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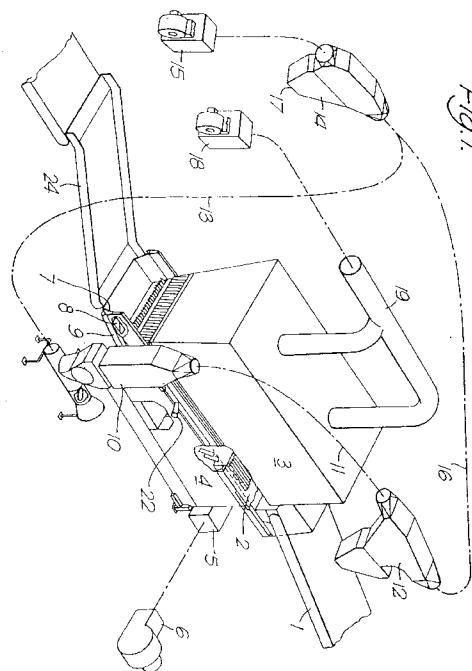
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(54) **Method and apparatus for separation of heavy and light particles from particulate material.**

(57) Apparatus for the separation of heavy and light particles from particulate material which includes means for fluidising and agitating the material to cause heavy particles to sink from the acceptable material and comprising a deck adapted to receive material at a reception end and means for vibrating said deck to cause the material to move longitudinally along it to a discharge end, said deck having a number of longitudinally extending troughs separated by peaks and providing an upwardly directed air flow in the troughs characterised by control means for causing the velocity of the upwardly directed fluidising air in each trough to initially increase to a point below the peaks and to then continue upwards at a reducing velocity.



This invention relates to a method and apparatus for separation of relatively heavy and light particles from particulate material and is particularly, although not exclusively, applicable for the separation of objectionable particles from tobacco material, for example from cut or uncut tobacco. Such objectionable particles may be "heavies", for example, coarse cut stem pieces and/or "lights", for example particles of dust. The invention can however also be applied to other particulate materials such as vegetables, paper, and mineral materials, or any other particulate material which requires separation. The invention will be described, however, with respect to tobacco materials.

In processing, different tobacco components are treated in different ways before being combined to form the final blend. For example, lamina undergoes a different conditioning treatment to stem and is cut more finely. If there is some cross-contamination of tobacco type such as stem on lamina or lamina on stem, problems will occur after cutting. After cutting, some of the stem in lamina will be so coarsely cut it will be deemed to be objectionable and some of the lamina will be so finely cut it will, in the latter stages of processing, be rendered to dust. For the maintenance of quality, both the overtly large and small particles must be removed from the tobacco prior to being manufactured into the cigarette rod.

One way of removing objectionable particles has been provided for in cigarette making machines, in that prior to forming the unwrapped cigarette rod, the tobacco in the machines is passed through a winnower and air lifted. In passing through the winnower, some heavy objectionable particles are removed. In air lifting, some of the dust passes through the machine to be removed by filtration before the air is exhausted to the atmosphere. Both of these processes are inefficient and remove only a portion of the objectionable material present. Their efficiency is also load dependent, that is, the more objectionable material present, the lower their efficiency. Their discrimination of the winnows is also poor, resulting in acceptable material being rejected with the objectionable.

Another method of removing objectionable material for example is to classify it out by air lifting. There are several styles of classification in existence. These work on the principle that the heavy particles can be separated from the light particles by passing them through a moving stream of air which carries the light particles off with it for separation later, while the heavy particles due to their mass/aerodynamic qualities are left behind.

As the light particles are usually the acceptable and less robust portion of the tobacco and the air velocities used are in the order of 3,000 ft/min or higher, this form of separation usually results in some degradation of the good tobacco components. Again discrimination between heavy and light particles is

poor due to the aerodynamic shadowing and the very short time in which separation occurs.

United States Patent Specification No. 4 646 759 shows apparatus for the separation of tobacco into two fractions, for example "heavies" and "lights". The tobacco is supplied to a separator unit including a vibrating conveyer and streams of air rising through the conveyer plate lift the lighter particles away. The particles most desirable for use as cigarette filler are pulled away and into an upper collector chamber and there deposited into a collector tray leaving the heavy particles to be discharged separately.

The present Applicants attempted to overcome some of the objectionable aspects of the arrangements referred to above and in their corresponding European Patent Application No. 89309703.0 (Publication No. 0 361 815, published 4 April 1990) a method of separating objectionable particles from host tobacco material and apparatus for carrying out the method are described. The apparatus comprises means for fluidising the material to form a carpet in an air stream, means for simultaneously agitating the material to release the dust and heavy particles and arranging the air flow velocity of the air stream to cause the dust to rise and the heavy particles to sink from the carpet. Means are provided for removing the dust and the heavy particles. Further research into this method and equipment have shown that the stratified air velocities over the deck which form the carpet of material can be more efficiently produced by control of the air entering the troughs and the present invention is therefore intended to provide a more efficient apparatus of the kind referred to in European Patent Application No. 89309703.0.

According to the present invention apparatus for the separation of heavy and light particles from particulate material which includes means for fluidising and agitating the material to cause heavy particles to sink from the acceptable material and comprising a deck adapted to receive material at a reception end and means for vibrating said deck to cause the material to move longitudinally along it to a discharge end, said deck having a number of longitudinally extending troughs separated by peaks and providing an upwardly directed air-flow in the troughs characterised by control means for causing the velocity of the upwardly directed fluidising air in each trough to initially increase to a point below the peaks and to then continue upwards at a reducing velocity.

The invention can be performed in various ways and various embodiments will now be described by way of example and with reference to the accompanying drawings which show apparatus for treating tobacco material in which :

Figure 1 is a diagrammatic view of an embodiment of the apparatus as shown in European Patent Application No. 89309703.0 (Publication No. 0 361 815) to which the present invention can

be applied.

Figure 2 is a diagrammatic cross-section through part of the apparatus shown in Figure 1;

Figure 3 is an enlarged perspective view of part of the fluidised bed deck shown in Figure 1;

Figure 4 is a diagrammatic view showing the relative position of a tobacco carpet on the fluidised bed deck shown in Figure 1;

Figures 5, 6 and 7 are diagrammatic representations showing the principle of progressive separation of acceptable tobacco material from the heavier material;

Figure 8 is a diagrammatic cross-sectional view of part of a separation deck showing a construction applying the principles set out in Figures 5, 6 and 7;

Figure 9 is a diagrammatic cross-sectional view of a deck provided with four troughs;

Figure 10 is a diagrammatic cross-sectional view showing an alternative construction;

Figure 11 is a diagrammatic perspective view of the construction shown in Figure 10;

Figure 12 is a diagrammatic cross-section through another construction according to the invention;

Figure 13 shows a typical air velocity profile required for the apparatus to work;

Figures 14 and 15 are diagrammatic cross-sectional views of trough shapes;

Figures 16 and 17 are diagrammatic cross-sectional views of further trough shapes according to the invention;

Figure 18 shows a series of cross-sections through a trough peak of the type shown in Figure 8;

Figure 19 is a plan view of the trough peaks shown in Figure 18; and,

Figure 20 shows a method of cleaning heavy materials or winnows delivered by the discharge openings in the trough.

The apparatus shown in Figures 1, 2, 3 and 4 of the drawings, is as shown in European Application No. 89309703.0 and is an example of apparatus to which the present invention can be applied. As shown in Figures 1, 2, 3 and 4 the apparatus comprises a feed conveyor 1, which transports tobacco material to be treated onto a vibrating fluid bed deck 2. If desired, the tobacco having left conveyor 1 can be teased by a stream of air which acts to spread, separate and untangle the material. As the material reaches the deck 2, means can be provided to further spread it evenly over the full deck width, for example by means of a baffle (not shown). The deck 2 is inclined and its vibratory action causes the tobacco to be transported along it. A flared hood 3 is provided and beneath the hood a combination of perforated and/or perforated and plain, and perforated sheets with slots is used to cause the tobacco to become fluidised with the com-

bination of the deck's vibrating action and air velocity introduced from a plenum 4 beneath the deck 2. Air is introduced into the plenum through suitable ducting 5 from a fan 6.

The deck beneath the hood 3 is corrugated to provide higher air velocity at its peak than in its troughs. Heavy particles fall through the fluidised carpet of tobacco thus produced which is teased open by the action of the air and vibration and fall into the troughs between the peaks of the corrugated bed. Slots are provided through which the heavy particles fall, and the air-flow through the slots is set so that it cannot support the heavy objectionable material.

