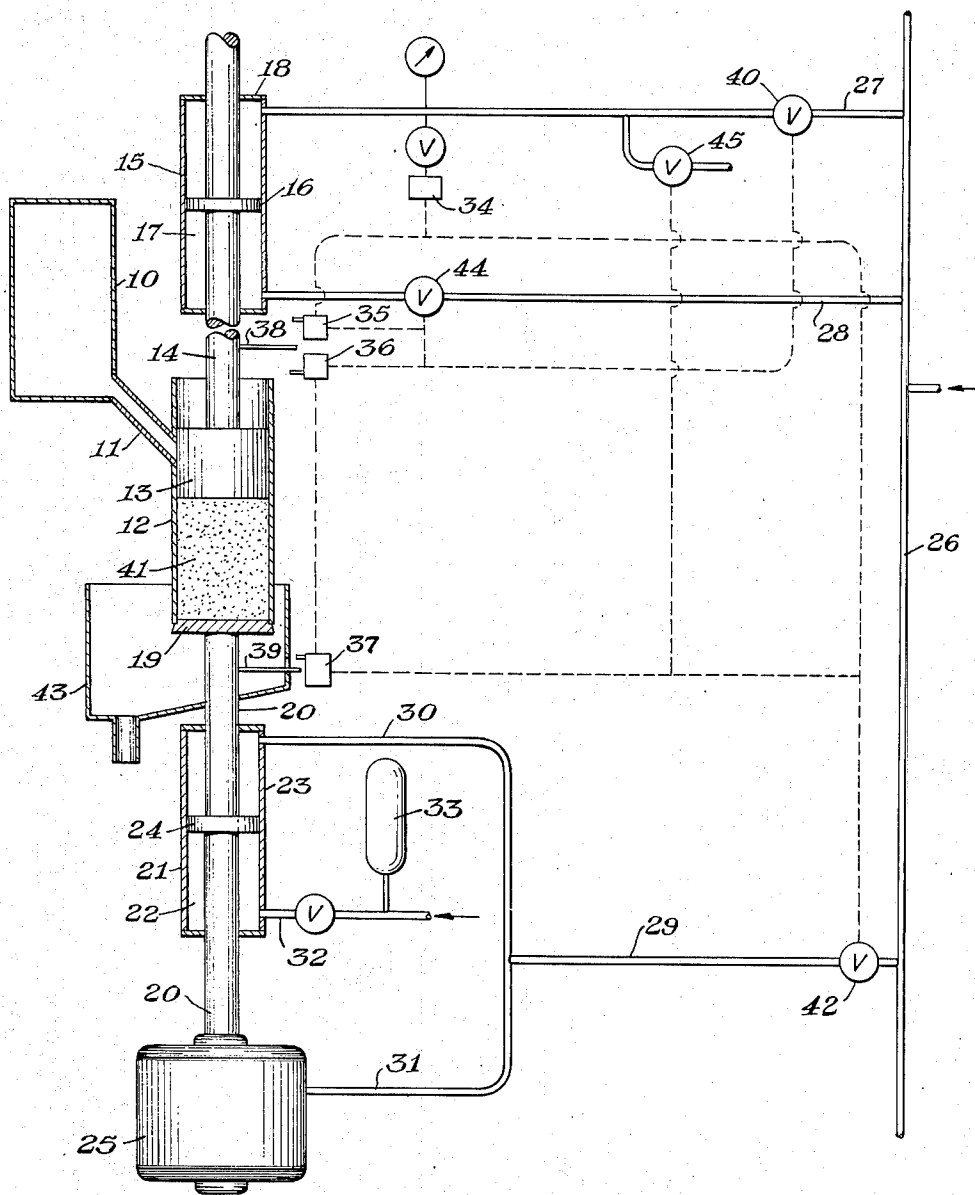


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MACHINE FOR DENSIFYING POWDERS AND FOR TRANSFERRING
THEM FROM ONE ATMOSPHERE TO ANOTHER
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MACHINE FOR DENSIFYING POWDERS AND
FOR TRANSFERRING THEM FROM ONE
ATMOSPHERE TO ANOTHERLouis O. Simenson, Berkeley, Calif., assignor to
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1

This invention relates to a pump for moving powdered or dusty materials from one atmosphere to another without significant leakage of the one atmosphere to the other.

Many industries are troubled by the necessity for handling finely divided powders or dusts in large quantities. These may be pyrophoric, or they may present explosion hazards when mixed with air. For these and other reasons, such dusts are commonly transferred, as produced, to an inert atmosphere, or they are discharged from one medium to another with the exercise of rigid safety precautions. It is commonly observed that, at the point of discharge, using the available equipment, the new atmosphere leaks back into the old one, and the old atmosphere leaks into the new one. This is objectionable and costly, either because of newly created hazards, or because of loss of expensive materials, or because of the added load on pumps required to maintain either atmosphere in a preselected condition of pressure or concentration of constituents. One such problem arises in the manufacture of alkali metal alkyl xanthates which are produced in fine powder form in a flammable reaction medium and are pyrophoric when freed from that medium until they are pelletized. It is necessary to prevent leakage of flammable vapors from the reaction vessel, and to protect the fine powder from ignition. Other dusts or powders which present other but equally aggravating problems are found in many industries, and include powdered caustic alkalies, wood flours, resin dusts, and many others.

