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Oetiker

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[45] **Dec. 3, 1974**

[54] **STRATIFIER WITH A PNEUMATIC PRODUCT RECIRCULATION**

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[63] Continuation of Ser. No. 12,108, Feb. 17, 1970, abandoned.

[30] **Foreign Application Priority Data**

Feb. 21, 1969 Switzerland 2706/69

[52] **U.S. Cl.** **209/469,** 209/467, 209/488, 209/492, 209/504

[51] **Int. Cl.** **B07b 4/08,** B07b 11/06

[58] **Field of Search** 209/466–469, 209/488, 492, 502, 321, 474–476, 312, 318, 504

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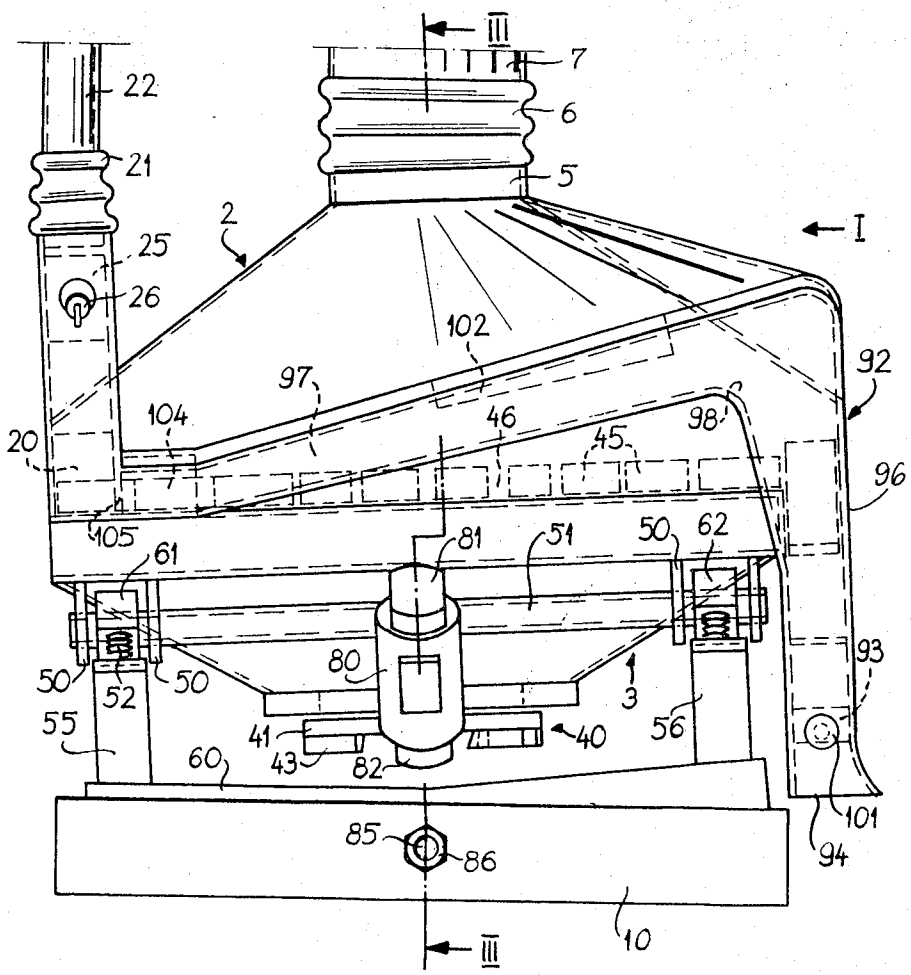
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Assistant Examiner—Ralph J. Hill
Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

A method and apparatus for pneumatically stratifying granular materials wherein a pneumatic means is provided for recycling a middlings product to the feed. The middlings are raised pneumatically and then separated from the gas and subsequently conveyed by vibration to the feed. Separation of the middlings product, pneumatic treatment at the inlets and outlets, pulsating means and reciprocating means are also disclosed.

24 Claims, 6 Drawing Figures



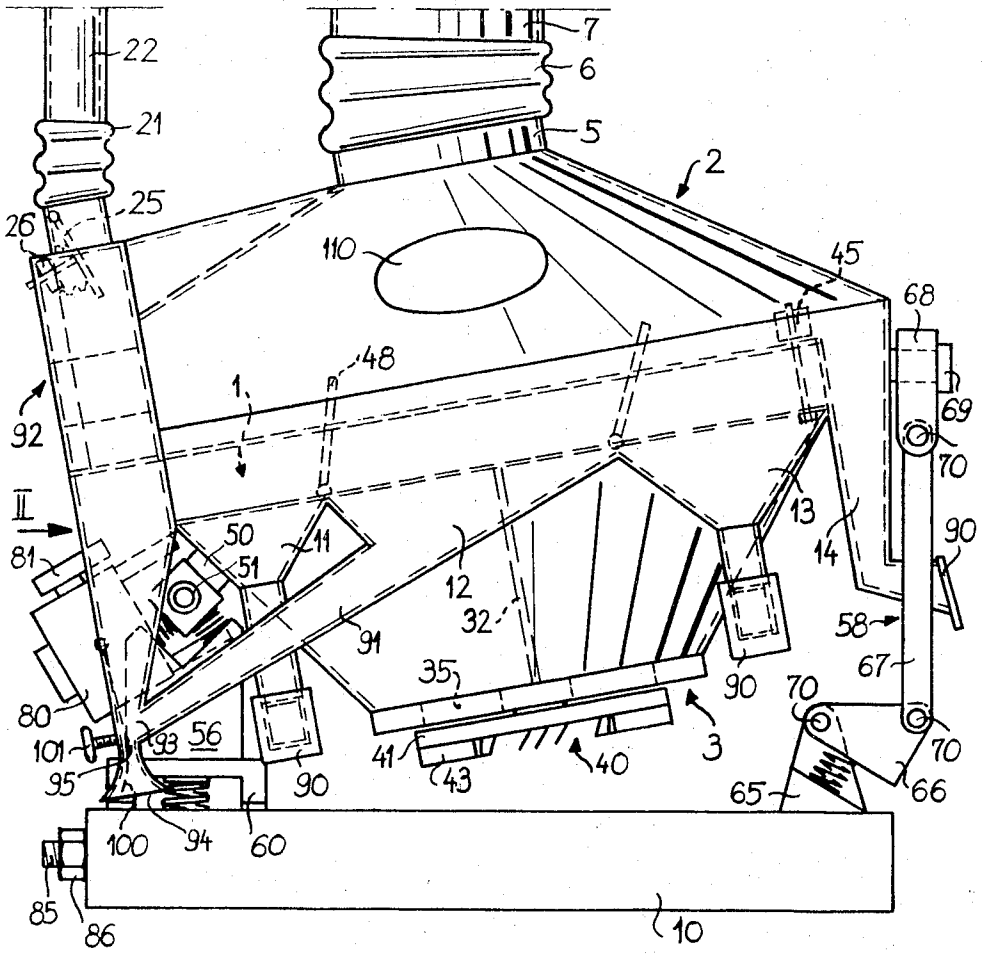

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92
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91
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101
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95
90
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Fig.1

