(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 847 861 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
17.06.1998 Bulletin 1998/25

(51) Int. Cl.[6]: **B41J 2/175**

(21) Application number: **97301032.5**

(22) Date of filing: **18.02.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **14.12.1996 GB 9626016**
21.01.1997 GB 9701157

(71) Applicant:
DYNAMIC CASSETTE INTERNATIONAL LIMITED
Boston, Lincolnshire PE21 7TX (GB)

(72) Inventors:
- **Studholme, William J.**
  Boston, Lincolnshire PE21 7TX (GB)
- **Counihan, Nigel J.**
  Boston, Lincolnshire PE21 7TX (GB)
- **Vickers, Kevin**
  Boston, Lincolnshire PE21 7TX (GB)
- **Studholme, John W.**
  Boston, Lincolnshire PE21 7TX (GB)

(74) Representative:
Dempster, Benjamin John Naftel et al
Withers & Rogers
4 Dyer's Buildings,
Holborn
London EC1N 2JT (GB)

(54) A method and apparatus for filling an ink cartridge for a printer

(57) A method of filling an ink cartridge 10 for a printer comprises placing the cartridge in a refill station 52 reducing the pressure in the cartridge 10 by connecting a vacuum bottle 58, and connecting an ink supply 56 at atmospheric pressure such that ink is drawn from the supply 56 into the cartridge 10 by the pressure differential.

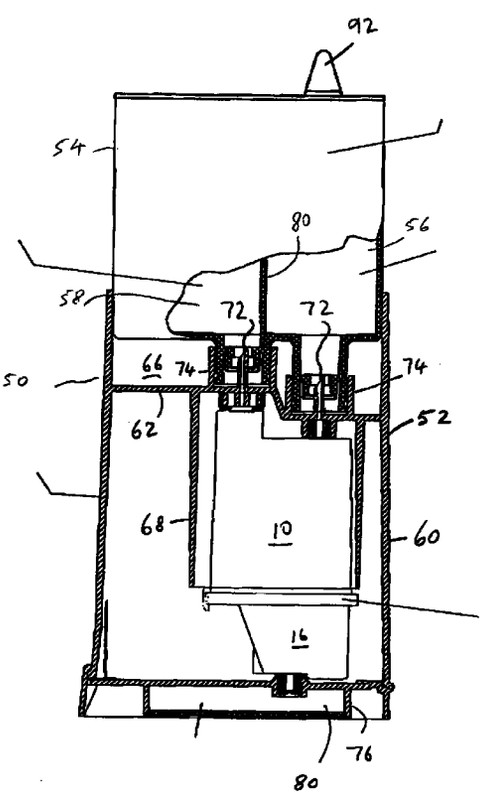

Fig.7

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Description

The invention relates to a method and apparatus for filling an ink cartridge for an printer.

Figs. 1-4 show a known ink cartridge for an ink jet printer in side elevation, front elevation, top plan view and underneath plan view respectively. The cartridge 10 defines an ink chamber 12 including an airbag 14. The airbag 14 is a rectangular two-layer bag having a central aperture into the bag which is connected to an upper air chamber 16 of the cartridge 10 which is vented to atmosphere through a vent hole 18 of the cartridge. The bag 14 is folded within the ink chamber 12 symmetrically to form two halves or lungs so that each half of the bag 14 extends nearly to the floor of the ink chamber 12 and nearly the full width of the ink chamber 12. Each half of the bag 14 is staked to the convex surface of a leaf-spring 20 which acts in a direction to deflate the bag half. There is a print head port 22 in the floor of the cartridge 10 and a bubbler hole 24.

As ink is used from the print head, then the displaced volume is replaced by inflation of the airbag 14. Inflation of the airbag is resisted by the springs 20 which results in negative pressure inside the ink chamber 12 of the cartridge 10. As the airbag 14 inflates beyond a certain point, the pressure drops in the ink chamber 12 sufficiently for air to be drawn in through the bubbler hole 24, resulting in a rise in internal pressure, allowing the airbag 14 to deflate a little. In this way, the bubbler hole 24 and airbag 14 work in tandem to control the negative pressure between two levels. If the pressure drops too much, then ink cannot be drawn from the print head and printing will be affected. If the pressure rises to approach ambient atmospheric pressure, then the ink will drool freely from the cartridge 10 causing it to leak or adversely affect print quality. The sized bubbler hole 24 and the airbag 14 act to keep the internal negative pressure within limits between these two undesirable extremes.

A second known cartridge has two flexible sides which are held apart with leaf-springs within the cartridge. The flexible sides are enclosed within rigid covers but are generally open to atmosphere. When the cartridge is filled with ink, the flexible sides are nearly completely out against the rigid covers. The leaf-springs act to push the flexible sides out still further so creating a negative pressure within the cartridge which is sufficient to prevent the cartridge drooling ink from the print head port. As ink is used from the cartridge, the sides are drawn in against the action of the leaf-springs. The cartridge will eventually stop printing when it can supply no more ink and at this point may be thrown away.

It is known to refill each of these known cartridges using a syringe or similar device to squirt ink into the cartridge for example through a fill-hole of the cartridge which will need to be unblocked. A refill machine using an electric pump is also known.

According to one aspect of the invention there is provided a method of filling an ink cartridge for a printer comprising reducing the pressure in the cartridge and connecting an ink supply at a higher pressure to the cartridge such that ink is drawn from the supply into the cartridge by the pressure differential.

This method is simple and clean and avoids any leakage due to overfilling. Also, any excess ink left in the cartridge may be removed insuring that an optimum fresh charge of ink is present in the cartridge.

The method may further include the step of deflating an airbag within the cartridge before the ink supply is connected to the cartridge. Thus, where an airbag 14 is provided in the known cartridge 10, for example, a problem is that a lung can be in any state between completely inflated and completely deflated when the cartridge is empty. If the airbag is inflated at the start of the filling process the cartridge will clearly accept much less ink than if the airbag is deflated. The airbag may be deflated by reducing the pressure in the airbag. The airbag is preferably deflated by connecting the airbag to a vacuum bottle. The pressure may be reduced in the cartridge by attaching the cartridge to a vacuum bottle. The ink supply may be at atmospheric pressure.

According to another aspect of the invention there is provided a method of filling a flexible cartridge comprising deflating the cartridge, connecting an ink supply to the cartridge, and reducing the pressure around the cartridge to reinflate the cartridge, and thereby draw the ink into the cartridge from the supply.

The cartridge may be deflated by reducing the pressure in the cartridge. The pressure may be reduced in the cartridge by attaching the cartridge to a vacuum bottle.

The pressure may be reduced around the cartridge by placing the cartridge in a container and reducing the pressure in the container which may be achieved by connecting the container to a vacuum bottle.

The ink in the ink supply may be at atmosphere pressure.

According to another aspect of the invention, there is provided apparatus for carrying out the method of either of the preceding aspects of the invention.

