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METHOD AND APPARATUS FOR CONTROLLING THE COMPOSITION AND SUPPLY OF SOLID CARBONACEOUS MATERIAL AND LIQUID BINDING MATERIAL TO A BRIQUETTING PRESS

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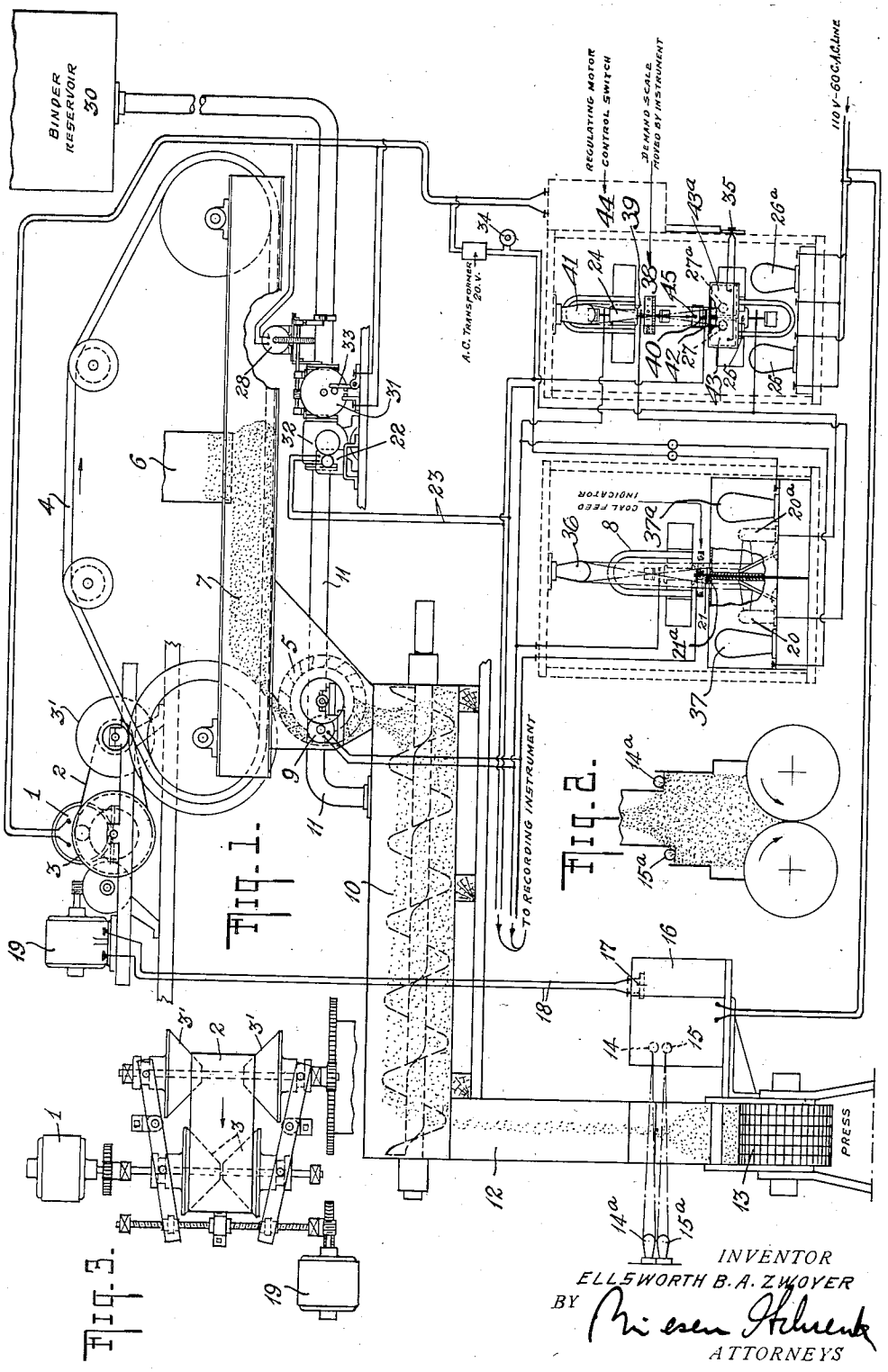


Fig. 1.

Fig. 2.

Fig. 3.