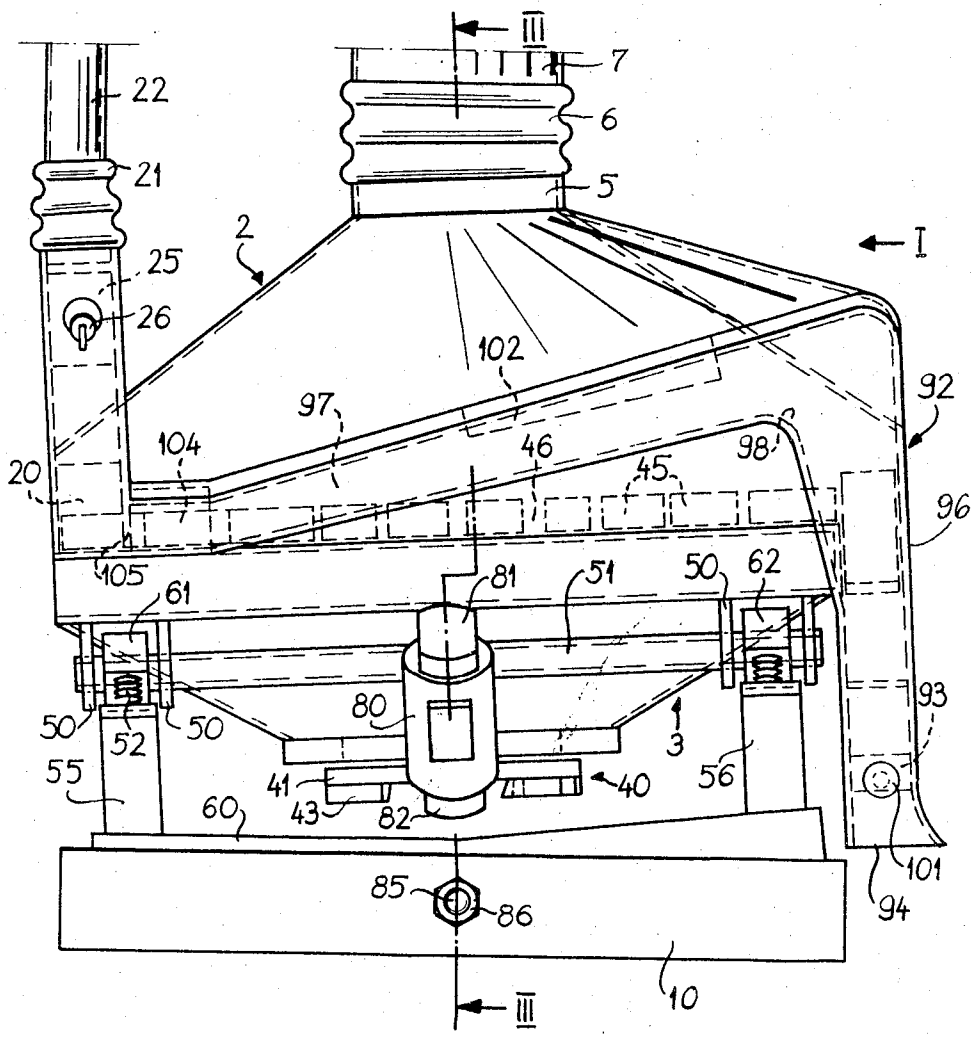

III
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92
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104
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98
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105
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62
61
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101
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III

Fig.2

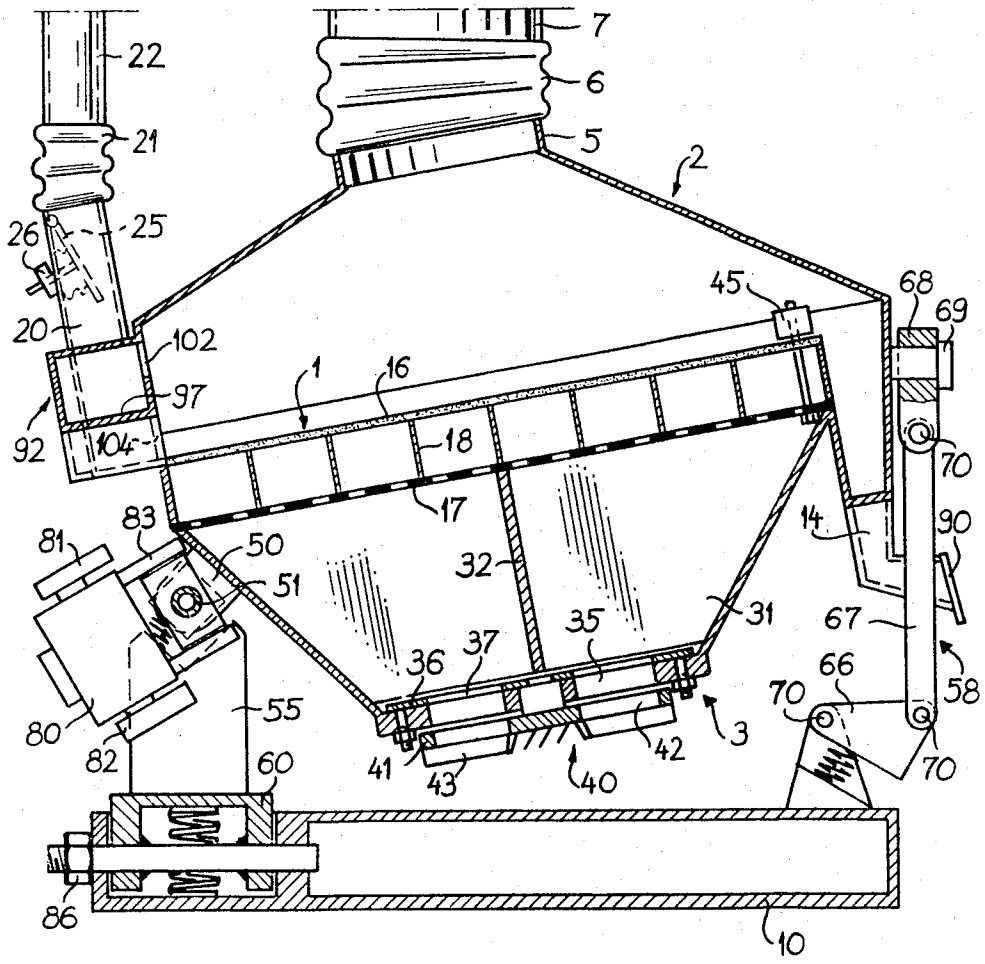

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92
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Fig.3