According to another aspect of the invention there is provided apparatus for filling an ink cartridge, the apparatus comprising means to reduce the pressure in the cartridge and means for connecting an ink supply to the evacuated cartridge such that ink is drawn into the cartridge.

The apparatus may further include an ink reservoir which may be at atmospheric pressure. In one embodiment the ink reservoir is at least partly flexible and may be a bag which collapses as ink is drawn out. In a preferred embodiment the ink reservoir is connected to the cartridge evacuating means. In this way, a single combined unit can be connected to the cartridge. The ink reservoir may be integral with the cartridge evacuating means.

The apparatus preferably includes means for locat-

ing the ink reservoir.

The apparatus preferably includes means for locating the cartridge. The cartridge locating means may comprise two parts which are moved together to locate the cartridge between them. The cartridge locating means may comprise a cartridge receiving means and a second part which is arranged to be connected thereto and, for example, the cartridge locating means may comprise a container and a lid.

The apparatus may include means for locating the cartridge evacuating means.

The means to reduce pressure in the cartridge may comprise a vacuum bottle.

The apparatus may include a one-way valve for the print head opening.

The connecting means may be arranged to be connected through the print head opening. This will ensure that the print head is full of ink so that the cartridge is immediately ready for use.

The connecting means may comprise a spear to pierce a septum and provide a flow path.

According to a further aspect of the invention there is provided apparatus for use in refilling an ink cartridge which includes an air bag, the apparatus including means for evacuating the air bag and means permitting a final predetermined volume of air to be in the air bag.

The apparatus preferably includes a chamber of predetermined size which is connectable to the air bag.

The apparatus may include a container to receive the cartridge, the container being substantially airtight and means for evacuating the container. In the case of the cartridge with flexible sides this will draw ink from the supply into the cartridge. The container evacuating means may comprise a vacuum bottle.

The apparatus may include means for evacuating an air bag in a cartridge. The air bag evacuating means may comprise a vacuum bottle. The apparatus preferably includes means for locating the air bag evacuating means.

According to a further aspect of the invention there is provided a station comprising means to receive and locate a cartridge, means to cover the apertures of a located cartridge and enable at least one of the cartridge apertures to be connected to external means.

The external means may comprise an ink supply and may comprise means to reduce the pressure in or around the cartridge such as a vacuum bottle. The means may comprise at least one spear to pierce a septum and provide a flow path.

According to another aspect of the invention there is provided a refill cartridge comprising a chamber containing ink and a chamber containing a vacuum.

The refill cartridge preferably includes means for locating it with respect to a cartridge to be refilled or a filling station therefor. Three embodiments of the invention will now be described by way of an example and with reference to the accompanying drawings, in which:

Fig. 5 is a side elevation impartial cross-section of the open refill station of the embodiment with a cartridge in it;

Fig. 6 is the view of Fig. 5 with the refill station closed;

Fig. 7 is the view of Fig. 6 with the supply cartridge in place;

Fig. 8 is a detailed view of a connection between the supply cartridge and refill station;

Fig. 9 is a side elevational view in partial cross-section of the apparatus of the second embodiment with the vacuum bottle in place;

Fig. 10 is a plan view of the refill station of Fig. 9 with the lid open;

Fig. 11 is a side elevational view in partial cross-section of the apparatus of Fig. 9 with the supply cartridge in place;

Fig. 12 is a side elevation in cross-section of the refill station of the third embodiment with the first bottle connected; and,

Fig. 13 is the view of Fig. 12 but with the second supply bottle connected.

The apparatus 50 of the first embodiment comprises a reusable fill station 52 and a one time use supply cartridge 54 defining two chambers 56, 58, one containing ink and the other containing a partial vacuum. The apparatus 50 is for refilling the known cartridge 10 hereinbefore described.

The refill station 52 comprises a parallel sided tube 60 with an egg-shaped cross-section, the tube 60 being divided non-centrally by a transverse dividing wall 62 to define a larger cavity 64 facing in one direction and a smaller cavity 66 facing in the other direction. An inner rectangular wall 68 extends into the larger cavity 64 to define a cup shaped recess to receive the cartridge 10, which is of generally rectangular cross-section, and locate it. The end of the cartridge 10 is stepped with the print head port 22 on the end surface of an extension and the bubbler hole 24 in the non-extended end surface. The divider wall 62 is correspondingly stepped and seats 70 are provided to engage the cartridge 10 around the port 22 and around the bubbler hole 24. Each seat 70 defines a bore which extends through the divider wall 62 and through a spear 72 on the opposite side of the divider wall 62 extending into the smaller cavity 66 parallel to the walls of the tube 60. Each spear 72 takes the form of an angle cut circular tube and is surrounded by a wall 74. The wall 74 in each case is locating means for two extended necks 76 of the supply

cartridge 54, one for the ink chamber 56 and one for the vacuum chamber 58.

At the other end of the larger cavity 64, a lid 76 is hingedly connected to one side of the tube 60 to close over the cartridge 10. A one-way valve 78 is positioned on the inner surface of the lid to seat over the air bag vent hole 18. The one-way valve leads to a wide shallow chamber in the lid, the surface of which opposite the one-way valve is defined as a flexible bladder 80.

The supply cartridge 54 is arranged to be received and located by the walls of the tube 60 into the smaller cavity 66 with the extended necks 75 of the two chambers being received and located by the walls 74. The chambers 56, 58 are separated by an internal wall 80 between the necks which is parallel to the short side walls of the supply cartridge. The vacuum chamber 58 may be about 125ml in volume and at a pressure of -0.9 bar. As shown in detail in Fig. 8, each neck includes an inner wall 82 within the neck and connected thereto by an annular portion 84 so as to trap a rubber septum 86 between the neck and the inner wall. The rubber septum is supported by a top hat shaped plug 88 the rim of which seats on the lower edge of the inner wall. An O-ring 90 is provided in the outside of the neck to seal against the wall, the O-ring being located in a groove in the external neck. The O-ring may be omitted in other embodiments.

A synthetic rubber stopper 92 is provided in the opposite end of the supply cartridge from the external necks and communicates with the ink chamber 56 so that the ink chamber can be opened to atmosphere.

In use, the lid 76 of the refill station 52 is opened and the cartridge 10 to be refilled is inserted into the station seating on the seats 70 and located by the wall 68. The lid is closed and clipped into place with the one-way valve 78 aligned with and seated over the air bag vent 18. The refill station 52 is then inverted and placed on a desk top or similar flat surface. The supply cartridge is pushed onto the top of the inverted refill station into the smaller cavity 66 such that the necks are received by the walls. The spears will then pierce the rubber septums. The partial vacuum in the vacuum chamber 58 is thus coupled through the refill station 52 to the print head port 22 of the cartridge 10 to be refilled. Air within the cartridge 10 is therefore drawn out through the print head port 22 into the vacuum chamber 58. The user then removes the synthetic rubber stopper in the top of the supply cartridge so that the ink chamber is open to atmosphere. As the pressure decreases within the cartridge 10, ink is drawn into the cartridge 10 through the bubbler hole 24 via the spear and seat. At the same time air is drawn into the ink chamber of the supply cartridge through the aperture previously filled by the stopper.

