

Jan. 10, 1933.

T. M. CHANCE
VALVE GEAR FOR COAL WASHERS AND CONCENTRATORS
AND METHOD OF OPERATING THE SAME
Filed March 3, 1930

1,894,020

4 Sheets-Sheet 1

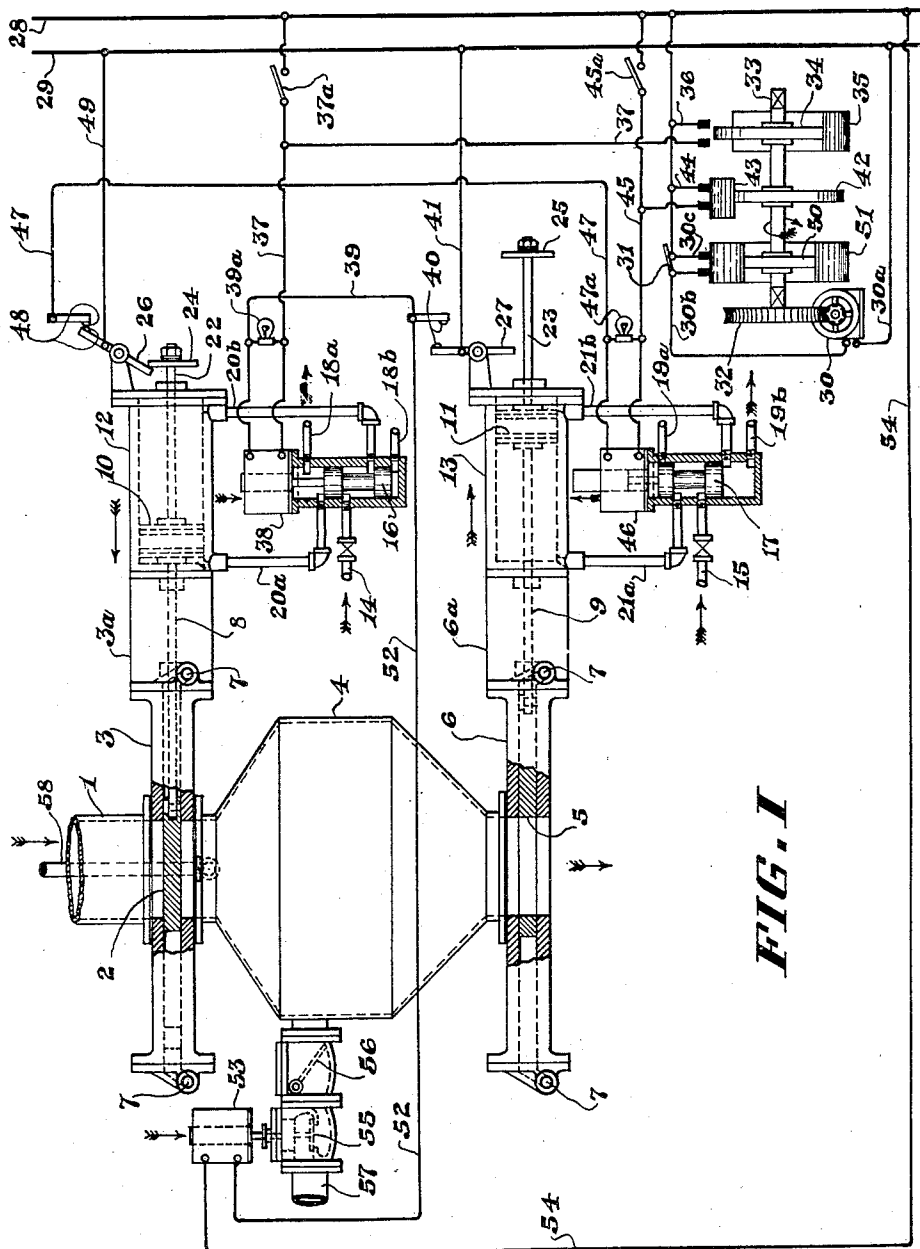


FIG. 1

Witnesses

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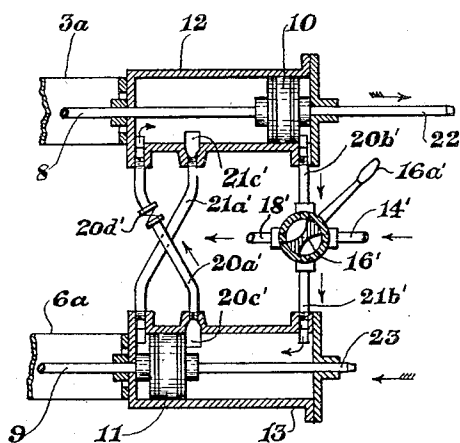


