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(54) Molten metal handling vessels.

(57) Molten metal handling vessels e.g. ladles for holding e.g. molten steel having slide gate valves for controlling the flow of molten metal therefrom. Apparatus (1,20) has a container (2,21) to hold a supply of particulate matter (3,22), the container having an outlet and means (6,25) for opening and closing the outlet for controlling the flow of particulate matter from the container and means (4,8,23,30) for conveying the particulate matter to the bore of a slide gate valve assembly of a vessel.

The apparatus enables particulate matter to be accurately conveyed to a slide gate bore without the need for steelworks personnel to be exposed to the hazardous task of applying particulate matter manually to very hot vessels. In addition the apparatus enhances the free-opening of slide gate valves by reducing the incidence of blocked slide gate valve assemblies.

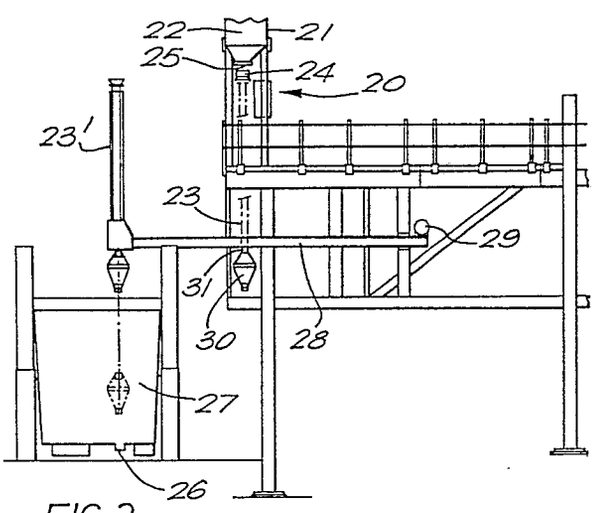

FIG. 3.

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Description

MOLTEN METAL HANDLING VESSELS

The present invention relates to molten metal handling vessels more particularly to apparatus for conveying particulate matter to the outlet nozzle of molten metal handling vessels.

In the metallurgical industry slide gate valves for controlling the egress of molten metal from molten metal handling vessels e.g. transport or treatment ladles has become increasingly common. A particulate refractory material is generally used to fill the outlet bore of a slide gate valve so that on opening the slide gate valve unrestricted flow of molten metal occurs. The effect of the particulate material is to form a barrier against the molten metal which otherwise would enter the bore of the slide gate valve and may solidify therein due to the incidence of a chilling effect and so block the valve.

In use of the particulate material a crust is formed on its outer surface by the action of the high temperature of the molten metal e.g. steel such that when the slide gate valve is opened the unsintered material beneath the crust is expelled from the bore of the slide gate. The crust has insufficient strength to withstand the ferrostatic pressure of the steel in the ladle and collapses thus allowing the steel to discharge freely through the bore of the slide gate assembly.

This procedure has been found to be about 80% successful and of the remainder about 10% require that the particulate material is dislodged, usually by means of e.g. a rod or bar inserted into the slide gate bore. The final 10% of slide gate free-opening is generally effected by means of an oxygen lance which may be used to melt the obstruction which has replaced the particulate material in the bore.

It is known that the above task is extremely disadvantageous with metallurgical plant operatives having to make numerous attempts to effect unblocking of slide gate valves. A consequence of extensive oxygen lancing often results in the refractory of the slide gate valve assembly being damaged, leading to a premature failure of the valve. Furthermore molten metal splash frequently accompanies oxygen lancing and accidents have been known in which operators are injured e.g. burned by molten metal.

In addition the use of an oxygen lance may contaminate the molten metal, particularly in the case of steel, to such an extent that it would be unsuitable for many purposes, e.g. drawn and wall-ironed steel container production, and accordingly, downgraded to a less high quality specification. This may be inconvenient to a steelplant and may be uneconomic. Oxygen lancing oxidises some of the consituent alloying elements of a steel e.g. aluminium, silicon, manganese into oxides which may coalesce to form unacceptably large inclusions. In respect of drawn and wall-ironed steels, the size of acceptable inclusions is 100 microns or less.

External attempts to unblock a ladle slide gate valve are further complicated by the widespread use of ladle pouring tubes commonly referred to as shrouds. These tubes are attached to the external nozzle of the slide gate valve assembly which confines the steel and protects it from contamination from atmospheric gases such as oxygen and nitrogen as the steel is poured into a subsequent process vessel e.g. into a continuous casting tundish. Such ladle pouring tubes may be up to about 1-1$\frac{1}{2}$ metres in length making it impossible to insert a tube or bar to dislodge an obstruction in the ladle slide gate valve.

