June 24, 1941. K. PRINS 2,246,532

COAL CLEANING APPARATUS

Filed April 17, 1940 3 Sheets-Sheet 1

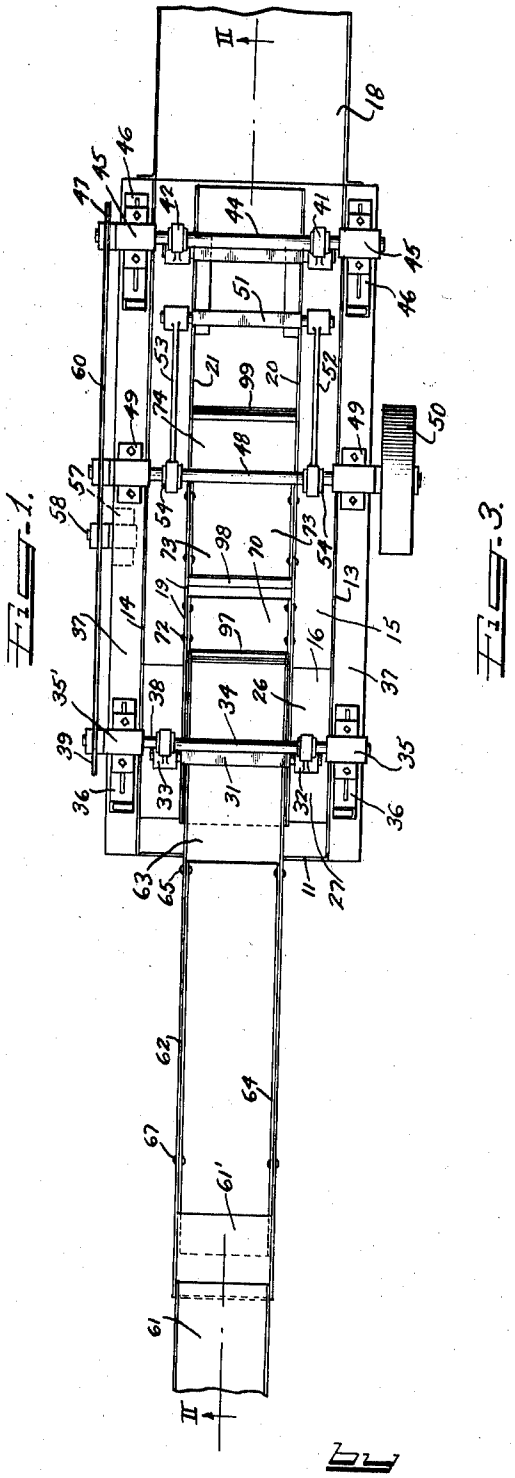


Fig. 1.

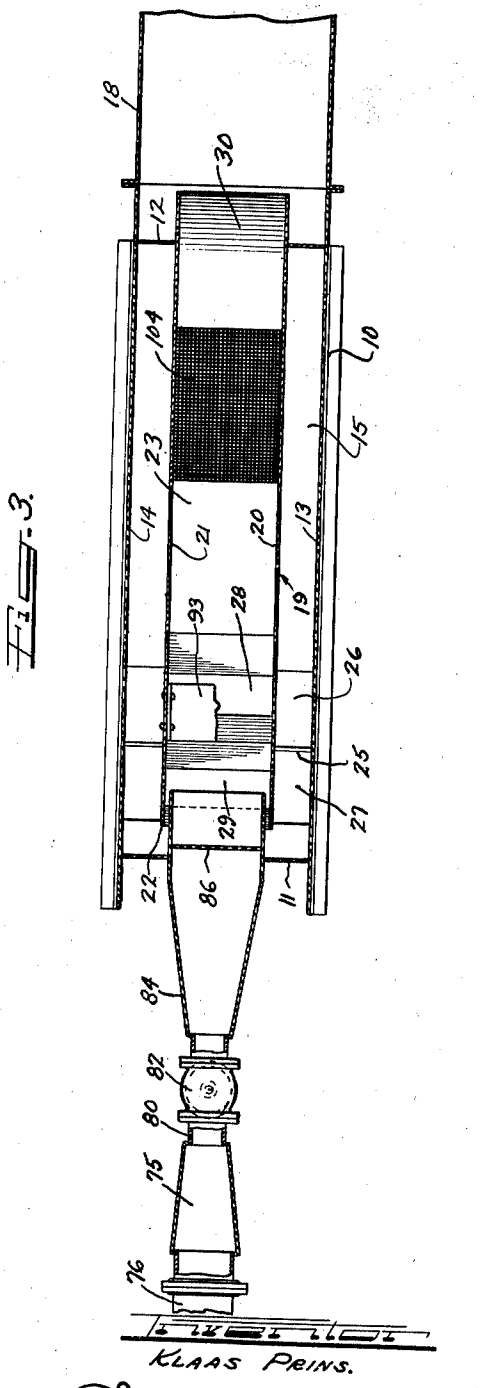


Fig. 3.