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METHOD AND APPARATUS FOR CONTROLLING THE COMPOSITION AND SUPPLY OF SOLID CARBONACEOUS MATERIAL AND LIQUID BINDING MATERIAL TO A BRIQUETTING PRESS

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12 Claims. (Cl. 44—10)

The invention relates to methods and apparatus for automatically controlling in a uniform manner the supply of a briquette mixture to a briquetting press. The invention will be described with particular reference to a briquette mixture which comprises carbonaceous material of the order of anthracite coal and a binder therefor of the order of coal tar pitch or sulphite pitch and molasses and to a briquetting press, of a type such as shown in the Zwoyer Patent No. 1,627,222.

Heretofore it has been customary in making coal briquettes to prepare a mixture of the fuel and the binder and to manipulate said mixture in a mixer, masticator, or otherwise, until the mixture is ready to be introduced to the briquetting press itself. It was found that the briquetting press required a fairly constant head of briquette material in order to function satisfactorily. If there was not sufficient head, the briquettes as formed in the molds of the press were not sufficiently dense while if the head was greater than necessary, the material would not be properly compressed in the press pockets or molds. It was, however, very difficult to maintain a uniform head of briquette material or to depend on human labor to maintain such a head and the present improvements were accordingly devised as a remedy for this situation and to permit the head of briquette mixture to be automatically maintained at a constant predetermined height.

Apparatus capable of use in connection with the new process is shown in the drawing in which Fig. 1 is a diagrammatic elevation of the entire apparatus with parts in vertical section; Fig. 2 is a diagrammatic view in the nature of a vertical section, looking toward the lamps of Fig. 1, and Fig. 3 is a detailed plan view of the motor and variable speed transmission.

In the drawing the motor 1 operating through a variable speed transmission, such as illustrated in Fig. 3, drives the coal conveyor 4 via the belt 2 running over the cone pulleys 3 and 3' of the variable transmission device in the direction of the arrow shown in Fig. 1. The coal conveyor is an endless conveyor which delivers coal to the wheel 5 in quantities proportional to the speed of the wheel 5. The coal fines enter at 6 and at 7 accumulate for continuous removal by the conveyor 4 at a rate corresponding to the rate of progression of said conveyor. The wheel 5 is of the water turbine type and is operated in an over-shot manner by the coal fines which are delivered to it by the conveyor 4. Connected with and operated by the wheel 5 is a tachometer generator 9, the output current of which is used to energize an electric meter or indicator 8 suitably connected thereto and adapted to register said current in terms of pounds per minute. As the amount of current generated by the tachometer generator 9 is proportional to the speed at which the wheel 5 is rotated by the flow of coal from the conveyor 4, the amount of coal passed along by the wheel 5 is registered on the indicator 8. The wheel 5 delivers the coal to the mixer 10 wherein the coal meets binder material flowing in through the conduit 11, the coal and the binder being thoroughly intermingled while passing through the mixer. From the mixer the briquette mixture can be treated in a masticator (not shown) or it can be fed directly into the press hopper 12. The briquetting press 13 should not be in operation until the briquette mixture in the hopper 12 makes contact as it might be called, with the photo-electric cells 14 and 15 in the photo cell amplifier 16; in other words, until a situation such as indicated in Fig. 2 is reached. At this moment the press 13 is put in motion. The head of briquette mixture in the hopper 12 is established by the location of the photo-electric cell amplifier 16 by means of which the rate of flow of the material to be briquetted is regulated in such a way as to maintain the height of the briquette mixture in the hopper 12 at a point between cells 14 and 15, 14 representing the upper limit and 15 the lower limit to which the head may go.

Connected with the photo cell amplifier 16 is the coal feed control switch 17 which through the wires 18 controls the speed and direction of the motor 19. The motor 19 affecting the variable speed control shown in Fig. 3 in one way or the other as governed by the photo cell amplifier 16 causes the cones 3 and 3' to change their relations and consequently to change the speed of the belt 2, thereby causing the coal conveyor 4 to move more rapidly or more slowly and in turn feeding more or less coal to the wheel 5 and into the mixer 10. The lamps 14^a and 15^a and the cells 14 and 15 establish lines of light which are adapted to be obscured to a greater or to a lesser extent by the height of the briquette material accumulated above the press 13 in the hopper 12. If the height of the mixture falls below the line 15—15^a, this indicates that the rate of flow is slower than the demand of the press 13. When this occurs the electric bulb 15^a will set the regulating motor 19 in motion to increase the speed

of the coal conveyor 4, thereby delivering more coal. When, however, the head of the material above the press 13 rises higher, that condition indicates that the coal is being fed too fast and since the light between 14a and 14 is obstructed the regulating motor 19 will be set in motion in the opposite direction, decreasing the speed of the coal conveyor 4, delivering less coal to the wheel 5 and the mixer 10, and creating a demand rate of flow which will be indicated by the pointer 21 on the instrument 8 in pounds per minute.

