

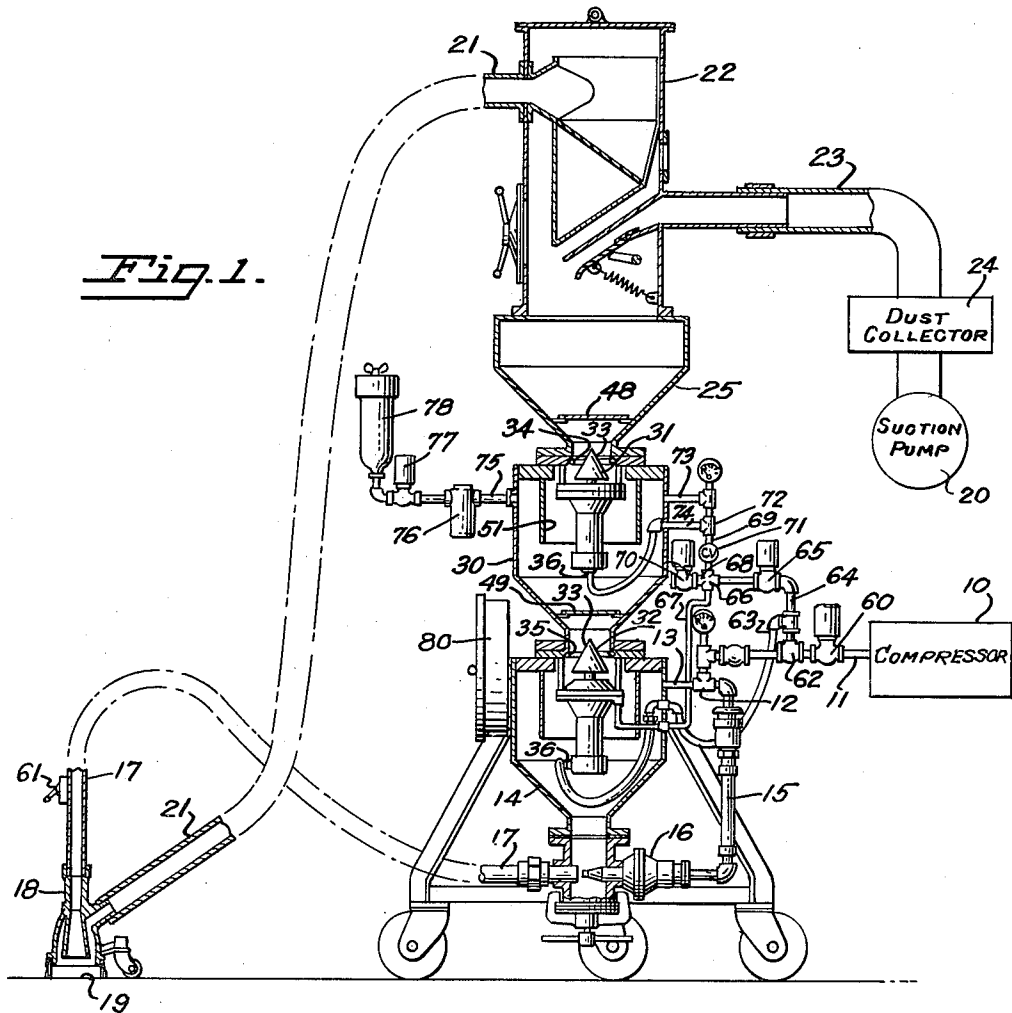
May 20, 1952

L. H. BISHOP ET AL
SURFACE TREATING APPARATUS

2,597,434

Filed Dec. 27, 1948

3 Sheets-Sheet 1



