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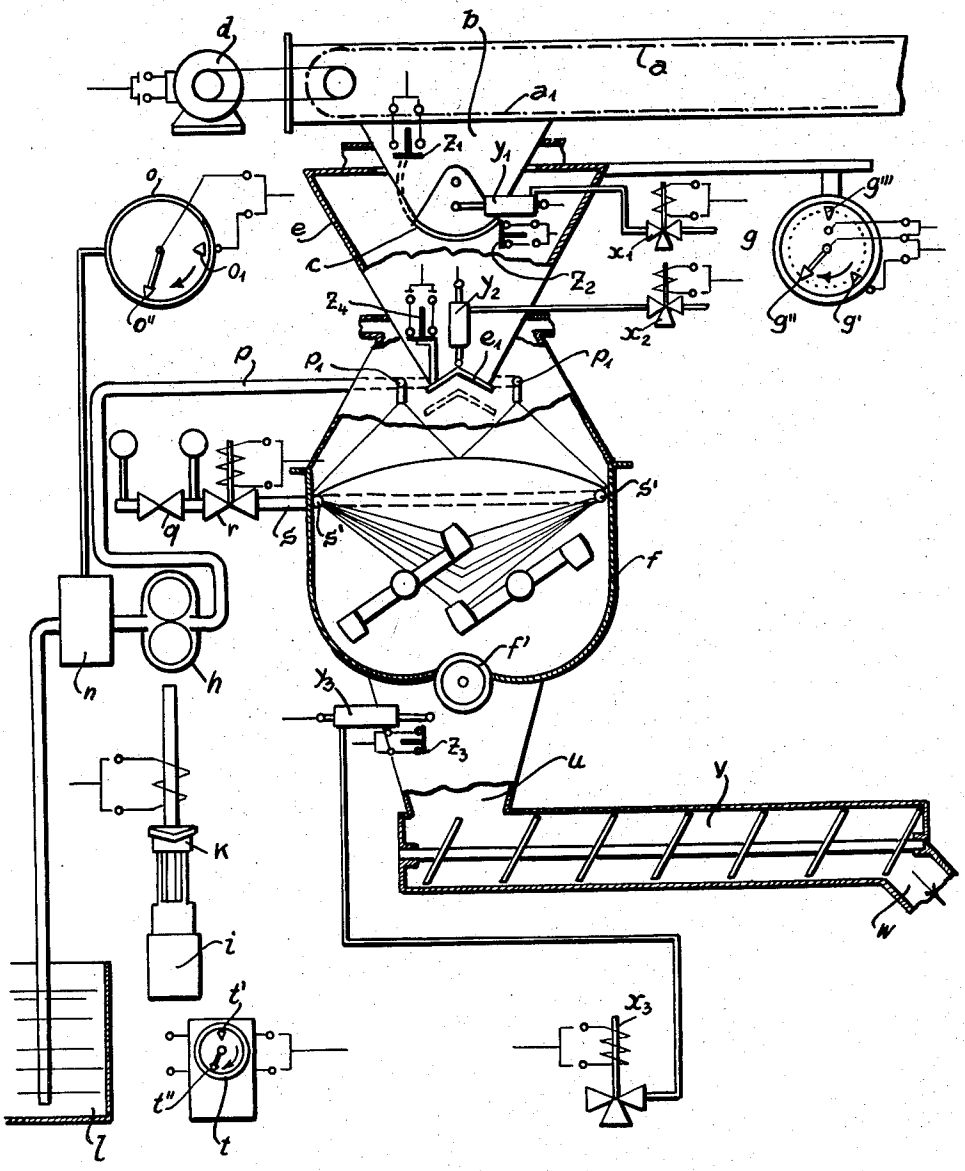

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INSTALLATION FOR MAKING BRIQUETTES

Paul Munderich, Rothenbergen, near Gelnhausen, Germany, assignor to Wibau Westdeutsche Industrie- und Strassenbau-Maschinen-Gesellschaft m.b.H., Rothenberg, near Gelnhausen, Germany, a German company

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The subject of the invention is an installation for the manufacture of pressable briquetting material, in particular bituminous coal.

In the briquetting of bituminous coal, the consumption of binder—generally coal-tar pitch—must be regarded as the most important cost factor. The likewise well-known fact that the possibilities of profit in briquetting (for many mining undertakings, this is merely the unprofitable exploitation of a waste product) are few or non-existent, necessarily leads to a demand for the reduction of binder requirement, since in view of the generally good organisation of briquette factories, this offers the only chance of effectively reducing the costs.

