

Feb. 12, 1957

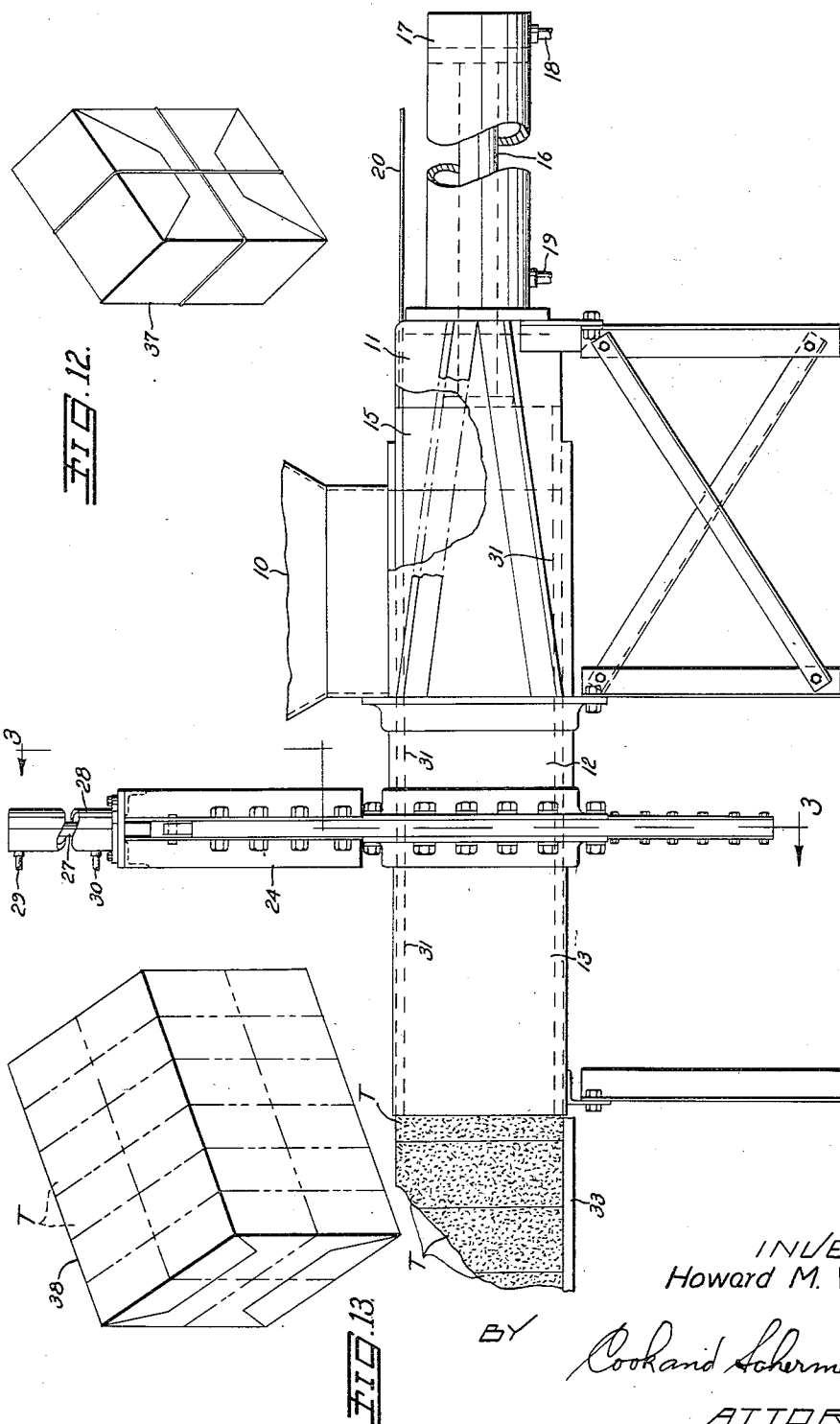
H. M. WALL

2,780,987

WOOD FLOUR PRESS-METHOD, APPARATUS AND PRODUCT

Filed Jan. 12, 1953

5 Sheets-Sheet 1



Feb. 12, 1957

H. M. WALL

2,780,987

WOOD FLOUR PRESS-METHOD, APPARATUS AND PRODUCT

Filed Jan. 12, 1953

5 Sheets-Sheet 2

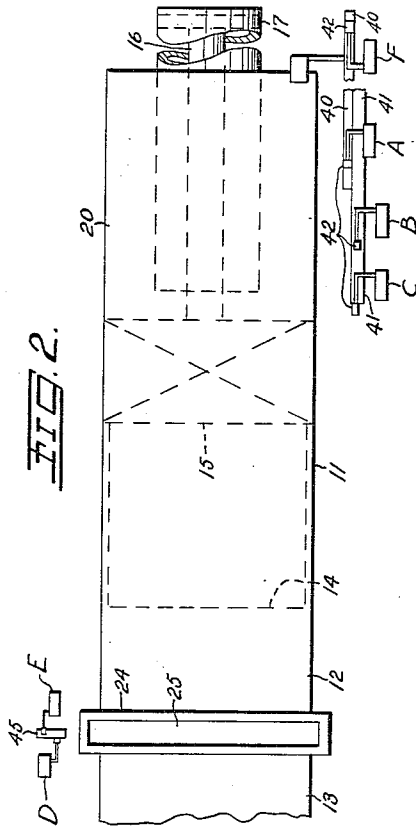


FIG. 2.

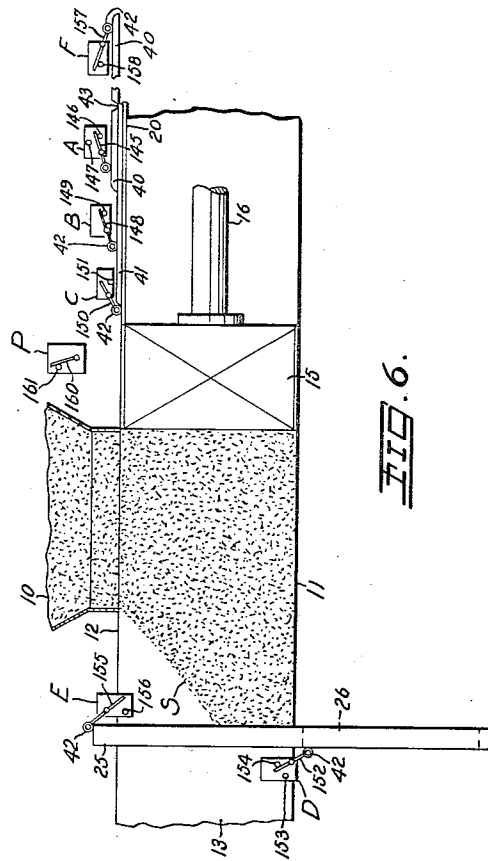


FIG. 6.

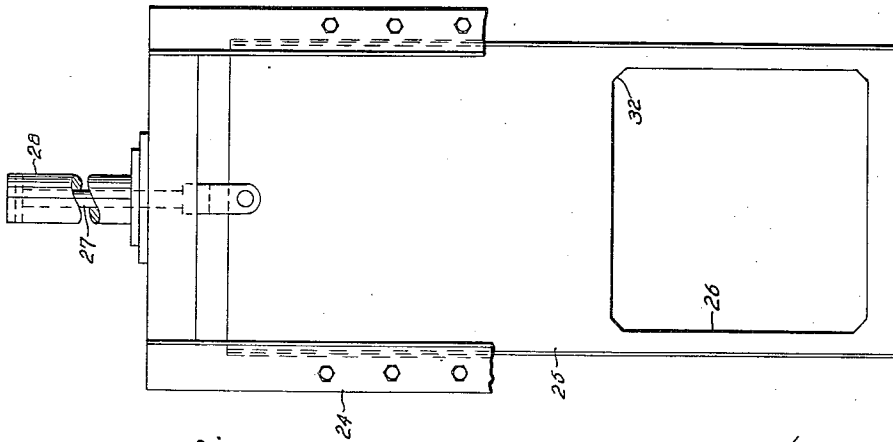


FIG. 3.

