

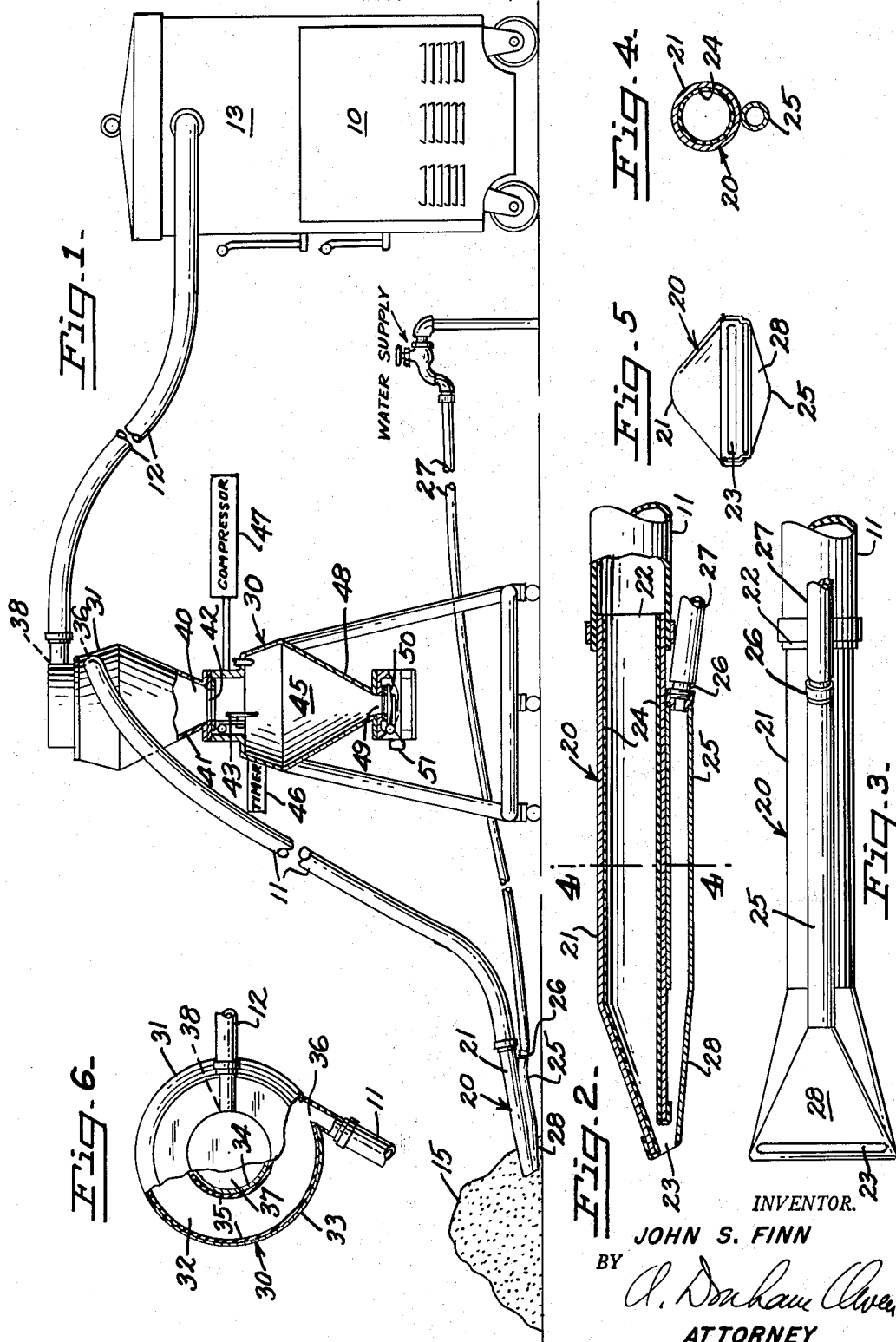
May 8, 1956

J. S. FINN

2,744,792

APPARATUS FOR CONVEYING COMMINUTED MATERIALS

Filed March 7, 1952



INVENTOR.

