

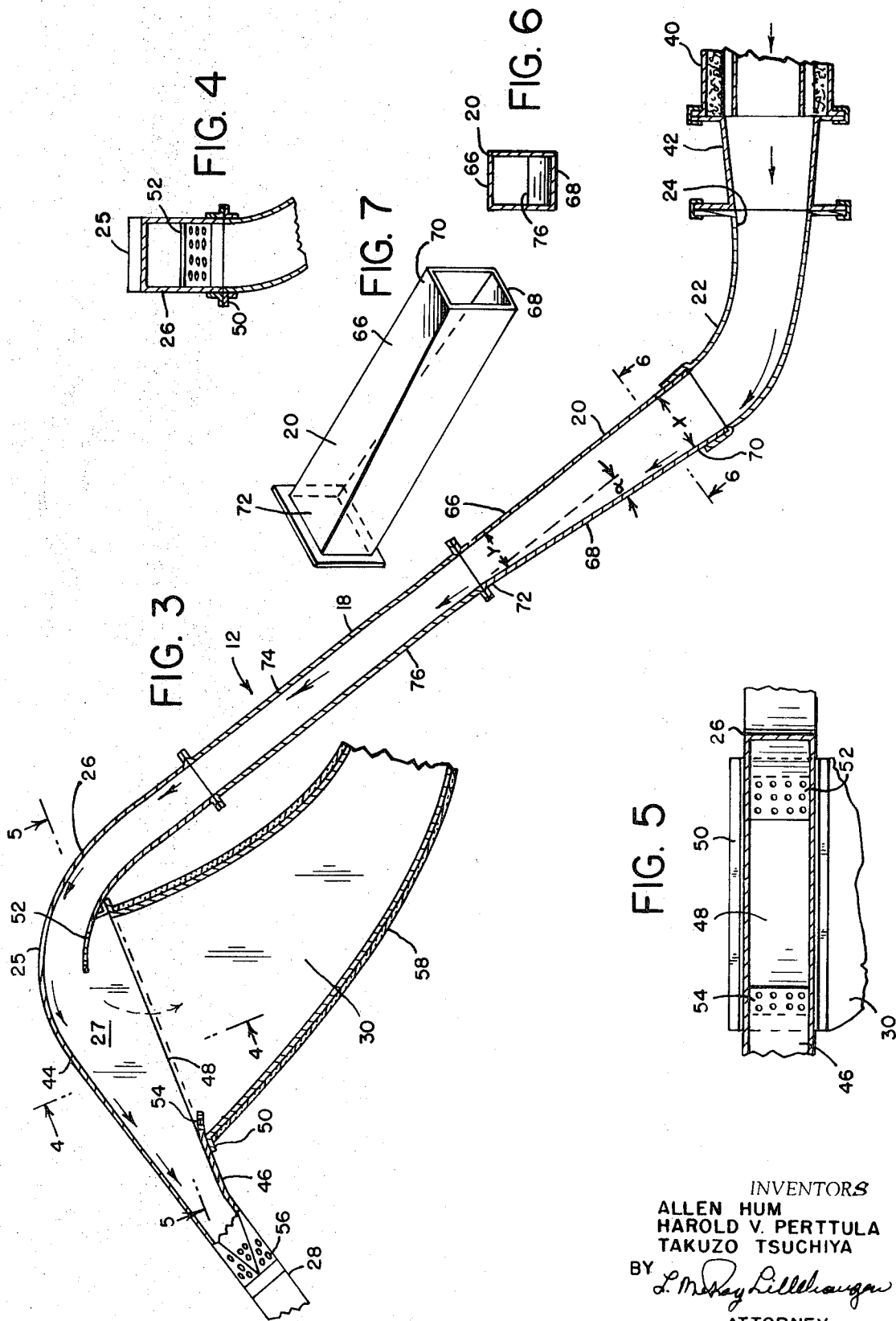
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A. HUM ET AL
SEPARATING APPARATUS