INVENTOR
Howard M. Wall

BY *Cook and Schermerhorn*
ATTORNEYS

Feb. 12, 1957

H. M. WALL

2,780,987

WOOD FLOUR PRESS-METHOD, APPARATUS AND PRODUCT

Filed Jan. 12, 1953

5 Sheets-Sheet 3

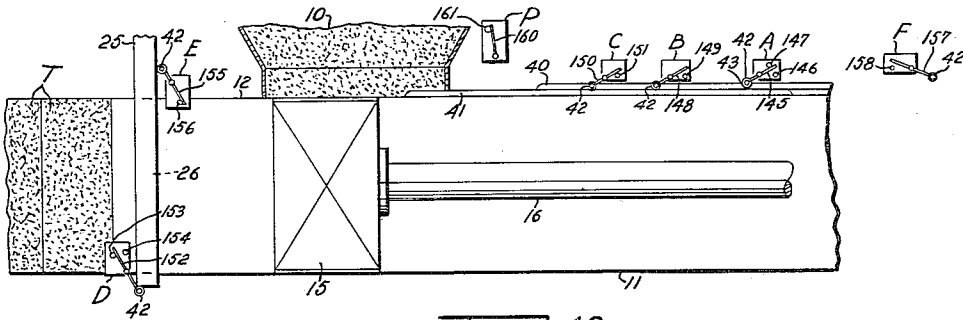


FIG. 10.

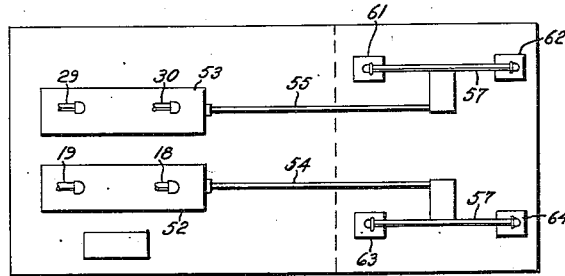


FIG. 4.

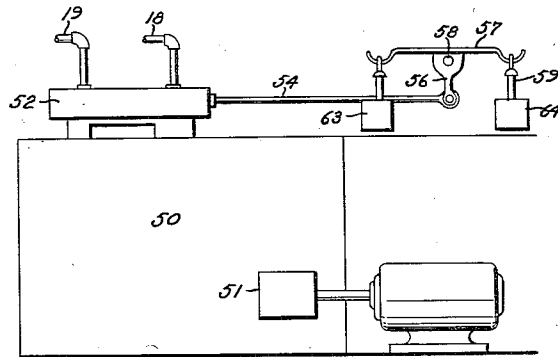


FIG. 5.

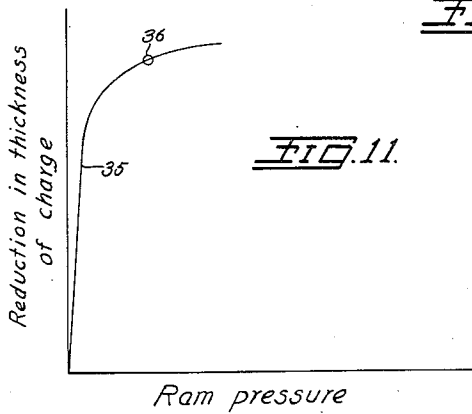


FIG. 11.

INVENTOR
Howard M. Wall

BY *Cook and Schermerhorn*
ATTORNEYS

Feb. 12, 1957

H. M. WALL

2,780,987

WOOD FLOUR PRESS-METHOD, APPARATUS AND PRODUCT

Filed Jan. 12, 1953

5 Sheets-Sheet 4

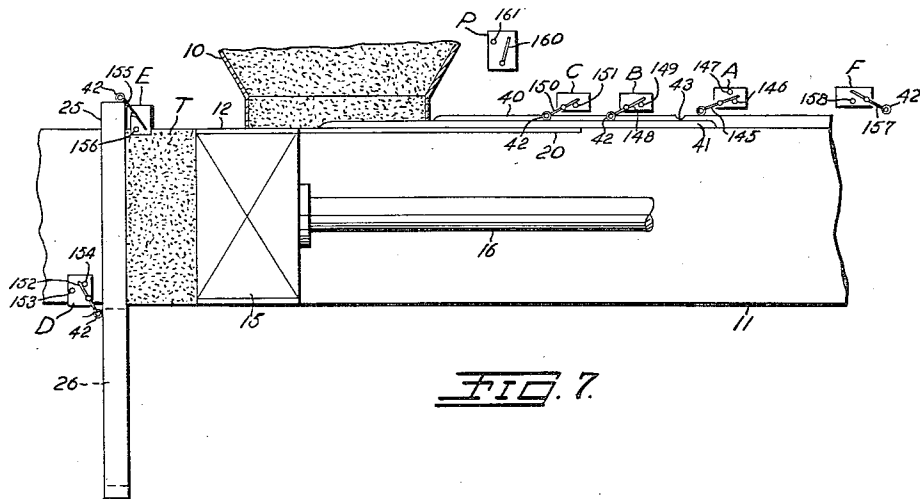


FIG. 7.

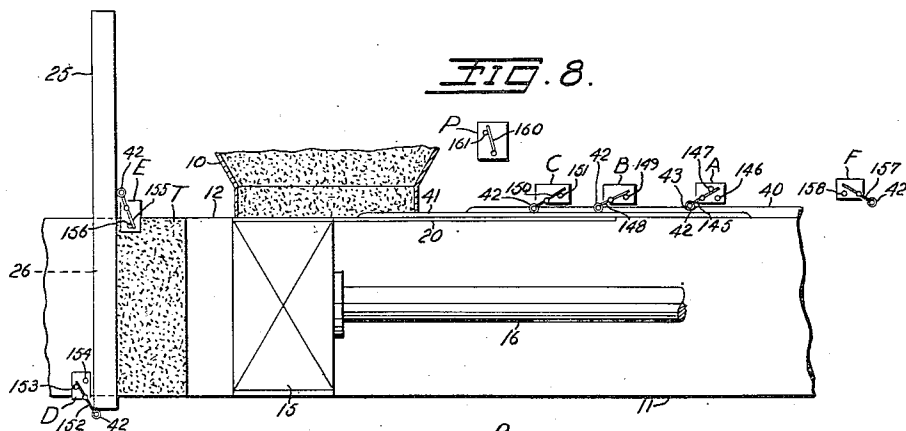
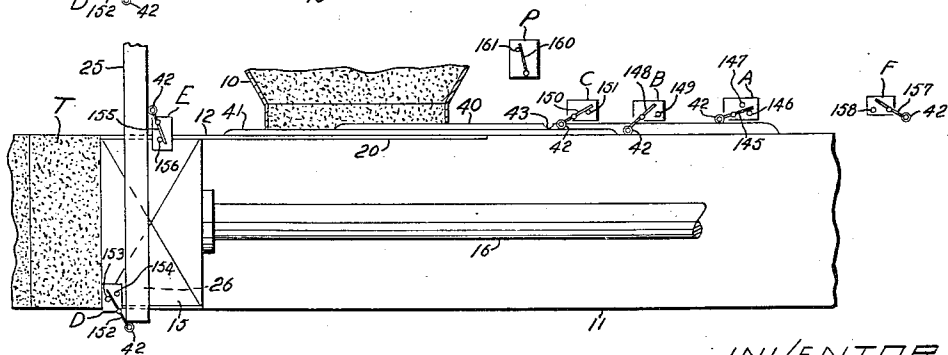


FIG. 8.