The instrument 8 in turn controls the rate of flow of the binder which must at all times be proportional to the amount of coal flowing through the mixer. This control is exercised through the photo cells 20 and 20a of the instrument 8. This instrument is a photo-electric cell amplifier. On its pointer 21 is a thin plate 21a which acts as a shutter to control the passage of light beams from the lamp 36 to the two D. C. photo cells 20 and 20a below said shutter which are operated by current furnished by the binder generator 22 through the electric connections 23. The cells 20 and 20a are enclosed in separate boxes, each having an opening corresponding in length to the full travel of the pointer bearing shutter, so as to be capable of admitting all of the light to one or the other cell when the shutter is in one or the other of its extreme positions, and in the intermediate positions of the shutter to admit as much of the light to one cell as is excluded from the other.

The function of the shutter 21a is consequently to admit light to one cell and to exclude a like amount through the other and in this way to cause more current to pass through one than through the other. The photo cells 20 and 20a have suitable output connections to amplifiers 37 and 37a respectively. The photo cell 20 and its respective amplifier 37 are suitably connected to an electric meter or indicator 24 and controls the movement of a demand scale 38 having in cooperative relation therewith a fixed pointer 39 which gives an indication corresponding to the amount of binder, in pounds per minute, which should flow through the conduit 11 in proportion to the rate flow of the coal shown on the indicator 8. When the rate of flow of the coal changes due to a change in speed or direction of the motor 19, the pointer 21 moves until it registers the new rate of flow. Movement of the pointer 21 causes the shutter 21a mounted thereon to vary the amount of light beams reaching the photocell 20 from the lamp 36 thus causing the indicator 24 to rotate the demand scale 38 so that the pointer 39 indicates the amount of binder that is needed to be mixed with the amount of coal now being delivered to the mixer 10 in order to keep the proportions of coal and binder in the mixed briquette material constant. For example, let us now assume that the rate flow of coal shown on the instrument 8 is 1000 lbs. per minute, the capacity of the instrument being 2000 lbs., and that the binder proportion should be 10%, the capacity of the instrument 24 being 200 lbs. In that case the pointer of the instrument 8 would necessarily be placed in a central position of its capacity, the shutter 21a would admit a like amount of light to each photo cell, causing the demand scale in 24 which has a capacity of 200 lbs. to advance to one-half of its travel, indicating 100 lbs. per minute.

The photocell 20a and its respective amplifier 37a are suitably connected to a binder delivery control device 25, the function of which is to assure a delivery of 100 lbs. per minute of binder to the conduit 11. Movement of the pointer 21 therefore also simultaneously causes the shutter 21a mounted thereon to vary the amount of light beams reaching the photocell 20a from the lamp 36 to vary the position of a movable pointer 40 in the control device 25. Mounted on the extreme end of the pointer 40 is a thin plate which acts as a shutter to control the passage of light beams from the lamp 41 to photo cells 27 and 27a situated below the shutter. These light beams pass through small openings 42 in the separate enclosures 43 and 43a and fall upon the photocells 27 and 27a respectively mounted therein, which have suitable output connections to the amplifiers 26 and 26a respectively. The photocells 27 and 27a are suitably connected to a regulating motor control switch in the switch box 44 which controls the direction and speed of operation of the valve motor 28.

If the demand rate of flow of the binder material deviates as much as .1% of the total flow as shown on the scale 45, in either direction due to the changing rate of feed of the coal into the mixer 10, the shutter on the pointer 40 will interrupt the light beams from the lamp 41, to either the photocell 27 or 27a depending upon whether the binder is to be increased or decreased and cause the binder regulating motor 28 to increase or decrease the binder rate of flow, holding it to within .2% of the demand rate of flow as shown on the scale 38. When the demanded rate of binder, as shown on the scale 38, has been established, the pointer 40 will then recede into a neutral zone between the photocells 27 and 27a admitting light to both photocells, and the valve motor 28 will continue to deliver the demanded rate until the rate of feed of the coal is again changed due to a variation of the head of mixed material in the press hopper 12 from the predetermined height.

