

Nov. 19, 1940.

H. G. HAGUE

2,222,030

APPARATUS FOR THE SEPARATION OF MATERIALS

Filed June 9, 1938

3 Sheets-Sheet 1

FIG. 1 -

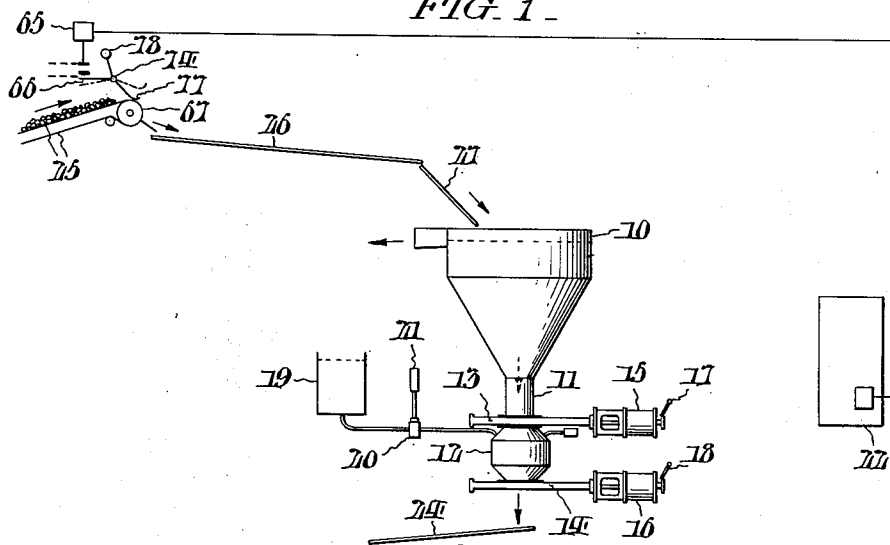
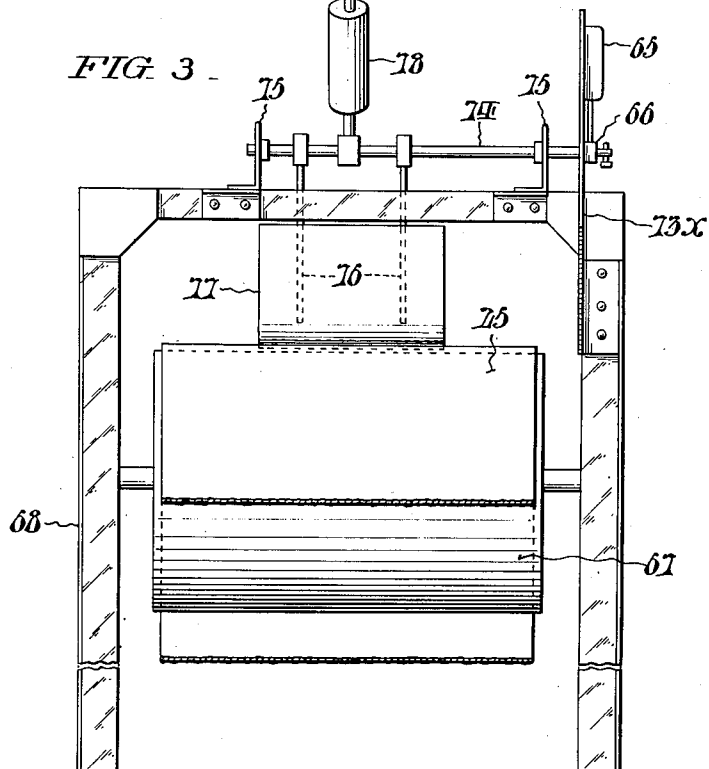