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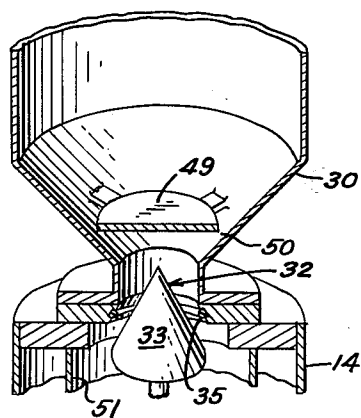
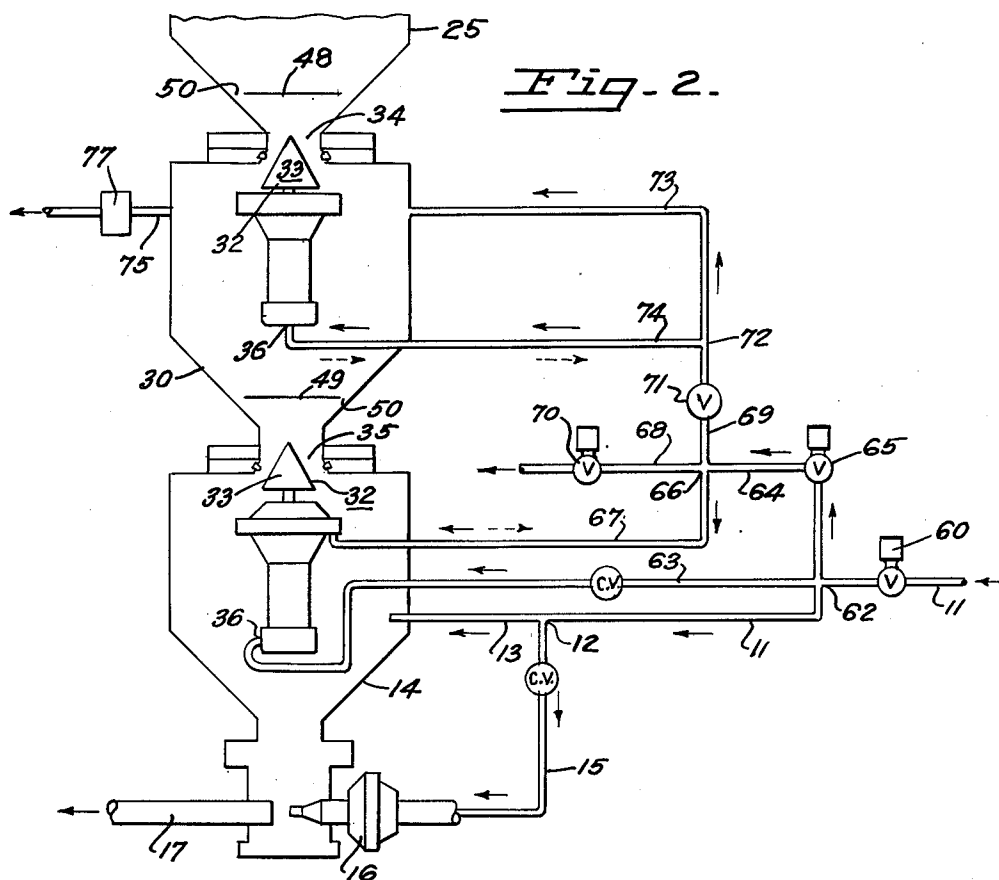
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3 Sheets-Sheet 2