Collators (not shown in Figure 1) are arranged beneath the slots which transport the heavy material to a gallery 7 at one side of the bed 2 and the material progresses down the gallery to window 8 through which it falls onto a conveyer 9. Conveyer 9 lifts the particles to a classifier 10 where any acceptable tobacco in the heavy particles is segregated and recycled by being passed through a ducting 11 to a separator 12 through which it is returned to the loading conveyer 1. Heavy objectionable particles are dropped out of the bottom of the classifier 10 and are passed through ducting 13 to a separator 14 from which they are ejected at 17. An extraction fan filter is indicated by reference numeral 15. Ducting 16 returns air from the separator 12 via the separator 14 to the fan filter 15.

Light objectionable particles such as dust are lifted above the top of the fluidised carpet of tobacco by the air-stream and taken to a fan-filter 18 via extraction ducting 19 leading from the top of the hood 3. As the hood 3 is flared from bottom to top, the air velocity within it is reduced from bottom to top. This prevents the fluidised carpet of tobacco from being lifted beyond fluidisation and ensures that any acceptable particles of tobacco entrained in the fluidised air drop out as its velocity reduces before it is extracted from the hood.

The air used to fluidise the tobacco can be of a specific temperature and RH to influence the final temperature and moisture of the tobacco at the discharge end of the vibrating bed 2.

Throughout the whole process, the bulk of the acceptable tobacco is supported on a cushion of air which produces the fluidisation required and this gentle form of support prevents the host tobacco from degrading.

Figure 2 is a diagrammatic cross-sectional view of part of the apparatus and the same numerals are used to indicate similar parts as in Figure 1. As will be seen from Figure 2, the vibrating deck 2 is carried on a spring-mounted frame to which it is connected by fibreglass springs 21. The deck is vibrated by a drive-arm 22 as shown in Figure 1 and the collectors of the "heavies" are shown as channels 23. The cleaned, cut lamina emerging from the deck is delivered to a

removal conveyer 24. Reference numeral 25 indicated a baffle in the plenum which acts to distribute air and reference numeral 26 indicates a further baffle in the base of the deck. The convoluted deck is preferably made with a 10% open area from perforated sheet and is indicated by reference numeral 27, but larger or smaller cores of perforation could be used.

An air deflector 28 is provided in the upper part of the hood 3 and baffles are indicated by reference numeral 29.

The construction of the vibrating deck is shown more clearly in Figures 3 and 4. Figure 3 shows the corrugated deck surface with the peaks of the corrugations indicated by reference numeral 30 and the troughs by reference numeral 31. The bottom 32 of each trough is flat and the whole construction is made from perforated material so that an air flow can be passed through it. As will be seen from Figure 2, the corrugated surface is carried on the perforated channels 23, which are connected on each side to lengthwise extending box section galleries. Reference to Figure 3 will show that a row of slots 37 is provided which extends angularly across the deck, each slot being located at the bottom of one of the troughs 31. A collector channel 23 is located beneath each row of slots. The channels 23 are made from a perforated material to allow an appropriate air flow through them for the fluidised bed.

Figure 4 shows how the carpet of tobacco material indicated by reference numeral 45 is located by the fluid bed in relation to the corrugated surface provided by the deck of the bed. Approximately one third of the carpet impinges into the channels below the peaks 30 although it will be appreciated that there will be large fragments falling from the lower surface, indicated by reference numeral 47 and dust and other smaller fragments indicated by reference numeral 48 rising above it. As the peaks of the deck extend into the carpet of material, vibration of the deck is transmitted to the material, thus teasing it while it is in a fluid state. Moreover, because the vibration is transmitted to the carpet of material, it helps to move it down the conveyer thus ensuring a rapid throughput of material. It has been found that a relatively thin layer of material transported rapidly through the conveyer is more effective than moving a much thicker layer at slower speed.

Due to the angled construction of the collector channels 23, heavy material which has fallen through the openings 37 is transported across the deck and into the galleries. Because the whole deck is vibrating, the gallery 37 now acts as a conveyor to move the heavy material to the position indicated by reference numeral 8 in Figure 1 so that it can be removed.

Investigations have shown that the progressive separation of acceptable tobacco material from the heavier material can be achieved progressively and Figures 5, 6 and 7 show such progressive separation

principles.

In these three Figures a perforated trough is indicated by reference numeral 100, the peaks at each upper side of the trough are indicated by reference numeral 101 and air is supplied to the underside of the trough through a duct 102 having baffle side walls 103 and 104.

Figure 5 shows four stages of progressively altering the shape of the trough 100. Thus at the top of the Figure the trough is a flat curved shape and is progressively curved bringing the curve in steeper as shown at the lower end of the Figure. With a constant air flow indicated by arrow 105 the lighter acceptable tobacco indicated by reference numeral 106 progressively separates from the heavier material 107 and at the bottom of the Figure it will be seen that the light acceptable material 106 has remained at the top of the trough between the peaks 101 and the heavy material 107 is now clearly spaced away from it at the bottom of the trough.

Figure 6 is a similar schematic progressive diagram showing how with a trough shaped substantially as shown at the bottom of Figure 5 separation can be achieved by progressively increasing the volume of air available to the underside of the perforated shape. Thus at the top of the Figure the air inlet for air flow 105 is relatively small but at the bottom of the Figure the air inlet extends across the whole width of the duct.

Figure 7 illustrates the use of combined control of air volume by entry size and distribution control by shape of the duct can provide separation. The same reference numerals are again used to indicate similar features. It should be noted that the bottom diagram in Figure 7 is not to scale, the width of the mouth of the trough should be the same as that in the diagrams above it. From this it will be understood that with this last arrangement the base of the duct is wider than the width across the throat of the trough between the peaks 101. Alternatively the width of the mouth of the trough can be smaller than those shown above it, illustrating that progressive separation can be achieved individually, or by a combination of a progressive increase in the curve of the perforated material, an increase of the volume of air (and hence its pressure) below it or by an increase of the velocity of the air at the peaks of the curve by reducing the width of the curve in this area.

From Figures 5, 6 and 7 it will be appreciated that the use of baffle walls 103 and 104 provide control means and act as air guide means to enable careful control of the the air flow through the bottom and opposed side walls of the trough to give accurate control of the separation.

The principles illustrated in Figures 5, 6 and 7 are applied to a deck as shown in Figure 8. In this diagrammatic cross-section of one trough in a deck, the trough is indicated by reference numeral 100. The

trough has opposed side walls 110, a bottom portion 111 which is of a narrower V-shape than the side walls 110, and an upper portion formed by angled walls 112 which form peaks between the troughs. In Figure 8 two peaks are shown each side of the trough.

The bottom and side walls of each trough are perforated and air guide means are provided by longitudinally extending baffle means in the form of spaced apart baffle walls 113, 114 which extend downwardly from the points where the side walls 110 merge into the upper walls 112, that is immediately beneath the peaks, to beneath the bottom 111 of the trough where they are joined by a lower wall 115. This wall is perforated to allow air to be supplied to an air control chamber 116 formed by the baffle walls around the trough 100.

Air is supplied to the air control chamber 116 from plenum chamber 117 below the deck, air entry being indicated by arrows 118.

With the appropriate air pressure the air control chamber around the trough together with the shape of the trough and the peaks causes the carpet of good tobacco 119 to be lifted to the throat of the trough between the peaks whilst the heavy unwanted material 120 drops downwardly. The velocity of the upward air flow in the trough initially increases to a point below the peaks and then continues upwards at a reduced velocity.

In order to gather the unwanted heavies 120 an opening 121 is provided in the troughs 100 towards the discharge end of the deck. This discharge opening 121 leads downwardly through a passage 122 to a heavy particle discharge location 123 beneath the peak adjacent the trough concerned. The discharge location 123 is formed between the baffle walls 113 and the baffle wall of an adjacent trough (not shown in Figure 8).

Openings 124 are provided in a lower wall 125 of the passage 122 to allow an air flow into the discharge opening to maintain separation above the opening.

Figure 9 is a diagrammatic cross-sectional view of a deck provided with four troughs constructed as shown in Figure 8. For ease of calibration/trimming of air flow through the passages 122 additional air flow can be provided through control opening 126 from the plenum chamber 117.