FIG. 3 -



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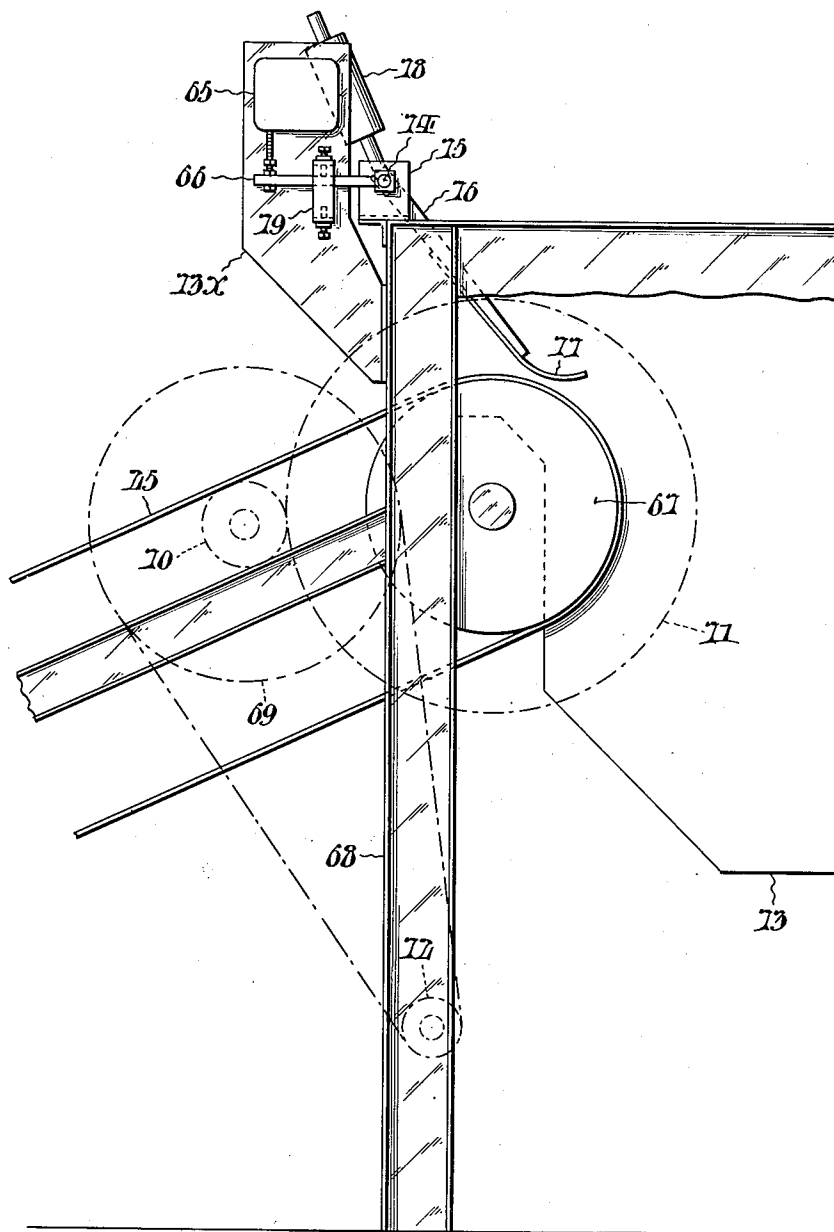
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APPARATUS FOR THE SEPARATION OF MATERIALS