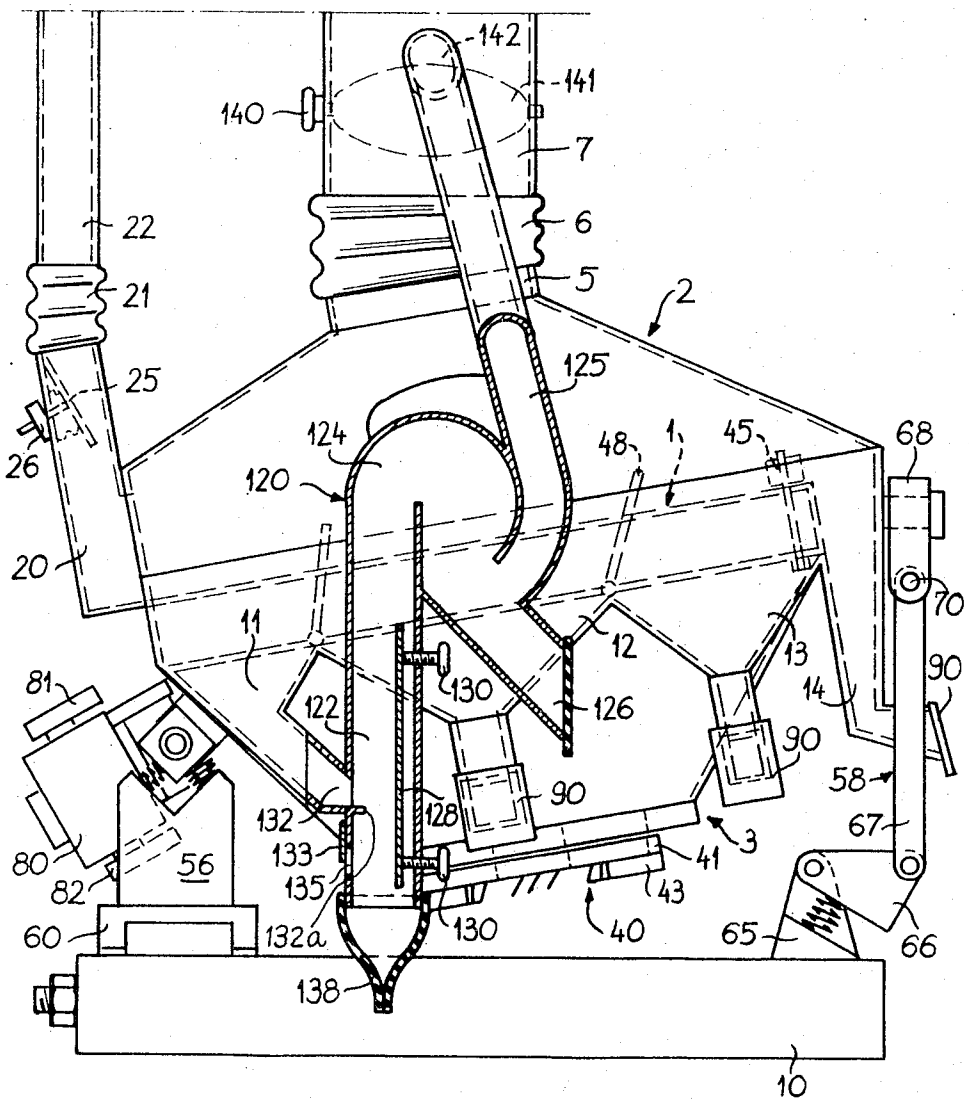

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122
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126
90
58
132
128
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67
80
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133
41
3
82
135
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60
132a
130
40
65
66
138
10

Fig. 4

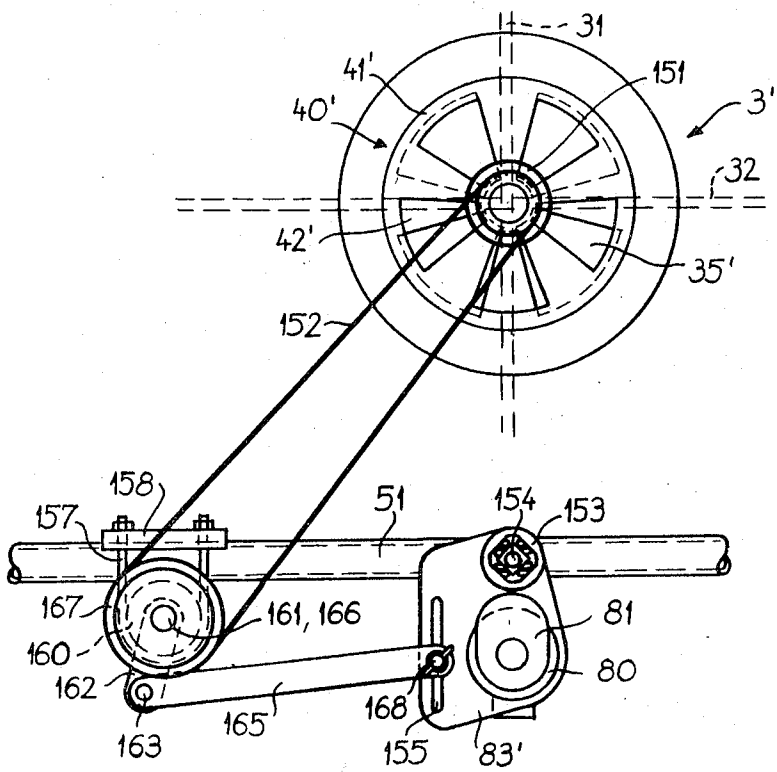

31
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40'
3'
32
42'
35'
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158
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167
161, 166
81
160
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162
168
165
163
155
83'

Fig.5

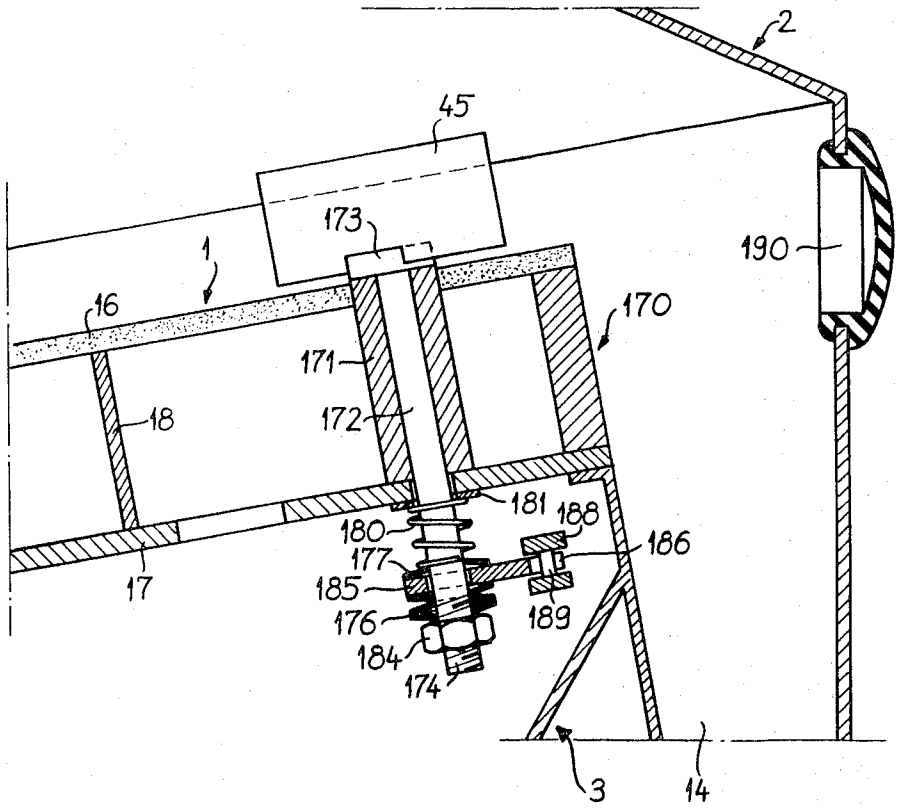

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173
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3
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Fig.6

STRATIFIER WITH A PNEUMATIC PRODUCT RECIRCULATION

CROSS-REFERENCE TO PARENT

This case is a continuation of Ser. No. 12,108, filed Feb. 17, 1970, now abandoned.

