Feb. 23, 1943. B. GROB 2,311,940

BRIQUETTING MACHINE

Filed March 16, 1936 2 Sheets-Sheet 1

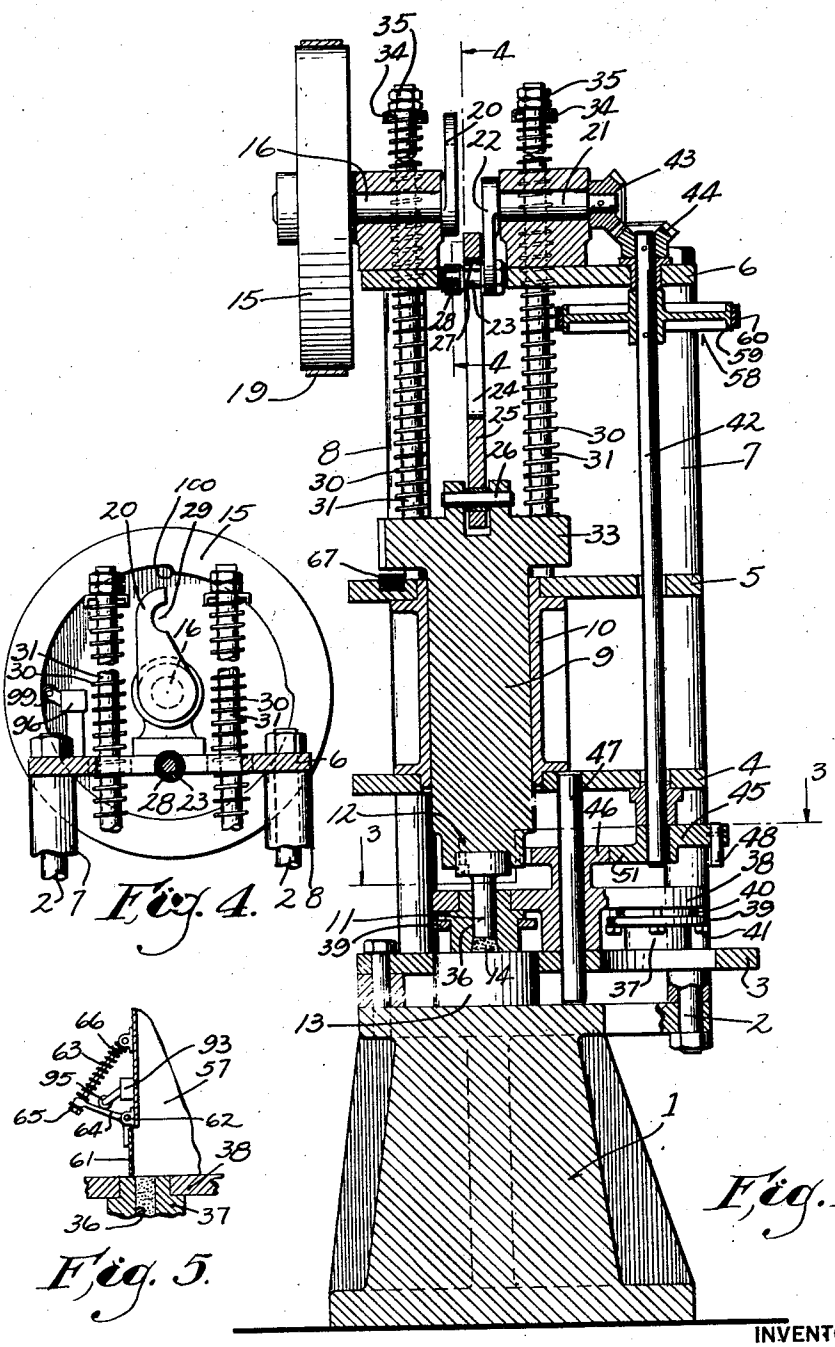


Fig. 1.

