Sept. 24, 1963 F. E. WOOD 3,105,040

METHOD AND APPARATUS FOR SEPARATING INTERMIXED DIVIDED MATERIALS

Filed Oct. 29, 1959 4 Sheets-Sheet 1

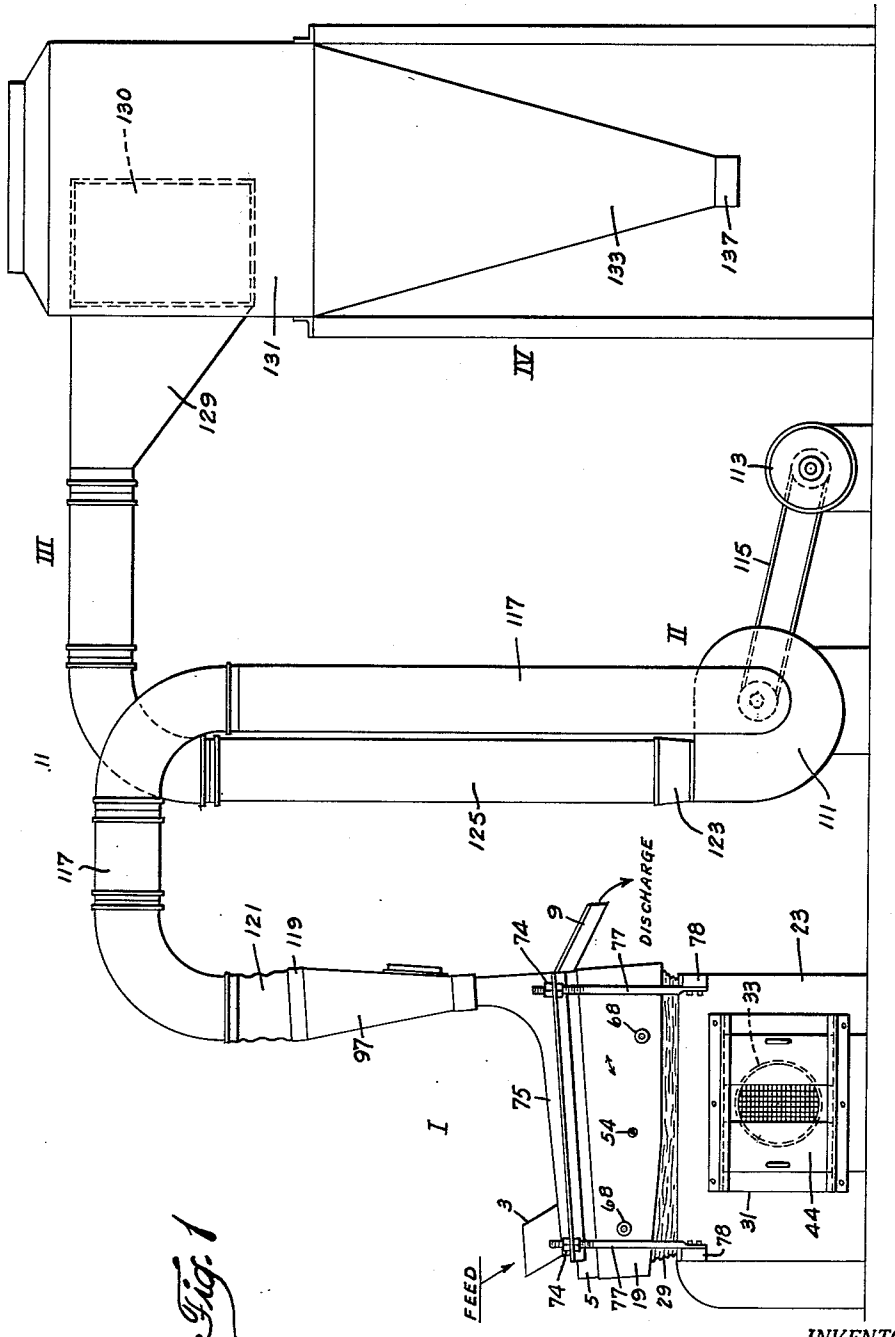


Fig. 1

INVENTOR.
FRANK E. WOOD

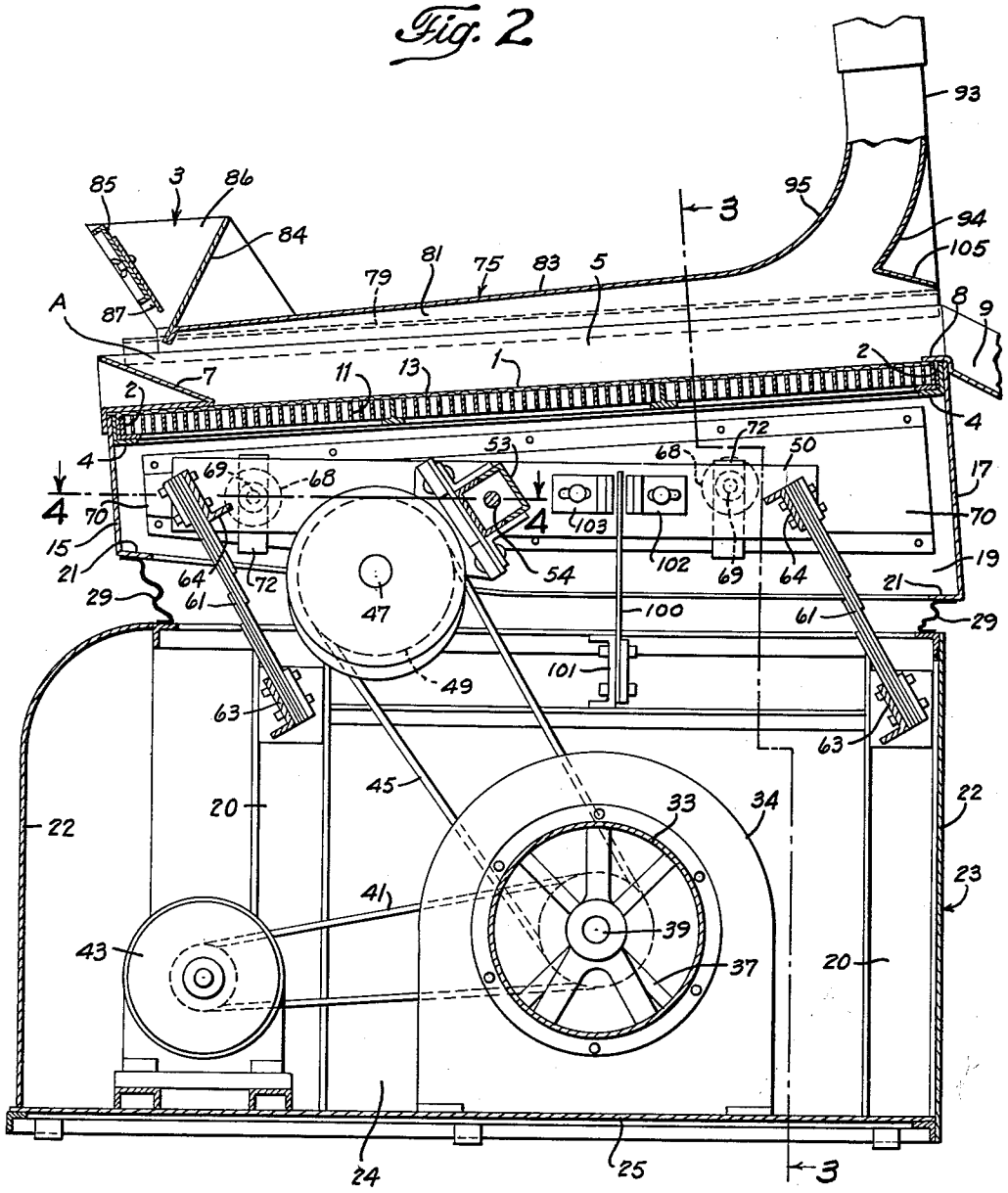