As mentioned previously, the cartridge 10 includes a spring biased air bag 14 and the air bag 14 is normally vented to atmosphere through the air vent 18. Without the lid of the refill station, during the refill period, the partial vacuum in the cartridge 10 would cause the airbag 14 in the cartridge 10 to over-inflate, severely reducing the space available for ink. In tests, the capacity of a 40ml cartridge was reduced by more than 10ml. The air vent 18 can simply be plugged. If the air bag 14 is fully deflated, the cartridge is prone to drool and in practice the air bag 14 is required to be partially inflated to introduce a slight negative pressure within the cartridge to maximise capacity while preventing drooling. The cavity in the lid is of a predetermined size to achieve this.

During the filling, the first application of the partial vacuum causes the air bag 14 to inflate by drawing air through the one-way valve to a point where the pressure in the cartridge matches that within the cavity in the lid. As the partial vacuum decreases in the ink cartridge, the one-way valve in the lid closes trapping the requiring amount of air in the air bag 14. With the air bag 14 of the cartridge partially inflated, when the cartridge is removed from the refill station, the cartridge can be simply wiped clean and installed straight onto the printer.

As mentioned previously, it is a problem with the forced injection systems for refilling, that if the user tries to refill a cartridge which is not entirely empty then excess ink can leak from the refill system causing a mess. In the embodiment, at the end of the refill cycle, any excess ink is drawn safely into the vacuum chamber of the supply cartridge and will be contained there to be discarded with the supply cartridge at the end of the cycle.

The second embodiment shown in Figs. 9 to 11 is similar to the first embodiment and only the differences between the embodiments will be described. The same reference numerals will be used for equivalent features.

In the second embodiment, the refill station 52 includes a further aperture 94 in the divider wall 62 between the wall 68 and the outer tube 60 to receive a slim vacuum bottle (102). The vacuum bottle 102 is of oval cross-section and may have a volume of 25ml at a pressure of -0.9 bar. The vacuum bottle includes an external neck with the same features as the external necks 75 of the supply cartridge. Similarly, the inner surface of the lid is provided with an inwardly directed spear 95 parallel to the walls of the tube 60 and defining a one way valve 96 therebehind. A moulded cover 98 is provided over the one way valve and across and over the seat of the air bag vent 18 which does not include a one way valve. A further one way valve 100 is provided in the cover which is one way to the lid cavity which is of predetermined volume such as 7.5ml.

This embodiment caters for the situation where the air bag 14 might be full of air after the cartridge has been emptied. To deflate the air bag, the vacuum bottle is pressed home onto the spear 95 being located between the wall of the tube 60 and the wall 68. The partial vacuum causes the first one way valve behind the spear to open thus allowing air in the air bag to be drawn out to the vacuum bottle thus deflating the air bag. After this has been achieved, the bottle can be

removed and the one way valve will close again keeping the air bag deflated.

The apparatus is then used in the same way as the first embodiment resulting in a predetermined volume of air entering the airbag from the lid cavity. The cavity in the lid of the refill station will vent to atmosphere when the lid is open resulting in the station resetting itself for the next refill.

Tests have shown that a cartridge 10 refilled by the apparatus of the second embodiment results in excellent print performance on first use of the cartridge. This is probably due to the following processes. The vacuum initially used to deflate the lungs will tend to clear any blockages in the cartridge breather system i.e. the bubbler hole 24. The vacuum used to draw the ink into the cartridge applied through the print head port 22 tends to clear any blockage in the print head port 22. The final stage in the refill cycle allows ink in the cartridge to be drawn through the print head port and into the vacuum chamber 58 priming the print head and flushing it with new ink. Any void in the ink in the print head will collapse as the vacuum is released, being replaced by more ink from cartridge. This is an important distinction from the prior systems discussed, as a system using a pressurised ink feed would have the opposite effect. A void in the print head would expand when the pressure was released resulting in poor print performance.

In a further embodiment, the single rigid supply cartridge 10 may be replaced by a separate vacuum bottle and an ink supply in the form of a flexible bag of ink having a suitable neck for connection to the refill station. In this case the stopper would not be needed and the bag would collapse as ink was withdrawn.

The apparatus 200 of the third embodiment also comprises a container 202 and a lid 204. The lid 204 is a snap fit on the container 202 and O-ring seal 206 is provided to aid sealing although sealing may be achieved in any desired way. The apparatus 200 is for use with the second known cartridge hereinbefore described. The lid 204 includes a row of three outwardly extending circular walls 208, 209, 210. Within each wall 208, 209, 210 is a tubular spear 212 connected to the wall 208, 209, 210 by a annular part 214. Behind the spear 212 of the first wall 208 is provided a one way valve 216 letting flow outwards through the spear 212. Behind the spear 212 of the second wall 209 is provided a one way valve 218 permitting flow inwards through the spear. The walls 208, 209 are provided on a shallow upturned tray 220 on top of the main body 222 of the lid 204. The cavity defined therebetween communicates with the interior of the container through an aperture 224 beneath the first wall 208. An O-ring seal 226 is provided around the aperture 224.

The apparatus further includes two bottles 228, 230. Each bottle includes two necks 236 provided with septums in the same way as the supply cartridge 54 of the first and second embodiments. The first bottle 228 contains a partial vacuum and the necks are arranged to fit into and be located by the walls 208, 209. The neck received by the wall 209 is blocked and the neck is purely provided to improve location.

The second bottle 230 is divided in two like the supply cartridge of the first and second embodiments to define an ink chamber 232 behind one external neck and a vacuum chamber 234 behind the other.

In use, the cartridge to be refilled will be placed into the container 202 and lid 204 clipped on. The lid seals against the container holding the cartridge forming a chamber just larger than the cartridge itself. The lid 204 seals against the print head of the cartridge through the O-ring 226. The first stage of refilling the cartridge is to collapse the sides of the cartridge wall to create a maximum space for the new ink. To deflate the cartridge, the first bottle 228 is plugged into the top of the refill station with the external necks being received in the walls 208, 209. The partial vacuum will draw most of the air from the cartridge out through the aperture 224 and through the spear 212 in the first wall 208 through the one way valve 216. Any residual ink will also be drawn out. The first bottle 228 is then removed from the station leaving the sides of the cartridge drawn in, the print head being sealed through the seal 226 and one way valve 216. During the process of drawing in the sides of the cartridge, the chamber that the cartridge is placed in is open to atmosphere through the spear 212 of the wall 210 allowing air to enter the container so that there is no vacuum within the container to resist movement of the sides.