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3 Sheets-Sheet 2

FIG. 2



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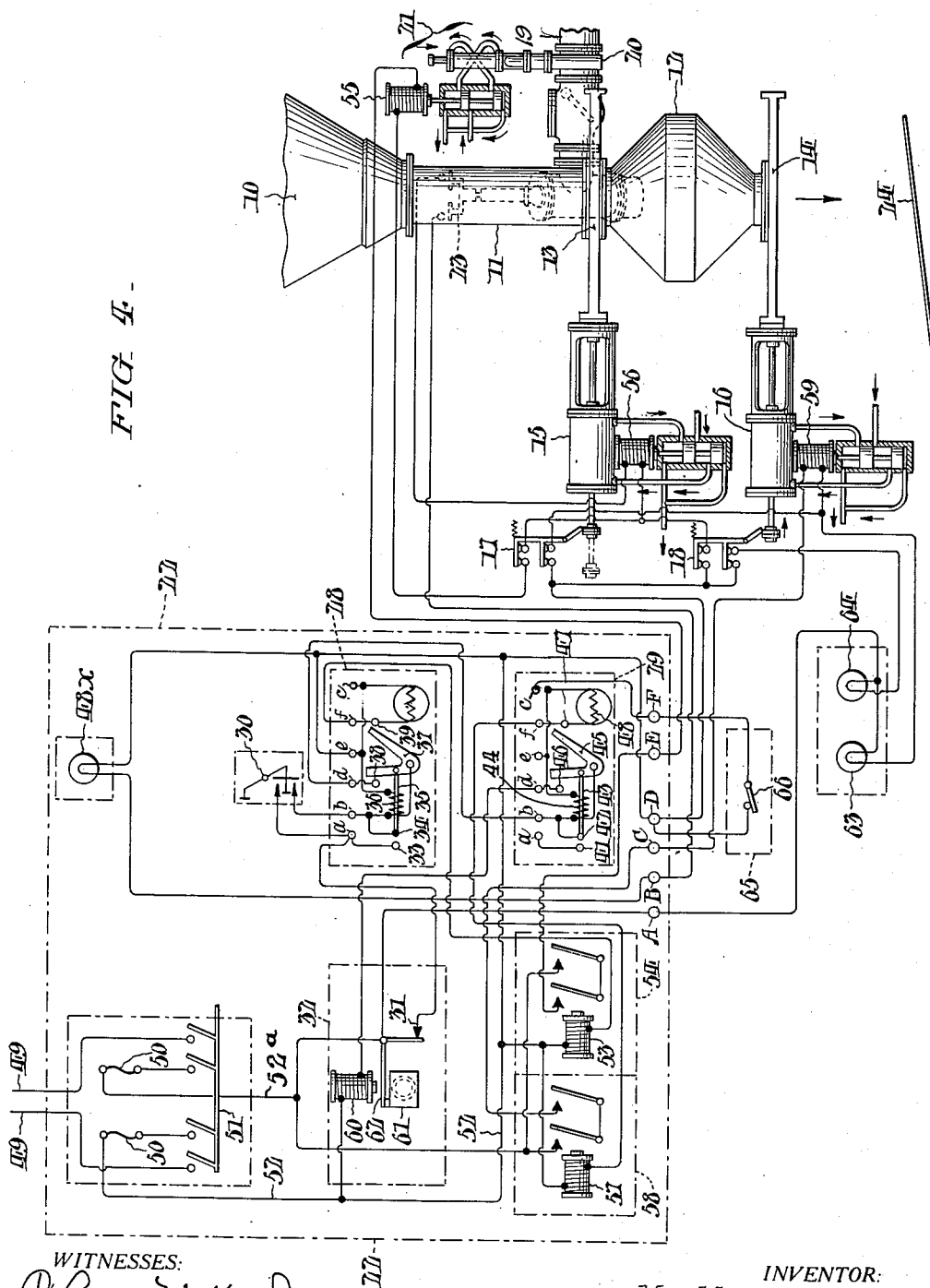
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3 Sheets-Sheet 3

FIG. 4.



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2,222,030

APPARATUS FOR THE SEPARATION OF MATERIALS

Harold George Hague, Barnehurst, England, assignor to Provident Trust Company of Philadelphia, Philadelphia, Pa., a corporation of Pennsylvania, and Marcus A. Walker, Scranton, Pa., trustees under the will of Thomas M. Chance, deceased

