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LOW PRESSURE PNEUMATIC CONVEYOR

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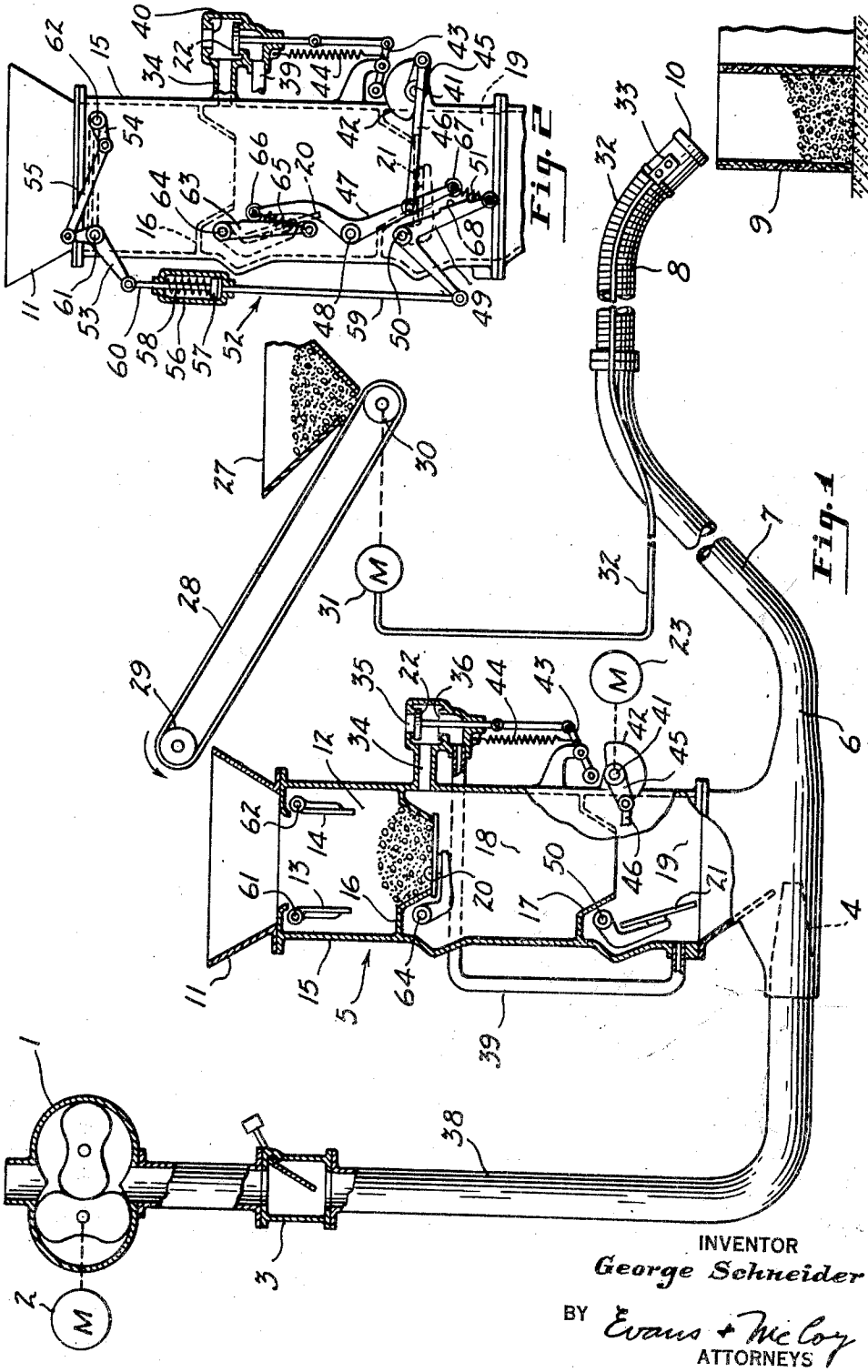


Fig. 2

Fig. 1

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LOW PRESSURE PNEUMATIC CONVEYOR

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1 Claim. (Cl. 302—55)

This invention relates to a method of and an apparatus for conveying dry coarse aggregate from a storage pile to concrete forms in which concrete is to be made by the intrusion method.