The second bottle 230 is then placed on top of the refill station with the ink chamber neck being received in the wall 209 and the vacuum chamber neck being received in the wall 210. The stopper is removed from the ink chamber 232 and the partial vacuum from the vacuum chamber 234. The partial vacuum draws the sides of the cartridge out again and creates a partial vacuum inside the container 202. This creates a partial vacuum inside the cartridge resulting in ink from the ink chamber being drawn through the one way valve into the cartridge through its print head. After the refill cycle is complete, the empty bottle 230 is removed and discarded. The lid 204 is unclipped and the cartridge is placed on an absorbent pad for a few minutes until the internal pressure has stabilised. The cartridge is then ready to install back onto the printer.

Claims

1. A method of filling an ink cartridge for a printer comprising reducing the pressure in the cartridge and connecting an ink supply at a higher pressure to the cartridge such that ink is drawn from the supply into the cartridge by the pressure differential.

2. A method as claimed in claim 1, wherein the method further includes the step of deflating an airbag within the cartridge before the ink supply is

connected to the cartridge.

3. A method as claimed in claim 2, wherein the airbag is deflated by reducing the pressure in the airbag.

4. A method as claimed in claim 3, wherein the airbag is deflated by connecting the airbag to a vacuum bottle.

5. A method as claimed in any preceding claim, wherein the pressure is reduced in the cartridge by attaching the cartridge to a vacuum bottle.

6. A method as claimed in any preceding claim, wherein the ink supply is at atmospheric pressure.

7. A method of filling a flexible cartridge comprising deflating the cartridge, connecting an ink supply to the cartridge, and reducing the pressure around the cartridge to reinflate the cartridge, and thereby draw the ink into the cartridge from the supply.

8. A method as claimed in claim 7, wherein the cartridge is deflated by reducing the pressure in the cartridge.

9. A method as claimed in claim 7 or claim 8, wherein the pressure is reduced in the cartridge by attaching the cartridge to a vacuum bottle.

10. A method as claimed in claim 7, 8 or 9, wherein the pressure is reduced around the cartridge by placing the cartridge in a container and reducing the pressure in the container.

11. A method as claimed in claim 10, wherein the pressure in the container is reduced by connecting the container to a vacuum bottle.

12. A method as claimed in any of claims 7 to 11, wherein the ink in the ink supply is at atmosphere pressure.

13. Apparatus for carrying out the method of any preceding claim.

14. Apparatus for filling an ink cartridge, the apparatus comprising means to reduce the pressure in the cartridge and means for connecting an ink supply to the evacuated cartridge such that ink is drawn into the cartridge.

15. Apparatus as claimed in claim 14, wherein the apparatus further includes an ink reservoir.

16. Apparatus as claimed in claim 15, wherein the ink reservoir is at atmospheric pressure.

17. Apparatus as claimed in claim 15 or claim 16, wherein the ink reservoir is at least partly flexible.

18. Apparatus as claimed in claim 17, wherein the ink reservoir is a bag which collapses as ink is drawn out.

19. Apparatus as claimed in any of claims 15 to 18, wherein the ink reservoir is connected to the cartridge evacuating means.

20. Apparatus as claimed in claim 19, wherein the ink reservoir is integral with the cartridge evacuating means.

21. Apparatus as claimed in any of claims 14 to 20, wherein the apparatus includes means for locating the ink supply.

22. Apparatus as claimed in any of claims 14 to 21, wherein the apparatus includes means for locating the cartridge.

23. Apparatus as claimed in claim 22, wherein the cartridge locating means comprises two parts which are moved together to locate the cartridge between them.

24. Apparatus as claimed in claim 23, wherein the cartridge locating means comprises a cartridge receiving means and a second part which is arranged to be connected to the cartridge receiving means.

25. Apparatus as claimed in claim 24, wherein the cartridge locating means comprises a container and a lid.

26. Apparatus as claimed in any of claims 14 to 25, wherein the apparatus includes means for locating the cartridge evacuating means.

27. Apparatus as claimed in any of claims 14 to 26, wherein the means to reduce pressure in the cartridge comprises a vacuum bottle.

28. Apparatus as claimed in any of claims 14 to 27, wherein the apparatus includes a one-way valve for a print head opening of the cartridge.

29. Apparatus as claimed in any of claims 14 to 28, wherein the connecting means is arranged to be connected through the cartridge print head opening.

30. Apparatus as claimed in any of claims 14 to 29, wherein the connecting means comprises a spear to pierce a septum and provide a flow path.

31. Apparatus for use in refilling an ink cartridge which includes an air bag, the apparatus including means for evacuating the air bag and means permitting a final predetermined volume of air to be in the air bag.

32. Apparatus as claimed in claim 31, wherein the apparatus includes a chamber of predetermined size which is connectable to the air bag.

33. Apparatus as claimed in claim 31 or claim 32, wherein the apparatus includes a container to receive the cartridge, the container being substantially airtight and means for evacuating the container.

34. Apparatus as claimed in claim 33, wherein the container evacuating means comprises a vacuum bottle.

35. Apparatus as claimed in any of claims 31 to 34, wherein the apparatus includes means for evacuating an air bag in a cartridge.

36. Apparatus as claimed in claim 35, wherein the air bag evacuating means comprises a vacuum bottle.

37. Apparatus as claimed in claim 36, wherein the apparatus includes means for locating the air bag evacuating means.

38. A station comprising means to receive and locate a cartridge, means to cover the apertures of a located cartridge and enable at least one of the cartridge apertures to be connected to external means.

39. A station as claimed in claim 38, wherein the external means comprises an ink supply.

40. A station as claimed in claim 38 or claim 39, wherein the external means comprises means to reduce the pressure in or around the cartridge.

41. A station as claimed in claim 40, wherein the external means comprises a vacuum bottle.

42. A station as claimed in any of claims 38 to 41, wherein the means comprises at least one spear to pierce a septum and provide a flow path.

43. A refill cartridge comprising a chamber containing ink and a chamber containing a vacuum.

44. A refill cartridge as claimed in claim 43, wherein the refill cartridge includes means for locating it with respect to a cartridge to be refilled or a filling station therefor.

