37 is free to enter the piercing tube 35 and to bubble up through the tube 35 into the interior of the ink bottle 1 thus allowing the ink within bottle 1 to flow downwardly through the piercing tube 35 into the ink reservoir 21 and to replace the ink 17 drained from the bottle 1. In this manner, atmospheric pressure is maintained within the bottle 1 and the ink 17 is free to flow from the bottle 1 so as to maintain a desired quantity of ink 22 in reservoir 21.

If it is desired to remove bottle 1 from the ink jet printing apparatus, the bottle is merely unscrewed from the female threads 27 in reservoir lid 23. As the bottle is unscrewed, diaphragm 19 will maintain sealing engagement with the outer surface of piercing tube 35. As the membrane 19 moves clear of the piercing tube 35, the resilient membrane 19 will spring closed so as to effectively close slit 20 (or other opening punctured through the membrane), thus retaining ink remaining in the bottle 1. In essence, the resilient characteristics of the membrane 19 cause the slit 20 to act as a normally closed valve which upon removal of the piercing tube automatically and quickly closes. In this manner, a partly filled bottle may be removed from the piercing tube 35 substantially without spillage or leakage of ink, even though the bottle is in an inverted dispensing position. Further, because the slit 20 in membrane 19 resiliently closes, any remaining ink within the bottle is maintained in a closed container, thus preventing evaporation of solvents and preventing air borne contaminants from entering the ink bottle. Because of the open spider support

structure 39 for piercing tube 35 and openings 41, in the event ink leaks from slit 20 as the bottle is removed, the ink will flow into reservoir and is not wasted.

CLAIMS:

1. An ink jet printing apparatus comprising: an ink reservoir (21); a replaceable ink container (1) for supplying ink to said reservoir (21), said container (1) having a supply of ink therein; a puncturable diaphragm (19) closing said container (1); a puncturing member (35) carried by said ink reservoir (21) and having a passage therethrough via which ink in said container (1) can be exchanged for air, said puncturing member (35) being engageable with said diaphragm (19) upon said diaphragm (19) facing said puncturing member (35), upon said container (1) and said diaphragm (19) being moved toward said puncturing member (35) said puncturing member (35) piercing through said diaphragm (19) and said diaphragm (19) engaging the sides of said puncturing member (35) so as to substantially prevent ink from leaking between said puncturing member (35) and said diaphragm (19), said puncturing member (35) opening communication between the ink within said container (1) and said ink reservoir (21) thereby permitting ink to flow through said passage in the puncturing member (35) from said container (1) into said ink reservoir (21); and an air path (37) in communication with the atmosphere and said reservoir (21) so that ink from within said container (1) and atmospheric air may be exchanged within said container (1) via said passage in said puncturing member (35) so that ink is free to flow from said container (1) into said reservoir (21) and so that the pressure within said container (1) is maintained substantially at atmospheric pressure.

2. An ink jet printing system as claimed in claim 1 wherein said puncturable diaphragm (19) has an area of weakness (20) engageable by said puncturing member (35) so as to facilitate puncturing of said diaphragm (19).

3. An ink jet printing system as claimed in claim 2 wherein said area of weakness (20) is a slit (20) pre-formed in said diaphragm (19) which does not fully extend through the thickness of said diaphragm (19).

4. An ink jet printing system as claimed in claim 1, 2 or 3 wherein said puncturing member (35) extends downwardly into said reservoir (21), and wherein upon the level of the ink in said reservoir (21) dropping below the level of the lower end of said puncturing member (35), atmospheric air via said air path (37) and ink are exchanged within said container (1) via said puncturing member (35).

5. An ink jet printing system as claimed in any one of the preceding claims wherein said container (1) has a cap (15) secured to its mouth (9) overlying said puncturable diaphragm (19), said cap (15) having an opening (33) therein for receiving said puncturing member (35) as the container (1) is moved into puncturing relation with said puncturing member (35) as the latter punctures through said diaphragm (19).