For some materials, for example CRS, expanded tobacco and most British blends, one discharge opening per channel is sufficient to remove the majority of the winnows. Burly and Cased blends however are more difficult to open and require longer decks and may require more than one discharge opening per channel. Using several discharge openings in series together with progressively reducing the air flow through the openings will give a very discriminating and positive separation of good from bad.

Figures 10 and 11 show how individual/paired discharge opening control can be achieved by gating

bleed in areas between the discharge openings and venting the air flow through the peaks 112.

In Figures 10 and 11 the same reference numerals are used to indicated similar parts as in Figures 8 and 9. As shown in Figure 10 air flow through the openings 126 is bled off through control openings 127 at the upper end of each peak. The openings 127 are provided above the openings 126. With this arrangement the bleed openings 127 are more accessible than the openings 126 being above the deck and can be reduced or enlarged as required to achieve the necessary flow through the discharge openings 121. The flow out of the openings 127 is indicated by arrows 128.

Figure 11 is a diagrammatic perspective view showing the trough 100, the peaks and the baffle walls 113 and 114. It will be appreciated that there will be further troughs on each side of the baffle walls shown. With this arrangement there are two longitudinally spaced apart discharge openings 121 in the slot which are shown in broken lines in the drawing. The entrances into the passages 122 through the baffle wall 113 are indicated by reference numeral 130. In this construction the discharge openings 121 in the trough 100 to the left of that shown also exit into the same discharge location 123 as the trough shown in the drawing. These discharge openings 121 leading to openings 131 in the wall 114. Thus two troughs empty into the same discharge location 123.

Figure 12 is a diagrammatic cross-section through another construction which can be used to provide the desired air flow through the trough 100. With this arrangement the upper surface of the deck is made up from perforated sheet 150 which is carried on baffle elements 151. Each baffle element has baffle walls 152, 153 and an upper wall 154. As will be seen the baffle walls are shaped to provide the air flow into the trough and the top walls 154 prevent air flow through the peaks indicated in this embodiment by reference numeral 155. Any of the discharge constructions described above can be used with this arrangement.

Figure 13 shows a typical air velocity profile required for the bed to work on certain types of tobacco. It will be seen that at the bottom of the trough the air velocity is 450 feet per minute, at a mid-point 500 feet per minute plus, as the air slows down towards the peak it reaches 450 feet and above the peak 150 feet per minute, this being the profile to provide the desired stratification effect. This profile can be achieved not only by using a variety of shapes of trough but also a variety of perforation patterns in the trough and two such arrangement are shown in Figures 14 and 15.

In Figure 14 a nominal triangular shape is used with a flat bottom to the trough 100. The density of holes at the flat bottom 160 of the trough 100 is ten holes per centimetre. The lower part of the side walls

110 as indicated at 161 has eight holes per centimetre which reduces to four holes per centimetre at the top 162. Thus in this embodiment the air profile is achieved not only by the shape of the trough but also by the air guiding means provided by the particular hole pattern.

Figure 15 shows another arrangement in which the trough 100 is substantially straight sided but the upper part of its walls 112 which form the peaks are of triangular construction. With this arrangement the perforation pattern has four holes per centimetre in the bottom 163 of the trough 100, four holes per centimetre reducing to two holes per centimetre at the upper end in the side walls 110 and two holes per centimetre in the upper side walls 112 which form the peaks.

Figures 16 and 17 are diagrammatic cross-sectional views of further trough constructions according to the invention and show how the air velocity profile required for the bed to work can also be achieved by what is, in effect, selected baffling over a flat perforated sheet. In the construction shown in Figure 19 the bed has a number of longitudinally extending rail members 170, 171, 172. These rail members are shaped to provide together the trough side walls and peaks. Each trough 100 has diverging side walls 173, 174 which provide a throat 175 at their upper ends. The walls then diverge to provide upper walls 176, 177 which provide a mouth to the trough 100. Air is supplied to the troughs 100 from a plenum chamber 117 and due to the shape of the trough the throat 175 acts as a venturi. The air therefore accelerates upwardly through the trough 175 and then slows down again as it exits through the throat which in the construction shown in Figure 14 is of a shallow bell shape. This type of unit, even when multi-sided shapes are used, is relatively cheap to produce and in applications where cost is critical would be a convenient design. The heavies could be taken off at any convenient point either by openings in the perforated base wall 178 or by allowing the heavies to move to the end of the deck.

Figure 17 shows another construction of somewhat similar type but in this case the rail members 180, 181, 182, 183 are shaped to provide a deeper bell shaped portion between upper walls 184, 185 above the throat 186. The lower walls 187, 188 open out as shown above the support plate 178.

Although the rail sections are shown as having solid walls air bleeds into the troughs could be provided if desired to further enhance the air flow.

Figure 18 shows a series of cross-sections through a peak of the type of construction shown, for example, in Figure 8 taken at various points in the length of the deck and illustrate how just the shape of the peak can be used to increase the opening and separation of the tobacco. Figure 19 shows a plan view of the deck incorporating this arrangement and

shows two troughs 100. The sections A, B and C are indicated in Figure 18 appropriately. The peak 190 between the troughs 100 and taken at cross-section line A-A is relatively wide and the good tobacco 119 is carried at the level of the peak and partly into the troughs 100. The section B-B which is at a mid-point in the length of the deck is approximately half the width of the peak at A-A but the width of the troughs 100 remains constant. As will be seen from Figure 19 the troughs converge towards each other at the discharge end of the deck. The alteration in shape of the peak 190 has caused the air flow velocity to increase and the good tobacco is now raised somewhat and is only just below the peak. Finally, at section C-C at the end of the deck the peak has merely become the joint between the two side walls of the trough 100, there is air flow through the side walls as indicated by the perforated construction and the air flow is now about 800 feet per minute. This causes the good tobacco to become totally airborne and completely split from the heavy/winnows 120 which remain in the bottom of the trough. With these arrangements the final mechanical splitting/air lifting is much more positive and easier to achieve.

This type of construction can be employed with any of the other constructions described above to enable easy discharge of the good materials.

Figure 20 shows a method of cleaning heavy materials or winnows which come out of the discharge openings and off the end of the deck. These materials may contain a small amount of good tobacco and they can be cleaned as shown in Figure 23, which is a diagrammatic cross-sectional view of the end of the apparatus by allowing them to pass through an opening 200 in a horizontal deck 201. One side of the opening is perforated at 201 and is in communication with the plenum chamber 117. Thus as the heavies 120 pass through the opening 200 a blast of plenum air passes through them and carries any light materials away into a discharge chamber 203. The air direction through this chamber is indicated by arrow 204 and any good materials are carried out into the flow of goods material 119 issuing from the deck and passing over a support tray 205.

This arrangement is most suitable when a mode is employed in which the good product is not air lifted off the deck.

## Claims

1. Apparatus for the separation of heavy and light particles from particulate material which includes means for fluidising and agitating the material to cause unwanted heavy particles to sink from the acceptable material and comprising a deck adapted to receive material at a reception end and means for vibrating said deck to cause the ma-

