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Description

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, though 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.

DE-A-2025011 describes a method of providing peristaltic pumping action to a flexible tube. A number of coils of the tube are wound about a cylinder. The pumping action is supplied by rotating rollers, which partially occlude the delivery line and which rotate about their own axis and about the axis of the coils.

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 under pressure at a controllable flow rate a flow of base material from a reservoir of base material and a flow of hardener from a reservoir of hardener, combining said flows into a combined flow of base material/hardener mix through a delivery line, and applying a pumping action to the combined flow, characterised in that the base material is heated by a heating element within the delivery line, in that a peristaltic pumping action is applied along a flexible portion of the delivery line by means of a pair of arcuate pivotal pressure shoes compressing the delivery line against a plurality of ball races mounted on a rotor, which cause only partial occlusion of the flexible portion, such that waves of contraction are applied along the delivery line at a rate different from the rate of the combined flow and hardener through the delivery line, which pressure shoes are caused to pivot away from the delivery line as the flexible portion

expands, which movement is used to operate a switch which causes the flow of base material and hardener to cease when a predetermined level of pressure in the delivery line is reached and further characterised in that the flexible portion of the delivery line substantially forms a single loop which is easily removable if the combined hardener and base material solidify therein.

The invention also provides apparatus for use in dispensing a curable substance comprising a base material and a hardener therefore, which apparatus comprises a first pumping device to urge under pressure a flow of base material at a controllable flow rate from a reservoir thereof along a first flow path, a second pumping device to urge under pressure 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 combined flow of base material/hardener mix through a delivery line, and a third pumping device to apply a pumping action to the combined flow, characterised in that the base material is heated by a heating element within the delivery line and in that the third pumping device applies a peristaltic pumping action along a flexible portion of the delivery line by means of a pair of pivotal arcuate pressure shoes compressing the delivery line against a plurality of ball races mounted on a rotor, which cause only partial occlusion of the flexible portion, and which third pumping device is driven by driving means at a speed to cause waves of contraction along the delivery line at a rate different from the rate of the combined flow through the delivery line, which pressure shoes are pivotal away from the delivery line as the flexible portion expands, which movement operates a switch which causes the flow of base material and hardener to cease when a predetermined level of pressure in the delivery line is reached, and further characterised in that the flexible portion of the delivery line forms substantially a single loop which is easily removable if the combined hardener and base material solidifies therein.

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,

Figure 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 adjusters 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 so 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/hardener 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 (i.e. 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 nipples 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 penetration expected to gaps 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 under pressure at a controllable flow rate a flow of base material from a reservoir (10) of base material and a flow of hardener from a reservoir (11) of hardener, combining said flows into a combined flow of base material/hardener mix through a delivery line (19), and applying a pumping action to the combined flow, characterised in that the base material is heated by a heating element within the delivery line, in that a peristaltic pumping action is applied along a flexible portion of the delivery line by means of a pair of arcuate pivotal pressure shoes compressing the delivery line against a plurality of ball races (26) mounted on a rotor (25), which cause only partial occlusion of the flexible portion, such that waves of contraction are applied along the delivery line at a rate different from the rate of

the combined flow and hardener through the delivery line, which pressure shoes are caused to pivot away from the delivery line as the flexible portion expands, which movement is used to operate a switch (33) which causes the flow of base material and hardener to cease when a predetermined level of pressure in the delivery line is reached and further characterised in that the flexible portion of the delivery line substantially forms a single loop which is easily removable if the combined hardener and base material solidify therein.