The apparatus for conveying the aggregate comprises an endless belt conveyor discharging into the hopper of a gate type air lock and an injector nozzle delivering the dry aggregate received from the air lock through a discharge conduit to a flexible tube forming the discharge end of said conduit. A Roots-type blower is provided upstream of the injector nozzle to produce an air pressure of from 5 to 20 p. s. i. gage and to blow the dry aggregate through the flexible tube to concrete forms. The length of the discharge conduit may be increased or decreased by adding or subtracting sections of pipe which results in increase or decrease, respectively, of the pressure produced by the blower. However, the pressure in the discharge conduit is preferably kept low so that the flexible discharge end of the conduit may be handled manually.

In filling a concrete form, the flexible tube is manually moved back and forth to evenly distribute the fine and coarse particles in the dry aggregate and to avoid the formation of piles within the forms. After the forms are filled with aggregate, grout or mortar containing a properly designed mixture of Portland cement, sand, water, etc., is pumped into the forms in the form of a slurry to fill the voids between the particles and to consolidate the mass. This mixture may be of the type disclosed in Wertz Patent No. 2,313,107 or any other suitable type. This method of making concrete is well known and is described in Wertz Patent No. 2,313,110 and 2,560,619.

The hereinafter described method of filling the concrete forms with dry aggregate is particularly desirable since it insures an even distribution of the fine and coarse particles of aggregate in the concrete. If the open discharge end of the discharge conduit is held stationary and is not moved back and forth, a conical-shaped pile will be formed, the smaller particles of aggregate tending to remain in the central part of the piles and the larger particles to roll to the edges. Dumping of aggregate in conical-shaped piles, dropping of aggregate free through water, sliding it down long open chutes, all tend to separate the particles and to destroy the grading.

The device described above allows placing the aggregate in thin layers, avoids such separation of the particles, and allows reduction in the size of the voids between the particles so as to reduce the cement requirements to a minimum, which in turn lowers the heat generated during hydration and the resulting expanding and contracting of the mass due to the heating and cooling. The method and apparatus of the present invention is especially suitable for the building or repair of tunnel walls or other structures where the forms are not readily accessible.

An object of this invention is to provide a pneumatic conveyor with means located at the open downstream end

of the discharge conduit to control the amount of aggregate fed to the hopper of the air lock by the endless belt conveyor.

A further object of the invention is to provide a low pressure conveyor for dry, coarse aggregate employing air pressures of from 5 to 20 p. s. i. gage.

A still further object of the invention is to evenly distribute the fine and coarse particles of aggregate in a concrete form prior to the addition of mortar.

Other objects will appear from the following description.

Fig. 1 is a side elevation of the pneumatic conveyor with parts broken away and shown in vertical section.

Fig. 2 is fragmentary side elevation of the air lock of Fig. 1 with the operating mechanism for the gate valve and equalizing valve shown schematically.

Refering more particularly to the drawings, Fig. 1 shows a low pressure pneumatic conveyor having a Roots-type air compressor 1 driven by a motor 2 which may be an internal combustion engine, steam engine, electric motor, or other suitable prime mover. A non-return valve or check valve 3 is provided downstream of the blower, and a suitable pressure relief valve may also be provided if desired. The blower 1 delivers air at a pressure of from 5 to 20 p. s. i. gage through a supply conduit 38 to a straight-through type injector nozzle 4 receiving dry aggregate from a gate type air lock 5. Aggregate from the air lock 5 is entrained in high velocity air from the nozzle 4 and is blown into the entrance 6 of a discharge conduit 7 which is alined with the nozzle. The entrained dry aggregate is carried through the discharge conduit 7 to a flexible or swingable portion 8 thereof adjacent the open downstream end 10 of the discharge conduit 7, said flexible portion 8 discharging the dry aggregate to a concrete form 9 or any other point of use. The low pressure of 5 to 20 p. s. i. gage produced by the air compressor 1 upstream of the injector nozzle 4 permits the flexible portion 8 to be handled manually since the forces tending to whip the end of the pipe around are small at low pressure.

