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VACUUM EXPANSION EXFOLIATOR

Filed Jan. 2, 1962

2 Sheets-Sheet 1

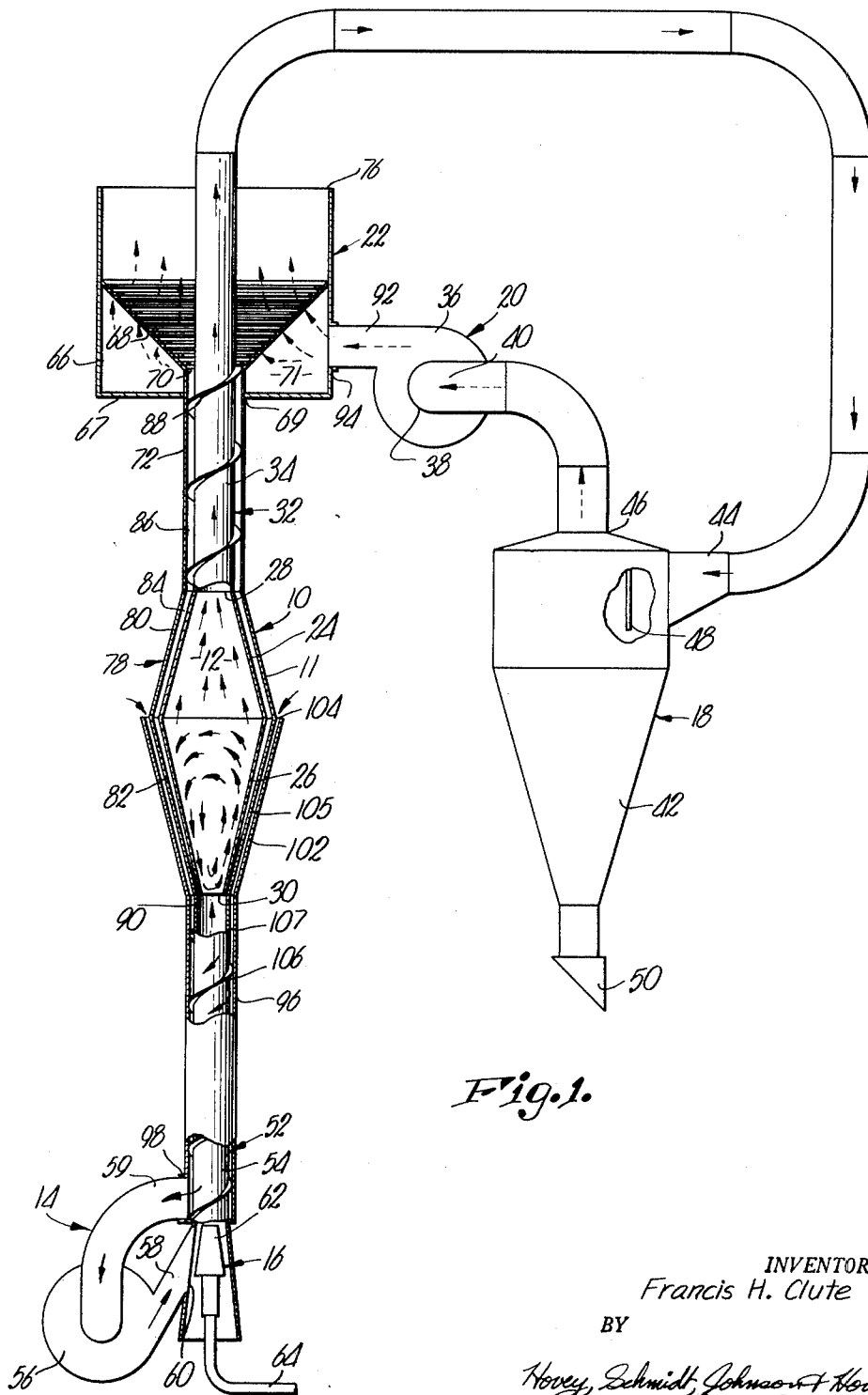


Fig. 1.