In practice where it is known that a blockage exists, the ladle shroud tube is disconnected and efforts then made to open the nozzle. When metal eventually flows, it is highly contaminated with oxides and further contaminated by atmospheric gases until such time as the tundish is full and able to maintain casting. The ladle nozzle may be momentarily closed in order to reconnect the ladle shroud tube thereto.

The initial steel made in oxidising unshrouded conditions may have to be downgraded or even scrapped and in any event represents a loss to the steel maker.

Generally the application of particulate material to the bore of a slide gate is a manual operation e.g. an operator may simply throw one or more pre-weighed bags of material into the ladle aimed at the zone of the ladle floor comprising the slide gate. In some cases, the operator may first introduce a guide tube, fitted with a funnel so as to more accurately direct the particulate material to the slide gate bore.

However, both methods suffer from the disadvantage that they are suspectible to careless operation, especially if the ladle has been extensively preheated. The radiant heat from the ladle can cause the operator to introduce the particulate material without making any attempt at accurately aiming the pre-weighed bags or correctly positioning the guide tube, because working conditions close to the red-hot ladle are inconvenient, even in the event that additional protective clothing and other safety related equipment is worn.

Inevitably the result is that a proportion of the particulate material is deposited on the floor of the ladle and accordingly insufficient material does not enter the bore of the slide gate valve with the deleterious results described above.

It has now been found that by use of apparatus of the invention the known disadvantages associated with the opening of molten metal handling vessel slide gate valves may be minimised.

According to the present invention there is provided apparatus for applying particulate matter to the bore of a slide gate valve of a molten metal handling vessel, the apparatus comprising a container for the particulate matter, the container having an outlet, means for opening and closing the outlet for controlling the flow of particulate matter from the container, and means for conveying the particulate matter from the outlet to the bore of the slide gate valve assembly of the vessel.

Means for controlling the flow of particulate matter is preferably a slide valve which may be mechanically, hydraulically, electrically or pneumatically actuated.

One means for conveying the particulate matter from a container to the bore of a slide gate valve assembly of a molten metal handling vessel comprises an inclined first delivery tube extending from the outlet of the container to a position above the vessel, the tube having an aperture at its lower end communicating with an aperture in the wall of a substantially vertical sleeve fixed to the lower end of the tube. A second delivery tube in sliding engagement with the sleeve and adapted to extend between the sleeve and the slide gate assembly has an aperture in its lateral surface such that the aperture may be brought into alignment with the apertures in the sleeve and first delivery tube when, in use, the second delivery tube reaches the lowermost extent of its travel. The second delivery tube may be raised and/or lowered manually or operated mechanically e.g. by rack and pinion, wire or chain hoist but more preferably it is raised or lowered between its functional limits by means of one or more pairs of frictional rollers contacting opposite lateral surfaces of the tube actuated by pneumatic, hydraulic or electrical means. The material from which the delivery tube is formed may be one or more of ferrous metals or alloys e.g. steel and non-ferrous metals or alloys e.g. aluminium alloy.

The first delivery tube may be adapted to swivel away from and/or towards the vessel. It will be appreciated that generally whenever the first tube is swivelled the second tube will be in its raised position.

Another means for conveying the particulate matter from a storage container to the bore of a slide gate valve assembly of a molten metal handling vessel comprises a horizontally disposed arm having means for reciprocating the arm between a retracted position and an extended position, one end of the arm having attached thereto a substantially vertical delivery tube. When the arm is in a retracted position the delivery tube substantially coincides with the vertical axis of the storage container. When the arm is extendedthe vertical axis of the delivery tube substantially coincides with the slide gate valve assembly. By use of adjustable stops or switches the travel of the arm and thus the position of the delivery tube may be accurately predetermined.

At the lowermost end of the delivery tube another container is attached and hereinafter the second container will be designated the dispenser. The dispenser has an open top in communication with the bore of the delivery tube and an aperture in its base. The aperture may be sealed by means of an openable valve and the mechanism for opening the valve may be associated with the delivery tube. The delivery tube is in sliding engagement with the attachment means of the arm and the tube is adapted to extend between the attachment means and the slide gate valve assembly. The valve in the dispenser may be actuated when the delivery tube approaches its predetermined lowermost limit of travel. The means adopted by which the horizontal arm may reciprocate and the vertical tube may be raised and/or lowered include manual or mechanical operation by e.g. rack and pinion, but more preferably they are moved between their functional limits by means of a wire or chain winch or hoist actuated by pneumatic, hydraulic or electrical means.