JOHN S. FINN

BY

A. Durham Oliver

ATTORNEY

1

2,744,792

APPARATUS FOR CONVEYING COMMINUTED MATERIALS

John S. Finn, Burlingame, Calif., assignor, by mesne assignments, to William H. Mead, Oakland, Calif.

Application March 7, 1952, Serial No. 275,360

3 Claims. (Cl. 302—14)

This invention relates to a method and an apparatus for moving granular materials from one location to another. More specifically the invention relates to a method and an apparatus for picking up granular material in a fluid stream, conveying the material to another location, and depositing it there. Still more specifically, the invention relates particularly to a pickup nozzle for such an apparatus.

Suppose, for example, that there has been a sand-blasting operation and that the sand has accumulated on the floor. With this invention the sand can be picked up off the floor in a strong suction current, conveyed to a separation tank, separated out of the suction current, and deposited in a reservoir. The invention saves or replaces hand labor, and provides a less expensive and more efficient way of moving granular material.

Important problems have been solved by this invention, and one instance where the invention has proved invaluable will be related to give some idea of its importance. Most ships and submarines have tanks which must periodically be sandblasted. These include fuel storage tanks, ballast tanks, cargo tanks used for the transportation of edible oils, and many other types. Many of these tanks are difficult to work in; for example, one such tank, often located at the bow of a cargo ship, is wedge-shaped and there is no appreciable flat floor or place to walk around inside it. It is about thirty feet high, twenty feet long, twenty feet across at the rear, and it narrows to a point at the front. Periodically all these different types of tanks have to be cleaned, and open sandblasting has been the preferred cleaning method. As the operator starts at the bottom and works up the walls, the sand accumulates in the bottom of the tank. When he has finished, a large quantity of sand has accumulated there, and it must all be removed before any liquid can be stored in the tank.

Heretofore it has taken eighty man-days to remove the sand from such a tank. Twenty men, working full time with shovels and a bucket line, have taken four days to get it all out. With this invention one man can clean it out all by himself in half a day and do it more thoroughly.

These and other important results of this invention are achieved by the method of sucking up the abrasive (or other material) in a stream of water. The material is then carried by suction to a separation station, which may be a hundred feet away from the nozzle, where the abrasive is removed from the air stream. Then the abrasive is transferred to the desired location in the outer air without affecting the vacuum conditions in the conveying system or at the separator.

In accomplishing this method, the main problem that had to be solved was in connection with the pickup and conveying operations. When, as in the prior art, the sand was sucked in damp, it would tend to plug the conveying hose or suction duct. Lumps of sand would build up until that blocked off the suction duct completely, and then the device ceased to operate. It was then diffi-

2

cult to un-plug the duct, but this had to be done before operation could be resumed. This plugging also tended to overload the vacuum pump and otherwise damage the device.

The present invention solves this problem by a novel nozzle which prevents the suction hose from becoming plugged with granular material and prevents the vacuum pump from being overloaded. My new nozzle does this by providing a constant stream of water, which impinges on the sand at the point where it is drawn into the nozzle and breaks it up into a slurry. The wet sand will not plug up the suction duct and work stoppages are thereby prevented.

The complete apparatus includes a strong vacuum pump which produces a low pressure condition in a duct system. The granular material is drawn into the system at the nozzle, where a current of water impinges with it. The wet material is carried in a high-velocity stream into a cyclone separator, where the solid material is centrifugally thrown out of the air. The wet sand may then be passed out into a storage vessel in the open atmosphere, through a series of valves.

In the drawings:

Fig. 1 is a view in elevation and partly in section of an apparatus embodying the principles of the invention, some parts being shown diagrammatically.

Fig. 2 is a side view in elevation and in section of a nozzle embodying the principles of this invention and through which the granular material is picked up.

Fig. 3 is a bottom plan view of the nozzle shown in Fig. 2.