FIG. II

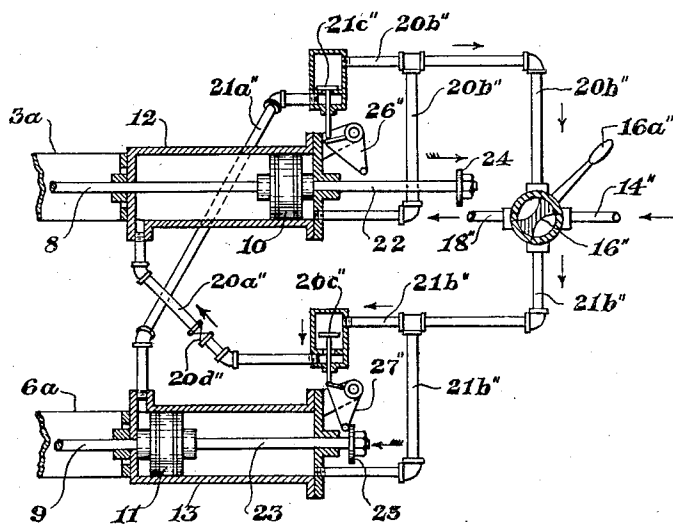


FIG. III

Witnesses

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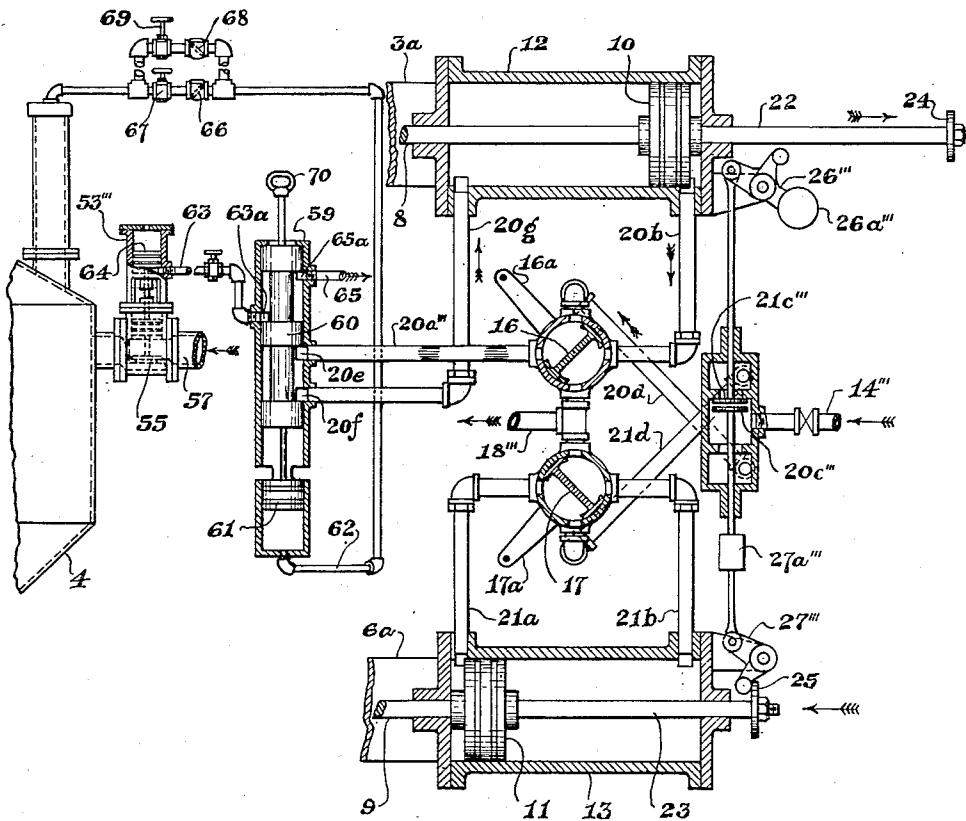


FIG. IV

Witnesses

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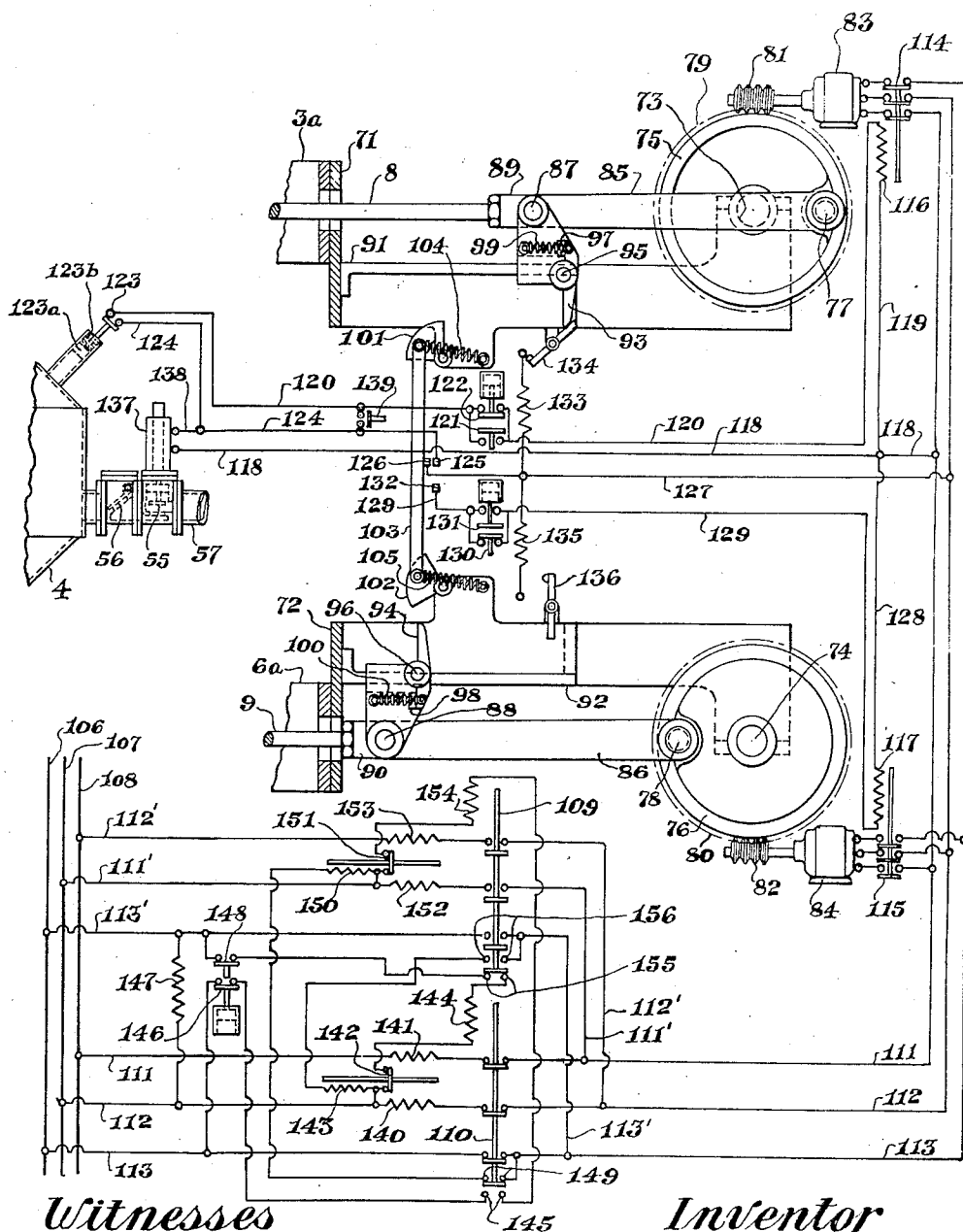
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4 Sheets-Sheet 4



Witnesses

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FIG. V

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VALVE GEAR FOR COAL WASHERS AND CONCENTRATORS AND METHOD OF OPERATING THE SAME

Application filed March 3, 1930. Serial No. 432,895.

