

METHOD AND APPARATUS FOR INJECTING CHOCKING MATERIALS

FIELD OF INVENTION

5 The present invention relates to a method and apparatus for transferring a settable fluent material into a cavity, and particularly although not solely to a method and apparatus for injecting a chocking material or the like into a cavity around a housing tube for supporting a bearing within the tube.

10 BACKGROUND

 It is known to use shims or chocks to support machinery in a desired position and/or alignment with respect to a supporting surface.

15 It is also known to use a settable fluent chocking material that is introduced, while fluent, between the machinery and a support structure, and allowed to set to maintain the machinery in a pre-arranged position and/or alignment. Adjustment devices, such as screwed supports, may be used to initially bring the machinery into the desired position and/or alignment. The screwed supports hold the machinery
20 stable while the fluent chocking material is being introduced and while it is setting. The chocking material, once it has cured or set, provides a strong and stable connection between the machinery and its supporting structure. Suitable settable chocking materials include grouts, slurries and other cementitious materials, and epoxies and other resins.

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 One application using the settable fluent chocking material is for securing stern tube bearings in a ship's structure to maintain the bearing at a desired position and alignment. A settable fluent chocking material is typically introduced into respective annular cavities around the bearings at each end of the stern tube. A
30 conventional way of introducing the chocking material into the cavities is by manually pouring the chocking material progressively into each tube cavity.

Chocking materials are available in container, e.g. cans. The number of containers of chocking material required for a particular application depends on the volume of the cavity to be filled. At times, several containers of chocking material may be required. To ensure that there is an even distribution of the chocking material within the cavity, the feeding of the chocking material is carried out at a slow and steady rate. However, the rate at which the chocking material is fed cannot be too slow when the curing or setting time of the chocking material is relatively short. The setting or curing time depends, at least in part, on the type of the chocking material that is being employed. The temperature of the chocking material may also influence the setting or curing time.

The chocking material may be prevented from setting or curing before the cavity is fully filled with chocking material by feeding the chocking material into the cavity in a sufficiently short time. However, if the chocking material is not fed into the cavity in a proper manner, for example is not steadily fed into the cavity, the chocking material may be unevenly distributed within the cavity and/or may contain voids. If the cured chocking material has voids or cavities, it tends to be more brittle which can lead to cracking and breakdown of the chocking material. If the feeding of the chocking material into the cavity is not completed in a sufficiently short period, i.e. before the material fed first begins to set or cure, then the chocking material fed later may not bond as well as, or may not bond with, the chocking material fed earlier. This is likely when the chocking material is fed into the cavity in batches, e.g. from several containers. In this case, it is possible that the first batch of chocking material that is fed into the cavity may cure before the feeding of a later batch is completed. If the feeding of the later batch is not carried out within the curing period of the first batch, the later batch of chocking material may not bond well with the first batch if the first batch is substantially cured before the second batch comes into contact with it. This results in weak bonding between batches of chocking material within the cavity.

Hence, it is accordingly an object of the present invention to provide a method and apparatus for injecting fluent material which addresses the abovementioned disadvantages or which will at least provide the public with a useful choice.

5 **BRIEF DESCRIPTION OF THE INVENTION**

In a first aspect the present invention may be broadly said to be a method for transferring a settable fluent material into a cavity, the cavity having a cavity filling port and a cavity vent port, the vent port being located above the filling port, and the
10 method comprising the steps of:

(a) connecting an outlet port of a reservoir to an inlet port of a pump,

(b) connecting an outlet port of the pump to the cavity filling port,
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(c) at least partially filling the reservoir with the fluent material,

(d) operating the pump to transfer the fluent material from the reservoir to the cavity, and
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(e) allowing the fluent material in the cavity to set to a solid.

The fluent material is preferably a resin material, for example an epoxy resin, or a cementitious material.
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In step (e) the fluent material preferably sets to a rigid solid.

The cavity may be a substantially annular space between a shaft bearing and a tube housing the bearing.
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The fluent material may be made from a plurality of component materials which are mixed together in the reservoir prior to operating the pump in step (d).

The reservoir is preferably higher than the pump and the fluent material is transferred from the reservoir to the pump by gravitational force.

5 The fluent material is preferably transferred from the pump to the cavity by application of a pressurised gas to the pump.