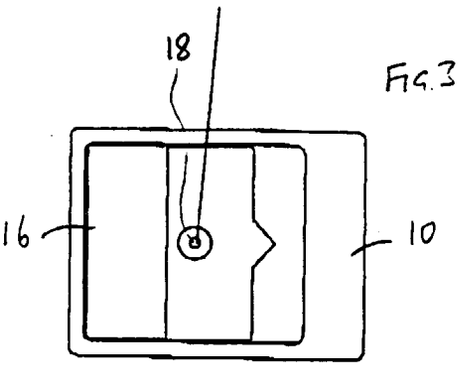


Fig.3

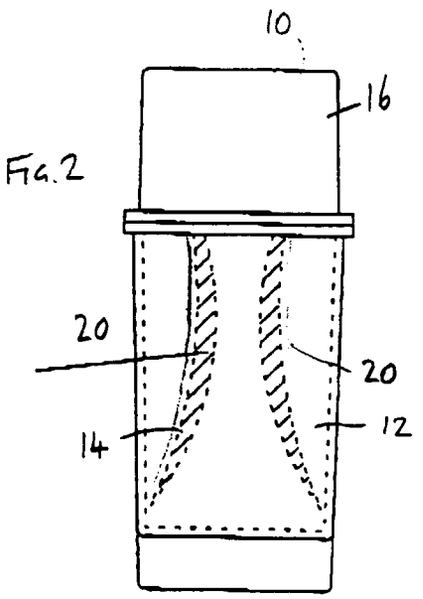


Fig.2

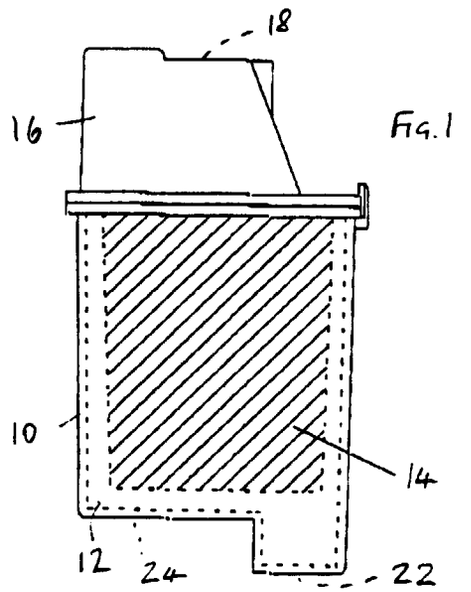


Fig.1

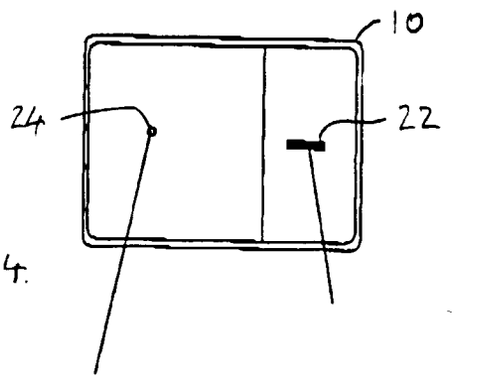


Fig 4.