The power which operates the regulating motors 19 (for the coal) and 28 (for the binder) is furnished from the electric main at any voltage through relays operated by the photo cells 14, 15 for motor 19 and photo cells 27, 27a for motor 28.

Assuming that conditions were such that the rate flow of coal shown on instrument 8 was 1000 lbs. per minute and of the binder 100 lbs. per minute, but that at this rate the head of briquette mixture above the press 13 in the hopper 12 rises to such a height as to shut off the light from 14a to 14 and that the proper rate of flow should only be 500 lbs. of coal and 50 lbs. of binder: In that case the result will be that the motor 19 and consequently the cones 3 and 3', the belt 2 and conveyer 4 will be regulated so that less coal will be fed to the wheel 5 and mixer 10 until the proper condition is established with respect to the cells 14 and 15. As half as much coal is being fed to the wheel 5, the tachometer generator 9 delivers proportionately less current to the indicator 8 causing the pointer of the coal feed indicator 8 to become stationary at 500 lbs. on the scale thereof and allowing, by means of the shutter thereon, only half as much light as before, from the light source 36, to fall on the photo cell 20. The effect of this condition will be to cause the electric meter or indicator 24 to register a demand only one-half as much as it previously was, i. e. a demand of 50 lbs. per minute as the binder proportion still remains 10% with respect to the coal. Since the instrument 8 has a capacity of 2000 lbs. and only 25% of the light beams from the lamp 36 will be admitted to the cell 20 in the 500 lbs. instance it follows that 75% of the

light must be admitted to the photo cell 20a, thus simultaneously causing the pointer 40 to advance and by means of the shutter mounted thereon to exclude one-half the amount of light reaching the photo cell 27a from the light source 41 in the 100 lbs. instance which starts the motor 28 in the direction to reduce the binder rate of flow until it has reached the demanded rate of 50 lbs. When the pointer 40 recedes into a neutral zone between 27 and 27a, admitting light to both cells, the demanded rate of 50 lbs. of binder will have been established and this rate of binder will continue to be delivered until there is a change in conditions at 14, 14a and 15, 15a.

Similarly if 1000 lbs. of coal and 100 lbs. of binder are too little to maintain the proper head of briquette mixture over the briquetting press 13, conditions are reversed by a corresponding control over the motors 19 and 28 until the proper flow of briquette material into the hopper 12 is automatically reached, at which time the rate of coal flow into the mixer and the rate of binder flow into the mixer will be constantly maintained at the ratio of 10 to 1 or whatever other ratio the appliance may be set for.

Taking up next the course of the binder, it requires a certain amount of pressure to operate the binder meter 32 which may be supplied either by an over-head reservoir 30 or from a floor level tank by a pump. In the latter case a relieving system is required as shown in my companion application Serial No. 556,027. From an initial cost point of view, it is more economical to use a floor level tank and a pumping system. As shown in the drawing of the present application, however, an over-head reservoir 30 is illustrated from which the binder flows by gravity to a regulating cock 31 to which is directly connected the binder regulating motor 28. The meter 32 is directly connected to a tachometer generator 22 which furnishes the current to operate instruments 24 and 25.

The motors 1 and 28 are connected in series so that they may start and stop simultaneously. To the regulating cock 31 is connected an electric cut-out switch 33 which will be open when the regulating cock is closed, causing the motors 1 and 28 to stop. The push-button switch 34 connects a low A. C. voltage to the binder delivery control instrument 25, causing the pointer bearing the shutter to advance, excluding the light from cell 27a when the push-button is depressed. By depressing the push-button for three seconds, the motor 28 will have closed the regulating cock 31 and opened the switch 33 to both motors 1 and 28 so that both coal and binder cease to flow. When the push-button is released, the motors 1 and 28 again begin to function.