6. An ink jet printing system as claimed in any one of the preceding claims wherein said diaphragm (19) has a surface energy less than the surface tension of the ink so that droplets of ink will be substantially prevented from leaking through the region of said diaphragm (19) punctured by said puncturing member (35) upon removal of said container (1) from said puncturing member (35).

7. An ink jet printing system as claimed in claim 6 wherein the surface energy of said diaphragm (19) is about 20 dyne/cm and the surface tension of said ink is about 35 dyne/cm.

8. An ink bottle for an ink jet printing system, the latter having an ink reservoir (21) for holding a supply of ink for said ink jet printing system, said bottle having a closed container body (1) having a mouth (9) at one end thereof, a puncturable diaphragm (19) sealingly secured to said mouth (9) closing the bottle, said diaphragm (19) being a sheet of resilient elastomeric material, a cap (15) secured to said mouth (9) and overlying said diaphragm (19), said cap (15) having an opening (33) therethrough exposing a portion of said diaphragm (19) so as to be pierced by a puncturing member (35) when the bottle is installed in said ink jet printing system in inverted position with the mouth (9) facing downwardly such that ink from within said bottle and atmospheric air are exchanged via

a passage through said puncturing member (35), said diaphragm (19) engaging the sides of said puncturing member (35) so as to substantially prevent ink from leaking between said puncturing member (35) and said diaphragm (19).

9. An ink bottle as claimed in claim 8 wherein said cap (15) has external threads (29) for threaded engagement with internal threads (27) provided in said ink jet printing system such that said bottle may be installed in said ink jet printing system with said puncturing member (35) piercing through said diaphragm (19) and so as to maintain said bottle in substantially sealed relation with said ink jet printing system.

10. An ink bottle as claimed in claim 8 or 9 wherein said diaphragm (19) has a surface energy less than the surface tension of said ink so that droplets of ink will be substantially prevented from leaking through the region of said diaphragm (19) punctured by said puncturing member (35) upon removal of said container (1) from said puncturing member (35).

11. An ink supply system for an ink jet printing apparatus comprising an ink reservoir (21) for containing a supply of ink which is supplied to an ink jet printing head or the like, a replaceable ink bottle (1) for containing a supply of ink for said ink reservoir (21), an ink bottle diaphragm (19) carried by said ink bottle (1), a puncturing member (35) carried by said ink reservoir (21) and having a passage therethrough via which ink in said bottle (1) can be exchanged for air, said puncturing member (35) being engageable with said diaphragm (19) upon said ink bottle (1) being moved toward said puncturing member (35) so that said puncturing member (35) punctures through said diaphragm (19), said puncturing member (35) being sealingly engageable with said diaphragm (19) so as to substantially prevent the leakage of ink between said puncturing member (35) and the region of said diaphragm (19) in engagement with said puncturing member (35), and an air path (37) between the outside atmosphere and said reservoir (21) enabling the exchange of air and ink within said ink bottle (1) via said passage through said puncturing member (35).

12. An ink supply system as claimed in claim 11 wherein said puncturing member (35) extends downwardly into said reservoir (21) to a predetermined level such that upon said ink level within said reservoir (21) falling below the level of the said puncturing member (35), air from within said reservoir (21) may enter said puncturing member (35) to be exchanged with ink within said bottle (1) thus allowing ink to flow into said reservoir (21) via said puncturing member (35).

13. An ink supply system as claimed in claim 11 or 12 wherein said diaphragm (19) has a surface energy less than the surface tension of said ink so that droplets of ink will be substantially prevented from leaking through the region of said diaphragm (19) punctured by said puncturing member (35) upon removal of said bottle (1) from said puncturing member (35).

14. An ink supply system as claimed in claim 11, 12 or 13 wherein said diaphragm (19) has an area of weakness (20) engageable by said puncturing member (35) as said bottle (1) is moved into its operating position so as to facilitate puncturing of said diaphragm (19).