By use of apparatus of the present invention irrespective of the condition of the molten metal handling vessel e.g. whether it is hot or cold the correct quantity and deposition of particulate matter is possible and thus substantially enhance the 'free-opening' rate of slide gate valves and so benefit the steel plant both in terms of operator safety and cost effectiveness.

The particulate matter may be for example any one or more of sand, chromite, olivine, alumina, zircon, magnesite, bauxite, alumina-silicates and calcium silicates or the like.

The invention is illustrated with reference to the accompanying diagrammatic drawings in which:-

Figure 1 is a partly-sectioned elevation of a schematic layout of one embodiment of apparatus according to the invention;

Figure 2 is an elevation showing the functional aspects of the embodiment of Figure 1 in more detail;

Figure 3 is an elevation of a schematic layout of another embodiment of apparatus according to the invention;

Figure 4 is an elevation showing several functional aspects of the embodiment of Figure 3 in more detail with the dispenser in a raised position and

Figure 5 is an elevation showing several functional aspects of the embodiment of Figure 3 in more detail with the dispenser in a lowered position.

Referring to Figure 1 and 2 apparatus 1 for dispensing particulate matter has a container 2 for storing a supply of the particulate matter 3 and an inclined first delivery tube 4 is attached to the container via a swivellable connection 5. Valve 6 controls the flow of matter 3 from container 2. Tube 4 communicates with a sleeve 7 which has an internal diameter slightly greater than the external diameter of second delivery tube 8 which is in slidable engagement with sleeve 7.

The tube 8 may be raised or lowered via frictional rollers 9 variably actuated by reversible motor 10. An aperture 11 in tube 8 aligns with the exit aperture of tube 4 and a corresponding aperture in sleeve 7 whenever tube 8 reaches the limit of its downward travel as determined by flange 12. The apparatus is adapted in order that the delivery tube 8 extends into ladle 13 generally above slide gate valve 14 such that the particulate matter 3 may be deposited into the bore 15. Sleeve 7 has a pivotable rod 16 by which means the delivery assembly 4,7 and 8 may be moved away from or towards ladle 13.

In Figure 2 tube 8 is shown in its raised position. The container 2 is supported by frame 17 and stand 18. The delivery tube 4 is fabricated to ensure that sleeve 7 is positioned at a distance K from stand 18. The rod 16 and a check rope (not shown) on the

opposite side of rod 16 constitute means to ensure that delivery pipe 8 registers with the slide gate bore 15. The position and relative dimensions of aperture 11 and flange 12 are indicated by X and Y and X^1 Y^1. When flange 12 engages with stop 19, aperture 11 is coincident with the outlet from tube 4 and the aperture in sleeve 7.

In Figure 3, apparatus 20 for conveying and dispensing particulate matter has a container 21 for storing a supply of particulate matter 22. A vertical delivery tube 23 is shown in dotted lines in a parked position beneath container 21, the open end 24 of the tube 23 being coincidental with the outlet valve 25 which controls the flow of matter from the container. The vertical delivery tube 23^1 shown in an elevated position in solid lines is above the slide gate valve 26 located in the base of a ladle 27. The tube 23^1 having been movedfrom its parked and filling position to an extended position prior to dispensing the particulate material by an horizontal arm 28 using a motorized cable winch 29. The arm 28 is supported by rollers 41 as shown in Figure 4.

In Figure 4 and 5 the functional aspects of the invention described in Figure 3 are shown in more detail. The vertical tube 23 (23^1) has a dispenser 30 attached to its lowermost end 31. The dispenser has a valve 32 in its base 33. The vertical tube is in slidable engagement with a set of frictional rollers 34 held by plates 35 which also serve to mate arm 28 and tube 23 together. The tube 23 and hence dispenser 30 may be raised or lowered via frictional rollers 34 variably actuated by reversable motorized cable winch 29 via cable 37 and pulley mechanism 38. The valve 32 in the dispenser is opened by engagement of the valve lift guide bars 39 with adjustable stops 40 as the vertical tube 23 is lowered towards the nozzle.

In use of the apparatus according to the invention an operative e.g. a crane driver is able to perform all the functions related to dispensing particulate matter into the bore of a slide gate valve e.g. a ladle. In addition, to simplify and automate much of the process the apparatus is suitable for use in association with a ladle indexing system operating in such a manner that when the ladle is presented to the apparatus a bracket fitted to the operating stand co-operates with a lug fitted to the ladle to enable consistent ladle positioning to be maintained relative to the apparatus.