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS.

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Fig. 2



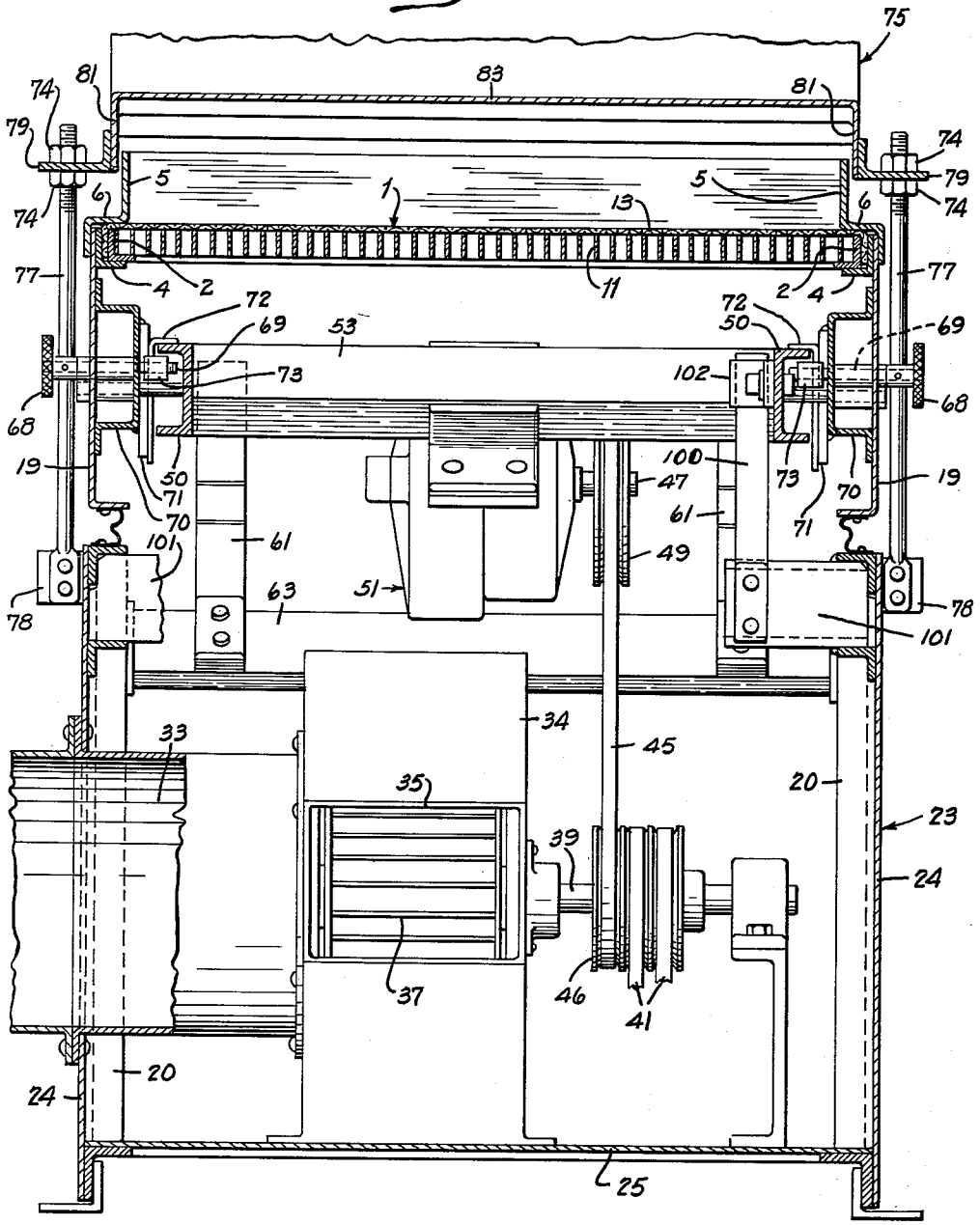
INVENTOR.
FRANK E. WOOD
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ATTORNEYS.