The objects of the present invention include the provision of apparatus for transferring dusts or fine powders from one atmosphere to another without interchange between those atmospheres and the provision of such apparatus capable of so densifying powders as to reduce or eliminate the hazards incident to their original dusty condition. A particular object is the provision of such apparatus capable of automatic repetitive operation.

The apparatus of the invention comprises a vertical cylinder connected through a chute with a source of supply of the dust to be transferred, a disk capable of forming a mechanical seal over the lower end of the cylinder, a piston within the cylinder for compressing a charge of powder therein, means above the cylinder for advancing and retracting the piston, means below the cylinder for holding the disk firmly while the load in the cylinder is being compacted and for retracting the disk and rotating it to abrade the

2

lower end of the compacted dust plug and convert the same into a coarser and denser powder, and auxiliary control means for moving each of the working parts in its proper sequence.

The apparatus will be described more fully with reference to the annexed drawing, the single figure of which is a vertical section through the principal elements of the dust pump, and a diagrammatic representation of one satisfactory set of controls therefor.

A source or supply 10 of fine powder is connected through chute 11 with a vertically disposed compression chamber, such as cylinder 12. Piston 13, having a close sliding fit in cylinder 12, is carried at the lower end of rod 14, the upper portion of which passes through hydraulic cylinder 15 and carries a second piston 16, dividing cylinder 15 into separate lower chamber 17 and upper chamber 18. A disk 19, coaxial with the lower end of cylinder 12, and shaped to make a tight mechanical closure over the end of said cylinder, is carried at the upper extremity of shaft 20 which extends downwardly through another hydraulic cylinder 21 which is divided into lower chamber 22 and upper chamber 23 by piston 24 carried on shaft 20. Shaft 20 extends below cylinder 20 and its lower extremity forms the axis of a positive displacement gear motor 25. A source (not shown) of hydraulic fluid is connected through a header 26 and lines 27, 28, 29, 30 and 31 to chambers 18, 17 and 23 and to motor 25, respectively. Chamber 22 is connected through line 32 with pressure accumulator 33 and the source (not shown) of hydraulic fluid. The several lines are valved and the valves are connected with and actuated by electrical circuits, as will be described later. The electrical circuits contain switches 34, 35, 36 and 37, the first of which is actuated in response to a preselected pressure condition in chamber 18 and the others of which are tripped by arms 38 and 39 mounted on shafts 14 and 20, respectively.

The operation of the apparatus is repetitive, and, for ease of understanding may be deemed to begin with piston 13 raised to a position above the opening of chute 11 into cylinder 12. Power is admitted to cylinder 12 from the supply 10 while disk 19 is in the illustrated position closing the lower end of cylinder 12. Hydraulic fluid is supplied through line 27 and control valve 40 to upper chamber 18 in hydraulic cylinder 15. Full pressure is not attained immediately in chamber 18, due to pressure drop in the lines and to the initial yielding of the body of powder in cylinder 12. As piston 13 is forced downward by the hydraulic

pressure in chamber 18, the pressure increases and the powder is compacted. Pressure switch 34 is actuated when the pressure in chamber 18 reached a value which has been found sufficient to give the desired density to the plug 41 of compacted powder. Switch 34 opens valve 42 in line 29 which supplies hydraulic fluid to lines 30 and 31 to lower shaft 20 and its supported disk 19 away from cylinder 12 and to drive motor 25, thereby rotating disk 19. The pressure in chamber 22 is held constant by accumulator 33, and, until this pressure is overcome by the combination of the forces transmitted through the powder plug 41 by piston 13 and the pressure in chamber 23, disk 19 is held securely in place against cylinder 12 and motor 25 cannot turn. When disk 19 is freed, hydraulic fluid passes through motor 25, causing disk 19 to rotate and abrade a relatively coarse and dense powder from the plug 41 being forced out of cylinder 12. This powder may be collected in a suitable hopper 43 and fed to further processing apparatus or to packaging equipment.

As hydraulic fluid moves through motor 25, the resulting pressure drop draws additional fluid from chamber 23 through line 30, reducing the pressure therein. The constant pressure in accumulator 33 and in chamber 22 then causes shaft 20 and disk 19 to rise until disk 19 is held securely against cylinder 12. Thereupon, motor 25 is no longer free to rotate.

In the course of the downward movement of piston 13, and before the plug 41 of compacted powder has been worn too thin by the action of rotating disk 19 to maintain an effective seal against intrusion of air into cylinder 12, switch 36 is actuated by arm 38 carried on rod 14. This closes valve 40. When disk 19 approaches its seated position beneath cylinder 12, arm 39 actuates switch 37. Switches 36 and 37 are interlocked so that when both are closed they close valve 42 which, however, allows excess fluid from chamber 23 to be forced back into line 26. Valves 44 and 45 are opened when valve 42 is closed. Valve 44 admits hydraulic fluid to chamber 17 and valve 45 releases the fluid from chamber 18. These conditions favor a rapid upward stroke of piston 13 to admit more power from chute 11 to cylinder 12. At the upper end of the stroke of piston 13, arm 38 actuates switch 35 which resets pressure switch 34, closes valve 45, opens valve 40 and thus puts the apparatus in condition to start another cycle. The described sequence is repeated as long as desired.