In accordance with the embodiment of the invention as illustrated in respect to Figures 1 and 2 an overhead crane collects a ladle from the ladle preparation area with the slide gate closed and transfers the ladle using the indexing equipment mentioned above into alignment with the dispensing apparatus 1. The pivotable arm 16 is rotated into position by a machine operator to swivel the delivery tubes until the full extent of the restraining wire is reached. Arm 16 is then locked (means not shown) to prevent further movement during subsequent dispensing of the particulate matter. By virtue of suitable safety latches (not shown) no particulate matter can leave the container whilst tube 8 is in its elevated position. The operator then actuates slide valve 6. An electrical control circuit connected to valve 6 comprises a variable timer control (not shown) which enables the slide valve 6 to remain open for a predetermined time, thus permitting a variable yet controllable quantity of particulate matter to be discharged from container 2.

The particulate matter falls under the influence of gravity along inclined tube 4 into tube 8 via aperture 11. Aperture 11 may be in the form of ventrical slots so permitting the free-running of friction rollers 9. The operator will normally wait a few seconds to allow the delivery tubes to empty before raising tube 8.

The conditioned ladle may now be moved away by the overhead crane when the operator will unlock rod 16 and swivel the tubes away from the ladle adjacent stand 18.

In use of the embodiment of the invention as illustrated with respect to Figures 3,4, and 5 a steelworker in the ladle preparation area or a crane driver in his cabin may perform all the functions related to conveying and dispensing particulate matter into the bore of a slide gate valve as a highly automated regime and may be controlled by radio or other telemetric means.

With the slide gate closed a newly commissioned ladle is brought alongside apparatus 20 and parked in a position as previously predetermined to enable the vertical axis of the extended vertical delivery tube 23^1 to coincide with the bore of the slide gate valve 26. Whenever a ladle is parked, the delivery tube is in its own parked position beneath the particulate matter container 21.

The operator initiates the flow of particulate matter the volume of which may be varied by an adjustable timer or other adjustable flow control means. The matter descends through the tube 23 into the dispenser 30. The operator now initiates the automated nozzle filling cycle such that the horizontal arm 28 extends until it reaches an appropriate stop or limit switch, previously pre-determined, as mentioned above. At which point winch 29 is activated to lower the tube 23^1 and as the dispenser approaches the bore of the slide gate valve 26 the valve 32 in the dispenser is opened by interaction between the valve lift guide bars mechanism 39 making contact with the adjustable stops 40 at the top of the tube. The particulate matter is accurately presented to the slide gate bore since the vertical axis of the bore and the dispenser are adapted to coincide.

When the vertical tube reaches the lowest extent of its downward travel as set by an adjustable limit switch, winch 29 is reversed, the vertical tube is raised and when raised the horizontal arm is retracted to its parked position beneath the container 21 in preparation to commence another slide gate valve filling cycle. Conveniently, the limit switches may be located on the drum of winch 29.

By use of the apparatus of the present invention particulate matter may be introduced accurately and controllably into a ladle which may be at an elevated temperature without any need for the operator to encounter any heat hazard or strenuous physical work.

The invention also includes a method of intrducing particulate matter into the bore of a slide gate valve

assembly of a molten metal handling vessel using apparatus as herein before defined.

Claims

1. Apparatus (1 or 20) for applying particulate matter (3,22) to the bore (15) of a slide gate valve (14,26) of a molten metal handling vessel (13,27) characterized in that, the apparatus (1 or 20) comprises a container (2,21) for the particulate matter (3,22), the container having an outlet, means (6,25) for opening and closing the outlet for controlling the flow of particulate matter from the container, and means (4,8 or 23,30) for conveying the particulate matter from the outlet to the bore (15) of the slide gate valve assembly (14,26) of the vessel (13,27).

2. Apparatus (1 or 20) according to claim 1 characterized in that the means for conveying the particulate matter (3,22) includes a substantially vertical delivery tube (8 or 23) positioned above the vessel (13,27).

3. Apparatus (1 or 20) according to claim 1 or claim 2 characterized in that the delivery tube (8 or 23) is raised or lowered between its functional limits by one or more pairs of frictional rollers (9,34) actuated by pneumatic, hydraulic or electrical means.

4. Apparatus (1 or 20) according to any one of the preceding claims characterized in that the delivery tube (8 or 23) is raised or lowered by a winch (29).