Most briquette factories operate on the so-called ground pitch kneading process. In this process, the moisture content of the fine coal from the washery is reduced from about 10% to just 1% in suitable special driers with a drier outlet temperature of 90–100° C. The coal thus prepared is now passed by means of a conveyor to the dry coal bunker, whence it is taken by means of a proportioning conveyor to the feed worm conveyor. The hard pitch is broken manually in the pitch storage bunkers, is crushed to the required size (about 1 mm.) in an edge runner mill and carried by a conveyor to the ground pitch bunker. It is thence removed by means of a primitive proportioning device and passed to the feed screw, where it is brought together with the dried fine coal. Dried coal and ground pitch are now passed via a mixing conveyor worm to the feed conveyor and thence via a central distributor to the individual steam kneading machines.

In the steam kneading machine, due to the kneading process and the steam supplied, which assists the liquefaction of the ground pitch and facilitates the increase in the moisture content to the degree required for subsequent pressing, i.e. 2–4%, the actual conversion and preparation of the mixture of fine coal and ground pitch to form a pressable briquetting material now takes place. After passing through the kneading machine, the finished briquetting material generally passes directly to the feed head of the briquetting press.

Apart from the advantage of perfect continuity, a critical analysis of this process clearly shows serious disadvantages, viz:

(*a*) Inaccurate binder feed: The necessary proportion of binder can be regulated only approximately. Uncertainty regarding this adjustment generally results in an over-proportioning of binder.

(*b*) Perfectly homogeneous mixing of hot fine coal and cold ground pitch is impossible, either in the feed unit which brings the two substances together or in the mixing worm following this unit, and is rendered difficult by the fact that while the individual grains of ground pitch undoubtedly begin to melt, they never entirely liquefy, so that partial premature binding together of the ground pitch grains and their subsequent enveloping by very fine coal dust necessarily takes place (formation of pockets oversaturated with binder).

The impossibility of producing a really intimate mixture of coal and ground pitch thus also results in a non-uniform dispersion of binder in the finished briquetting material, since the aforesaid pocket formation cannot be eliminated by the kneading process. On the contrary, it is rather reinforced, due to the so-called "blotting paper" effect, in which binder is removed from the coarser grain fraction by the very finest grains. This fact is responsible for considerable scatter in the strength values of the pressed briquettes, resulting in necessary additional over-proportioning of the required binder amount.

(*c*) Unequal moisture distribution within the briquette material. The stream of material travelling through the kneading machine is in itself loosened only slightly or not at all, so that only a small part of the surface of the briquetting material is exposed to the action of steam (steam is introduced by means of nozzles above the stream of material). This inequality is also responsible for scatter in the strength values of the briquettes and leads to overproportioning of binder.

(*d*) The necessary grinding process involves the use of relatively hard sorts of binder, which subsequently obstructs the required spreading of thin films of binder on the individual grain surfaces.

(*e*) Labour requirement for the preparation of the hard pitch, associated with the health hazards for the pitch workers (pitch cancer).

(*f*) Machine requirement for the preparation of the hard pitch (grinding by edge runner mill).

(*g*) Unacceptable outlay from the machinery point of view makes it difficult to meet the requirement for simultaneous production of different qualities of briquettes. If some of the briquettes have to be of a particularly high-grade quality, for example for export and overseas despatch, the entire installation has to be operated with this adjustment.

The object of the present invention is to provide a fully automatic charge-mixing installation for the manufacture of a briquetting material which is pressable immediately after leaving the mixer and which obviates the aforesaid disadvantages.

The installation according to the invention has a device for weighing out the loose briquetting material in predetermined charge quantities and for feeding said material, devices for the simultaneous spraying of predetermined quantities of liquid binder and steam to the briquetting material in the mixer, a device for discharging the pressable briquetting material from the mixer, and control means for automatically controlling said devices according to a predetermined programme and for regulating the time sequence of the charges.

The drawing shows diagrammatically a constructional example of a charge-mixing installation according to the invention.

At *a* is shown a conveyor belt, for example a so-called Redler belt for the loose or bulk material (fine coal), which is driven by a motor *d*. In the discharge region a_1 of the conveyor belt is a collecting shaft *b*, the outlet of which is provided with a flap *c*. For opening the outlet of the collecting shaft *b*, the flap *c* can be swung from the closure position shown in the clockwise direction into the position shown in dotted lines under the action of a control cylinder y_1 operated by compressed air. The cylinder y_1 is controlled by an electromagnetically operated valve x_1 in a manner to be described more fully hereinafter.