Fig. 4 is a view in section through the nozzle, taken along the line IV—IV in Fig. 2.

Fig. 5 is a view in end elevation of the nozzle looking at Fig. 2 from the right hand end.

Fig. 6 is a top plan view of the cyclone separator, some parts being broken away and shown in section.

The method of the invention begins with the important step of drawing the granular material into a high velocity suction stream, while at the same time impinging a stream of water on the granular material at the point where the material is drawn into the stream. This step is what prevents plugging of the suction duct.

The wet granular material is then conveyed by a swiftly moving suction current, under low pressure conditions, to a separation station, which is preferably adjacent the location where the granular material is to be deposited. Then the granular material is removed from the air, preferably by centrifugal force with or without a simultaneous lowering of velocity of the air stream. The centrifugal force may be produced by whirling the air stream around in a circle or by a violent change in direction or by both. The change in velocity may be produced by enlarging the cross-sectional area of the air stream. Once the granular material has been separated out, the air stream is conveyed away from the separation station.

When the material is separated out from the air stream, it is dropped and collected in an atmosphere which is still under low pressure conditions. The next important thing to accomplish is to transfer the collected material into the outer atmosphere without affecting the pressure conditions in the separator or in the conveying suction current. This may be accomplished by transferring the collected material into an enclosed area which may be isolated from the collection area, isolating this enclosed area, raising the pressure therein to substantially atmospheric, and finally transferring the material out into the open air. Preferably this is done by dropping the collected material into an intermediate collecting zone, isolating the intermediate zone, introducing air thereto, and then dropping the material out of the intermediate zone into the open atmosphere. Then the isolated area is re-

joined to the collection area and a vacuum induced therein by the air stream. The velocity of the air stream is sufficient to restore the vacuum instantaneously without substantial disruption.

The advantages of the above-described method are apparent. It obviates hand labor; it is continuous; and it is quick. Furthermore, it is completely clean, because no material is spilled between the pickup point and the depositing point. It is dustless, because the material is wet down the moment it is picked up. Also, the old, serious problem of getting the suction line plugged is solved by transporting the material in a wet-down state, or slurry.

A preferred apparatus for accomplishing the above described method is shown in Figs. 1 to 6. Three principal units are connected together by suitable conduits: (1) a pump unit 10 which produces the vacuum that moves the air stream and the granular material 15, (2) a nozzle 20 which picks up the granular material; and (3) a separating and unloading unit 30 between the nozzle 20 and the pump unit 10, where the granular material 15 is removed from the air stream and subsequently transferred to the atmosphere. A conduit 11 conveys the granular material 15 in a high-velocity, low-pressure stream from the nozzle 20 to the unit 30; and a conduit 12 conveys the air from the unit 30 to the pump unit 10. The unit 30 may be located as far as 300 feet from the pump 10 and as far as 100 feet from the nozzle 20.

So far as the blower unit 10 is concerned, any suitable means of producing a vacuum may be used and for that reason it is not illustrated in detail. Preferably the motor (not shown) will be about 10 H. P. and be capable of producing a vacuum of 12 to 15 inches of mercury and move about 325 cubic feet of air per minute. There may be a filter unit 13 adjacent the blower 10, to remove from the air stream any solids which may have been carried out of the separator 30.

The nozzle 20 (see Figs. 2 to 5) preferably comprises a tube 21 with an open cylindrical upper end 22 connected to the conduit 11 and a flattened open lower end or mouth 23 by which the material 15 can be sucked in even when only a small amount of abrasive remains on the floor. Preferably the nozzle interior is coated with a rubber liner 24 to prevent the abrasive 15 from wearing out the tube 21.