5. Apparatus (1 or 20) according to any one of the preceding claims characterized in that the means (6,25) for controlling the flow of particulate matter is a slide valve.

6. Apparatus (1 or 20) according to any one of the preceding claims characterized in that the delivery tube (4,8 or 23) is formed from ferrous metals, non-ferrous metals or alloys.

7. Apparatus (1) according to any one of the preceding claims characterized in that the conveying means for the particulate matter (3) comprises an inclined first delivery tube (4).

8. Apparatus (20) according to any one of claims 1 to 6 characterized in that the apparatus (20) comprises a substantially horizontal arm (28) comprising means for reciprocating motion between a retracted position and an extended position.

9. Apparatus (20) according to claim 8 characterized in that the substantially horizontal arm (28) has attached at one distal end a substantially vertical delivery tube (23).

10. Apparatus (20) according to claim 8 or claim 9 characterized in that the substantially vertical tube (23) has attached to its lowermost end a dispenser (30).

11. Apparatus (20) according to claim 10 characterized in that the dispenser (30) comprises a valve (31) in its base (33) which is opened by engagement of lift guide bars (39) with adjustable stops (40).

12. A method of introducing particulate matter (3,22) into the bore (15) of a slide gate valve assembly (14,26) of a molten metal handling vessel (13,27) characterized by use of apparatus (1 or 20) as hereinbefore defined.