In a second aspect the present invention may be broadly said to be an apparatus for transferring a settable fluent material into a cavity, the cavity having a cavity filling port and a cavity vent port, the vent port being higher than the filling port, and the apparatus comprising:

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a reservoir for containing the material to be transferred into the cavity; and

a pump having a pump chamber, the pump chamber being connected to the reservoir, and the reservoir being higher than the pump chamber,

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wherein the pump is operable to alternately de-pressurise and pressurise the pump chamber allowing the material to move from the reservoir to the pump chamber when the pump chamber is de-pressurised and moving the material from the pump chamber to the pump outlet port when the pump chamber is pressurised, so that the apparatus transfers the material in the reservoir to the cavity when the pump chamber is successively pressurised and de-pressurised and the pump outlet port is connected to the cavity filling port.

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25 Preferably, the apparatus further comprises:

a first valve which is openable to permit movement of the material from the reservoir to the pump chamber and is closeable to block movement of the material in the opposite direction from the pump chamber to the reservoir;

a second valve which is openable to permit movement of the material from the pump chamber to the pump outlet port and is closeable to allow the pump chamber to fill with the material moving from the reservoir to the pump chamber; and

5 a pump driver for alternately increasing and decreasing the volume of the pump chamber, the increasing volume accommodating the material moving from the reservoir to the pump chamber, and the material in the pump chamber being transferred from the pump chamber to the cavity, via the pump outlet port and cavity filling port, when the volume of the pump chamber decreases.

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More preferably, the pump chamber is a cylinder in which a piston reciprocates to increase and decrease the volume of the pump chamber;

an application of pressurised gas to the piston drives the piston in one
15 direction to decrease the volume of the pump chamber; and

a vent valve is opened to relieve the application of the pressurised gas to the piston to allow movement of the material from the reservoir to the pump chamber to increase the volume of the pump chamber.

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This invention may also be said broadly to consist in the parts, elements and features referred to or indicated in the specification of the application, individually or collectively, and any or all combinations of any two or more of said parts, elements or features, and where specific integers are mentioned herein which have known
25 equivalents in the art to which this invention relates, such known equivalents are deemed to be incorporated herein as if individually set forth.

BRIEF DESCRIPTION OF THE DRAWINGS

30 A preferred form of the present invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a schematic view of an apparatus for injecting a chocking material;

Figure 2 is a schematic view showing aspects of the injection process;

5 Figure 3 is an elevation view of a stern tube.

DETAILED DESCRIPTION OF THE INVENTION

10 With reference to Figure 2, there is shown a schematic view of a system used for injecting a fluent chocking material into a cavity inside a tube 3 such as a stern tube. The system comprises a pump or compression drum 2 and a reservoir or mixing drum 4. A pipe 6 is provided to connect an inlet port of the compression drum 2 to an outlet port of the mixing drum 4. In the preferred embodiment, the mixing drum 4 is
15 situated at a level higher than that of the compression drum 2.

Referring to Figure 1, the pump or compression drum 2 comprises a piston assembly 8, a cover 10 and a cylinder 12. The cover 10 is tightly secured to an open end of the cylinder 12 by bolts 20 so that an air-tight enclosure is formed within the
20 cylinder 12. Other suitable securing means may also be adopted.

The piston assembly 8 comprises a plunging rod 14 having a piston 18 at one end and a flange 16 at an opposite end. The flange 16 slides along at least two guide rods 22. The other end of each guide rod 22 is secured to the cover 10. The rods 22
25 serve as supports and guides for the piston assembly 8 and when the piston assembly 8 is actuated, the flange 16 slides down. The two guide rods 22 are substantially parallel to one another. Nuts 21 secured to the distal ends of the guide rods 22 limit the upward travel of the piston assembly 8 within the cylinder 12 of the compression drum 2. The space within the cylinder 12 below the piston 18 defines a pump
30 chamber having a volume which varies as the piston reciprocates in the cylinder 12.

In a preferred embodiment, the piston 18 has substantially the same diameter as the inner diameter of the cylinder 12 to provide a seal between the cylinder and the piston 18 as the piston slides within the cylinder 12. In operation, the piston 18 slides within the cylinder 12 to pressurise and pump the fluent chocking material. The
5 plunging rod 14 is preferably centrally situated on the piston 18. In the preferred embodiment, a seal (not shown) seals between the piston 18 and the inner surface of the cylinder 12. This seal can be made of rubber or other suitable material, and may be one or more sealing rings.

