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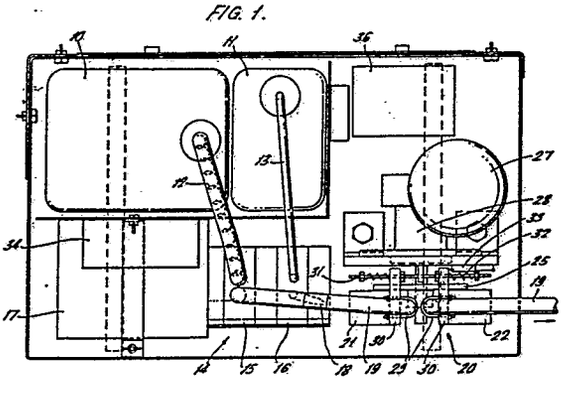
(54) **Dispensing curable substances.**

(57) Apparatus for dispensing curable substances comprises a pump (15) for delivering resin in metered quantities from a reservoir (10), a pump (16) for delivering hardener in metered quantities from a reservoir (11), a junction (18) to combine the flows of resin and hardener, and a device (20) to apply to the delivery tube (19) a peristaltic pumping action, but with only partial occlusion of the delivery tube, so as to deliver thoroughly mixed and ready to use resin filler.

FIG. 1.



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Description

DISPENSING CURABLE SUBSTANCES

This invention relates to a method and apparatus for dispensing a curable substance comprising a base material and a hardener therefor.

The invention is particularly, thought not exclusively, concerned with the repair of reinforced concrete structures. Fine cracks appearing in reinforced concrete structures need to be sealed off to prevent exposure of the reinforcing bars to the elements causing corrosion of the reinforcing bars. This is done by injecting a curable substance, commonly epoxy resin, into the cracks.

Conventionally known techniques involve preparing a mix of resin and hardener and introducing the mix into the cracks either by a gravity feed or by a force feed from a pump. These methods tend to be slow and have a high labour cost. Another technique, which uses a continuous process, involves using pumps to pump the resin and hardener in the appropriate ratio, combining the output from the pumps in a manifold and then feeding the combined resin/hardener through a worm device to induce a thorough mix. The worm device in this technique, however, creates a great deal of back pressure, as it is the pressure loss which provides the energy for mixing the constituents. Also, cleaning is a considerable problem in this method.

According to the present invention there is provided a method of dispensing a curable substance comprising a base material and a hardener therefor, which method comprises the steps of:
providing a flow of base material under pressure at a controllable flow rate from a reservoir thereof, providing a flow of hardener under pressure at a controllable flow rate from a reservoir thereof, combining said flows into a flow of base material/hardener mix through a delivery line, and applying a peristaltic pumping action to the delivery line along a flexible portion thereof at a rate different from the rate of the flow through the delivery line, in which peristaltic pumping action only partial occlusion of the flexible portion of the delivery line is caused.

The invention also provides apparatus for use in dispensing a curable substance comprising a base material and a hardener therefor, which apparatus comprises first means to urge a flow of base material at a controllable flow rate from a reservoir thereof along a first flow path, second means to urge a flow of hardener at a controllable flow rate from a reservoir thereof along a second flow path, means to combine said flows into a flow of base material/hardener mix through a delivery line, and means to apply a peristaltic pumping action to the delivery line along a flexible portion thereof at a rate different from the rate of flow through the delivery line, in which only partial occlusion of the flexible portion of the delivery line occurs.

By way of example, an embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figures 1 and 2 show plan and elevational views of apparatus according to the invention,

Figures 3 shows a form of a nipple and cap, and

Figure 4 shows the nipple with a delivery line connected.

In Figures 1 and 2 there is seen a preferred form of apparatus according to the invention. The apparatus is for use in repairing cracks in reinforced concrete structures, as will be described in more detail. The apparatus is portable to enable its use from an access cradle. The apparatus carries a container 10 for the base material, e.g. epoxy resin, and a container 11 for an appropriate hardener. Conduits 12 and 13, conveniently of plastics tubing, lead from each container to a pumping device 14. The pumping device 14 is conveniently a pair of ganged peristaltic pumps 15 and 16 working side by side, both driven by a common motor 17, which is conveniently an electric motor. This enables accurate regulation of the delivery of measurable quantities of both base material and hardener. However, it will be appreciated that other pumping arrangements may be used instead, for example, using gear pumps.