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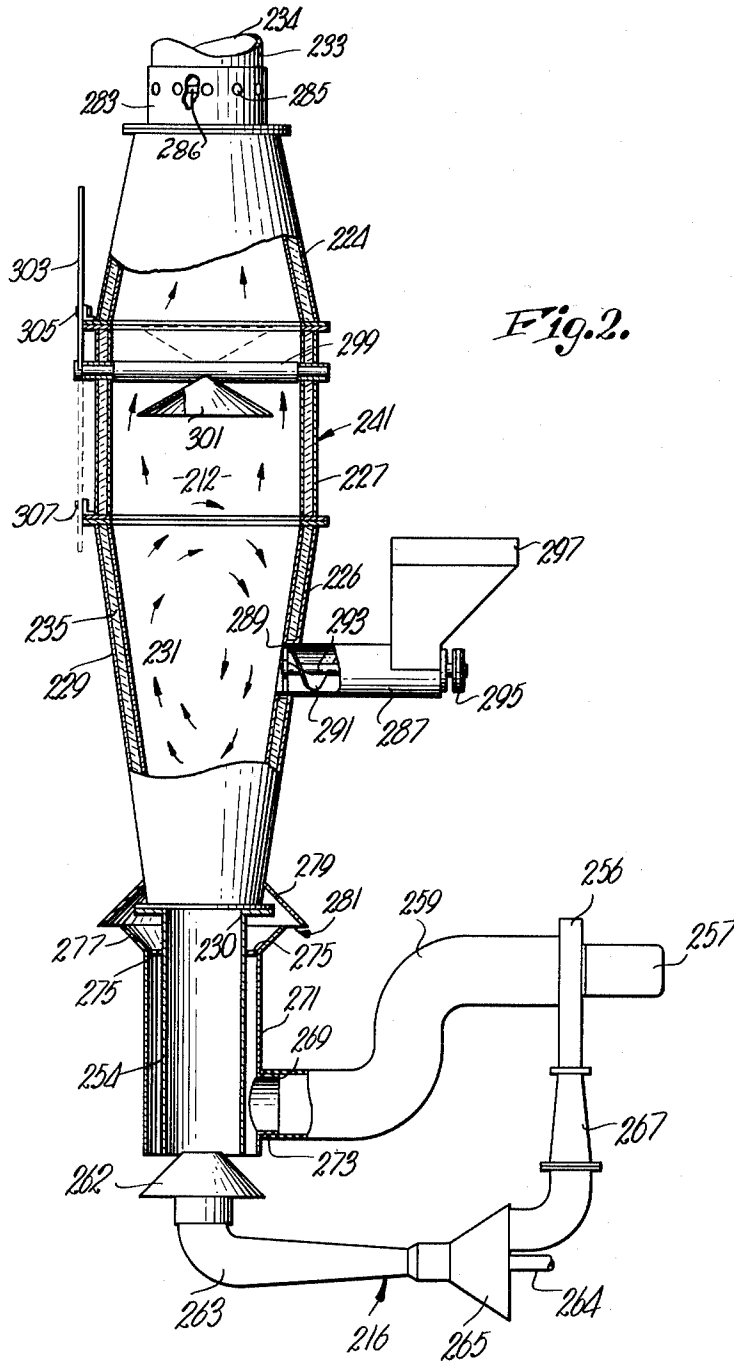
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VACUUM EXPANSION EXFOLIATOR

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12 Claims. (Cl. 263—21)

This invention relates to a machine for exfoliating materials such as vermiculite, pearlite, clay or the like, and more particularly, to a machine for suspending the materials within a heated air stream for raising the temperature thereof to the exfoliation temperature.

It is the primary object of the present invention to provide a machine for suspending expandable material within a stream of heated air until the temperature of exfoliation of the materials is reached so that the exfoliated materials may be carried off by the air stream, leaving the unexfoliated materials suspended in the heated atmosphere.

Another object of the present invention is the provision of a machine for exfoliating the aforesaid materials wherein an expansion chamber is provided and a stream of heated air is directed under pressure through the chamber for carrying the materials thereinto, whereby the materials are caused to be suspended in the air stream within the chamber as a result of the pressure reduction due to the expansion thereof until the temperature of exfoliation thereof is reached.

Yet another object of the present invention is the provision of suction means operably coupled to the chamber of the above-mentioned machine and in communication with the outlet thereof, whereby the exfoliated materials, by virtue of the decrease in density thereof due to exfoliation, may be removed from suspension within the chamber and carried away from the latter, leaving the unexfoliated materials in suspension within said chamber.