BACKGROUND OF THE INVENTION

In this type of material treatment, which is known also as "light grain-sorting," and involving the combined use of vibration and fluidization, equivalent to aeration by an air current, it is known to subject a second fraction, of partial fractions obtained separately from the repeated material treatments, by returning it to the incoming bulk material, together with the latter, to a second treatment in order to improve the degree of sorting or separation. Such recirculation frequently proves absolutely necessary, since a clean separation, into the various components of the bulk material mixture, cannot be effected completely, with economically acceptable equipment expenditures, without an excessive stay or dwell period of the bulk material in the range of action of the treatments effecting the separation, that is, vibration and fluidization or pneumatic aeration.

In known arrangements, this return of material into the total material flow is effected by mechanical conveyor elements, such as bucket conveyors, returning material to the total material input through the material inlet to the material support. Thus, the recirculating arrangements necessitate the provision of a special driving means and at least one gate, if the separation of the bulk material mixture takes place in a closed chamber collecting the aeration air in a pipe leading from the chamber, and this also involves considerable increase in operating expenses. For example, increased expenses are involved in the additional driving means and in the elastic or flexible connections.

SUMMARY OF THE INVENTION

This invention is directed to the separation of components of mixtures of bulk materials utilizing vibration and fluidization and, more particularly, to a novel, improved, simpler and more efficient method and apparatus for effecting such separation with a higher degree of efficiency.

In accordance with the invention, it has been found, surprisingly, that, in addition to the air current necessary for aeration and flowing through the material support and the layer, with subsequent collection under a hood and exhaust from the hood, separately supplied and conducted treatment air can be fed into the exhaust air current. Thus, in accordance with the invention, at least one treatment air flow is provided and conducted separately from the air current flowing through the layer on the support, and utilized to effect separate treatments of the bulk material, fed through the inlet, or parts of the bulk material, and the aeration air current and the treatment air current are conjointly exhausted after the aeration treatment and the special treatment.

In addition to the separation of bulk material mixtures, according to specific gravities, under the influence of vibrations and aeration, it is known to effect a so-called inlet aspiration of the incoming bulk material, that is, to direct the air current, necessary for the aeration, in the range of the inlet across the incoming bulk mixture and thus to separate the light fractions. However, this stepwise use of the aerating air for a second purpose has the disadvantage that light portions of the bulk mixture, which were removed on the vibrating material support by the air current, are deposited again at least partly in the bulk material during the sifting in the inlet. This is usually connected with a constant circulation of certain bulk material components, which leads to a reduction of the effectiveness of the separating method, after which light portions, under the influence of heavier portions, are discharged with the latter from the apparatus. Variations of the air current manifest themselves immediately as variations in the inlet sifting, because of the varying layer thickness of the bulk material.

An advantage of using a separate air current for aeration of the bulk material on the vibrating support and another special treatment air current for separate treatment of the bulk material from the separation operation, or apart of the bulk material, resides in the fact that optimum air flow conditions must be created for these separate treatments, and this leads to a substantial improvement in efficiency of the operation. In addition, these measures permit the simplified performance of treatments which could be carried out heretofore only at much greater expense. Thus, mixture components which must be fed a second time, under the influence of vibration and aeration, to the material support, can be returned again to the range of the inlet utilizing the separated air current as a pneumatic conveyor.

In addition, certain light fractions of the bulk mixture can be removed by air sifting, by causing the separately conducted treatment air to flow through the inlet in such a way that neither contaminated air nor air moistened by a previous treatment or influenced by working variations in the current, are used.

Additionally, the mixture components issuing through an outlet can be exhausted by air sifting between this outlet and the joint exhaust of the aeration air current and the treatment air current in the outlet. Despite the separate flow of air, the treatment air, for a separate treatment, the air current passing through the material support, and the layer of material on the support can be pulsated by periodic interruption of the main air aeration air flow.

The invention apparatus includes a main air inlet or air feeding device beneath a porous and gas-permeable material support, for the air current for aerating the bulk material mixture flowing over this support, and includes a separate air inlet opening connected to a special flow duct for the flow of the treatment air current which is conducted to a treatment apparatus separate from the aeration arrangement. Means are provided for commonly or conjointly exhausting the treatment air current and the aeration air current, collected under a hood covering the material support, after the aeration treatment and the separate treatment.

In concordance with the invention method, it is essential that, in the invention apparatus, the individual air currents for the two separate treatments of the material are fed separately to the treatment stations in the apparatus.

A flow duct can be arranged adjoining the air inlet for the treatment air, for the pneumatic feed from the range of at least one of the outlets up to the range of the bulk material inlet.

An air passage can be provided, under the hood covering the material support, for the treatment air providing the pneumatic feed, and this air passage can be provided between the mouth of a feed pipe in the range of the material inlet and a deflection arranged at a higher level opposite this mouth.

The treatment air can be fed from the treatment air inlet through a falling bulk mixture mist in the range of the material inlet and into the air current under the hood.

Additionally, an air sifting duct can be formed between the inlet for the treatment air and the common exhaust, into which one of the outlets opens above the inlet.

A periodically operating air current interrupter can be provided in the main air supply to the material support.

The application of the aforementioned measures individually or in combination offers the advantages of a very economical operation of the overall apparatus, a very efficient separating effect on the bulk mixture supply, and substantial savings in equipment costs.

An object of the invention is to provide an improved method of and apparatus for separating mixtures of bulk materials, according to specific gravity, under the influence of vibration and aeration.

Another object of the invention is to provide such a method and apparatus in which a separate treatment air current flow is provided and at least part of the bulk material is subjected to a separate treatment by the treatment air current.

A further object of the invention is to provide such a method and apparatus in which, after aeration and such separate treatment, the aeration air current and the treatment air current are commonly exhausted.

Another object of the invention is to provide such a method and apparatus in which treatment air flow is pulsating.

