Aug. 20, 1957 D. WESTON ET AL 2,803,346

MOVABLE BED STRATIFIER WITH CONSTANT PNEUMATIC CURRENT

Filed May 25, 1954 3 Sheets-Sheet 1

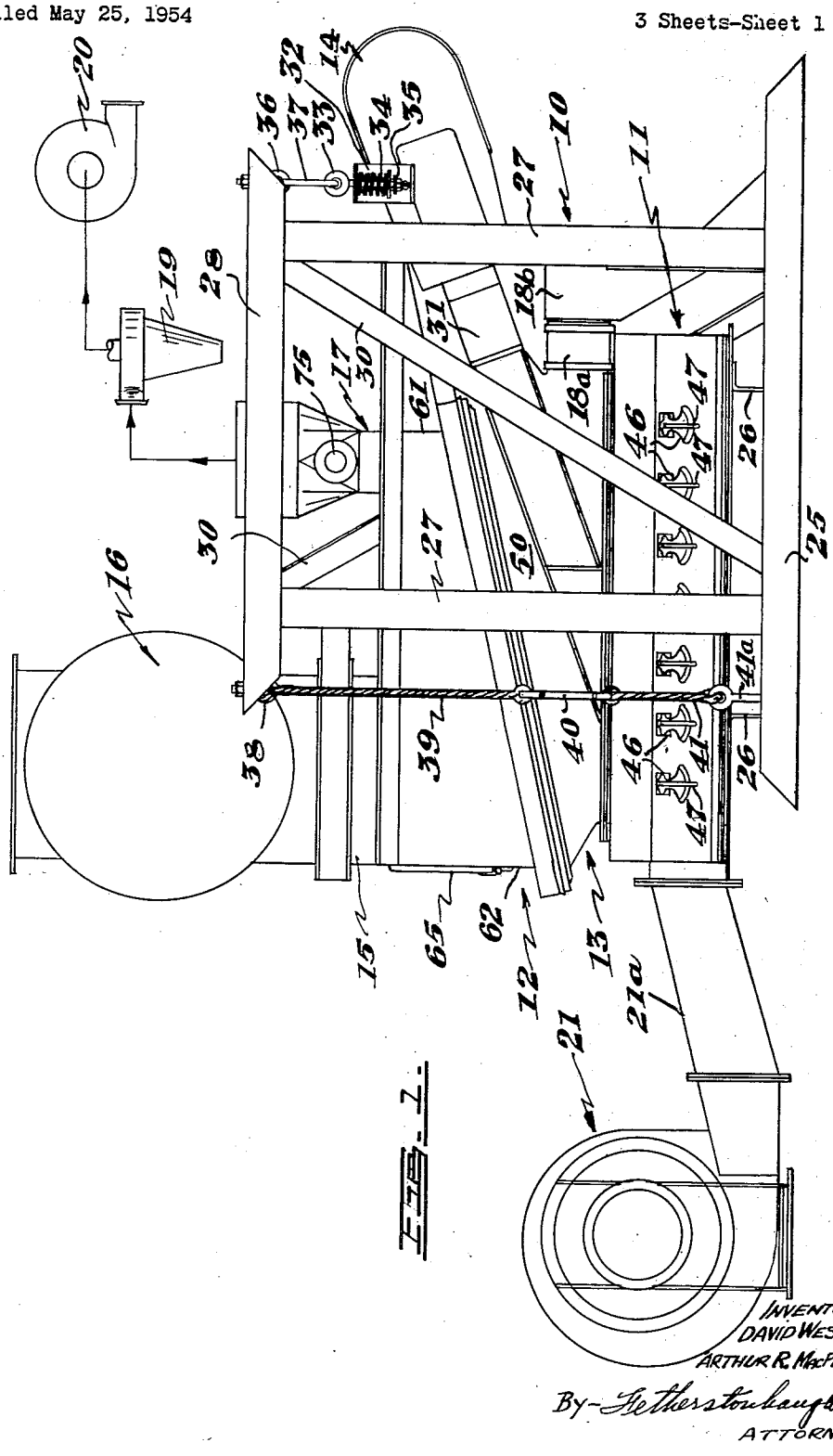


FIG. 1.

