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APPARATUS FOR ELEVATING GRANULAR MATERIAL

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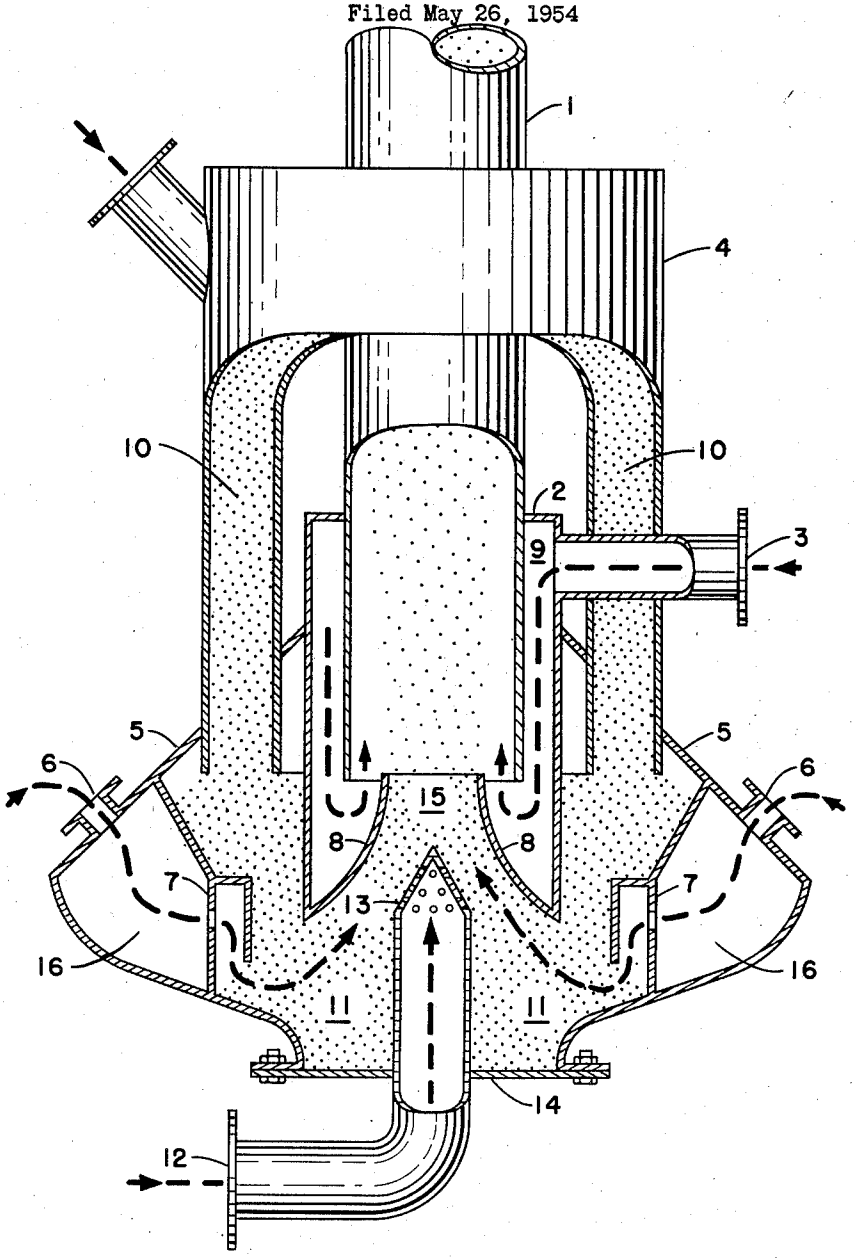

INVENTORS.
Daniel F. Cameron and
John H. Smith
BY Floyd Trimble
ATTORNEY.

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APPARATUS FOR ELEVATING GRANULAR MATERIAL

Daniel F. Cameron and John H. Smith, Ponca City, Okla., assignors to Continental Oil Company, Ponca City, Okla., a corporation of Delaware

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2 Claims. (Cl. 302—52)

This invention relates to an apparatus suitable for elevating granular materials, and more particularly it relates to an apparatus suitable for use in petroleum refining and other chemical processes involving the transfer and circulation of a contact material such as a catalyst of discrete particle size.