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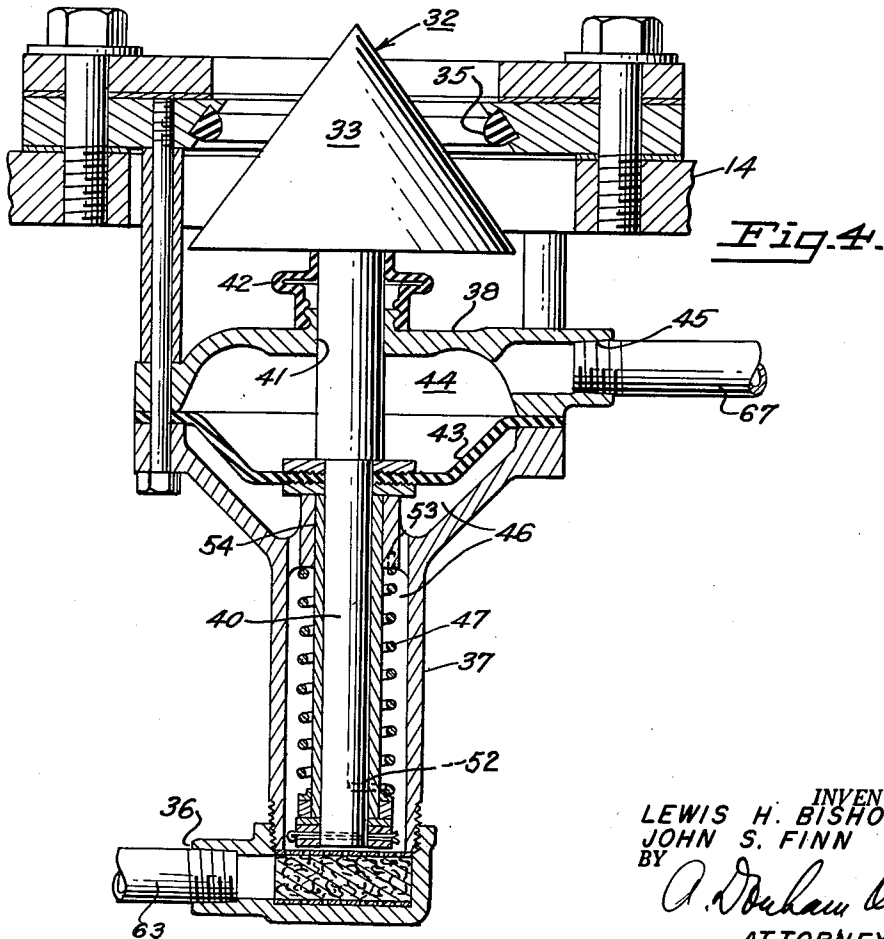
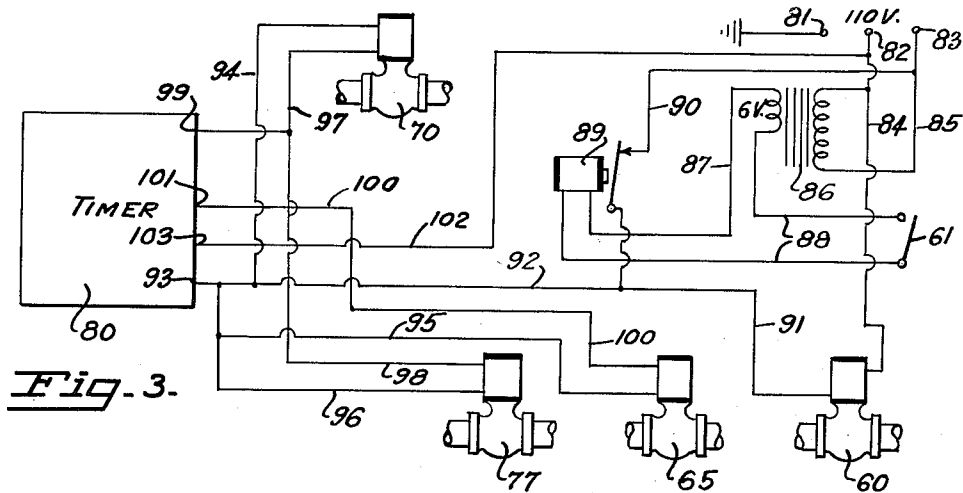
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,597,434

SURFACE TREATING APPARATUS

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11 Claims. (Cl. 51—12)

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This invention relates to a method for continuous operation of a surface treating machine and to a continuously operating surface treating apparatus. More particularly, this invention relates to a method and an apparatus for continuously impelling abrasive against a surface, removing the abrasive and waste material from the surface, separating the abrasive and waste material, and reusing the abrasive. The invention also relates to a method and an apparatus for intermittently transferring material from a chamber under one set of pressure conditions to a chamber under another set of pressure conditions.

The invention is particularly useful with surface treating methods and apparatus of the type described in the patent to William H. Mead, No. 2,455,514, issued December 7, 1948. That device simultaneously impels treating material against a surface and suction-removes the spent abrasive and waste material. By employing a grit reclaimer, such as that described in the co-pending application No. 778,378, filed October 7, 1947, the spent abrasive can be separated from the waste material and re-used.

The problems solved by this present invention are those having to do with making possible continuous operation of such or similar apparatus. The problems arise from the fact that the abrasive, which is impelled against a surface by a high-pressure blast of air or by an impeller wheel and is removed from the surface by a vacuum pump, carries along with it the waste material which is abraded from the surface. The abrasive grit is next separated from the waste material while still under extremely low pressure conditions. One problem which had to be solved before the apparatus could operate continuously was how to restore the abrasive from the low pressure atmosphere without either interfering with the low pressure conditions in the abrasive-removing line, or reducing the high pressure in the abrasive-impelling line.

Heretofore, it was necessary to shut off the machine during such transfer, so that the pressure in the blast line dropped to atmospheric while the pressure in the suction line rose to atmospheric. Then a valve between the abrasive feed hopper and the abrasive reclaimer could be opened and the material transferred. This necessity for periodic stoppages for transfer limited the length of time the machine could be operated continuously to the time taken to consume one feed-hopper full of abrasive. Every time the contents of the hopper were consumed,

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the operator had to stop the machine to refill the hopper.