Fig. 4.

Fig. 5.

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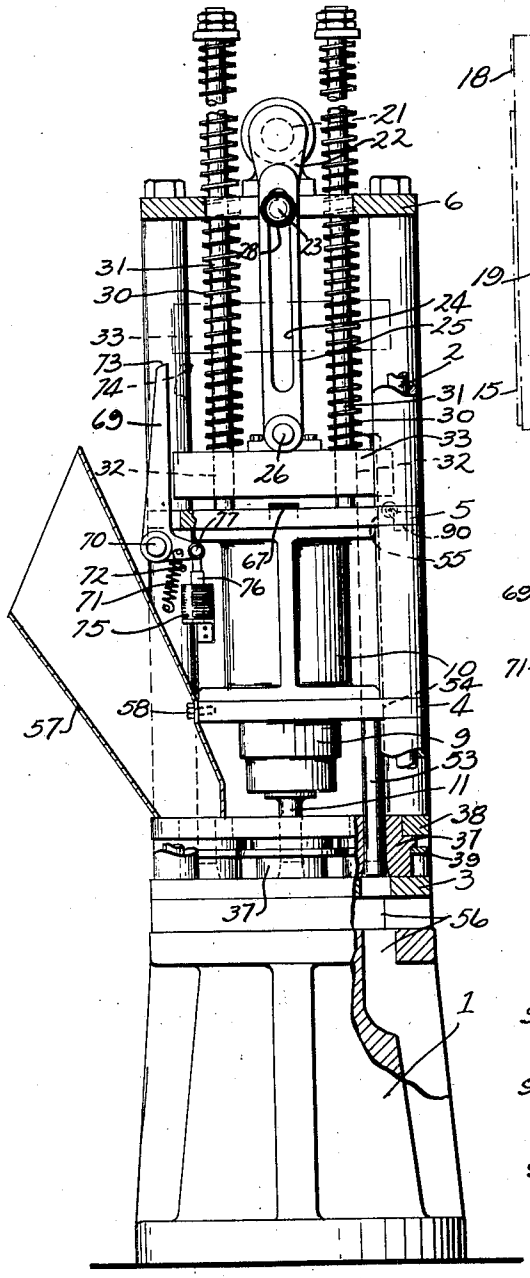


Fig. 2.

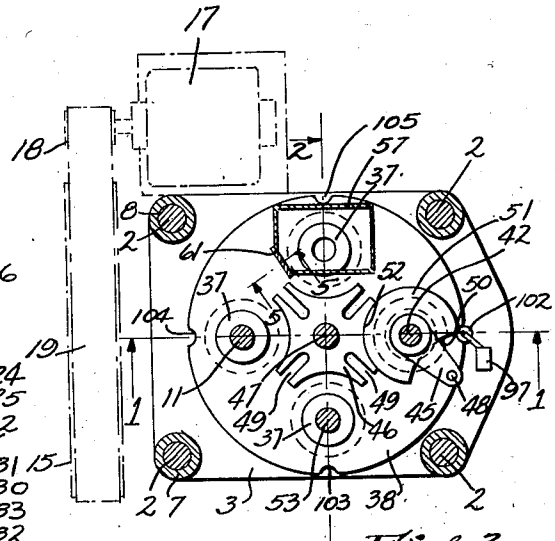


Fig. 3.

