Feb. 12, 1935. R. T. BOWLING 1,990,632

METHOD OF MAKING BRIQUETTES

Filed Dec. 23, 1932 2 Sheets-Sheet 1

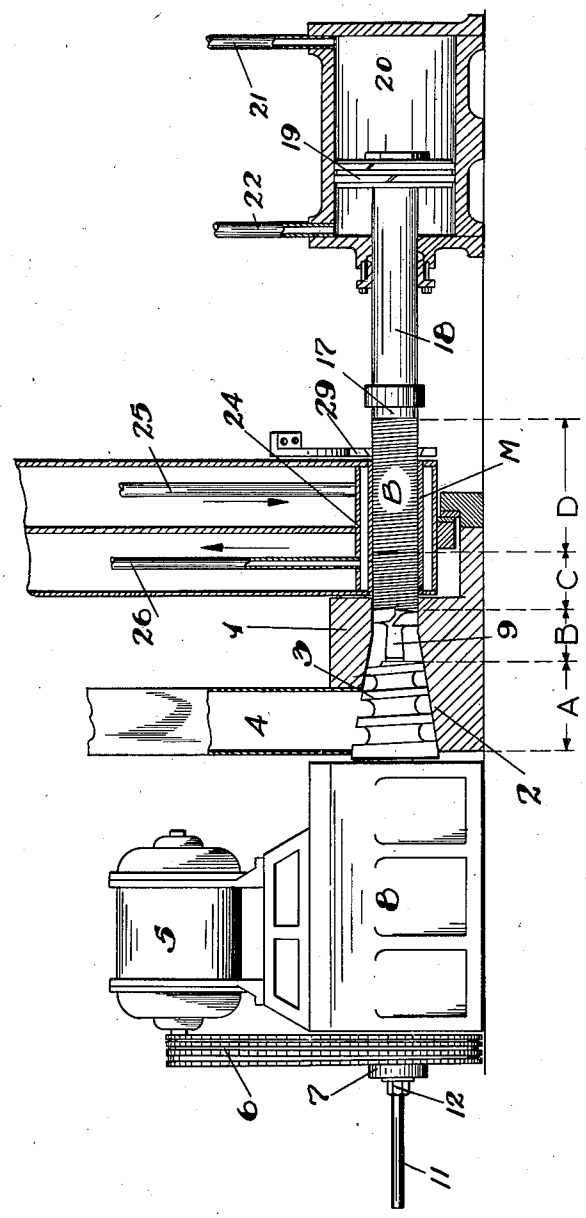


Fig. 1

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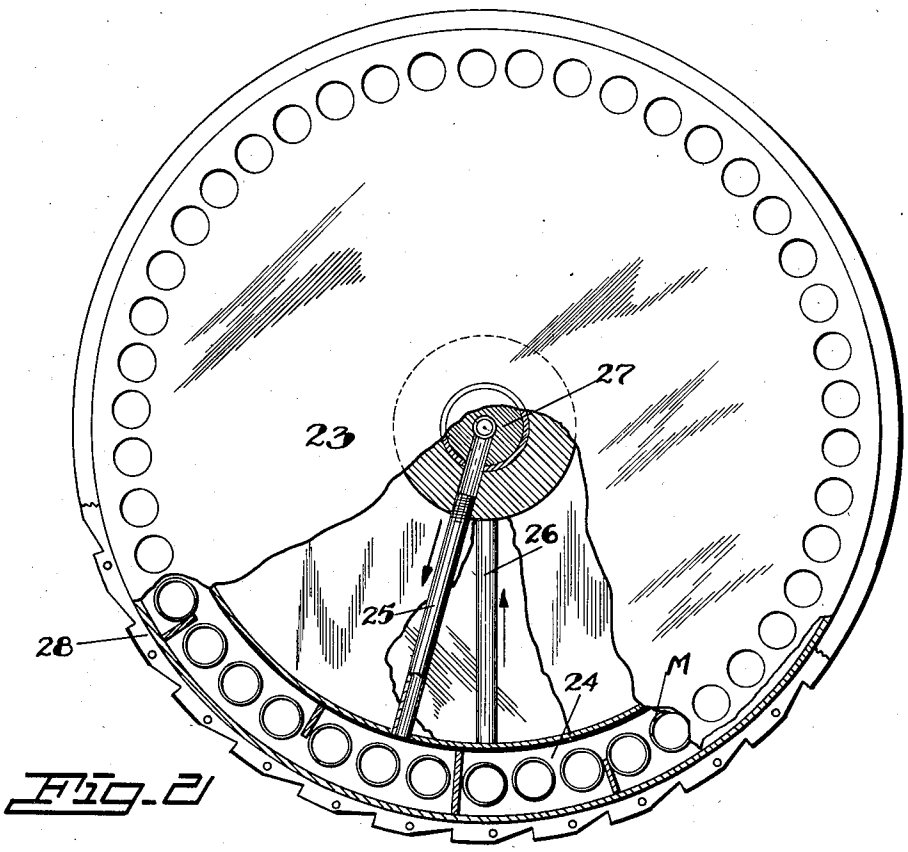