One important object of this invention is to provide an apparatus enabling continuous operation of such a machine. This invention automatically replenishes the feed hopper during use, and there is no need to interrupt operations for refilling the hopper.

Another object of the invention is to provide an apparatus for transferring material between chambers under different pressure conditions.

Another object of the invention is to provide a transfer apparatus of the type described which will not adversely affect the pressure conditions in the chambers.

Another object of the apparatus is to provide an apparatus for transferring granular material from a low pressure chamber to a high-pressure chamber without substantially altering the pressure conditions in either chamber.

A further object of the invention is to provide an automatic transfer device of the type described.

Another object of the invention is to provide a time-controlled transfer apparatus.

A further object of the invention is to provide an apparatus suitable for continuous sand-blasting with a relatively small quantity of grit.

A further object is to achieve continuous sand blasting over a long period of time, without having to supplement a relatively small, mobile supply of abrasive.

Other objects and advantages of the invention will appear from the following detailed description of an embodiment, presented in accordance with U. S. Revised Statutes, Sec. 4888. It is appreciated that changes in detail may be made in accordance with the principles set forth, so that a machine differing in some details from this embodiment would still be within the spirit of the invention as described in the appended claims.

In the drawings:

Fig. 1 is a view in elevation, partly in section, of a continuous surface treating apparatus embodying the principles of the invention;

Fig. 2 is a diagram of the piping circuit in the transfer apparatus;

Fig. 3 is a diagram of the electrical circuit employed;

Fig. 4 is an enlarged view in elevation and in section of the lower dump valve; and

Fig. 5 is a view in perspective and in section of the apparatus in the vicinity of the lower dump valve.

The apparatus employs an intermediate chamber between the low pressure reclaimer hopper and the high pressure feed hopper. By connecting the intermediate chamber to only one of the said chambers at a time, the material is transferred first from the low pressure hopper to the intermediate chamber and subsequently from the intermediate chamber to the feed hopper. The pressure of the intermediate chamber is raised before the valve to the high pressure chamber is to be open, and after this valve is closed the pressure in the chamber is reduced before the valve to the low pressure chamber is opened. All of these valves and pressure adaptors are controlled by a timing device which alternates them according to a predetermined cycle.

Fig. 1 shows a device embodying the principles of this invention used in conjunction with a surface-treating apparatus of the type described more fully in Patent No. 2,455,514. A compressor 10 sends air under pressure through a conduit 11. At a manifold 12 the air current is divided, a conduit 13 shunting some of the air into a grit feed hopper 14, while the rest of the air is fed through a conduit 15 into a grit-feed valve 16. This valve 16 is preferably of a type described in the copending application by William H. Mead, Ser. No. 55,243, filed October 18, 1948, which issued as Patent No. 2,521,931, dated September 12, 1950. Grit is introduced from the hopper 14 into the blast current at the valve 16 and is fed through a conduit 17 to an operating head 18, where it is impelled against a surface 19.

A suction pump 20 draws the spent abrasive and waste material (such as paint flakes, rust, sawdust, etc.) out of the head 18 through a suction conduit 21 into a grit reclaimer 22, preferably of the type disclosed in pending application Serial No. 778,378, filed October 7, 1947. Here the abrasive and waste are separated, and the waste is carried out through a conduit 23 to any form of dust collector. The reclaimed abrasive falls down into a reclaimer hopper 25, still under near-vacuum conditions.

Between the reclaimer hopper 25 and the feed hopper 14 is positioned an intermediate transfer chamber 30. At its upper end is an upper dump valve 31, and at its lower end is a lower dump valve 32. Both valves 31 and 32 comprise air-actuated, cone-shaped plugs 33, which are closed against the respective openings 34 or 35 by compressed air entering through openings 36 at the lower end of the valves.

The upper valve 31 opens by a combination of spring pressure and gravity, dropping when the air pressure inside the valve falls below a certain level, and then permits grit to fall from the reclaimer hopper 25 into the intermediate transfer chamber 30.

The lower valve 32 is adapted for quicker and more positive control. As shown in Fig. 4, the lower valve 32 is supported by a housing 37 which is suspended from the feed hopper housing 14. The lower end of the housing 37 is closed except for the opening 36, and the upper end is also closed, preferably by a hood 38. A valve stem 40, which depends from the cone 33, is slidable up and down through an opening 41 in the hood 38. To prevent grit from working down through the opening 41, a flexible, collapsible sleeve or boot 42 is secured tightly around the stem 40 and around the opening 41.