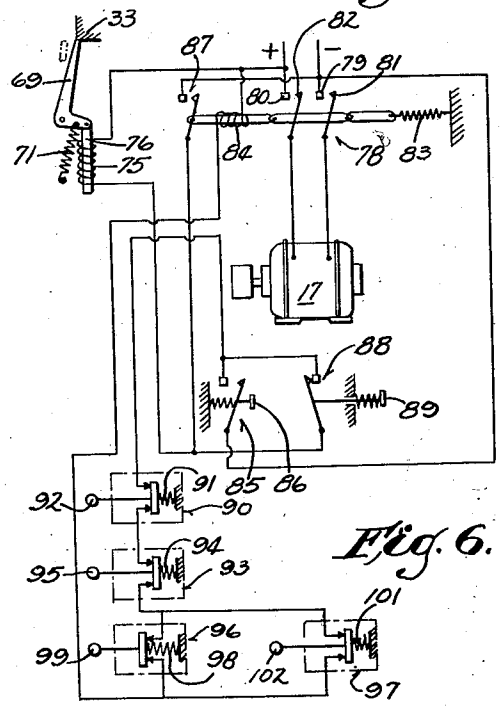


Fig. 6.

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UNITED STATES PATENT OFFICE

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BRIQUETTING MACHINE

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Application March 16, 1936, Serial No. 69,246

14 Claims. (Cl. 78—13)

This invention relates to briquetting. More especially the invention relates to a machine and method for forming solid briquettes from relatively finely divided metal particles, as for instance the cast iron chips resulting from turning, planing or drilling of cast iron.

In the past briquettes of such materials have been formed in machines involving high pressure pumps, or accumulators, as for instance in hydraulically operated presses operating after the manner of bailing machines. Such methods involve very heavy and expensive machines, in part by the necessity for providing framework for the reaction of the sustained high pressures and in part by the necessity for driving means and other members capable of withstanding heavy delivery of power over considerable periods of time.

It has been found, however, that the energy required for the briquetting of metal chips or particles is best and most economically provided by a sudden blow such, for instance, as may be delivered from a tool carried by a following body or weight upon striking an anvil. The compression of loose metal particles into a solid briquette requires little expenditure of energy until almost at the final instant of the compression, following which the energy required increases very rapidly to maximum.

One of the purposes of the invention is to provide a very simple, compact and efficient machine which will deliver energy in successive strokes substantially as required for briquetting of materials or for purposes having similar power absorbing characteristics, while receiving energy from a primary motion source at a very low and relatively constant rate. Another purpose is to provide an improved briquette formed of metal particles in an improved and novel manner. Still other purposes will be apparent from this specification.

The invention consists in the construction and arrangement of the parts herein illustrated, described and claimed, and in such modifications of the structure illustrated and described as may be equivalent to the structure of the claims, a variety of such modifications being contemplated as within the scope of the invention.

Similar reference characters have been used throughout each of the several views of the drawings in which:

Figure 1 is a vertical section through a machine incorporating the invention, the section being taken approximately along the line 1—1 of Fig. 3.

Figure 2 is a view of the machine partly in section, the sectioned portions being taken approximately along the line 2—2 of Fig. 3.

Figure 3 is a horizontal section through the machine taken approximately along the line 3—3 of Fig. 1.

Figure 4 is a partial vertical section, taken approximately along line 4—4 of Fig. 1.

Figure 5 is a partial section taken approximately along line 5—5 of Fig. 3 and enlarged.

Figure 6 is a more or less diagrammatic view showing the relative operating arrangement of certain control mechanism of the machine.

The machine, as here shown, is a briquetting machine which includes a base 1 to which are rigidly fixed four laterally spaced similar vertical rods 2, 2, etc. A number of vertically spaced plates 3, 4, 5, 6 are provided with suitable holes for the rods 2, and are located vertically by suitable tubular spacer elements such as 7, 8 between the plates and carried by the rods 2. A weight or ram 9 is vertically movable in a guide or slide 10 and at its lower end carries a briquetting tool or hammer 11, suitably fixed with the ram as by screws 12. Fixed in plate 3, and solidly seated on base 1 there is an anvil or abutment 13 against which tool 11 may react to compress a briquette, such as 14.