From the pumps 15 and 16, the conduits 12 and 13 lead to a junction 18, such as a T-piece or a Y-piece, connecting to a delivery line 19, also conveniently of plastics tubing. The delivery line 19 is fed through a device 20 which applies to it a kind of peristaltic pumping action as will be described. The device 20 comprises two arcuate pressure shoes 21 and 22 which are pivotally mounted on pivots 23 and 24. The shoes 21 and 22 extend generally around a rotor 25 on which there are mounted a plurality of ball races 26. The rotor 25 is driven by a motor 27, which is conveniently an electric motor, through a gear box 28. The delivery line 19 is fed into the space between the ball races 26 and the pressure shoes 21 and 22. U-bolts 29 at the free ends 30 of the shoes 21 and 22 hold the delivery line 19 in position. The pressure shoes 21 and 22 are biased pivotally towards each other by spring-loaded adjustors 31 and 32 arranged at the free ends 30 of the shoes 21 and 22. It will be seen that the delivery line 19 is compressed between the pressure shoes 21 and 22 and the ball races 26. The delivery line 19 is contracted by each ball race 26 in turn as the rotor 25 rotates, with an effect like a peristaltic pumping action, ie. the line is subjected to repeated waves of contraction.

The separation of the shoes 21 and 22 is adjusted to that only partial occlusion of the delivery line 19 is caused. The device 20 is run so that the waves of contraction to which it subjects the delivery line 19 are applied at a differential rate relative to the flow of the base material/hanrdener mix through the delivery line. That is, the waves of contraction may be applied along the delivery line 19 in the same direction as flow therethrough and at a faster or slower speed, or alternatively, in the opposite direction. The effect is to cause the base material/hardener mix passing through the delivery line to undergo repeated changes of speed and/or direction, thereby encouraging its thorough mixing.

Preferably, the device 20 is run in the same direction as the direction of flow through the delivery line 19 (ie. anti-clockwise in Figure 2) and at a faster rate. An advantage of doing it this way is that it provides an additional effect of boosting the output pressure. A thorough mixing of the base material and hardener is achieved whilst the output from the delivery line is not of an unduly fluctuating nature.

Preferably, the device 20 is run in the same direction and at least twice as fast as the pumps 15 and 16 delivering the flow to the delivery line 19, and typically the difference may be 40 times.

To sense the output pressure of the flow through the delivery line 19, a micro-switch 33 is mounted adjacent the free end 30 of one of the pressure shoes 22. As pressure in the delivery line 19 builds up, there is some expansion of the flexible tubing and this causes outward pivoting of the pressure shoes 21 and 22. The micro-switch 33 trips upon outward pivotal movement of the pressure shoe 22. The position of the micro-switch 33 relative to the pressure shoe 22 can be adjusted so that the micro-switch trips when pressure in the delivery line 19 reaches a predetermined level. The micro-switch 33 is connected to control circuitry which switches off both motors 17 and 27 when the micro-switch trips.

The apparatus advantageously includes an air heater 34 for keeping the base material in container 10 fluid in low ambient temperatures. In addition, an immersion heater element 35 is provided in the conduit 12 leading from the base material container 10 to the pump 15. There is preferably thermostatic control of the heater element 35, and this may be achieved by using the heater element itself as a thermostat. The immersion heater element 35 has the advantage of enabling ready control of the temperature of the base material drawn from the container 10 regardless of ambient temperature and without the need for pre-heating prior to use of the apparatus. This is of significant practical advantage because the wax point of presently available resins which are used as a base material have their wax point at about 10°C and will therefore normally be too viscous.

The apparatus also advantageously includes a variable time switching device 36 in its control circuitry. This device 36 can be set to operate cyclically to run the motors 17 and 27 from time to time to purge the system and prevent clogging due to curing of the base material and hardener while it remains in the delivery line 19. Cleaning of the delivery line and conduits at the end of a job can be effected by passing suitable solvents therethrough. If the delivery line 19 becomes badly blocked, however, it can simply be replaced.

The apparatus is suitable for use in the treatment of fine cracks in reinforced concrete structures. This involves the injection of a curable substance into the cracks. The technique is to stick a nipple on the face of the structure at either end of the crack and shutter off the face of the crack between the nipples, using for example, plaster. The curable substance is injected through one of the nipples until it begins to ooze out of the other nipple. Injection is ceased and the nipple are capped and left for the substance to set in the crack. For long cracks, a number of injection nipples may be used in line, with each being capped in turn as the crack is treated along its length.