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Fig. 3



INVENTOR.
FRANK E. WOOD

BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS.

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METHOD AND APPARATUS FOR SEPARATING INTERMIXED DIVIDED MATERIALS

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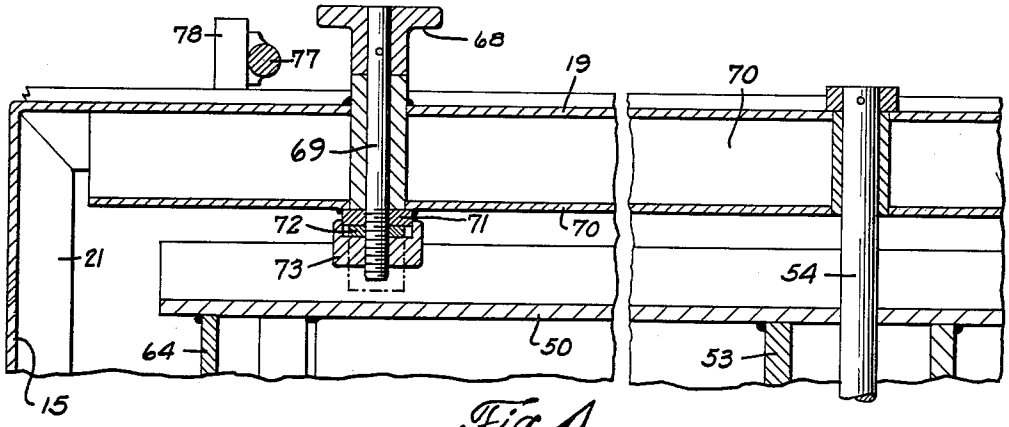


Fig. 4

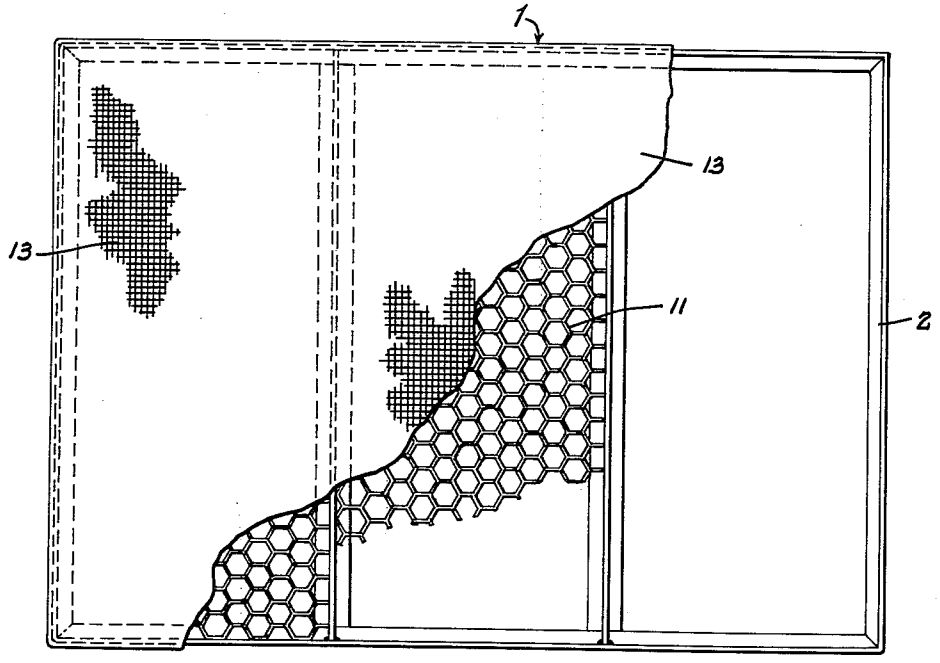


Fig. 5

INVENTOR.
FRANK E. WOOD
BY
Morgan, Finnegan, Durham & Pine
ATTORNEYS.

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3,105,040
METHOD AND APPARATUS FOR SEPARATING INTERMIXED DIVIDED MATERIALS

Frank E. Wood, Dallas, Tex.; Augusta C. Wood, executrix of said Frank E. Wood, deceased, assignor to Sutton, Steele & Steele, Inc., Dallas, Tex., a corporation of Texas

Filed Oct. 29, 1959, Ser. No. 849,624
7 Claims. (Cl. 209—466)

This invention relates to a process and apparatus for separating dry, intermixed particulate materials which vary in size and may also vary in weight and/or density.

Objects and advantages of the invention will be set forth in part hereinafter and in part will be obvious herefrom, or may be learned by practice with the invention, the same being realized and attained by means of the processes, steps, instrumentalities and combinations pointed out in the appended claims.

The invention consists in the novel steps, processes, parts, constructions, arrangements, combinations and improvements herein shown and described.

The accompanying drawings, referred to herein and constituting a part hereof, illustrate one embodiment of the invention, and together with the description, serve to explain the principles of the invention.

Of the drawings:

FIG. 1 is a schematic, general view, in side elevation, of an apparatus embodying and utilizing the invention;

FIG. 2 is a longitudinal, vertical section, with parts in elevation, of the separating apparatus or "fines floater" embodying the invention.