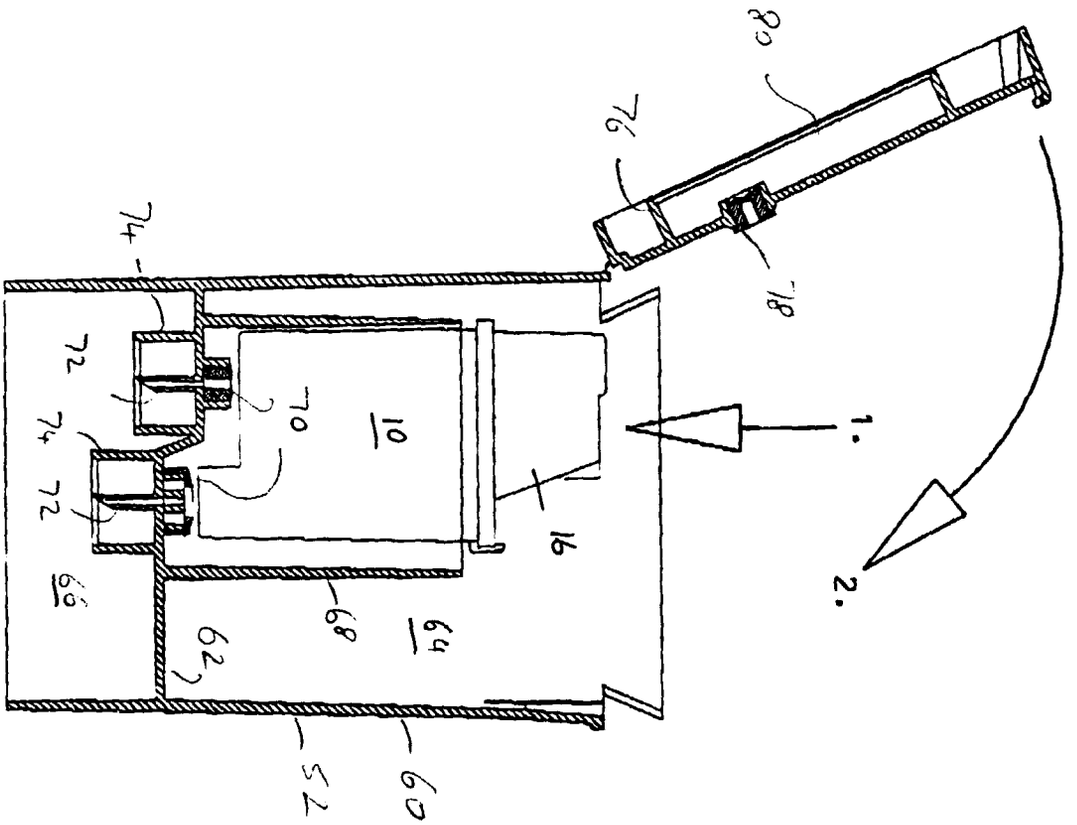


FIG 5A

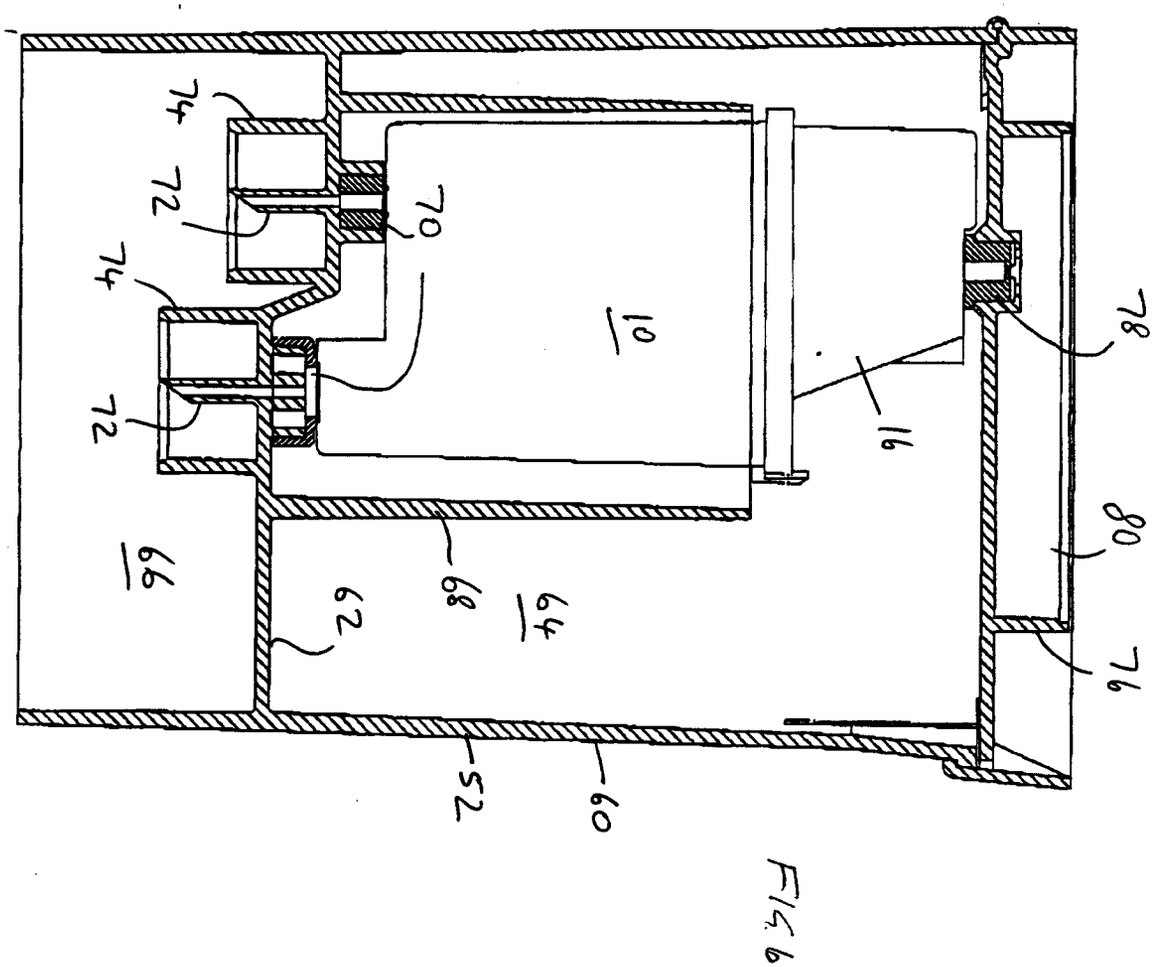


Fig. 6