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INVENTORS
ALLEN HUM
HAROLD V. PERTTULA
TAKUZO TSUCHIYA
BY *L. M. Lillhaugen*
ATTORNEY

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3,553,944

SEPARATING APPARATUS

Allen Hum, Minneapolis, Minn., Harold V. Perttula, San Jose, Calif., and Takuzo Tsuchiya, Minneapolis, Minn., assignors to General Mills, Inc., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

Apparatus comprising an elongated duct provided with curved elbow end portions and a straight intermediate duct portion therebetween having means for deflecting particles to the outer wall of the downstream curved elbow and removing carrier medium from the inner wall thereof for receiving and separating particles from a carrier medium which is caused to flow in a prescribed manner at a relatively high velocity.

The present invention relates to a separating apparatus, and more particularly to an apparatus for receiving a mobile mixture of product and a carrier medium, separating the product and medium from each other, and discharging them at different points for further processing.

According to the known prior art, various devices and methods are known for separating mixtures of solid substances from a carrier medium. One of the most well known of such devices for example, is a cone-shaped cyclone separator into which a mixture of particles and gas, such as air, is introduced in such a manner that a spiral is created. The particles are discharged through one opening, while the carrier medium is removed through another opening. It has been found that such devices have not always been the most effective and the most satisfactory in all instances for separating certain mixtures, such as a mixture which includes steam.

One object of the present invention is to provide an improved apparatus for separating particles of material from a carrier medium.

Another object is to provide an apparatus for receiving a mobile mixture of particles and a carrier medium, and effectively separating the particles from the medium.

A further object is to provide an improved apparatus for continuously separating particles of material from a mixture of said particles and a high velocity superheated steam, and removing the particles and steam through separate discharge openings for further processing.

Other objects and advantages will become apparent from a consideration of the following specification and accompanying drawings. Before proceeding with a detailed description of the invention however, a brief description of it will be presented.

Preferably, the apparatus includes an inclined elongate duct having curved portions proximate its two ends. The discharge end portion of the apparatus includes two openings, a discharge duct having an opening therein for removing the particles, and an exhaust opening of considerably larger dimensions which leads to an exhaust duct, for removing the carrier medium. A negative pressure is applied to the exhaust duct for withdrawing the carrier medium from the apparatus. The inlet portion of the elongate duct is provided with means for deflecting a mobile mixture of particles and carrier medium from one of the inner surfaces of the duct to an opposite surface. As the mixture flows past the exhaust opening in the discharge end portion, the medium loses its velocity by expanding within the end portion into the exhaust duct, and the negative pressure created within the duct sucks the me-

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dium out of the apparatus. As the particles flow through the discharge end portion past the exhaust opening, they tend to follow the surface opposite the surface having the exhaust opening therein, by centrifugal force. The particles are ultimately discharged through the opening in the discharge duct.

The invention will best be understood by reference to the following drawings wherein:

FIG. 1 is a partial side elevational view illustrating the invention;

FIG. 2 is a top plan view of the apparatus illustrated in FIG. 1;

FIG. 3 is an enlarged partial sectional view of the invention;

FIG. 4 is a sectional view taken along line 4—4 of FIG. 3;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 3;

FIG. 6 is a sectional view taken along line 6—6 of FIG. 3; and

FIG. 7 is a perspective view illustrating one part of the apparatus.

FIGS. 1 and 2 illustrate a receiving and separating apparatus designated generally by reference numeral 10. The apparatus includes an elongate duct 12 which is shown as being inclined with respect to a floor, and as projecting through an opening 14 in a wall 16. While the duct 12 is illustrated as having a rectangular cross-sectional shape, it should be recognized that other shapes might readily be used as well. Moreover, if preferred the duct might have a negative slope, or it might be aligned in a horizontal plane.