Fig. 2

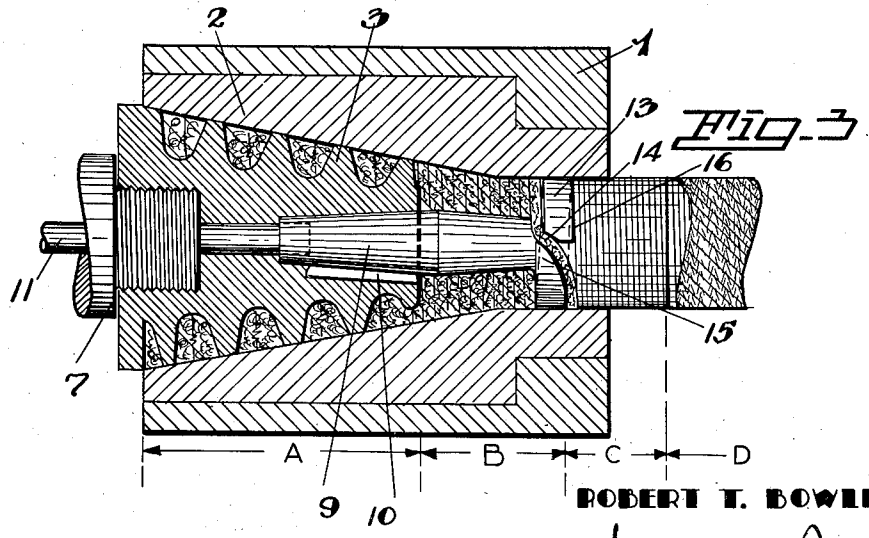


Fig. 3

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METHOD OF MAKING BRIQUETTES

Robert T. Bowling, Lewiston, Idaho, assignor, by mesne assignments, to Wood Briquettes, Inc., Lewiston, Idaho

Application December 23, 1932, Serial No. 648,604

5 Claims. (Cl. 44—10)

My present invention relates to an improved method of making briquettes from vegetable matter for use as fuel. In carrying out my invention I utilize saw dust, wood shavings, fibers, and other similar products, which are finely comminuted, and this comminuted material is compressed to form a solid, cylindrical briquette which possesses the required solidity to insure durability for commercial purposes, and which also possesses the necessary density to insure slow disintegration while burning.

Essentially, my improved process or method, involves a two-stage compression of the comminuted material, which I find to be necessary for the production of a briquette that fulfills the above requirements. By tests, experiments and actual practice, I have succeeded in overcoming difficulties, and I have solved problems, that formerly stood in the way of the manufacture of a commercially successful briquette of this character.

One of the difficulties encountered in the manufacture of the fuel briquettes by compression of the comminuted material in a mold for that purpose, particularly white-pine, white-fir, red-fir, and other cone-bearing or coniferous woods, is the natural resilience of the material, which heretofore has prevented the material from being properly compacted to insure durability. This difficulty I overcome by subjecting the material to a continuous compression during the time required for the manufacture of the briquette, which time is approximately twenty seconds for a five pound briquette.

Another problem which I have solved by the employment of my two-stage compression process for the material involves the creation of heat in the core, and in the briquette made from the core, due to friction caused by the pressure to which the comminuted material is subjected, and which forms the self-binder that is necessary to overcome the resilience of the material. The generated heat also tends to cause expansion of the material, while the briquette is in process of manufacture, and to overcome this tendency I subject the core from which the briquette is made, as well as the briquette itself, to a cooling step, which step is initiated while the core and the briquette are still held under compression, and which cooling step is continued thereafter during a period of time sufficient to cool the briquette.