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MOVABLE BED STRATIFIER WITH CONSTANT PNEUMATIC CURRENT

Filed May 25, 1954 3 Sheets-Sheet 2

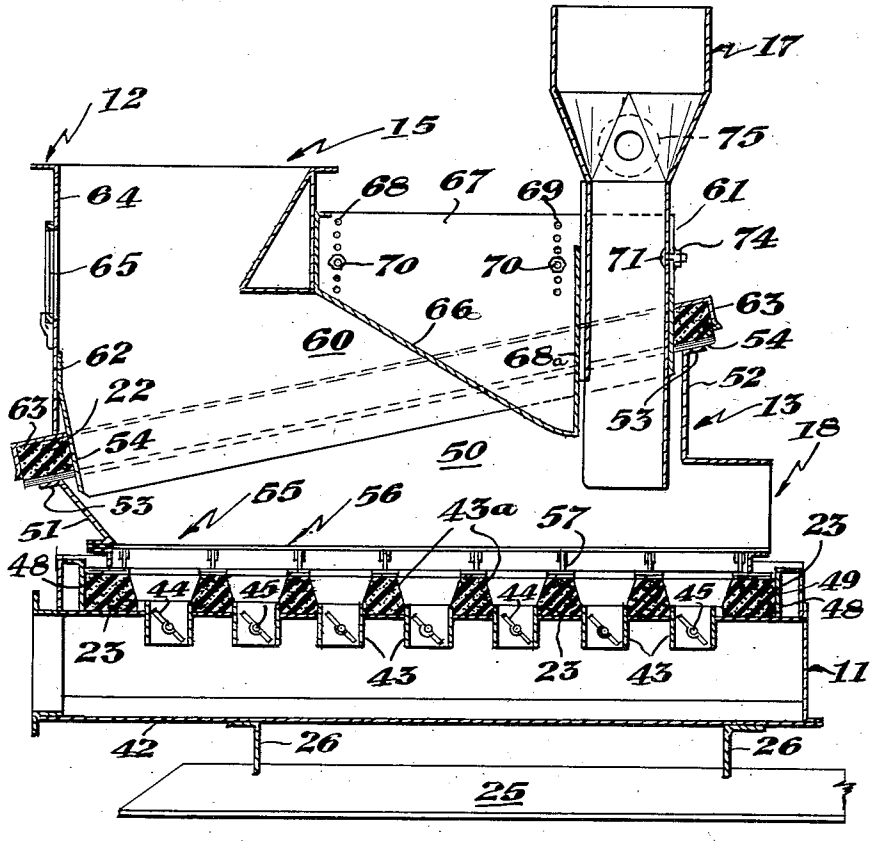


FIG. 2.

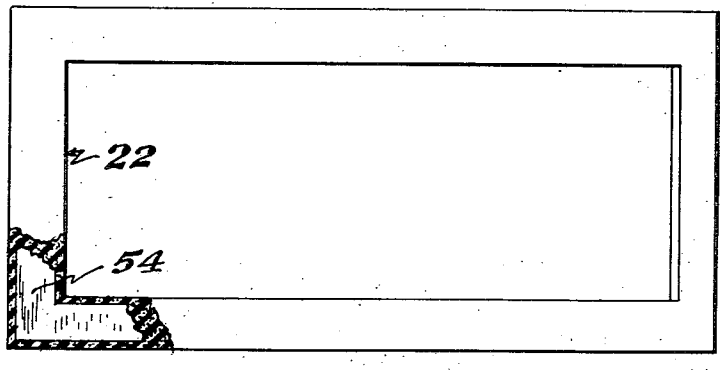


FIG. 4.