FIG. 3 is a transverse, vertical section on line 3—3 of FIG. 2;

FIG. 4 is an enlarged fragmentary section along line 4—4 of FIG. 2; and

FIG. 5 is a plan view, partly broken away, of the air-pervious deck construction.

More particularly, the invention relates to improvements in the separation of relatively fine particles which form a contaminant or undesired fraction in a mass of intermixed particles of substantially homogeneous density wherein the coarser and heavier materials are desired to be separated as free from such contaminants as possible. The invention also is capable of separating intermixed particles of low density from others of greater density together with fine particles of the greater density from a mixture of heterogeneous densities.

One object of the invention is to provide a new and useful process and mechanism for separating fine from coarse materials by the use of air flotation as the initial step in combination with other forces to effect displacement of stratified fine from the settled coarse particles very rapidly, automatically, in high volume, and with the minimum of attrition or degradation of the particles being treated. The invention combines the use of air-pressure fluidization and stratification within a vibrating bed of intermixed particles varying in size and weight and/or density. Vertical displacement of said fine light particles is effected by progressive air-pressure fluidization and stratification followed by the progressive removal of the flotant fine and light particles by means of a relatively gentle withdrawal in an air draft moving transversely to the stratifying air across the top of the fluidized bed. The coarser and heavier particles are caused to settle to lower strata in the bed by gravitational stratification, sinking against the elevating action of air pressure passing upwardly into the bed, their sinking being aided by mechanical vibration imparted to the bed. The settled strata of heavier materials are caused to travel along the foraminous supporting surface of a deck, which is inclined upwardly in the direction of mechanical thrust and bed travel. Said heavier particles accumulate as a concentrated settled stratum from which the fine and light particles are progressively moved upwardly by the floating and agitating actions of the air and mechanical movement and thence over and along the top of the bed by the transverse suction or withdrawing action of the aspirated air. The flotant light fine particles are thus progressively drawn off as they find their way to and above the top of the fluidized bed. Finally, a substantially increased air current adjacent the ultimate discharge locus of the settled heavy stratum is applied to cleanse residual light particles out of the discharging settled stratum and particles of intermediate weight or density are isolated and caused to travel either with the settled heavy particles or with the flotant light particles, as desired.

The method of the invention has proven effective in the efficient and inexpensive separation of materials which heretofore have presented very serious separation problems. Some mixtures of materials, although differing substantially in particle sizes, defy effective separation by screening or by conventional gravity separators. For example, there are mixtures of cork particles containing coarse and fine particles of low density cork (the valuable product), intermixed with coarse and fine particles of "hardback" (a denser, dark-colored cork material from the outer bark, which is a reject), and with coarse and fine particles of sand (a reject of relatively high density). Such mixtures below 30 mesh in maximum particles size cannot be screened effectively. Many of the fine light cork particles are flat or plate-like in shape and they have a high electrostatic capacity. Such particles rapidly mat up and clog or blind the screen openings and refuse to pass through openings which are below 30 mesh although the particles are substantially smaller in size than such openings.

However, by using the method and apparatus of the invention, these light, fine cork particles are rapidly and efficiently separated from the intermixed mass regardless of their shapes and electro-static properties. Being clean cork, they are a valuable fraction of the mixture when so separated. After having so removed the light cork fines as a separate product, the fine denser particles of sand and hardback, which settle and discharge from the separator deck as a sink product along with the coarser cork particles, can be readily screened out of the remaining mixture by a fine screen of say, 48 mesh, and are rejected. Then the plus 48 mesh, i.e. the coarse cork particles, may be separated from the remaining coarse sand and hardback particles by using a conventional pneumatic gravity separating table, so that a clean coarse cork float product is thus obtained. In this manner a total clean cork product, of the full size range 30 mesh x 0 and having substantial value, is salvaged from a mixture which was virtually worthless.

Another example of the unexpected utility of the invention is found in the separation of soy bean meats from hull fragments. The whole beans are first run through a "cracker" which fragments the beans and thereby loosens the hulls from the meat fragments. The hull fragments are a light fibrous material of substantially lower density than the meats, but because of shapes, electro-static properties and the like, are difficult to separate economically by ordinary screening and/or by pneumo-gravity separation. In conventional practice the cracked beans are first run through a multiple set of screens, the over product of each screen being then subjected to conventional aspiration (an air column with an upward stream of air through which the particle mixture falls—not to be confused with the gentle horizontal aspiration of stratification-freed particles at the top of a fluidized bed, in accordance with the invention); thence to another

set of screens, through a beater for further breakage of the fragments, thence to another set of screens and aspirators. These steps are repeated several times at great expense in equipment, low output and loss of valuable oil-bearing meat particles in the rejects.

By contrast the invention is capable of rapidly and efficiently handling and separating large quantities of cracked soy beans with a minimum of equipment and of loss. In applying the invention to this problem, the cracked beans are first run through the apparatus of the invention (hereinafter for convenience called the "fines floater unit") and thereby over 80% of the meats are removed as a clean final heavy product. The flotant residue, consisting of hull fragments intermixed with very fine meat particles, is withdrawn by transverse aspiration, collected and then screened over a set of double-deck vibrating screens. The overs from the first screen, consisitng of the coarser hull and meat particles from the aspirated flotant residue, are sent to a conventional pneumatic gravity separator; the finer overs from the second screen are similarly sent to another such separator; while the through product from the second screen consists essentially of the finest meat particles (less than 1.0% of the original feed), which are sent to final meat product, joining with the sink particles from the fines floater. The separating tables produce an additional 10% of sinks which are contributed to the final meat product, while the final rejects constitute some 8.8% of hulls from the separating tables. In this operation the fines floater unit of itself is capable of handling quantities of cracked soy beans as high as 250 tons per 24 hour day and, in one pass, separating some 80% of clean meat fragments therefrom.