Another object of the present invention is the provision of means for preheating the materials to be exfoliated prior to the introduction thereof into the aforesaid chamber, whereby the exfoliation temperature of the materials is more readily attained to thereby render the process of exfoliation more efficient.

Yet another object of the present invention is the provision of means for passing the materials above the aforesaid chamber along a path which is in thermal interchange relationship with the latter, whereby the materials are preheated by the heat radiated from said chamber prior to the introduction thereof at the inlet of the chamber.

Still another object of the present invention is the provision of means for passing materials to be exfoliated directly into the chamber of the character described, whereby materials which require a predetermined moisture content for exfoliation may be introduced into the chamber without changing said moisture content thereof to thus be in condition for proper exfoliation within said chamber.

Other objects of the present invention will become apparent as the following specification progresses, reference being had to the accompanying drawing, wherein:

FIGURE 1 is a schematic, side elevational view of an exfoliating machine which forms one embodiment of the present invention, with certain components thereof being broken away and in cross section and with the direction of flow of air therethrough being indicated by suitable arrows; and

FIG. 2 is a fragmentary, elevational view of an exfoliating machine which forms another embodiment of the subject invention, parts being broken away and in section to reveal details of construction.

The present invention provides an expansion chamber into which materials to be exfoliated are introduced by means of a stream of heated air flowing through the cham-

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ber so as to suspend the materials in the air stream within the chamber until the temperature of exfoliation of the materials is attained. Thereupon, the exfoliated materials are removed from the chamber by suction means and pass to collection means spaced from the chamber.

The air stream is created exteriorly of the chamber, and the air is heated to a temperature sufficient to exfoliate the materials prior to the introduction of the air stream into the chamber. The materials are caused to be suspended within the chamber by virtue of the reduction of air pressure thereon when the air stream expands upon entering the chamber. After the exfoliation temperature is reached, the density of the materials in the exfoliated state is less than that of the materials in the unexfoliated state and is of a value sufficient to render the exfoliated materials removable from the chamber under the influence of said suction means.

Means are also provided in the machine of the subject invention for preheating the materials prior to the introduction thereof into the chamber so that the temperature of exfoliation is more readily attained within the expansion chamber. To this end, the materials are passed about the chamber exteriorly thereof as the materials pass toward the inlet of the chamber so that the materials may absorb the heat radiated from the chamber. Similarly, the air directed to the blower means for creating the stream of air exteriorly of the chamber, is also preheated in the manner set forth in the case of the preheating of the materials.

The machine which forms one embodiment of the present invention is broadly denoted by the numeral 10 and comprises an elongated, hollow body 11 presenting an expansion chamber 12, blower means 14, burner means 16, collector means 18, suction means 20 and hopper means 22.

Machine 10 is adapted for exfoliating or expanding materials capable of being exfoliated or expanded under the influence of heat, such as vermiculite, pearlite, clay or the like. Body 11 is comprised of an upper portion 24 and a lower portion 26, each of said portions 24 and 26 being substantially frusto-conical and secured together at the ends thereof of greatest diameter. Portion 24 is provided with an opening 28 at the normally uppermost end thereof, providing an outlet for chamber 12, and portion 26 is provided with an opening 30 at the normally lowermost end thereof presenting an inlet for chamber 12. Body 11 may be supported in any suitable manner with the openings 28 and 30 in substantially vertical alignment. It is to be noted that the transverse cross sections of portions 24 and 26 are circular and decrease as the openings 28 and 30 respectively, are approached.

Conduit structure, broadly denoted by the numeral 32 and comprising an elongated pipe 34, extends upwardly from chamber 12 and secured to upper portion 24 in fluid communication with opening 28. Pipe 34 interconnects opening 28 with suction means 20 and collector means 18 is connected with pipe 34 intermediate the suction means 20 and outlet 28.

Suction means 20 comprises a blower 36 actuated by a suitable source of power and having a suction side 38 to which the outermost end 40 of pipe 34 is operably coupled. Thus, when blower 36 is actuated, the same is sufficient to create a flow of air within pipe 34 outwardly and away from opening 28.