Application June 9, 1938, Serial No. 212,779
In Great Britain June 11, 1937

4 Claims. (Cl. 209—496)

This invention relates to apparatus of the kind in which materials of different specific gravity are separated in a chamber containing a fluid medium, through which the heavier solids (hereinafter referred to as "refuse") sink to the bottom of the chamber, from where they are discharged through a second chamber provided with an intake valve and a discharge valve which are operated alternately to minimize loss from the first chamber through the second chamber. The valves may be power operated, and means may be provided for effecting the application of energy to either valve to cause opening thereof only when the other valve is substantially closed, the said means being operated by the operation of the valves. These means preferably take the form of limit switches actuated by the valves. The cycle, commencing from the time when both valves are closed, consists in opening the intake valve (which may be done after water has been supplied to the refuse chamber) so that the refuse which has sunk to the bottom of the first chamber enters the second chamber, closing the intake valve, opening the discharge valve so that the refuse collected in the second chamber is discharged therefrom, and closing the discharge valve. This cycle is repeated so long as the apparatus is in operation, so that the contents of the second or refuse chamber are discharged at regular intervals. A system of this character is disclosed in U. S. Patent No. 1,894,020, granted January 10, 1933, to Thomas M. Chance. These regular intervals are chosen so that during one such interval the refuse chamber is substantially filled with refuse, and then so long as the rate and nature of the feed does not vary, the refuse chamber will continue to be filled during each subsequent interval. If, however, the rate of feed decreases, the refuse chamber will not be filled with refuse during each interval, and in the extreme case when there is no feed or when the feed is intermittent there may be little or no refuse collected in the refuse chamber before the discharge valve is opened. This results in inefficiency of operation.

The object of the present invention is to avoid these difficulties and to render the apparatus suitable for dealing with material which is fed into the apparatus at different rates without the necessity for effecting manual adjustments to deal with a cessation or variation of feed.

In the apparatus of the present invention, means responsive to the feed to the apparatus is provided for varying automatically the intervals between successive discharges from the

refuse chamber to suit variations of the feed. In its simplest form, this means is responsive only to the presence and absence of feed, and prevents further operation of the valves when there is no feed. In practice it is found that this is sufficient to deal with variations of feed, since when the rate of feed is reduced it usually becomes intermittent, and the means then prevents operation of the valves during those intervals when there is no feed. Means of this kind preferably comprises a flap arranged above the conveyor feeding material to the apparatus, so that any feed present will move the flap against the action of gravity or other bias to control the operation of at least the discharge valve, the operation ceasing when the flap returns to its original position, under the action of the bias, in the absence of feed.

In one form of apparatus such as above referred to, the time interval between successive openings of the discharge valve is determined by a timing device, such as an electric motor operated device; and the present invention may conveniently be applied to such apparatus by arranging for the feed responsive means to stop and start the timing apparatus. If the timing device is stopped, it is preferably stopped at an instant when the discharge valve is open.

Apparatus in accordance with the present invention is particularly suited for cleaning coal with a fluid mass of sand and water, and the invention will be hereinafter described with reference to such apparatus, one construction of which is illustrated in the accompanying drawings.

In the drawings, Fig. 1 shows diagrammatically the complete layout of the feed arrangements for a coal-cleaning apparatus, as well as the layout of the apparatus itself;

Fig. 2 shows a side elevation; and

Fig. 3 is a front elevation of the top of the moving conveyor shown in Fig. 1; and

Fig. 4 shows a diagram of connections of the operating mechanisms for the refuse-gates and for the water-supply valve.

Referring now to Fig. 1, the apparatus comprises a first or separating chamber in the form of an inverted cone 10 terminating in a column 11. The lower end of this column communicates with the second or refuse chamber 12 through the intake slide valve 13. Discharge slide valve 14 is located at the lower end of the refuse chamber 12. The valves 13 and 14 are adapted to be actuated respectively by hydraulic

cylinders or engines 15, 16 which are controlled electrically through limit switches 17 and 18.

A connection is provided between the refuse chamber and a suitable water supply indicated at 19, this said connection including a water supply valve 20 which is adapted to control the supply of water to the refuse chamber 12. The water supply valve 20 is actuated by an hydraulic cylinder or engine 21 controlled electrically from the control panel 22.

The electrical control circuits of the intake valve 13, the discharge valve 14 and water supply valve 20 are coordinated or "interlocked" so as to insure the correct sequence of operation as follows:

Starting with both intake and discharge valves in the closed position and the water supply valve 20 closed, the water supply valve engine 21 is caused to open the valve 20 to admit water to the refuse chamber 12. When the chamber is filled with water a pressure switch 23 is actuated by pressure of the water in the chamber. This pressure switch is arranged in the control circuit of the intake valve 13 and when open prevents the valve 13 from opening. When pressure switch 23 closes, valve 13 is caused to open and on opening causes water supply valve 20 to close. The intake valve 13 is held open for sufficient time for the refuse chamber 12 to fill with refuse from the column 11. Then the intake valve 13 is closed whereupon the discharge valve 14 is opened to discharge the refuse on to a screen 24, where it may be washed and any sand clinging to the refuse thereby removed, to be subsequently returned to the first chamber 10. The discharge valve 14 is finally closed, and the cycle of operations is completed, and may be repeated.