There is seen in Figure 3 a nipple 50 and cap 51 suitable for use with the above described apparatus. The nipple 50 has a flat surface 52 for sticking onto the face of a concrete structure, a spigot 53 for attachment of the delivery line 19 from the apparatus, and a through bore 54. The spigot 53 has an external profile with a tapered portion 55 leading to a shoulder 56. To attach the delivery line 19 to the nipple 50, the end of the line is simply push fitted over the spigot 53, after which a holding ring 57 on the outside of the line is brought up to act as a retaining clamp, as seen in Figure 4. The cap 51 is a simple snap-fit over the spigot 53 of the nipple.

There are several important criteria in the repair of cracks using this technique. One is to obtain consistent gel times for the curable substance. This is an indication of the correct proportions of base material and hardener. Another is to have control over the injection pressure: a maximum permissible pressure of 2 bar is commonly stipulated. Excess pressure may cause further damage to the structure by widening the crack. Cracks of as little as 0.1 mm width may be treated, with an expected penetration of 0.05 mm. A rate of injection of about 20 ml/minute is adequate.

Claims

1. A method of dispensing a curable substance comprising a base material and a hardener therefor, which method comprises the steps of:
providing a flow of base material under pressure at a controllable flow rate from a reservoir thereof, providing a flow of hardener under pressure at a controllable flow rate from a reservoir thereof, combining said flows into a flow of base material/hardener mix through a delivery line, and applying a peristaltic pumping action to the delivery line along a flexible portion thereof at a rate different from the rate of the flow through the delivery line, in which peristaltic pumping action only partial occlusion of the flexible portion of the delivery line is caused.

2. A method as claimed in claim 1 in which the peristaltic pumping action is applied in the same direction as the direction of flow through the delivery line and at at least twice the rate.

3. A method as claimed in claim 1 or claim 2 and including the step of providing heating for the flow of base material.

4. A method as claimed in claim 3 and including the step of providing thermostatic control for regulating the temperature of the flow of base material.

5. A method as claimed in any preceding claim and further including the step of providing a sensor for sensing the pressure of the flow in

the delivery line and operable to stop the flow from the delivery line upon sensing a predetermined pressure.

6. Apparatus for use in dispensing a curable substance comprising a base material and a hardener therefor, which apparatus comprises first means to urge a flow of base material at a controllable flow rate from a reservoir thereof along a first flow path, second means to urge a flow of hardener at a controllable flow rate from a reservoir thereof along a second flow path, means to combine said flows into a flow of base material/hardener mix through a delivery line, and means to apply a peristaltic pumping action to the delivery line along a flexible portion thereof at a rate different from the rate of flow through the delivery line, in which only partial occlusion of the flexible portion of the delivery line occurs.

7. Apparatus as claimed in claim 6 and including means for heating the flow of base material in the first flow path.

8. Apparatus as claimed in claim 7 and including thermostatic control means to regulate the temperature of the flow of base material in the first flow path.

9. Apparatus as claimed in claim 7 or claim 8 wherein said heating means comprises an immersion heater element extending in the first flow path.

10. Apparatus as claimed in claim 9 wherein the immersion heater element is used to provide thermostatic control of the temperature of said flow in the first flow path.

11. Apparatus as claimed in any one of claims 6 to 10 and including pressure sensor means to sense the pressure of the flow in the delivery line and operable to stop said flow from the delivery line upon sensing a predetermined presuure.

12. Apparatus as claimed in any one of claims 6 to 11 and including adjustable time control means operable to provide intermittent operation of the apparatus to act to purge the delivery line and prevent clogging.