2. A method as claimed in claim 1 in which the peristaltic pumping action is applied such that the waves of contraction are applied in the same direction as the direction of flow of base material and hardener through the delivery line (19) and at at least twice the rate of the flow of the base material and hardener through the delivery line.
3. A method as claimed in claim 1 or claim 2 and including the step of providing thermostatic control for regulating the temperature of the flow of base material.
4. Apparatus for use in dispensing a curable substance comprising a base material and a hardener therefore, which apparatus comprises a first pumping device (15) to urge under pressure a flow of base material at a controllable flow rate from a reservoir (10) thereof along a first flow path (12), a second pumping device (16) to urge under pressure a flow of hardener at a controllable flow rate from a reservoir (11) thereof along a second flow path (13), means (18) to combine said flows into a combined flow of base material/hardener mix through a delivery line (19), and a third pumping device (20) to apply a pumping action to the combined flow, characterised in that the base material is heated by a heating element within the delivery line and in that the third pumping device applies a peristaltic pumping action along a flexible portion of the delivery line by means of a pair of pivotal arcuate pressure shoes compressing the delivery line against a plurality of ball races (26) mounted on a rotor (25), which cause only partial occlusion of the flexible portion, and which third pumping device is driven by driving means (27,28) at a speed to cause waves of contraction along the delivery line at a rate different from the rate of the combined flow through the delivery line, which pressure shoes are pivotal away from the delivery line as the flexible portion expands, which movement op-

erates a switch (33) which causes the flow of base material and hardener to cease when a predetermined level of pressure in the delivery line is reached, and further characterised in that the flexible portion of the delivery line forms substantially a single loop which is easily removable if the combined hardener and base material solidifies therein.

5. Apparatus as claimed in claim 4 including thermostatic control to regulate the temperature of the flow of base material in the first flow path (12).
6. Apparatus as claimed in claim 5 wherein the thermostatic control of the temperature of said flow in the first flow path (12) comprises an immersion heater element (35).
7. Apparatus as claimed in any one of claims 4 to 6 and including adjustable time control (36) operable to provide intermittent operation of the apparatus to act to purge the delivery line (19) and prevent clogging.

Patentansprüche

1. Verfahren zum Abgeben einer aushärtbaren, ein Basismaterial und einen Aushärter umfassenden Substanz, welches Verfahren folgende Schritte umfaßt:
Erzeugen eines Basismaterialstroms aus einem Basismaterialreservoir (10) und eines Aushärterstroms aus einem Aushärterreservoir (11) und zwar jeweils unter Druck und mit steuerbarer Geschwindigkeit,
Kombinieren der Ströme zu einem kombinierten Strom von Basismaterial/Aushärter-Gemisch durch eine Ausgabeleitung (19) und Ausüben einer Pumpwirkung auf den kombinierten Strom,
dadurch gekennzeichnet, daß
das Basismaterial in der Ausgabeleitung durch ein Heizelement beheizt wird, daß
entlang eines flexiblen Abschnitts der Ausgabeleitung eine peristaltische Pumpwirkung ausgeübt wird mittels eines Paares von gekrümmten, schwenkbaren, die Ausgabeleitung gegen eine Mehrzahl von auf einem Rotor (25) angeordneten Laufringen drückenden Druckschuhen, welche nur partielle Einschnürung des flexiblen Abschnitts bewirken, so daß
entlang der Ausgabeleitung Kontraktionswellen erzeugt werden, mit einer Geschwindigkeit, die sich von der Geschwindigkeit des kombinierten Stroms von Basismaterial und Aushärter durch die Ausgabeleitung unterscheidet, und wobei die Druckschuhe zum Wegschwenken von der

Ausgabeleitung gebracht werden, wenn sich der flexible Abschnitt ausdehnt, wobei die Bewegung dazu benutzt wird, einen Schalter (33) zu betätigen, der den Strom des Basismaterials und des Aushärters zum Aufhören bringt, wenn in der Ausgabeleitung ein vorbestimmtes Druckniveau erreicht ist, und ferner **dadurch gekennzeichnet**, daß der flexible Abschnitt der Ausgabeleitung im wesentlichen eine Einzelschleife bildet, welche leicht zu entfernen ist, wenn das Aushärter-Basismaterial-Gemisch darin fest wird.