In this Fig. 1 are shown also a belt conveyor 25 which feeds the raw coal on to feed chutes 26 and 27 delivering into the cone 10.

The cycle of operations is predetermined, the various valves remaining open for definite minimum periods. Each time cycle is determined by two timers, one determining the time between the opening of the water supply valve 20 and the closing of the intake valve 13, cycle (i), and the other determining the interval between the opening and closing of the discharge valve 14, cycle (ii).

Reference is now directed to Fig. 4 of the drawings. Here the parts of the apparatus which are shown also in Fig. 1 are designated by the same reference numerals. The time cycles (i) and (ii) are determined by timers 28 and 29 respectively, mounted on the control panel 22. Suitable timers for the purpose are well known (being exemplified by the "CR 2823-MC9 Definite Time Relay," illustrated and explained on page 978 of catalogue "GEA-600A" of the General Electric Company, Schenectady, N. Y.), so that only their external connections to the circuits of the control system and such of their internal features as are necessary to an understanding of their coaction with the external circuits are here referred to, and very diagrammatically illustrated.

The component parts of the two timers 28 and 29 are identical, but their connections are somewhat different.

Both timers have six terminals designated by reference letters *a*, *b*, *c*, *d*, *e*, and *f*. Terminals 28*a* and 28*b* are connected to a switch 30 which is arranged to make the timing circuit of the timer 28 when closed. Terminal 28*a* is connected also to a fixed contact 31 of a restarting relay 32, the purpose of which appears in the sequel, and to a

contact 33 within the timer 28. The terminal 28*b* is connected to a contact 34 on a movable core part 35 of the timer 28. An actuating coil or solenoid of the timer 28 is indicated at 36, and a movable contact of this timer, indicated at 37, is shown connected to the terminal 28*b*. This movable contact 37 is intended to engage, alternatively, with contacts 38, 39 in the timer, which are connected to its terminals 28*d*, 28*f*, respectively. The solenoid 36 actuates the parts 35 and 37, the latter especially through the usual mechanism of the timer, not shown. In the timer 29, the terminal 29*a* is connected only to a contact 41, while the terminal 29*b* is connected to a contact 42 on a movable core part 43. An actuating solenoid or coil of timer 29 is indicated at 44, and its movable contact 45 is shown connected to the terminal 29*b*, being intended to engage alternatively with contacts 46, 47 connected respectively to terminals 29*d* and 29*f*. In the unoperated position lever 37 is in contact with 39 and lever 45 is in contact with 47.

The solenoid 36 is connected between terminals 28*b* and 28*c*, and the solenoid 44 is connected between terminals 29*b* and 29*c*. The energizing coil 40 of a timer motor is connected between terminal 28*c* and contact 39; and the energizing coil 48 of a timer motor is connected between terminal 29*c* and contact 47. Terminal 28*e* is connected to terminal 28*c*. Terminal 28*d* is connected to terminal 29*b*. Terminal 28*e* is connected direct to terminal D of the panel, and to terminal B through a lamp 48*x* adapted to be illuminated, when the pressure switch 23 is closed, by means of circuit connections described hereinafter. Terminals 28*c* and 29*c* are connected also through lead 52 to the incoming supply 49 through one of the fuses 50 and circuit breaker 51 and a connection is made from lead 52 to one side of the operating coil 53 of a relay 54 for controlling both the solenoid 55 associated with the water supply valve engine 21, and the solenoid 56 associated with the intake slide valve engine 15. This side of the coil 53 is also connected with one side of the operating coil 57 of a relay 58 for controlling the solenoid 59 associated with the discharge slide valve engine 16. The other side of coil 57 is connected to terminal 29*f*. The other side of the coil 53 is connected to terminal 28*f*.