The object of my invention is to provide an interlocked valve gear that may be usefully applied to removing solid materials sinking in apparatus for separating materials of different specific gravities of the type described in United States Patent 1,559,937, in upward current classifiers and in other apparatus of a like nature. It is directed to both those types of valve gear utilizing refuse, or concentrate, slide valves reciprocated by pistons actuated by fluid pressure media, such as steam, compressed air, liquids and the like, and to types mechanically driven.

My invention is illustrated in the accompanying drawings, which are all diagrammatic vertical elevations in partial cross-section, and in which minor details such as stuffing box structures, and the like, have been omitted for the sake of brevity. In the drawings, Figure I illustrates an electrically controlled valve gear, Figure II a ported-cylinder construction with single operating valve and Figure III a single operating valve design using mechanically controlled secondary valves. Figure IV shows a valve gear adapted to automatically control liquid used for filling the refuse, or concentrate chamber and Figure V a mechanically driven gear. Like number indicate like parts in the several drawings.

The operation and construction of the apparatus shown in Figure I is as follows. Materials sinking from the separating tank that have passed through connection 1 and slide valve 2, contained in valve chest 3, into chamber 4, are discharged therefrom by open slide valve 5, contained in valve chest 6, said valve 5 being opened after closure of said valve 2. Valves 2 and 5 are connected by piston rods 8 and 9 to pistons 10 and 11, operating in cylinders 12 and 13, said cylinders being attached to valve chests 3 and 6 by distance pieces 3a and 6a. Said chests are provided with drain connections 7 at either end to permit the release of fine materials and for the introduction of water. Connection 1 contains liquid components of the separating medium and chamber 4 may be filled with said liquid before opening of upper slide valve 2. Pistons 10 and 11 are reciprocated by a

fluid pressure medium admitted from inlets 14 and 15 through piston valves 16 and 17 and discharged therefrom by exhausts 18a, 18b and 19a, 19b, conduits 20a, 20b and 21a, 21b, connecting cylinders 12 and 13 to the casings containing valves 16 and 17.

Pistons valves 16 and 17 are raised by gravity operated electrical solenoids 38 and 46, said valves falling when current is cut off said solenoids. Current can feed solenoids 38 and 46 through contactors 40 and 48 only when said contactors are closed by links 27 and 26 being moved to the closing position by washers 25 and 24, carried on tail-rods 23 and 22 attached to pistons 11 and 10, said washers being axially adjustable on said rods. Contactors 40 and 48 are positioned automatically in the open position, by springs or other mechanism not shown, the links 26 and 27 returning to said open position when washers 24 and 25 move away from the cylinders.

To ensure discharge of solids from connection 1 without the simultaneous discharge of a large uncontrolled volume of liquid, only one slide valve may be substantially open at any time and the necessary alternate, interlocked, timed reciprocations of pistons 10 and 11 are secured in the following manner.

An alternating electrical current feeds electric motor 30 through circuits 30a, 30b and 30c connected to feed busses 28 and 29, disconnecting switch 31 being provided for manually stopping said motor. Motor 30 rotates, through gearing 32, timing disks 34 and 42 mounted on shaft 33. Disk 34 maintains an electrical circuit through wires 36 and 37 as long as peripheral contactor 35 bridges the opening between the ends of said wires. Current thus flows from buss 28 through wire 36, contactor 35 and wire 37 to energize solenoid 38 and lift the plunger thereof, raising piston valve 16, provided the return circuit from said solenoid comprising wire 39, contactor 40, wire 41 and feed buss 29 is closed by link 27 closing said contactor 40 under the action of washer 25. The operating fluid medium is now free to flow from inlet 14 through conduit 20a into cylinder 12 and exhaust from said cylinder through con-

duit 20b into exhaust 18b, thereby forcing piston 10 to open slide valve 2, until said piston reaches the mechanical limit of its stroke. Shortly after said piston moves outward, washer 24 moves out of contact with link 26, opening contactor 48 and isolating solenoid 46, controlling lower slide valve 5, until the return of said piston.

Further rotation of disk 34 causes contactor 35 to break the circuit between wires 36 and 37, solenoid 38 is deenergized, the solenoid plunger and piston valve 16 fall and the cycle is reversed, exhaust occurring through conduit 20a and exhaust 18a and admission through conduit 20b and inlet 14. Slide valve 2 now closes and when washer 24 moves link 26 sufficiently, contacts 48 are closed, in preparation for the next opening of lower slide valve 5.

Timing disk 42 carries peripheral contactor 43 which energizes lower solenoid 46 in the same manner that contactor 35 energizes upper solenoid 38, wires 44, 45, 47 and 49 connecting feed buss 28 through said solenoid 46 and contactor 48 to feed buss 29 when contactor 43 bridges the opening between wires 44 and 45. Likewise, lower piston valve 17 functions similarly to upper piston valve 16. Said valve 17 is raised by the plunger of solenoid 46, when said solenoid is energized, thus admitting the operating fluid medium from inlet 15 through conduit 21a to cylinder 13 and exhausting said medium from said cylinder through conduit 21b to exhaust 19b, thereby producing the opening stroke of lower slide valve 5 and isolating upper solenoid 38, controlling upper slide valve 2, as soon as washer 25 moves away from lever 27, permitting said lever to open contactor 40. As disk 42 continues to rotate, peripheral contactor 43 opens the circuit to solenoid 46, permitting said solenoid plunger and piston valve 17 to fall and closing slide valve 5 by pressure medium exhausting from the front end of cylinder 13 through conduit 21a to exhaust 19a and entering from inlet 15 through conduit 21b to the rear end of said cylinder 13, thus reversing the motion of piston 11.