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Filed May 25, 1954 3 Sheets-Sheet 3

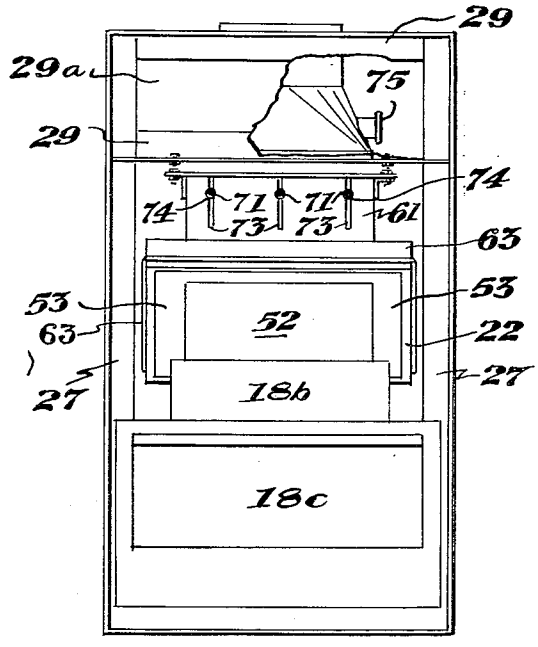


FIG. 3.

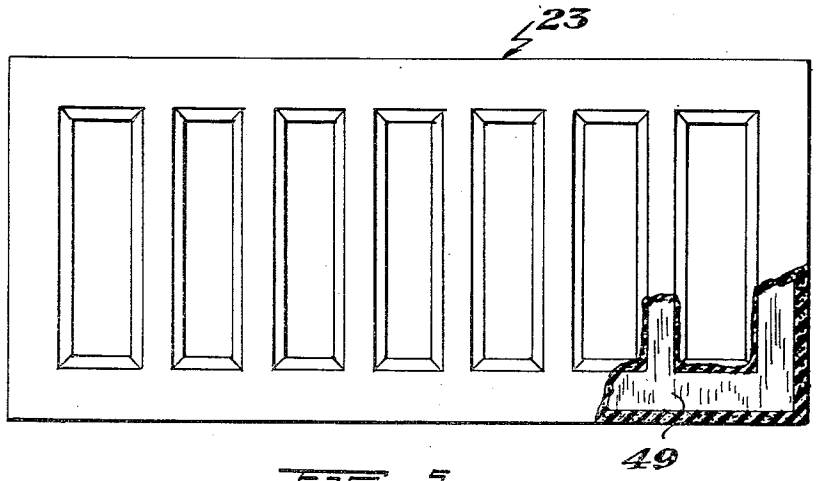


FIG. 5.

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United States Patent Office

2,803,346

Patented Aug. 20, 1957

2,803,346

MOVABLE BED STRATIFIER WITH CONSTANT PNEUMATIC CURRENT

David Weston, Toronto, Ontario, and Arthur R. MacPherson, Ottawa, Ontario, Canada

Application May 25, 1954, Serial No. 432,199

Claims priority, application Canada April 30, 1954

4 Claims. (Cl. 209—466)

This invention relates to a method and apparatus for classifying dry particulate material into a fraction made up of particles having a relatively high surface-weight ratio and one where the particles have a relatively low surface-weight ratio. While the method and apparatus were particularly designed to remove opened asbestos fibre bundles from host rock and unopened fibre bundles, the invention is by no means limited to the treatment of asbestos ore.

The objects of the invention are to provide a method and apparatus for quickly and effectively classifying dry materials into the fractions mentioned in the preceding paragraph, whereby a single machine according to the invention, or a small number of such machines, may be utilized to handle tonnages which, using prior art techniques, called for an appreciably larger number of units.

We have discovered that the desired classification can be effected very quickly in a chamber provided with an air-permeable separating deck along which a bed of the material is conveyed by the application of mechanical movement to the bottom of the bed while air under pressure is directed upwardly through the deck. The airflow and mechanical movement act in conjunction to stratify the bed of material, during its travel along the deck, into strata wherein the particles are characterized by surface-weight ratios which decrease with proximity to the deck. Suction is applied above the deck and the upper strata, i. e. a fraction of the material made up of particles having a relatively high surface-weight ratio, is drawn off upwardly in an airstream, and the remaining material is discharged at the end of the deck remote from the feed end. The chamber is preferably operated at a sub-atmospheric pressure.