Below the outlet of the collecting shaft *b* is a weighing container *e*, which is coupled to a weighing mechanism, not shown, and the outlet of which is controlled by a shutter *e'*. Said shutter *e'* can be moved under the action of a control cylinder y_2, operating on compressed air, from the closed position shown to an open position

indicated by dotted lines. The control cylinder y_2 is controlled by an electromagnetically operated valve x_2. The weighing container or its weighing mechanism is operatively connected to a weight indicator g having a circular scale. The indicator g has at the origin of the circular scale a zero mark g''', a moving pointer g' and a preset pointer g'', which pointers are formed as electrical contacts. When the two pointers cover one another, an electrical circuit is closed, the purpose of which will be described later.

Below the outlet of the weighing container e is a mixer f which, as shown, is preferably constructed as a high capacity double shaft mixer. In the region of the inlet from the weighing container, spraying nozzles are provided in the mixer f for the liquid binder, the spraying range of which is indicated and which are connected by a pipeline p to a feed pump h. The feed pump h is driven by a motor i by means of an electromagnetic clutch k and draws binder from a tank l via a pipeline m and a flowmeter n, which is connected to a flow quantity indicator o. The indicator o has a circular scale, co-operating with a moving pointer o' and a preset pointer o''. The two pointers are formed as electrical contacts and close an electrical circuit when they cover one another.

In the upper part of the mixer f steam injection nozzles s' are provided, which are supplied with steam from a pipeline s, controlled by means of an electromagnetically operated shut-off valve r. Preceding the valve r is a pressure regulating device q. The range of action of the jets from the nozzles s' is indicated in the drawing.

The outlet of the mixer f situated in the container bottom is closable by a rotary slide f' adapted to be operated by a compressed air control cylinder y_3. The cylinder y_3 is controlled by means of an electromagnetically operated valve x_3. Underneath the rotary slide f' is an intermediate container u, from which the mixed material is fed by a worm conveyor v directly to the briquetting press w.

For operating the described members of the installation, according to the embodiment shown, purely electrical control means are provided by way of example.

A hand switch, not shown, serves for the initial control of the electromagnetic valve x_1, the coil of which is also electrically connected to the moving pointer g' or the preset pointer g''. This arrangement is such that the magnet valve can be opened when the pointers g' and g'' do not cover one another, but is closed by the electrical pulse imparted when the pointers cover one another.

In the end regions of the opening and closing movements, respectively, of the flap c of the collecting shaft b are end switches z_1 and z_2, the switch z_1 being operated by the opened flap and the switch z_2 by the closed flap. The switches z_1 and z_2 are connected to the circuit of the driving motor d of the conveyor belt a in such a manner that the switch z_1, operated on opening of the flap c, starts the motor d, while the switch z_2, operated on closing of the flap c, stops said motor.

A hand switch, not shown, is provided for the initial control of the electromagnetic valve x_2. In addition, the electromagnetic valve x_2 is operatively connected electrically to the indicator g in such a manner that the valve closes when the moving pointer g' covers the zero pointer g'''.

In the end region of the closing movement of the shutter e' of the weighing container e is a switch z_4, which is operated by the movement of the shutter and which is operatively connected to the electromagnetic valve x_1 in such a manner that the pulse imparted by the switch z_4 on closing of the shutter opens the electromagnetic valve x_1.

In addition, the switch z_4 controls the circuit of the electromagnetic clutch k in such a manner that the pulse imparted by the switch z_4 on closing of the shutter e' renders the clutch k power transmitting. The clutch k is also operatively connected to the indicator o in such a manner that when the moving pointer o' covers the preset pointer o'', the power transmission through the clutch k is interrupted.

A hand switch, not shown, is provided for the initial control of the clutch k and at the same time serves for the initial control of the steam electromagnetic valve r. The electromagnetic valve r in its turn is operatively connected to the indicator o in such a manner that when the moving pointer o' covers the preset pointer o'', the valve r is closed.

The indicator o is also electrically operatively connected to the electromagnetic valve x_3 in such a manner that when the moving pointer o' covers the preset pointer o'', a pulse is imparted for the opening of the electromagnet valve x_3. The operation of the indicator o is furthermore subjected to a time-adjustable time switch t, which is started by the pulse on coincidence of the pointers o'' and o'. The time switch t has a preset pointer t'' and a moving pointer t', which are formed as electrical contacts and to which electrical leads are connected. These leads, which when the preset pointer t'' is covered by the moving pointer t', are connected together, provide an electrical operative connection between the electromagnetic valve x_3 and the time switch t, such that the valve is closed when the moving pointer t covers the preset pointer t''.