As slide valve 5 approaches the end of its closing stroke, washer 25 moves lever 27 to close contactor 40 and thus prepare the circuit to solenoid 38 for the next cycle of upper slide valve 2, which occurs when peripheral contactor 35 again completes said circuit.

It will thus be seen that contactors 40 and 48 respectively delimit the movement of slide valves 2 and 5 and that as long as the automatic gear is in operation one of said slide valves must reach a predetermined point in its closing stroke before the other can be opened. Further, should either valve stall due to an obstruction on its closing stroke and thus fail to operate the contactor for the other valve, the cycle will continue with said other valve idle and the stalled valve will

again open, permitting the obstruction to fall and free said valve for final closing.

Signals, to indicate whether the valves are working, may be provided as shown by the lights 39a and 47a, and further signals may be provided, operated by tail-rods 22 and 23, to indicate the position of said rods.

The time during which each slide valve is open depends on the relative arc lengths of peripheral contactors 35 and 43, if continuous contactors are used, or of the position of the operating points if rotating snap-action contact switches are used. It may be desirable to ensure the motor 30 is stopped with both slide valves closed and to accomplish this end a third disk 50 may be mounted on switch shaft 33, fitted with peripheral contactor 51 that opens the circuit 30b and 30c when contactors 35 and 43 are both open. Switch 31 normally prevents such open circuiting from occurring and the motor runs continuously. When said switch 31 is opened, the motor will stop as soon as contactor 51 rotates to the open position, one slide valve closed and the other also closed unless stalled in the closing position by a foreign obstruction to its further movement.

Manual control of the valve gear is provided, independent of the automatic timing gear, by switches 37a and 45a in extensions of circuits 37 and 45, the manually controlled circuits still being in series with the interlocking contactors 48 and 40.

In those types of apparatus in which the refuse, or concentrate, chamber 4 is emptied of its liquid contents upon the opening of slide valve 5 and refilled from an external source, such refilling may be accomplished automatically by the parts 52 to 58 inclusive in which wire 52 conducts current from feed buss 29 through wires 41 and 39, when contactor 40 is closed, to solenoid 53, said current returning through wire 54 to feed buss 28. Solenoid 53 is thus energized, raising balanced valve 55 and permitting flow from liquid source 57 through non-return check valve 56 to chamber 4. Said liquid fills said chamber 4, displacing the contained air through air vent 58, which latter may be either valve controlled or carried to a height greater than the static head developed in chamber 4 when slide valve 2 opens. By this construction, valve 55 is open during the entire period contactor 40 is closed, so that said valve remains open during the period upper slide valve 2 is opened. It is therefore necessary to supply liquid from source 57 under a head less than that existing in chamber 4 when said valve 2 is open, to prevent continued flow upward through said valve 2. For the same reason, check valve 56 must be provided to prevent reverse flow from chamber 4 into source 57 when valve 2 is open. To utilize this method of filling, there must be sufficient pause between the closing of slide valve 5

and the opening of slide valve 2 to allow time for the filling period, said pause being produced by providing a gap between the front end of timing contactor 35 and the rear end of contactor 43, the filling operation automatically starting immediately upon the closing of contactor 40 by the closing movement of valve 5 and being free to continue until the front end of contactor 35 closes circuit between 36 and 37, thus opening slide valve 2. If valve 5 does not close sufficiently to close contactor 40, neither the filling operation nor opening of valve 2 will occur, said valve 5 again opening and closing when contactor 43 rotates to the proper position. It should be noted that there need be no such gap between contactor 35 and 43 in those types of apparatus in which valve 5 discharges into a water-seal and chamber 4 is not emptied of its liquid contents—under such conditions the opening of valve 2 can occur coincidentally with the final closing of valve 5.

Under some conditions, such as when the static head of liquid source 57 is greater than that existing in chamber 4 when valve 2 is open, it may be necessary to automatically close valve 55 before valve 2 is opened, thus incidentally doing away with the necessity of check valve 56. This may be accomplished by carrying return circuit 54 through a peripheral contactor carried on a fourth timing disk on shaft 33, said contactor closing the circuit in said 54 during the gap above referred to between the front end of contactor 35 and the rear end of contactor 43 and opening the circuit during the remaining part of each revolution of said shaft 33. The feed circuit to solenoid 53 would still pass through wires 41 and 39 and contactor 40, so that the opening of valve 55 would still be interlocked with the closing of slide valve 5. As such use of a fourth timing disk could be applied readily by anyone skilled in the art, especially in view of the foregoing description of the other timing disks, it has not been shown in Figure I for the sake of clearness of said drawings. It will be understood that while valve 55 is shown as directly operated by a solenoid, any suitable type of fluid pressure medium operated valve may be applied, the solenoid 53 operating the pilot valve controlling flow of said medium to and from said valve.

In Figure II, distance pieces 3a and 6a connect slide valve chests of the type shown in Figure I to cylinders 12 and 13, containing pistons 10 and 11, operating rods 8 and 9 attached to slide valves in said chests, and carrying tail-rods 22 and 23 to visually indicate the position of said valves. Fluid pressure medium, admitted through inlet 14' to the four-way valve 16', worked by lever 16a', passes through conduit 21b' and closes the

lower slide valve by carrying piston 11 to the left. As said piston approaches the end of its stroke it uncovers port 20c', admitting said medium through conduit 20a' to cylinder 12, causing piston 10 to move to the right and open the upper slide valve. During the closing movement of piston 11, exhaust occurs from the front end of cylinder 13 through conduit 21a', port 21c', cylinder 12, conduit 20b' and four-way valve 16' to exhaust 18' and during the opening movement of piston 10, exhaust passes from the rear end of cylinder 12 through 20b' and valve 16' to said exhaust 18'. If now, four-way valve 16' is reversed, piston 10 closes the upper slide valve, admission occurring from 14', through said valve 16' and conduit 20b' and exhaust through 20a', 20c', cylinder 13, 21b', and valve 16' to exhaust 18'. Immediately piston 10 uncovers port 21c', the outstroke of piston 11 occurs by admission from cylinder 12 through conduit 21a' and exhaust through 21b', valve 16' and exhaust 18'. To permit stopping the cycle with both slide valves in the closed position, stop-valve 20d' is provided in conduit 20a', closure of which will prevent admission through said conduit when port 20c' is uncovered by piston 11.