The nozzle 20 is supplied with a water supply tube 25 having a fitting 26 at its upper end to which a water hose 27 is secured. The tube 25 may be round at the fitting 26, and it preferably terminates in a flat end 28 which opens directly into the primary tube 21 adjacent the mouth 23. For a nozzle 20 three inches in diameter at 22, the diameter of the fitting may be about $\frac{3}{4}$ of an inch, and the fitting 26 may lie about eighteen inches from the mouth 23. A suitable mouth 23 may be about 6 inches wide by $\frac{3}{8}$ inch high, and the end 28 may be about the same width; $\frac{1}{8}$ of an inch high and lie about $1\frac{1}{2}$ inches from the mouth 23. This air stream impinges with the incoming material 23 adjacent the mouth 22 and keeps it from packing together.

The nozzle 20 is a very important element in this combination. Prior to its use, the pump 10 would become overloaded when too much abrasive was sucked in, and on many occasions the duct 11 became completely plugged with sand, and the whole operation had to be stopped until the duct 11 could be cleaned out. The provision of a supply of water through the hose 27 and the tube 25 eliminates this plugging and choking, and assures a rapid, even flow of sand or other material through the duct 11 to the separating and unloading unit 30.

The unit 30 includes a cyclone 31 (see Fig. 6) where the wet solid material is unloaded from the suction stream. Preferably the cyclone 31 comprises a substantially annular chamber 32 much larger in cross-

section than the conduits 11 or 12 and located between the substantially cylindrical outer wall 33 of the unit 30 and a cylindrical wall 34 which depends from the closed top of the unit 30. Preferably the outer wall 33 flares out toward its lower end so that the wet material will be more easily thrown out from the air stream into the hopper 40 below. Preferably the cyclone 31 and the surfaces adjacent to it are lined with rubber 35 to protect them from the wearing action of abrasive. The air stream from the duct 11 preferably enters the cyclone 31 tangentially thereto through the opening 36, and the wet solid particles are thrown out against the outwardly sloping walls 33. Any remaining wet granular material is thrown out when the suction stream passes down out of the annular chamber 32, is whipped sharply around the depending cylindrical wall 34, and up into the cylindrical outlet chamber 37. Finally, the air stream, with the granular material all removed, passes through the outlet opening 38 at the top of the chamber 37 and into the duct 12, and the material falls into the hopper 40.

The next step is to get the wet solid material out of the reclaiming 30 into the atmosphere without substantially affecting the vacuum in the cyclone 31 and in the ducts 11 and 12. After being shaken out of the air stream in the cyclone 31, the material falls into an upper hopper 40 which preferably has sloping side walls 41, and down toward an opening 42 through the bottom of the hopper 40. A valve 43 controls the passage of the material from the upper hopper 40 to a lower hopper 45. This enables the upper hopper 40 to be maintained at a vacuum and enables the lower hopper 45 to be alternated between vacuum pressure (when the valve 43 is open) and atmospheric pressure (when the valve 43 is closed).

The intermediate valve 43 may be time-controlled by a timer 46, and may be operated by air pressure from a compressor 47. The timer switch 46 may periodically energize or de-energize a solenoid (not shown) that controls the air circuit that operates the valve 43. The intervals are set for optimum performance with the material concerned, usually about 15 seconds open followed by 15 seconds closed.

Material entering the hopper 45 falls down the sloping walls 48 toward the opening 49, where an unloader valve 50 at the bottom of the lower hopper 45 may be gravity operated, a counterbalance 51 being secured to it. The counterbalance 51 may be set to open the valve when the pressure on the valve 50 is equivalent to about one pound of sand at atmospheric pressure. So long as the chamber 45 is under a vacuum, the weight of the wet sand will not open the valve 50; but when the valve 43 is closed, air may pass through a conduit (not shown) into the hopper 45, and when the vacuum is broken, the valve 50 will be opened if material has accumulated on it.

Operation

In operation the powerful pump 10 exerts a considerable suction force through the ducts 12 and 11 and on the nozzle 20. The source of water is turned on to deliver water to the nozzle 20, via the hose 27, fitting 26, and tube 25. The nozzle 20 may then be inserted in the dry solid comminuted material 15 which is to be moved. As the material 15 is sucked in through the mouth 23, it is met by a stream of water coming through the tube 25. The water mixes with the material 15 adjacent the mouth 23 to wet it down and thereby prevent it from blocking the duct 11 and overloading the motor 10.