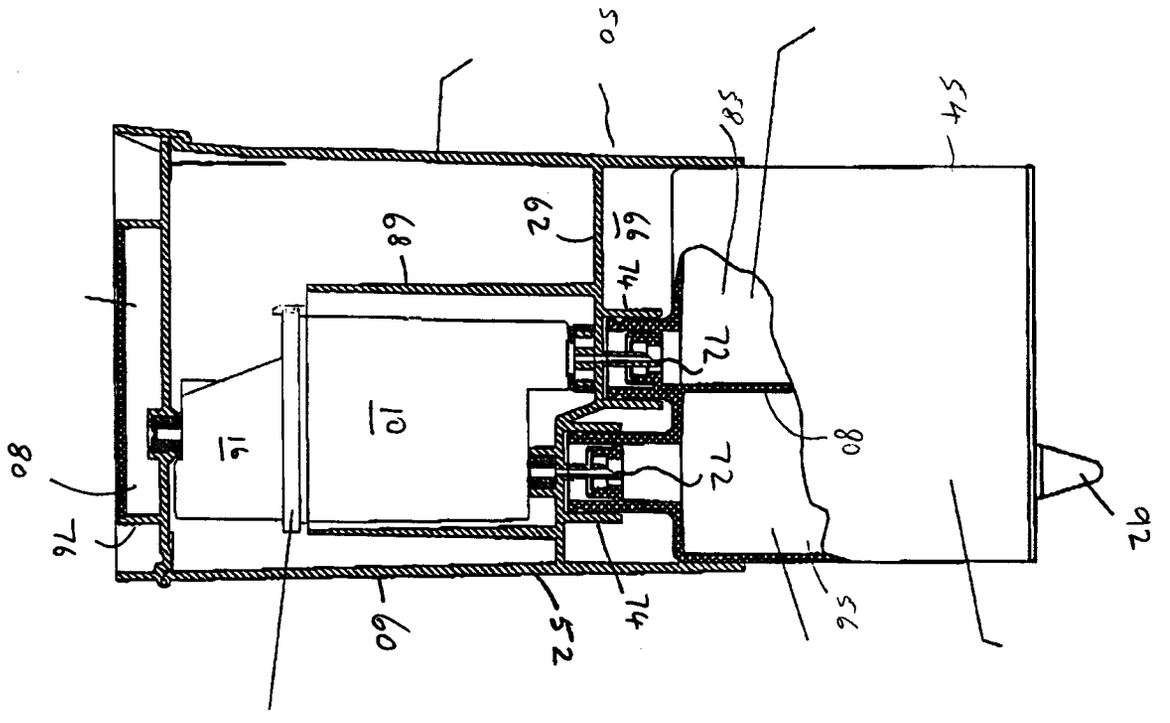


FIG. 7

Fig. 8

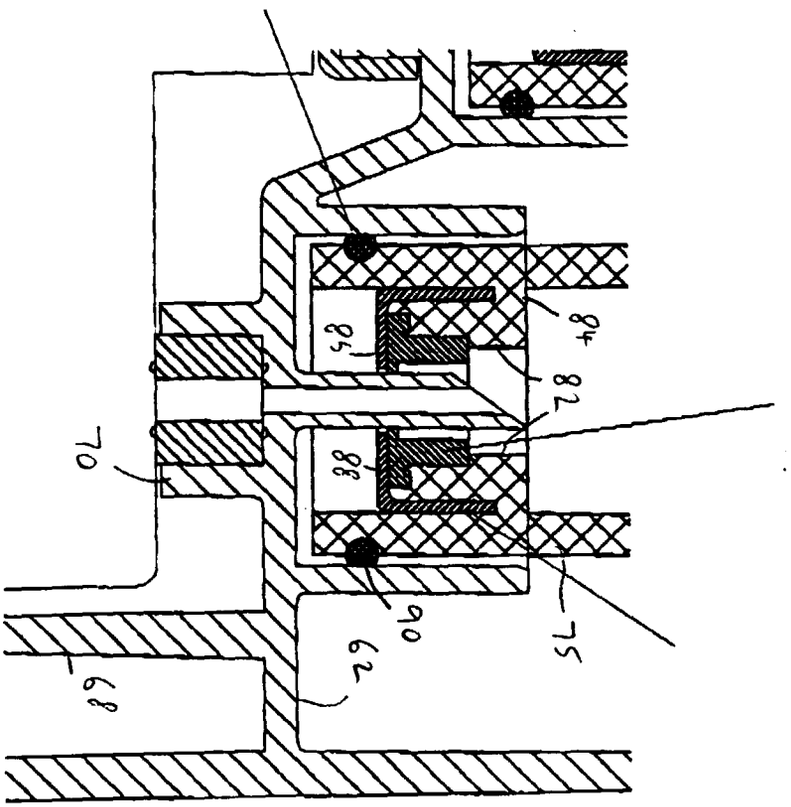
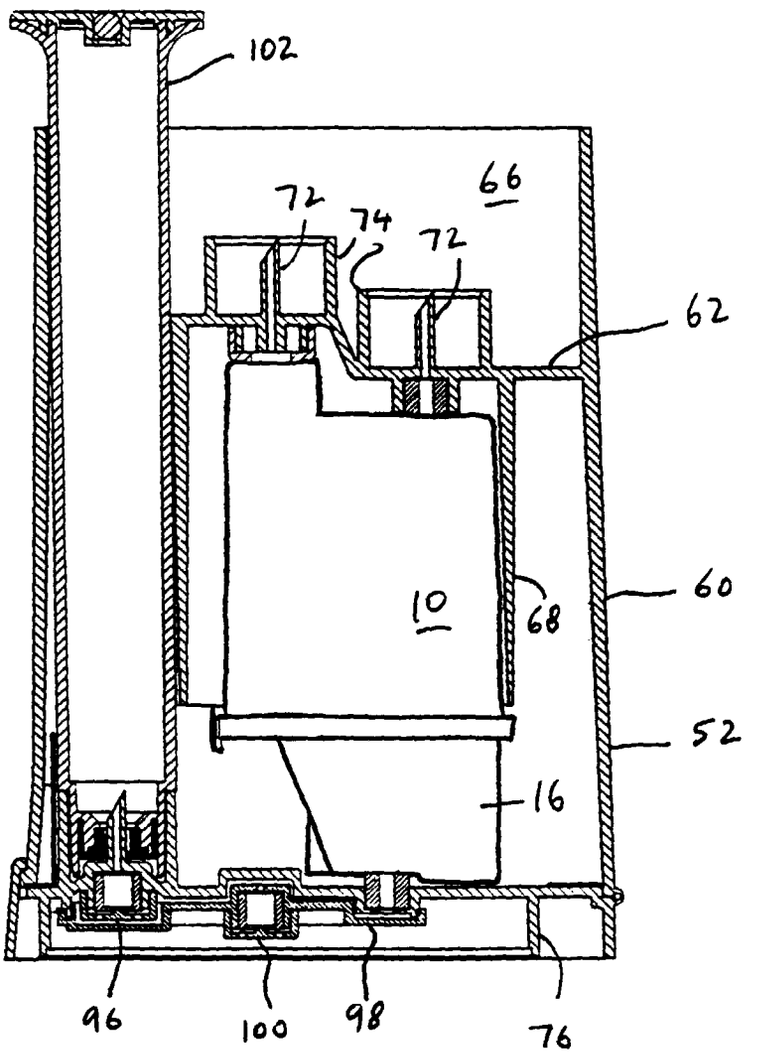