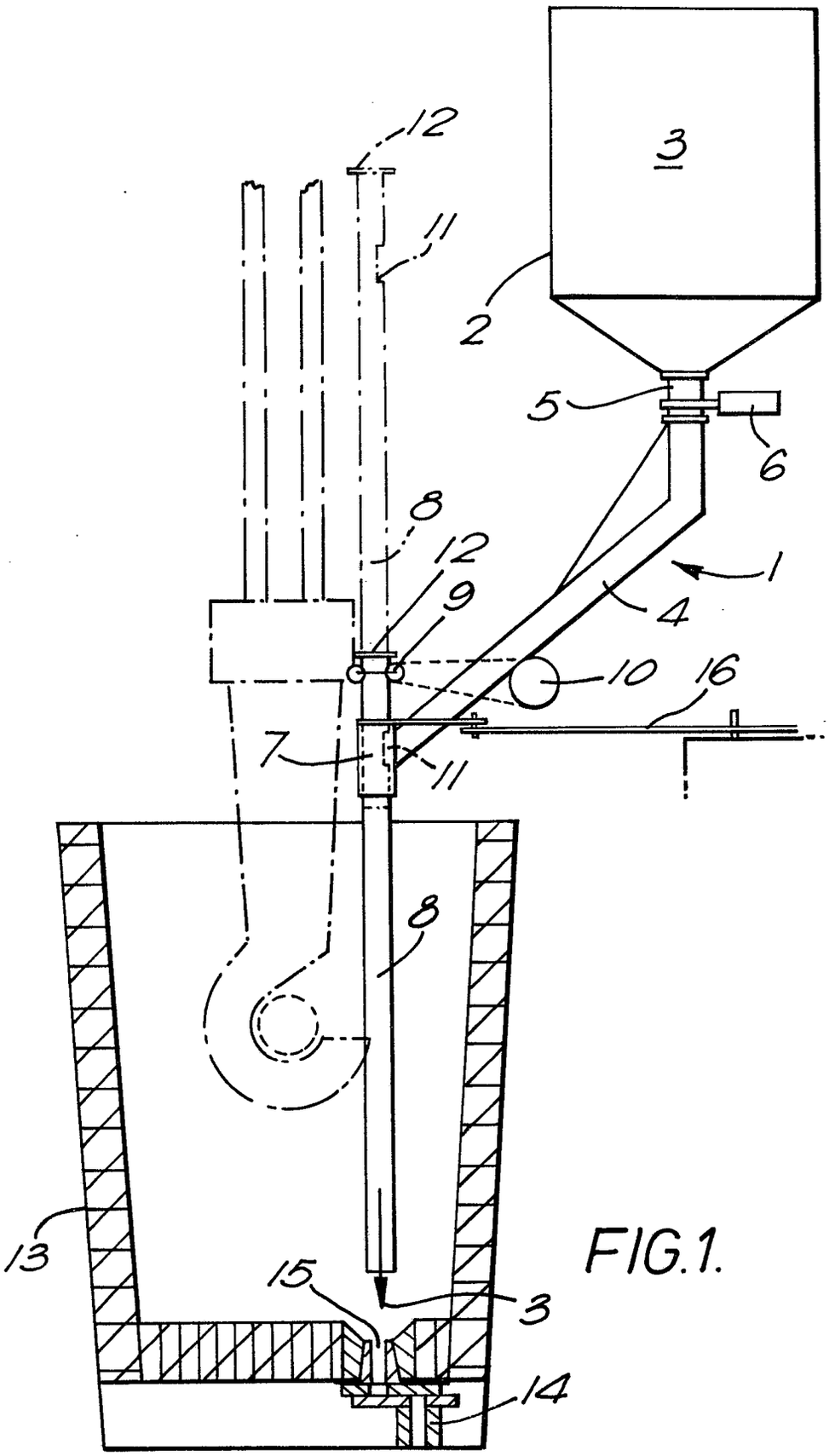

FIG.1.

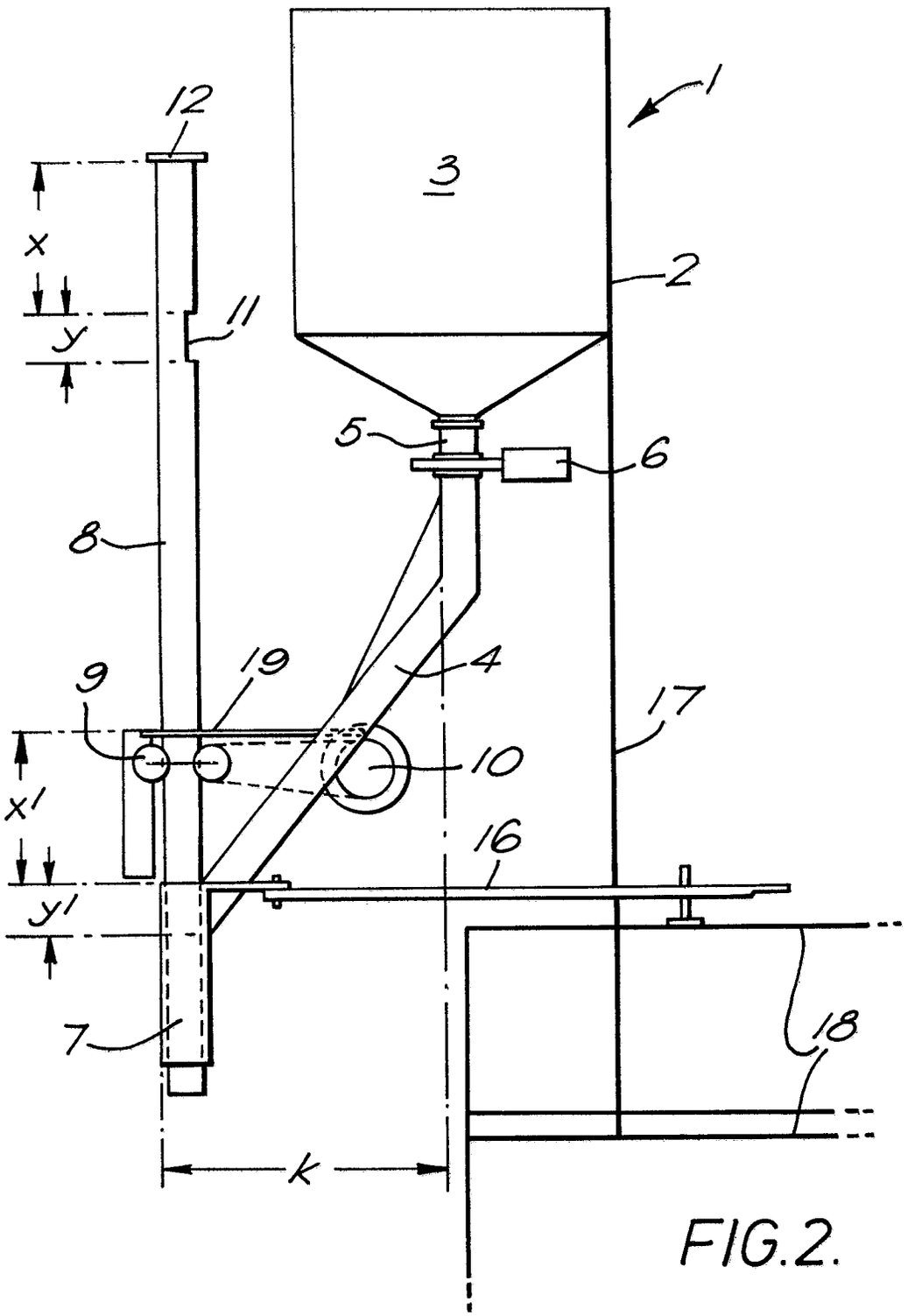

FIG.2.