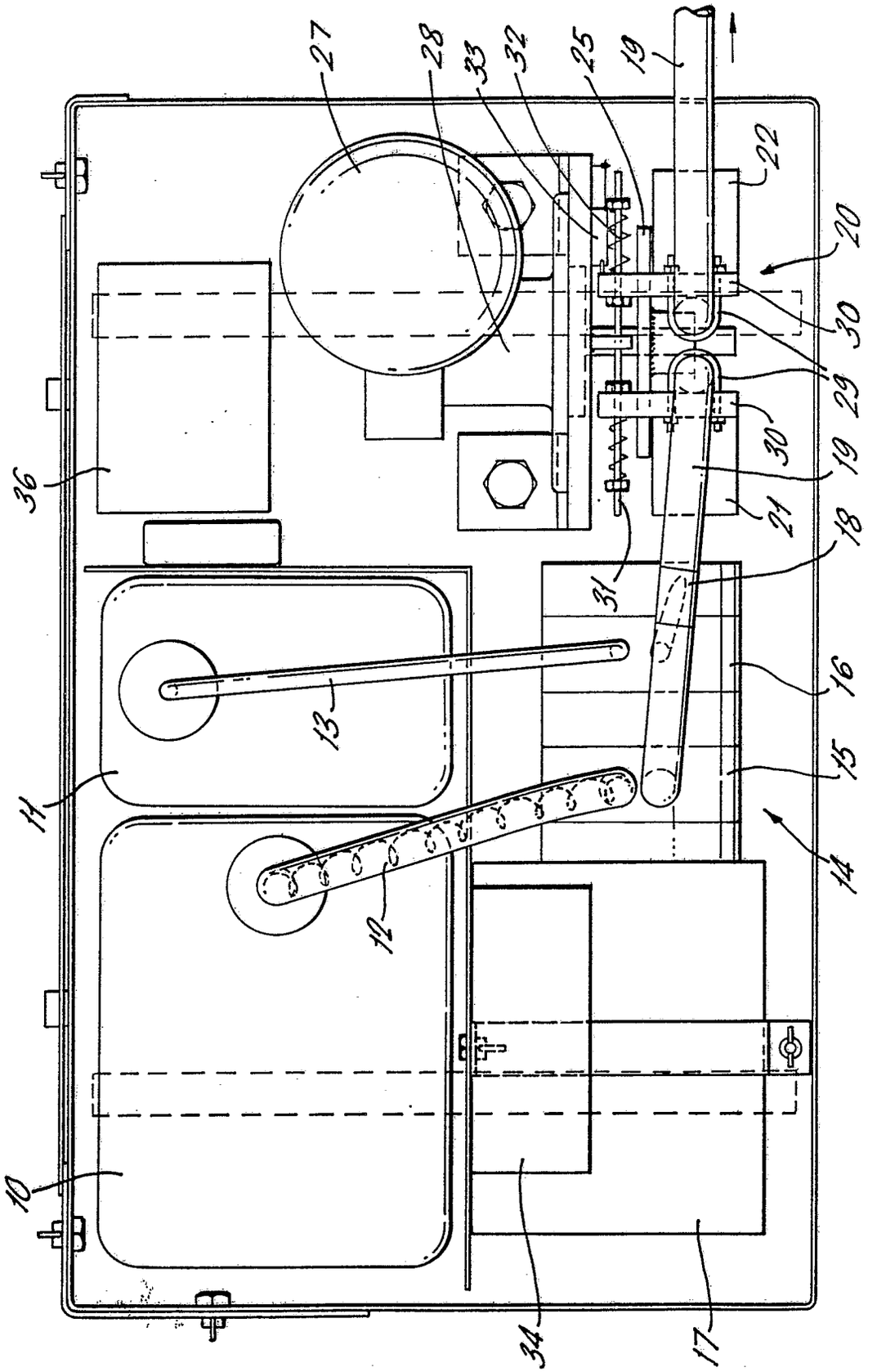
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FIG. 1.