Below the hood 38 is an annular flexible diaphragm 43. Its inner periphery is secured to the stem 40 and its outer periphery is secured to the

housing 37. The diaphragm 43 and the hood 38 enclose an upper chamber 44, having an opening 45 through which compressed air may enter from the duct 67, in a manner to be explained. Below the diaphragm is a lower chamber 46, open only to the air pressure inlet 36.

A stretched spring 47 surrounds the stem 40 in the lower chamber 46. The lower end 52 of the spring 47 is secured to the stem 40, while upper end 53 of the spring is anchored to the valve housing 37. The spring 47 biases the valve 32 downwardly toward its open position. The force of the spring 47 augments the force of gravity and aids in providing a quicker opening action against the friction of the stem 40 in its guides 41 and 54 and the force necessary to compress the boot 42.

Preferably the spring 47 is a light one; for example, a very successful valve uses a spring which exerts a force of about ten pounds. When the blast line is operated at 100 p. s. i., a typical diaphragm 43 (having an area of 20 square inches) will be forced up with 2000 lbs. pressure by air in the chamber 46. Thus the spring will not open the valve until the air pressure in the upper chamber reaches about 1990 lbs., or 99.5 p. s. i. Due to this relationship, the valve 32 and the whole apparatus may be operated over a very wide range of pressures without changing the spring 47, and the valve 32 will not open until the pressure in chamber 44 almost balances the pressure in chamber 46.

The chamber 46 is kept under pressure continuously during operation of the machine, and this air pressure holds the cone 33 normally up against the opening 35. However, when the air pressure in the upper chamber 44 (in a manner to be described) balances the air pressure in the lower chamber 46, the weight of the cone and other moving parts overbalances the spring 47 and the cone 33 drops, opening the valve 32.

A baffle plate 48, 49 is positioned above each opening 34, 35 just above where the point of the cone 33 rests when the cone is in its upper or closed position. These baffles 48, 49 prevent the grit from stacking up over the openings 34, 35 and keep the space above the openings free so that the cones 33 can close quickly and easily. Otherwise, when the pressure changes in the chamber 30 there might be disruption of the system by a leak from the high pressure chamber 14 into the lower pressure chamber 25. All the grit must pass through the spaces 50 between the periphery of the baffle plates and the hopper walls. Then it slides down the inclined hopper walls and into the vertical opening.

Preferably a shroud 51 hangs down underneath and around each opening 34 and 35 to keep grit out of the air openings adjacent the upper ends of the hoppers 14 and 30.

The pressure in the reclaimer hopper 25 is normally about ten inches of mercury, while the pressure in the feed hopper chamber 14, during typical operating conditions, is normally kept at about one hundred pounds per square inch; therefore, valves 31 and 32 are never allowed to open at the same time while the apparatus is operating. Moreover, the air inside the intermediate chamber 30 is brought to a pressure approaching the pressure in the feed hopper 14 (approximately one hundred pounds per square inch in this case) before the valve 32 is opened. The pressure is reduced after the valve 32 closes and before the valve 31 opens. These conditions are obtained by means of the pressure control circuits shown in

Fig. 2 and the electrical control circuits shown in Fig. 3.

In the pressure conduit 11 is a master solenoid valve 60, controlled by a suitable electric switch 61 on the operating head 18. This switch 61 is thus used to shut the blast line off and on; it may also, if desired, be used to turn on and off the timing mechanism 80.

Between the valve 60 and the T fitting 12 on the conduit 11 is an X fitting 62. At the fitting 62 two conduits 63 and 64 open off the line 11. The conduit 63 leads to the lower opening 36 of the lower dump valve 32 and air pressure therein urges the valve 32 toward a closed position when the machine is operating.

The conduit 64 leads through a second solenoid valve 65, which can effect control of the valves 31 and 32 as well as the pressure inside the intermediate chamber 30. Beyond the solenoid valve 65, is another X fitting 66, from which three conduits 67, 68 and 69 lead out. The conduit 67 leads to the opening 45 in the upper chamber 44 of the lower dump valve 32. Compressed air which passes through the solenoid valve 65 is conducted to the chamber 44 and opens the valve 32. The pressures above and below the diaphragm 43 balance each other and gravity and the spring 47 open the valve 32.

The conduit 68 leads to a third solenoid valve 70, and thence vents to the atmosphere when the valve 70 is open. The solenoid valve 70 is opened only when and at the same moment as the solenoid valve 65 is closed, and at that time quickly bleeds the air from the chamber 44, so that the lower valve 32 closes.