The ram 9, together with tool 11, is alternately raised and dropped by mechanism as follows: A fly wheel pulley 15 fixed on a shaft 16 is driven from a motor, such as 17, through a pulley 18 and belt 19. Also fixed on shaft 16 is a crank 20. A shaft 21, co-axial with shaft 16 has fixed thereon a crank 22 carrying a crank pin 23 which extends through a vertical slot 24 in a lifting rod 25 pivoted at 26 with the ram 9. In the downward position of crank 22 and of tool 11 the upper end of slot 24 clears the crank pin 23, as at 27.

The end of crank pin 23 carries a member 28 preferably of shock absorbing material, such as rubber. At each revolution of shaft 16 an open side socket portion 29 of crank 20 engages the member 28 and turns crank 22 to lift ram 9, the crank pin 23 then engaging the upper end of slot 24 to lift the ram through the rod 25. But after reaching the upper position of crank 22 the open side of socket 29 will permit the crank 22 to travel ahead of crank 20 and this occurs almost immediately after crank 20 passes its upper center, the weight 9 then moving quickly downward to deliver a blow of the tool 11, and the downward movement being materially assisted by springs such as 30, of which there are four, spaced lat-

erally on posts such as 31, which extend through suitable bores such as 32 in the upper flange 33 of ram 9, the posts being fixed at their lower end in the plate 5. Springs 30 are compressed during upward movement of ram 9 and rest at their one end against the upper surface of the flange 33 of ram 9, and at their upper end abut against washers such as 34, retained by nuts 35 on the posts 31. By the described mechanism, at each revolution of the crank 20, the ram 9 and tool 11 are first lifted at a speed dependent upon the speed of fly wheel 15, and then released for the tool 11 to deliver a hammer blow against the work material. By reason of the crank action the start of the up movement is relatively very slow, and the fly wheel furnishes inertia to provide power at the intermediate, high speed portion of the up stroke, whereby motor 17 may be of relatively low, constant power capacity.

At the lower end of its stroke the tool 11 enters bores such as 36 of block or die members such as 37, of which there are four, fixed on an index plate 38, and equally spaced, for index movement one after another to a position underneath the tool 11, the members 37 being removably fixed on the plate by the means of clamp rings such as 39 engaging a flange 40, and retained by screws, such as 41.

Indexing mechanism for plate 38 is connected for operation from shaft 21, as follows: A vertical shaft 42 is driven from shaft 21 through bevel gears 43 and 44 and carries, at its lower end, the driving crank 45 of a four position Geneva motion device having a driven member 46 fixed with index plate 38 to revolve on a stud 47, and a driving pin 48 fixed with the crank 45 to engage slots 49 of the member 46. During the major portion of the revolution of crank 45 the member 46 and index plate 38 are locked against rotation by the engagement of flange member 51 with complementary surfaces such as 52 on the member 46.

The indexing mechanism is arranged for the shaft 42 to make one revolution for each revolution of the crank 22, and to index the plate 38 one quarter turn at each stroke of the ram 9, thus moving the block members 37 successively underneath the tool 11, the indexing motion being so timed that, following the disengagement of the tool 11 from the block member 37 during upward movement, and prior to the start of the next drop of the tool 11, a new block member 37 is positioned to be entered by the tool.

In addition to the tool 11, the ram 9 also has fixed therewith a knock-out punch or member 53, which is fixed with the upper flange 33 of ram 9 and suitably guided in bores 54, 55 respectively in the plates 4 and 5. The knock-out punch 53 is positioned to enter the bore of the block members 37 in the next succeeding index position of the members after the operation of the tool 11. Punch 53 extends materially below the lower surface of the tool 11, and therefore will operate upon the briquettes 14 compressed by the tool 11 to force them out of the blocks 37, there being a downwardly opening channel 56 provided through the plate 3 and in the base 1 through which the finished briquettes are dropped.