- terial to move longitudinally along it to a discharge end, said deck having a number of longitudinally extending troughs separated by peaks and providing an upwardly directed air flow in the troughs characterised by control means for causing the velocity of the upwardly directed fluidising air in each trough to initially increase to a point below the peaks and to then continue upwards at a reducing velocity.
2. Apparatus as claimed in claim 1 characterised in that the control means include the shape, and/or pattern and/or dimensions of air openings in the walls of the trough.
  3. Apparatus as claimed in claim 1 or claim 2 characterised in that the control means includes guide means for controlling air flow through air openings in the wall of the trough.
  4. Apparatus as claimed in claim 1, claim 2 or claim 3 characterised in that the control means include the shape of the trough walls.
  5. Apparatus as claimed in claim 4 characterised in that the cross-sectional shape of the trough defined by its walls includes a venturi, so that the air flow increases up to a venturi neck and then decreases as it leaves the trough at a mouth between the peaks.
  6. Apparatus as claimed in claim 3 characterised in that the bottom and side walls of each trough are perforated and said air guiding means is provided by longitudinally extending baffle means which direct air to said perforations.
  7. Apparatus as claimed in claim 6 characterised in that means are shaped to provide an air control chamber around each trough, each chamber having spaced apart baffle walls which extend downwardly from points on the trough side walls beneath the peaks to points below the bottom of the trough and a lower wall joining said baffle walls and through which air is supplied to the air control chamber.
  8. Apparatus as claimed in claim 7 characterised in that the cross-sectional width of the air control chamber at its lower wall is greater or smaller than at the points where the baffle walls meet the trough side walls.
  9. Apparatus as claimed in any one of claims 1 to 8 characterised by means for causing the material to lift out of the trough mouths as it approaches the discharge end of the deck.
  10. Apparatus as claimed in claim 9 characterised in that means are provided for increasing the air flow velocity in the troughs from the inlet to the discharge end of the deck.
  11. Apparatus as claimed in claim 10 characterised in that the cross-sectional widths of the peaks between the troughs decreases as a function of the length of the troughs.
  12. Apparatus as claimed in claim 11 characterised by means for removing heavy particles through the bottom of the troughs.
  13. Apparatus as claimed in claim 12 characterised in that the heavy particles are removed through discharge openings in the bottom of each trough which lead to a heavy particle discharge location beneath an adjacent peak.
  14. Apparatus as claimed in claim 13 characterised in that said discharge location is formed between said baffle walls of adjacent troughs.
  15. Apparatus as claimed in claim 13 characterised by means for providing an air flow into said discharge openings.
  16. Apparatus as claimed in claim 15 characterised by means for calibrating the said air flow into said discharge openings.
  17. Apparatus as claimed in claim 16 characterised in that said calibrating means includes air venting ducts in said peaks.
  18. Apparatus as claimed in claim 15 characterised in that air is supplied to said air control chambers and said discharge openings from a plenum chamber.
  19. Apparatus as claimed in claim 13 characterised in that two or more longitudinally spaced apart openings are provided in each trough.
  20. Apparatus as claimed in claim 2 characterised in that the bottom and side walls of the troughs are perforated said air guiding and stratification means being provided by the number and/or size of perforations per unit from the bottom of each trough up the side walls to a level beneath the peaks.
  21. Apparatus as claimed in claim 5 characterised in that the cross-section of the trough above the venturi is bell shaped.
  22. Apparatus as claimed in claim 5 or claim 21

characterised in that the deck includes a perforated sheet member on which are mounted a number of longitudinally extending rail members the cross-sections of which are shaped to provide together the trough side walls and peaks.