Figure III illustrates apparatus functioning in the same manner as that of Figure II but, in which piston controlled ports 20c' and 21c' are replaced by valves 20c'' and 21c'', operated by links 27'' and 26'' worked by tail-rod washers 24 and 25, and providing a pressure interlock similar to that produced by the electrical interlock of the contactors 40 and 48 shown in Figure I. Pressure medium, admitted by the single four-way valve 16'', worked by lever 16a'', from inlet 14'' to conduit 21b'' closes the lower slide valve, the final closing movement of washer 25 opening valve 20c'' by means of link 27'', thus admitting medium from 21b'' through conduit 20a'' to open the upper slide valve. During the lower slide valve closing stroke exhaust occurs through conduit 21a'', valve 21c'' (held open by washer 24 and link 26''), and four-way valve 16'' to exhaust 18'' and during the upper slide valve opening stroke exhaust passes from cylinder 12 through conduit 20b'' and valve 16'' to said exhaust 18''. Closing of the upper slide valve is effected by reversing valve 16'', causing admission through 20b'' and exhaust through 20a'' and valve 20c'' (held open by washer 25 and link 27''). Immediately washer 24 opens valve 21c'' by moving link 26'', the lower slide valve opens, as the pressure medium is then free to flow through 21a'' from 20b'' to the front end of cylinder 13 and exhaust from the rear end of said cylinder through 21b'' and valve 16'' to exhaust 18''. Stopping the cycle with both slide valves in the closed position is effected by closing stop-valve 20d''

in conduit 20a'', closing admission to the front end of cylinder 12, when valve 20c'' is opened by washer 25.

From the foregoing description of Figures II and III, it will be seen that these particular valve gears are best adapted to those types of apparatus in which refilling of the refuse, or concentrate, chamber, (such as chamber 4 of Figure I) with liquid is not required, because there is ordinarily no time interval between the closing of the lower valve and the opening of the upper unless such an interval is secured by closing valves 20d' or 20d''.

In the apparatus of Figures II and III each cylinder acts as a receiver for fluid medium flowing into the other cylinder on its opening stroke. This may not be desirable under certain conditions, as for example when steam is used for said medium, and the apparatus of Figure IV eliminates such receiver effect and permits automatic liquid filling of the refuse, or concentrate, chamber.

In said Figure IV, distance pieces 3a and 6a connect slide valve chests of the type shown in Figure I to cylinder 12 and 13, containing pistons 10 and 11 operating rods 8 and 9 attached to slide valves in said chests. The operation and construction of the apparatus is as follows. Pressure medium introduced through inlet 14''' passes through interlocking valve 20c''', opened by lower tail-rod washer 25 moving link 27''' when the lower slide valve closes, and closed by counterweight 27a''' when said link is released by the opening of said valve, to conduit 20d and through four-way valve 16 into conduit 20a'''. Said conduit 20a''' terminates in port 20e in the wall of cylinder 59 containing piston valve 60. Said piston valve 60 is raised by plunger 61 working in an extension of 59 and falls by gravity, pressure being applied and released through conduit 62 opening into refuse, or concentrate, chamber 4, said chamber 4 connecting said valve chests as in Figure I. When said piston valve is raised by said pressure, it connects said port 20e with port 20f, permitting the pressure medium to flow from 20a''' into conduit 20g and carry piston 10 to the right, opening the upper slide valve, and simultaneously allowing interlocking valve 21c''' to close under the action of counterweight 26a''', isolating lower cylinder operating valve 17 from inlet 14'''. During said opening, exhaust takes place from the rear end of cylinder 12 through conduit 20b and valve 16 to exhaust 18'''.

Said four-way valve 16 is now reversed and admission occurs through said valve from conduit 20d to said rear end of cylinder 12, moving piston 10 to the left and closing the upper slide valve, exhaust occurring from the front end of said cylinder through conduit 20g, port 20f, piston valve 60, port

20e, conduit 20a''' and valve 16 to exhaust 18'''. During the final closing movement, washer 24 moves link 26''' to open valve 21c''' in preparation for the next opening of the lower slide valve. Four-way valve 17 is now reversed, causing admission from inlet 14''' through 21c''', conduit 21d, valve 17, conduit 21a, and exhaust through conduit 21b and valve 17 to exhaust 18'''. Piston 11 then moves to the right, isolating upper cylinder operating valve 16 by allowing counterweight 27a''' to close interlocking valve 20c''', and opening the lower slide valve.

The filling of chamber 4 with liquid, and the reciprocation of piston valve 60, is effected as follows. Assuming the parts in the position shown, hydraulic pressure from the separating receptacle communicates through the open upper slide valve, chamber 4 and conduit 62 to maintain plunger 61 and piston valve 60 in a raised position, said valve 60 connecting conduit 20a''' with 20g, through ports 20e and 20f, and conduit 63 with exhaust 65 through ports 63a and 65a. Gravity operated piston 64 therefore remains in its lower position in cylinder 53''' with balanced valve 55, connected to said piston, closed to prevent liquid from pressure source 57 entering chamber 4. If now the upper slide valve is closed and chamber 4 emptied by opening the lower slide valve, plunger 61 falls by gravity immediately the pressure in 4 drops sufficiently, carrying down piston valve 60 to bring ports 63a into communication with port 20e and to isolate ports 65a and 20f. This produces no effect on piston 64 until after the lower slide valve closes sufficiently to open interlocking valve 20c'''. If then four-way valve 16 is thrown to open the upper slide valve, admission occurs through 20a''' and 63 to lift piston 64 and open valve 55. Liquid now fills chamber 4 from pressure source 57, displacing the air therein through an air vent if desired, and finally develops sufficient pressure to raise plunger 61 and valve 60, bringing port 20e into communication with 20f and port 63a with port 65a. Piston 64 immediately falls, exhausting through 65, to close valve 55; opening of the upper slide valve occurs due to admission to cylinder 12 through 20a''' and 20g; and the cycle is completed. Plunger 61 is then maintained in its raised position, after closure of valve 55, by pressure communicated from the separating receptacle through the open upper slide valve until said pressure is released by the closing of said valve and the opening of the lower slide valve.