In order to continuously fill the bores 36 of the blocks 37 with work material to be operated upon by the tool 11, a hopper 57, of suitable form and capacity, is supported as for instance from the plate 4 by screws 58, in a position to deliver work material to the bores 36 in the indexing position of the blocks 37 immediately preceding the position in which tool 11 operates. The work material moves downwardly by gravity to fill the bores 36, being materially assisted in this movement by the jarring motion at each descending movement of ram 9, which also tends to pack the material closely in the bore of the block, and in the next indexing movement the lower edge of the hopper wall scrapes off the excess work material to deliver the blocks 37 to the position operated upon by tool 11 substantially filled with the material, the next following operation of the tool 11 compressing the material into closely homogeneous briquette form as at 14. It will thus be seen that so long as the hopper 57 contains the material to be operated, briquettes will be formed one after another and delivered downwardly through the channel 56, a briquette being formed at each downward stroke of the tool 11, and the speed of production being limited only by the speed at which the ram 9 can be reciprocated.

A brake, generally denoted by the numeral 58 is added to the index shaft 42 to reduce any tendency to overrun. Brake 58 includes a brake drum 59 and a brake band 60, the band being prevented from rotating and being frictionally engaged with the periphery of the drum 59 by springs, not shown, or in any suitable manner.

The hopper 57, in the direction of the index station at which the tool 11 operates, is provided with a hinged door or member 61, pivoted at 62 and normally restrained in the position shown in Fig. 5 by the pressure of a spring 63, there being a member 64 fixed with the door member 61, and normally forced by spring 63 against stop nuts 65 on a pivoted bolt 66. The purpose of the door 61 is to provide a member which is yieldable in the event that foreign material, too large to be formed into a briquette, or otherwise unsuitable for the purpose of the machine, should be inadvertently mixed with the material in the hopper 57. If such foreign material should drop down into the blocks 37 it will do no harm, but if it should lodge in a manner to project over the edges of the die the descending tool 11 might damage the tool or the blocks, unless prevented. Any foreign material so lodged would swing the door 61, operating trip mechanism to stop the machine, as later described.

Should the hopper 57 become empty of the material to be briquetted, whereby no material enters the blocks 37, the descent of the ram 9 might damage the tool 11 or the anvil 13, unless prevented. To avoid such damage a resilient buffer or bumper 67 is fixed with the plate 5 and projects sufficiently above the plate to abut the flange 33 of the ram 9 before the descending tool 11 would contact the anvil 13.

Various control and safety devices are provided as follows:

A dog member 69 pivoted to the frame at 70 is continuously urged by a spring 71 in the direction of a stop pin 72. When resting against the stop pin 72 the upper end 73 is in the dotted line position shown at 74, Fig. 2, and the member 67 would then prevent the descent of the ram 9 by the engagement of the flange 33 therewith. During operation of the machine the member 69 is continuously maintained in the full line position shown in Fig. 2 by the means of a solenoid 75, the core 76 of which is pivoted with the member 69 at 77.

Referring to Fig. 6, current is supplied to the motor 17 through a solenoid controlled main switch generally denoted by the numeral 78, which includes main line contacts 79, 80 com-

plementary to contacts 81, 82 which lead to the motor and are movable in the direction to open the contacts by the means of a spring 83, but may be moved in the other direction to close the motor circuit by a solenoid 84. The circuit for solenoid 84 may be temporarily closed to start the motor 17 by the means of a normally open switch 85, operated by a push button 86. When switch 85 is closed the solenoid 84 is operative, thus closing switch 78 to operate motor 17, and at the same time closing a switch 87, which will then remain closed to complete the circuit through solenoid 84 irrespective of the position of switch 85, which may then be released by the operator, the motor continuing to run. For manual control of the stopping of the motor, there is provided a switch generally denoted by the numeral 88. Switch 88 is normally closed, but can be opened by a push button 89 which opens the circuit of solenoid 84, whereupon spring 83 opens motor switch 78 to stop the motor.