2. Verfahren nach Anspruch 1, bei welchem die peristaltische Pumpwirkung derart angelegt wird, daß die Kontraktionswellen in Richtung des kombinierten Stroms des Basismaterials und des Aushärters durch die Ausgabeleitung und mit wenigstens der doppelten Geschwindigkeit des Stroms des Basismaterials und des Aushärters durch die Ausgabeleitung angelegt werden.
3. Verfahren nach Anspruch 1 oder 2, welches weiterhin den Schritt des Bereitstellens einer thermostatischen Steuerung zur Regelung der Temperatur des Stroms des Basismaterials umfaßt.
4. Vorrichtung zur Benutzung beim Abgeben einer aushärtbaren, ein Basismaterial und einen Aushärter umfassenden Substanz, wobei die Vorrichtung umfaßt:
eine erste Pumpeinrichtung (15), um unter Druck einen Strom von Basismaterial mit steuerbarer Geschwindigkeit aus einem Basismaterialreservoir (10) entlang eines ersten Strömungswegs (12) zu bewirken,
eine zweite Pumpeinrichtung (16), um unter Druck einen Strom von Aushärter mit steuerbarer Geschwindigkeit aus einem Aushärterreservoir (11) entlang eines zweiten Strömungswegs (13) zu bewirken,
Mittel (18) zum Kombinieren der Ströme zu einem kombinierten Strom von Basismaterial/Aushärter-Gemisch durch eine Ausgabeleitung (19) und
eine dritte Pumpeinrichtung (20) zum Ausüben einer Pumpwirkung auf den kombinierten Strom,
dadurch gekennzeichnet, daß
das Basismaterial in der Ausgabeleitung durch ein Heizelement beheizt wird und daß
die dritte Pumpeinrichtung entlang eines flexiblen Abschnitts der Ausgabeleitung eine peristaltische Pumpwirkung ausübt mittels eines Paares von gekrümmten, schwenkbaren, die Ausgabeleitung gegen eine Mehrzahl von auf

einem Rotor (25) angeordneten Laufringen drückenden Druckschuhen, welche nur partielle Einschnürung des flexiblen Abschnitts bewirken, wobei die dritte Pumpeinrichtung von Antriebsmitteln (27,28) mit einer solchen Antriebsgeschwindigkeit angetrieben wird, daß entlang der Ausgabeleitung Kontraktionswellen erzeugt werden, mit einer Geschwindigkeit, die sich von der Geschwindigkeit des kombinierten Stroms durch die Ausgabeleitung unterscheidet, und wobei die Druckschuhe von der Ausgabeleitung wegschwenkbar sind, wenn sich der flexible Abschnitt ausdehnt, und wobei durch diese Bewegung ein Schalter (33) betätigt wird, der den Strom des Basismaterials und des Aushärter zum Aufhören bringt, wenn in der Ausgabeleitung ein vorbestimmtes Druckniveau erreicht ist, und ferner **dadurch gekennzeichnet**, daß der flexible Abschnitt der Ausgabeleitung im wesentlichen eine Einzelschleife bildet, welche leicht zu entfernen ist, wenn das Aushärter-Basismaterial-Gemisch darin fest wird.

5. Vorrichtung nach Anspruch 4, welche eine thermostatische Steuerung zur Regelung der Temperatur des Stroms des Basismaterials im ersten Strömungsweg (12) umfaßt.
6. Vorrichtung nach Anspruch 5, bei welcher die thermostatische Steuerung der Temperatur des Stroms im ersten Strömungsweg (12) ein Im-mersionsheizelement (35) umfaßt.
7. Vorrichtung nach einem der Ansprüche 4 bis 6, welche eine einstellbare Zeitsteuerung (36) umfaßt, die in einer Weise betreibbar ist, um einen intermittierenden Betrieb der Vorrichtung vorzusehen, um die Ausgabeleitung (19) zu reinigen und Verstopfen zu verhindern.

Revendications

1. Procédé de distribution d'une substance durcissable comprenant une matière de base et un durcisseur pour celle-ci, lequel procédé comprend les étapes qui consistent à établir sous pression, à un débit d'écoulement réglable, un écoulement de matière de base depuis un réservoir (10) de matière de base et un écoulement de durcisseur depuis un réservoir (11) de durcisseur, à combiner lesdits écoulements en un écoulement combiné de mélange matière de base/durcisseur dans une conduite (19) d'amenée, et à appliquer une action de pompage à l'écoulement combiné, caractérisé en ce que la matière de base est