The method of our invention may be generally defined as a method of classifying dry material into a fraction made up of particles having a relatively high surface-weight ratio and a fraction made up of particles having a relatively low surface-weight ratio, which comprises forming a relatively shallow bed of the material, continually advancing said bed by the application of mechanical movement to the bottom thereof, continuously maintaining the bed by adding new material at the upstream end thereof, continuously feeding a gaseous medium upwardly through said bed whereby to cause said bed, as it advances, to stratify under the joint influence of said mechanical movement and the upward passage of the gaseous medium through the bed, continuously applying suction to the top of the bed across the width thereof at a point adjacent the downstream end of the bed to remove upwardly and carry away by entrainment a stratified fraction of the material, said fraction being made up of particles having a relatively high surface-weight ratio, and continuously discharging the fraction of said bed remaining after the upward removal of the first fraction. Of the mechanical movements which may be applied to advance the bed we prefer to use a biased reciprocatory motion of controlled amplitude such, for

instance, as may be produced by an electromagnetic pulse type feeding unit. Examples of this type of unit are those manufactured by the Syntron Company of Homer City, Pennsylvania, United States of America. Other suitable motions which may be employed are shaking and vibrating such as may be produced by other types of vibratory devices, rotating cams, eccentrics and the like.

The invention includes apparatus specially adapted to carry out the process of the preceding paragraph. This apparatus comprises a rigid supporting frame, an air-distributing manifold rigidly mounted in the lower portion of said frame, said manifold having a plurality of air-delivery ports, a hood section rigidly mounted in the upper portion of said frame, a vibrating section suspended independently of said hood section and said air-distributing manifold and located between said hood section and said manifold, vibratory feeder means suspended from said frame and secured to said vibrating section for vibrating the latter, said vibrating section including an air-permeable separating deck, said air-delivery ports being arranged to feed air through said air-permeable separating deck, said vibrating section being connected with said hood section and with said manifold by means of air-tight seals, each seal including a section of resilient material disposed so as to obviate transference of the vibratory motion of the vibrating section to either said hood section or said air-distributing manifold, means for feeding air under pressure to said manifold, inlet means for feeding material to one end of said separating deck, means adjacent the other end of the deck for upwardly withdrawing a classified fraction of the material fed therealong, and means at said other end of the deck for discharging the remaining material, said means for withdrawing material upwardly comprising a suction means located at a point remote from said bed and a conduit connected to said suction means, said conduit extending through said hood section toward said separating deck and terminating at a point adjacent, but spaced from, said deck.

In drawings which illustrate a preferred embodiment of the invention:

Figure 1 is a side elevation,

Figure 2 is a central longitudinal section showing on a more generous scale the portions of the apparatus where the classification occurs,

Figure 3 is an end elevation with the vibratory feeder removed,

Figure 4 is a top plan view of the upper seal, and

Figure 5 is a top plan view of the lower seal.

Referring first to Figures 1 and 2, the main parts of the apparatus are supporting frame **10**, air-distributing manifold **11**, hood section **12**, vibrating section **13**, vibratory feeder **14**, feed inlet **15** provided with airlock **16**, conduit **17** for carrying off one classified fraction in an airstream, discharge port **18** for removing the remaining material, cyclonic product collector **19**, suction fan **20**, air-delivery blower **21**, upper seal **22**, and lower seal **23**. The arrangement and nature of these parts will now be described in greater detail.

The supporting frame **10** is made up of a base **25**; a pair of beams **26** extending transversely across said base and rigidly supporting air-distributing manifold **11**; four vertical beams **27**; a pair of horizontal beams **28** forming, in conjunction with transverse beams **29** and panels **29***a* (see Figure 3), the upper portion of the frame; and bracing members **30**.