Collector means 18 comprises a bin 42 having a fluid and materials inlet 44, and a fluid outlet 46. Inlet 44 is operably coupled to the proximal portion of pipe 34 and outlet 46 being connected to the extension of pipe 34 interconnecting collector means 18 and suction means 20. Baffle structure 48 within bin 42 deflects the incoming materials so that the same pass downwardly and

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gravitate to the lowermost extremity 50 of bin 42 where the same are collected and may be removed in any suitable manner.

Conduit means, broadly denoted by the numeral 52, is secured to body 11 at the opening 30 of lower portion 26 and comprises an elongated pipe 54 in communication with opening 30 and extending downwardly therefrom. The lowermost end of pipe 54 is open and is flared outwardly to accommodate burner means 16.

Blower means 14 comprises a blower 56 actuated in a manner similar to the actuation of blower 36 and is provided with an upwardly directed pressure side 58 in communication with an opening 60 in pipe 54 adjacent the lowermost end of the latter. Air is received in blower 56 through a suction side 59 in a manner to be described.

Burner means 16 comprises a burner head 62 which is supplied with a combustible fuel from a tube 64, the latter adapted to be operably coupled to a source of said fuel. Head 62 of burner means 16 is located adjacent opening 60 and is disposed to heat the air thereabove within pipe 54 to a temperature sufficient to exfoliate the materials to be introduced into chamber 12. It is evident that when blower 56 is actuated, air is directed through the pressure side 58 into opening 60, and then, since the pressure side 58 is directed upwardly, into pipe 54. The pressure of the air passing into opening 60 and into pipe 54, is sufficient to carry the air heated by burner head 62 upwardly and through opening 30 into chamber 12.

Hopper means 22 comprises a container 66 having a bottom wall 67 provided with an opening 69 through which pipe 34 extends. A slotted, funnel-shaped, materials-receiving receptacle 68 is secured to the side walls of container 66 above bottom wall 67 to present a space 71 below receptacle 68 and bottom wall 67. Receptacle 68 is provided with an opening 70 at the normally lowermost extremity thereof above opening 69 and in communication with an elongated, upper tube 72 surrounding pipe 34 and passing through opening 69. It is to be noted that pipe 34 passes centrally through receptacle 68 and tube 72 is substantially concentric with pipe 34.

Upper tube 76 is in communication with the upper open end of sleeve means broadly denoted by the numeral 78, surrounding portions 24 and 26 of chamber 12. Sleeve means 78 comprises a frusto-conical sleeve portion 80 surrounding portion 24, and a frusto-conical sleeve portion 82 surrounding portion 26. Sleeve portions 80 and 82 are interconnected at proximal ends thereof and are substantially complementary to the respective portions 24 and 26 of body 11. The lowermost end of sleeve portion 82 is open and disposed adjacent to and concentrically with opening 30 of portion 26.

The sleeve portions 80 and 82, along with portions 24 and 26 of chamber 12, provide a materials passage 84 which communicates with a materials passage 86 formed by upper tube 72 and the outer surface of pipe 34.

A spiral vane 88 is disposed within passage 86 between pipe 34 and upper tube 72 and is provided with upper and lower ends adjacent openings 70 and 28 respectively. Vane 88 directs materials placed within receptacle 68 about a spiral path as the materials gravitate toward passage 84. The materials continue through passage 84 and issue therefrom into the uppermost end of pipe 54 adjacent and below opening 30.

Blower 36 is provided with a pressure side 92 which is in communication with space 71 through an opening 94 in the side of container 66. Air passing through blower 36 is forced out through pressure side 92 and into container 66. Since receptacle 68 is secured to and engageable with a continuous line along the inner walls of container 66, the air passing into space 71 is caused to pass through the slots of receptacle 68 and then through the materials from which the air emerges thereabove.

A lower tube 96 surrounds pipe 54 and is substantially

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the same length as the latter. Lower tube 96 is secured in any suitable manner at the closed, lowermost end thereof to the proximal portion of pipe 54, and tube 96 is provided with an opening 98 therein adjacent the lowermost end thereof for interconnection with the suction side 59 of blower 56.