chauffée par un élément chauffant dans la conduite d'amenée, en ce qu'une action de pompage péristaltique est appliquée le long d'un tronçon flexible de la conduite d'amenée au moyen de deux patins de pression incurvés pivotants, comprimant la conduite d'amenée contre plusieurs bagues (26) à billes montées sur un rotor (25), ce qui provoque une obturation seulement partielle du tronçon flexible, de manière que des ondes de contraction soient appliquées le long de la conduite d'amenée à un débit différent du débit de l'écoulement combiné et du durcisseur dans la conduite d'amenée, lesquels patins de pression sont amenés à s'éloigner en pivotant de la conduite d'amenée lorsque le tronçon flexible s'expand, lequel mouvement est utilisé pour actionner un interrupteur (33) qui fait cesser l'écoulement de matière de base et de durcisseur lorsqu'un niveau prédéterminé de pression dans la conduite d'amenée est atteint, et en outre caractérisé en ce que le tronçon flexible de la conduite d'amenée forme sensiblement une boucle unique qui peut être aisément enlevée si le durcisseur et la matière de base combinés s'y solidifient.

2. Procédé selon la revendication 1, dans lequel l'action de pompage péristaltique est appliquée de manière que les ondes de contraction soient appliquées dans le même sens que le sens d'écoulement de la matière de base et du durcisseur dans la conduite d'amenée (19) et à au moins le double du débit de l'écoulement de la matière de base et du durcisseur dans la conduite d'amenée.
3. Procédé selon la revendication 1 ou la revendication 2, et comprenant l'étape qui consiste à utiliser une commande thermostatique pour réguler la température de l'écoulement de la matière de base.
4. Appareil à utiliser dans la distribution d'une substance durcissable comprenant une matière de base et un durcisseur pour celle-ci, lequel appareil comporte un premier dispositif de pompage (15) destiné à faire circuler sous pression un écoulement de matière de base à un débit d'écoulement réglable depuis un réservoir (10) de cette matière le long d'un premier trajet (12) d'écoulement, un deuxième dispositif de pompage (16) destiné à faire circuler sous pression un écoulement de durcisseur à un débit d'écoulement réglable depuis un réservoir (11) de ce durcisseur suivant un deuxième trajet d'écoulement (13), des moyens (18) destinés à combiner lesdits

écoulements en un écoulement combiné de mélange matière de base/durcisseur dans une conduite (19) d'amenée, et un troisième dispositif de pompage (20) destiné à appliquer une action de pompage à l'écoulement combiné, caractérisé en ce que la matière de base est chauffée par un élément chauffant dans la conduite d'amenée et en ce que le troisième dispositif de pompage applique une action de pompage péristaltique le long d'un tronçon flexible de la conduite d'amenée au moyen de deux patins de pression incurvés pivotants, comprimant la conduite d'amenée contre plusieurs bagues (26) à billes montées sur un rotor (25), ce qui provoque une obturation seulement partielle du tronçon flexible, et le quel troisième dispositif de pompage est entraîné par des moyens d'entraînement (27, 28) à une vitesse provoquant des ondes de contraction le long de la conduite d'amenée à un débit différent de l'écoulement combiné dans la conduite d'amenée, lesquels patins de pression s'éloignent en pivotant de la conduite d'amenée lorsque le tronçon flexible s'expand, lequel mouvement agit sur un interrupteur (33) qui fait cesser l'écoulement de matière de base et de durcisseur lorsqu'un niveau prédéterminé de pression dans la conduite d'amenée est atteint, et caractérisé en outre en ce que le tronçon flexible de la conduite d'amenée forme sensiblement une boucle unique qui peut être aisément enlevée si le durcisseur et la matière de base combinés s'y solidifient.

5. Appareil selon la revendication 4, comprenant une commande thermoplastique pour réguler la température de l'écoulement de la matière de base dans le premier trajet (12) d'écoulement.
6. Appareil selon la revendication 5, dans lequel la commande thermostatique de la température dudit écoulement dans le premier trajet (12) d'écoulement comprend un élément chauffant (35) à immersion.
7. Appareil selon l'une quelconque des revendications 4 à 6 et comprenant une commande de temps réglable (36) pouvant être mise en oeuvre pour établir un fonctionnement intermittent de l'appareil afin d'agir de façon à purger la conduite (19) d'amenée et empêcher l'engorgement.