Operation of relays 54 and 58 is adapted to cause operation of the three solenoids 55, 56, and 59 above referred to.

The restarting relay 32 comprises an operating coil 60 connected between one terminal of the supply 49 and the terminal 29*d*. The coil 60 is adapted when energized to cause operation of gearing 61 which in turn opens contact member 62 cooperating with contact 31. Coiled spring means are provided in conjunction with said gearing whereby upon de-energization of said coil 60 said gearing is reversed under action of this spring. There is then a time lag between de-energization of said coil and re-making of contact 31.

Lamps 63 and 64 are provided in conjunction with the circuits of the solenoids 56 and 59, respectively, so as to indicate that the intake valve or discharge valve, respectively, is closed.

In accordance with the invention, a switch 65 is connected to terminals D and F of the control panel 22, and this switch is arranged to be operated by a member 66 as hereinafter described with reference to Figs. 2 and 3 of the accompanying drawings, which will now be described.

Here the belt conveyor 25, which feeds the raw coal through chute 73 on to the feed chutes (not here shown), is arranged to pass over the roller 67 mounted on suitable framework 68 and driven through gearing 69, 70, 71 from a rotating shaft 72.

On the framework 68 is mounted a bracket 73x carrying the switch 65. The operating member 66 for the switch 65 is rigid with a shaft 74 which is supported pivotally in posts 75. Keyed to the shaft 74 are two arms 76 to which is attached a plate 77 having a curved end adapted to rest normally just clear of the belt 25 as it passes over the roller 67. The shaft 74 also carries a counterweight 78 for the plate 77. On the bracket 73x is carried a U-shaped member 79 with adjusting screws which extend towards the upper and lower sides of the arm member 66. These adjusting screws are provided for limiting the movement of the arm member about the pivots of the shaft 74.

Coal on the said belt 25 engages the plate 77 and moves it out of its path. If the layer of coal on the belt is sufficiently thick, the plate 77 is moved to such an extent that the switch 65 is closed. If the thickness of coal on the belt 25 diminishes, or if the supply of coal is intermittent, the plate 77 will fall back under gravity, and the switch 65 opens once more.

In operation, coal is fed to the belt 25 and travels to the cone 10, operating the switch 65 on its way. Meanwhile the circuit breaker 51 on the control panel in Fig. 4 has been operated to connect the panel to the supply and the control switch 30 is closed. The water supply valve 20, and both intake and discharge valves are all closed.

Referring now to Fig. 4, immediately switch 30 is closed, the solenoid 36 of the timer 28 is energized, being connected to the 52 side of the line through 28e and to the 52a side of the line through 28b, 30, 28a, and 31. The core 35 is thereby caused to move to close contacts 33, 34 which complete a retaining circuit for the timer 28. Simultaneously the closing of switch 30 energizes timing motor 40 which is connected to the 52 side of the line through 28c and 28e and to the 52a side of the line through 39, 37, 34, 33, 28a, and 31, and causes energization of relay winding 53 which is connected directly to the 52 side of the line and is connected to the 52a side of the line through 28f, 39, 37, 34, 33, 28a, and 31. Energization of relay winding 53 causes the relay 54 to close, which energizes solenoid 55 through 17 and D and through E and 54, thereby opening water supply valve 20. Water is then fed into the refuse chamber 12 until it is nearly filled, and then water enters the pipe leading to the piston of the pressure switch 23. When sufficient water has been supplied to the chamber 12, the pressure switch 23 is operated, thereby closing the circuit for solenoid 56, which operates the valve engine 15 to open the intake slide valve 13. This circuit for solenoid 56 extends from a point on the 52 side of the line (at the right and above the timer 29 in Fig. 4) up through the lamp 48x, down through B, over through pressure switch 23 and back through coil 56, down through limit switch 18, and up through lamp 64 and A (past the connection to relay 32) to the 52a side of the line. Opening of valve 13 breaks the water supply valve circuit by the action of limit switch 17 and water supply valve 20 closes. It will be noted that the operating circuit through the solenoid 56 includes the limit switch 18, so that the discharge valve 14

must be closed before the solenoids 56 can be energized.