Examples of other material separations in which the fines floater of the invention has been found useful include the removal of carbon particles from zinc oxide residues of a zinc smelter; removal with minimum breakage of fines from calcined lime stone; and removal of fines from dry ceramic mixes. The latter two types of materials represent examples of size separation in mixtures wherein the density of the particles is essentially homogeneous.

Generally and broadly described, in a present preferred embodiment of the invention a fan in the base of the fines floater machine supplies upward air pressure to the porous deck. The feed material enters at the rear of the deck, and is conveyed by vibration slightly uphill toward the discharge end. During its travel from feed to discharge the bed of material is agitated and kept in a fluidized state by the air coming through the deck and by deck vibration. As stratification occurs, the lighter and/or finer particles rise gently to the surface of the moving material bed and into the influence of the aspirated air stream moving across the top of the bed.

The vertically moving stratifying air pressure has a relatively low velocity but a marked fluidizing or stratifying effect. This is achieved both by the thickness of the bed of materials upon the deck and by the relatively fine mesh of the deck material which tends to retain a static pressure in the air chest below the deck. As the bed of materials travels forwardly and upwardly toward the discharge end of the deck, the upward air pressure, in accordance with known principles causes the light-weight fine particles, and (if present) particles which are of light weight because of relatively low density, to rise toward the top of the bed. Particles which initially resist lifting because of their intermediate weights or because of their entanglement with other particles in the lower strata of the bed ultimately find their way to or near the top while heavy particles (of greater weight because of size and/or density) work their way downward through the bed against the lifting action of the fluidizing air.

This segregation of particles according to size and weight is, of course, aided by the agitation of the bed from the vibratory movement of the deck, because the particles are shaken about and tend to travel to and report at the stratum dictated by the response of their weights to the lifting action of the fluidizing air pressure. Thus, there is proceeding throughout the bed a concomitant upward movement of light-weight particles and a formation of inclined zones or strata of similarly sized particles of the same density along the length of the bed. A substantial amount of the finest and lightest materials will find their way rapidly to the top adjacent the feed area, while the somewhat larger and heavier intermediate particles will work upward as the bed progresses toward the discharge end, gaining in depth as more and more coarse particles come together at the bottom of the bed.

In order to effect withdrawal of the fine and light particles which find their way progressively to the top of the bed as stated, a separate means is provided for drawing a relatively gentle air current across the top of the bed and toward the discharge end above the discharge of the settled, coarse, heavy particles. This transverse air current is caused to travel at substantially constant velocity from the feed end to the discharge end of the bed, with preferably a slight positive gradient or increase in air velocity toward discharge to insure maximum stability of the withdrawal action. For this purpose a specially designed hood is provided overlying the entire stratifying area of the bed and separate source of air suction is provided to create and maintain the transverse aspirating air draft.

The hood confines the stratifying and fluidizing air pressure substantially within the bed of materials where it does its work. Having reached the top of the bed below the hood, the relatively gentle transverse air suction entrains and draws the elevated fine and light particles transversely across the top of the bed for ultimate upward suction removal. The shape and position of the overlying hood are important factors in maintaining the desired relationship between the fluidizing upward action of the stratifying air and the velocity and strength of the transverse air draft which removed the flotant superior particles. The velocity of this transverse aspirating air flow may be regulated by raising or lowering the hood above the deck (or by changing the contour of the hood) so as to entrain only the desired sizes of particles, depending upon the range of sizes and densities of the component particles. Thus, by way of example but not limitation, in a homogeneous feed mixture of sizes ranging from 3/8" to zero, it is possible to remove as fines particles from 20 mesh to zero; while in a feed of 50 mesh to zero, fines from 100 mesh to zero can be removed.

Finally, as the settled stratum of heavy sink particles reaches the elevated discharge end of the deck, a relatively strong blast of air is admitted above and counter to the discharging flow of the settled stratum. This blast of air is drawn in substantially parallel to the top of the settled stratum and then, adjacent the discharge end, travels upwardly with the entrained light and fine particles which have been drawn from and across the top of the bed. Thereby a final "scrubbing" effect is applied to dislodge adhering fines from the discharging heavy particles and determine the ultimate disposition of intermediate particles.

Novel and advantageous features of the invention include the following:

(1) A multiple stage separation effect with zones of particles forming horizontally and vertically to isolate and entrain the fines, without affecting the constant discharge rate of the cleaned coarser fraction.

(2) A "scrubbing" effect which dislodges adhering fines from coarse particles. This results from collision between particles moving from feed end to discharge under the combined effects of air and vibration.

(3) There is no degradation loss of coarse (or heavy) finished product due to particle impact often found in

separators discharging material into a high velocity air-collecting chamber, vertical aspirator or cyclone.

(4) "In-between" particles are retained longer in the entrainment zone. Intermediate weight, or peculiarly shaped particles of indecisive apparent density remain in the entrainment zone from ten to twenty seconds until predominant characteristics impel them to the proper zone. This unusual action has been referred to as "fingerprint" or "profile" aspiration.

(5) Separated, coarse particles are moved toward the discharge by high-speed mechanical conveyance, with the coarse product generally constituting the major percentage by weight and volume of finished product.

(6) There is no fixed relationship between the tonnage of acceptable coarse particles produced and the tonnage of intermediate or fine product. The coarse (or heavy) particles separate easily and in large volumes. The complex separation between fines and intermediate particles requires longer, and the rate of final separation may be either high or low, depending on the allowable size distribution for the fines or light end-product.