15. An ink supply system as claimed in any one of claims 11 to 14 wherein said reservoir (21) has an opening (41) proximate said puncturing member (35) such that ink that may leak around said puncturing member (35) or that may leak through said diaphragm (19) will flow into said reservoir (21).

16. An ink supply system as claimed in any one of claims 11 to 15 wherein said diaphragm (19) is of sheet elastomeric material such that the opening punctured therethrough by said puncturing member (35) will substantially re-close upon removal of said bottle (1) from said puncturing member (35) thereby to substantially re-seal said bottle (1) so as to at least in part prevent the contamination of any ink remaining in said bottle (1) such that said bottle (1) may be again installed on said puncturing member (35).

17. A method of supplying ink to an ink jet printing system, the latter having a closed ink reservoir (21), a puncturing tube (35) extending above the reservoir (21) and providing via the

passage therethrough communication to the interior of said reservoir (21) with said puncturing tube (35) extending downwardly within said reservoir (21) to a predetermined level, an air passageway (37) extending from the atmosphere exteriorly of said reservoir (21) to said reservoir (21), and an ink bottle (1) having a puncturable diaphragm (19), said method comprising the steps of: orienting said ink bottle (1) such that said diaphragm (19) faces said puncturing tube (35); causing said puncturing tube (35) to pierce through said diaphragm (19) thereby to open communication via the passage through the tube (35) between the interior of said ink bottle (1) and said reservoir (21) such that ink from within said ink bottle (1) may flow into said reservoir (21), said diaphragm (19) engaging the sides of said puncturing tube (35) so as to substantially prevent ink from leaking between said puncturing tube (35) and said diaphragm (19); and allowing the exchange of ink from said bottle (1) into said reservoir (21) and of atmospheric air into said bottle (1) as the ink flows therefrom via the passage of said puncturing tube (35).

18. A method as claimed in claim 17 further comprising the step of permitting the exchange of ink and air via said puncturing tube (35) upon the level of the ink within said reservoir (21) dropping below the level of the lower end of said puncturing tube (35) within said reservoir (21).