FIG. 1.

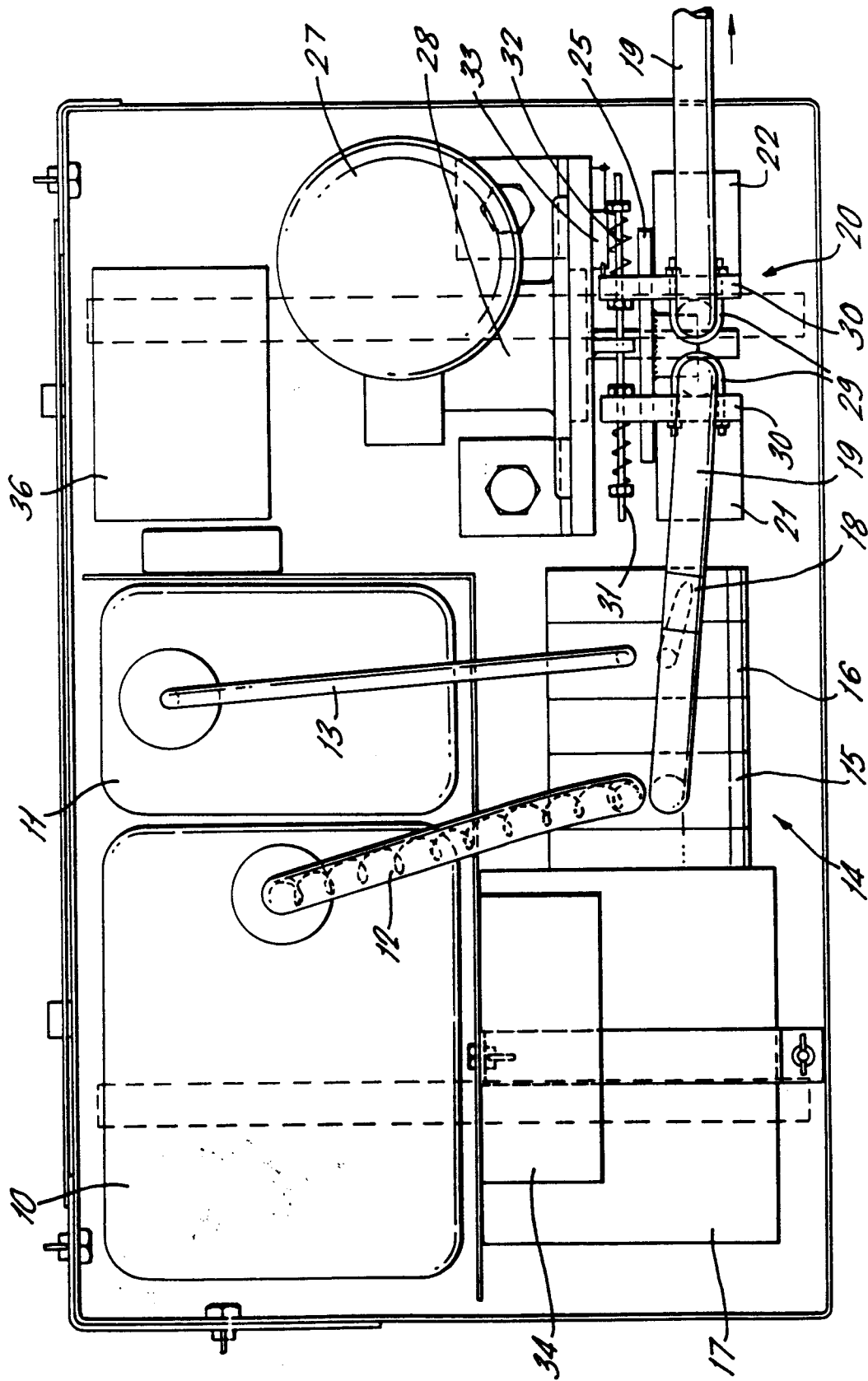


FIG. 2.

