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ELEVATION OF GRANULAR SOLIDS

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Fig. 1

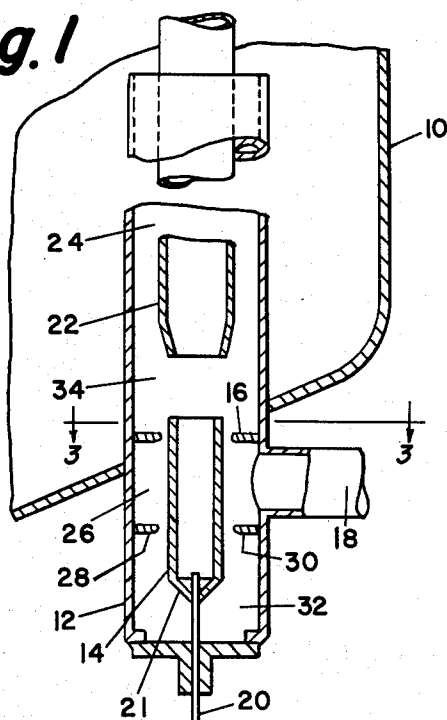


Fig. 2

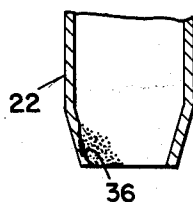


Fig. 3

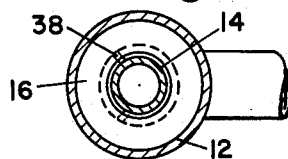


Fig. 4

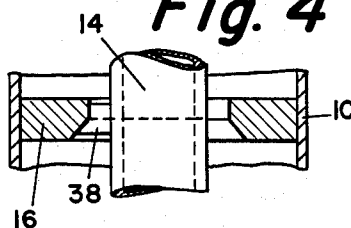


Fig. 5

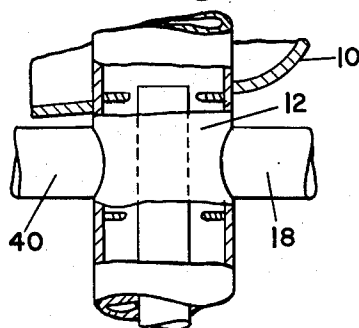
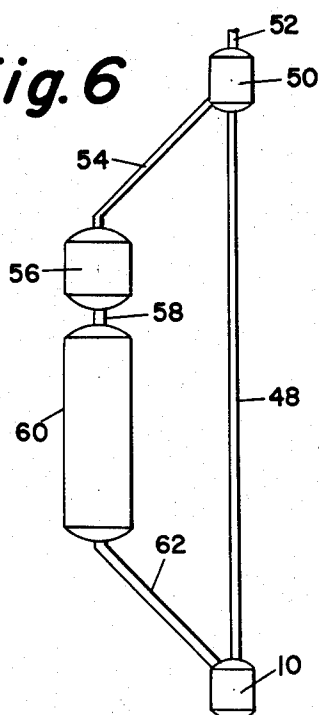


Fig. 6



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ELEVATION OF GRANULAR SOLIDS

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Original application May 31, 1960, Ser. No. 33,040, now Patent No. 3,052,501, dated Sept. 4, 1962. Divided and this application Mar. 16, 1962, Ser. No. 182,704 1 Claim. (Cl. 302—53)

This invention relates to an improvement in a known type of apparatus for elevating granular solids whereby erosion which would otherwise occur at the inlet of the lift conduit is reduced or eliminated.

In the elevation of granular solids by means of a lifting fluid, the lower end of the lift conduit is generally positioned within an engaging vessel into which the granular solids which are to be elevated are introduced, and into which a lifting fluid is introduced in order to engage the granular solids and carry them into the lift conduit and upwardly therethrough.

Various types of apparatus for bringing about the engagement of granular solids with lifting gas are employed in commercial installations. A highly satisfactory type of apparatus for this purpose is that which is disclosed in Patent No. 2,674,496 issued April 6, 1954 to Clarence H. Thayer.

Apparatus as disclosed in the above patent comprises a vertical nozzle which has an open upper end and an open lower end, and which is slidably positioned within an aperture in a partition plate. The upper end of the nozzle is positioned beneath the lower end of the lift conduit, and the nozzle and lift conduit are preferably coaxial. Surrounding a lower portion of the lift conduit and surrounding the nozzle is a sleeve which has a closed lower end and an open upper end which communicates with the interior of the engaging vessel. A horizontal fluid conduit communicates with a chamber located within the sleeve and beneath the partition plate. Fluid introduced through the conduit passes downwardly in the portion of the chamber surrounding the nozzle and enters the lower end of the nozzle. Granular solids within the engaging vessel pass downwardly by gravity through the annular space between the lower end of the lift conduit and the sleeve. When the solids reach the space between the upper end of the nozzle and the lower end of the lift conduit, they are engaged by fluid passing upwardly from the upper end of the nozzle. The fluid carries the solids into the lower end of the lift conduit and upwardly therethrough.