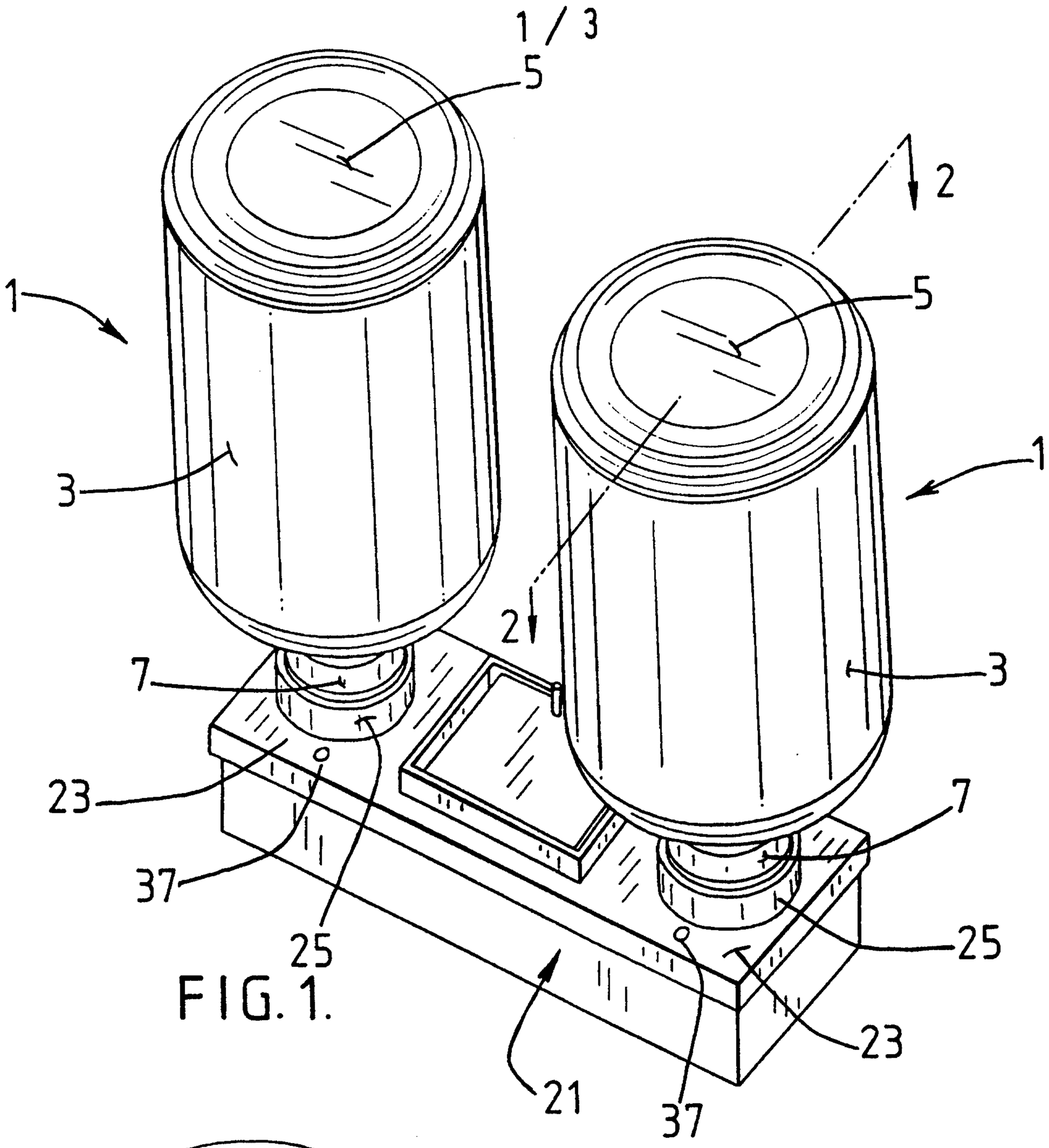


FIG. 1.

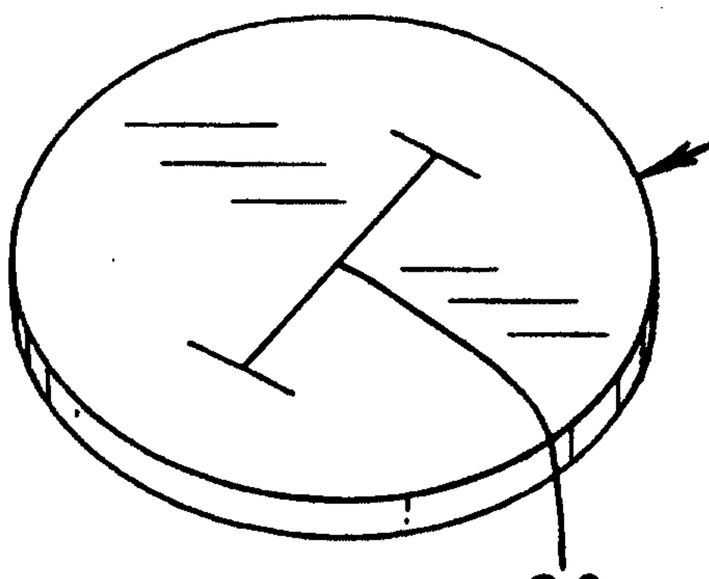


FIG. 3.