The vibrating section **13**, and the vibratory feeder **14** attached thereto by the arms **31**, are freely suspended from the horizontal beams **28** in the following way. L-shaped brackets **32** are mounted on the opposite sides of vibratory feeder **14**. Eye-bolts **33** are mounted in

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brackets **32** and are provided with compression springs **34** and retaining nuts **35**. A second pair of eye-bolts **36** are attached to corresponding ends of beams **28**, and the vibratory feeder **14** is suspended by cables **37** passed through the eyes of the bolts **33** and **36**. At the other ends of beams **28**, another pair of eye-bolts are provided. These bolts have been labelled **38**, and they each anchor a cable **39** which supports the end of the vibrating section **13** opposite the vibratory feeder **14**, by virtue of being secured at their lower ends to anchoring means **40** rigidly secured to the opposite side walls of the vibrating section. The anchoring means **40** are in turn connected to the base **25** by cables **41** and eye-bolts **41***a*.

The air-distributing manifold **11** consists of a hollow rectangular box-like base **42** having a plurality of similar rectangular openings in its top wall. Mounted in each of these rectangular openings is a rectangular conduit **43**. Each conduit **43** is provided with a damper **44**, and the dampers are mounted on shafts **45** which extend transversely across the box-like base **42**. Shafts **45** are rotatably mounted in bearing pads **46** secured to the side walls of box **42**, and each shaft **45** has secured to it an adjusting arm **47**, whereby the shafts may be turned to vary the settings of the dampers **44** in the conduits **43**. Manifold **11** includes, above box-like base **42**, a rectangular seating **48** for lower seal **23**. A conduit **21***a* leads from blower **21** into base **42** of manifold **11**.

Seal **23** is a thick rectangular section of soft resilient material such as foam rubber, and is provided near its upper surface with a metallic reinforcing layer **49**, sheet aluminum being preferred. The seal must of course be formed to permit passage of air upwardly from the manifold **11** to the vibrating section, and it is therefor provided with a number of rectangular passageways **43***a* located to match the positioning of the rectangular conduits **43**.

The vibrating section **13** has side walls **50**, to which the feeder arms **31** are rigidly secured, and opposite end walls **51** and **52**. Discharge port **18** is located in the lower portion of end wall **52**. The upper edges of side walls **50** and end walls **51** and **52** are each provided with an outwardly extending lip or flange **53**, provided to support the lower surface of upper seal **22**. Upper seal **22** is, like lower seal **23**, a thick rectangular section of resilient material such as foam rubber, and is also provided, near the surface thereof which faces vibrating section **13**, with a metallic reinforcing layer, as best seen at **54** in Figures 2 and 4.

Side walls **50**, and end walls **51** and **52**, of vibrating section **13**, are connected along their lower edges to a rectangular, generally horizontally disposed, separating deck indicated by reference numeral **55**. Deck **55** is made up of a large number of narrow bars **56**, set upon their edges and running longitudinally of the bed, and a number of bars **57** extending transversely across the deck beneath the bars **56**. The bars **56** run parallel to one another and are spaced closely adjacent one another to permit passage of air therebetween without allowing material being classified to escape downwardly between the bars. When vibratory feeder **14** is actuated the whole of vibrating section **13**, i. e. side walls **50**, end walls **51** and **52**, and the deck **55** made up of bars **56** and **57**, is vibrated.

We do not propose to provide any detailed description of the vibratory feeder **14** since such feeders are known per se and any vibratory feeder may be employed which is capable of directionally vibrating the vibrating section **13**, i. e. imparting biased reciprocation to the section so that material fed to one end of the deck is caused to travel towards the other end thereof.

The discharge port **18** leads, via a flexible conduit **18***a*, to a discharge chute **18***b* rigidly mounted between two of the vertical posts **27** of frame **10**. The end of chute **18***b* is substantially sealed against the admission of air, by the provision of a flexible rectangular skirt **18***c* formed

of rubber or comparable material and secured, along its upper edge only, to the chute **18***b*. With this arrangement, whenever an appreciable weight of material builds up in the chute behind the skirt the material's weight will force the skirt open and permit the material to escape, and, once the material has escaped, the skirt will reassume its vertical sealing position until forced to reopen by the weight of a new batch of material. According to an alternative arrangement the skirt may be set to permit continuous discharge of the material, or a rotary air-lock may be employed.