In filling concrete forms, thin layers of dry aggregate are added by swing the open end 10 of the flexible portion 8 back and forth, avoiding the formation of conical-shaped piles and evenly distributing the fine and coarse particles of aggregate. The even distribution tends to reduce the size of the voids between the particles of aggregate and thereby reduces the cement requirements. After the concrete forms are filled with aggregate, they are filled with suitable mortar which is slowly pumped as a slurry into the forms to fill the voids between the particles.

The low pressure pneumatic conveyor described may be made large enough to convey to the concrete forms dry, coarse aggregate containing particles having a diameter of from about ½ to 4 inches. However, where the concrete wall being formed is less than one foot thick, it is preferable to use coarse aggregate having particles with a diameter or size less than about 1½ inches. Concrete aggregates consist of crushed stone, gravel, blast furnace slag, or other approved inert materials of similar character or combinations thereof having hard, strong, durable particles free from adherent coating and free from organic matter. Fine aggregate ordinarily consists of sand while coarse aggregate ordinarily has a size range of from ⅜ inch to 4 inches.

The recommended size and grading of coarse aggregate depends on the thickness of the concrete section which is to be formed by the intrusion method. If the thickness is less than 12 inches, the aggregate will preferably range in size from ⅜ inch to 1½ inches and the discharge conduit 7 will be designed with an inside di-

ameter of at least 5 inches throughout the length of the conduit so as to be able to carry such aggregate.

In a typical installation motor 2 may be capable of delivering 50 horsepower, compressor 1 may have a volumetric capacity of 1200 to 1300 cubic feet of air per minute and may be capable of delivering 5 to 6 pounds per square inch gage pressure, and the air lock 5 may be capable of handling 10 to 15 tons of coarse aggregate per hour. In such an installation a 6-inch straight through injector may be provided at 4 to deliver coarse aggregate entrained in air through pipe 7 which may have an inside diameter of about 6 inches and may be 150 feet in length. With such an installation coarse aggregate ranging in size from ⅜ inch to 1½ inches can be delivered from the entrance 6 of discharge conduit 7 at least 100 feet horizontally or more than 50 feet vertically to the open end 10 of the discharge conduit and the pressure in the discharge end of the conduit will be such that the flexible tube 8 can easily be moved back and forth manually.

A gate type air lock, such as air lock 5, unlike the conventional rotary air lock which incorporates a rotor divided into 4 or more compartments, is specifically designed for handling abrasive materials, such as sand, crushed rock, ashes, and so forth, and may be designed to handle 100 tons or more an hour.

Gate lock 5 includes a receiver hopper 11 which communicates at its lower end with an upper compartment or chamber 12. Upper gates 13 and 14 provided between hopper 11 and compartment 12 are actuated in unison to open and close said compartment but these upper gates are not air-tight and act only as a batcher to release material from receiver hopper 11 to upper compartment 13. The upper compartment 12 is always under approximately the same pressure as the receiver hopper 11 so that when gates 13 and 14 are opened, there is no pressure differential to hold up the material. The gate lock 5 has a peripheral casing wall 15 and hopper-shaped partitions 16 and 17 that define an intermediate chamber or compartment 18 and a lower chamber or compartment 19, said compartments being rectangular in horizontal cross section. A middle gate 20 hinged to the casing of the gate lock opens and closes the opening in the bottom of intermediate partition 16 and a similar lower gate 21 is adapted to engage the bottom of lower partition 17. The middle and lower gates 20 and 21 are ordinarily air-tight when closed and one of the gates is always closed to prevent back-flow of air.

A pressure equalizing valve 22 is provided for the purpose of equalizing the air pressure in the compartments before establishing communication between them by opening the gates, and the motion of the gates and the equalizing valve is synchronized. Any conventional operating mechanism may be used to operate gates 13, 14, 20 and 21 and equalizing valve 22 in the required sequence so as to discharge dry coarse aggregate in batches from the gate lock 5. This operating mechanism is normally driven by a small electric motor 23 or other suitable prime mover at an approximately constant speed; however, motor 23 may be a variable speed motor if desired so that the capacity of the air lock may be varied.