The forces which act to discharge the compacted plug 41 of powder from cylinder 12 are the hydraulic pressures in chambers 18 and 23. Those which act to hold the powder in cylinder 12 are the friction generated in compacting the powder and the hydraulic pressure in chamber 22 which is supplied by accumulator 33. Variations in the nature of the powder being handled, which result in differences in its tendency to jam in the compressing cylinder, are compensated for by adjustment of the operating pressure of accumulator 33, which is supplied independently of the other pressures in the system. If the powder being acted on is free-flowing, it must be compacted tightly before it will form the required seal against "blow outs," and a relatively high pressure must be maintained in the accumulator. If, however, the powder is sticky or has a tendency to form a coherent mass, a relatively low pressure is required in the accumulator, to form the desired plug and to prevent jamming.

The distance below cylinder 12 to which disk 19 drops and at which it operates is controlled by the setting of control valve 40. This valve controls the rate at which hydraulic fluid is supplied to chamber 18, and hence the rate at which piston 13 is caused to descend, forcing downward plug 41 and disk 19. Valve 42 similarly controls the lag between the depression of disk 19 and the beginning of rotation of motor 25. Thus, the settings of valves 40 and 42 affect the rate of attrition of plug 41 by disk 19.

In the compaction of pyrophoric alkali metal alkyl xanthate powders, the herein-described apparatus accepts a fluffy powdered feed having a bulk density of about 20 pounds or less per cubic foot and compresses it to a plug from which the abrader disk grinds a non-pyrophoric powder having a bulk density of 40 to 60 pounds per cubic foot. This is done with an available hydraulic pressure to header 26 of about 1500 pounds per square inch, and pressure switch 34 is set to operate at about 600 pounds per square inch. The independently maintained pressure in accumulator 33 is about 1200 pounds per square inch. Having described the new machine and its mode of operation, the selection of suitable pressure conditions for use with other powders is within the skill of the art.

I claim:

1. In a machine for densifying powders and for transferring them from one atmosphere to another, the combination of a vertical compression cylinder; a piston therein; an externally and coaxially supported disk closure over the end of the cylinder opposing said piston; means for supplying a compressible powder intermittently to the cylinder between said piston and said disk; external pressure means for advancing the piston to compress powder against said disk; a constant pressure means associated with said disk for holding it in engagement with the cylinder until said constant pressure is overcome by that applied to the piston; means associated with said disk for causing it to rotate in abrading relationship to the compacted powder forced from the cylinder when the disk is disengaged from the end of the compression cylinder; means associated with the piston and responsive to a predetermined penetration thereof into the compression cylinder: (a) to reverse the direction of said external pressure means and thereby to return the piston to its original position, and (b) to restore control of said disk to said constant pressure means, thereby to return said disk to engagement with said cylinder and to immobilize said disk; and, means responsive to the reengagement of the disk with the cylinder to reactivate said external pressure means for advancing the piston.

2. In a machine for densifying powders and for transferring them from one atmosphere to another, the combination of a vertical compression cylinder; a piston therein; an externally and coaxially supported disk closure over the end of the cylinder opposing said piston; means for supplying a compressible powder intermittently to the cylinder between said piston and said disk; a two-way hydraulic cylinder mounted coaxially about an external extension of the piston rod; a similar two-way hydraulic cylinder mounted coaxially on the support for said disk; a motor mounted on the end of the shaft supporting said disk; means for supplying hydraulic fluid under pressure to the outer end of the first said hydraulic cylinder to advance the piston to compress powder against said disk; pressure sensi-

5

tive means, responsive to the attainment of a predetermined pressure in the outer end of said first hydraulic cylinder for supplying hydraulic fluid to the inner end of said second hydraulic cylinder; means for maintaining a constant hydraulic pressure in the outer end of the second said hydraulic cylinder for holding the disk in engagement with the compression cylinder until said constant pressure is overcome by the pressure applied to the piston in combination with that exerted in the inner chamber of the second hydraulic cylinder; means for driving the motor and for rotating the disk in abrading relationship to the compacted powder forced from the cylinder when the disk is disengaged from the compression cylinder; means associated with the piston and responsive to a predetermined penetra-

6

tion thereof into the compression cylinder: (a) to admit hydraulic fluid under pressure to the inner end of the first said hydraulic cylinder and to release the fluid from the outer end thereof, and (b) to release hydraulic fluid from the inner end of the second said hydraulic cylinder and thereby to restore control of said disk to said constant hydraulic pressure means, to return the disk to engagement with the compression cylinder and to immobilize said disk; and, means responsive to the reengagement of the disk with the compression cylinder to reactivate the means for supplying hydraulic fluid to the outer end of the first said hydraulic cylinder and for releasing hydraulic fluid from the inner end of said cylinder.

No references cited