The hood section **12** is rigidly mounted in the upper portion of frame **10**, directly above vibrating section **13**. The hood **12** is generally rectangular and is made up of side walls **60**, and end walls **61** and **62**. The hood is provided around its base with a rectangular seating **63** for upper seal **22**. Hood section **12** includes a hopper portion **64** provided with the feed inlet **15** and an inspection door **65**; and the hood includes a roof portion **66** which extends between hopper portion **64** and conduit **17** and slopes downwardly towards the lower end of the conduit. A wall **67** extends vertically upward from each longitudinal edge of roof portion **66**; and each wall **67** is provided with two series of vertically aligned holes **68** and **69**, whereby the vertical disposition of roof **66** may be adjusted by passing bolts **70** through side walls **60** of hood section **12** and a selected hole in each series **68** and **69** in each wall **67**.

A wall **68***a* extends vertically upwardly from the lower edge of roof **66**, and the conduit **17** is mounted between this wall **68***a* and the end wall **61** of the hood section. The height of the lower end of conduit **17** above the separating deck **55** is adjustable due to the provision of three bolts **71** rigidly secured to conduit **17**, and three vertical slots **73** in end wall **61**. During vertical adjustment of the conduit the bolts **71** ride in the slots, and, when the desired position has been reached, nuts **74** carried by the bolts **71** are tightened to clamp the conduit in position. Conduit **17** is provided, silghtly above the level of the hood section **12**, with a pair of oppositely disposed inspection ports **75**.

Having described the structural nature of the preferred embodiment of the invention shown in the drawings, we will now describe the way in which this apparatus would be used to separate opened asbestos fibre bundles from host rock and unopened fibre bundles.

The blower **21** and suction fan **20** are turned on and their speeds and intake openings adjusted, along with the settings of dampers **44**, to provide a sub-atmospheric pressure within the apparatus, and to provide for removal of air via conduit **17** at a rate sufficient for entrainment of all separated asbestos fibre at the contemplated rate of feed. The air from blower **21** travels along conduit **21***a* and enters box **42**, whence it is fed upwardly through conduits **43** and passageways **43***a* and passes between bars **56** of separating deck **55**.

The vibratory feeder **14** is energized and the mixture to be separated is then fed, via air-lock **16**, inlet opening **15**, and hopper portion **64**, onto the end of the vibrating separating deck **55** adjacent end wall **51**. A relatively shallow bed of the mixture forms on deck **55** and advances toward the opposite end of the deck under the influence of the directional vibratory motion being imparted to the vibrating section. As the mixture travels along the bed it is not only affected by the vibration but also affected by the classifying effect of the air from manifold **11** sweeping upwardly through the bed. Under the joint influence of the vibration and the movement of air upwardly through the bed, the mixture which formed the bed will, prior to reaching the downstream end of the bed, be classified into a lower layer consisting of host rock and unopened fibre bundles and an upper layer consisting of opened asbestos fibre. The high surface-weight ratio of the opened asbestos fibre compared with that of the host

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rock and unopened fibre bundles leads to very clear stratification into the layers described.

As the bed passes beneath conduit **17**, the upper layer of opened fibre is drawn upwardly by suction and entrained in the stream of air being drawn through the conduit by the fan **20**. As this airstream passes through cyclone **19** the fibre carried in the stream is collected in known manner, as the cyclone's apex discharge.

After the withdrawal of the opened fibre layer the remaining portion of the bed is gravity discharged through port **18**, conduit **18***a*, and discharge chute **18***b*.

While the case of asbestos has been particularly mentioned in this specification, the method and apparatus of the invention may be used in the treatment of other ores or materials, since all that is required for stratification in the bed is that the particles which are to be separated have fairly pronounced differences either in specific gravity or in surface area. The combined airflow and vibration employed effects stratification in accordance with the tendency of particles which are specifically light, or of relatively large surface area, to rise to the top of the bed, and the tendency of particles which are specifically heavy or of comparatively small surface area, to work their way to the lower levels of the bed.

