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PACKING APPARATUS AND METHOD

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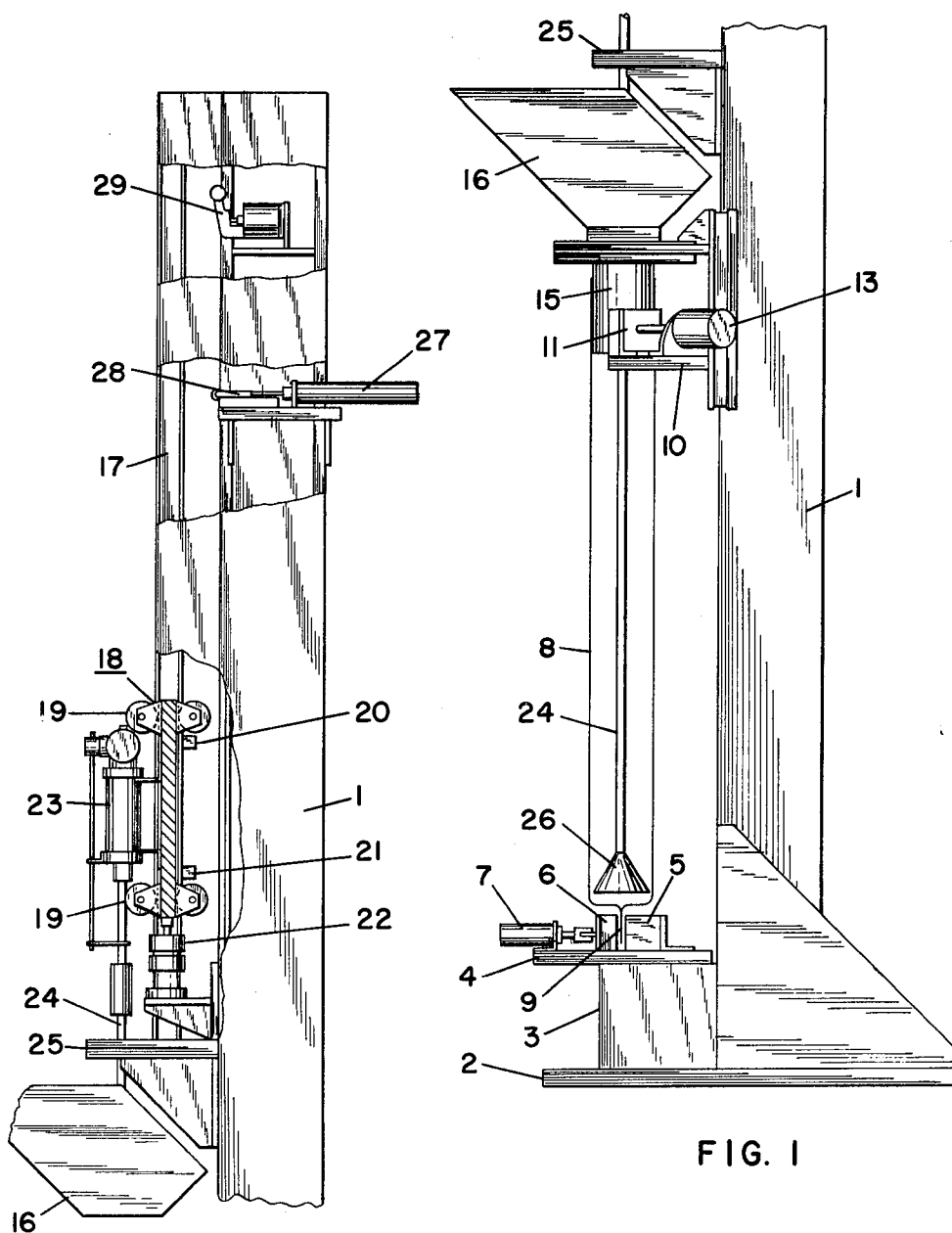


FIG. 2

FIG. 1

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1

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PACKING APPARATUS AND METHOD
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ABSTRACT OF THE DISCLOSURE

An apparatus for packing a material in an upright container. A vibrating tamp stick is mounted on a carriage which can move in opposition to the container against a uniform force. As the tamp stick vibrates, material flows around its tip and is packed by it, forcing the carriage and the container to gradually separate until the container is completely packed.

In a widely-used method of packing AN-FO (ammonium nitrate-fuel oil explosives), nitrocarbonitrates, high explosives, and other particulate materials into cylindrical containers, a tamp stick moves above the flue of the hopper and pushes material which falls beneath it through the hopper and all the way to the bottom of the container where the tamp stick packs it before again rising above the flue of the hopper.

As the cylinders may be several feet in length, this procedure requires a very long stroke for the tamp stick and is therefore slow. In addition, a large quantity of material is tamped at the end of each stroke which may result in low densities or a non-uniform density throughout the cylinder.