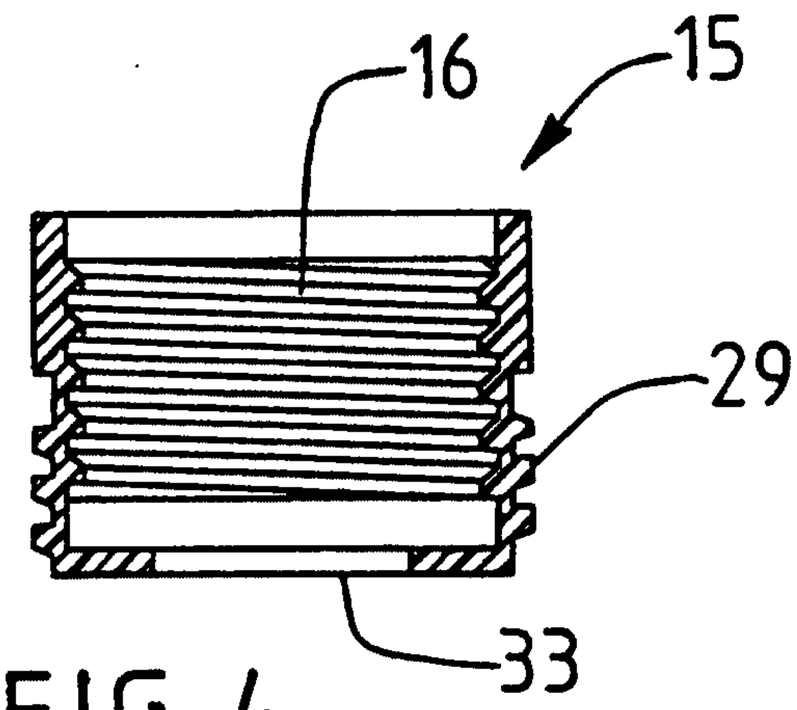


FIG. 4.

FIG. 2.