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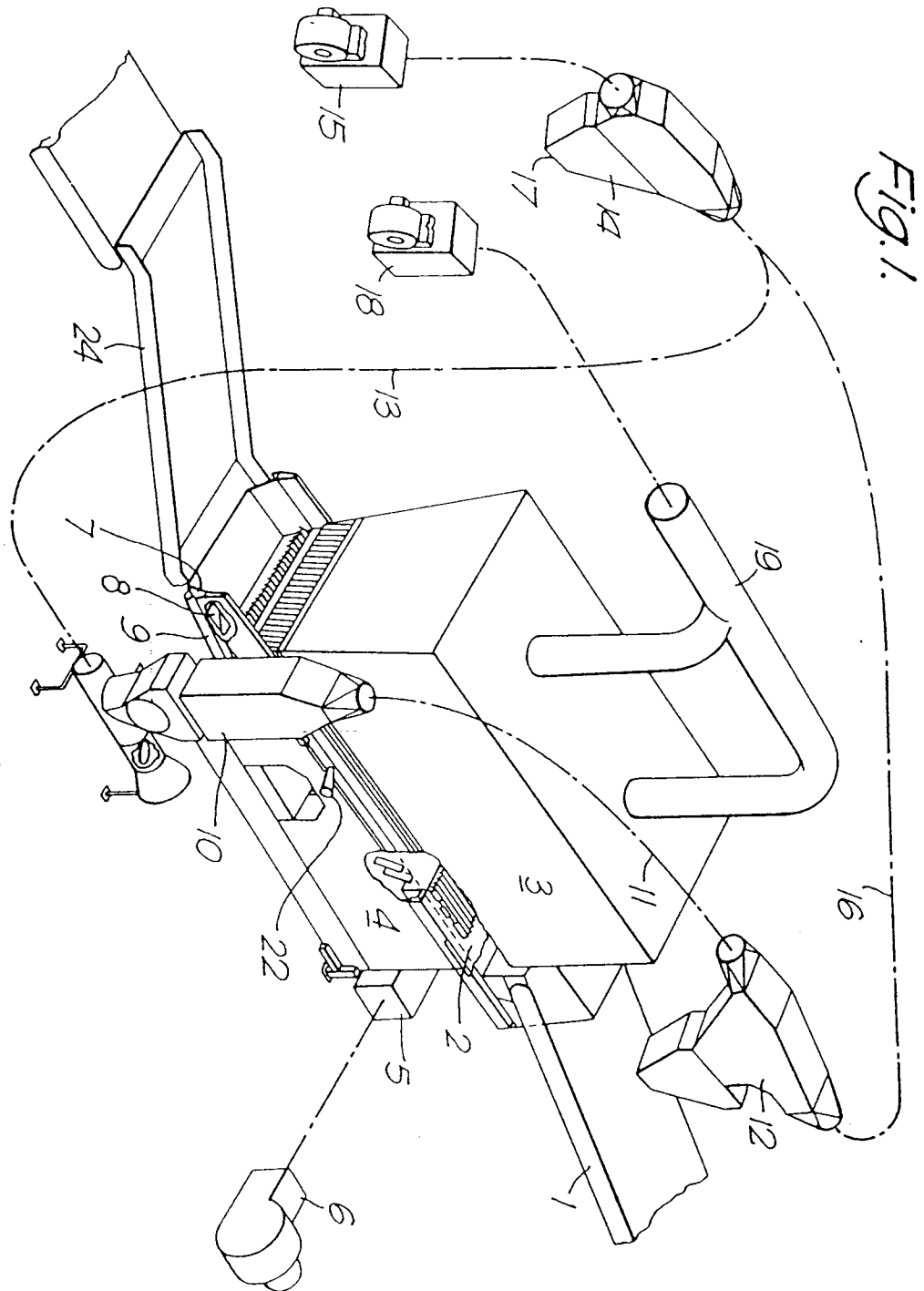
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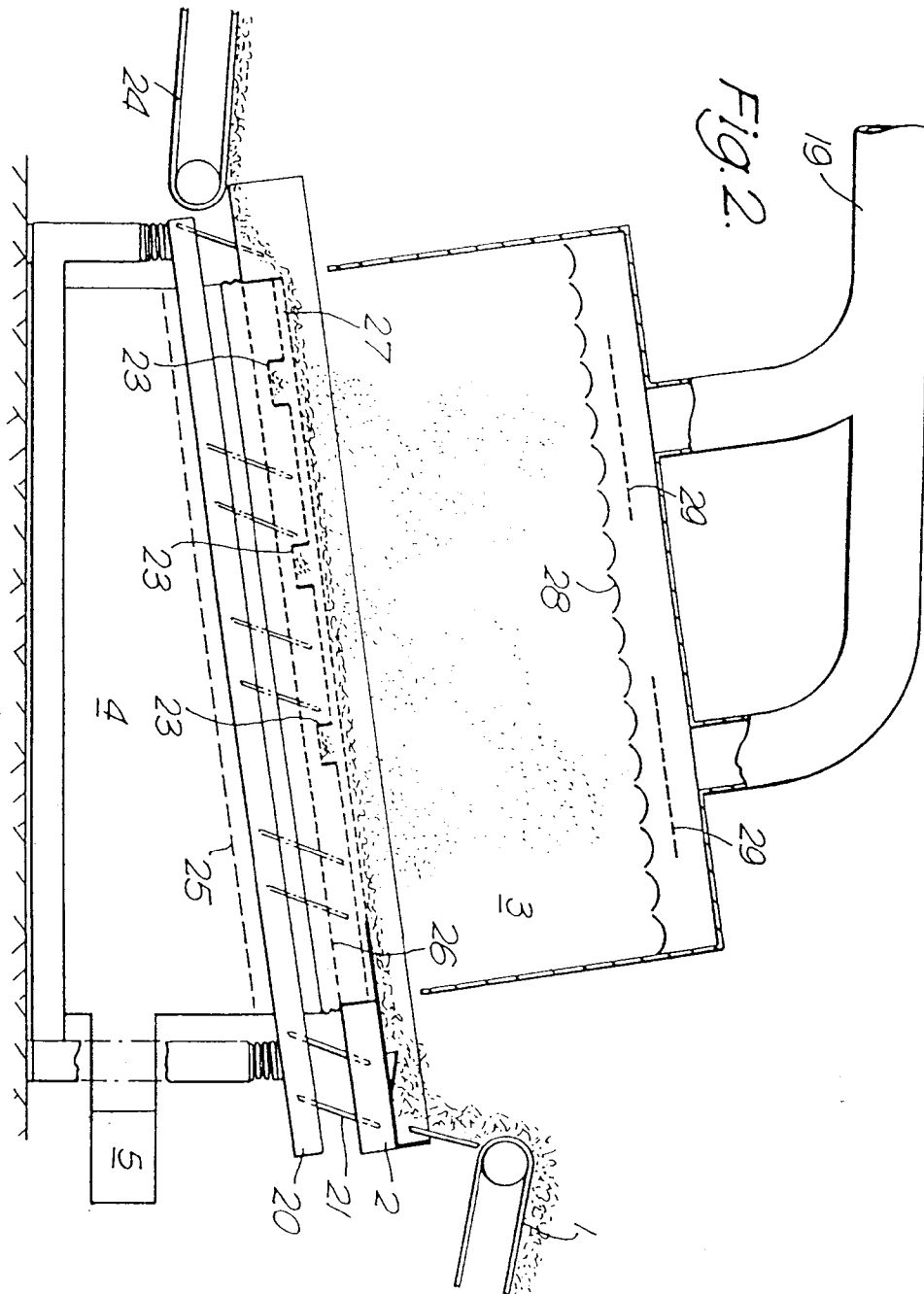
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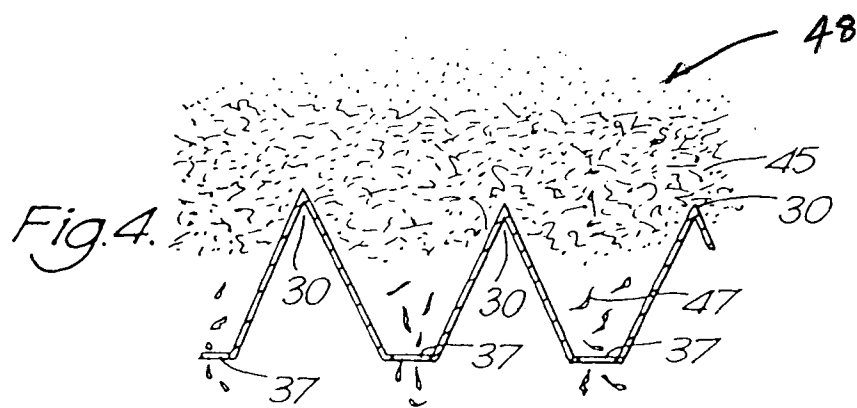
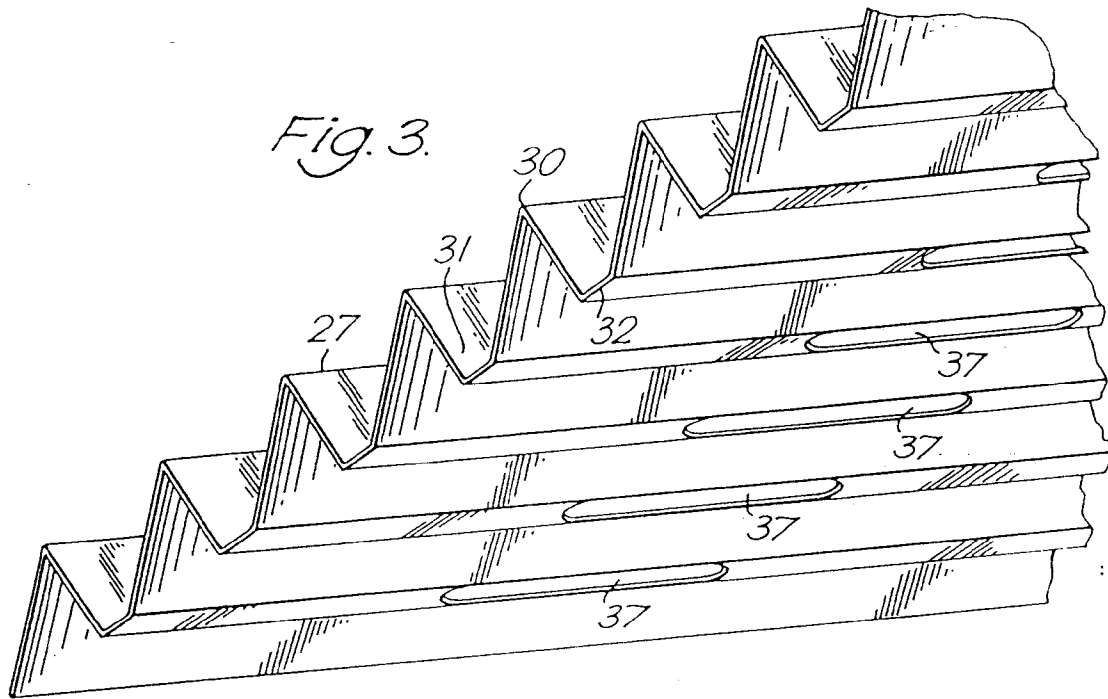
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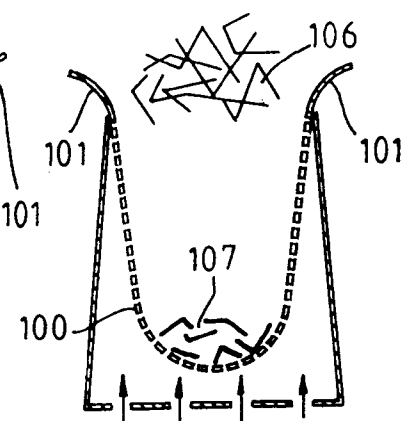
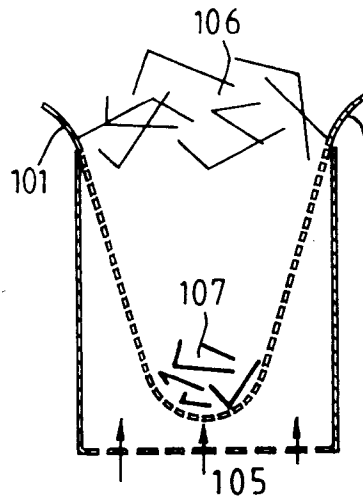
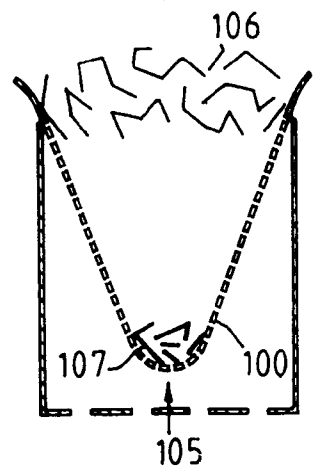