In operation of apparatus as above described, it has been found that erosion of the metal in the lift conduit by the granular solids frequently occurs at the lower end of the lift conduit. The present invention is directed to an improvement in the apparatus whereby this erosion and excessive attrition of the solids by contact with metal surfaces are reduced or eliminated.

This invention will be more fully described with reference to the attached drawing wherein FIGURE 1 is a partial view, in sectional elevation, illustrating the prior art apparatus to which the present invention is applied, FIGURE 2 is a detailed diagram of the lower end of the lift conduit illustrating the erosion which occurs in operation of the apparatus of FIGURE 1, FIGURES 3 and 4 are sectional plan and elevation views showing construction according to one embodiment of the invention, FIGURE 5 is a sectional elevation showing construction according to another embodiment of the invention, and FIGURE 6 is a schematic illustration of a pneumatic elevation system to which the invention is applied in one embodiment.

Referring to FIGURE 1, the number 10 represents the

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wall of an engager vessel, only a portion of which is illustrated. Also shown in FIGURE 1 are sleeve 12, nozzle 14, partition plate 16, and fluid conduit 18. A shaft 20 is secured by struts 21 to the lower end of the nozzle 14, and is slidably positioned within a packing gland at the lower end of the sleeve 12, in order that the nozzle 14 can be moved vertically from outside the sleeve 12.

As described in Patent No. 2,674,496 referred to previously, the movement of the nozzle 14 upwardly and downwardly provides a control over the rate of flow of granular solids into and through the lift conduit. The lower end of the lift conduit is indicated by the numeral 22.

In operation, granular solids within engaging vessel 10 pass downwardly by gravity through the open upper end of the sleeve 12 into the annular space 24 between the sleeve 12 and the lower end of the lift conduit. Lifting fluid, for example air, is introduced through conduit 18 into the chamber 26 which is within the sleeve 12 and which surrounds the nozzle 14. The fluid passes downwardly through the apertures 28 in guide ring 30 into the chamber 32 which is positioned within the sleeve 12. The fluid then reverses direction, as indicated by the arrows, and passes into the lower end of the nozzle 14. Upon issuing from the upper end of the nozzle 14, the fluid picks up granular solids from the region 34 and carries them into the lower end of the lift conduit.

Referring now to FIGURE 2, the lower end 22 of the lift conduit is shown in a detailed view. The lower end has a somewhat tapered cross section as described in the Patent No. 2,674,496 referred to previously. As shown in FIGURE 2, the inner wall of the tapered portion of the lift conduit contains an eroded portion 36. Such eroded portions are not peculiar to lift conduits having tapered lower ends as shown, but also occur in the case of lift conduits which are not tapered at the lower end.

The eroded portion of the lift conduit is on the side of the apparatus opposite to the fluid conduit 18. The cause of the erosion is a lateral displacement of the nozzle 14 by the force of the fluid introduced through conduit 18 into chamber 26. It is necessary to provide a small clearance, for example one-sixteenth inch clearance in the case of apparatus for use with an eight inch diameter lift conduit, between the nozzle 14 and the edges of the central aperture in the partition plate 16. When the force of the fluid laterally displaces the nozzle 14 into misalignment within the aperture in plate 16 an increased space for passage of fluid upwardly between the aperture and the nozzle is provided on the side nearest conduit 18. Consequently a substantial portion of the fluid bypasses through this space, rather than passing downwardly through the apertures 28. The fluid which bypasses in this manner exerts an unbalanced force on the solids in the region 34 so that the solids are driven against the wall of the lift conduit in the portion of the lower end 22 which is opposite the fluid conduit 18. This impingement results in the erosion illustrated in FIGURE 2.

Turning now to FIGURES 3 and 4, one embodiment is illustrated therein for overcoming the erosion illustrated in FIGURE 2. Two spacers 38 are secured to the inner edge of the partition plate 16 in the indicated positions. Spacers at the inner edge of the guide ring 30 can be employed, alternatively or in addition to the spacers 38, but are usually unnecessary. The spacers are in slidable relationship with the nozzle 14, and prevent the nozzle from being laterally displaced by the force of the fluid which is introduced through line 18. The space between the nozzle 14 and the aperture in the partition plate 16 is maintained substantially constant in cross sectional area throughout the circumference, and consequently excessive by-passing of fluid through this space

is prevented. Also, any force which is exerted by the by-passing fluid is substantially uniform around the circumference and does not result in any abnormal driving of solids against the wall at the lower end of the lift conduit; erosion of metal and attrition of solids are thereby avoided.