The conduit 69 leads up through a check valve 71 (which prevents air from flowing backwards through the conduit 69 and out the valve 70 when the latter is open) to a T fitting 72. There, the conduit 69 is divided into a conduit 73 passing into the tank 30 and a conduit 74 leading to the dump valve 31. Thus, when the solenoid valve 65 is open, the valve 31 is closed almost immediately and when the pressure inside the tank 30 reaches approximately the level of the pressure inside the hopper 14, the valve 32 opens.

Preferably the conduits are of sufficiently small diameter so that the pressure does not build up instantaneously in the upper chamber 46 of the valve 32 or inside the intermediate chamber 30. After the valve 31 has closed, three or four seconds may elapse before the pressure in the chamber 46 and in the chamber 30 approximates the pressure in the hopper 14. In this way there will be no drop in pressure when the valve 32 opens. Otherwise, there will not be complete continuity, and a portion of the surface 19 may be skipped and not treated during the time necessary to equalize the pressure. This is one problem which the present device solves in the manner just indicated.

A bleed conduit 75 leads out from the tank 30 through a strainer 76 to a solenoid valve 77, and when the valve 77 is open, air may pass out through a muffler 78 to the open air. The strainer 76 prevents any grit from getting into solenoid 77 and damaging it, and the check valve 71 performs the same function for the solenoid valve 70. The muffler 78 silences the noise from the rush of air.

Since the solenoid valve 60 is open whenever the machine is operating, the air current then flows through the blast conduit 17 and through the conduit 63 to fill the lower chamber 46 of the dump valve 32 to hold it closed. The other

three solenoid valves 65, 70 and 77 are controlled by a timer 80. When the valve 65 is open, the valves 70 and 77 are closed, and vice versa.

The electrical circuit is shown in Fig. 3. Preferably a three line A. C. supply is used, with one wire 81 grounded. From the second side 82 and the third side 83 of a 110-volt A. C. supply, wires 84 and 85 lead to a 110-volt-6-volt transformer 86. From each pole of the 6-volt side, wires 87 and 88 lead to a 6-volt relay 89, line 88 passing through the master switch 61. From one pole of the relay actuator, a wire 90 leads to the side 82 of the 110 volt input line. From the other side of the relay actuator 89, one wire 91 leads to the master solenoid 60, and another wire 92 leads to post 93 of the timer 80. The solenoid 60 is thus independent from the timer 80, but both the timer 80 and the valve 60 are energized by the switch 61. When the current is on, the valve 60 is always open, and the timer 80 operates continuously.

Wires 94, 95 and 96 each lead from the timer post 93 to one side of the solenoids 65, 70 and 77, respectively. Wires 97 and 98 lead back from the opposite sides of the solenoids 70 and 77 to a switch element 99 of the timer 80, and a wire 100 leads from the opposite side of the solenoid 65 to a switch element 101 on the timer 80. Another wire 102 leads from the timer post 103 to the A. C. line 82.

All three solenoids 65, 70 and 77 operate simultaneously but not in the same direction. That is, when the circuit controlling the valve 65 is closed so that the valve 65 is open, the circuit controlling the valves 70 and 77 is open so that the valves 70 and 77 are closed. Air will then pass into and be confined in the tank 30. When the circuit controlling the valve 65 is open, the valve 65 is closed, and no air passes beyond it. Simultaneously, the other circuit is closed, and the valve 70 is opened to bleed off the valve 32 so that the latter closes almost instantly on a short drop in pressure. The same circuit simultaneously opens the valve 77 to bleed out the tank 30 and valve 31, which opens when the pressure has dropped.

In operation, when the master switch 61 is turned on, the solenoid valve 60 is opened to admit air from the compressor 10 through the conduit 11 to the feed tank 14 and feed valve 16, so that abrasive is sent to the head 18. At the same time, the timer 80 is started and runs its cycle.

For convenience, we shall assume that the solenoid valve 65 is closed to begin with. Therefore, no air flows from the conduit 11 into the conduit 64, and consequently none flows in the conduits 67, 73 and 74. The upper dump valve 31 is held open by its spring and by gravity. The lower dump valve 32 is closed, because there is no pressure in the upper chamber 44 and the lower chamber 46 is under high pressure. The suction pump 20 is operating, and it keeps the reclaimer hopper 25 at a vacuum of about 10 inches of mercury. Any reclaimed grit remaining in the reclaimer 25 falls through the slits 50 around the edges of the plate 43 and is stored in the tank 30.