Another method and apparatus for packing materials in upright containers is described in Douglass British Pat. 774,039. Douglass vibrates the tamp stick in the container, the tamp stick never rising above the container. The tamp stick is held by friction to a bar which vibrates it. As the material flows around the tip of the tamp stick and is packed by it, the force of the tamp stick against the packed material overcomes the friction, permitting the tamp stick to rise in the container.

While the Douglass apparatus and method offer some advantages over prior methods, the use of friction to hold the tamp stick may produce non-uniform densities. This is because it is difficult to control the amount of friction and even to keep it constant during the packing of a single container. Therefore, a container may be packed more densely at the bottom and less densely at the top when the friction grip has worn down somewhat. Variations from container to container may also occur.

I have invented an apparatus for packing material in an upright container and a method for so packing which is rapid, which results in a uniform density of material throughout the container and from one container to the next, and which may be controlled to give a wide range of predetermined densities. In my apparatus and method, a vertical tamp stick mounted on a carriage vertically vibrates in the container beginning at the bottom of the cylinder, but in "vibrating" the tip of the tamp stick remains in the container. As the particulate material flows into the container and around the tamp stick, the carriage gradually moves in opposition to the container against the force of gravity due to the force of the tamp stick against the packed material. Because the carriage moves against the force of gravity, which is constant, the material is packed at a uniform density throughout the container and from one container to the next. The density of the material is easily controlled by changing the weight forcing the tamp stick and the container together.

The apparatus of this invention may best be understood

2

by reference to the accompanying drawings. FIG. 1 is a side view partially in section of the bottom portion of the apparatus and FIG. 2 is a side view of the top portion of the apparatus. FIG. 3 is a diagrammatic drawing of the air system of the apparatus.

In FIG. 1, a main support 1 is mounted on base 2. A second support 3 holds platform 4. On this platform is mounted a fixed clamp 5 and a movable clamp 6 controlled by air cylinder 7. A flexible container 8 has a nip 9 which is held by clamps 5 and 6. A second platform 10 is fixed to main support 1 and holds movable clamps 11 and 12 (on opposite side, shown in FIG. 3) which are controlled by air cylinders 13 and 14, respectively (air cylinder 14 is on the opposite side and is shown in FIG. 3). These clamps, which press container 8 against nipple 15 of hopper 16, move at an angle of 30° to the viewer in order to facilitate placing the container over the nipple.

In FIG. 2, a track 17 and a corresponding track on the opposite side (not shown) is attached to main support 1. A carriage 18 has four wheels 19 which ride on track 17 and an additional four wheels (not shown) which ride on the corresponding track on the opposite side. The carriage has trip 20 and arm 21 whose purposes will be explained later. The carriage rests on shock absorber 22 and supports a vibrating air cylinder 23 which vibrates tamp stick 24. In FIG. 1, tamp stick 24 guided by tamp guide 25 passes through hopper 16 and nipple 15 to the bottom of container 8; it has an upright conical tip 26 at its base, which encourages the downward flow of material around it.

In FIG. 2, air cylinder 27 operates rod 28 which can extend to the left to prevent carriage 18 from moving down. Cam 29 is actuated when it is contacted by trip 20 of carriage 18.

To operate the apparatus, carriage 18 is placed at the top of the main support so that arm 21 rests on rod 28. The operator places a container over nipple 15 with the nip 9 between clamps 5 and 6 if a container having a nip is used.

Referring now to FIG. 3, filter and lubricator 30 provides an air supply for the air system. Air passes from the filter and lubricator 30 through shut-off valve 31 and foot valves 32 and 33. The operator actuates foot valve 32 which allows air to flow into air cylinders 13 and 14 moving clamps 11 and 12, respectively, against the container. He also actuates foot valve 33 which allows air to flow into air cylinder 7 which moves clamp 6 against nip 9. When the cylinder is securely held in place, the operator presses starter valve 34 which allows air to flow through emergency shut-off valve 35 through line 36, valve 34, and line 37 into valve 38, moving this valve so that air passes from line 39 into line 40 and then to lines 41, 42, and 43. The air in line 41 enters air cylinder 27 which causes rod 28 to withdraw. In FIG. 2 this causes carriage 18 to fall until it strikes shock absorber 22. The air in line 42 passes through regulator 44 which controls the pressure into air vibrator 45 which vibrates hopper 16 and nipple 15 so that material placed within it easily flows through nipple 15 and into the container. The air in line 43 flows through one-way valve 46 into bowl 47. Air from bowl 47 enters air vibrator 23 which vibrates tamp stick 24. This bowl provides a residual air supply so that the tamp stick continues to vibrate a few strokes after the air supply is turned off in order to assure that rod 38 will lodge under arm 21. The tamp stick preferably vibrates at least about 25 vibrations per minute at an amplitude not exceeding the length of the shell and preferably at about 1/2 to about 4 inches.