A further object of the invention is to provide such a method and apparatus characterized by simplicity, economy and increased efficiency.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. **1** is an elevation view, looking in the direction of arrow I of FIG. **2**, of one form of apparatus for performing the method of the invention;

FIG. **2** is an elevation view of the apparatus looking in the direction of the arrow II of FIG. **1**;

FIG. **3** is a vertical sectional view of the apparatus taken on the line III—III of FIG. **2**;

FIG. **4** is an elevation view, partly in section, illustrating details of a modified form of the apparatus;

FIG. **5** is a partial bottom plan view illustrating a further modification of the apparatus; and

FIG. **6** is a partial vertical sectional view, to a much larger scale, illustrating a further modification of the apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. **1, 2** and **3**, the apparatus of the invention comprises a material support **1** which is porous and gas-permeable, and thus also permable to air. The apparatus further includes a hood **2** arranged above support **1** and an air supply device or main air inlet **3** arranged beneath the gas-permeable support. Hood **2** opens into a line **5** connected by an elastic bellows **6** with an air exhaust pipe **7.** Hood **2** also encloses several outlets **11, 12, 13** and **14** which are arranged laterally about gas-permeable material support **1.** An inlet **20,** for feeding of bulk material, discharges onto material support **1,** and this inlet **20** is connected by a bellows **21** with a material feed pipe **22.** Inlet **20** opens on to material support **1** in the same plane as the supporting surface of the support **1,** and has pivotally mounted therein a feed regulating flap or damper provided with a counterweight **26.**

The air feeding device or main inlet arranged beneath material support **1** acts simultaneously as a partial distributing device for the air current, since its entire base area is subdivided by partitions **31** and **32** into separate air flow passages. Each air flow passage, at the lowest point of the apparatus, has a respective air supply opening **35** for supply of air thereto. Above each air supply opening **35,** there is arranged an adjustable flap or partition **36** having openings **37** which permit individual regulation of the effective cross section of each air supply opening **35.** A moving shut-off valve **40** is arranged on the inlet side of the air supply openings and, in the embodiment of the invention shown in FIGS. **1, 2** and **3,** comprises a rotating disk **41** having s number of passages **42** greater than the number of air supply openings **35.** For the purpose of effecting rotation of disk **41,** as a moving shut-off element relative to air supply openings **35,** disk **41** has, in the range of the passages **35,** inclined vanes **43** oriented in such a manner that a rotary movement is imparted to the treatment air acting on the bulk material to be treated, so that disk **41** is driven in the manner of a turbine runner.

Material support **1** comprises a porous mat **16,** a perforated plate **17** and spacers **18.** For the purpose of influencing the discharge of bulk material treated on the porous and gas-permeable material support **1,** adjustable baffle plates **45** are provided along one side thereof, and define between themselves adjustable discharge gaps **46.** Distribution flaps are arranged along the other side of material support **1** in such a manner that the push-off-bulk material, from various outlet regions of the porous and gas-permeable material support **1,** can be fed without change in quantity, to the various outlets **11–14.**

In addition to the treatment effected by the air drawn through the entire apparatus from main air inlet or air feeding device **3** to the hood **2** and into line **5,** means are provided for effecting a vibration treatment. For this purpose, a shaft **51** is positioned in apertures in two pairs of side bars **50** on an assembly consisting of material support **1,** hood **2** and air feeding device **3.** This assembly is mounted for vibration and oscillation by springs **52** in oppositely directed sockets **55** and **56,** and a hinged support generally indicated at **58.** The support by springs **52** in the two sockets **55** and **56** can be adjusted by the clamping rocker **60,** the two springs **52** being arranged obliquely to each other between the sockets **55** and **56** and the bearings **61** and **62** on shaft **51.**

Proceeding from base **10** to the vibratable assembly, hinged support **58** comprises a bearing block **65,** a substantially horizontal lateral plate **66,** a substantially ver-

tical link **67**, and a bearing head **68** engaging a pivot pin **69** on the assembly. Respective hinge pins **70** interconnect bearing block **65** to lateral plate **66**, lateral plate **66** to link **67** and link **67** to bearing head **68**.

The throw vibration movement is produced by a motor **80** provided with eccentric weight **81** and **82**, this motor being oscillatably mounted, in a known manner, by elastic oscillation blocks, on shaft **51**. Clamping rocker **60** is secured on a shaft **85** mounted in base **10**, and can be clamped to socket **10** by a nut **86** threaded on shaft **85**.

Elastic shut-off elements **90**, for example rubber plates, are associated with the various outlets **11**, **13** and **14** in such a manner that the shut-off elements are pressed against the peripheries of the outlet openings by the pressure gradient existing between the outer atmosphere and the interiors of the respective outlet openings.

Outlet **12** is provided with an outlet pipe **91** which communicates with a flow duct **92** designed as a conveyor line. Flow duct **92** is formed by an air inlet opening **94**, arranged below the exit **93** of pipe **91** connected to outlet **12**, an injector-like constriction **95**, a diverging rising duct **96**, and a trough **97** sloping downwardly to the range of material inlet **20** from a deflection section **98** arranged in elevated relation to mouth **93**, of outlet **12**, and the transfer level from inlet **20** to material support **1**. Constriction **95** is variable in cross section by a screw **101** acting on a movable plate **100**. In the range of trough **97** between deflection portion **98** and the range of material inlet **20**, there is provided an air slot **102** opening under hood **20**. In the range of material inlet **20**, flow duct **92**, designed as a conveyor line, opens to the porous, gas-permeable support **1**. Between material inlet **20** and the mouth **104** of this conveyor line there is arranged a partition **105**, preferably curved in the direction of flow.

At least one sight glass **110** is provided in hood **2** for observing the work on the material on support **1**.

The apparatus shown in FIGS. **1**, **2** and **3** is operable to perform the method which will now be described. A bulk material mixture, to be subjected to a separation treatment in accordance with the specific gravities of its components, is supplied through material inlet **20** to porous, gas-permeable material support **1**, with the feed being regulated, by the counterweight-loaded flap **25**, in such a manner that no excess secondary air is introduced into the apparatus from feed pipe **22**. The separation of the bulk material mixture is effected by subjecting the mixture to the influence of vibrations of material support **1**, which latter effects, at the same time, feeding of the material from inlet **20** to the outlets. In the illustrated apparatus, these vibrations, which are throw vibrations, are imparted to support **1** by motor **80**, mounted for oscillation on the construction, and having the imbalance-producing eccentric weights **81** and **82**. The conveying effect of the vibrations imparted to material support **1** can be influenced by the dual inclination adjustment means. One means is represented with the rocker and the pivot pin with respect to one machine shaft, but, in the other means, and in contrast with the illustration, the hinged support must be adjustable. In addition to the influence of the vibrations in separating the bulk material mixture on material support **1**, the bulk material is subjected to the influence of an air current drawn through material support **1** and effecting aeration of the bulk material through which the air current flows. The fractions of the charged bulk material mixture, separated according to the specific gravities of the components, are discharged through outlets provided for this purpose.

In the application of this method of separating bulk material mixtures under the influence of an air current flowing through material support **1** and the layer of material thereon, it has been found, in accordance with the invention, that separate treatments of the bulk material supplied through the inlet, or parts of the bulk material so supplied, can be effected in the same apparatus. For these separate treatments, there is used a treatment air flow which is sparate from the air current flow required for the aeration, and which is exhausted, after the treatment, conjointly or commonly with the aeration air current.