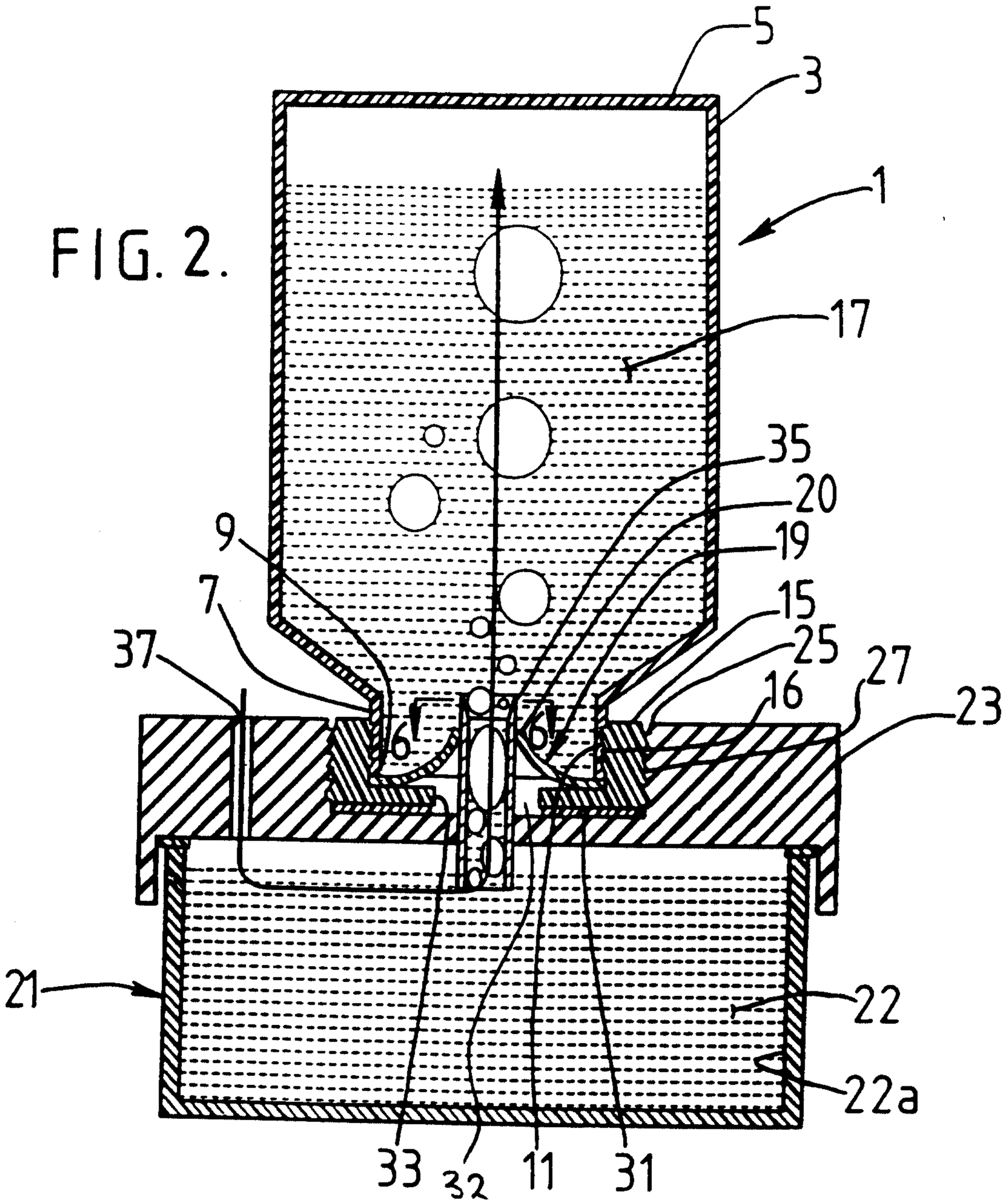


FIG. 6.