(7) Extremely little air is used. The dust control requirements are not an expensive problem with the fines floater. In terms of cubic feet per minute of air (c.f.m.) per ton of finished material per hour, the apparatus of the invention requires only a fraction of the c.f.m. requirement necessary for well-known aspirating systems.

The fine and light particles removed by the aspirating action of the transverse upper air stream are drawn into and received by a dust collector mechanism. It should be understood that this aspirating stream of air essentially acts as a gentle collecting medium for the fine and light particles which are freed upwardly by the stratifying action heretofore described. In other words, there is not a violent air blast action in either the zones of stratification (where the upward air pressure merely gently assists the natural tendency of the finer light particles to float), while the aspirating air current acts essentially to collect the fine light particles which rise to the top of the bed.

Referring now in detail to the present preferred embodiment of the invention illustrated in the accompanying drawings, the general overall arrangement of an apparatus embodying and utilizing the invention is schematically shown in FIG. 1. As there shown the separating mechanism or "fines floater" which constitutes the essential elements of the present invention is generally indicated as I; the apparatus for creating the aspirating air for withdrawing the flotant fine particles as II, comprising withdrawal conduit and suction fan; the apparatus for tranporting the withdrawn fine and lighter particles to a dust collection mechanism constitutes the conduit generally indicated by III; and the dust and fines collecting cyclone system by IV.

Referring in detail to the stratifying and separating apparatus itself (I), the mechanical features thereof are generally disclosed in FIGS. 2, 3, 4 and 5. As shown, an air-pervious deck **1** is provided for receiving the mixture of particles to be separated, these being fed across the width of the rear end of the deck by a feed hopper **3**. The deck itself is essentially rectangular in plan (FIG. 5), being formed of a rectangular frame **2** seated upon flanges **4** of a supporting framework having elevated side wall members **5** for confining the sides of the bed to the desired depth, an inclined feeding and retaining plate **7** at the rear end below the mouth of the feed hopper, and a front discharge lip **8** substantially flush with the deck and leading to the discharge trough **9**. The air-pervious or foraminous surface of the deck may constitute a supporting ply of hexagonal cells or honeycomb construction **11** within the deck frame **2**, over which is superimposed a finer mesh screen cover **13** which, in some cases may be a very fine mesh cloth or felt, depending upon the nature of the materials being separated. As shown the deck surface is smooth and continuous and will preferably be without any riffles or obstructions on the air-pervious surface transverse to the movement of the bed of materials.

As previously stated, the deck is mounted so that the discharge end **8** is higher than the feed end **7**, the deck preferably having a constant upward slope from the rear feed end to the forward discharge end. The deck itself is preferably mounted between flanges **4** and **6** in a supporting box-like framework having rear wall **15**, front wall **17**, and side members **19** with bottom flanges **21**, the bottom and top of said frame of course being open for the upward passage of air to and through the deck. The deck **1** and the supporting deck framework **15–19** are movably suspended above a rectangular, stationary air chest **23**, formed of structural supporting vertical corner posts **20** extending upwardly from a fixed base plate **25**. The chest is closed by end walls **22** and side walls **24**, but the top has a large rectangular opening below and substantially co-extensive with the deck **1** above.

A flexible seal **29** is provided between the bottom of the deck frame and the top of the air chest to permit vibratory movement of the deck with respect to the air chest while confining the flow of air from the latter. Said seal may be of impervious canvas, rubber or other suitable material well known in the art. The air chest, which is externally sealed except for an air filter inlet **31** and fan-connecting conduit **33**, contains an air-pressure producing fan of conventional construction having an external stator or hood **34**, air delivery opening **35** and internal rotor **37** for creating the desired upward air pressure for the deck **1**. The rotor of the fan is driven by shaft **39** which, by means of suitable belt and pulley arrangement **41** is powered by motor **43**. The c.f.m. delivered by the fan may be varied by any conventional means, such as air control veil **44** on the air inlet **31**.

The motor and fan assembly are also utilized to furnish the power for imparting vibratory movement to the table. For this purpose a belt **45** driven from pulley **46** on shaft **39** drives shaft **47** through pulley **49** mounted thereon. An eccentric **51** also mounted on said shaft is designed to impart rapid vibratory motion to the framework **15–19** through the agency of an interior vibration frame consisting of two longitudinal beams **50** which are cross connected by a square, hollow, center beam **53**, which is secured at either end to beams **50** as by welding. Said interior frame is mounted for rotation about a horizontal central axis **54**, the ends of which are rotatably mounted in the beams **50**, this construction facilitating variations in the longitudinal slope or "end raise" of the deck as described below.

The deck-supporting frame, including said vibration frame, is mounted for vibratory motion with respect to the stationary air chest by means of two pairs of leaf spring rocker arms **61** at the front and rear ends of the deck frame, respectively. Said spring arms are inclined upwardly and rearwardly, the lower ends being bolted by brackets **63** extending from the air-chest posts **20** in the air-chest frame and the upper ends being bolted to brackets **64** which extend inwardly from either end of the vibration frame beams **50**. This system is designed to impart very rapid vibratory movement of small amplitude to the deck, a preferred vibration being at approximately 850 to 900 cycles per minute with an amplitude of approximately ¼". As indicated, the movement is forward and upward along the deck thereby tending to lift and project the bed along the forwardly and upwardly inclined deck in known manner.

Means are provided for varying the end raise or longitudinal inclination of the deck. For this purpose the vibration frame and the deck frame attached thereto may be adjustably rocked about the axis shaft **54** and clamped in the adjusted position by four external handwheels **68** adjacent each corner of the vibration frame. More in detail, handwheels **68** are pinned to bolts **69** which extend through openings in walls **19** and strengthening brackets

70 welded to walls 19. The inner ends of the bolts project through guide plates 71 fixed to and depending from the inner faces of brackets 70. Vertically slotted hangers 72 are hung on the upper surfaces of the beams 50, the bolts 69 extending through the slots in the depending legs of said hangers. Nuts 73, threaded on the inner ends of the bolts are provided with wings which engage the vertical edges of plates 71, leaving gaps on either side of the hanger edges for play and limited rotary motion.