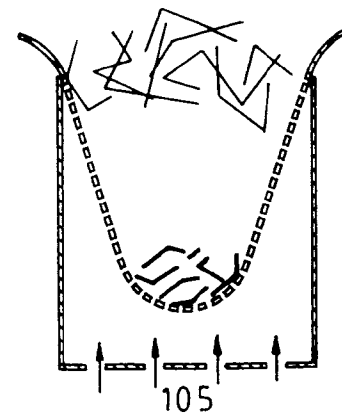
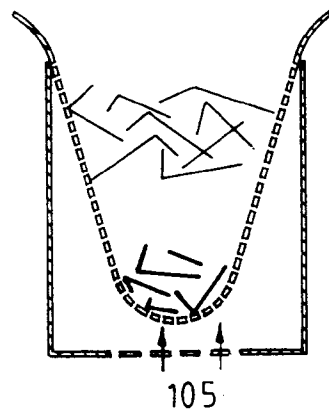
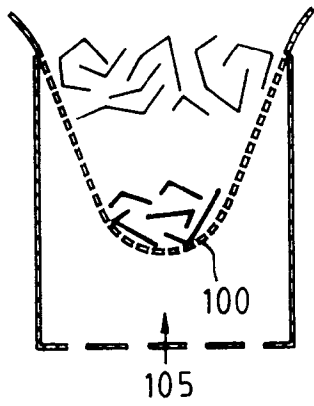
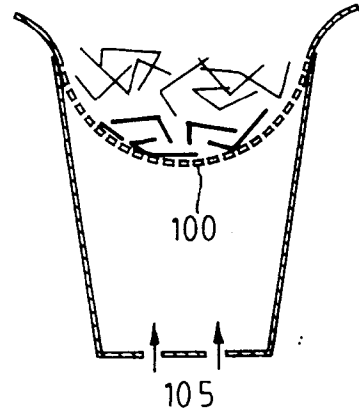
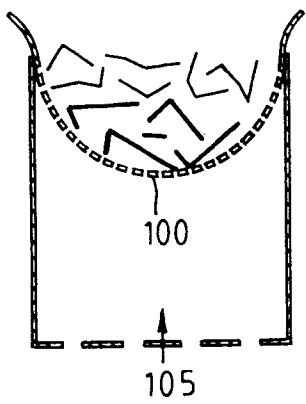
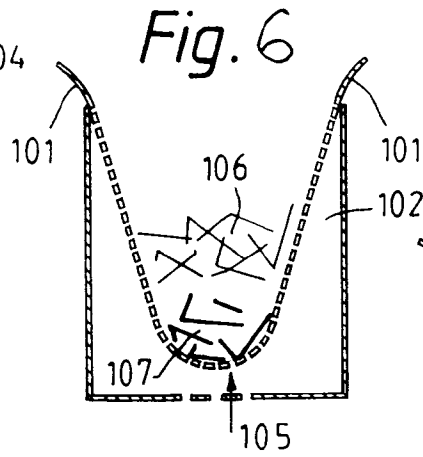
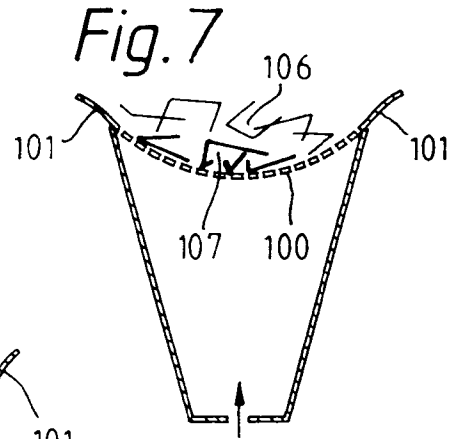
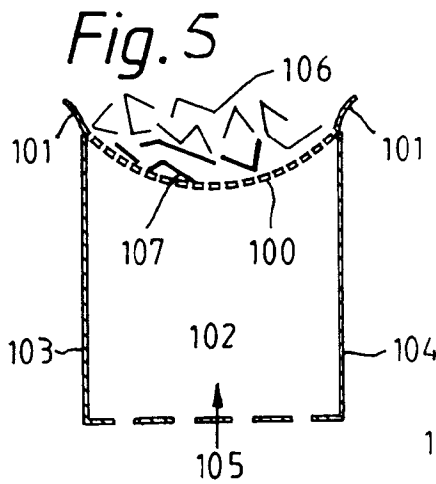
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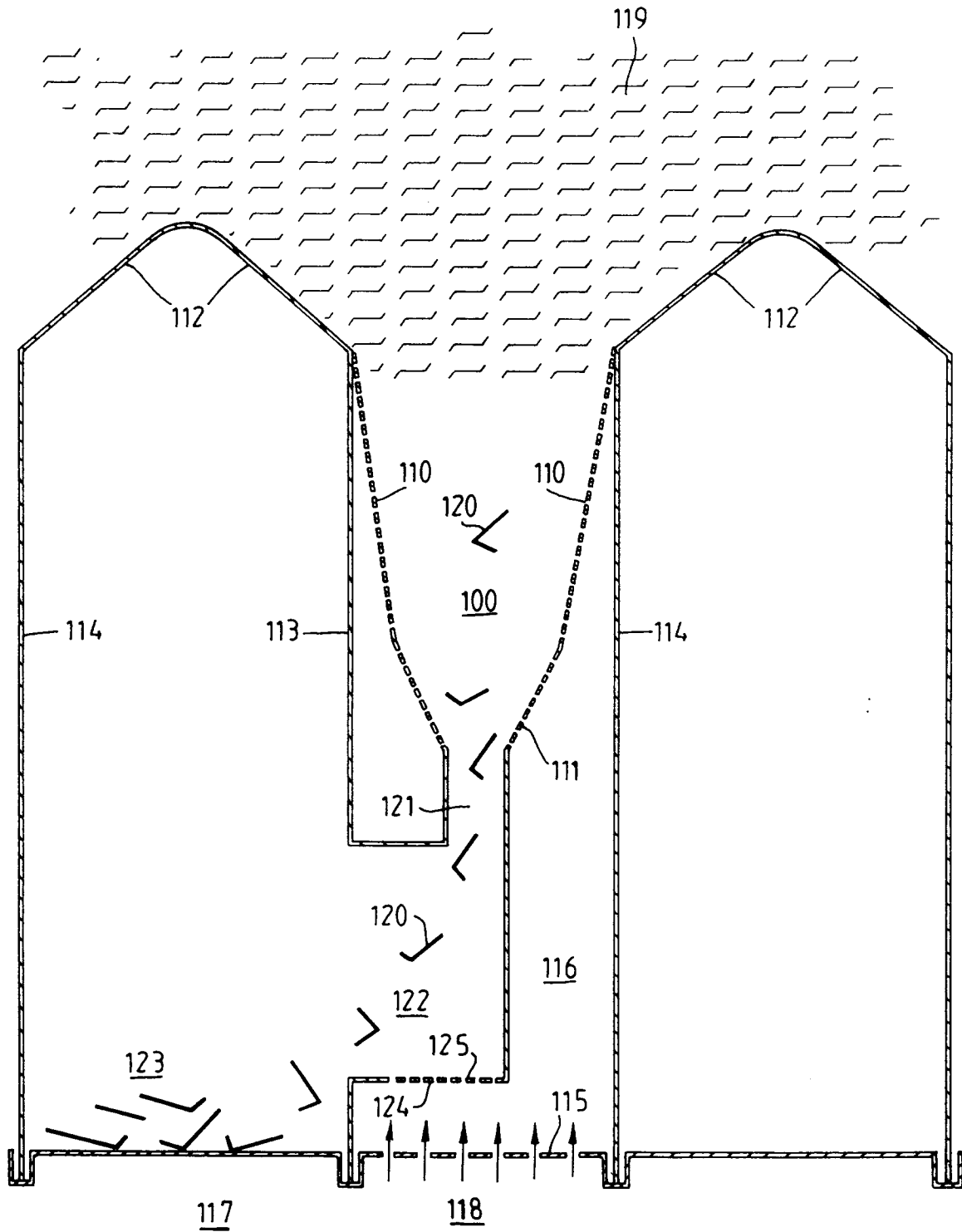
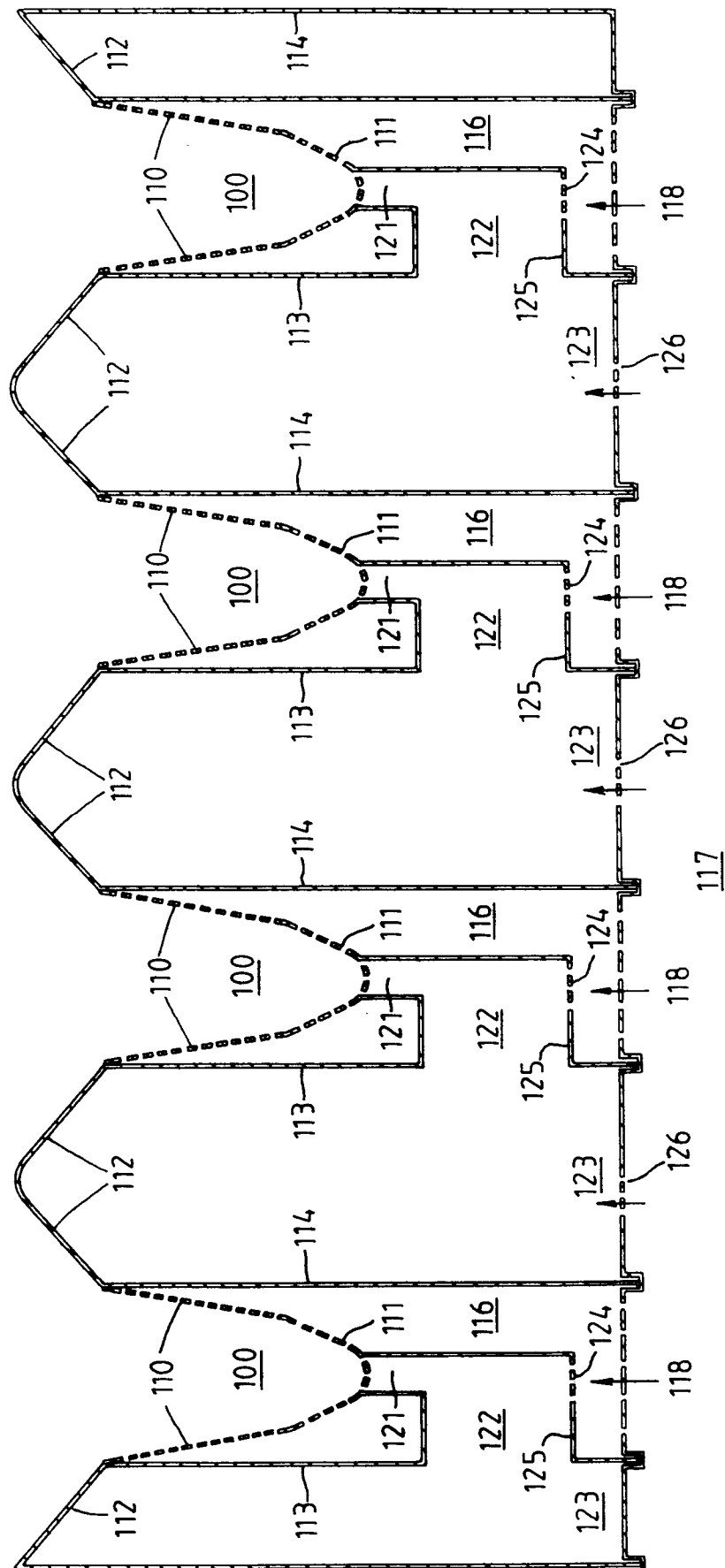