The solenoid 75, operating the latch or dog 69, is also connected, as shown in Fig. 6, to receive current through the switches 85, 87, 88 in the manner described for the solenoid 84. Solenoid 75 will therefore receive current at all times when the motor is receiving current, but at other times, when main switch 78 is open or when the main line power fails, solenoid 75 will be inoperative and latch 69 will stand in the full line position shown in Fig. 6, thereby engaging the flange 33 to prevent downward movement of the ram 9.

In addition to the several switches 85, 87, 88 controlling the solenoids 75 and 84 as described, there are also other switches, which are normally in a position for the solenoids to operate as previously described, but which operate under certain conditions to interrupt the main switch 78 and move cam 69 to the position shown in Fig. 6, as follows:

A switch unit generally denoted by the numeral 90, Figs. 2 and 6, includes contacts normally closed by a spring 91, but which may be opened by pressure on an exposed operating element 92. Switch 90 is positioned for the element 92 to be operated to open the switch in the event that the ram 9 descends sufficiently far to contact the bumper or buffer 67, as for instance in the event there is no material in die 37 to form a briquette, as when hopper 57 is empty. Since current for solenoids 84 and 75 passes through switch 90, as shown in Fig. 6, the opening of switch 90 will stop the motor, and simultaneously position dog 69 to retain the ram in its uppermost position.

Another switch 93, Figs. 5 and 6, also provides contacts normally closed by a spring 94, and an exposed operating member 95 positioned to be contacted in the event that the hopper door or gate 61 is swung open by foreign material during the indexing of the blocks 37, as previously described. Similarly to the operation of the switch 90, opening of switch 93 will deenergize solenoids 84 and 75 whereby to stop the motor and simultaneously position dog 69 to prevent the next downward stroke of ram 9.

A pair of switches, consisting of the switch 96, Figs. 4 and 6, and switch 97, Figs. 3 and 6, cooperate to interrupt operation of the machine in the event that the indexing movement fails to correctly position the blocks 37. The switch 96 provides contacts normally opened by a spring 98, and an exposed contact member 99 positioned to be operated to close the switch 96 by a cam portion 100 fixed on the inner rim of the fly wheel pulley 15, the cam 100 being of a forward position relative to the crank 20 such that the switch 96 is closed only during the time in which indexing normally takes place. Thus the switch 96 is always closed during an indexing movement and open at other times. The switch 97 provides contacts urged to closed position by a spring 101 and an exposed operating member 102 positioned to be moved to open the switch by the movement of the index plate 38, the rim of the plate acting as a cam for opening switch 97 during movement of the plate from one to the other index position. When the plate 38 stands in correct indexed position the switch operating member 102 drops into one or another of the depressions 103, 104, 105, etc., and the switch 97 is then closed. It will be apparent that if for any reason the indexing is not completed during the time that switch 96 remains closed, then both the switches 96 and 97 will be open, interrupting the current to the solenoids 75 and 84, whereby to stop the motor 17 and position the dog 69 to prevent the next succeeding downward stroke of ram 9. So long as the indexing is normally completed one or the other of the switches 96 or 97 will be closed at all times whereby to complete the circuits of solenoids 75 and 84 and to permit continuous operation of the machine.

It will be understood that suitable modifications in the electrical control mechanism, operative in the manner stated are contemplated to suit various types of motor and line current employed for the operation of the machine.

By the mechanism here disclosed, briquettes of substantially any desired diameter, according to the size of the machine, may be extremely rapidly formed from any suitable material, it being only required that the operator maintain work material in the hopper of the machine. Thus one operator may attend a considerable number of machines, particularly by reason of the control features explained. Certain of the mechanism as here illustrated in a briquetting machine is also contemplated for a variety of other purposes as previously stated.