Feb. 12, 1957

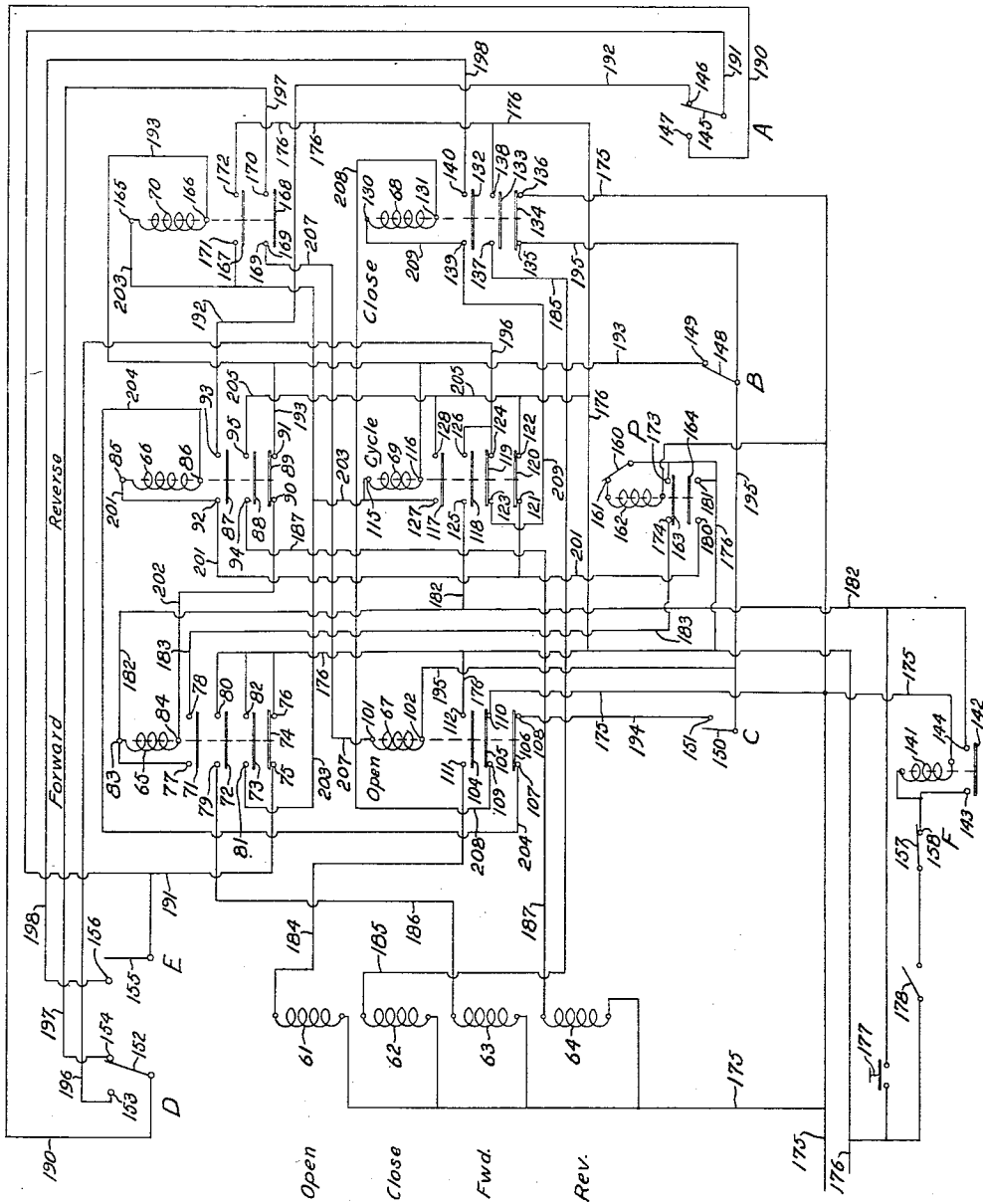
H. M. WALL

2,780,987

WOOD FLOUR PRESS-METHOD, APPARATUS AND PRODUCT

Filed Jan. 12, 1953

5 Sheets-Sheet 5



INVENTOR
Howard M. Wall

BY *Cook and Schermerhorn*
ATTORNEYS

1

2,780,987

WOOD FLOUR PRESS—METHOD, APPARATUS, AND PRODUCT

Howard M. Wall, Portland, Oreg., assignor to Portco Corporation, Portland, Oreg., a corporation of Oregon

Application January 12, 1953, Serial No. 330,861

5 Claims. (Cl. 100—35)

This invention relates to the compressing of sander dust and like material into light density, self-sustaining blocks.

So-called sander dust is a type of wood flour which is produced in great quantity as a by-product in sanding operations to smooth and finish the surfaces of lumber and plywood panels and the like. Sander dust is distinguished from other types of wood flour in that it is an attrition type material that has a much longer fiber than ordinary wood flour made in the conventional hammer mill or attrition type grinding equipment. Sander dust in plywood mills is produced by rotary type sanders having drums which oscillate longitudinally as they turn. This action tends to tear rough surface portions off the plywood and produces the relatively long fiber. Such fiber is more desirable than the conventional hammer mill or attrition type ground material for the reason that it not only acts as a filler in a felt sheet, but it also contributes some bursting strength to the sheet itself. As a result, the long fibers of sander dust make a stronger sheet than the conventional type of wood flour used previously. The dust has a relatively fine particle size ranging from approximately 20 mesh to -100 mesh, U. S. standard.

It is readily apparent, then that sander dust is exceedingly finer than the wood and other vegetable fiber materials ordinarily used for making light density heat and sound insulating batts and boards, and also much finer than sawdust. By reason of its fibrous characteristics, sander dust differs more importantly from sawdust than in the matter of mere size, inasmuch as particles of sawdust comprise minute angular blocks of wood tissue having substantially no fibrous characteristics whatever.

Another unique and distinguishing characteristic of sander dust from plywood mills, which are the most prolific source, is its extreme dryness. The sanding operations in a plywood mill follow the kiln drying of the panels, usually while the panels are still hot. Hence, the sander dust which has been removed from the surfaces of such panels comprises the driest portions of the panels, and, for all practical purposes, fresh sander dust may be regarded as "bone dry." Sawdust, even from kiln dry lumber, never attains such a high degree of dryness because it is largely derived from interior portions of boards which generally have a higher moisture content than the surface portions. In the case of wood fiber manufactured especially for paper or fiberboard products, the nature of the manufacturing process usually produces a fiber with a relatively high moisture content.

The fineness of the particle size in sander dust and its extreme dryness create a fire hazard and other handling

2

and storage problems. The material in a loose condition is always subject to a dust explosion. The material has found acceptance in the paper industry for certain uses, but the storage and handling difficulties of the fine dry dust, together with cost and geographical considerations, have limited its utilization. Most paper plants are located at a considerable distance from the plywood mills which produce the sander dust, and the material is very bulky to ship and store according to conventional practice.

The general objects of the present invention are, therefore, to provide a novel method of baling the sander dust to facilitate storage, handling and transportation, to provide a new form of "unit package" of sander dust which will effect a saving in handling, freight and storage costs, and to provide a novel apparatus for carrying out the method and making such a unit package.

More specific objects are to provide a method of compressing sander dust into coherent, self-sustaining, light density blocks which can be packaged and stored without undue fire hazard, which can be handled and transported without disintegrating, and which will disintegrate readily in the conventional paper mill beaters. Additional objects are to provide a semi- or fully automatic wood flour press for forming such blocks quickly and economically without an excessive expenditure of power or manual effort.

Notwithstanding the fact that dry sander dust has heretofore been considered incapable of being compressed into coherent self-sustaining blocks, this desirable result has nevertheless been accomplished by the present method and apparatus. A charge of the sander dust is fed into a tubular compression chamber, where the air is squeezed out and the dust compressed by the application of a steady pressure of a relatively low value reaching a maximum of approximately 300 pounds per square inch. This pressure is applied by the flat face of a ram acting to compress the dust against a gate which forms one end of the chamber. A single application of pressure of this magnitude is sufficient to squeeze out the included air and effect a loose felting of the fibrous particles. When the desired compacting of the material has been attained, the ram is backed away from the charge a short distance to relax the pressure and allow the gate to be opened.

The ram is then moved forward a second time to push the compressed charge into a passage which constitutes a continuation of the compression chamber. This passage may be referred to as a decompression or relaxation chamber in that, although the compressed blocks are still confined laterally, the longitudinal pressure is relieved or diminished without being reduced to zero. Each newly formed block thus pushes the previously formed blocks ahead of it through the passage until they are finally discharged one by one from the open end thereof. The blocks thereby become adjusted gradually to the reduction in pressure, and, although they are not solid or hard, they are sufficiently coherent and self-sustaining to be handled for wrapping or other suitable packaging. No bonding material is employed, and the applied pressure and other conditions are not such as to plasticize any thermoplastic materials naturally existing in the wood. Coherence is achieved solely by what may be best described as a loose dry felting or mechanical interlocking action of the particles.