To regulate the rate of flow in both directions in conduit 62, check valves 66 and 68 and throttle valves 67 and 69 may be used, and manual control of said piston valve 60 is afforded by rod 70, to permit opening the upper slide valve when chamber 4 is empty.

It will be seen from the foregoing that the apparatus of Figure IV is doubly interlocked, the filling of chamber 4, generally requiring the closing of the lower slide valve, being necessary before pressure can be applied to open the upper slide valve. Interlocking valve 20c''' is therefore not essential although its use may always be desirable because it prevents opening of liquid supply valve 55, by reversing four-way valve 16, before the lower slide valve closes, thus eliminating liquid waste. Again, with certain proportions of apparatus, the flow through valve 55 could be conceivably greater than the discharge through said lower valve and a pressure to throw the piston valve might be thus built up in chamber 4, even with said slide valve open, under which conditions interlocking valve 20c''' would be essential.

Automatic liquid filling, controlled by the filling action itself, as shown in Figure IV, has the great advantage that only that time of the operating cycle actually necessary to perform the filling operation need be allocated to said filling operation, the opening of the upper slide valve occurring immediately that filling is completed.

It will be understood that this method of automatic filling control may be applied to the apparatus of Figure I, instead of the electrical contactor with inferential time control, and to that of Figures II and III, by inserting in series in conduits 20a, 20a' and 20a'' respectively, the piston valve cylinder 59 of Figure IV, connecting the cylinder portion of said conduits to port 20e and the valved control portion to port 20f.

It will be further understood that the apparatus of Figure IV may omit the automatic liquid filling structure in those embodiments in which chamber 4 discharges to a water-seal and is not filled with liquid at each cycle, such modification merely requiring the direct junction of conduits 20a''' and 20g into a common conduit, such as 20a of Figure I.

The operation and construction of the mechanically operated valve gear shown in Figure V is as follows. Distance pieces 3a and 6a connect slide valve chests, of the type shown in Figure I and attached to a refuse, or concentrate, chamber similar to chamber 4 of said Figure I, to crank shaft frames 71 and 72, carrying crank shafts 73 and 74. Said crank shafts are provided with crank disks 75 and 76 to which are fitted crank pins 77 and 78 and driving worm gears 79 and 80, driven by worms 81 and 82 of three phase alternating current electric motors 83 and 84. Connecting rods 85 and 86 connect said crank pins through wrist pins 87 and 88 to cross-heads 89 and 90 working on slides 91 and 92. Said cross-heads are attached to rods 8 and 9 operating slide valves working in said slide valve chests, and carrying pawls 93 and 94 swinging on centers 95 and 96 and maintained

against stops 97 and 98 by springs 99 and 100.

The interlocking gear comprises links 101 and 102 connected by switch bar 103, fitted with contact point 126 adapted to alternately engage contact points 125 and 132. Said links 101 and 102 are respectively moved past the dead center of springs 104 and 105 by said pawls 93 and 94 and carried to the end of their stroke by said springs. Said links and pawls constitute a ratchet escapement, the pawl being free to swing back on the opening stroke of its slide valve and the link free to turn when said slide valve has completed its closing stroke.

Electric current for operating motors 83 and 84 is carried from feed busses 106, 107 and 108 through overload relay operated circuit breakers 109 or 110, hereinafter more fully described, to feeders 111, 112 and 113, breaker 110 being shown in the closed position in the drawings. Said feeders carry current into said motors through disconnecting switches 114 and 115, operated by coils 116 and 117. Coil 116 is energized from feeder 111 through wires 118, 119 and 120, contactors 121 or 122, pressure switch 123, wire 124, interlocking contact points 125 and 126, and return wire 127 connecting to feeder 111. Coil 117 is energized from said feeder 111 through wires 118, 128 and 129, contactors 130 or 131, interlocking contact points 132 and 126, and said return wire 127. Contactors 121 and 130 are closed by gravity and opened by coils 133 and 135. Said coils are energized by switches 134 and 136, closed by pawls 93 and 94 when crossheads 89 and 90 approach the end of the opening stroke and automatically opened when said crossheads return on the closing stroke. Said coils 133 and 135 are respectively connected from said return wire 127 in series through switches 134 and 136 to wire 118. Contactors 122 and 131 are closed by said coils 133 and 135 and opened by gravity, closure being against a time regulating element shown as a dashpot.

Refuse, or concentrate, chamber 4 may be filled with liquid from liquid source 57, by balanced valve 55 opened by the raising of the solenoid plunger of solenoid 137 connected to an extension of said wire 118 and by wire 138 to said wire 124, check valve 56 preventing return flow while valve 55 is still open, if the pressure in 4, due to opening of the upper slide valve, exceeds that in source 57.

The operation of the foregoing electrical circuits is as follows. Assuming the parts in the position shown with the upper slide valve fully open, the closing of switch 134 by pawl 93 energizes coil 133 and opens circuit 120 through the opening of contactor 121, de-energizing coil 116 and opening switch 114, thus stopping motor 83. Contactor 122 now closes, under the action of said coil 133, after

a predetermined time interval set by the adjustment of the regulating dashpot, giving the rest period desired to pass material through the upper slide valve to chamber 4.