The two photo-electric cells 27, 27a of the instrument 25 are arranged to operate on A. C. current through a sensitive relay switch 35 which is energized or deenergized in accordance with the amount of light falling on the respective photo cells 27 and 27a from the light source 41 so that the current to the motor 28 is either on or off. There is a low voltage A. C. connection through the push-button stop switch 34 to the switch valve 31, 33 for the purpose of stopping the apparatus as and when desired. The arrangement and operations of the photo-electric cells and the circuits are all more or less conventional and therefore do not require detailed elaboration or description. Their construction may be varied in many ways so long as the fundamental principles are maintained; thus, the coal delivering sytem has the electric generator 9 responsive to the rate of coal flow and that generator controls the setting of conditions in the instrument 8 by which the effects on photo cells 20 and 20a are varied. The cells 20 and 20a in turn as they vary affect the setting of the conditions in the instruments 24 and 25 as there is a change in these instruments there will be a corresponding change effected through the action of the photo cells 27 and 27a, on the binder control motor 28, whereby the binder control motor 28 at all times delivers binder material to the mixer 10 in the same ratio as between coal and binder which is predeterminately established for the mixture. The coal flow on the other hand is controlled by conditions established by the photo cells 14 and 15 with reference to the height of the head of briquette material above the press 13. As the height of that head varies, the photo cells 14 and 15 exercise a corresponding control over the coal feed control motor 19 which in turn correspondingly feeds more or less coal into the mixer and thence to the head while, by reason of the electrical connections between 9, 8, 20, 20a, 24, 27, 27a and 28, the binder rate follows the coal rate under maintenance of the desired proportion.

Among the main features of the process described is that the material to be measured (coal) shall be made to produce an electric current sufficient to operate an electric indicating instrument sensitive to the rate at which the material to be measured flows through the apparatus and that a constant rate of flow in any proportion both of the coal and of the binder may be maintained without mechanical touch and at the same time may be varied without changing the proportion in conformity with a control determined by the height of the head of the briquette material in the hopper 12. According to the present invention the speed of the press 13 and the height of the head required therefor are first determined according to the nature of the material, consistency, etc. Thereafter the height of the head to be established is then automatically controlled by the function of the cells 14 and 15 and is automatically maintained at the proper level. In the meantime the binder control is such that operating in harmony with the coal feed control the proper amount of binder always in the predetermined proportion will constantly flow into the mixer in conformity with the amount of coal that is being fed in.

I claim:

1. The method of controlling the composition and supply of a mixture of solid carbonaceous material and liquid binding material to a briquetting press, which comprises feeding solid carbonaceous material from a source of supply, introducing a liquid binding material into said carbonaceous material for admixture therewith, causing the feed of said solid material to control the rate of feed of said liquid binding material to maintain a predetermined proportion between the ingredients of the mixture, feeding the mixture to the press at a rate sufficient to maintain a predetermined head of mixed material above the press, controlling the rate of feed of said solid carbonaceous material to correspond with the rate of feed of the mixture, and modifying and correcting the rate of feed of the solid and liquid materials in accordance with variations of the head of the mixed material from a predetermined level.

2. The method of controlling the composition

and supply of a mixture of solid carbonaceous material and liquid binding material to a briquetting press, which comprises feeding solid carbonaceous material from a source of supply, introducing a liquid binding material into said carbonaceous material for admixture therewith, controlling the rate of feed of said liquid binding material in dependence upon the rate of feed of said solid material to maintain a predetermined proportion between the ingredients of the mixture, feeding the mixture to the press at a rate sufficient to create a head of mixed material above the press, passing two vertically spaced beams of radiant energy across the path of drop of the mixture at predetermined distances from the press, and decreasing or increasing the rate of feed of the solid material according as the head of material above the press rises high enough to block both beams or falls low enough to afford unobstructed passage for both beams whereby the feed of material is regulated to maintain the head of mixture between the limits defined by such beams.

3. The method of controlling the composition and supply of solid carbonaceous material and liquid binding material to a briquetting press, which comprises feeding the solid carbonaceous material from a source of supply, causing the feed of said solid material to create electrical currents and causing said currents in turn to cause indication of the rate at which the solid material is being fed, introducing a liquid binding material into said carbonaceous material for admixture therewith, controlling the rate of feed of said liquid binding material in accordance with fluctuations in said generated current to maintain a predetermined proportion between the ingredients of the mixture, feeding the mixture to the press at a rate sufficient to maintain a predetermined head of mixed material above the press, controlling the rate of feed of said solid carbonaceous material to correspond with the rate of feed of the mixture, and modifying and correcting the rate of feed of the solid material in accordance with variations of the head of the mixed material above the press from a predetermined level.