3

The density of the blocks thus produced varies with the particle size, kind of wood, and the degree of dimensional stabilization attained in the compression process. Typical densities for Douglas fir range between 17.8 and 23.1 pounds per cubic foot, which are between half and three quarters of the density of the wood from which the sander dust was derived.

It will be understood that the above-described method and apparatus have utility in processing other types of wood flour. The properties of sander dust are such that greater difficulties are encountered in compressing this material into a coherent block, hence it is believed apparent that if the method and apparatus will form coherent blocks from sander dust they will also form coherent blocks from other types of wood flour.

The present compressed sander dust block is to be distinguished from other compressed wood and other vegetable fiber products, such as sawdust briquettes, high and low density fiberboards, and very low density vegetable fiber mats or batts used largely for insulation purposes. The latter are composed of material having a large particle size exhibiting a shredded or stringy texture which is very coarse and rough in appearance and to the touch. Conventional fiberboard processes usually involve bonding materials and thermoplastic or thermosetting reactions occurring under pressure at an elevated temperature between heated press platens. Sawdust briquettes, often formed in the shape of a cylinder to simulate a log, are also made under high pressures and temperatures and in the presence of sufficient moisture to plasticize certain thermoplastic materials in the wood. They are characterized by a hard, glazed resinous surface indicative of the temperature and pressure employed. Coherence of the particles results from the action of a natural or added adhesive, and not from mechanical interlocking of the particles. Also, high density fiberboard and sawdust briquettes not only are of relatively high density, but they are hard and durable, substantially like natural wood, as exhibited by their resistance to mechanical impact.

Applicant's compressed sander dust blocks are relatively soft and fragile and can be readily torn apart with the fingers. Without lateral support, they will disintegrate from the normal vibration of transportation, but, if suitably wrapped or packaged, they tend to retain their original block shape and dimensions without collapsing into loose bulk material. The extreme dryness of applicant's source material, when it is processed directly and immediately from sander dust recovered from the hot surfaces of kiln dry plywood panels, precludes any possibility of adhesive bonding in the absence of an additive binder, even with the application of tremendous pressure. For this reason, it has heretofore always been considered impossible to compress sander dust into a self-sustaining block and all known previous attempts to do so have failed.

The invention further resides in various details of the method and apparatus which will be explained in connection with the accompanying drawings illustrating a preferred embodiment of the apparatus.

In the drawings:

Figure 1 is a side elevation view, with parts broken away, of a wood flour press for carrying out the method of the invention;

Figure 2 is a fragmentary top plan view of the machine shown in Figure 1;

Figure 3 is a sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a top plan view of the hydraulic system and control valves for operating the machine of Figure 1;

Figure 5 is a side elevation view of the hydraulic apparatus shown in Figure 4;

Figures 6-10 are a sequence of views illustrating the principal steps in an operating cycle of the machine;

Figure 11 is a stress-strain curve showing deformation

4

of the charge of sander dust under increasing ram pressure;

Figure 12 is a perspective view of a single block unit package;

Figure 13 is a perspective view of a plurality of blocks wrapped in one package; and

Figure 14 is a wiring diagram of the electrical system of the machine.

MACHINE, METHOD AND PRODUCT

Figures 1, 2 and 3 illustrate the principal features of the machine for carrying out the process of the invention. The sander dust S to be baled is deposited in a hopper 10 surmounting a horizontal tubular passage 11 having a section 12 adjacent the hopper which will be referred to as a compression chamber, and a more remote section 13 which will be designated as a decompression or relaxation chamber. An opening 14 in the top of the passage 11 communicates with hopper 10.

A ram 15 is mounted for reciprocating travel in the passage 11 beneath the hopper 10. Ram 15 is connected with a piston rod 16 on a piston in a double acting cylinder 17. A pipe connection 18 admits fluid pressure to one end of the cylinder for driving the ram forward, and a pipe connection 19 at the other end of the cylinder admits fluid pressure for retracting the ram. The ram carries a hopper gate 20 to close the opening 14 when the ram is forward and prevent the discharge of material from the hopper 10 behind the ram.

Between the passage sections 12 and 13 is mounted a guide frame 24 for a vertical compression gate 25. The upper portion of this gate is solid and forms an abutment wall at the end of compression chamber 12 when the gate is lowered. The lower end of the gate contains an opening 26 the same size as the passage 11 to establish open communication between the chambers 12 and 13 when the gate is raised. Gate 25 is connected with a vertical piston rod 27 on a piston in cylinder 28 mounted on the frame 24. A pipe connection 29 at the upper end of cylinder 28 admits fluid pressure to lower the gate, and a pipe connection 30 at the lower end of the cylinder admits fluid pressure to raise the gate.

The corners of passage 11 are filled with 45 degree fillets extending through chambers 12 and 13, and the corners 32 of the opening 26 in compression gate 25 are similarly shaped. The inside walls of chambers 12 and 13 have the same size and shape as the opening 26, as shown in Figure 3. Ram 15 has beveled corners to fit the passage.

The inside surfaces of passage 11 and the ram surfaces are preferably covered with a suitable hard plastic composition to prevent any possibility of metal to metal contact which might produce sparking.

The compressed blocks T are pushed through chamber 13 by the ram and discharged on a table 33 for wrapping.

Figures 6 to 10 illustrate successive steps in an operating cycle of the machine. In Figure 6 the ram is fully retracted to admit the material S from the hopper into the passage 11, where it piles up against the compression gate 25, substantially filling the compression chamber 12, as well as the remaining space in passage 11 directly beneath the hopper.

In Figure 7 the ram has moved forward to its maximum compression position, closing the opening 14 with the hopper gate 20 and compressing the charge of material against the compression gate 25 to form a block T. As the ram moves forward to its Figure 7 position, the resistance imposed by the material entrapped in the compression chamber gradually increases as the material is pushed into the empty upper corner of the compression chamber and as air is being expelled from the compression chamber. The fit of the ram in the passage 11 and the fit of the gate 25 in its guide frame 24 allow for expelling the trapped air as the ram moves forward.

After the pressure exerted by the ram on the material

5

has reached a predetermined value, such as, for example, 300 pounds per square inch, the ram is reversed and retracted a short distance away from the compressed charge or block, as shown in Figure 8. This relieves the ram force acting on gate 25, allowing it to be raised to open position, which gate movement has already taken place in Figure 8. Preferably, the ram is caused to dwell in its Figure 7 position for a few seconds to allow a time interval for the wood fibers to "set" in compressed condition. This reduces the tendency of the compressed block to spring back and expand when the ram pressure is removed.

The ram is then advanced to its Figure 9 position to push the newly formed block through the gate opening 26 and into the decompression or relaxation chamber 13, pushing the other blocks in chamber 13 ahead of it.

When the ram has been partially retracted, as shown in Figure 10, compression gate 25 is again lowered in preparation for the next cycle and the ram continues its movement back to its Figure 6 position, admitting a new charge of material into passage 11 for compression.

When the ram moves forward in its compression stroke from its Figure 6 position to its Figure 7 position there is at first relatively little resistance to movement and the pressure in cylinder 17 does not build up rapidly until the particles are squeezed together sufficiently closely to expel the entrapped air. This is illustrated graphically in Figure 11. The thickness curve 35 then breaks abruptly to the right with very little additional movement of the ram as the pressure increases, and, at a certain point, will continue in a substantially horizontal line without appreciable further movement of the ram, indicating that no further reduction in volume is occurring. In the present process it is desired to terminate the compression stroke at some point on the bend of the curve between the substantially horizontal and the substantially vertical portions, as indicated, for example, at point 36. Any further reduction in volume would, obviously, require exceedingly heavier and stronger equipment, both in the ram and compression chamber 12, and in the hydraulic system including the pump, valves and pipelines.