In the end region of the closing movement of the rotary slide f' is an end switch z_3, which is operated by the rotary slide f' and is operatively connected to the electromagnetic valve x_2 in such a manner that the pulse imparted by the switch z_3 on closing of the rotary slide opens the electromagnetic valve x_2.

After the described electrically controlled installation has been set manually in operation, it continues to function automatically. For starting, the circuit of the electromagnetic valve x_1 is first closed by means of the hand switch, so that said valve allows compressed air to enter the control cylinder y_1. The control member in the cylinder swings the flap c in the clockwise direction until the latter operates the switch z_1, after the outlet of the collecting shaft b has been opened. The driving motor d is thereby switched on and the conveyor belt a is thus started and loose material, i.e. fine coal, is charged through the collecting shaft into the weighing container. When the weight of the loose material in the weighing container has reached a predetermined value, the rotary moving pointer g' of the indicator g covers the preset pointer g'', set to this predetermined value, thereby providing the disconnecting pulse for the electromagnetic valve x_1. The latter shuts off the supply of compressed air and at the same time discharges the control cylinder y_1, so that the flap c closes the outlet of the collecting shaft and actuates the end switch z_2, imparting the stopping pulse for the motor d and thereby preventing further supply of loose material.

The electromagnetic valve x_2 is now opened by the second hand switch, likewise previously mentioned and not shown, whereupon the control cylinder y_2 opens the shutter e' of the weighing container e. The weighing container e discharges into the mixer f, the moving pointer g' returning, and on covering the zero pointer g''' giving the disconnection pulse for the electromagnetic valve x_2. The latter interrupts the supply of compressed air to y_2 and at the same time discharges the cylinder y_2, so that its control member returns to the starting position and closes the weighing container e. The weighing container shutter e', at the end of its closing movement, operates the end switch z_4, which imparts an opening pulse for the electromagnetic valve x_1, and hence initiates the automatic repetition of the weighing process.

By means of the third hand switch, not shown, the electromagnetic clutch k is now engaged, starting the pump h by the motor i. The binder is drawn by the pump h from the container l via the pipeline m and flowmeter n

and is fed to the spray nozzles p' in the mixer f, via the pressure pipeline p.

The same hand switch also imparts an opening pulse for the electromagnetic valve r, so that due to the pressure regulating device, which is connected in front of said valve and by means of which the amount of steam supplied per unit time can be regulated, steam passes through the pipeline s and the nozzle s' to the mixer. Binder and steam thus enter the mixer at the same time. As the binder passes through the flowmeter n, the moving pointer o' of the quantity presetting instrument o moves until after a predetermined quantity of binder has passed, it covers the preset pointer o'', thereby imparting a pulse for the disengagement of the clutch k, for closing the steam electromagnetic valve r and for opening the electromagnetic valve x_3. In accordance with this last pulse, the control cylinder y_3, under the action of the compressed air entering through the electromagnetic valve x_3, opens the rotary slide f', whereupon the pressable briquetting material, mixed with binder with the addition of steam, falls from the mixer f into the intermediate container u, which effects equalization between the periodical arrival of briquetting material from the mixer and its continuous removal by the worm conveyor y.

When the moving pointer o' of the binder quantity presetting instrument o covers the preset pointer o'' a further pulse is given for starting the adjustable time switch t.

This time switch t acts as a time-delay relay and serves to determine the charge time sequence. After the expiration of the adjusted time, the moving pointer t' of the time switch t covers the preset pointer t'', giving a pulse for the closing of the electromagnetic valve x_3. The latter shuts off the supply of compressed air to the control cylinder y_3 and discharges the latter, so that the rotary slide f' closes and at the same time operates the end switch z_3. This end switch—after the aforesaid, re-initiated weighing process has been concluded—opens the electromagnetic valve x_2, whereupon the weighed loose material is supplied to the mixer f. At the end of this operation, the closing shutter e' operates the end switch z_4, whereupon the supply of binder and steam to the mixer is re-initiated. A blocking member, not shown, blocks the pulse of the end switch z_3 before the weighing of the weighing container is concluded.

It will be seen from the mode of operation described in the foregoing, that the installation continues to function automatically after the weighing operation and the binder and steam supply have been switched on in succession by means of the aforesaid hand switches. The motor i of the binder pump and the drive of the mixer f are here regarded as running continuously.