Briquettes of metal particles such as are produced by the machine here disclosed, have novel characteristics which are particularly useful in the melting of the material. If small metal particles are loosely placed in a melting furnace the particles will be oxidized before melting to such extent as to be substantially completely wasted. The product of this machine however is a briquette having a skin or surface which is substantially the equivalent of solid metal, and little or no oxidizing can take place on this surface during the heating to melting temperature. At the same time the interior material is still relatively loosely arranged. This is principally because of the novel hammer-like characteristics of the briquetting pressure whereby the material in the interior does not have sufficient time to rearrange its particles into minimum space. However, once the melting has started on the exterior of a briquette formed in this machine, it will proceed relatively rapidly, comparable in speed to the melting of fine particles, yet without oxidizing, because the exterior skin of molten metal prevents contact with air. It is obvious that the provision of a relatively very closely compacted skin and loosely compacted interior, as in the briquettes formed in this machine, will result in considerable saving in

time and cost of melting as compared with previous briquettes.

Moreover the briquette formed in the machine here shown requires relatively much less time and power for its formation, as compared with a briquette which is substantially equally compressed throughout. Where the briquetting is done by relatively slow action devices, such for instance as hydraulic or toggle presses, there is little or no difference in the density of the surface skin and the inner material, and the result is that, in order to obtain sufficient surface density, sufficient time and power must be used in such machines to compact the entire body of particles to substantially the surface density.

For these reasons the machine and method herein disclosed operate with considerably saving of both time and power to effect a briquette having novel characteristics, and the briquette thus formed effects considerable savings in the time and cost of subsequent melting. It will be understood that so far as concerns the novelty of the method and product, a briquette of the characteristics mentioned, may be formed in a variety of different machines, or even by suitable hand tools, such as a sledge hammer, used with a suitable punch, die and anvil.

What is claimed is:

1. In a briquetting machine of the percussion blow type including tool and anvil means and means for relative reciprocation thereof to effect a continuous series of percussion blows of the tool in the direction of the anvil, the combination of movable means providing a series of apertures for material to be briquetted, indexing means for successive movement of said apertures one after another to a position to receive said tool during said percussion blows, and timing means predetermining a single percussion blow during the tool receiving position of each aperture.

2. In a briquetting machine, the combination of an anvil, a ram vertically moveable above said anvil, a tool driven toward said anvil by downward movement of said ram, mechanism for effecting alternate upward and downward movement of said ram, means providing a succession of openings adapted to receive briquetting material, indexing mechanism for intermittently moving said means during movements of said ram to bring said openings successively into tool receiving position over said anvil, means for retaining said ram in elevated position, said last named means being normally ineffective, means for delivering briquetting material to said openings successively, a movable gate normally positioned to remove excess material from successive openings during indexing movement, and means responsive to movement of said gate for rendering said normally ineffective means effective to retain said ram in elevated position.

3. In a briquetting machine, the combination of an anvil, a ram vertically moveable above said anvil, mechanism for elevating said ram and automatically releasable to effect free downward movement of the latter toward said anvil, a tool driven by downward movement of said ram, means providing a succession of material receiving openings, indexing mechanism operable during ram movements for bringing said openings successively into tool receiving position over said anvil, means for retaining said ram in elevated position, said last named means being normally ineffective, means for delivering material to said openings successively, and means responsive to excessive filling of any of said openings for rendering said normally ineffective means effective to retain said ram in elevated position.

4. In a briquetting machine, the combination of a vertically movable ram, mechanism for elevating said ram and automatically releasable to effect free downward movement of the latter, a tool driven by downward movement of said ram, a plurality of work receiving cavities, indexing mechanism intermittently operable during ram movements for presenting said cavities successively beneath said tool, means for supplying material to said cavities, and means controlled by excessive filling of any of said cavities for interrupting ram movement.

5. In a briquetting machine, the combination of a vertically moveable ram, mechanism for elevating and releasing said ram to effect free downward movement of the latter, a briquette forming chamber and coacting tool relatively actuated by downward movement of said ram, and means responsive to excessive filling of said chamber for interrupting ram movement.