An advantage of the present method and apparatus is that satisfactory cohesion is obtained for the desired purpose at a relatively low pressure which does not require a powerful hydraulic pump and massive structures for the cylinder 17 and compression chamber 12. At the point 36 on the curve, where approximately 300 pounds per square inch unit pressure is applied to the charge, sufficient cohesion for the purpose is obtained, provided that the lateral restraint on the charge is maintained for a time and the end restraint is relaxed gradually in the manner provided by the decompression or relaxation chamber 13. No moisture or binding material is introduced, the cohesive effect being merely one of mechanical interengagement of the fibrous and semi-fibrous particles in the nature of a loose felting action.

In chamber 13 the compressed blocks are laterally confined the same as in compression chamber 12, but the horizontal end compression is much less, since it depends upon the frictional resistance of the end blocks against sliding movement. Whenever the blocks are pushed along by a new block entering the chamber, the end compression is temporarily increased. The chamber 13 is long enough to accommodate a number of the blocks, and so the blocks travel through this chamber in step by step movement lasting for a corresponding number of cycles of operation of the machine. During this interval in the chamber 13, the blocks expand horizontally in a direction longitudinally of the chamber to a certain extent and become sufficiently stabilized, or "set," so that they do not break apart from sudden expansion when they are pushed out of the end of the passage.

The friction of the passage walls in chamber 13 imposes considerable resistance to movement of the material when the ram moves forward to its Figure 9 position, and also

6

imposes considerable resistance to any movement of re-expansion after the ram is retracted from its Figure 9 position, whereby the blocks in the intermediate portion of the chamber 13 remain subjected to substantial end compression even after the ram is retracted. The length of chamber 13 determines the amount of resistance to movement and thereby the moving force applied by the ram as well as the holding force of the passage walls to resist re-expansion when the ram is retracted. The individual blocks maintain their identity and exhibit no tendency to stick together or merge into each other in chamber 13.

Filletts 31 prevent tearing of the corners of the blocks as they leave the end of chamber 13. Square corners introduce small volumes of the material having relatively large surface areas in the corners of the passageway subject to frictional forces tending to retard the movement of these parts of the material more than the central portions of the block, resulting in fractures and breakage of the corner portions when filletts are not used.

In the baling of sander dust from the kiln dried face veneers of plywood sheets, satisfactory results have been obtained with the passage 11 having a square cross sectional shape sixteen inches on a side. The blocks are compressed to a thickness of approximately eight inches in Figure 7, and they subsequently expand to some extent in thickness, with relatively less expansion in directions transverse to the axis of compression. If the ram is immediately retracted from its Figure 7 position upon attainment of the desired pressure, the blocks expand to about nine inches in thickness, but if they are held under compression for a few seconds they become more stabilized or "set" and then expand only to about eight and one-half inches. Typical blocks, stabilized in the manner described, have a density of 23.1 pounds per cubic foot, and, although somewhat fragile, they may be readily lifted and handled for packaging purposes.

Figure 12 shows a single block 37 approximately 16 inches by 16 inches by 8½ inches, wrapped in paper and tied with paper twine. Such packages may be shipped by by autotruck or railroad car, and otherwise handled as any other merchandise without losing their shape or apparent solidity. It is not necessary to seal the packages. When thus confined by the paper and twine, the material exhibits no tendency, even under the vibration incident to transportation, to crumble and sift out of the packages. Such packages may be dropped into the conventional paper beaters in a paper mill without untying or unwrapping, as they are readily broken up by the beaters and all the material employed in the package is susceptible to pulping and suitable for making new paper.

Figure 13 illustrates a larger unit package containing 24 blocks assembled together and contained in a single paper and twine wrapping. Such a package weighs approximately 700 pounds if the blocks are properly stabilized, and its dimensions are approximately

32" x 32" x 51"

These larger packages are of convenient size for loading in railroad boxcars and are readily handled by industrial lift trucks without pallets, using load clamp arms which lift a tier of three packages by gripping the sides of the bottom package.

Handled in this way, the substantially bone-dry and highly explosive sander dust may be stored and transported cleanly and economically and without undue fire hazard. The values of pressure, density, weight and dimensions are those which have been used successfully in practice. They are cited by way of example only and are not intended to limit the invention. The invention is not limited to sander dust as a source material but is of particular advantage in the treatment of this material because all the known methods and machines for compressing or packaging other materials have been found

to be inoperable for applicant's purpose in practical application to sander dust.

CONTROL SYSTEM

Attached to the hopper gate 20 for reciprocation with this gate and the ram 15 are a pair of guide or cam bars 40 and 41 for actuating the switches A, B, C and F as shown in Figures 2 and 6. The switches A and F are mounted for actuation by the bar 40 and the switches B and C are mounted for actuation by bar 41. Both bars have sloping ends and flat track surfaces to engage rollers 42 on the actuating arms of the switches. Guide bar 40 is equipped with a notch or depression 43 to produce an additional actuation of switch A at an intermediate point in the ram movement.

Attached to the compression gate 25 is a vertical guide or cam bar 45 for actuating the switches D and E. This bar is omitted in Figures 6 to 10 to clarify the diagrammatic representations, the rollers 42 being represented as directly engaging portions of the gate. Also, for purposes of the diagrams, rollers 42 on all these limit switches are represented as mounted on the ends of the switch arms, but it is to be understood that conventional limit switches are employed in practice.

The switch P is a fluid pressure responsive switch connected with the pipe 18 of cylinder 17.

The switches just referred to are associated with electrical and hydraulic systems to control the cycle of operations described in connection with Figures 6-10. The hydraulic system shown in Figures 4 and 5 comprises a reservoir 50, pump 51, a ram reversing valve 52 and a compression gate reversing valve 53. The reversing valves are of conventional construction and are equipped with reciprocating valve rods 54 and 55 to reverse the fluid pressure and relief connections with pipes 18, 19, 29 and 30 to move the ram 15 and gate 25 in opposite directions. Each of these valve rods is connected with a depending lever arm 56 on a walking beam lever 57 which is pivotally mounted at 58. The opposite ends of the walking beams are connected with magnetic plunger-type armatures 59 in the respective solenoids 61, 62, 63 and 64.

When solenoid 61 is energized, the valve rod 55 is pulled to the right to admit fluid pressure to pipe 30 for raising the gate 25, and when solenoid 62 is energized the valve rod is pushed to the left to admit fluid pressure to pipe 29 to lower the gate. When solenoid 63 is energized, valve rod 54 is pulled to the right to connect pipe 18 with fluid pressure to move the ram 15 forward, and when solenoid 64 is energized, rod 54 is pushed to the left to connect pipe 19 with fluid pressure to retract the ram.

The solenoids 61, 62, 63 and 64 are controlled by a plurality of relays in the electrical system shown in Figure 14. These relays are identified by reference numerals applied to their solenoid coils. Relay 65 is designated as a forward relay, and relay 66 as a reverse relay. Relay 65 is designated as an open relay, and relay 68 is designated as a closed relay. Relay 69 is designated as a cycle relay and relay 70 is an additional relay to change certain circuit connections as will hereinafter appear.

The armature of forward relay 65 is equipped with four contact bars 71, 72, 73 and 74. When the relay coil 65 is deenergized, the contact bar 74 engages and interconnects the stationary contacts 75 and 76. When the relay coil 65 is energized, bar 71 engages stationary contacts 77 and 78, bar 72 engages contacts 79 and 80, and bar 73 engages stationary contacts 81 and 82. The coil 65 is connected with terminals 83 and 84.

Reverse relay coil 66 is connected with terminals 85 and 86. Its armature carries three contact bars 87, 88 and 89. When the relay coil 66 is deenergized, the contact bar 89 engages stationary contacts 90 and 91. When the relay is energized, bar 87 engages stationary contacts 92 and 93, and bar 88 engages stationary contacts 94 and 95.

The coil 67 of the open relay is connected with terminals 101 and 102. Its armature carries the three contact bars 104, 105 and 106. When this relay is deenergized, bar 106 engages stationary contacts 107 and 108 and bar 105 engages stationary contacts 109 and 110. When the relay is energized bar 104 engages stationary contacts 111 and 112.