A frusto-conical sleeve section 102 is secured to the upper open end of tube 96 and extends upwardly and outwardly therefrom in surrounding relationship to sleeve portion 82 of sleeve means 78. Sleeve section 102 terminates adjacent the junction of sleeve portions 80 and 82 to form an annular opening 104 intermediate the openings 28 and 30 of chamber 12. Sleeve portion 82 and sleeve section 102 form an air passage 105 therebetween communicating with opening 104, and pipe 54 and tube 96 form therebetween an air passage 107 communicating with passage 105 and opening 98.

A spirally disposed vane 106 is positioned within passage 107 to direct air entering opening 104 and into the passage 105 about a spiral path as the same moves toward opening 98 and the suction side 100 of blower 56.

In operation, materials to be exfoliated are disposed within receptacle 68 within container 66. Burner head 62 is ignited and blowers 36 and 56 are actuated. Burner head 62 is adjusted so that the same heats the air in pipe 54 to a temperature sufficient to exfoliate the materials and blower 56 forces the heated air upwardly through pipe 54 and into chamber 12.

Materials within receptacle 68 gravitate toward opening 90 along passages 84 and 86 and are introduced into the rising air stream at a point directly below opening 30. The pressure of the air stream is sufficient to carry the materials upwardly and into chamber 12 where the air stream expands, thus causing a reduction in the air pressure on the materials and causing the latter to be suspended in the air stream. The materials are suspended within the air stream so long as the temperature of the materials is below the temperature of exfoliation thereof. The materials in suspension follow a path denoted by the arrows forming a circular pattern within portion 26 of chamber 12, as illustrated in FIG. 1.

When the temperature of the materials reaches the value required for exfoliation, the density of the materials is materially reduced to a value sufficient to cause the exfoliated materials to be removed from chamber 12 by virtue of the suction action of blower 36. The exfoliated materials pass into pipe 34 and into bin 42 where the materials are separated from the flow of air by the baffle structure 48. Thereupon, the materials gravitate to the lowermost extremity 50 and the same may then be removed in any suitable manner.

It is clear that pipes 34 and 54 are subjected to heat by virtue of the flow of heated air therewithin. It is further evident that the materials gravitating within passages 84 and 86 are in thermal interchange relationship with portion 24 and pipe 34 respectively, as the materials move toward opening 30 therebelow. The materials in passage 86 are, therefore, heated by the heat radiated from chamber 12 and pipe 34 and the aforesaid construction provides preheating means for the materials prior to the introduction thereof into the air stream at a point below opening 30.

As air enters annular opening 104 and passes downwardly through passages 105 and 107, the air is heated by the heat radiated from portion 26 of body 11, and sleeve portion 82 and the heat radiated from pipe 54 respectively. The preheated air then enters the suction side 59 of blower 56 and outwardly through the pressure side 58 of the latter and into pipe 54 through opening 60. It is, therefore, clear that the last-mentioned construction provides preheating means for the air entering blower 56 and pipe 54.

By virtue of the preheating of the materials and air, the process of exfoliation is made more efficient and the temperatures of exfoliation of the materials is more readily attained thereby.

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It is evident that the materials within receptacle 68 are additionally preheated by directing air from the pressure side 92 of blower 36 into container 66 and upwardly through the materials in receptacle 68 by virtue of the slots in the latter.

Although suction is applied at opening 28 of portion 24 for removing the exfoliated materials from chamber 12, it is to be understood that, by proper selection of the operating characteristics of blower 56 and the configuration of chamber 12, the air stream created by blower 56 and passing through chamber 12 is alone sufficient to convey the exfoliated materials from chamber 12 in the absence of blower 36.

Another embodiment of the subject invention is illustrated in FIG. 2 and comprises a hollow body broadly denoted by the numeral 211, including an upper portion 224, a lower portion 226 and a central portion 227 interconnecting portions 224 and 226. Upper portion 224 is substantially frusto-conical and terminates at the end of lesser diameter in an opening (not shown) communicating with one end 233 of an elongated conduit 234. Conduit 234 is adapted to be operably coupled to a device such as collector means 18 in FIG. 1 for collecting materials exfoliated within body 211.

Lower portion 226 is substantially frusto-conical and is of a substantially greater length than upper portion 224. Portion 226 terminates in an opening 230 at the lowermost end thereof in communication with an elongated pipe 254 depending from the body 211.