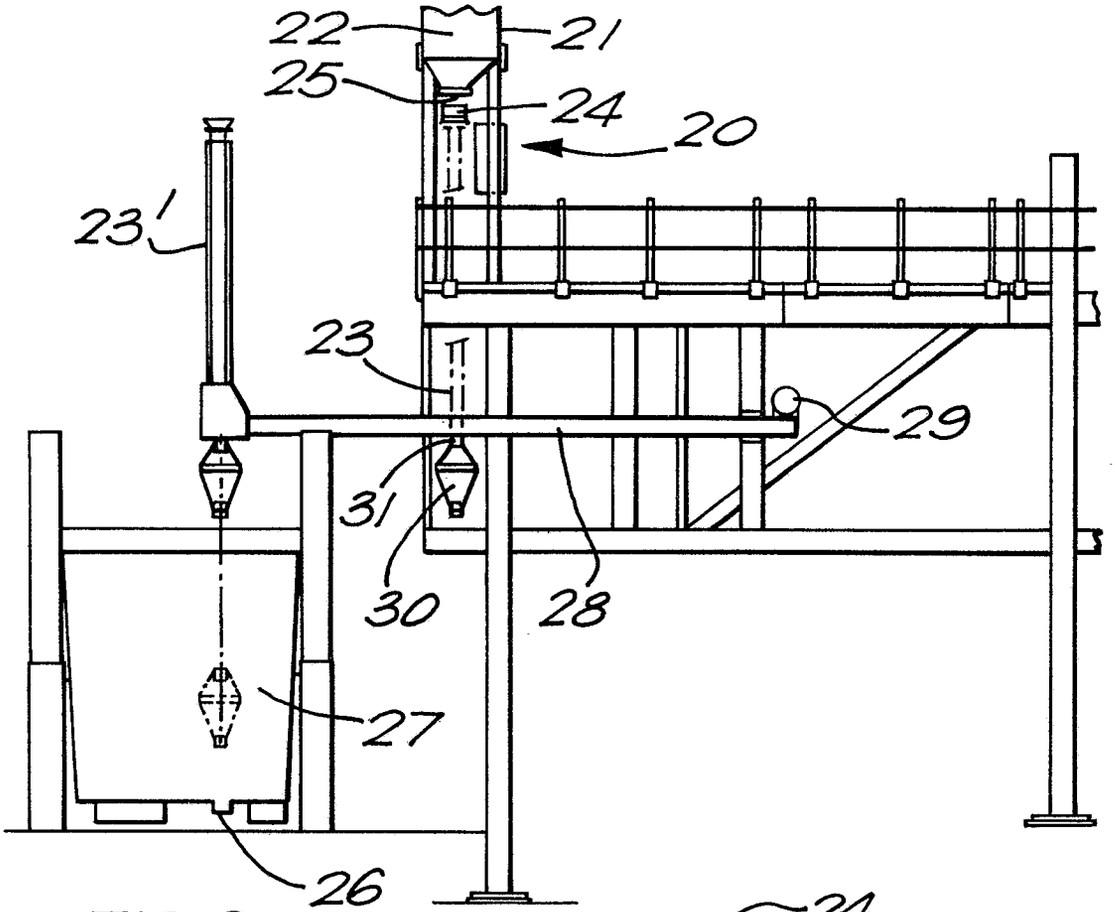

FIG. 3.