The coil 69 of the cycle relay is connected with terminals 115 and 116. The armature of this relay carries four contact bars 117, 118, 119 and 120. When the relay is deenergized, the contact bar 120 engages stationary contacts 121 and 122 and contact bar 119 engages stationary contacts 123 and 124. When the relay is energized, contact bar 118 engages stationary contacts 125 and 126, and contact bar 117 engages stationary contacts 127 and 128.

The coil 68 of the closed relay is connected with terminals 130 and 131. The armature of this relay carries three contact bars 132, 133 and 134. When the relay is deenergized, the contact bar 134 engages stationary contacts 135 and 136. When the relay is energized, contact bar 133 engages stationary contacts 137 and 138, and contact bar 132 engages stationary contacts 139 and 140.

Relay coil 70 is connected with terminals 165 and 166. The armature of this relay carries two contact bars 167 and 168. When the relay is energized contact bar 168 engages stationary contacts 169 and 170 and contact bar 167 engages stationary contacts 171 and 172.

Switch A comprises a switch arm 145 and a pair of stationary contacts 146 and 147. Switch B comprises a switch arm 148 and a single stationary contact 149. Switch C comprises a switch arm 150 and a single stationary contact 151. Switch D comprises a switch arm 152 and a pair of stationary contacts 153 and 154. Switch E comprises a switch arm 155 and a single stationary contact 156. Switch F comprises a switch arm 157 and a single stationary contact 158. The switch P comprises a switch arm 160 which normally engages a stationary contact 161.

Associated with the switch F is a slow-closing delay relay having a solenoid coil 141 and an armature contact bar 142. When the relay is energized, contact bar 142 engages and interconnects stationary contacts 143 and 144 after a short delay.

Associated with the pressure switch P is a slow-opening delay relay having a solenoid coil 162 and a pair of armature contact bars 163 and 164. This solenoid is normally energized by switch P to hold contact bar 163 in engagement with stationary upper contacts 173 and 174 and holding contact bar 164 normally out of engagement with stationary lower contacts 180 and 181. When coil 162 is deenergized the contact bars 163 and 164 drop after a short delay to disengage the upper contacts and interconnect the lower contacts.

The system is energized from a pair of line wires 175 and 176. Line wire 175 is connected with the four solenoids 61, 62, 63 and 64 and also has branch connections to contact 136 of close relay 68, contact 110 of open relay 67, delay relay coil 162, and delay relay coil 141. Line wire 176 is connected with a normally open push button starter switch 177 and another manual switch 178, the latter being in series with the members 157, 158, of limit switch F, delay relay coil 141 and relay contact 143.

Line wire 176 also makes connection with switch arm 160 of pressure switch P, contacts 173 and 181 of delay relay 162, and the contacts 80, 82 and 76 of forward relay 65. It also connects with contact 112 of open relay 67 and has a branch, designated by the same numeral, connected with contact 122 of cycle relay 69, contact 138 of close relay 68, and contact 172 of the relay 70.

The switches 178 and 157, when closed, energize relay 141 to establish a shunt circuit around the push button

starter switch 177, these components being contained in a circuit through wire 182 connected with contact 125 of cycle relay 69 and terminal 83 of forward relay coil 65.

Open solenoid 61 is energized through wire 184 connected with terminal 111 of open relay 67, close solenoid 62 is energized through wire 185 connected with terminal 137 of close relay 68, forward solenoid 63 is energized through wire 186 connected with terminal 79 of forward relay 65, and reverse relay 64 is energized through wire 187 connected with terminal 94 of reverse relay 66.

Contact 147 of limit switch A is connected through wire 190 to switch arm 152 of switch D. Switch arm 145 of switch A is connected through wire 191 with contact 75 of forward relay 65 and switch arm 155 of limit switch E. Contact 146 of switch A is connected through wire 192 to contact 93 of reverse relay 66.

The switch arms 148 and 150 of limit switches B and C are connected through wire 195 to terminal 135 of close relay 68. Contact 149 of switch B is connected through wire 193 to terminal 116 of cycle relay 69, terminal 166 of relay 70, and contact 91 of reverse relay 66. Contact 151 of switch C is connected through wire 194 to contact 108 of open relay 67.

Contact 153 of limit switch D is connected through wire 196 to contacts 124 and 126 of cycle relay 69. Contact 154 of switch D is connected through wire 197 to contact 170 of relay 70. Contact 156 of limit switch E is connected through wire 198 to contact 140 of close relay 68.

Contact 161 of pressure switch P is connected to one terminal of delay relay coil 162, the other terminal of which is connected to line wire 175 as mentioned. Contact 174 is connected through wire 183 with contact 78 of forward relay 65. Contact 180 is connected through wires, all designated by the numeral 201, with terminal 85 of reverse relay coil 66, contact 92 of this relay and contact 121 of cycle relay 69.

Terminal 84 of forward relay 65 is connected through wire 202 with contact 90 of reverse relay 66. Contact 81 is connected through wire connections, all designated by the numeral 203, with terminal 165 and contact 171 of relay 70, and terminal 115 and contact 127 of cycle relay 69.

Terminal 86 of reverse relay coil 66 is connected through wire 204 to contact 107 of open relay 67. Contact 95 is connected through wire 205 to contacts 122 and 128 of cycle relay 69.

Wire connections 207 connect terminal 101 of open relay 67 with contact 169 of the relay 70. Contact 109 is connected through wire 208 with terminal 131 of close relay coil 68.

Contact 123 of cycle relay 69 is connected through wire 209 with terminal 130 and contact 139 of close relay 68.

OPERATION

Before describing the operation of the hydraulic and electrical systems in detail it will be explained that switch 178 in Figure 14 is a manual switch connected in series with the limit switch F to provide the option of automatic continuous operation or single cycle operation. Figure 6 illustrates the normal rest position of the parts at the completion of a cycle of operation wherein switch F has just been closed by the extreme rearward movement of guide bar 40. When switch 178 is already closed, the closing of switch F by the rearward movement of the ram starts the next cycle of operation and the machine continues to re-cycle automatically, but when switch 178 is open as shown, the parts remain in the rest position shown in Figure 6. A single cycle of operation may then be performed by momentarily closing the push button starting switch 177.

With the switches in the positions shown in Figures 6

and 14, the electrical system is completely deenergized except for delay relay 162 which is energized. Switches 177 and 178 are open and the relay armature contact bars are all in the positions shown. The roller end of switch arm 145 of switch A rests on guide bar 40 with the switch arm engaging contact 146 which establishes no active circuit. The roller end of switch arm 148 of switch B rests on guide bar 41, holding the switch arm in engagement with the single contact 149 which establishes no active circuit. The roller 42 of switch arm 150 of switch C has dropped off the end of guide bar 41, disengaging the switch arm from the single contact 151. Switch arm 160 of pressure switch P engages the low pressure contact 161 which energizes delay relay 162 but the contact bar 163 does not complete an active circuit at this time. Roller 42 of switch arm 155 of switch E is released by the lower position of compression gate 25 to disengage the switch arm from the single contact 156. Switch arm 152 of switch D is held by the gate in engagement with contact 154, but this does not complete an active circuit.

Closing of the circuit through wire 182, either by means of push button switch 177 or by manual switch 178 and limit switch F, completes a temporary starting circuit to energize forward relay coil 65 through the wire 182, coil 65, wire 202, contact bar 89 reverse relay 66, wire 193, switch arm 148 of closed limit switch B, wire 195, and contact bar 134 of deenergized close relay 68, back to line wire 175.

Energization of forward relay coil 65 lifts the contact bars 71, 72 and 73 to make three new circuits, the lifting of contact bar 74 being without effect in this phase of the operation. Since neither switch 177 nor switch F remains closed, the first function of forward relay 65 is to close a holding circuit for its own coil 65. This is accomplished through the shunting of switches 177 and F by contact bar 71, wire 183, and contact bar 163 back to wire 176 which is the line wire connected with the starting circuit wire 182.

The second circuit established by the energization of forward relay 65 is through line wire 176, contact bar 72, wire 186, forward solenoid 63, and line wire 175 to energize forward solenoid 63. Energization of forward solenoid 63 rocks the walking beam lever 57 to pull valve rod 54 to the right in Figures 4 and 5, admitting fluid pressure to pipe 18 and connecting pipe 19 with relief pressure to move the ram 11 to the left from its retracted position shown in Figure 6.