Coarse aggregate is conveyed to the hopper 11 from a hopper 27 or a storage pile by means of a conventional belt conveyor comprising an endless belt 28 mounted on a pair of rollers 29 and 30, one positioned over the hopper 11 and the other beneath the hopper 27. The endless belt conveyor is driven by a suitable motor 31 connected by suitable driving means to roller 30. Motor 31 may be a variable speed electric motor connected by suitable conductors in a flexible conduit 32 to a control switch 33 which is connected to the outside of flexible tube 8 near the open end 10. Control switch 33 serves to start and stop motor 31 and may be provided with means to vary the speed of motor 31. By means of the switch 33 the amount of coarse aggregate fed to hopper 11 by the endless belt conveyor may be controlled by an operator positioned at the discharge end of the discharge conduit 7. The speeds of motor 23 and 31 are predetermined, the operating means for the gate lock 5 operating on a time cycle synchronized with the endless belt conveyor so that the aggregate is fed into injector 4 in a series of batches of the desired volume which total the rate of feed to the hopper 11 by the endless belt conveyor.

Equalizing valve 22 of gate lock 5 is shown in its upper position in Fig. 1 and in its lower position in Fig. 2. In the lower position of valve 22 the intermediate chamber 18 communicates with atmosphere through a passage 34 and a vent 35 and valve 22 sealingly engages a lower valve seat 36. In the upper position of valve 22 shown in Fig. 1 the chamber 18 communicates with the chamber 19 through a passage 39 and valve 22 sealingly engages its upper valve seat 40 to cut off communication with atmosphere through vent 35. While passage 39 is shown connected to the chamber 19, it is to be understood that this passage may be connected to the supply conduit 38 or any other part of the machine having a pressure close to the pressure in the chamber 19 since the purpose of passage 39 is to equalize the pressure between chamber 18 and chamber 19 before opening of gate 21. Similarly the vent 35 may be connected by a passage to chamber 12 instead of atmosphere.

Any suitable operating mechanism may be driven by motor 23 to operate the gates and valve of the air lock 5 in the proper sequence and the details of this operating mechanism form no part of the present invention. Fig. 2 contains a schematic showing of one type of operating mechanism which may be employed. This mechanism includes a shaft 41 normally driven at a predetermined speed by the motor 23 and a cam 42 fixed to the shaft 41 for rotation therewith. Valve 22 is connected to and actuated by a pivoted lever 43 which is actuated by the cam 42. A spring 44 holds the end of the lever 43 in engagement with the cam 42 and closes the valve 22 when the cam is in the position shown in Fig. 1.

The opening and closing of the gates 13, 14, 20 and 21 is synchronized with the opening and closing of valve 22 by the operating mechanism which includes a crank 45 fixed to the outer end of shaft 41 for rotation therewith and pivotally connected to one end of a connecting rod 46 and a main oscillating lever 47 pivotally connected to the other end of connecting rod 46. Lever 47 is mounted for oscillation on a stationary pivot pin 48 located at a distance from said other end of connecting rod 46 greater than the distance from shaft 41 to said one end of rod 46 so that rotary movement of crank 45 at a fixed angular speed causes a reciprocatory movement of rod 46 and a continuous oscillatory movement of lever 47 about its axis at 48.

A system of levers opens gates 13, 14 and 21 in unison and closes them in unison. This lever system includes a lower bell crank 49 rotatably mounted on a stationary pivot pin 50 about which lower gate 21 swings. Bell crank 49 is connected by a spring 51 to the lower end of oscillating lever 47 and by a connecting rod 52 to one end of an upper bell crank 53 which is connected at its other end to lever 54 by means of another connecting rod 55 whereby the swinging of lever 47 counter-clockwise closes gates 13, 14 and 21 and the swinging of lever 47 clockwise opens these gates.

To prevent damage to the operating mechanism when particles of aggregate impede or prevent closing of upper gates 13 and 14, the connecting rod 52 is provided with a connection which is yieldable in the closing direction. This yieldable connection may be of many forms but is shown schematicaly as a cylinder 56 having a piston 57 therein that is biased toward the bottom end of the cylinder by a compression spring 58. The cylinder extends from and is integral with the lower portions 59 of the connecting rod 52 and the piston 57 is fixed to the upper portion 60 of rod 52. Bell crank 53 and lever 54 are mounted for rotation about the pivot pins 61 and 62

of gates 13 and 14, respectively, and are fixed to these gates for swinging therewith. A lever 63 integral with gate 20 is mounted for rotation with gate 20 on a pivot pin 64.