The mixture of sap, resin, pitch, and other natural moisture or organic gummy substances present in the saw dust, is expressed from the particles of material, and this mixture is employed as an internal self-binder for the briquette.

In carrying out my two-stage compression process I employ the following steps, of finely comminuting or grinding the material while relatively dry; feeding and subjecting the material to a first compression; severing a ribbon or continuous lamination from this compressed mass; laying the ribbon in a spiral formation and simultaneously subjecting the spirally laid ribbon to a second compression to form a core; heating the compressed mass and the compressed core by internal friction to express moisture and thereby provide a self-binder; continuously subjecting the core to pressure during the formation of a briquette; fashioning the core into a briquette; cooling the briquette; employing the core in the step of delivering the completed briquette; and controlling the density of the briquette.

In order that my improved process may readily be understood I have disclosed in the accompanying drawings so much of a briquette-making machine as is necessary for the purpose, said machine forming the subject matter of an application for patent Serial Number 648,603 filed by me under date of December 23, 1932.

Figure 1 is a view partly in elevation and parity in section illustrating parts of the machine by means of which the steps of the process or method are accomplished.

Figure 2 is a view partly in elevation and partly in section of the water-cooled, rotary, mold-carrier, employed in the process of manufacturing the briquettes.

Figure 3 is an enlarged vertical, longitudinal sectional detail view showing the process of forming the compressed mass, the core, and the resulting briquette.

In Figure 3 I show a housing 1 with a stationary mold 2 therein which is of frusto-conical form to provide a tapered feed chamber A, and a first compression chamber B in which the material is first compressed into a compact, non-rotary mass. The core C is cut from this mass in a continuous spiral ribbon and the spiral ribbon or continuous lamination, by a second compression, is spirally laid to form the core that eventuates in the briquette D. A movable mold M is employed to provide part of the chamber in which the second compression takes place, and this mold is one of an endless series of molds employed in the formation and delivery of the briquettes D.

Within the tapered feed chamber A a rotary feed screw 3 turns, and is supplied with material through the vertical feed chute 4. The feed screw is revolved or rotated, intemittently, with power from a motor 5, through the belt-drive 6 to the screw-shaft 7, which shaft is journaled in bearings, including a thrust bearing, at 8 in Figure 1. The feed screw or spiral conveyer 3 is rigidly secured on the working end of the shaft, and as best seen in Figure 3 a double-tapered spindle 9 is keyed at 10 in a socket at the smaller

end of the feed screw. The shaft 7 is tubular to accommodate a clamp rod 11, which has a threaded portion and a nut 12, by means of which the spindle is drawn into and locked in its socket.

The free end of the spindle is provided with a compression head 13 in the form of a circular disk that is spaced a predetermined distance in advance of the smaller end of the feed screw to form the first compression chamber in which the compressed mass of material is formed at B. The material in this chamber B is compressed by the action of the feed screw, against the inner face of the compression head 13, and while both the feed-screw and the compression head revolve, intermittently, it will be understood that there is no movement of the compressed mass of material adjacent to the compression head, at any time. The material is "laid" in a thick ribbon by the tapered screw and as the material is expressed from the face of the screw it gradually loses its rotary movement. Thereafter the mass in its first stage of compression, is intermittently and gradually pressed, longitudinally, toward the rear face of the head 13, its volume reduced, and its density increased as the material nears the head. Thus, by the action of the tapered feed screw, in combination with the compression head, the first stage of compression of the material is accomplished, and a non-rotary, compact, mass of material is provided in the chamber B.

In Figures 1 and 3 it will be seen that the compression head is provided with a transversely arranged diagonal slot 14 that extends inwardly from its outer periphery to the spindle, and thence beyond the spindle to the center of the head, gradually merging with the front face of the head.

The rear face of the head is fashioned with a cutting edge 15 that projects slightly beyond the plane of the inner face of the head, and this cutter is employed, as the head revolves, to slice or cut from the stationary, compressed, mass of material in the first compression chamber B, a continuous ribbon, or spiral layer, which, while still compressed, and by action of the rotary compression head, is passed through the slot 14, from left to right in Figure 3.