Referring to FIGURE 5, another embodiment is illustrated for reducing or eliminating the erosion illustrated in FIGURE 2. In this embodiment, two fluid conduits 18 and 40 are provided, which are substantially coaxial with each other and are positioned diametrically opposite each other. Each of the two conduits is connected to suitable means not shown for introducing fluid at substantially the same rate into each of the two conduits. For example the conduits may be connected with a common manifold into which fluid is introduced from a suitable source not shown. In this embodiment, the forces of the fluids introduced from each of the two conduits are counterbalanced in their effect on the nozzle and consequently the latter is not laterally displaced by the force of the fluid introduced. Spacers can be provided in the embodiment of FIGURE 5, but they are usually unnecessary.

In the embodiment of FIGURE 3, the spacers 38 are both positioned more than 90° away from the conduit 18. In a typical embodiment, each of the two spacers is located about 120° away from the conduit 18. In place of the two spacers, a single spacer can be employed located 180° from the conduit 18, but the arrangement illustrated in FIGURE 3 usually provides a more stable construction. Spacers can also be provided on the same side of the apparatus as the conduit 18, but such spacers are unnecessary, and may be undesirable from the standpoint of reducing too much the clearance between the nozzle 14 and the surrounding apparatus.

Where spacers are employed, any construction which provides one or more spacers within the aperture between the partition plate and the nozzle, on the side of the nozzle opposite to the fluid conduit, can be employed. The spacers may be secured to the partition plate in slidable relation to the nozzle. Alternatively, the spacers may be secured to the outer wall of the nozzle in slidable relation with the wall of the aperture in the partition plate; in this embodiment, elongated spacers are used so that a portion of the spacer is within the aperture in the partition plate regardless of the vertical position of the nozzle.

The invention is applicable generally to the elevation of granular solids by lifting gas. A typical example is the elevation of granular solid cracking catalyst having size in the range from 3 to 8 mesh as used in the catalytic cracking of higher boiling petroleum fractions to produce gasoline. Typical lifting gases include steam, air,

and flue gas. The invention is applicable also to other pneumatic elevation processes.

In FIGURE 6, a catalytic cracking system is shown wherein the regenerated cracking catalyst is elevated from engager 10 through lift conduit means indicated generally at 48 to disengager 50. The lifting fluid inlet means are not shown in FIGURE 6, having been fully disclosed in connection with the other figures. The lift conduit means may include a plurality of lift conduits such as that in FIGURE 1, separate lifting fluid introduction means being provided for each lift conduit. The invention is also applicable however to systems having only one lift conduit and associated lifting fluid inlet means.

Lifting fluid is separated from solid catalyst and removed through line 52. The separated catalyst is then gravitated as a compact mass through line 54, cracking reactor 56, line 58, catalyst regenerator 60, and line 62. Reactants and cracked products, oxygen-containing gas and flue gas are introduced into and removed from the reactor and regenerator respectively in a conventional manner.

In the embodiment illustrated in FIGURE 5, any suitable arrangement of a plurality of fluid inlet conduits spaced substantially equidistant from each other around the periphery of the sleeve can be employed. For example, three conduits spaced at intervals of 120° from each other can be employed, and other suitable arrangements will be apparent from the disclosure herein.

This application is a division of application Serial No. 33,040 filed May 31, 1960, now patent No. 3,052,501, September 4, 1962, by the present inventor.

The invention claimed is:

Apparatus for elevating granular solids which comprises an engaging vessel, a lift conduit having its lower end positioned within the engaging vessel, a sleeve positioned about the lower portion of the lift conduit and having an open upper end within the engaging vessel and a closed lower end, a transverse partition plate within the sleeve, a nozzle having an open lower end and an open upper end beneath the lower end of the lift conduit and slidably arranged within an aperture in the partition plate, a plurality of horizontal fluid conduits spaced substantially equidistant from each other around the periphery of the sleeve, each adapted to introduce fluid at the same rate into the portion of the sleeve surrounding the nozzle, whereby fluid introduced through the fluid conduits is prevented from laterally displacing the nozzle into misalignment within the aperture.

References Cited in the file of this patent

UNITED STATES PATENTS

2,674,496	Thayer	Apr. 6, 1954
3,052,501	Paxton	Sept. 4, 1962