10 The cylinder 12 is provided with at least one stopper 26 which is positioned at one end of the cylinder 12 opposite to the piston assembly 8. The stopper 26 stops the piston 18 from moving downward beyond a point of contact between the piston 18 and the stopper 26. The stopper 26 is preferably a rim surrounding the inner
15 circumference of the cylinder 12. In an alternate form, the stopper 26 is provided by two or more moulded protrusions at the inner surface of the cylinder 12. When two such protrusions are used, they are preferably positioned directly opposite one another and at the same height from base of the cylinder 12 such that when the piston 18 is in contact with the protrusions, the piston 18 is positioned substantially parallel to the base of the cylinder 12.

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The pump or compression drum 2 includes a pump air inlet 28 and a pump vent or air outlet 30. The air inlet 28 and the air outlet 30 preferably are pipes that extend from the cover 10. However, it is envisaged that other suitable positions can also be adopted.

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A pressurised gas, preferably from a source of compressed air 31, is introduced into the cylinder 12 via the air inlet 28. The force from the compressed air acts upon a major upper surface of the piston 18 and pushes the piston 18, and therefore the piston assembly 8, downward towards the stoppers 26 for pressurising
30 fluent chocking material contained in the cylinder below the piston.

In the pipe of the air outlet 30, there is provided an air release valve 32 for controlling the venting or release of air from within the cylinder 12 above the piston 18 when the piston assembly 8 is actuated to rise in the cylinder.

5 Referring also to Figure 1, the pump or compression drum 2 has a pump inlet 34 for receiving fluent chocking material from the reservoir or mixing drum 4 and a pump outlet 36 for dispensing the fluent chocking material from the cylinder 12 to a filling port or spout 38 of a cavity, in a housing or stern tube 3, that is to be injected with the fluent chocking material. The pump inlet 34 and the pump outlet 36 are
10 positioned below the stopper 26. In the preferred form, the pump inlet 34 and the pump outlet 36 are positioned opposing one another but are not limited as such. The pump outlet 36 is provided with a pump outlet valve 37 for selectively controlling the flow of the fluent chocking material dispensed from the pump outlet 36 for transfer into the cavity in the tube 3 via the filling spout 38.

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The reservoir or mixing drum 4 is preferably provided with an indicator 40 that indicates the amount of the fluent chocking material contained in the mixing drum 4. The indicator 40 is placed within the mixing drum 4, and may be a dip stick and/or may have a graduated scale. However, an indicator or graduated scale outside
20 the reservoir or mixing drum 4 can also be used if the mixing drum 4 is transparent or at least has a transparent portion to allow the level of the contents to be readily seen from outside the reservoir drum.

The reservoir or mixing drum 4 further comprises a reservoir outlet 41 for
25 connection to the pump inlet 34 and for dispensing the chocking material from the reservoir. The fluent chocking material is dispensed from the reservoir through the reservoir outlet 41 and delivered to the pump or compression drum 2 via a reservoir outlet pipe 6. The pipe 6 is provided with a reservoir outlet valve 44 for controlling the flow of the chocking material from the reservoir or mixing drum 4 to the pump or
30 compression drum 2. The reservoir outlet 41 preferably is positioned proximate the base of the mixing drum 4.

Before introducing the fluent chocking material into the cylinder 12, the air release valve 32 and the reservoir outlet valve 44 are closed. The pump outlet valve 37 is open and compressed air from the source 31 is introduced into the cylinder 12. The compressed air drives the piston assembly 8 down towards the base of the cylinder 12. As the piston assembly 8 moves towards the base of the cylinder 12, air from within the cylinder 12 under the piston 18 escapes through the pump outlet 36 at the base of the cylinder 12. The compressed air from source 31 continues to drive the piston assembly 8 until the piston 18 of the piston assembly 8 is in contact with the stoppers 26. The piston assembly 8 is always in this position before the fluent chocking material is introduced into the cylinder 12.