The front face of the compression head 13 is a compression-face, and as indicated at 16 this face is in the form of a spiral or annular cam-face. Thus, as the ribbon passes through and emerges from the slot 14, the ribbon is "laid" by the action of the cam-face or compression face of the head, in spiral laminations to form the core C. This laying of the ribbon in spiral formation to form the solid core C is the second stage of compression, and the pressure exerted under this second compression is greater than that of the first compression.

Thus, in the formation of the core C, the feed-screw forms and compresses a spiral layer of the material of approximately one-half inch thick, into the first compression chamber to form the compact mass; then the cutter 15 severs a spiral ribbon of this compressed mass of approximately five-sixteenths of an inch in thickness, and by the second stage of compression this ribbon is pressed into spiral laminations of approximately one-eighth of an inch in thickness, as indicated in Figure 3.

During the first stage of compression, the material, from a free state, is gradually compressed against the compression head and the walls of the compression chamber, and due to friction created by this compression an internal heat is generated. During the second stage this compressed material is further compressed by means of the head 13 to a more solid density, and the internal heat thereby generated, due to friction, reaches a higher degree of temperature than that attained by the first compression.

The heat thus generated melts, dissolves, or thins the natural moisture content or natural organic gummy constituents of the wood so that the thinned moisture content under compression, is distributed over the entire area of the compressed material, including the spirally formed laminations that make up the core and briquette. This moisture content forms a self binder which becomes most effective when the briquette, still under compression, is cooled.

The second stage of compression of the core is accomplished against a yielding-resistance, which in this instance is produced by means of a gradually-decreasing, hydraulic pressure, that is exerted against a reciprocable head 17 which is alined, axially, with the feed screw and the compression head. The final compression is thus accomplished between a rotary compression head and a yielding-resistance head, and the yielding resistance of the reciprocable head, may be varied, to vary the density or solidity of the resulting core C and the briquette D.

As best seen in Figure 1 the yielding-resistance head 17 is mounted on the end of a reciprocable stem 18, which has a piston 19 reciprocating in the oil cylinder 20 that is provided with an outlet pipe 21 at one side of the piston and an oil inlet pipe 22 at the other side of the piston. The head 17, at intervals, or intermittently, and by positive mechanical action, is advanced toward the mold M, but stops short of the mold, then on its yielding-resistance or working stroke in the opposite direction the head 17 moves to the right in Figure 1 against the gradually-decreasing hydraulic pressure in the cylinder 20.

The mold M, forming part of the second-stage compression chamber, is one of an annular series of molds that are mounted in the circular, rotary, mold carrier 23, which is provided with a water jacket 24 enclosing the series of molds. This jacket is supplied with water through the inlet pipe 25 and the water flows from the jacket through outlet pipe 26, an axial feed through the carrier shaft 27, being indicated for circulation of water from a suitable source.

This mold carrier is intermittently rotated or revolved through the co-action of an annular rack or rack ring 28 with a ratchet mechanism, and, as indicated in Figure 1 a stationary trimming knife or cutter 29 is located adjacent the rotary mold for a purpose to be described. There are two of these knives or cutters employed, one at each side of the rotary mold, for trimming the opposite ends of the briquette D.

In the initial operation of the briquette making machine, all of the series of molds M are loaded with a dummy-briquette, that is, a solid, cylindrical, wooden block of the same size and shape of the briquette to be manufactured, is placed in each mold M.

The rotary mold carrier is turned, intermittently, to bring each succeeding block in a mold to the lowermost station of the carrier, and thus each block is successively brought into axial alinement with the rotary compression head and the yielding-resistance compression head. As a successive core C is lengthened into a briquette D, the dummy-blocks are successively discharged from the carrier, until all of the blocks have been

replaced by briquettes D. Then the lowermost briquette D in its mold M is clamped, between the forward end of the core C and the adjoining face of the reciprocating head 17 while the latter is in advanced position. As the rotary compression head lays the spiral lamination to form the core C and thereby increases the length of the core, the latter gradually forces the briquette D, against the yielding resistance of the head 17, from its mold M, and the completed briquette D, after having been moved to position free from the carrier, drops to a waiting receptacle, or is disposed of in other suitable manner.