In practice, these assemblies are loosened by turning the handwheels 68, the vibrating frame and with it the deck frame 2 and deck-supporting framework 15–19 are rocked about shaft 54 to the desired inclination and then the handwheels used to tighten and lock the mechanism in the adjusted position.

Means are also provided for damping the vibrating movement of the deck and its associated frameworks. As shown, two vertical resilient straps 100 are fixed at its lower end to the upper part of the stationary air chest by bolted brackets 101. The free upper end of straps 100 lie in the spaces between two pairs of bumper brackets 102 and 103 which are mounted respectively fore and aft of the strap ends. Said bumper brackets are attached by bolt and slot constructions to the inner faces of beams 50 of the vibrating frame. Thereby the amplitude of the vibration may be adjustably damped.

Referring now to the means for guiding and controlling the transverse aspirating air current or stream which withdraws the elevated fine and light particles from the top of the bed, same includes a specially designed hood 75 which overlies the entire upper surface of the deck. The air hood is essentially a rigid casing, rectangular in plan and stationary with respect to the vibrating deck, being supported above the deck by four supporting rods 77, the lower ends of which are fixed to brackets 78 at the four upper corners of the air chest. The upper ends of rods 77 are threaded and fixed by double nuts 74 to flanges 79 which project laterally from the side walls of the hood. The hood has vertical side wall members 81 which extend along either side of the hood throughout its length, overlapping and slightly spaced from the deck frame walls 5 so as to provide space for air passage therebetween. A flat roof member 83 forms and closes the top of the hood, being integral with the sides 81. The top edges or upper profiles of the side members 81 are, as shown, inclined upwardly and forwardly at a somewhat steeper angle than the surface of the deck itself.

Preferably the rear end of the hood is open to admit air drawn thereinto. For this purpose a space exists at A, extending across the hood end the width of the deck, between the delivery exit of the feed hopper 3 and the inclined guide plate 7. The feed hopper is mounted on the top 83 of the hood adjacent the rear edge thereof. Said hopper is V-shaped in cross section, having front wall 84 tilted downwardly and rearwardly and back wall 85 tilted downwardly and forwardly. Said inclined walls are welded at their respective ends to rhomboidal end walls 86 which rise from and are welded to the upper face of hood top plate 83. A slidably adjustable plate 87 is mounted on back wall 85 by a bolt and slot arrangement so that the size of the feed opening of the hopper may be varied. Thus the stream of air drawn into the hood passes through the mixture of materials being cascaded onto plate 7 and fed to the deck, so that an initial entrainment of fine light particles is thereby effected.

As shown, the top of the hood is inclined upwardly and forwardly so as to provide greater space toward the front end of the deck. This contour is such as to provide a substantially uniform velocity of air flow throughout the length of the hood, thereby to draw off gently the risen lighter and finer particles as stratification within the bed proceeds. The front end of the hood terminates in a duct formed by vertical wall 93 which curves downwardly and rearwardly at 94, while the top 83 of the hood is curved upwardly and forwardly as shown at 95 so that the walls 93, 94 and the curved portion 95 form a curved duct which rises from the front end of the hood above the deck to communicate with the suction conduit 97 of the portion II of the apparatus.

In accordance with the invention, means are provided for varying the cross-section of the air passageway formed between the hood and the top of the deck to achieve some variation in the velocity of the transverse air stream which travels along the hood and up the duct as described. This variation is achieved by means of the hood-supporting bolts 77, which as shown are threaded at their upper ends and provided with the double nuts 74 which fasten the flanges 79 of the hood to the supporting rods 77. By adjusting the setting of these nuts, the spacing between the top of the hood and the top of the bed of material lying on the deck may be varied as desired.

Referring now to the means for providing the "scrubbing" air currents which are directed across the discharging stratum of heavy material at the front end of the deck and into the upwardly flowing stream of air in the duct, an upwardly and rearwardly inclined baffle plate 105 is provided at the front end of the hood extending from the bottom end of the downwardly and rearwardly curved duct wall 94. The angle of inclination of baffle 105 may be variable about a hinge, not shown. Thus the baffle 105 lies over the discharge end of the deck itself and provides a means for guiding air currents which are drawn in at the discharge opening of the deck over and across discharging flow of the settled coarse particles and thence upwardly into the duct. This supplementary, relatively strong air current performs the final "scrubbing" action to remove residual clinging fine particles from the discharging product and oppose the exit therewith of fine and light particles which it is desired to remove and which flow up the duct with the other particles already entrained in the suction stream.

Referring now to the portion II of the apparatus (FIG. 1), the suction fan 111 for aspirating the hood and creating the transverse air stream is mounted conveniently in front of the separating mechanism I, said fan being driven by motor 113 with conventional belt and pulley connections 115. The inlet side of 111 is connected to a pipe or conduit 117 which communicates with the upper end of the duct of hood 75 by means of the connecting channel 97, the upper end of which is tapered to a circular cross-section at 119 and communicates with the circular end of conduit 117 by means of a flexible connector 121. Conventional means, not shown, may be provided for varying the intake of fan 111, thereby further to regulate the air flow relative to the air-output of stratifying fan 37 and to thus accommodate the operation to different materials and mixtures.