The lower end of lever 63 is connected to the upper end of lever 47 by a spring 65 which is similar to the spring 51 so that oscillation of lever 47 in one direction closes middle gate 20, the upper and lower gates being open when gate 20 is closed, and vice versa. Each end of the main oscillating lever 47 is provided with a similar inwardly projecting pin or roller which is adapted to impart a quick opening movement to the gates. A roller 66 on the upper end of the lever 47 engages a hardened face portion of the lever 63 as the lever 47 is moving counterclockwise to rotate the lever 63 in a direction to open the gate 20. In a similar manner a roller 67 on the lower end of the lever 47 engages a hardened face portion 68 of the bell crank 49 when the lever 47 is moved clockwise so as to impart a quick opening movement to the gates 13, 14 and 21. The spring and roller at each end of the main lever 47 act in the same way to impart a quick opening and a quick closing movement to the gates, the springs 51 and 65 allowing the gates to dwell in the closed position during a considerable portion of the rotation of the crank 45. Such a dwell is provided due to the fact that the springs continue to be stretched and extended by the lever 47 after the gates are fully closed and are therefore ineffective to vary the position of the closed gates for a considerable period of time.

The gate lock operating mechanism described above operates the equalizing valve and the gates in a regular sequence, the cam 42 operating equalizing valve 22 while the crank 45 oscillates main lever 47, bell cranks 49 and 53, and levers 54 and 63, to open and close the gates in the proper sequence so as to deliver coarse aggregate in batches from hopper 11 to the injector nozzle 4. In the first position of crank 45 shown in Fig. 1 the cam 42 is disengaged from the lever 43 and valve 22 is in its top position equalizing the pressures in chambers 18 and 19. If the crank 45 is rotated in one direction to a second position approximately 90 degrees from the position shown in Fig. 1, the cam 42 will engage one end of lever 43 and lower valve 22 to equalize the pressures in chambers 12 and 18. If the crank 45 is rotated in the same direction another 90 degrees to a third position shown in Fig. 2, valve 22 will remain in its lower position, gates 13, 14 and 21 will close and middle gate 20 will open. Further 90 degree rotation of crank 45 and cam 42 to a fourth position moves valve 22 to its uppermost

position to equalize the pressure in chambers 18 and 19. Subsequently the crank 45 may be rotated in the same direction to its first position shown in Fig. 1 to complete one cycle, the middle gate closing and the lower gate opening after the pressures in chambers 18 and 19 are equalized by passages 34 and 39. The gate lock 5 is operated so that the pressures in chambers 12 and 18 are equalized before middle gate 20 is opened and the pressures in chambers 18 and 19 are equalized before lower gate 21 is opened. It will be understood that the design of the cam 42 and the amount of rotation of the cam necessary to open or close the valve 22 may vary considerably and that the 90-degree rotations mentioned above are taken merely as an example.

It is to be understood that in accordance with the provision of the patent statutes, variations and modifications of the specific devices herein shown and described may be made without departing from the spirit of the invention.

What I claim is:

A low pressure penumatic conveyor for transferring aggregate to concrete forms comprising: a low pressure rotary air compressor, an injector nozzle, a discharge conduit having a flexible portion at its downstream end, a supply conduit for carrying air from said compressor through said nozzle to said discharge conduit, a gate type air lock having a hopper, an intermediate chamber, and a lower chamber communicating with said discharge conduit, said air lock having gates located above and below said intermediate chamber, a conveyor for supplying aggregate to said hopper, motor means for driving said conveyor at a predetermined speed, means for operating said gates in sequence to cause aggregate introduced into said hopper to pass successively through said intermediate and lower chambers to said discharge conduit so as to be entrained by air from said injector nozzle, and means located near the open downstream end of said flexible portion for controlling the amount of aggregate fed to said hopper by said conveyor.

References Cited in the file of this patent

UNITED STATES PATENTS

699,405	Newhouse	May 6, 1902
894,813	Buzzell	Aug. 4, 1908
1,298,426	Weber	Mar. 25, 1919
1,591,378	Hansen	July 6, 1926
1,684,370	Schuster	Sept. 11, 1928

FOREIGN PATENTS

615,970	Germany	Dec. 12, 1931