Various hydrocarbon conversions or treating operations employ systems of the type above designated. In these processes the catalyst or other contact material in the form of granules, pellets, beads, etc., of comparatively large particle size is continuously circulated through one or more reaction zones. The contact material flows downward by gravity and then it is elevated from the lower level to a substantially higher level. Several methods have been proposed in the prior art for elevating the material. One such method employs mechanical means wherein bucket elevators are used for transporting the material to the required elevation. More recently, however, pneumatic means have been employed for this purpose. An apparatus of the latter type, generally comprises a vertical lift pipe with an introduction chamber at the lower end where the granular material is engaged by the gaseous lift medium in an amount sufficient to carry the material upward through the lift pipe. The vertical uplift pipe is provided at its upper end with a disengaging chamber where the granular material is disengaged from the gaseous lift medium and returned to the down-flow path.

Pneumatic lift systems employing both a single lift pipe and multiple lift pipes are in commercial use. The multiple lift system may comprise a series of individual lift pipes extending from the lower lift hopper or introduction chamber to the upper lift hopper or disengaging chamber, or they may comprise short multiple lift feeder pipes which extend from the introduction chamber upward into the lower end of a large single lift pipe. Disadvantages in the prior art pneumatic means for the elevation of granular solids are attrition as a result of impact and friction and erosion of the exposed metal of the lift pipe due to friction between the individual granules and the lift pipe. Various means have heretofore been employed for the purpose of holding these losses to a minimum, however, none have been entirely satisfactory.

If particles move upwardly in a substantially straight line of flow, low attrition losses occur. These straight line flows are easily obtained if the lift pipe is of comparatively small diameter; but as the diameter of the lift pipe is extended to greater and greater size for the purpose of handling the required large quantity of granular solids, the attainment of a straight line flow upward becomes more difficult. This is true because of the tendency of the particles to flow laterally in a random motion with resultant introduction of factors tending to cause attrition.

In the prior art processes, these solid particles enter the lift pipe together with a sufficient amount of gas to lift a controlled amount of the solids to a point wherein they enter the main gas stream. The solid particles then

accelerate until equilibrium is established between the force due to the friction of the lifting gas flowing past the solid particles and the force of gravity on the particles. Since the mass rate of flow is constant throughout the lift line, the distance between the solid particles becomes greater as their velocity increases; therefore, in the lower section of the lift line where the velocity of the solid particles is low, the density of the mixed gas solid base is high. The main gas stream is then introduced into the center of this high density mixed space channel up the center of the lift line while the solids grind their way along the pipe walls. This situation tends to perpetuate itself since there is less resistance to gas flow through the clear channel in the center of the pipe than through the dense mixed space along the pipe wall.

It is, therefore, a principal object of the present invention to provide a pneumatic lifting apparatus whereby solid particles may be elevated from a lower to a higher level with a minimum of breakage. It is another object of our invention to provide a pneumatic lifting apparatus whereby solid particles may be lifted from a lower to a higher level with a minimum of erosion to the lift apparatus. These and other objects and advantages will become apparent as the invention is hereinafter more thoroughly disclosed.

The specific reactions of catalytic cracking, dehydrogenation, hydrogen transfer and combination of such reactions exemplify operations of the general type to which the features of this invention are particularly directed. A description of the improved apparatus herein provided as applied to the catalytic cracking of hydrocarbons will serve to illustrate the features and advantages of the invention and the subsequent description will, therefore, be directed particularly to such an apparatus and to the improved form of the apparatus in which it is conducted.

Referring to the drawing, the catalyst in the form of granules, pellets, beads, etc., employed in the catalytic cracking process is introduced into the annular zone 10 from which point the catalyst flows downward by gravity into chamber 11. From chamber 11 the catalyst is forced upward to the top of the uplift pipe 15 which extends upward into lift pipe 1 through the action of the secondary stream of the uplift gaseous medium introduced into chamber 11 through perforations 13 in pipe 12. A primary stream of the gaseous uplift medium entering chamber 11 by way of line 6, chamber 16, and baffle means 7 aids in the movement of the catalyst upward to the base of the lift pipe 1. The main stream of the uplift gaseous medium is introduced through line 3 into housing 2 where it flows downward in the annular zone 9 until it strikes baffle 8. This causes the direction of flow of the main stream of the uplift gaseous medium to reverse and to flow upward into the base near the periphery of the uplift pipe. It will be thus seen that the granular materials are introduced into the lift pipe near its center and the main gas stream is introduced into the lift pipe near its periphery. Introducing the two materials in this manner, the gas and the solid, there is no tendency for the solid material to flow along the walls of the lift pipe. Actually the tendency is for the particles to flow up the center portion of the lift pipe. The relative quantities of gas flowing in the various streams may be varied considerably as long as certain minimum requirements are met. These minimum requirements are:

(1) The volume of the gas flowing in the main gas stream should be at least equal to the volume of gas flowing in the primary and secondary gas streams.