When the core C has displaced the briquette D, the former occupies the mold M and at that time the rotary mold carrier is moved one step to bring a succeeding mold and briquette into alinement with the two compression heads 13 and 17, and a succeeding briquette is fashioned.

As the carrier revolves, it carries the briquettes in their molds successively past the knives 29 which trim off the opposite ends of the briquettes to insure a uniform length for the completed briquettes.

Thus it will be apparent that after the briquette has been fashioned in its mold M, the briquette remains therein during one complete revolution of the carrier, before the briquette is removed from the mold. During this revolution of the carrier the briquette is cooled, by the circulation of water through the water jacket and in contact with the enclosed mold, and at the time for delivery of the completed briquette, the latter is properly cooled to insure its density and solidity.

It will be understood that the motor 5, and the other prime movers, employed to rotate the carrier and reciprocate the head 17, respectively, are all controlled, as by electrical devices, so that the intermittent movement of the rotary screw and its compression head; the rotary movement of the mold carrier; and the reciprocating movement of the head 17, are produced at synchronized intervals, thus insuring that the operation of the machine is automatic, and the production of successive briquettes is accomplished with regularity and dispatch.

Apparatus other than the two-stage compression machine illustrated might be employed in pressing and feeding the material, the pressure of the second-stage, particularly, being of such high degree as to internally heat the core by friction and to express the moisture as oil, resin, pitch &c. to form an internal binder which permeates the entire core and briquette to form a solid and dense block.

Thus it will be evident that a high degree of pressure is positively applied to the rear end of the core C, and a yielding resistance or gradually receding pressure is applied to the outer end of the briquette D. If a maximum density or solidity is desired for the completed briquette, the hydraulic pressure back of the hydraulic piston is increased to a maximum degree below the positive pressure on the core, and this hydraulic pressure is maintained in order that the briquettes may be of uniform density. If a less dense or solid briquette is desired, the hydraulic pressure back of the hydraulic piston is decreased in order that the reciprocating head may oppose the pressure from the rotary head with less resistance, but in such case the yielding resistance is also uniform, in order that the density of the successive briquettes may be uniform in character.

Thus the yielding resistance and consequent compression, while sufficient to overcome the resistance or resiliency of the material, may be varied to suit different kinds of wood employed in making the briquettes; also to conform to the degree of moisture in the different kinds of wood; and also to regulate the friction and consequent heat created or generated within the mass, the core, and the briquette, in the formation of the self-binder.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The continuous process of making a solid briquette from comminuted woody material which consists in compressing and maintaining the material under pressure in a compact block, simultaneously severing a continuous strip from one end of the block and laying the strip in spiral laminations to form a core, and simultaneously applying pressure to the laminated core to form a solid briquette.

2. The continuous process of making a solid briquette from comminuted woody material which consists in compressing and maintaining the material under pressure in a compact block, simultaneously severing a continuous strip from one end of the block and laying the strip in spiral laminations to form a core, simultaneously applying pressure to the laminated core to form a solid, briquette, and initiating cooling of the briquette while it is still under compression.

3. The continuous process of making a solid briquette from comminuted woody material which consists in compressing and maintaining the material under pressure in a tubular compact block, simultaneously severing a continuous strip from one end of the block and laying the strip in spiral laminations in a mold to form a core, and simultaneously applying a greater degree of pressure to the laminated core to form the solid briquette.

4. The continuous process of making a solid briquette from comminuted woody material which consists in compressing and maintaining the material under pressure in a tubular compact block, simultaneously separating a continuous strip from one end of the block and laying the strip in spiral laminations in a mold to form a core, and simultaneously applying pressure to one end of the core and a yielding resistance to the other end of the core to form the solid briquette.

5. The continuous process of forming a solid cylindrical briquette from comminuted woody material in its natural state under a pressure sufficient to create friction and generate internal heat thereby converting the moisture content of the material to a natural binder, which consists in compressing and maintaining the material under pressure in a compact block, simultaneously separating a continuous strip from one end of the block and laying the strip in spiral laminations to form a core, simultaneously applying a greater pressure at opposite ends of the core to form a solid briquette, and finally initiating the cooling of the briquette while still under pressure.

ROBERT T. BOWLING.