In operation, the fluent chocking material is first introduced into the reservoir or mixing drum 4 progressively until it reaches a satisfactory level indicated by the indicator 40. The chocking material is preferably introduced into the reservoir and the pumping operation commenced without substantial delay such as to prevent the fluent chocking material from setting or curing before being transferred to the cavity via the pump or compression drum 2. Individual component materials of the chocking material are mixed in the mixing drum 4 by means of a stirrer (not shown). For example, one suitable chocking material is a two-part resin comprising a primary resin and a secondary activator or hardener. In this case, the primary resin and the hardener are measured into the reservoir or mixing drum where they are stirred to ensure they are well mixed before being transferred into the compression drum and pumped into the cavity.

After mixing is completed, the pump outlet valve 37 and the air release valve 32 are opened. The reservoir outlet valve 44 is then opened to allow the chocking material from the reservoir or mixing drum 4 to flow to the pump chamber in the compression drum 2. As the reservoir or mixing drum 4 is at a height above the compression drum 2, gravitational force causes the chocking material to flow from the mixing drum 4 to the compression drum 2. The chocking material flows through the pipe 6 and enters the compression drum 2 via the pump inlet 34. As the chocking material enters the cylinder 12, air within the cylinder 12 below the piston 18 is forced

out through the pump outlet 36. When a portion of the chocking material flows through the pump outlet 36, indicating that the space with the cylinder 12 below the piston 18 is at least partially filled with chocking material, the pump outlet valve 37 is closed.

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The flow of the chocking material from the mixing drum 4 to the compression drum 2 continues. As more and more chocking material moves into the cylinder 12, the force from the chocking material pushes the piston assembly 8 away from the stopper 26, towards the cover 10. Air in the cylinder 12 between the cover 10 and the piston 18 escapes through the air vent or release valve 32 to allow the piston 18 to move towards the cover 10 as the chocking material pushes the piston 18 upwards.

Once the cylinder 12 is substantially filled up with the chocking material, the air release valve 32 is closed, the pump outlet valve 37 is opened again, and reservoir outlet valve 44 is closed. The closing of the reservoir outlet valve 44 prevents backflow of chocking material back into the reservoir. Compressed air from source 31 is then introduced via pump air inlet 28 into the cylinder 12 to drive the piston assembly 8 towards the stopper 26. The force of the compressed air from source 31 acts upon the piston 18 and that in turn acts upon the chocking material under the piston to pressurise the material which is forced out through the pump outlet 36 to deliver the chocking material via the cavity filling port or spout 38 on the tube 3 to fill the cavity in the tube with chocking material. The steady injection of the chocking material into the tube 3 avoids the formation of voids, air bubbles or cavities within the chocking material in the tube 3. The ability to transfer the chocking material to the tube cavity as soon as it has been mixed helps reduce the possibility that a portion of the chocking material may cure even before it has been fed into the tube 3. The system of the present invention provides a continuous process for injecting a substantial batch of a chocking material into the tube 3.

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The process of feeding the compression drum 2 with a batch volume of chocking material and pressurising the batch within the cylinder 12 to force the

chocking material into the tube 3 can be repeated with further batches until the tube 3 is satisfactorily filled with chocking material.

5 With reference to Figure 3, the chocking material is injected into the annular cavity in a stern tube 3 through the filling port or spout 38. The spout 38 is positioned at the lower end of the stern tube 3 such that when the chocking material is injected into the cavity in the stern tube 3, the chocking material moves upward against gravity to steadily and progressively fill the cavity in the stern tube 3 with chocking material. The cavity in the stern tube 3 is filled when excess chocking material spills out from
10 cavity vent port or spout 46 which is arranged at a height above the filling port or spout 38. Air in the cavity is expelled via the vent port 46 as the cavity steadily fills with the chocking material.

In a preferred application, the cavity in the stern tube is an annular cavity
15 surrounding a bearing which supports a shaft. A stern tube typically has a pair of such cavities, one at each end of the stern tube, and each cavity carrying a bearing which supports a rotatable shaft. Before the chocking material is injected into the cavities, the shaft is pre-set into a desired position and alignment, for example by adjusting radial set screws threaded in the tube and which provide an initial adjustable
20 support for the bearings. The chocking material is then introduced into the tube cavity and allowed to cure or set to a hard solid. The hardened chocking material fixes and maintains the bearings in the pre-set position and alignment, and provides a stable support for the bearings even when under full operating load.