After a period of time determined to occur before all the grit is used out of the tank 14 the timer 80 throws a switch which opens the solenoid 65 and closes the solenoids 70 and 77. Air then flows from the conduit 11, through the conduit 64, into the conduits 67, 73 and 74. From the conduit 74 air passes into the upper dump

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valve 31 and closes it almost immediately. Air passing through the conduit 73 fills the tank 30, and the pressure soon approaches and equals the pressure in the feed hopper 14. At the same time, air fills the upper chamber 44 of the valve 32, and when it reaches a pressure closely approaching that in chamber 46, the valve is opened by its spring 47 and its co-acting forces. Grit inside the tank 30 can then fall down through the slits 50 around the baffle 49 and down into the feed hopper 14, replenishing it without interfering with the pressure conditions in the blast line.

When the timer 60 reaches another predetermined position, the solenoid valve 65 is closed and the valves 70 and 77 are opened. Conduits 67, 73 and 74 are cut off from their supply of air, while conduits 68 and 75 are opened to the atmosphere. Air immediately bleeds out of the upper chamber 44 of the lower dump valve 32, while the check valve 71 prevents any cushioning effect from the conduits 73 and 74. When the pressure has dropped only a short way (usually a pound, or less) the air pressure in the chamber 46 closes the lower dump valve 32. The air in the tank 30 flows to atmosphere out the conduit 75 through the strainer 76, solenoid valve 77, and muffler 78. Simultaneously the air in the upper dump valve 31 flows back through the conduit 74 into the conduit 73, through the tank 30 and the conduit 75, and out to atmosphere. When the pressure is low enough (i. e., approaching atmospheric), the upper dump valve 31 opens, and what little air remains is immediately sucked out by the pump 20. In a typical installation the pump 20 draws 300 cubic feet of air per minute. Since the volume of the chamber 30 is only a cubic foot or so, this small pressure differential will not affect the operation at the head. When the valve 31 opens, the grit stored up in the chamber 25 may then fall down again into the chamber 30, completing the cycle.

What is claimed is:

1. An apparatus for continuous abrasive-blasting, comprising a feed hopper for storing abrasive material, an air blast line, a feed valve for feeding said material into said line, an operating head where said material is impinged against a surface, a suction line for withdrawing said material and waste from said surface, a separator for salvaging said material out of said waste, a reclaimer hopper for receiving said withdrawn material, an intermediate hopper between said reclaimer hopper and said feed hopper, a first transfer valve between said reclaimer hopper and said intermediate hopper, a second transfer valve between said intermediate hopper and said feed hopper, a timing device, and an electrical relay operated by said timing device to alternately close said first valve and open said second valve and close said second valve and open said first valve.

2. An apparatus for continuous abrasive-blasting, comprising a feed hopper for storing abrasive material, an air blast line, a feed valve for feeding said material into said line, an operating head where said material is impinged against a surface, a suction line for withdrawing said material and waste from said surface, a separator for salvaging said material out of said waste, a reclaimer hopper for receiving said salvaged material, an intermediate hopper between said reclaimer hopper and said feed hopper, a first transfer valve between said reclaimer hopper and said intermediate hopper, a second transfer valve

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between said intermediate hopper and said feed hopper, a timing device, an electrical relay operated by said timing device to alternately close said first valve and open said second valve and close said second valve and open said first valve, means to admit air to said intermediate hopper when said first valve is closed, and means to bleed air from said intermediate hopper when said second valve is closed.

3. An apparatus for transferring granular material from a low pressure chamber to a high pressure chamber, comprising an intermediate chamber placed below said low pressure chamber and above said high pressure chamber, a first valve between said intermediate chamber and said low pressure chamber, a second valve between said intermediate chamber and said high pressure chamber, a timing device, and means operated by said timing device for alternately opening said first valve while said second valve is closed and opening said second valve while said first valve is closed.

4. The apparatus of claim 3 in which there is means controlled by said timer for increasing the pressure in said intermediate chamber between the time said first valve closes and the time said second valve opens, and means controlled by said timer for reducing the pressure in said intermediate chamber between the time said second valve closes and the time said first valve opens.

5. An apparatus for transferring granular material from a low pressure chamber to a high pressure chamber, comprising an intermediate chamber placed below said low pressure chamber and above said high pressure chamber, a first valve between said intermediate chamber and said low pressure chamber, a second valve between said intermediate chamber and said high pressure chamber, a timing device, and an electrical relay control operated by said timing device for alternately opening said first valve while said second valve is closed and opening said second valve while said first valve is closed.