(2) The velocity of the gas flowing in the main gas stream where introduced into the conveyor tube should be at least equal to the velocity of the gas flowing in the primary and secondary gas streams at the point where the latter enter the conveyor tube.

Obviously many modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, as for example, the exact shape of the apparatus may be either cylindrical or rectangular. For convenience we prefer the cylindrical type of apparatus. As to the gaseous uplift medium, that may be any gas which will not react with or have any detrimental effect upon the granular material under operating conditions. Suitable gases include air, nitrogen, carbon dioxide, flue gas, etc. It will, therefore, be understood that the foregoing description is given by way of illustration only, and not of limitation and it is contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

We claim:

1. An apparatus for elevating granular material by means of a gaseous medium comprising a vertically elongated vessel, a housing surrounding the lower portion of said elongated vessel forming a first chamber, the lower portion of said first chamber in open communication with the lower end of said elongated vessel, a second housing surrounding said first housing forming a second chamber, the lower portion of said second chamber extending below said first chamber, the first chamber adjacent to said elongated vessel adapted to conduct a downwardly moving first stream of an uplift gaseous medium, means for introducing a gaseous medium into said first chamber, baffle means in the lower portion of said first chamber for changing the direction of flow of said first gaseous medium, whereby said gaseous medium enters said elongated vessel near the periphery of the same, means for changing the direction of flow of said granular material in the lower portion of said second chamber including baffle means forming an uplift pipe the upper end of said uplift pipe characterized in that it is smaller in diameter, concentric therewith, and extends within the opening of said elongated vessel, and means for introducing a second stream of uplift gaseous medium into said second chamber thus imparting an upward movement to said granular material causing said granular material to enter said elongated vessel near the center of the same, means for introducing a third stream of a gaseous medium into said second chamber consisting of a cylindrical vessel concentric with and extending into said second chamber said second mentioned cylindrical vessel terminating in a perforated cone through which perforations said third gaseous medium passes accelerating the upward movement of said granular material, characterized further in that the volume and velocity of the first-mentioned gaseous medium is at least equal to the combined volumes and velocity of the other two gaseous streams taken at a point where the gaseous streams enter said elongated vessel.

2. An apparatus for elevating granular material by means of a gaseous medium comprising a vertically elongated substantially cylindrical vessel, a housing surrounding the lower portion of said elongated vessel forming a first chamber, the lower portion of said first chamber in open communication with the lower end of said elongated vessel, a second housing surrounding said first housing forming a second chamber, the lower portion of said second chamber extending below said first chamber, the first chamber adjacent to said elongated vessel adapted to conduct a downwardly moving first stream of an uplift gaseous medium, means for introducing a gaseous medium into said first chamber, baffle means in the lower portion of said first chamber for changing the direction of flow of said first gaseous medium, whereby said gaseous medium enters said elongated vessel near the periphery of the same, means for changing the direction of flow of said granular material in the lower portion of said second chamber including baffle means forming an uplift pipe the upper end of said uplift pipe characterized in that it is smaller in diameter, concentric therewith, and extends within the opening of said elongated vessel, and means for introducing a second stream of uplift gaseous medium into said second chamber thus imparting an upward movement to said granular material causing said granular material to enter said elongated vessel near the center of the same, means for introducing a third stream of a gaseous medium into said second chamber consisting of a cylindrical vessel concentric with and extending into said second chamber said second mentioned cylindrical vessel terminating in a perforated cone through which perforations said third gaseous medium passes accelerating the upward movement of said granular material, characterized further in that the volume and velocity of the first-mentioned gaseous medium is at least equal to the combined volumes and velocity of the other two gaseous streams taken at a point where the gaseous streams enter said elongated vessel.

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