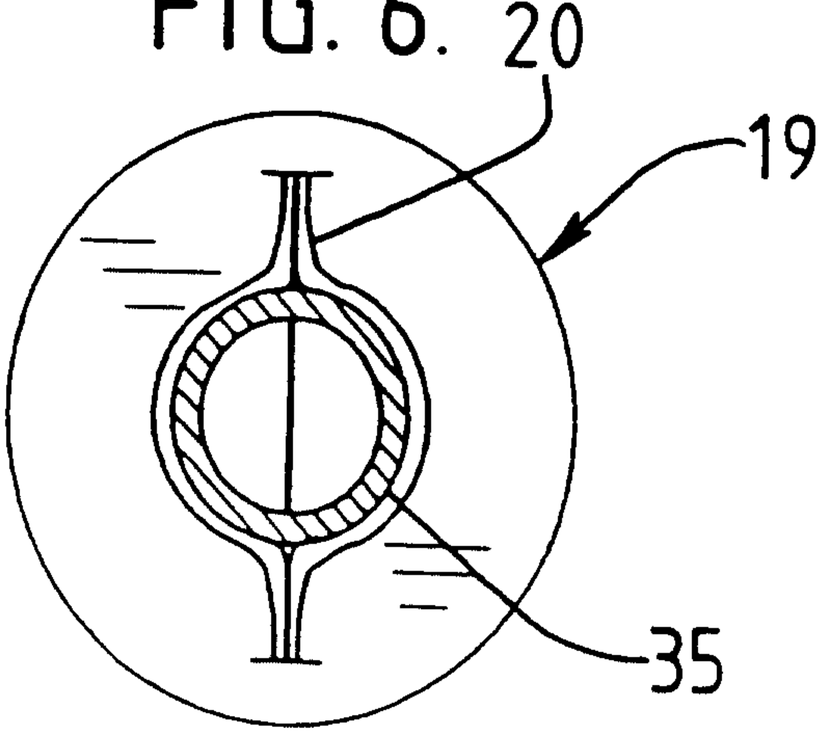
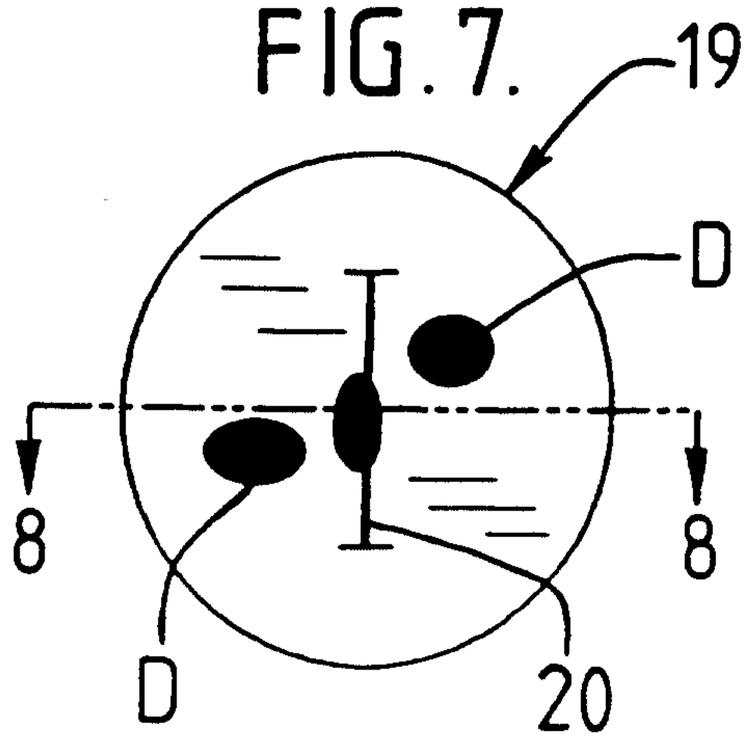