Fig.9



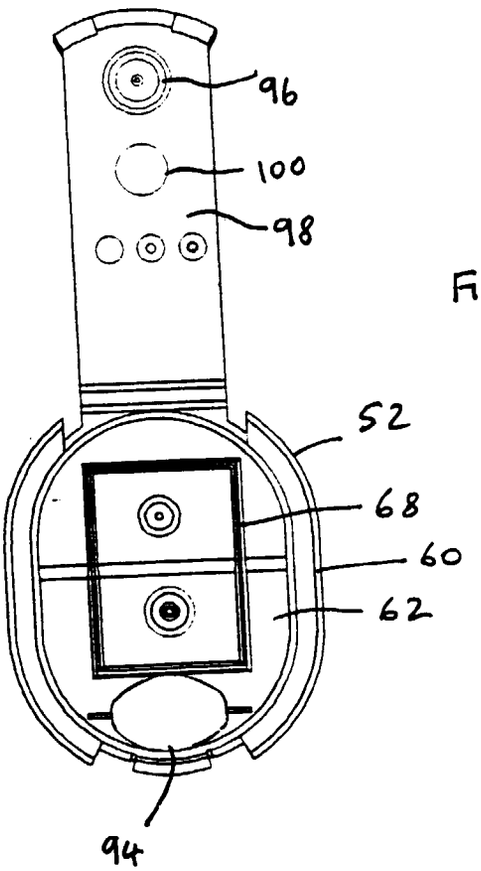


Fig.10

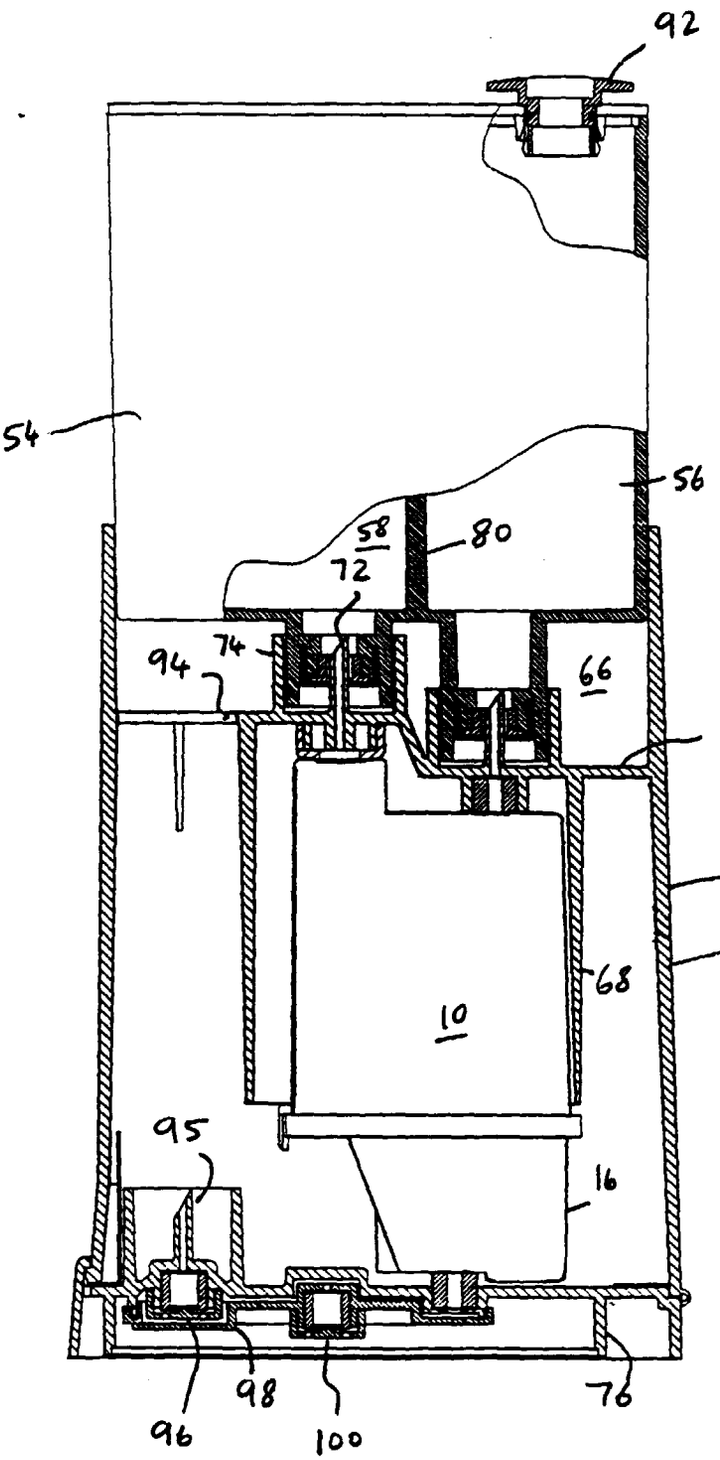


Fig.11

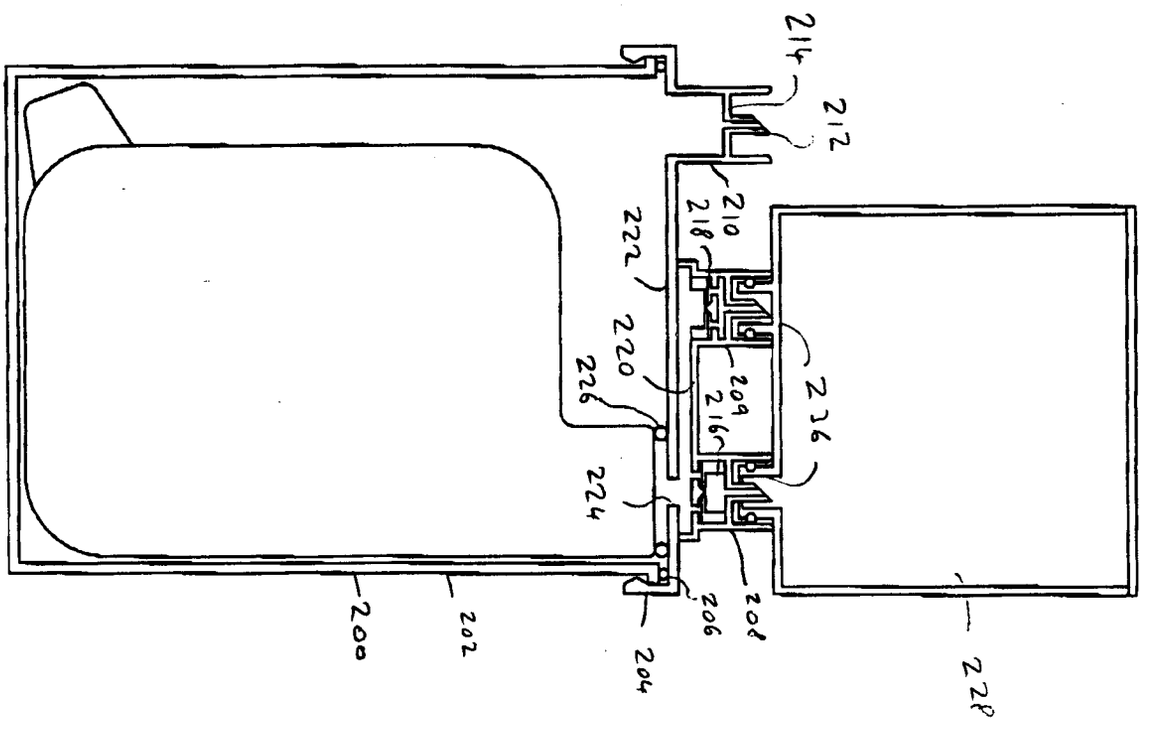

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FIG. 12

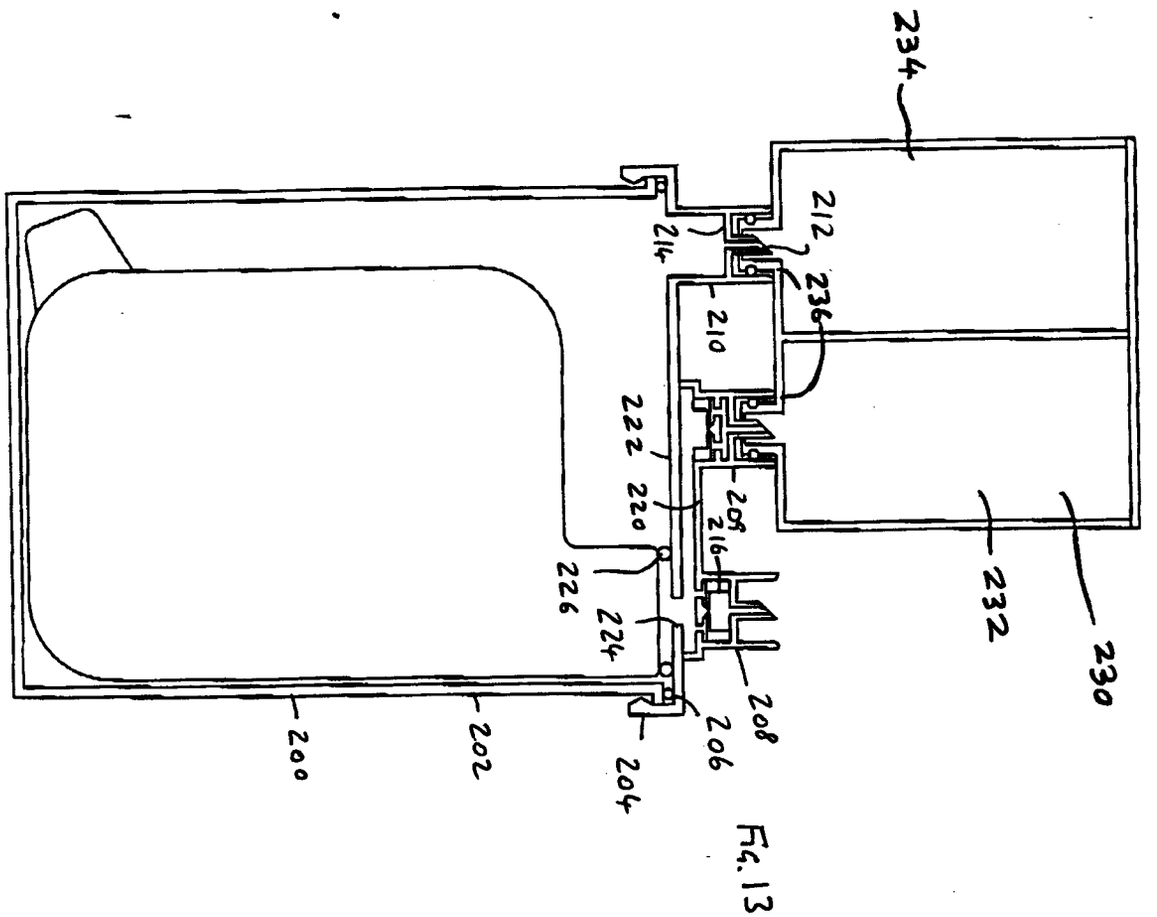
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Fig. 13