As illustrated, the elongate duct 12 includes sections 18 and 20 attached to each other by appropriate means; a first curved section or portion 22 attached to the section 20 at a first end and having an inlet opening 24 therein; and a second curved section or portion 26 attached to the section 18 which terminates with a discharge duct or end 28 having a discharge opening therein, and a curved top surface 25. Preferably, the duct 12, and the curved portions 22 and 26 are aligned with respect to each other as illustrated in FIG. 1; that is, the curved portions 22 and 26 project away from the duct in somewhat opposite directions, and they are all aligned along a straight line, i.e. a vertical plane, in this regard note FIG. 2. The purpose of this preferred arrangement is to assure a smooth flow of the mixture within the apparatus in a prescribed manner. It should be recognized of course, that the separate parts or sections could be oriented with respect to each other to form somewhat different configurations as well.

An exhaust duct 30 is attached at one of its ends to the curved portion 26, and it extends through a second opening 32 in the wall 16, where it is connected at its other end to a scrubber 34, or other device, for further processing the carrier medium removed from the elongate duct 12. As illustrated, an expansion chamber 27 is formed within the curved section 26, between the duct and its connection with the exhaust duct 30, which is somewhat larger than the duct. As known, scrubbers are used for removing dust particles from a carrier medium, as well as steam, if steam is present in the carrier medium.

Appropriate means are provided adjacent the inlet opening 24 for introducing material into the apparatus. For illustrative purposes, FIG. 1 shows a discharge nozzle 36 of a continuous puffing gun 38, of the type described and illustrated in Pat. No. 3,231,387. Since the puffing gun 38 forms no part of the present invention, it will not be described in further detail. A muffler 40 and a spacer or adapter 42, are interposed between the elongate duct

12 and the puffing gun 38. The muffler 40 can be of the type commonly used with puffing guns of this type, and will not be described in further detail.

FIGS. 3-5 illustrate the apparatus in somewhat greater detail. The curved section 26 is provided with a top surface or outer wall 44, and a bottom surface or inner wall 46 having an opening 48 therein. The opening 48 provides a passage into the duct 30. As shown, the duct 30 is attached to the curved section 26 by flanges 50, and appropriate fastener means such as bolts or rivets. As can be seen, especially in FIG. 5, the opening 48 is quite large when compared to the area of the bottom surface 46 of the section 26. Curved baffles 52 and 54, formed of a perforated plate, or as a perforated extension of the main duct, partially cover the rear and the front portions of the opening 48 respectively. The baffle 52 aids in guiding the product around the curved portion, and the baffle 54 prevents the product from rebounding back into the exhaust duct 30. If preferred of course, a screen could be placed over the entire opening. The discharge duct 28 is provided with a plurality of perforations or openings 56, which provide passages to the exterior of the duct.

The exhaust duct 30 is comprised of one or more sections joined together to form a passage to the scrubber 34. As depicted in FIG. 3, at least the duct portion adjacent to the opening 48 in the section 26, is covered with insulating material 58. Doors 60 and 62 are provided in section 26 and the exhaust duct 30 respectively, for permitting an operator to inspect the interior of the apparatus and for cleaning purposes. An exhaust fan 64 is provided for creating a negative pressure in the exhaust duct 30, so as to suck the carrier medium through the opening 48 and the duct 30.

The section 20 of duct 12 is provided with a top surface 66 and a bottom surface 68, and it is designed in such a manner that a tapered passage is provided which extends from the end 70 to the end 72 of section 20. As illustrated, the dimension X at the first end 70, is greater than the dimension Y at the second end 72. The section 18 is also provided with a top surface 74 and a bottom surface 76. As shown in FIG. 3, an angle α is formed between the lower surfaces 68 and 76 of the sections 18 and 20 respectively. This angle is referred to as the angle of climb, and its relative size can vary, depending upon a number of characteristics, such as the total length of the duct 12, and the velocity of the material flowing through the duct.