The wet material 15 is conveyed at considerable velocity from the nozzle 20 through the duct 11 and into the cyclone 31 through the tangential opening 36. The air stream whirls around the annular chamber 32, and the solid material is thrown out against the outwardly sloping

5

walls 33 and down into the hopper 40. Simultaneously there is a decrease in the velocity of the air stream, and this aids the separation action. Any granular material which remains is cast out of the suction stream when the air stream whips down below the wall 34, up into the cylindrical chamber 37, and out the opening 38 into the duct 12.

The solid material falls down into the hopper 40. During the initial half cycle of operation, the valve 43 is open, the valve 50 is closed, and the hopper 45 is under a vacuum. The material falls into the hopper 45 and builds up over the valve 50. The low pressure inside the hopper 45 enables the counterweight 51 and the air pressure outside to keep the valve 50 closed.

At the end of the first half cycle (which may be about 15 seconds in a particular case), the timer switch 46 closes the valve 43. The solid material then builds up over the valve 43, with the hopper 40 constantly being kept at a vacuum.

At the same time, a conduit (not shown) conducts air under pressure into the hopper tank 45. When the pressure builds up to a substantially atmospheric level, the weight of the solid material and the air inside overbalance the counterweight 51 and the outside atmosphere and open the valve 50. The material then falls out into a suitable container. When all the material has fallen out, the valve 50 closes automatically.

As the end of the second half cycle is approached, the tank 45 is empty and the tank 40 is filling up. The tank 45 is closed at both ends, and the inside pressure is approximately atmospheric. At the end of the second half cycle the timer switch 46 opens the valve 43, permitting the material collected in the hopper 40 to fall through into the lower hopper 45. The vacuum is so powerful, moving about 325 cubic feet of air per minute, that the approximately 2 cubic feet of air in the hopper 45 do not even cause a noticeable momentary slowing of the air stream. The operation of separation remains unaffected and operates continuously.

What is claimed is:

1. An apparatus for moving granular material from one location to another, comprising a pick-up nozzle adapted to receive said granular material in a gaseous suction current said nozzle having a main tube with a

6

pickup opening and a secondary tube connected with said main tube adjacent said pickup opening; a source of water connected to said secondary tube; a conduit connected to the main tube of said nozzle for conveying therethrough said material; suction means connected to said conduit to induce the flow of a gaseous current there-through under relatively low pressure conditions; a separation cyclone connected to said conduit; and valve means for passing the separated material out to the atmosphere without seriously affecting said suction current.

2. The apparatus of claim 1 in which said nozzle comprises a main tube having one end adapted to be connected to the conduit and having at its opposite end a mouth which is generally flat in cross-section, and a secondary tube extending from an opening inside said main tube and adjacent said mouth and connected at its opposite end to a supply of water, whereby the water will impinge on the granular material as said material is picked up at the mouth of said nozzle, and said material will be thoroughly wet down.

3. An apparatus for moving granular material from one location to another, comprising a pick-up nozzle adapted to receive said granular material in a gaseous suction current, said nozzle having a main tube with a pickup opening and a secondary tube connected with said main tube adjacent said pickup opening; a source of water connected to said secondary tube; a conduit connected to the main tube of said nozzle for conveying therethrough said material; suction means connected to said conduit to induce the flow of a gaseous current there-through under relatively low pressure conditions; means connected to said conduit for separating the wet granular material from the gaseous current; and valve means for passing the separated material out to the atmosphere without seriously affecting said suction current.

References Cited in the file of this patent

UNITED STATES PATENTS

289,315	Smith	Nov. 27, 1883
661,609	Hoover	Nov. 13, 1900
742,880	Lotz	Nov. 3, 1903
1,380,798	Hansen	June 7, 1921
2,193,738	Perrin	Mar. 12, 1940