Refuse material in the column 11 falls into the refuse chamber 12. After a predetermined interval, for which the timer motor is set, the timer motor trips a release (not shown) for the contact arm 37, which breaks contact at 39, and makes at 38. Breaking at contact 39 causes de-energization of the solenoid 56, upon which the intake valve 13 re-closes.

When the arm 37 makes contact at 38, solenoid 44 is energized, being connected to the 52 side of the line through 29c, F, 66, and D and to the 52a side through 29b, 28d, 38, 37, 34, 33, 28a, and 31, and the core 43 is operated; here, however, contacts 41, 42 serve no useful purpose. Simultaneously the timer motor for the bottom gate timer is energized, being connected to the 52 side through 29c, F, 66, and D and to the 52a side through 47, 45, 29b, 28d, 38, 37, 34, 33, 28a, and 31. At the same time, relay coil 57 is energized, being connected directly to the 52 side and being connected to the 52a side through 29f, 47, 45, 29b, 28d, 38, 37, 34, 33, 28a, and 31. Relay 58 operates in response to the energization of relay coil 57 and solenoid 59 is thereby energized, being connected to the 52 side of the line through limit switch 17, and D and to the 52a side through C and relay 58. Discharge valve 14 opens when solenoid 59 is energized. It will be noted that the operating circuit for the solenoid 59 includes the limit switch 17, so that valve 13 must be closed before the discharge valve 14 can be opened.

The refuse chamber empties during the time that timer 29 is operating. At the expiration of this period, the arm 45 is tripped and breaks contact with contact 47 and makes contact with contact 46. The restarting relay winding 60 is then energized, being connected directly to the 52 side of the line and to the 52a side of the line through 29d, 46, 45, 29b, 28d, 38, 37, 34, 33, 28a, and 31, whereupon the contact arm 62 breaks contact with contact 31, thus interrupting the supply to the timers 28 and 29, which revert to their unoperated positions. The winding 60 is simultaneously de-energized, and arm 62 remakes with contact 31 after the time interval determined by the gearing 61. This time interval, of say 5 seconds, enables the timers 28 and 29 to reset before the cycle is repeated. It will be seen that if switch 65 is open, or is opened, the connection to one side of the supply through the timer 29 is broken, and the discharge valve 14 will not close, or will open. If, then, no coal is being fed to the cone, and the hinge plate 77 falls under gravity, thus causing the switch 65 to open, the discharge valve 14 will open but will not close. At the same time valve 13 will be closed and will remain closed so long as valve 14 remains open.

As soon as the supply of coal is renewed, the hinge plate 77 is lifted again, and the apparatus resumes its normal state for complete operation.

It will be seen that the invention as described above also takes care of the case where the rate of feed is reduced, but not to zero; for a reduced rate of feed merely means that the feed is not continuous, so that operation of the valve is prevented during those intervals when coal is not fed past the flap, or when not enough is fed to keep switch 65 closed.

Having thus described my invention, I claim:

1. In apparatus for separating materials of different specific gravities in a fluid separating medium, including a separating chamber and a sub-

- 5 jacent refuse chamber, with valve means for controlling passage of refuse from the separating chamber into the refuse chamber and for discharging refuse from the refuse chamber, timing means for periodically actuating said valve means in sequence for the discharge of refuse, and means for feeding materials to be separated to said separating chamber; the combination with the apparatus as hereinbefore set forth of
- 10 means responsive to the feed of material to said separating chamber for controlling the operation of said valve means by said timing means; and thus varying the intervals between successive discharges of refuse according to the feed.
- 15 2. Apparatus as set forth in claim 1 including a conveyor for feeding materials to the separat-

ing chamber, and a flap above said conveyor responsive to the presence of material thereon and controlling the action of said valve means.

3. Apparatus as set forth in claim 1 including means controlled by said means responsive to the feed of material to the separating chamber for suspending the action of said timing means when the feed of such material is interrupted.

4. Apparatus as set forth in claim 1 including a motor operating the timing means controlling the operation of the valve means, and means for starting and stopping the timing motor in response to the feed of material to the separating chamber.

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