4. The method of controlling the composition and supply of a mixture of solid carbonaceous material and liquid binding material to a briquetting press, which comprises feeding solid carbonaceous material from a source of supply, introducing a liquid binding material into said carbonaceous material for admixture therewith, causing the flow of said solid material to generate electric current proportional to the actual rate of flow thereof and causing said current in turn to control the rate of feed of said liquid binding material, feeding the mixture to the press at a rate sufficient to maintain a predetermined head of mixed material above the press, controlling the rate of feed of said solid carbonaceous material to correspond with the rate of feed of the mixture, and modifying and correcting the rate of feed of the solid material in accordance with variations of the head of the mixed material above the press from a predetermined level.

5. The method of controlling the composition and supply of a mixture of solid carbonaceous material and liquid binding material to a briquetting press which comprises feeding solid carbonaceous material from a source of supply, introducing a liquid binding material into said carbonaceous material for admixture therewith, causing the flow of said solid material to generate electric current proportional to the actual rate of flow thereof and causing said current to control the rate of feed of said liquid binding material so as to maintain said flow of liquid material at the same ratio to the flow of solid material irrespective of variations in the flow of the solid material, feeding the mixture to the press at a rate sufficient to maintain a predetermined head of mixed material above the press, controlling the rate of feed of said solid carbonaceous material to correspond with the rate of feed of the mixture, and modifying and correcting the rate of feed of the solid material in accordance with variations of the head of the mixed material above the press from a predetermined level.

6. Apparatus for establishing a uniform supply of briquette mixture to a briquetting press which comprises a mixer, means for feeding solid carbonaceous material to said mixer, means for introducing liquid binder material to said mixer for admixture with said solid material, means controlled by the flow of said solid material to control the rate of feed of said liquid material so that the liquid material is maintained at the same ratio as predeterminately established with respect to the solid material irrespective of variations in the flow of the solid material, means for feeding the mixed materials to a briquetting press, said means comprising a hopper immediately in advance of said press, and means to maintain the head of the mixed material in the hopper at a predetermined level, said means comprising an electrical control device responsive to variations of the head of the mixed material from said predetermined level to correspondingly adjust the means for feeding said solid material, thereby causing said means to feed the solid material at a faster or slower rate as the height of the material in the hopper decreases or increases, respectively, below or above said predetermined level.

7. Apparatus for establishing a uniform supply of briquette mixture to a briquetting press which comprises a motor, variable speed transmission, feeding means responsive to said variable speed transmission for advancing the solid carbonaceous material to be briquetted, means for introducing liquid binder material to the solid material, means for mixing the two types of materials, means for feeding the mixed materials to a briquetting press, said means comprising a hopper immediately in advance of said press, and means to maintain the height of the mixed material in the hopper within predetermined limits, said means comprising an electrical control device responsive to the amount of material in the hopper at the predetermined limits to correspondingly adjust the variable speed transmission, thereby causing the feeding means for the solid material to move faster or slower as the height of the material in the hopper decreases or increases respectively below or above the said predetermined limits.

8. Apparatus such as set forth in claim 7 including a mechanical driving means in the path of the advancing solid material operated by the feed of the solid material, a tachometer generator operated by said mechanical driving means, and means controlled by said generator to indicate the actual rate of flow of said solid material, said means being also operative to control the rate of flow of said liquid binder material.

9. Apparatus such as set forth in claim 7 including means operative to vary the rate of flow of the binder material into the mixer as the feeding of the solid material increases or decreases,

and means for maintaining the changed rate of flow of binder material in the same ratio with respect to the solid material as predeterminately established.

10. Apparatus such as set forth in claim 7 in which the electrical control device includes light emitting means and photo-electric cells, the rays being directed upon the photo-electric cells said cells being situated at different levels with reference to said head and arranged to be obscured in sequence as the head accumulates, and means controlled by the photo-electric cells for increasing the speed transmission for the feed of the solid material when both photo-electric cells receive light rays and for decreasing the speed of said speed transmission when both cells receive no light.

11. In apparatus such as set forth in claim 7, a regulating device effective upon the feed of binder material comprising a regulating cock, an electric switch controlled by said regulating cock, and a manually controlled element for causing said switch to open and thereby to stop entirely the feed both of binder material and of solid material altogether.

12. An apparatus such as set forth in claim 7 including a mechanical driving means in the path of the advancing solid material operated by the feed of solid material, a tachometer generator operated by said mechanical motor, photo-electric cells, a device operated by said generator to control the amount of light which is effective upon the photo-electric cells, and means co-acting with the cells for controlling the rate of flow of the binder material into the mixer to correspond with the rate of flow of the solid material into the mixer.

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