The quantity pre-adjustments by means of the indicators g and o ensure a high degree of accuracy of the corresponding deliveries. The pressure-regulating installation q, connected in front of the steam electromagnetic valve r—the opening time of which is determined by the binder delivery time—ensures high accuracy of the necessary steam quantity supply per charge with regard to the rate of flow per unit time in connection with the dependent duration of steam injection. The desired relationships of the function of the driving motor d of the conveyor a and the closure flap c can be readily satisfied by means of the automatic control. Due to the aforesaid time switch t, the charge sequence can be regulated as desired and hence the mixing installation output can be matched exactly to the particular briquette press output.

A possible requirement for a proportioned delivery of different particle sizes can be met without difficulties by the incorporation of a circular pointer balance with a plurality of circuit components, by the provision of a corresponding number of conveyors opening into the weighing container and by appropriate extension of the associated switching processes.

The degree of perfection of the mixing effect depends to a considerable degree upon the fineness of the binder dispersion, the viscosity of the sprayed binder and the quality of the mixer.

With regard to the duration of binder injection, it is preferable to adjust the capacity of the spraying members so that spraying time is equal to mixing time, since experience has shown that only in this way is it possible to obtain optimum mixing effect.

The direction of the steam spraying members will preferably be such that the inflowing steam assists the loosening work of the mixer. Since uniform moisture dispersion in the briquetting material is of equal importance as the uniform dispersion of binder, the principle steam injection time=mixing time also applies to the supply of steam.

Comparison of such a charge mixing installation with the aforesaid known installation operating on the ground pitch kneading process is clearly in favour of the charge mixing installation according to the invention, since with the latter practically all of the disadvantageous factors can be eliminated. In particular, the disadvantages a–d referred to in the critical analysis of the ground pitch kneading process are obviated, since the proportioning of coal, binder and steam and the dispersion of binder and steam within the mixed material can be effected in an optimum manner, with simple control of the individual operations. The labour and machinery requirements mentioned under points e and f are likewise practically eliminated. It is no longer necessary for the binder to be broken up by so-called "pitch breakers" and crushed in an edge runner mill, but it can be supplied to the individual removal tanks by simple pumps direct from tank wagons via ordinary pipelines. Health hazards are entirely absent, since the system is closed in itself and the formation of free pitch dust is no longer possible.

A further economic advantage of this mixing installation, is the possibility of separate regulation of the binder proportions to be added for each individual installation, so that a factory having a plurality of presses can produce different qualities of briquettes simultaneously (point g). This possibility is not available to factories with pitch supply common to all the kneading machines.

In the constructional example described, an electropneumatic system has been chosen for the control of the automatic operation of the installation. Any other system may, however, be likewise employed.

I claim:

1. Apparatus for combining the elements of a briquetting material comprising a mixing vat, an input hopper having a discharge orifice opening into said vat, a displaceable shutter covering said orifice, weighing means coupled to said input hopper for weighing the content thereof, a conveyor for conveying selected of said elements toward said hopper, a collector operatively disposed with respect to said conveyor for receiving the selected elements therefrom and having a discharge aperture opening into said hopper, a flap closing said discharge aperture, first control means for opening said shutter and thereby said discharge orifice, second control means for opening said flap and thereby said discharge aperture, said weighing means including a first device settable to respond to a determinable weight in said hopper to actuate said second control means to close said flap and a second device responsive to zero weight in said hopper to actuate said first control means to close said shutter, a control responsive to the position of said flap to control movement of said conveyor, a switch correlating the position of said flap to the position of said shutter so that when said shutter is open the flap is closed, supply means for supplying a binder controllably into said vat, feed means for feeding steam controllably into said vat, and discharge means operatively associated with said vat for the discharge of briquetting material therefrom, said discharge means being coupled to said first control means to control the opening of said shutter.

2. Apparatus as claimed in claim 1 wherein the supply means for said binder comprises a binder source, a

pump coupling said source to said vat, and a flowmeter responsive to a predetermined flow of binder to control said pump, said apparatus comprising means operatively coupling said shutter to said pump to control operation of the latter in accordance with the position of said shutter.

3. Apparatus as claimed in claim 1 wherein said shutter is operatively coupled to the feed means for said steam to control the supply of steam in accordance with the position of said shutter.

4. Apparatus as claimed in claim 1 comprising a timer operatively coupled to and controlling said discharge means.

5. Apparatus as claimed in claim 1 comprising manual controls coupled to and operating said control means.

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