In operation, the apparatus has been used with excellent results for separating mobile particles from a carrier medium having a substantially lower density than the particles, such as steam. As an example, when using a continuous puffing gun as depicted in Pat. No. 3,231,387, a mixture of product such as cereal pellets, and superheated steam, is discharged from the gun at a high velocity. In many instances it is desirable, if not necessary, to separate the steam from the product after it has been discharged from the puffing gun, so that the product can be further processed. As known, if the steam is not separated from the product the product might become soggy, the equipment damp, and the environment in the work area quite humid. The present invention effectively and efficiently accomplishes this result.

The superheated steam and the product pass through the nozzle 36 of the puffing gun, through the muffler 40 and the spacer 42, and into the elongate duct 12 through the inlet opening 24. The velocity force of the steam is sufficient to carry the product past the curved portion of section 22, through the sections 18 and 20, and into the second curved portion of section 26, and more specifically, the chamber 27. As illustrated, the cross-sectional size of the passage becomes smaller from the opening 24 into the section 20; this effectively increases the velocity of the steam and helps to assure that the product flows through the elongate duct. As the product passes through

the curved portion 22, it initially follows the lower surface 68 of the section 20, by centrifugal force. As the product passes the angle of climb α formed by the junction between surfaces 68 and 76 of sections 20 and 18, the product is deflected in such a manner that it is transferred adjacent to the upper surface 74 of section 18 (note the arrows in FIG. 3 which illustrate the general path followed by the product). The top surface 74 of section 18 and the top surface 44 of the curved portion 26 are both tangent to the curved surface 25, thus effecting a smooth entry into and discharge from the curved portion 26. As the product passes through the curved portion 26, it is assured of a smooth continuous flow, and it follows the top surface or outer wall 44 by centrifugal force until it reaches the discharge duct 28.

As the high velocity steam enters the curved portion 26, it loses its velocity by expanding within the chamber 27, and through the opening 48 into the duct 30. The negative pressure created by the exhaust fan 64 sucks the steam which has a smaller density than the product, into the exhaust duct, therefore withdrawing it from the curved portion 26. The perforated baffles 52 and 54 aid in minimizing or preventing the product from also being drawn into the exhaust duct. The insulation 58 which covers the exhaust duct 30 prevents or minimizes the likelihood of steam condensing within the duct 30.

The suction pressure required in the exhaust duct 30 is dependent upon the steam pressure, the size of the discharge duct 28, as well as the size of the exhaust opening 48. Appropriate means (not shown) can be provided for controlling the pressure created by the fan 64, so as to fit specific operating conditions. A higher suction is required for higher steam pressures and larger discharge ducts. The amount of suction should be regulated so that no steam flows through the discharge duct 28. If the duct 28 is too large, higher suction is required; this however, might cause product hold-up in the discharge duct 28, thus resulting in a choked condition and/or the product being discharged through the exhaust opening 48 into the exhaust duct 30 with the steam. On the other hand, if the discharge duct 28 is too small, the product flow might be restricted by friction between the particles, friction between the particles and the duct wall, and by a counterflow of the suction air created by the exhaust fan 64. The size of the exhaust opening 48 should also be considered, as it has a minimum area requirement. If the opening is too small, more suction is required to draw the steam into the exhaust duct 30, this of course increases the likelihood of product being entrained with the steam passing into the exhaust duct. The above conditions can be at least partially relieved by drawing the majority of the steam exhaust air through the openings 56 in the duct 28. Since the velocity of the product is still quite high as it passes through section 26, there is only a minimum effect on the discharge of the product through the duct 28.

The physical shape of the apparatus can vary, depending upon a number of factors such as the available space in the work area, and the specific mixture being received and separated. While a rectangular cross-sectional shape of the ducts is illustrated, a square or circular cross-section could be used as well, as pointed out above. As a further modification, the steam pick-up could also be a side or top discharge, rather than a bottom discharge as shown; a bottom discharge however affords the least chance of product contamination. If a side or top discharge is used, it might be necessary to cover the opening with a screen or similar covering. Since the mixture being handled might be introduced by different devices, and since its make-up can vary, the relative length of the apparatus, especially duct 12, should be designed and dimensioned to make sure that the mixture flows into the curved portion 26, as smoothly as possible.