FIG. 7.



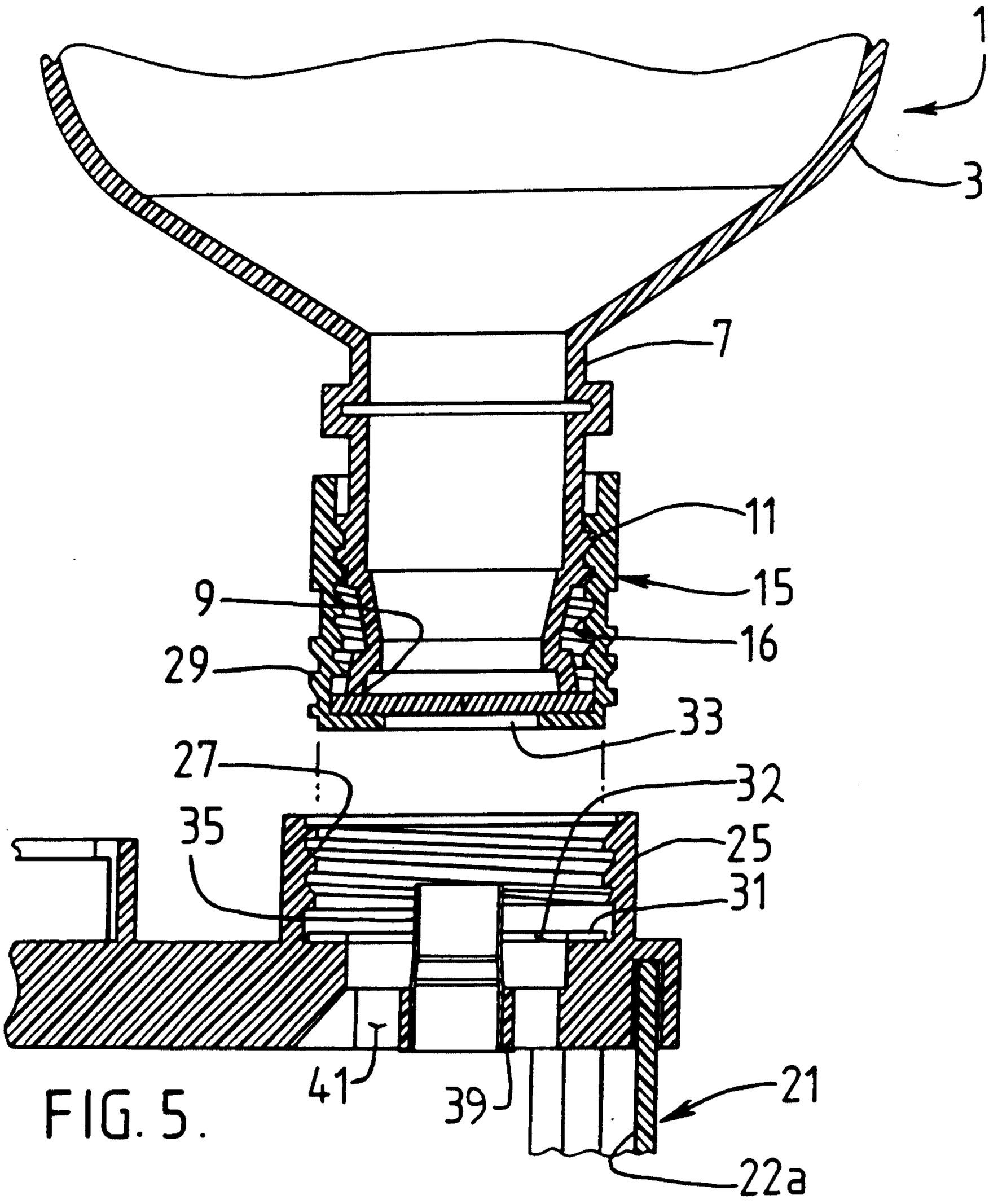


FIG. 5.

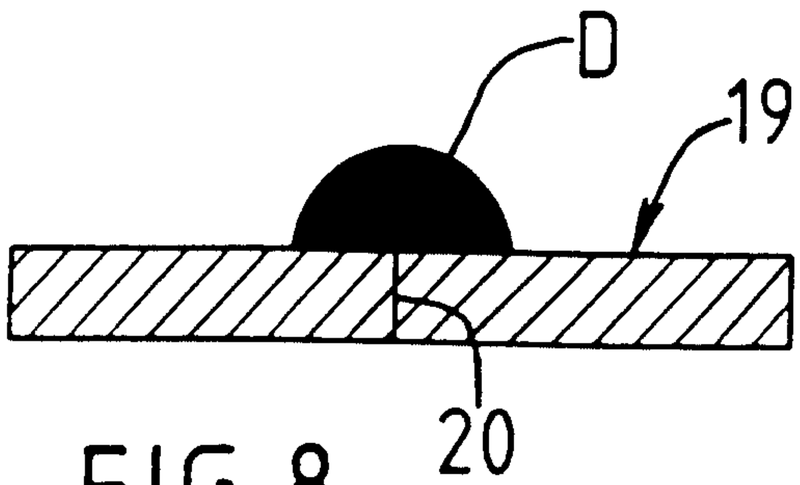


FIG. 8.

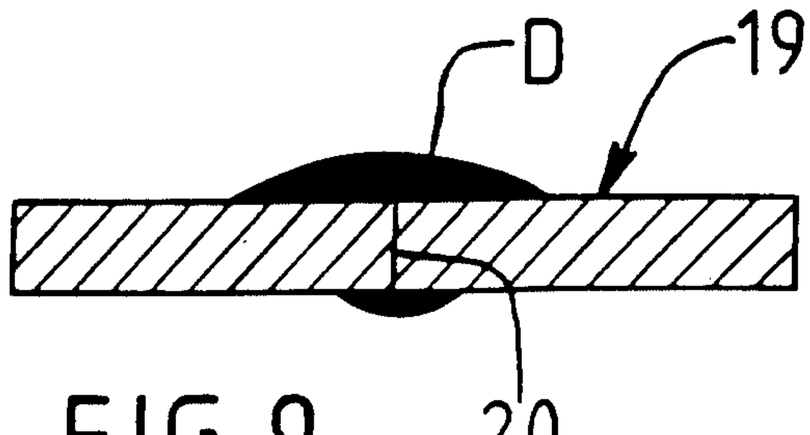


FIG. 9.