In the apparatus illustrated in FIGS. **1**, **2** and **3**, separate treatment of a part or all of the bulk material is effected by at least partly pneumatic conveyance of mixture components, which are separated from the bulk material mixture and flow into an outlet especially provided for this purpose. From the range of this outlet, the pneumatic conveyance of the mixture components is effected as a separate treatment directing the components thus treated back into the range of the inlet provided for the inflowing bulk material mixture.

In contrast to presently known so-called recirculations or returns of parts of the bulk material, using special conveyor devices provided between respective outlets and the inlet, the discovery of the present invention has proved to result in a substantial simplification with respect to these known procedures. The discovery of the present invention resides in that the energy imparters, namely the air and vibration, used for separation of the bulk material mixture, are used simultaneously for a separate treatment. In the above-mentioned pneumatic return of the separated layer, conveyance of the separated layer is effected, after elevated deflection, primarily by the vibration produced, and the conveyance leads up to the range of the inlet for the bulk material mixture. It is thereby possible to conduct the specially guided treatment air, before the returned mixture components are transferred to the material support, from the flow duct beneath the hood and to exhaust the treatment air from the hood together with the aeration air, and through the exhaust air line.

In order to improve the effectiveness of the separation utilizing vibration and air flow, the air flow through the material support and the layer thereon is interrupted periodically, so that, in effect, the main or aeration air flow is a pulsating air current. Simultaneously, the separately conducted treatment air can have a continuous flow, which is necessary particularly in pneumatic conveyance.

Due to the injector-like design of the flow duct **92**, for the treatment air, and which extends from the exit of one outlet, there is obtained the necessary pressure difference within the system. Without this particular provision, it would not be possible readily to obtain this flow. With this provision, however, a suitable pressure-velocity conversion is attained, and vice-versa. The number of openings in the rotating air flow interrupter **41**, designed as a turbine runner, preferably differs from the number of air supply openings to the gas-permeable material support.

In the illustrated apparatus for carrying out the above described method, there is obtained an economical op-

eration, and substantial savings in special apparatus for the return feed of that part of the bulk material subjected again to the influence of vibration and aeration. Any very light dust fractions still deposited from the treatment are conducted, in exactly the same apparatus, into the air current already laden from the aeration with the very light particles, so that, in this respect also, an improved operation of separating means is attained.

This improved dust removal, with respect to that part of the bulk material returned again for separation, is based on the fact that the dust particles, during the high level or elevated deflection, are no longer precipitated from the separately conducted treatment air through air slot **102** beneath hood **2.** Another improvement consists in that the returned part of the bulk material is fed to the incoming bulk material mixture in the range of the inlet and in the lateral region which is particularly preferable for the subsequent separation. By virtue of this, a final sharp separation of the returned partial amount of the material is substantially facilitated during the second passage through the apparatus. The overall efficiency thereby is substantially improved, as compared to presently known arrangements for returning mixtures to newly incoming bulk material mixtures.

It will be clear that the bulk material mixtures, fed through inlet **20,** can be subjected to air sifting in the region of this inlet in a similar manner, by using a separately conducted treatment air current, also combined with the aeration air current, which thus effects an initial relief, from the bulk material mixture, of the lightest fractions, such as husks, dust, etc. This insures, in the further separation on the porous, and gas permeable material support **1,** an effective operation, since these fractions will not be able to clog the relatively small openings provided in material support **1.**

The embodiment of the invention shown in FIG. **4** represents an apparatus for carrying out another method for separating bulk material mixtures, and represents a further simplification with respect to the already described apparatus as well as providing very great savings in additional equipment.

In the case of certain products, it is desirable to obtain individual light fractions, which are subdivided again into two partial fractions. In corn, this is the separation between the kernels and the husk parts, and this separation is desirable because the kernels have a very useful high fat content. In order to effect such a separation, it has been known to eliminate the light parts and to withdraw them subsequently in a special separation operation. In the first stage separation of bulk material mixtures according to the specific gravities of the mixture components, utilizing vibration and aeration, as already known, it has been found additionally that, following the initial separation and by the separate guiding of a special treatment air flow, a second separation is possible in a very simple manner. This involves conducting the product, discharged through an outlet, into a rising air sifting duct, forming part of the apparatus, and in which the very light husk parts and the somewhat heavier kernels can be separated by air sifting. The treatment air current required for this air sifting is directed through this duct and is discharged into the aeration air current separately directed through the porous material support. Both the treatment air current and the main or aeration air current are conjointly exhausted.

The basic apparatus corresponds to that shown in FIGS. **1, 2** and **3,** already described, but the pneumatic return through flow duct **92** from outlet **12** and into the range of material inlet **20** is omitted and is replaced by an auxiliary device **120.** Auxiliary device **120** has a rising duct **122,** a very simple material separator **124,** a treatment air line **125** and a fines exit gate **126.** Rising treatment air duct **122** is provided with an adjustable plate **128** with adjustment thereof being effected by two hand wheel operated screws **130.** On the opposite side from adjustable plate **128,** there is arranged the feed **132** from outlet **11.** Beneath feed **132,** there is provided a treatment air inlet port **135** whose flow area can be adjusted by a slide valve **133.** Duct **122** is closed at its bottom end by an elastic terminal gate **138.**

A throttle valve, or damper, **141** is arranged in air exhaust pipe **7,** and can be adjusted by a hand wheel **140.** Treatment air line **125** terminates above or downstream of throttle valve or damper **141,** and communicates with an aperture **142** in exhaust pipe **7,** so that both the main aeration air current and the treatment air current are combined for conjoint exhaust only downstream of throttle valve or damper **141.**

The apparatus illustrated in FIG. **4** provides for carrying out a treatment of the bulk material which will now be described. The bulk material mixture flows from feed pipe **22** through inlet **20** onto the porous, gas-permeable material support **1,** which is vibrated, in a throw vibration movement, by motor **80** carrying eccentric weights **81** and **82.** Due to this throw vibration, on the one hand, and the air current drawn through material support **1,** on the other hand, and which air current is transformed, by the moving air current interrupter **40** into a pulsating current, the bulk material mixture is separated according to the specific gravity of its components and the separated components are conveyed to the various outlets **11** through **14.** While the mixture components, separated according to their respective specific gravities under the action of vibration and air flow, issue individually through respective outlets **12, 13,** or **14,** the lightest fraction, collected in outlet **11,** is conducted through the adjoining feed **132** into duct **122.** By virtue of the vibration effective on outlet **11** and on duct **122,** transfer of this lightest fraction takes place over the projecting edge **132***a* of feed **132,** as a uniform mist. The treatment air for air sifting this material fraction enters through treatment air inlet port **135** into duct **122,** is conducted upwardly into material separator **124,** and flows through treatment air line **125** into air exhaust pipe **7.**

The air sifting of this fraction is effected, on the one hand, by varying the flow area of treatment air inlet port **135,** using slide valve **133,** and, on the other hand, by shifting or adjusting movable plate **138** utilizing hand screws **130.** This shifting or adjustment of plate **128** results in an adjustment of the cross section of the duct, and also results in an adjustment of the flow velocity of the treatment air current. In the case of corn, for example, the very light husk parts are carried by this air sifting with the rising treatment current into the material separator **124,** where they are removed from the air current and conducted to the fines discharge gate **138.** The latter closes and opens, respectively, in a gradual manner, in dependence on the amount of material contained therein, the gate opening against the

elastic closing force and the additional pneumatic closing force resulting from the pressure difference between the ambient atmosphere and the interior of duct **122.**

Despite the pulsating flow of the air current through the material support **1,** there are practically constant flow conditions in duct **122,** from treatment air inlet port **135** to aperture **142** in air exhaust pipe **7,** and such conditions are necessary, to a great extent, for air sifting. By virtue of this design, it is possible to utilize the suction power, necessary to produce the air current for aerating the bulk material to be separated by vibration and aeration, in the same flow system, to provide an at least partly separately directed current of treatment air for the separate treatment of the same bulk material. This results in savings both in energy and equipment, in carrying out bulk material treatments. A further effect in contrast to known methods and apparatus, is that the individual separate bulk materials are present in the desired form for the further treatment.