The third circuit established by energization of forward relay 65 may be traced through line wire 176, contact bar 73, wire 203, relay coil 70, wire 193, arm 148 of limit switch B, wire 195, contact bar 134 of deenergized close relay 68, and line wire 175.

The energization of relay coil 70 closes two additional circuits. The first is a holding circuit for relay coil 70 shunting the contact bar 73 of the forward relay 65. This circuit may be traced from line wire 176 through contact bar 167 of relay 70 back to the said wire 203. From wire 203 a second circuit is made through the coil of cycle relay 69, wire 193, closed switch B, wire 195, and contact bar 134 of deenergized close relay 68 to line wire 175. The lifting of contact bar 168 does not energize a new circuit at this time.

Cycle relay 69 closes a holding circuit for itself from terminal 115 through contact bar 117 and wire 205 back to line wire 176. The energization of this relay has no immediate effect on the system except to prepare certain circuits for future events.

The foregoing events all occur immediately when starting switch 177 is closed.

As the ram 15 starts to advance from its Figure 6 position, switch F opens and push button switch 177, if closed, is released by the operator to return to open position, whereby the starting circuit through wire 182 is broken. Switch C is closed by the movement of the forward end of guide bar 41 under the roller 42 of the

switch arm 150. This switch movement has no immediate effect on the system.

As the ram 15 moves forward on its compression stroke, the roller end of switch arm 145 on switch A drops momentarily into notch 43 in guide bar 40, engaging the switch arm for an instant with contact 147 and then returning the switch arm to contact 146 as the notch 143 moves on. This switch operation produces no function. Thus the ram continues to move forward to its Figure 7 position. When the resistance of the material ahead of the ram causes a pressure rise in cylinder 17 and pressure supply pipe 18 sufficient to actuate the pressure responsive switch P, the switch arm 160 of that switch disengages contact 161.

The movement of pressure switch arm 160 away from contact 161 deenergizes relay 162 which after a few seconds delay breaks the holding circuit hereinabove described for forward relay coil 65, thereby also deenergizing forward solenoid 63, and completes a circuit to reverse relay coil 66 through line wire 176, contact bar 164, wire 201, coil 66, wire 204, contact bar 106, wire 194, switch C, wire 195, contact bar 134, and wire 175. The delayed opening action of relay 162 provides the desired dwell interval for the ram in its Figure 7 position to set the loosely interlocked fibers of the compressed block and reduce expansion of the block after the ram pressure is removed.

Energization of reverse relay 66 closes a holding circuit for its own coil through wire 201, contact bar 87, wire 192, arm 145 of limit switch A, wire 191, contact bar 74 of the now deenergized forward relay 65 to line wire 176. Reverse solenoid 64 is energized by a circuit including line wire 175, solenoid 64, wire 187, contact bar 88, wire 205, and wire 176. The lifting of contact bar 89 merely opens the circuit to the other terminal 84 of the already deenergized forward relay coil 65. Energization of reverse solenoid 64 pushes valve rod 54 to the left in Figure 4, establishing fluid pressure in pipe 19 and relief in pipe 18 to the retract the ram toward its Figure 8 position. The pressure in pipe 18 is immediately relieved and arm 160 of pressure switch P returns to engagement with contact 161. This switch movement has no immediate effect on the system because reverse relay coil 66 is now energized through the holding circuit just described, and no new circuit can be completed through wire 183 when relay 162 is re-energized because contact 78 is not engaged by the contact bar 71 of the deenergized forward relay 65.

When the roller end of switch arm 145 of switch A drops into the recess 43, the arm disengages contact 146 and engages contact 147. Disengagement of switch arm 145 from contact 146 breaks the holding circuit for reverse relay coil 66 and deenergizes this relay, thereby deenergizing reverse solenoid 64.

When switch arm 145 engages contact 147 a circuit is established from line wire 176 through contact bar 74 of deenergized forward relay 65, wire 191, switch arm 145, wire 190, switch arm 152 of switch D, wire 197, contact bar 168 of energized relay 70, wire 207, open relay coil 67, wire 195, contact bar 134 of deenergized close relay 68, back to the other line wire 175. Energization of open relay 67 energizes open solenoid 61 by completing a circuit from line wire 175 through solenoid 61, wire 184, contact bar 104, back to the other line wire 176. A preparatory circuit is also partially completed from line wire 175 through contact bar 105, wire 208, to terminal 131 of the close relay coil 68 for the future energization of this relay. When the compression gate 25 starts to move upward, limit switch E is closed, but this switch movement has no immediate effect on the system.

When the compression gate 25 is fully open as indicated in Figure 8, the switch arm 152 of limit switch D disengages contact 154 and engages contact 153. There is no holding circuit for open relay coil 67, so the disengagement of switch arm 152 from contact 154 de-

energizes this relay. This does not change the position of valve rod 55.

When switch arm 152 of switch D engages contact 153, a new circuit for forward relay coil 65 is established through line wire 175, contact bar 134 of deenergized close relay 68, wire 195, switch arm 148 of closed switch B, wire 193, contact bar 89 of deenergized reverse relay 66, wire 202, relay coil 65, wire 182, contact bar 118 of closed cycle relay 69, wire 196, switch arm 152, wire 190, switch arm 145 of limit switch A, wire 191, contact bar 74 to the other line wire 176. A holding circuit for relay coil 65 is maintained through line wire 176, contact bar 163, wire 183, contact bar 71, to the terminal 83, and thence through the remaining portion of the initiating circuit just described.

The ram then moves forward to its Figure 9 position until the roller on switch arm 148 of limit switch B runs off the end of guide bar 41, causing this switch to open, thereby opening the circuits to forward relay coil 65 and forward solenoid 63 and stopping the forward movement of the ram in its Figure 9 position. At the beginning of this movement switch arm 145 rides out of recess 43 and returns the arm to engagement with contact 146.

The opening of limit switch B also deenergizes cycle relay coil 69 and relay coil 70 by interrupting the circuit through the wire 193. The deenergizing of cycle relay 69 energizes reverse relay coil 66 through a circuit from line wire 176, contact bar 120 of the cycle relay, wire 201, relay coil 66, wire 204, contact bar 106 of the deenergized open relay, wire 194, closed switch C, wire 195, contact bar 134 of the deenergized close relay, back to the other line wire 175.

The ram then reverses to its Figure 10 position where the roller end of switch arm 145 of switch A drops into recess 43 in guide bar 40. Switch arm 145 thereupon engages contact 147 again to energize close relay 68 in a circuit including line wire 175, contact bar 105 of deenergized open relay 67, wire 208, relay coil 68, wire 209, contact bar 119 of deenergized cycle relay 69, wire 196, switch arm 152 of switch D, wire 190, switch arm 145 of switch A, wire 191, contact bar 74 of deenergized forward relay 65, back to line wire 176. When close relay coil 68 is energized, contact bar 132 makes a holding circuit from wire 209 through wire 198, switch arm 155 of switch E, wire 191, and contact bar 74, back to the other line wire 176. Close solenoid 62 is energized by circuits including line wire 175, solenoid 62, wire 185, contact bar 133, and line wire 176. The return movement of the ram re-closes limit switch B.

As the compression gate moves downwardly, limit switch D is actuated to engage switch arm 152 with contact 154, and when the gate is fully closed limit switch E is actuated to disengage switch arm 155 from contact 156. This breaks the holding circuit just described for close relay coil 68, deenergizing this relay.

Reverse relay 66 is deenergized by the lifting of contact bar 134 while the close relay 68 is energized, and as soon as the close relay is deenergized the reverse relay is again reenergized. Then the ram continues back to its starting position shown in Figure 6, whereupon the roller end of switch arm 150 in limit switch C drops off the end of guide bar 41, disengaging the switch arm 150 from contact 151 and breaking the circuit to reverse relay coil 66. This leaves all the parts in their starting positions. Switch F is now closed and if manual switch 178 is closed the machine will run continuously in full automatic operation.