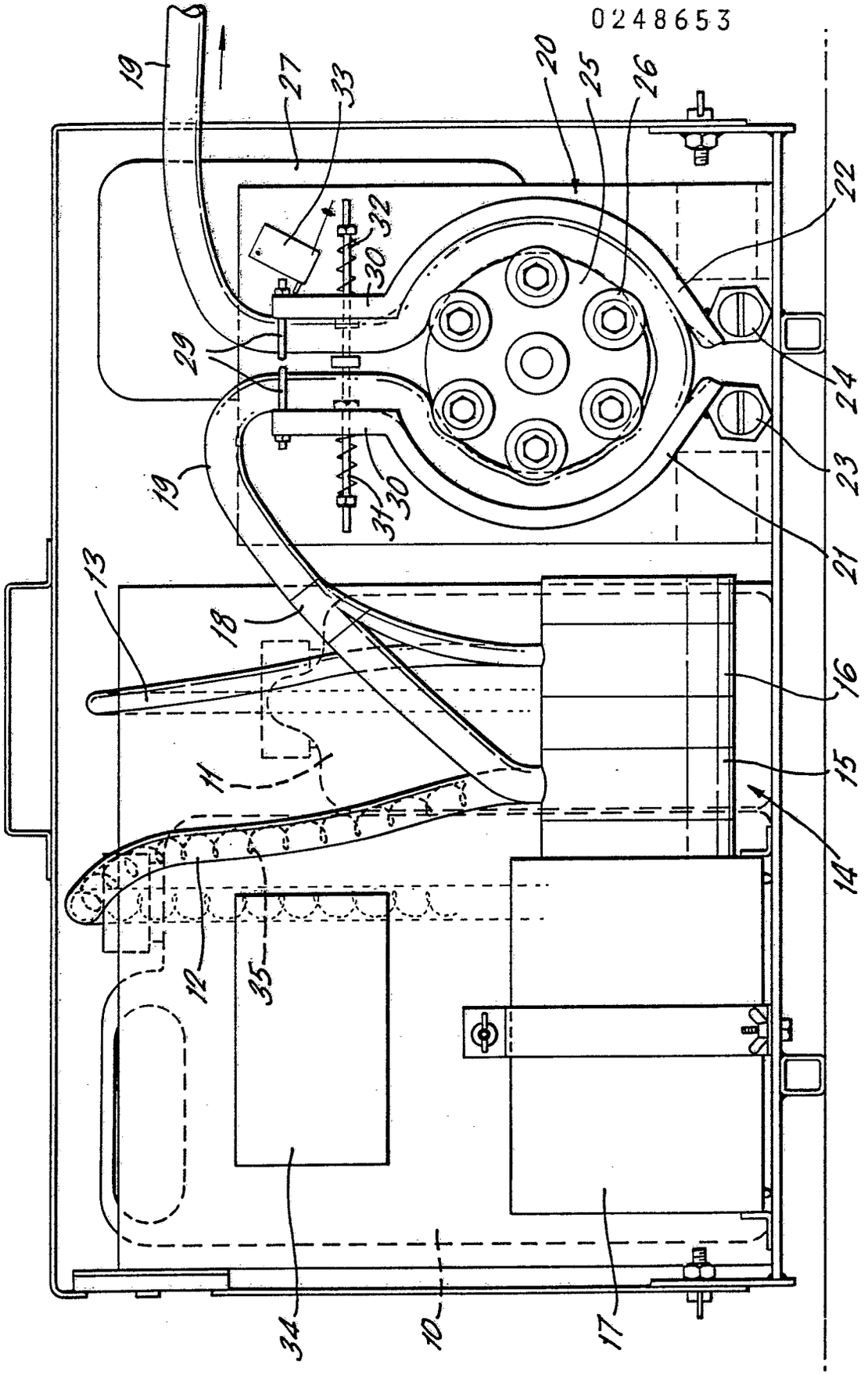
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FIG. 2.

FIG. 3.

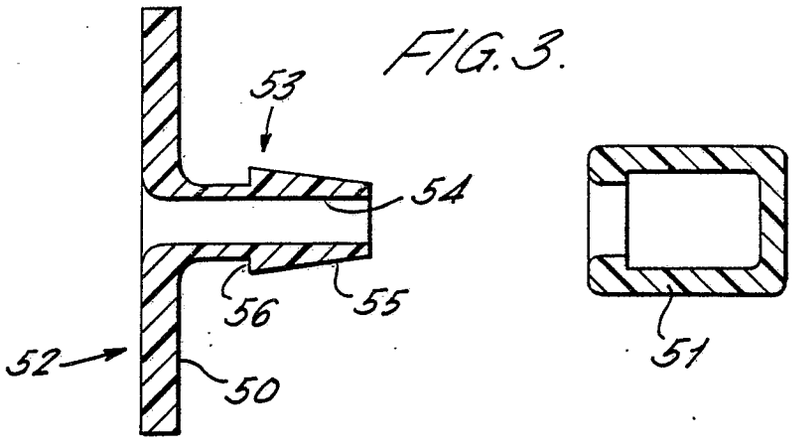

FIG. 4.