While, in the two embodiments shown in FIGS. **1, 2** and **3** and in FIG. **4,** respectively, the drive of the shut-off element interrupting the air flow, and including the disk **41** formed with the passages **42** and the vanes **43** extending into the flow area of these passages, is effected in the manner of a turbine wheel, FIG. **5** illustrates another type of drive for the flow interrupting element and which uses the vibration generator as the driving means. It has been found that the interesting principle of a turbine wheel for this drive has the disadvantage of not providing an absolutely constant speed of the interrupter disk, and thus an absolutely constant frequency of interruption of the air current. While it would be possible to provide a separate driving motor for the flow interruption element, this has the disadvantage that the expense is high and, in addition, such a motor would be subjected, unless special measures were provided, to the constant vibration of the vibratable assembly. The arrangement illustrated in FIG. **5** obviates this disadvantage and uses the available energy of the freely swinging motor **80** for driving the shut-off element interrupting the air current flowing through the material support **1.**

Referring to FIG. **5,** the moving shut-off element **40'** of the air supply device **3',** having air supply openings **35',** is designed as a rotating disk **41'** with passages **42'.** The number of passages **42'** preferably is greater than the number of air passages **35',** and, in the particular embodiment illustrated in FIG. **5,** the ratio is 5:4. A stepped disk **151** is secured to rotate with the disk **41',** and has the different diameters for receiving an endless driving element, such as an endless driving cord **152.**

Motor **80,** provided with the eccentric weights **81** and **82,** is mounted on a bearing plate **83'** for swinging or oscillation through the medium of elastic swinging supports **153** whose outer casing members are fixedly connected with bearing plate **83',** and with which is associated a bolt **154** fixed relative to shaft **51.** The particularly designed bearing plate **83'** is formed with an elongated rectilinear slot **155.**

A double-action freewheeling clutch **160** is also fixedly connected with shaft **51** by clamping studs **157** and a clamping yoke **158.** A stub shaft **161** on the driving side of clutch **160** has connected thereto a plate **162** which is articulated, through the medium of a bolt **163,** to a push rod or link **165** having a length sufficient to extend into the area of bearing plate **83'** and particularly slot **155** therein. Within the area of bearing plate **83',** link or pushrod **165** is adjustably articulated to bearing plate **83'** through a connection **168.** A stub shaft **166** on the driven side of freewheeling clutch **160** carries a stepped wheel **167** having a groove receiving driving cord **152.**

Since it is characteristic of a free swinging drive of this type, which acts on material support **1** and also on hood **2** and air supply device **3,** that motor **80,** due to the eccentric weights **81** and **82,** can perform a circular movement insofar as the bearing resistance will permit, there results a linear vibration, for the overall arrangement, perpendicular to shaft **51.** The latter deviates only slightly from its rectilinearity. On the other hand, motor **80,** with bearing plate **83'** mounted on elastic swinging mounts **153,** can perform an elastic swinging displacement or oscillation movement substantially parallel to shaft **51,** about the axis of bolt **154.**

Depending on the selected inclination of the axis of the rotor of motor **80,** the linear vibration, acting correspondingly on material support **1,** effects a throwing movement of bulk material on this support **1.** Due to the eccentric articulated securing of pushrod **165** to bearing plate **83',** this link moves relatively to shaft **51** on which double-action freewheeling clutch **160** is clamped. Stub shaft **161** on the driving side of clutch **160** and connected to plate **162** is thus oscillated. Due to double-action clutch **160,** this oscillating movement is transformed into a stepwise angular movement resulting in rotation, in one direction, of stub shaft **166** on the driven side of clutch **160.** Thus, stepped wheel **167** is stepped by successive angular steps corresponding to the oscillation frequency of plate **162,** and which is a function of the normal distance of link **165** from bolt **154** forming the axis of rotation of the elastic swinging block **153.** The effect is a quasi-continuous rotation of disk **41'** in strict proportionality to the oscillating frequency of the swingable assembly and of the motor **80** which produces the oscillation. This oscillating frequency can be adjusted, in addition, by adjusting the connection of push rod or link **165** along slot **155,** or by varying the transmission ratio, expressed in rotations per unit of time, between stepped wheel **167** and stepped disk **151.** This adjustability also adjusts the interruption frequency of the air current through material support **1.** The auxiliary device is very simple in its construction and assembly and requires practically no maintenance and no driving element with a special power source, and furthermore permits, in a very simple manner, adjustment of the frequency of interruption of the air current flow through the material support.

Even during operation of material separating apparatus, occasionally it is necessary to adjust individually the outlet flaps which are usually provided at outlets in the range of the push-off of bulk material from the material support. These adjustments are sometimes necessary to prevent a too vigorous overshooting, which would influence the separation operation. Additionally, it has long been desirable to shift an individual adjustment, after it has initially been set, conjointly with other adjustments, under certain operating conditions, while maintaining the individual adjustment. An arrangement for effecting such combined adjustment is illustrated in FIG. **6.**

Referring to FIG. **6,** material support **1** which comprises porous-gas-permeable plate **16,** perforated plate

17 and spacers 18, is provided, beneath hood 2 and along 1 lateral edge 170 toward outlet 14, with bearing sleeves 171. Sleeves 171 serve to receive shifting shafts 172 having a single head 173 at one end, with each head 173 being connected to a respective baffle plate 45. Shafts 172 extend through the entire material support 1 and each shaft has, at its other end, an external thread 174 receiving a net 184. Between nut 184 and perforated plate 17 of support 1 there are arranged cup springs 176, an operating plate 185, another cup spring 177, and a spiral or helical compression spring 180, a washer 181 being interposed between spring 180 and perforated plate 17. Each operating plate 185 on a respective bolt 172 has its free end formed with a slot 186. A movable linkage mounted on the machine, and extending over the entire length of the machine or at least through the distance between the extreme baffle plates 45, is provided, in the range of each slot 186 with a bolt 189 at least partially embraced by this slot.