Fig. 8

Fig. 9



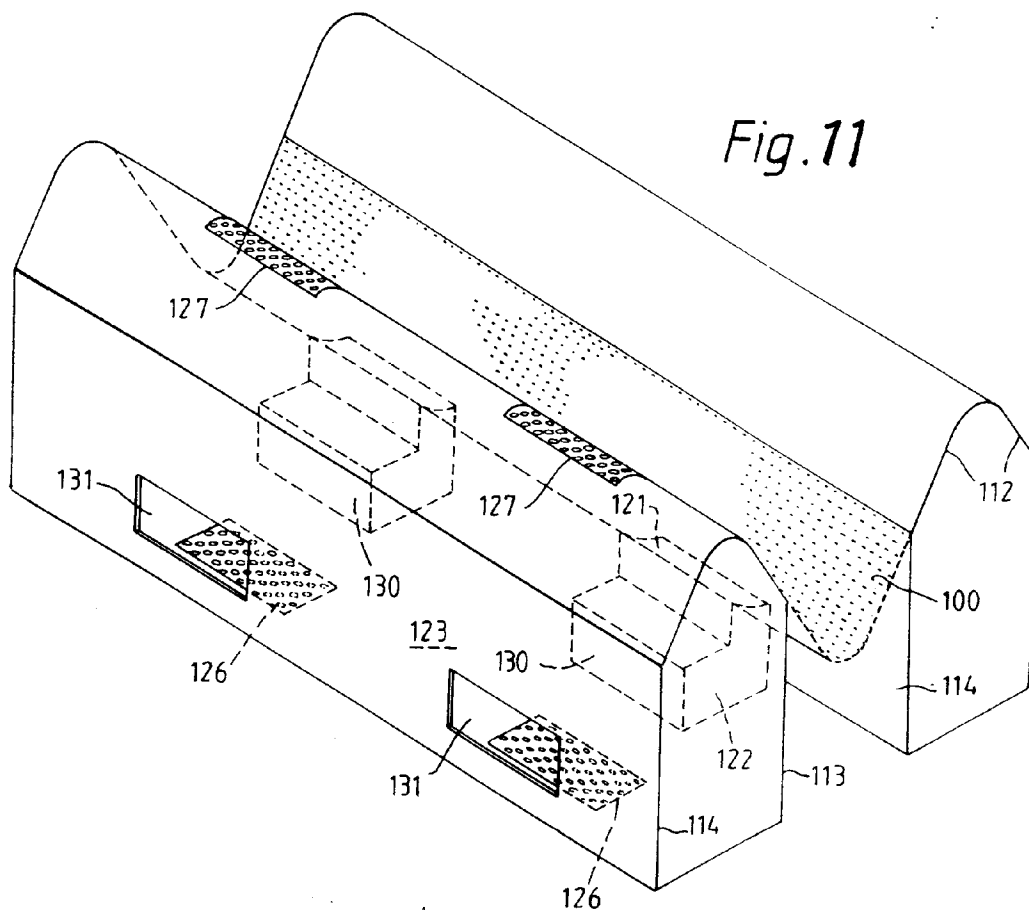
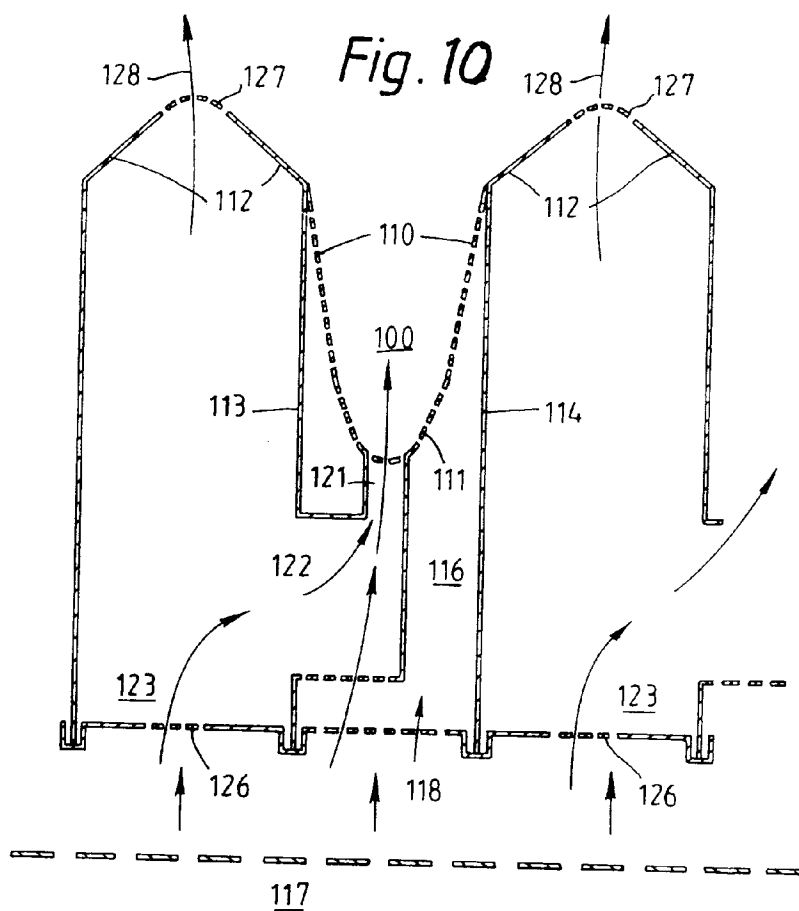