The material drawn off the top of the bed and through the conduit 117 passes through the fan and is blown out of the housing thereof through the exit connection 123 into the vertical conduit pipe 125 of portion III. Pipe 125, in turn, delivers the entrained particles to the body of a cyclone dust collector IV by means of an expanding connector 129 which introduces the air stream from the fan tangentially through opening 130 into the cylindrical top portion 131 of the cyclone. The lower part 133 of the cyclone forms a conical hopper into which the dust and fine and light particles fall as the stream of air loses its velocity in the upper part of the dust collector. A discharge trap 137 is provided at the bottom of the hopper for removal of materials in the conventional way.

The invention in its broader aspects is not limited to the specific process, steps and mechanisms shown and described but departures may be made therefrom within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages.

What is claimed is:

1. The method of separating intermixed divided materials varying in size which comprises maintaining a bed of said materials on an air pervious surface, moving the bed substantially unidirectionally along said surface from a feed locus to a discharge locus, vibrating the bed, passing air under pressure upwardly through the bed throughout its travel to fluidize the bed and effect stratification of fine and light particles progressively into flotant strata and permit sinking of coarser and heavier particles, discharging settled heavy particles from the surface, and removing flotant light fine particles as they arrive at the top of the bed by introducing a separate stream of air from above the top of the bed adjacent the feed locus thereof, confining and passing said separate air stream along and over the top of the bed throughout the length thereof in substantially continuous planar flow substantially parallel to the top of the bed and to said unidirectional movement of the bed to entrain and withdraw said light particles, and separately delivering and collecting said entrained particles.

2. The method of separating intermixed divided materials varying in size which comprises maintaining a bed of said materials on an air pervious surface, moving the bed substantially unidirectionally along said surface from a feed locus to a discharge locus, vibrating the bed, passing air under pressure upwardly through the bed throughout its travel to fluidize the bed and effect stratification of fine and light particles progressively into flotant strata and permit sinking of coarser and heavier particles, discharging settled heavy particles from the surface, and removing flotant light fine particles as they arrive at the top of the bed by introducing a separate stream of air from above the top of the bed adjacent the feed locus thereof, confining and passing said separate air stream along and over the top of the bed in substantially continuous planar flow substantially parallel to the top of the bed and to said unidirectional movement of the bed to entrain and withdraw said light particles, separately controlling the respective volumes and velocities of the fluidizing and stratifying air and of said separate stream of air, and separately delivering and collecting said entrained particles.

3. The method of separating intermixed divided materials varying in size which comprises maintaining a bed of said materials on an air pervious surface, moving the bed along said surface from a feed locus to a discharge locus, vibrating the bed, passing air under pressure upwardly through the bed throughout its travel to fluidize the bed and effect stratification of fine and light particles progressively into flotant strata and permit sinking of coarser and heavier particles, discharging settled heavy particles from the surface, removing flotant light fine particles as they arrive at the top of the bed by introducing a separate stream of air from above the top of the bed adjacent the feed locus thereof and through the material being fed to the bed, confining and passing said separate air stream along and over the top of the bed in substantially continuous planar flow substantially parallel to the top of the bed and to said unidirectional movement of the bed to entrain and withdraw said light particles, separately delivering and collecting said entrained particles, and passing another stream of air counter to the stream of discharging settled particles and counter to the direction of said first-mentioned stream of air to remove residual lighter particles, and joining said second stream of air with the terminal flow of said first stream.

4. The method of separating intermixed divided materials varying in size which comprises maintaining a relatively long and narrow bed of said materials on an air pervious surface, moving the bed substantially unidirectionally lengthwise along said surface from a feed locus to a discharge locus, inclining said bed upwardly in the direction of its travel, vibrating the bed, passing air under pressure upwardly through the bed throughout its travel to fluidize the bed and effect stratification of fine and light particles progressively into flotant strata and permit sinking of coarser and heavier particles, discharging settled heavy particles from the surface, and removing flotant light fine particles as they arrive at the top of the bed by introducing a separate stream of air from above the top of the bed adjacent the feed locus thereof and confining and passing said separate air stream along and over the top of the bed in substantially continuous planar flow substantially parallel to the top of the bed and to said unidirectional movement of the bed to entrain and withdraw said light particles, separately delivering and collecting said entrained particles, and passing another stream of air counter to the stream of discharging settled particles and counter to the direction of flow of said bed to remove residual lighter particles, and joining said second stream of air with the terminal flow of said first stream.

5. An apparatus for separating light fine particles from an intermixture of particles varying in size and weight including in combination an air pervious deck inclined upwardly from its feed to its discharge end, means for feeding said intermixture to the feed end of the deck, means for maintaining the mixture in a bed travelling toward the discharge end of the deck including means for vibrating the deck, a fan for blowing an upward pressure of air into and through said bed, a hood overlying the deck and enclosing the area above and at the sides of the bed, means for drawing a stream of air into the space under the hood above the bed from a source above the bed adjacent the feed end and across and above the bed substantially parallel to the top of the bed throughout the travel of said bed and beyond the discharge end thereof to entrain and carry away fine flotant particles, and means for separately discharging settled coarser and heavier materials from the discharge end of the deck.

6. In an apparatus according to claim 5, the combination of means for delivering said stream of air and entrained particles to a dust collector.

7. Apparatus according to claim 5 having means for varying the space between said hood and the bed of materials to thereby vary the action of said air stream.

References Cited in the file of this patent

UNITED STATES PATENTS

1,817,296	Davis	Aug. 4, 1931
1,870,042	Dorfan	Aug. 2, 1932
2,275,849	Fraser	Mar. 10, 1942
2,408,810	Puening	Oct. 8, 1946
2,702,635	Bowen	Feb. 22, 1955
2,764,293	Forsberg	Sept. 25, 1956
2,973,862	St. P. Vail	Mar. 7, 1961

FOREIGN PATENTS

764,808	Great Britain	Jan. 2, 1957