5 Said closing of 122 re-energizes coil 116, closing switch 114 thus starting motor 83 and closing the upper slide valve, during which coil 133 is de-energized by the opening of switch 134 when pawl 93 moves inward, con-

10 tactor 122 opening but contactor 121 at the same time closing and maintaining circuit 120. During the opening and closing stroke of crosshead 89, pressure switch 123 maintains circuit 120 because plunger 123a thereof is

15 held outward against spring 123b by pressure maintained in chamber 4 through the open upper slide valve.

As the top slide valve approaches the end of its closing stroke, pawl 93 carries link 101

20 past the dead center of springs 104 and 105 and said springs then throw said link clear of said pawl, dropping bar 103 and transferring contact point 126 from contact point 125 to 132. Switch 114 is thus opened and motor

25 83 stopped while switch 115 is closed through energizing of coil 117 and motor 84 started. The lower slide valve now makes its opening stroke, switch 136 is closed by pawl 94, coil

30 135 energized, contactor 130 opened and motor 84 thereby stopped, through the breaking of circuit 129 to de-energize coil 117 and thus open switch 115. After the time limit set by the controlling dashpot of contactor

35 131, said contactor closes under the action of energized coil 135, switch 115 again closes and motor 84 starts, closing the lower slide valve. As said lower valve approaches the end of its closing stroke, pawl 94 carries link

40 102 past the dead center of springs 104 and 105 and said springs then throw said link clear of said pawl, raising bar 103 and transferring contact point 126 from contact point 132 to 125. Switch 115 is thus opened and motor 84

45 stopped while solenoid 137 is energized, lifting valve 55 and causing liquid from source 57 to fill chamber 4, previously emptied by the opening of the lower slide valve and thus permitting pressure switch 123 to open under the action of spring 123b. As soon as sufficient

50 liquid enters said chamber to raise the pressure therein sufficiently (accompanied by the discharge of the contained air through a suitable air-vent, if desired) plunger 123a closes pressure switch 123, against the action of said

55 spring 123b. Circuit 120 is now again complete, coil 116 is energized, switch 114 closed, motor 83 starts and the opening of the top slide valve commences, thus completing the

60 cycle.

The method of filling chamber 4 in a measure duplicates that of Figure IV, in that there is no appreciable time lag between the end of the filling period and the opening of

65 the top slide valve. It will be understood

that solenoid 137 may indirectly open valve 55 through operating the control of any mechanical opening gear. Further, in these embodiments of apparatus in which liquid filling of chamber 4 is not required, said solenoid 138 and pressure switch 123 may be eliminated, connecting wire 120 directly to wire 124 and permitting the upper slide valve to open immediately that the lower valve is closed. Such a connection is shown by hand-

70 operated switch 139, which permits manual opening of said upper slide valve independently of the filling of chamber 4, when this may be desired.

In some cases, a time delay at the end of the opening stroke of either, or both, slide valves may not be desired and switches 134 and/or 136, with their accompanying electrical mechanisms may be eliminated, circuits 120 and/or 129 being continuous from

75 contact points 125 and/or 132 to coils 116 and/or 117. It will also be understood that the interlocking device 101 to 105, inclusive, with the adjunctive switches 114 and 115, may be replaced by any suitable mechanical

80 or electrical gear operated by the closing strokes of the two slide valves and adapted to alternately start and stop motors 83 and 84 in the necessary interlocked manner.

The aforesaid overload relay operated circuit breakers 109 and 110 function to stop and reverse either of motors 83 and 84 if the slide valves operated by said motors stall due to accidental obstructions to movement in either direction, such as by refuse jamming in

85 the valve opening or sand packing in the valve chest. This reversal thus permits the slide valve to move away from said obstruction, the motor so reversed continuing to run in the new direction until another obstruction causes a succeeding reversal.

These ends are accomplished in the following manner. Assuming motor 83 to stall with breaker 110 closed, as shown in the drawing. Overload in circuits 111 and 112 causes over-

90 load coils 140 and 141, in extensions of wires 111 and 112 connected to feed busses 108 and 109, to open contactor 142, previously closed by coil 143 through contacts 156 being closed by breaker 109 when the latter is open. This

95 de-energizes coil 144 and permits breaker 110 to open by gravity, closing contacts 145 which energizes coil 154 because dashpot controlled contactor 146 is already closed by shunt coil 147, contactor 148 controlling said coil 144

100 being likewise closed by said coil 147. This opening of 110 also opens contacts 149 controlling coil 150, which latter when energized closes contactor 151. Said contactor

105 151 is opened by overload coils 153 and 152 in circuits 112' and 111', which are extensions of 112 and 111, respectively.

The energizing of coil 154 now closes breaker 109, starting motor 83 in the reverse direction because of reversal of the leads 111

130

and 112. Closing of breaker 109 opens contacts 155 and closes contacts 156, thus isolating coil 144 and closing contactor 142, which had been opened by the overload condition, through coil 143. Contactor 151 had already been closed by coil 150 prior to the opening of contacts 149, produced by opening of breaker 110 so said opening has no effect thereon.

If now an overload occurs in the motor circuit, overload coils 152 and 153 will allow circuit-breaker 109 to open by gravity, through de-energizing coil 154, breaker 110 will be closed by closing contacts 155, energizing coil 144, and the motor will again reverse. It will be clear that the one pair of circuit breakers will operate either motor, as both motors are fed from the common circuits 111, 112 and 113.

When both motors are stopped, as by opening the main feed circuits, both circuit breakers will open and coils 144 and 154 would tend to simultaneously close both breakers when current is again available if connected directly to the power circuit. This is obviated by shunt coil 147 controlled contactors 148 and 146, said contactors being in series with coils 144 and 154 respectively, because contactor 148 closes immediately coil 147 is energized while the closing of contactor 146 is delayed by a time element, such as introduced by the dashpot shown connected thereto. The prior closing of contactor 148 therefore insures that circuit breaker 110 will be the first to close, and as its closing opens contacts 145, isolating coil 154, the later closing of 146 will have no effect, merely preparing coil 154 for energization when an overload opens breaker 110 and closes contacts 145. It will be understood that contactors 146 and 148 automatically open when shunt coil 147 is de-energized.