Nut 184 is tightened on thread 174 so that operating plate 185 is so gripped, between the pack of cup springs 176 and the combination of cup spring 177 with compression spring 177, that it can be displaced relative to the cup springs 176 and 177 only by expending a pretermined force. It is thus possible, after removing the elastic closing cover 190 in outlet 14, to adjust a baffle plate 45 individually by loosening nut 174 and effecting a relative angular displacement between bolt 172 and plate 185, after which nut 184 is retightened. On the other hand, by displacing the linkage 188, adjusting shaft 173, and thus the associated baffle plate 145, are turned due to the gripping action between cup springs 176, 177 and operating plate 185. The arrangement of FIG. 6 thus provides a solution for the problem of providing both individual and conjoint adjustment of individually adjustable baffle plates 45.

It will be clear that special details of the apparatus can be designed differently than as illustrated in the drawings, and this applies particularly with respect to the external design of the apparatus, the means for producing the vibrations, the vibratable support, the air supply and distribution, the collection of the bulk material and the conveyance of the material.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. In a method for separating bulk material mixtures into separated fractions, in accordance with the specific gravities of the mixture components, under the influence of vibrations of a material support carrying the bulk material in a layer and conveying it from an inlet to outlets for separated fractions, and under the influence of aeration by an aeration air current flowing through the material support and the layer, which aeration air current is collected in a hodd covering the material support and is exhausted from the hood: the improvement comprising the steps of providing an additional air current flowing along a path separate from the path of flow of the aeration air current flowing through such layer, the path of flow of such additional air current being completely outside such layer of bulk material; discharging at least one separated fraction of the bulk material, leaving its outlet into such additional air current; thereafter separating the additional air current flow from such at least one separated fraction; returning such at least one separated fraction to such layer; and exhausting the aeration air current from said hood conjointly with exhaustion of the separated additional air current.

2. A method, as claimed in claim 1, in which the additional air current flows along a path extending from a point below said material support to a point above said material support, and conveys such at least one separated fraction from such point below said material support to such point above said material support; said additional air current flow being separated from such at least one separated fraction at a point above said material support for flow into said hood.

3. A method, as claimed in claim 2, including the step of conveying such at least one separated fraction between such point below said material support and such point of separation of the additional air current flow from such at least one separated fraction.

4. A method, as claimed in claim 2, including the step of returning such at least one separated fraction, after separation of the additional air current flow therefrom, to such layer in the area of the inlet for the bulk material entering the material support for merger with such bulk material.

5. A method, as claimed im claim 1, in which said aeration air current flowing through such layer is periodically interrupted to provide a pulsating air current.

6. Apparatus for separating bulk material mixtures, in accordance with the specific gravities of the mixture components, under the influence of vibrations of a material support carrying the bulk material in a layer and conveying it from an inlet to outlets, and under the influence of aeration by an aeration air current flowing through the material support and the layer, which aeration air current is collected in a hood covering the material support and exhausted from the hood, said apparatus comprising, in combination, a porous and gas-permeable material support having an inlet for bulk material and outlets for separated fractions; means operable to feed bulk materials to said inlet; means operable to vibrate said support; a hood covering said support and connected to air exhaust means; a first aeration air inlet arranged beneath said support for flow of the aeration air current for aerating the bulk material mixture flowing over said material support; an additional air inlet separated from said first inlet port; a separate flow duct extending from said additional air inlet port into the range of said material inlet for the flow of an additional air current through said additional air inlet port and through said separate flow duct; means supplying material from at least one outlet to said separate flow duct for entrainment in said additional air current, for return through said separate flow duct to said bulk material inlet; and means in said separate flow duct separating said additional air current from the material supplied thereto, and communicating with said exhaust means for conjoint exhaust of the additional air current with the aeration air current collected under said hood.

7. Apparatus, as claimed in claim 6, in which said separate flow duct terminates in such range on said material support covered by said hood; said at least one of said outlets opening into said separate flow duct downstream therein from said additional air inlet port.

8. Apparatus, as claimed in claim 7, including an injector-like constriction in said separate flow duct between said additional air inlet port and the opening of said at least one outlet into said separate flow duct; said separate flow duct, downstream of said injector-like constriction, increasing in cross sectional flow area.

9. Apparatus, as claimed in claim 8, including means operable to adjust the flow area of said constriction.

10. Apparatus, as claimed in claim 7, in which said conveyor line, intermediate the opening of said at least one outlet thereinto and the range of said material inlet, is formed with a flow deflecting portion elevated substantially above said material support; said conveyor line being formed with an air slot beneath said hood and between said flow deflecting portion and the range of said material inlet.

11. Apparatus, as claimed in claim 7, including a partition positioned between said material inlet and the exit of said conveyor line to said material support.

12. Apparatus, as claimed in claim 11, in which said partition is curved in the direction of flow.

13. Apparatus, as claimed in claim 6, in which said separate flow duct forms a pneumatic conveyor line and is constructed as part of said hood covering said material support.

14. Apparatus, as claimed in claim 6, including a periodically operable air current interrupter provided in said aeration air inlet.

15. Apparatus, as claimed in claim 14, including panels subdividing said aeration air inlet into plural flow ducts communicating with said material support; each flow duct having a respective air supply opening; said periodically operable air current interrupter controlling flow of aeration air through said air supply openings and closing said air supply openings at least partially.

16. Apparatus, as claimed in claim 15, in which said periodically operable air current interrupter comprises a rotating disk having at least one aperture therethrough and positioned opposite said air supply openings.

17. Apparatus, as claimed in claim 16, in which said rotatable disk has a plurality of apertures therethrough.

18. Apparatus, as claimed in claim 16, in which said disk is formed as a turbine runner having inclined vanes in said apertures serving to drive said turbine runner by the aeration air flowing through said apertures and said air supply openings.

19. Apparatus, as claimed in claim 14, in which said air supply means is vibratable with said material support; a vibration-generating motor oscillatably mounted on said material support; eccentric weights rotatable by said motor; a free-wheeling clutch having a driving member and a driven member; means connecting said driving member to said motor for driving thereby; and means connecting said driven member in driving relation with said periodically operable air current interrupter.

20. Apparatus, as claimed in claim 19, including a first grooved pulley connected to said driven member; a second grooved pulley connected to said periodically operable air current interrupter; an endless drive means interconnecting said grooved pulleys; said pulleys having plural grooves of respective different diameters for adjustment of the transmission ratio between said free-wheeling clutch and said periodically operable air current interrupter.

21. Apparatus, as claimed in claim 19, in which said means connecting said motor to said clutch driving member comprises a link articulated at one end to said clutch driving member and articulated at the opposite end to said motor.

22. Apparatus, as claimed in claim 6, including a plurality of individually adjustable baffle plates each in the transition zone from said material support to a respective one of said outlets; and common adjusting means connected to all of said baffle plates for conjoint adjustment of the latter.

23. Apparatus, as claimed in claim 22, including a respective adjusting shaft secured to each baffle plate; and a respective adjusting plate adjustably secured to each adjusting shaft; said common adjusting means comprising a movable linkage articulated to all of said adjusting plates.

24. Apparatus, as claimed in claim 23, including spring means maintaining each adjusting plate in adjusted position on its associated adjusting shaft.

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