Central portion 227 is transversely cylindrical and with upper and lower portions 224 and 226, presents an expansion chamber broadly denoted by the numeral 212. As illustrated in FIG. 2, portions 224, 226 and 227 are each formed from a pair of spaced walls 229 and 231, having insulated means 235 therebetween for isolating the heat contained within chamber 212. In this respect, body 211 differs from body 11 illustrated in FIG. 1, for the latter does not insulate the walls of portions 24 and 26, but rather permits heat to be radiated therefrom to heat material passing toward inlet 30 through sleeve portions 80 and 82.

A burner, broadly denoted by the numeral 216, is disposed below body 211 and is provided with a burner head 262 below and partially within the open, lowermost end of pipe 254. A stem 263 interconnects head 262 with one end of an elongated tube 264, the latter supplying a combustible fuel to stem 263 and thereby to head 262 from a suitable source.

A frusto-conical hood 265 is secured to stem 263 and also communicates with one end of an elongated duct 267 which is operably coupled to a blower 256 having a motor 257 thereon. Motor 257 is adapted to be operably coupled with a source of electrical power for actuating blower 256. Duct 267 is secured to blower 256 on the output side thereof, and an elongated conduit 259 is secured at one end thereof to the input side of blower 256. The opposite end of conduit 259 is secured to a projecting sleeve 269 secured to a tube 271 surrounding pipe 254. Sleeve 269 communicates with the interior of tube 271 by being in surrounding relationship to an opening 273 within the latter.

Tube 271 is supported in any suitable manner on pipe 254 such as by braces 275 in circumferentially spaced relationship about pipe 254. A frusto-conical top member 277 is secured to the upper end of tube 271 and flares outwardly relative to pipe 254. A frusto-conical eave 279 is secured to lower portion 226 and extends outwardly and downwardly therefrom in overlying relationship to top member 277 to present an annular air inlet 281 between the lowermost edge of eave 279 and the uppermost edge of member 277.

A perforated sleeve 283 surrounds end 233 of conduit 234 above the opening in upper portion 224. The perforations 285 in sleeve 283 mate with slots 286 in end 233 to expose the slots to a greater or lesser degree to the

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atmosphere to thereby serve as an adjustable air vent for conduit 234.

Means for feeding material to be exfoliated into chamber 212 comprises a tubular housing 287 communicating at one open end thereof with an opening 289 in lower portion 226 in vertically spaced relationship to opening 230 thereof. An auger 291 is rotatably mounted within housing 287 and is provided with a shaft 293 extending outwardly from housing 287 remote from portion 226. A pulley 295 is secured to shaft 293 exteriorly of housing 287 and is adapted to be operably coupled with a source of power for rotating shaft 293, and thereby actuating auger 291 for directing material within housing 287 through opening 289, and into chamber 212. A hopper 297 is in communication with housing 287 and is adapted to contain material to be exfoliated.

An elongated shaft 299 is journaled in central portion 227 transversely of the longitudinal axis of body 211. A conical damper 301 is secured at the apex thereof to shaft 299 for rotation therewith. A lever 303 is secured to one end of shaft 299, which end projects through portion 227 as illustrated in FIG. 2. Lever 303 is utilized to rotate shaft 299 about the longitudinal axis thereof and thereby shift damper 301 from the solid-line position to the dashed-line position within chamber 212. Stop means 305 and 307 are provided on portion 227 for limiting the rotation of lever 303.

In operation, blower 256 is actuated by energizing motor 257 and burner 216 is ignited by directing combustible fuel through tube 264 and stem 263 into head 262. Air, therefore, is directed into hood 265, stem 263, through head 262 and into pipe 254 under pressure, and the air is heated by the ignition of the fuel at head 262. Therefore, heated air under pressure is directed into opening 230 and into chamber 212.

Material within hopper 297 is directed into chamber 212 by actuating auger 291 by causing shaft 293 to rotate under the influence of pulley 295. Material passing into opening 289 tends to gravitate toward opening 230, but when the material is acted upon by the incoming heated air under pressure, the same is directed upwardly and into a circulatory path as shown by the arrows within lower portion 226. So long as the material remains unexfoliated, the material will remain in portion 226 within the circulatory path. When the exfoliation temperature of the material is reached, the exfoliated material passes upwardly through central portion 227 and into portion 224 from whence it passes into conduit 234 and toward the collecting means secured to the latter. It is to be noted that the pressure of the incoming air is reduced by virtue of the construction of lower portion 226 since the transverse cross section thereof increases as central portion 227 is approached. Therefore, chamber 212 is substantially an expansion region to maintain the material therewithin until the exfoliation temperature of the material is reached.