Valve levers 16a' and 16a'' of Figures II and III respectively, and 16a and 17a of Figure IV, may either be manually, mechanically or electrically operated, the use of but a single valve to control both cylinders naturally simplifying any automatic device that may be used for this purpose. It will be clear that the apparatus shown in all of the drawings hereof is so directly interlocked that both slide valves cannot be open simultaneously, and if one valve stalls it may be repeatedly reversed until free, functioning in this respect in the manner already described with reference to the apparatus of Figure I. It further will be understood, that the manual or automatic operation of any of the devices herein shown may be controlled by refuse, or concentrate, indicating devices such as disclosed in United States Patent 1,686,435.

I do not limit myself to the specific forms of apparatus herein shown as these are intended to illustrate diagrammatically varia-

tions in the application of my present invention which latter basically covers that association of elements comprising a refuse, or concentrate, chamber fitted with interlocked intake and discharge reciprocating slide valves, the closing of an intake valve directly causing the opening of a discharge valve, said intake valve being at rest during the principal period of motion of said discharge valve and being substantially closed before causing a substantial opening of said discharge valve, and the closing of a discharge valve causing like operations in an intake valve.

It will be understood that there may be one or more refuse, or concentrate, chambers and that said chamber may be provided with single or plural intake and/or discharge valves.

In the specification and claims hereof the term "slide valve" is meant to include any reciprocating valve adapted to the purpose, and while the surface of said valve is generally plane and its movements rectilinear this is not a necessary condition and said term is used to likewise include curved valves oscillating in curved paths. It will also be understood that the term "reciprocation" is meant to include such an oscillation. It will be further understood that the term "piston" is meant to include any plunger or diaphragm structure capable of developing a reciprocating movement from a fluid pressure medium.

I claim:

1. In separating solids of unlike physical properties in which the heavier of said solids fall from a fluid separating body containing liquid into a chamber alternately communicating with said medium through an intake slide valve and with an exterior discharge through a discharge slide valve, said valves being reciprocated by energy externally applied, the improved apparatus comprising in combination means for causing the closing movement of said intake valve to effect the application of energy to produce an opening movement of said discharge valve after said intake valve has closed a predetermined distance; means for applying energy to close said discharge valve; means for causing the closing movement of said discharge valve to effect the application of energy to produce an opening movement of said intake valve after said discharge valve has closed a predetermined distance; and means for applying energy to close said intake valve, whereby the opening of either slide valve is dependent upon the closing of the other, and whereby one slide valve must be closed a predetermined distance before the other can be opened.

2. The apparatus of claim 1, and means for controlling the application of energy to close said valves by power operated means.

3. In separating solids of unlike physical

- properties in which the heavier of said solids fall from a fluid separating body containing liquid into a chamber alternately communicating with said medium through an intake slide valve and with an exterior discharge through a discharge slide valve, said valves being reciprocated by a fluid pressure medium admitted to cylinders containing pistons connected to said valves, the improved apparatus comprising in combination means for causing the closing movement of said intake valve to effect the admission of said medium to the discharge valve cylinder and produce an opening movement of said discharge valve after said intake valve has closed a predetermined distance; means for applying said medium to close said discharge valve; means for causing the closing movement of said discharge valve to effect the admission of said medium to the intake valve cylinder and produce an opening movement of said intake valve after said discharge valve has closed a predetermined distance; and means for applying said medium to close said intake valve, whereby the opening of either slide valve is dependent upon the closing of the other, and whereby one slide valve must be closed a predetermined distance before the other can be opened.
4. The apparatus of claim 3, and means for controlling said admissions by power operated means.
5. The apparatus of claim 1, and means for substantially filling said chamber with liquid before the opening of said intake valve.
6. The apparatus of claim 1, and means for delaying the opening of said intake valve until the liquid discharged from said chamber by the opening of said discharge valve has been substantially replaced.
7. The apparatus of claim 3, and means for substantially filling said chamber with liquid before the opening of said intake valve.
8. The apparatus of claim 3, and means for delaying the opening of said intake valve until the liquid discharged from said chamber by the opening of said discharge valve has been substantially replaced.
9. In a method for separating solids of unlike physical properties in which the heavier of said solids fall from a fluid separating body containing liquid into a subjacent region and accumulate therein, and in which said accumulations periodically are caused to pass from said region into a subjacent discharge after isolation of said region from said body, the improvement which consists in opening communication between said body and said region; in permitting said solids fallen from said body to fall into and accumulate in said region; in closing said communication; in causing the completion of said closing to apply energy for opening communication between said region and said subjacent discharge; in permitting said accumulated solids to discharge from said region through said opened communication into said subjacent discharge; in closing said communication; in causing the completion of said closing of said communication to apply energy for opening said first named communication between said body and said region; and in causing each of said closings to restrain each of said openings to maintain continuously said subjacent discharge substantially isolated from said separating body, whereby said falling solids are periodically discharged, and whereby each of said communications must be closed a predetermined fraction thereof before energy is released to open the other communication.
10. The method of claim 9, and in controlling the application of energy to close said communications by power from an extraneous source.
11. The method of claim 9, and in filling said region with liquid after said accumulation has substantially been discharged.
12. The method of claim 9, and in maintaining said region isolated from said separating body until said region has been substantially refilled with liquid after the discharge of said accumulation.
- In testimony that I claim the foregoing as my invention I have hereunto signed my name this first day of March, 1930.
- THOMAS M. CHANCE.

DISCLAIMER

1,894,020.—*Thomas M. Chance*, Merion, Pa. VALVE GEAR FOR COAL WASHERS AND CONCENTRATORS AND METHOD OF OPERATING THE SAME. Patent dated January 10, 1933. Disclaimer filed March 25, 1940, by *Provident Trust Company* and *Marcus A. Walker*, trustees under the will of *Thomas M. Chance*, deceased.

Hereby disclaim claims 1 to 8 inclusive.
[*Official Gazette April 16, 1940.*]