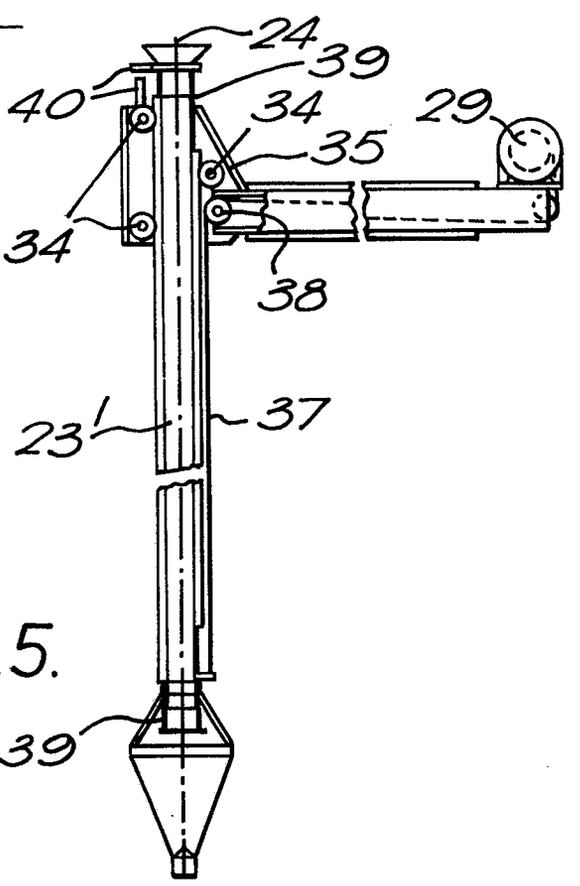

FIG. 5.

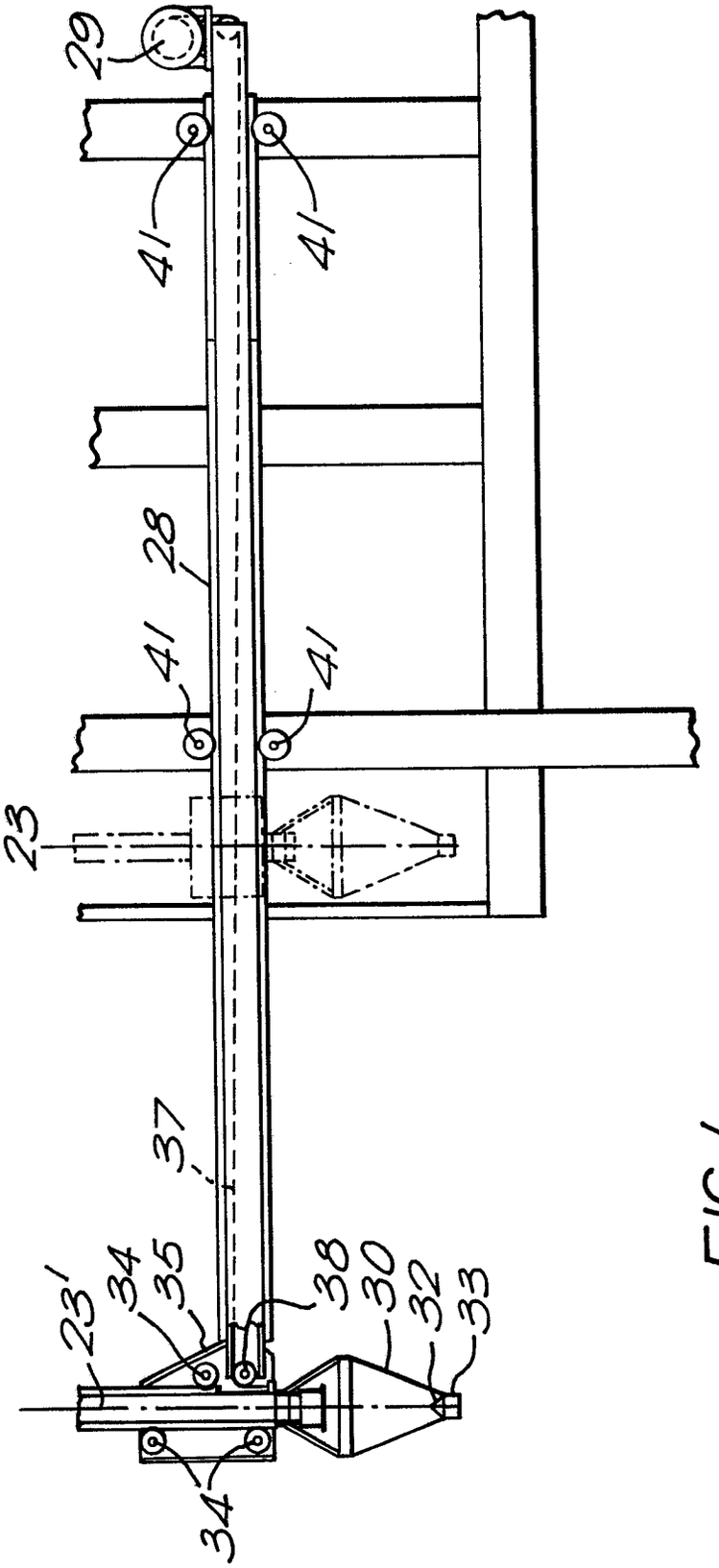

FIG. 4.