Fig. 12

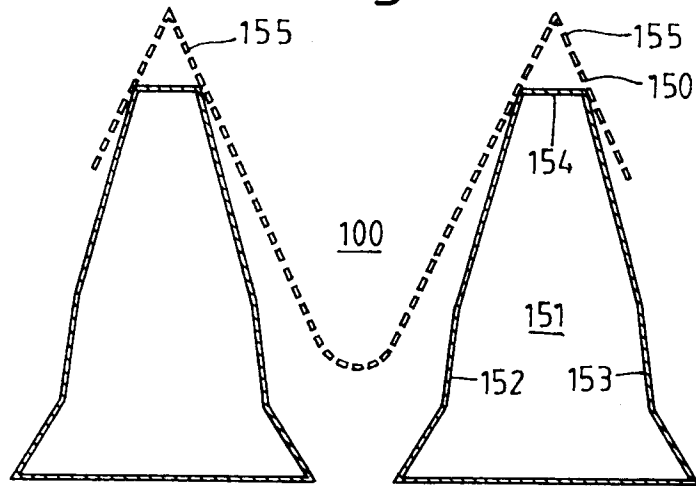


Fig. 13

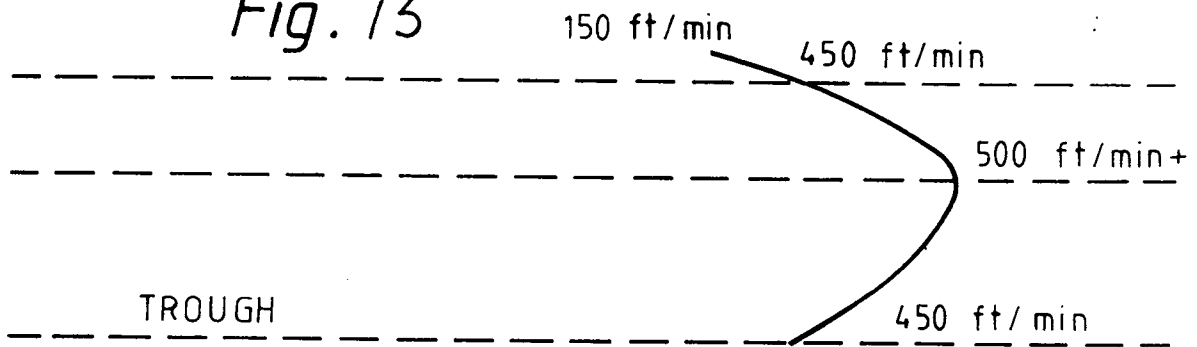


Fig. 14

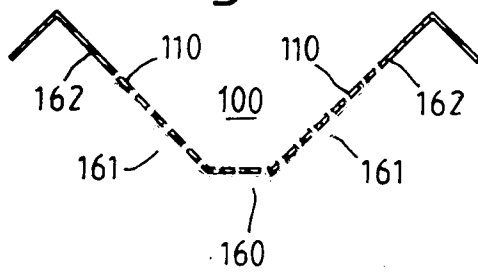
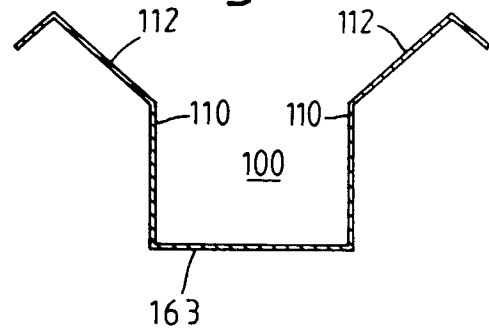


Fig. 15



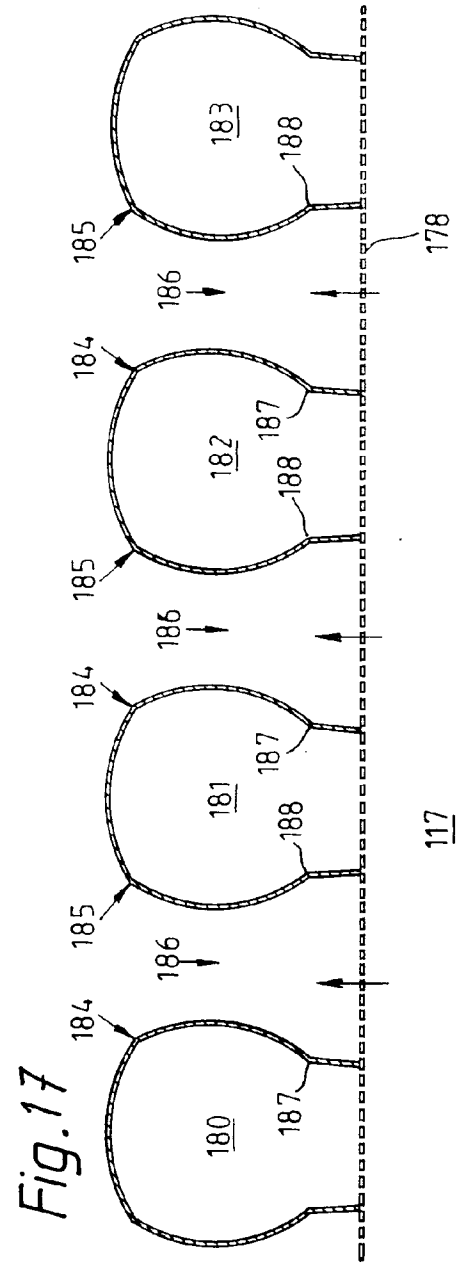
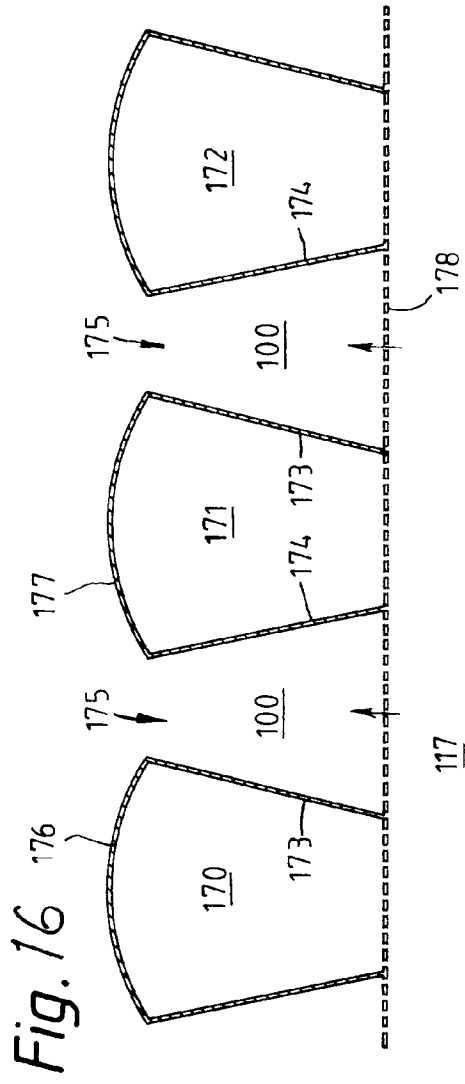


*Fig. 18*

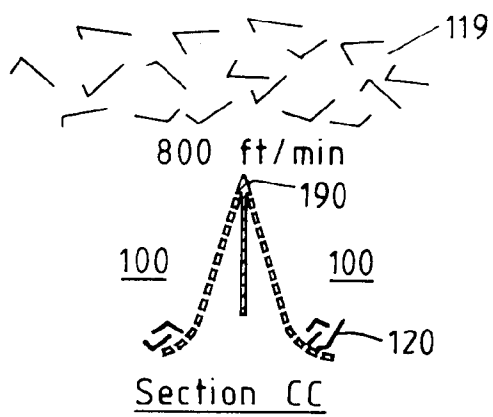
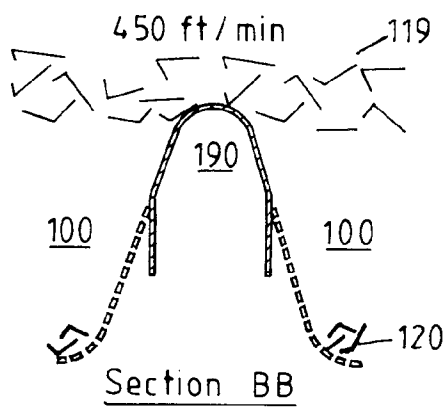
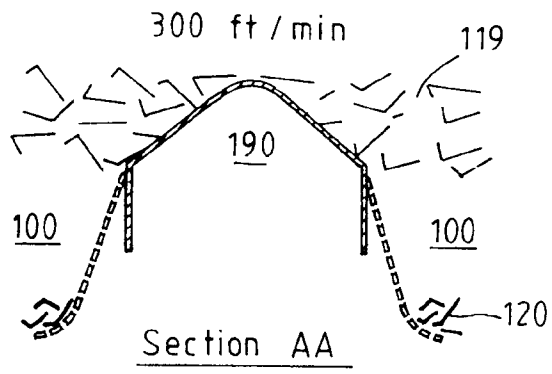


*Fig. 19*