It is noted that the actuation of blower 256 causes air to enter the air inlet 281 and into the region between pipe 254 and tube 271. Air then flows into opening 273 and through conduit 259 toward blower 256. Since heated air flows through pipe 254, the air flowing between the latter and tube 271 is substantially heated by the radiation of heat from pipe 254. Therefore, the air passing into hood 265 is substantially preheated to thereby increase the effectiveness of burner 216 to heat the air to be directed into chamber 212.

Damper 301 is positioned within the path of the exfoliated materials to control the amount passing toward the opening of upper portion 224 and thereby control the amount collected after the material passes through conduit 234. Lever 303 is manually manipulated to place damper 301 in proper position for the desired volume of the material to be collected.

The embodiment illustrated in FIG. 2 is preferably utilized with materials to be exfoliated which require a pre-

determined moisture content before the materials can be exfoliated. In this regard, certain types of clay require the predetermined moisture content and, therefore, the same are directly introduced into chamber 212 by virtue of housing 287 and auger 291. Those materials requiring little or no moisture content are preheated as in the embodiment illustrated in FIG. 1, and specifically, it has been found that pearlite and some types of vermiculite require little or no moisture content for exfoliation. Therefore, the embodiment illustrated in FIG. 1 is preferably used when exfoliating materials such as pearlite or vermiculite, and the embodiment illustrated in FIG. 2 is preferably used when using materials such as clay or other materials requiring a predetermined moisture content for exfoliation.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A machine for treating materials capable of being exfoliated, said machine comprising:

hollow structure including a body having a chamber provided with a material inlet means and a material outlet means spaced above said inlet means, and heat-conducting pipe beneath the body in communication with said inlet means and terminating in an open lower end;

blower means having an air inlet means and an air outlet means, said air outlet means being coupled with the pipe to direct currents of air into said chamber via said pipe and said material inlet means for flow upwardly out of said chamber through said material outlet means;

heater means adjacent said open end of the pipe for raising the temperature of the air in the pipe;

a material supply hopper;

means coupled with said hopper and said structure for feeding said material therefrom and into the air currents;

an air intake tube coupled with said air inlet means and surrounding the pipe in spaced relationship thereto, presenting an air passage in thermal interchange relationship with the pipe for heating the air prior to entering said air inlet means;

a material discharge conduit in communication with said material outlet means; and

a collector coupled with said conduit for receiving the material.

2. The invention of claim 1, and suction means coupled

with said collector for augmenting the action of said blower means.

3. The invention of claim 2, said hopper having a reticulate, material-containing receptacle therein, said suction means including a second blower having air discharge means coupled with the hopper and disposed to direct air through the receptacle to preheat the material in the latter.

4. The invention of claim 1, said body having a heat-conducting wall, said material feeding means including a second tube in surrounding relationship to said body and spaced therefrom to present a material passage in thermal interchange relationship to said wall.

5. The invention of claim 4, there being a helical vane within said second tube for directing said materials along a spiral path through said material passage.

6. The invention of claim 1, said body having a heat-conducting wall, said air intake tube surrounding and being spaced from a portion of said body and having an upper air intake end.

7. The invention of claim 6, and a helical vane within the air passage for directing air along a spiral path through said air passage.

8. The invention of claim 1, and damper means in said chamber adjacent said material outlet within the path of travel of the material passing toward said outlet for controlling the flow of said material.

9. The invention of claim 8, and means shiftably mounting the damper means within said chamber for varying the material flow.

10. The invention of claim 1, said conduit having structure for admitting a preselected amount of air thereinto for flow with the material passing through said conduit.

11. The invention of claim 10, said conduit having a slot, said structure including a rotatable, perforated sleeve surrounding said conduit at said slot.

12. The invention of claim 6, said air intake tube having structure for producing a serpentine path for the flow of air into said upper end.

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