The slow closing characteristic of delay relay 141 allows time for a full charge of material to drop down into the passage 11 from hopper 10 before the ram again starts forward in full automatic operation.

The following tabulation indicates the major relay movements produced by each switching event in a cycle of operation. Switching events are included which produce no relay movement.

Switch Event	Forward Relay 65	Reverse Relay 66	Open Relay 67	Close Relay 68	Cycle Relay 69	Relay 70
Rest position, Fig. 6	deenergized	deenergized	deenergized	deenergized	deenergized	deenergized
Closing of 177 (or 178 in first cycle)	energized				energized	energized
177 or F opens						
C closes						
A actuated and returned						
P opens, Fig. 7	deenergized	energized				
P closes						
A-145 engages 147		deenergized	energized			
E closes						
D-Fig. 8, 152 engages 153	energized		deenergized			
A-145 engages 146						
B-Fig. 9, opens	deenergized	energized			deenergized	deenergized
B closes						
A-Fig. 10, 145 engages 147		deenergized		energized		
D-152 engages 154						
E opens		energized		deenergized		
Fig. 6, C opens-F closes		deenergized				

When the machine is arranged to receive the sander dust by gravity flow from the bin which holds the bulk material, and is set for full automatic operation, the whole equipment can be operated by one man. His only duty is to take the blocks from the mouth of the machine as they are produced and pile them up so that they can be wrapped together, preferably as illustrated in Figure 13. This waste material is so bulky and must be held to such a low selling price that it has become uneconomic to bag it in the usual burlap sacks, for example, by filling the sacks with a conventional screw packer which allows the inclusion of only 50 pounds of material in a sack 24" x 40" flat measurement. With such a low density of the packed product, it is possible to load a maximum of only 25 tons in a 40-foot freight car with a 10-foot high ceiling, even when the car is loaded to full visible capacity. When such a car is loaded with applicant's new unit package of compressed sander dust, it is possible to load 35 tons in a car with a two-foot clearance beneath the ceiling, whereby the car can be unloaded at its destination by conventional industrial lift trucks carrying three bales to the load, such a load weighting approximately 2100 pounds. Whereas the unloading of a car of the sacked material required a minimum of sixteen man hours, the present type of package loading makes it possible for one man with a lift truck to unload a car in one hour.

An additional advantage resulting from the practice of the invention is that approximately 30% more material can be stored in a given space. This is important in paper plant mills where storage room is generally inadequate, and also, again, in the loading of freight cars. When the weight capacity of a car is better utilized by loading up to 70,000 pounds in applicant's packages instead of the customary 50,000 pounds in burlap bags, there results a freight rate reduction of two dollars per ton on a typical long haul. By these savings in storage space, freight, and handling costs, it is now economically feasible to utilize this waste material in large paper mills at a considerable distance from the plywood mills which produce the bulk of the material. Thus, still more of each harvested tree is utilized for the more efficient consumption of the country's limited timber resources.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. The method of making coherent blocks from wood flour in which blocks the fine fibrous particles of said flour are mechanically interlocked without and adhesive binder into a loose dry felted structure which is self-sustaining but which can readily be disintegrated to separate said particles, said method comprising forming each of said blocks by introducing a charge of said flour into a tubular compression chamber, compressing said charge between end walls of said chamber, one of which is movable into said chamber with sufficient endwise pressure to effect said interlocking of said particles while

subjecting said charge to lateral restraint by the side walls of said chamber and thereafter releasing said endwise pressure while maintaining said lateral restraint and discharging the resulting block from said chamber by forcing said resulting block endwise from said chamber into the entrance of a tubular passage forming an endwise continuation of said chamber and containing a series of previously formed blocks so as to advance said previously formed blocks through said passage and maintaining said lateral restraint upon said resulting block while it is being forced from said chamber and for a period of time while it is in said passage.

2. The method of making coherent blocks from wood flour in which blocks the fine fibrous particles of said flour are mechanically interlocked without an adhesive binder into a loose dry felted structure which is self-sustaining but which can readily be disintegrated to separate said particles, said method comprising forming each of said blocks by introducing a charge of said flour into a tubular compression chamber of generally rectangular cross section with filleted corners, compressing said charge between end walls of said chamber, one of which is movable into said chamber, with sufficient endwise pressure to effect said interlocking of said particles while subjecting said charge to lateral restraint by the side walls of said chamber and thereafter releasing said endwise pressure while maintaining said lateral restraint and discharging the resulting block from said chamber by removing one of said end walls laterally of said chamber and forcing said resulting block endwise through the resulting open end of said chamber into the entrance of a tubular passage forming an endwise continuation of said chamber and containing a series of previously formed blocks so as to advance previously formed blocks through said passage, and maintaining said lateral restraint upon said resulting block while it is being forced from said chamber and for a period of time while it is in said passage.

3. A press for making coherent blocks from wood flour in which blocks the fine fibrous particles of said flour are mechanically interlocked without an adhesive binder into a loose dry felted structure which is self-sustaining but which can readily be disintegrated to separate said particles, said press comprising a tubular structure having side walls forming a compression chamber, a laterally movable gate forming an end wall for said chamber, means for introducing a charge of said flour into said chamber, a plunger forming a movable end wall for the other end of said chamber, means for moving said plunger into said chamber to compress said charge between said end walls with sufficient pressure to effect said interlocking of said particles while said charge is subjected to lateral restraint by said side walls to form a resulting block, means for moving said plunger away from said resulting block to release said pressure, means for moving said gate laterally to open an end of said chamber, a structure providing a passage for previously formed

blocks having an entrance adjacent said end and forming an endwise continuation of said chamber, and means to move said plunger to force said resulting block out of said chamber into the entrance of said passage and advance said previously formed blocks through said passage, said passage adjacent said entrance being of the same size in cross section as said chamber so as to maintain said lateral restraint on said resultant block while it is being forced out of said chamber and for a period of time while it is in said passage.

4. A press for making coherent blocks from wood flour in which blocks the fine fibrous particles of said flour are mechanically interlocked without an adhesive binder into a loose dry felted structure which is self-sustaining but which can readily be disintegrated to separate said particles, said press comprising a tubular structure having side walls forming a compression chamber of generally rectangular cross section with filleted corners, a laterally movable gate forming an end wall for said chamber, means for introducing a charge of said flour into said chamber, a plunger forming a movable end wall for the other end of said chamber, means for moving said plunger into said chamber to compress said charge between said end walls with sufficient pressure to effect said interlocking of said particles while said charge is subjected to lateral restraint by said side walls to form a resulting block, means for moving said plunger away from said resulting block to release said pressure, means for moving said gate laterally to open an end of said chamber, said gate having an opening therein registering with said end and of the same size in cross section as said chamber, a structure providing a passage for previously formed blocks having an entrance adjacent said end and forming in conjunction

with said opening an endwise continuation of said chamber, and means to move said plunger to force said resulting block out of said chamber into the entrance of said passage and advance said previously formed blocks through said passage, said passage adjacent said entrance being of the same size in cross section as said chamber so as to maintain said lateral restraint on said resultant block while it is being forced out of said chamber and for a period of time while it is in said passage.

5. An article of manufacture comprising a coherent block of sander dust from kiln-dried wood in which block the fine fibrous particles of said dust are mechanically interlocked without an adhesive binder into a loose dry felted structure which is self-sustaining but which can readily be disintegrated to separate said fibrous particles, the dust in said blocks being compressed in one direction while subjected to lateral restraint and said block having a density between approximately one-half and three-quarters of the density of the original wood.

References Cited in the file of this patent

UNITED STATES PATENTS

764,926	Dederick	July 12, 1904
963,955	Spoon	July 12, 1910
994,349	Updegraff	June 6, 1911
1,468,130	Angier	Sept. 18, 1923
1,625,066	Viersen	Apr. 19, 1927
2,043,366	Bech	June 9, 1936
2,367,103	Davis et al.	Jan. 9, 1945
2,571,618	Rundell	Oct. 16, 1951
2,575,672	Miller	Nov. 20, 1951
2,593,569	Kelley	Apr. 22, 1952
2,682,139	Cox	June 29, 1954