As the product flows through the duct 12, it is deflected within the elongated duct 12 so that it initially follows a

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path adjacent to the bottom surface 68 of section 20, and then to a path adjacent to the upper surface 74 of section 18. In this manner, the mixture flows smoothly through the apparatus with a minimum amount of bouncing of the individual particles against each other, and against the inner surfaces of the elongate duct. If preferred of course, the dimensions of the sections 18 and 20 could be the same, i.e., the angle of climb eliminated. It has been found however, that if the angle of climb α is eliminated, the product does not flow through the apparatus as smoothly and separation of the product from the steam is not as efficient. As the mixture of product and steam passes into the curved portion 26, the product continues proximate the top surface 44 by centrifugal force, whereas the steam expands within the chamber 27, and the duct 30, and thus loses its velocity. The negative pressure created within the duct 30 can be readily regulated so that only the steam is removed from section 26. The product then flows out through the discharge duct 28 where it is processed further or stored for future use.

In the above description and attached drawings, a disclosure of the principles of this invention is presented, together with an embodiment with which the invention might be carried out.

Now, therefore, we claim:

1. Apparatus for separating mobile particles from a carrier medium comprising an elongated duct, said duct having a first curved elbow portion at a first end with an inlet opening at one end of the duct for admitting the particles and medium into the duct, a second curved elbow portion at a second end with a discharge opening therein at the outlet end for removing the particles therefrom, said second elbow having inner and outer walls, and a straight portion connected intermediate the elbow portions, the inner wall of said second curved elbow portion having an exhaust opening for removing the carrier medium from the elongated duct, said exhaust opening being spaced upstream from said discharge opening, an exhaust duct, means attaching said exhaust duct to the second curved elbow portion at said exhaust opening, means connected to said exhaust duct for applying a negative pressure within the duct thereby withdrawing the carrier medium from said second curved elbow portion, and means for deflecting the particles in said elongated duct so that they tend to follow the outer wall opposite the exhaust opening.

2. The combination of claim 1 wherein an expansion chamber is formed within the second curved elbow portion adjacent the exhaust opening, and the carrier medium loses its velocity as it expands within said chamber and the exhaust duct, said product being caused to flow

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through said second curved portion and out through the discharge duct.

3. The combination of claim 1 wherein a discharge duct is connected to the end of the second curved portion, and a plurality of openings are provided in said discharge duct wall proximate the discharge opening for permitting air to be drawn into the second curved elbow portion.

4. The combination of claim 1 wherein means is provided introducing the particles and carrier medium into the inlet opening of the first curved elbow portion.

5. The combination of claim 1 wherein the surface of the exhaust duct proximate the second curved portion is covered with an insulating material.

6. The combination of claim 1 wherein the elongate duct, the first curved portion, and the second curved portion lie in substantially the same plane, and said curved portions project away from the elongate duct in somewhat opposite directions.

7. The combination of claim 6 wherein baffle means is provided over at least a portion of the exhaust opening in the second curved elbow portion for preventing the particles from entering the exhaust duct.

8. The combination of claim 6 wherein the elongate duct is inclined with respect to a horizontal plane.

9. The combination of claim 6 wherein the deflection means is provided within said elongate duct adjacent the first curved portion.

10. The combination of claim 9 wherein a portion of the elongated duct adjacent said first curved elbow portion has a rectangular cross-sectional shape, one surface of said duct being inclined with respect to the opposite surface thereby forming a tapered passage which deflects the particles toward the outer wall of the second curved elbow portion.

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FRANK W. LUTTER, Primary Examiner

B. NOZICK, Assistant Examiner

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