25 In an alternative application, the stern tube houses a shaft carried in bearings located in each end of the tube, and the chocking material is pumped into cavities of tube supports which surround each end of the tube. The tube is pre-aligned and then secured in place by injecting the settable fluent chocking material into the cavities and allowing the chocking material to cure and harden.

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The steady pressure applied to the chocking material to pressurise it, the movement of the chocking material against gravity when filling up the cavity in the

stern tube 3, the introduction of the chocking material into the cavity at the filling port 38 located at or near the lowest point in the cavity, and the cavity vent port which allows air in the cavity to escape when the chocking material is introduced reduce the likelihood of the formation of cavities within the chocking material introduced into the tube cavity. This helps strengthen the cured and hardened chocking material.

Although the invention has been described by way of example and with reference to particular embodiments, it is to be understood that modifications and/or improvements may be made without departing from the scope or spirit of the invention. For example, suitable settable fluent chocking materials for use in this invention include settable grouts, slurries and other cementitious materials, and epoxies and other resins.

CLAIMS

1. A method for transferring a settable fluent material into a cavity, the cavity having a cavity filling port and a cavity vent port, the vent port being located above
5 the filling port, and the method comprising the steps of:
 - (a) connecting an outlet port of a reservoir to an inlet port of a pump,
 - (b) connecting an outlet port of the pump to the cavity filling port,
 - (c) at least partially filling the reservoir with the fluent material,
 - (d) operating the pump to transfer the fluent material from the reservoir to the
10 cavity, and
 - (e) allowing the fluent material in the cavity to set to a solid.
2. A method as claimed in claim 1 wherein the fluent material is a cementitious material.
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3. A method as claimed in claim 1 wherein the fluent material is a resin material.
4. A method as claimed in claim 3 wherein the resin material is an epoxy resin.
- 20 5. A method as claimed in any one of the previous claims wherein in step (e) the fluent material sets to a rigid solid.
6. A method as claimed in any one of the preceding claims wherein the cavity is a substantially annular space between a shaft bearing and a tube housing the bearing.
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7. A method as claimed in any one of the preceding claims wherein the fluent material is made from a plurality of component materials which are mixed together in the reservoir prior to operating the pump in step (d).
- 30 8. A method as claimed in any one of the preceding claims wherein the reservoir is higher than the pump and the fluent material is transferred from the reservoir to the pump by gravitational force.

9. A method as claimed in any one of the preceding claims wherein the fluent material is transferred from the pump to the cavity by application of a pressurised gas to the pump.

5 10. An apparatus for transferring a settable fluent material into a cavity, the cavity having a cavity filling port and a cavity vent port, the vent port being higher than the filling port, and the apparatus comprising:

a reservoir for containing the material to be transferred into the cavity; and

a pump having a pump chamber, the pump chamber being connected to the
10 reservoir, and the reservoir being higher than the pump chamber,

wherein the pump is operable to alternately de-pressurise and pressurise the pump chamber allowing the material to move from the reservoir to the pump chamber when the pump chamber is de-pressurised and moving the material from the pump chamber to the pump outlet port when the pump chamber is pressurised, so that the
15 apparatus transfers the material in the reservoir to the cavity when the pump chamber is successively pressurised and de-pressurised and the pump outlet port is connected to the cavity filling port.

11. An apparatus as claimed in claim 10 and further comprising:

20 a first valve which is openable to permit movement of the material from the reservoir to the pump chamber and is closeable to block movement of the material in the opposite direction from the pump chamber to the reservoir;

a second valve which is openable to permit movement of the material from the pump chamber to the pump outlet port and is closeable to allow the pump chamber to
25 fill with the material moving from the reservoir to the pump chamber; and

a pump driver for alternately increasing and decreasing the volume of the pump chamber, the increasing volume accommodating the material moving from the reservoir to the pump chamber, and the material in the pump chamber being transferred from the pump chamber to the cavity, via the pump outlet port and cavity
30 filling port, when the volume of the pump chamber decreases.

12. An apparatus as claimed in claim 11, wherein:

the pump chamber is a cylinder in which a piston reciprocates to increase and decrease the volume of the pump chamber;

an application of pressurised gas to the piston drives the piston in one
5 direction to decrease the volume of the pump chamber; and

a vent valve is opened to relieve the application of the pressurised gas to the piston to allow movement of the material from the reservoir to the pump chamber to increase the volume of the pump chamber.