6. An apparatus for transferring granular material from a low pressure chamber to a chamber maintained at high pressure by a high pressure line without upsetting the pressures concerned, comprising an intermediate chamber placed below said low pressure chamber and above said high pressure chamber; an air operated valve between said intermediate chamber and each of the other said chambers; a first solenoid valve adapted to open for simultaneously admitting air from said high pressure line to the upper of said valves to close it and for admitting air from said high pressure line to said intermediate chamber to build up the pressure therein and for admitting air from said high pressure line to said lower valve to open it when its pressure and the pressure in said intermediate chamber reach a predetermined value, said solenoid valve also being adapted to close for simultaneously cutting off all air from the high pressure line to said valves and said intermediate chamber; a second solenoid valve adapted to open to bleed air from said lower valve to close it; a third solenoid valve adapted to open for bleeding air from said intermediate chamber so that its pressure may be reduced and from said upper valve so that it may open when its pressure drops below a certain point; an electrical circuit to operate said solenoid valves; and a timer which adapted to alternately open said first solenoid valve and simultaneously close said second and

third solenoid valves for one part of a cycle, and to close said first solenoid valve and simultaneously open said second and third solenoid valves over another part of said cycle.

7. An apparatus for continuous abrasive-blasting, comprising: a feed hopper for storing abrasive material; an air blast conduit; means for feeding said material into said conduit; means for impinging said material from said conduit against a surface to be treated; means for withdrawing said material from said surface; a reclaimer hopper for receiving said withdrawn material; an intermediate hopper between said reclaimer hopper and said feed hopper; a first transfer valve between said reclaimer hopper and said intermediate hopper; a second transfer valve between said intermediate hopper and said feed hopper; a timing device; and means actuated by said timing device for alternately closing said first valve and opening said second valve, and closing said second valve and opening said first valve.

8. An apparatus for continuous abrasive-blasting, comprising a feed hopper for storing abrasive material; an air blast conduit; means for feeding said material into said conduit; means for impinging said material from said conduit against a surface; means for withdrawing said material from said surface; a reclaimer hopper for receiving said withdrawn material; an intermediate hopper between said reclaimer hopper and said feed hopper; a first transfer valve between said reclaimer hopper and said intermediate hopper; a second transfer valve between said intermediate hopper and said feed hopper; a timing device; means actuated by said timing device for alternately closing said first valve and opening said second valve, and closing said second valve and opening said first valve; means for admitting air to said intermediate hopper when said first valve is closed; and means for bleeding air from said intermediate hopper when said second valve is closed.

9. An apparatus for transferring granular material from a first chamber to a second chamber, comprising an intermediate chamber placed between said first and second chambers; a first valve between said intermediate chamber and said first chamber; a second valve between said intermediate chamber and said second chamber; a timing device; and means operated by said timing device for alternately opening said first valve while said second valve is closed and opening said second valve while said first valve is closed.

10. The apparatus of claim 9 in which there is means controlled by said timer for increasing the pressure in said intermediate chamber between the time said first valve closes and the time

said second valve opens, and means controlled by said timer for reducing the pressure in said intermediate chamber between the time said second valve closes and the time said first valve opens.

11. An apparatus for transferring granular material from a low pressure chamber to a chamber maintained at high pressure by a high pressure line, without upsetting the pressures concerned, comprising an intermediate chamber placed below said low pressure chamber and above said high pressure chamber; a pair of pneumatic valves, one being located between said intermediate chamber and each of the other said chambers to open and close the passages between said chambers; a first control valve adapted when opened to simultaneously admit gas from said high pressure line to the upper of said pneumatic valves to close it and to admit gas from said high pressure line to said intermediate chamber to build up the pressure therein and to admit gas from said high pressure line to the lower of said pneumatic valves to open it when its pressure and the pressure in said intermediate chamber reach a predetermined value, said first control valve also being adapted when closed to simultaneously cut off all gas from the high pressure line to said pneumatic valves and said intermediate chamber; a second control valve adapted when opened to bleed gas from said lower pneumatic valve to close it; a third control valve adapted when opened to bleed gas from said intermediate chamber so that its pressure may be reduced and from said upper pneumatic valve so that it may open when its pressure drops below a certain amount; and timing means adapted to alternately open said first control valve and simultaneously close said second and third control valves for one part of a cycle, and to close said first control valve and simultaneously open said second and third control valves for another part of said cycle.

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