What we claim as our invention is:

1. A dry material classifying apparatus comprising; a rigid supporting frame; an air-distributing manifold rigidly mounted in the lower portion of said frame, said manifold having a plurality of air-delivery ports; a hood section rigidly mounted in the upper portion of said frame; a vibrating section suspended independently of said hood section and said air-distributing manifold and located between said hood section and said manifold; vibratory feeder means suspended independently of said hood section and said air-distributing manifold and secured to said vibrating section for vibrating the latter; said vibrating section including an air-permeable separating deck, said air-delivery ports being arranged to feed air through said air-permeable separating deck; air-tight seals connecting said vibrating section with said hood section and with said manifold, each said seal including a thick section of soft resilient material disposed so as to obviate transference of the vibratory motion of the vibrating section to either said hood section or said air-distributing manifold; means for feeding air under pressure to said manifold; inlet means for feeding material to one end of said separating deck; means adjacent the other end of the deck for upwardly withdrawing a classified fraction of the material fed therealong; and means at said other end of the deck for discharging the remaining material; said means for withdrawing material upwardly comprising a suction means located at a point remote from said bed and a conduit connected to said suction means, said conduit extending through said hood section toward said separating deck and terminating at a point adjacent, but spaced a predeterminable distance from, said deck.

2. An apparatus as defined in claim 1, in which said hood section includes a roof portion which extends between said inlet means and said conduit and slopes downwardly towards said conduit, and means for adjusting the vertical disposition of said roof portion.

3. A dry material classifying apparatus comprising; a rigid supporting frame; an air-distributing manifold rigidly mounted in the lower portion of said frame, said manifold having a plurality of air-delivery ports; a hood section rigidly mounted in the upper portion of said frame; a vibrating section suspended independently of said hood section and said air-distributing manifold and located between said hood section and said manifold; vibratory feeder means suspended independently of said hood section and said air-distributing manifold and secured to said vibrating section for vibrating the latter; said vibrating section including an air-permeable separating deck comprising a plurality of closely spaced narrow bars running parallel to one another and arranged longitudinally of the bed, said air-delivery ports being arranged to feed air through said air-permeable separating deck; air-tight seals connecting said vibrating section with said hood section and with said manifold, each said seal including a thick section of soft resilient material disposed so as to obviate transference of the vibratory motion of the vibrating section to either said hood section or said air-distributing manifold; means for feeding air under pressure to said manifold; inlet means for feeding material to one end of said separating deck; means adjacent the other end of the deck for upwardly withdrawing a classified fraction of the material fed therealong; and means at said other end of the deck for discharging the remaining material; said means for withdrawing material upwardly comprising a suction means located at a point remote from said bed and a conduit connected to said suction means, said conduit extending through said hood section toward said separating deck and terminating at a point adjacent, but spaced a predeterminable distance from, said deck.

4. A dry material classifying apparatus comprising; a rigid supporting frame; an air-distributing manifold rigidly mounted in the lower portion of said frame, said manifold having a plurality of air-delivery ports; a hood section rigidly mounted in the upper portion of said frame; a vibrating section suspended independently of said hood section and said air-distributing manifold and located between said hood section and said manifold; vibratory feeder means suspended independently of said hood section and said air-distributing manifold and secured to said vibrating section for vibrating the latter; said vibrating section including an air-permeable separating deck, said air-delivery ports being arranged to feed air through said air-permeable separating deck; air-tight seals connecting said vibrating section with said hood section and with said manifold, each said seal comprising a thick layer of foam rubber provided with a reinforcement adjacent the surface of the seal which faces the vibrating section, said section of resilient material being disposed so as to obviate transference of the vibratory motion of the vibrating section to either said hood section or said air-distributing manifold; means for feeding air under pressure to said manifold; inlet means for feeding material to one end of said separating deck; means adjacent the other end of the deck for upwardly withdrawing a classified fraction of the material fed therealong; and means at said other end of the deck for discharging the remaining material; said means for withdrawing material upwardly comprising a suction means located at a point remote from said bed and a conduit connected to said suction means, said conduit extending through said hood section toward said separating deck and terminating at a point adjacent, but spaced a predeterminable distance from, said deck.

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