6. In a briquetting machine, the combination of a plurality of briquette forming chambers, means including a reciprocable ram for compressing briquette forming material in said chambers, power driven means for effecting retractive movements of said ram from said chambers, other means for effecting accelerated advance movements of said ram toward said chambers to compress the material therein, indexing means intermittently operable to bring said chambers successively into coacting relation with said ram, and timing means coacting with said indexing means to effect a single percussion blow against the material in each forming chamber.

7. In a briquetting machine, the combination of a plurality of briquette forming chambers, means for delivering briquette forming material thereto, means including a vertically reciprocable heavy ram above said chambers for compressing the material therein, indexing mechanism intermittently operable to position said chambers successively in coacting relation with said ram, and means operable in timed relation with said indexing mechanism for elevating and releasing said heavy ram to effect free gravitational movement thereof toward each positioned coacting chamber thereby to utilize the kinetic energy in said falling heavy ram to compress the material in said last named chamber into briquette form.

8. In a briquetting machine, the combination of a plurality of briquette forming chambers, means for delivering briquette forming material thereto, means including a vertically reciprocable ram above said chambers for compressing the material therein, means for intermittently elevating and releasing said ram to effect free gravitational movements thereof, means for accelerating said gravitational movements, indexing mechanism operating in timed relation with said ram movements for positioning said chambers successively in coacting relation with said ram, means operable to retain said ram in elevated position, said last named means being normally ineffective, and means for rendering said normally ineffective means effective to retain said ram in elevated position upon failure of said indexing mechanism to properly position a positioned chamber relative to said ram.

9. In a briquetting machine, the combination of a plurality of briquette forming chambers, means for delivering briquette forming material thereto, means including a vertically reciprocable

ram above said chambers for compressing the material therein, indexing mechanism intermittently operable to position said chambers successively in coacting relation with said ram, means operable in timed relation with said indexing mechanism for elevating and releasing said heavy ram to effect free downward movement thereof toward a positioned chamber, and means for interrupting ram movement upon failure of said indexing mechanism to properly position a positioned chamber relative to said ram.

10. In a briquetting machine, the combination of a plurality of briquette forming chambers, means for delivering briquette forming material thereto, means including a reciprocable ram for compressing the material therein, indexing mechanism intermittently operable to position said chambers successively in coacting relation with said ram, means for effecting reciprocation of said ram in timed relation with said indexing mechanism, and means for interrupting ram movement upon failure of said indexing mechanism to properly position a positioned chamber relative to said ram.

11. In a briquetting machine, the combination of a briquette forming chamber, means for delivering briquette forming material thereto, means including a reciprocable ram for compressing the material therein, power driven means for repeatedly reciprocating said ram, means automatically operable to arrest movement of said ram, said means being normally ineffective, and means responsive to an inadequate supply of material to said chamber for rendering said normally ineffective means effective to interrupt reciprocation of said ram.

12. In a briquetting machine, the combination of a briquette forming chamber, means including a vertically reciprocable ram above said chamber for compressing briquette forming material therein, means for repeatedly elevating and releasing said ram to effect material compressing gravitational movements thereof, and means responsive to an inadequate supply of material in said chamber for interrupting ram movement.

13. In a briquetting machine, the combination of a briquette forming chamber, means including a vertically reciprocable ram above said chamber for compressing the material therein, means for repeatedly elevating and releasing said ram to effect material compressing gravitational movements thereof, and means responsive to an inadequate supply of material in said chamber for interrupting ram movement, said last named means including an element positionable to support said ram in elevated position.

14. In a briquetting machine, the combination of a plurality of briquette forming chambers, means for delivering briquette forming material thereto, means including a reciprocable ram for compressing the material therein, indexing mechanism intermittently operable to position said chambers successively in coacting relation with said ram, means for reciprocating said ram in timed relation relative to said indexing movements, and means responsive to an inadequate supply of material to said chambers for interrupting reciprocation of said ram.

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