In FIG. 2, as the material in the hopper flows into the container and over upright conical tip 26 of tamp stick 24,

3

it is packed by the tamp stick, forcing the tamp stick and carriage 18 up track 17. When trip 20 of the carriage strikes cam 29, cam valve 48 (FIG. 3) is moved so that air flows from line 49 to line 50. This causes valve 38 to move to the position shown so that air no longer flows in lines 40, 41, 42, and 43 thereby stopping the hopper and tamp vibrators. But air will flow from line 51 into air cylinder 27 thereby moving rod 28 to the left (FIG. 2) which holds carriage 18 at the top of the apparatus. Foot valves 32 and 33 are now deactivated by the operator, opening clamps 6, 11, and 12 if used. The packed cylinder is then removed and another put into place. The entire process takes about 15 seconds for a 2½" by 24" cylinder.

Using a constant feed rate, frequency and amplitude of vibration, the density of the packed material can be easily controlled by varying the weight of the tamp stick and carriage. This weight may be increased to obtain greater densities or decreased as, for example, by attaching one end of a line hung through a pulley to the carriage and attaching a counterweight attached to the other end in order to obtain lower densities.

The density may also be controlled by changing the frequency and amplitude of the stroke or the feed rate of material into the container. For example, a faster feed rate or a lower frequency increases the increment of material packed per stroke resulting in lower densities. A higher frequency or a slower feed rate would reduce the increment packed per stroke producing higher densities. Varying the amplitude changes the impact force on the increment being packed. For example, the longer the stroke, the greater the force, resulting in higher densities; while a shorter stroke will impart less force producing lower densities. This invention enables the operator to easily, quickly, and accurately control the feed rate, the amplitude, and the frequency. In the apparatus of the drawings, the feed rate can be controlled by the internal diameter of nipple 15. The frequency of the stroke is controlled by the air pressure in air vibrator 23 and the amplitude is controlled by an adjustment on this vibrator.

The container may be a rigid shell, a semi-rigid shell, a flexible bag, a flexible bag inside of a rigid shell, or another type of container suitable for upright packing. If a container is used which is rigid enough so that clamps 6, 11, and 12 are not needed, valve 31 may be closed to make them inoperable. A flexible container may be maintained in an upright position by blowing air into the top of it, making nip 9 and clamp 6 unnecessary. It may be necessary to modify the size of nipple 15, the size of upright conical tip 26, the length of tamp stick 24, the distance the carriage moves, or the type of clamps in order to accommodate the particular container being packed. While it is preferable to have the carriage move upward against the force of gravity, it is also possible to have the container move downward against the force of gravity by attaching the container to one end of a line hung through a pulley and attaching a weight to the other end.

What is claimed is:

1. An apparatus for packing a material in an upright container comprising:

- (1) a carriage vertically movable in opposition relative to said container against the force of gravity,
- (2) a vertical tamp stick mounted on said carriage, and
- (3) means for vertically vibrating said tamp stick relative to said carriage, the tip of said tamp stick remaining in said container.

2. An apparatus according to claim 1 wherein said carriage moves upward against the force of gravity.

3. An apparatus according to claim 2 wherein said tamp stick has a narrow shaft and an upright conical tip.

4

4. An apparatus according to claim 2 wherein said means for vibrating said tamp stick vibrates said tamp stick at least about 25 vibrations per minute at an amplitude of about ½ to about 4 inches.

5. An apparatus according to claim 2 wherein said means for vibrating said tamp stick is a reciprocating air cylinder.

6. An apparatus according to claim 2 wherein said material is AN-FO, a nitrocarbonitrate, or a high explosive.

7. An apparatus according to claim 2 wherein means are provided to hold said carriage near its uppermost position.

8. An apparatus according to claim 2 wherein means are provided to stop said tamp stick from vibrating.

9. An apparatus according to claim 2 wherein said container is a flexible container and means are provided to blow air into the top of said container.

10. An apparatus according to claim 2 wherein a vibrating hopper and nipple are provided to hold and admit said material into said container.

11. An apparatus according to claim 10 wherein said tamp stick, hopper, and nipple are vibrated by air vibrators.

12. An apparatus according to claim 2 wherein said container is a flexible container having a nip at its base.

13. An apparatus according to claim 12 wherein clamps are provided to clasp said nip and to hold said container in a vertical position during packing.

14. A method of packing material into an upright container comprising:

- (1) vertically vibrating within said container relative to a carriage a tamp stick attached to said carriage and having a tip of a smaller diameter than the inside of said container,

- (2) admitting said material into the top of said container, and

- (3) permitting said container and said carriage to move apart against the force of gravity as said material is packed in said container by said vibrating tamp stick.

15. A method according to claim 14 wherein said carriage is permitted to move upward against the force of gravity.

16. A method according to claim 15 wherein said material is admitted from a vibrating hopper and nipple.

17. A method according to claim 15 including the additional final steps of holding said carriage near its uppermost position and stopping said tamp stick from vibrating.

18. A method according to claim 15 wherein said tamp stick is vibrated at least about 25 vibrations per minute at an amplitude of about ½ to about 4 inches.

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