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COAL CLEANING APPARATUS

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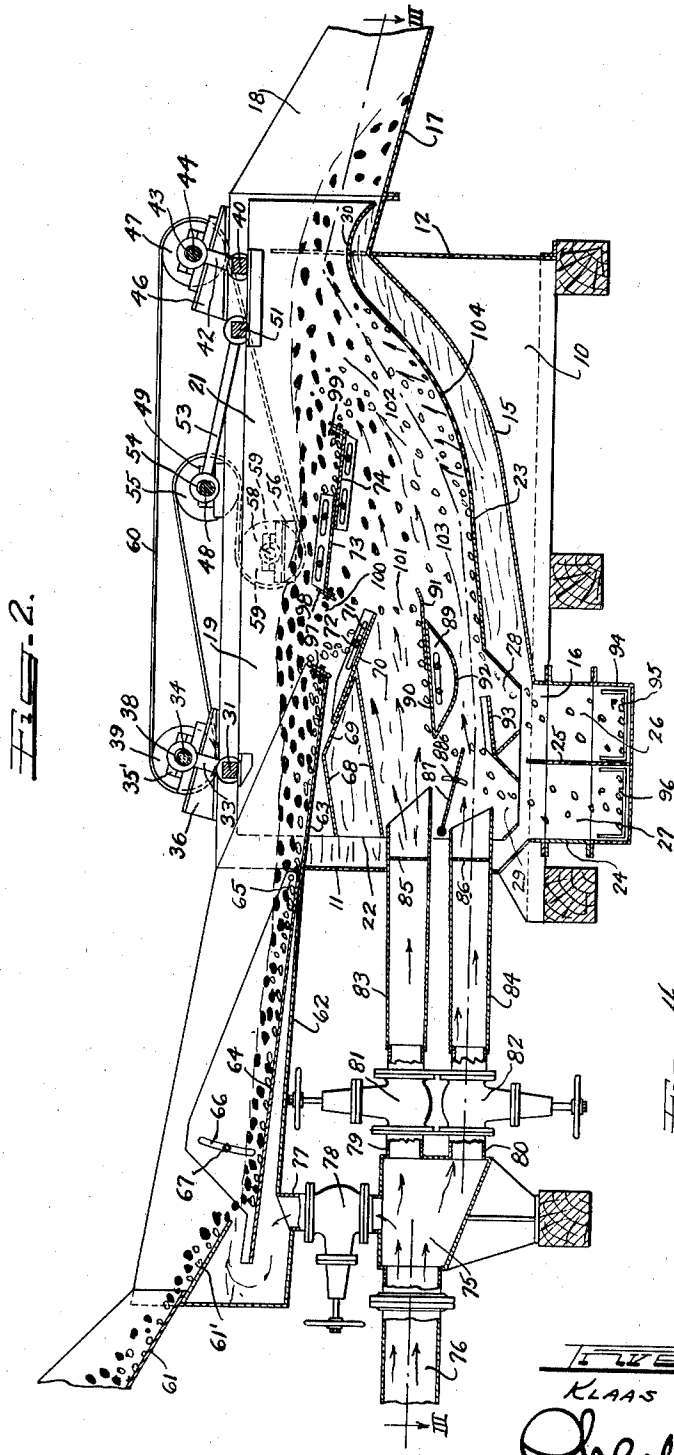


Fig. 2.

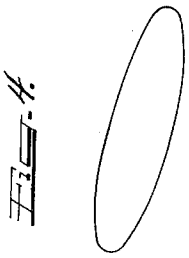


Fig. 4.

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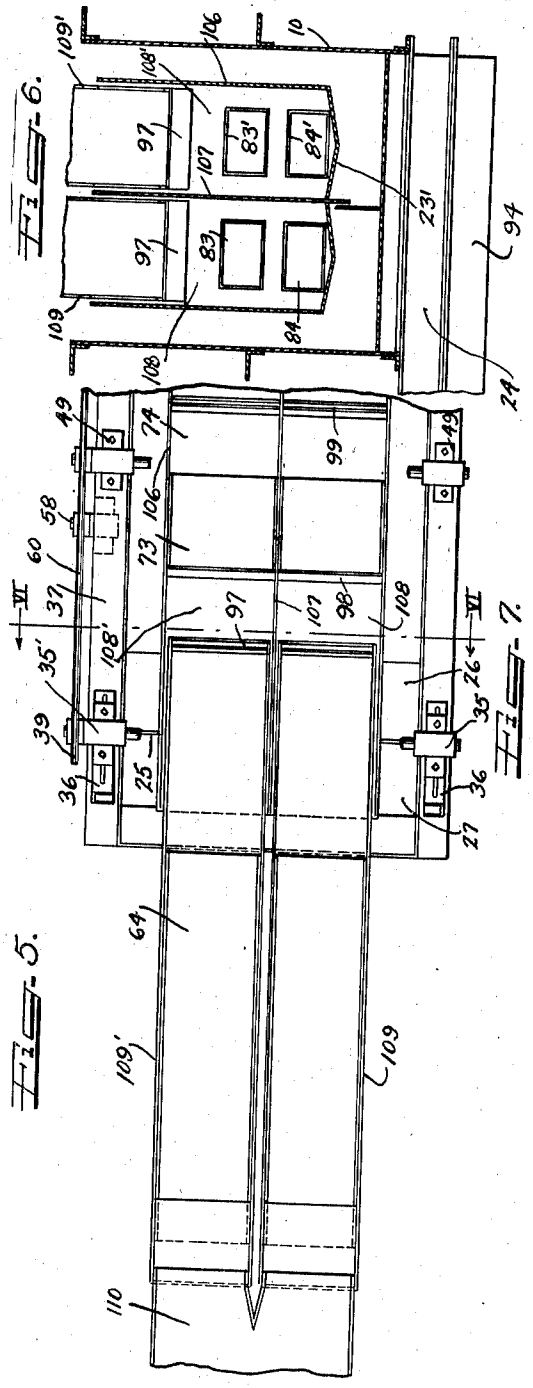
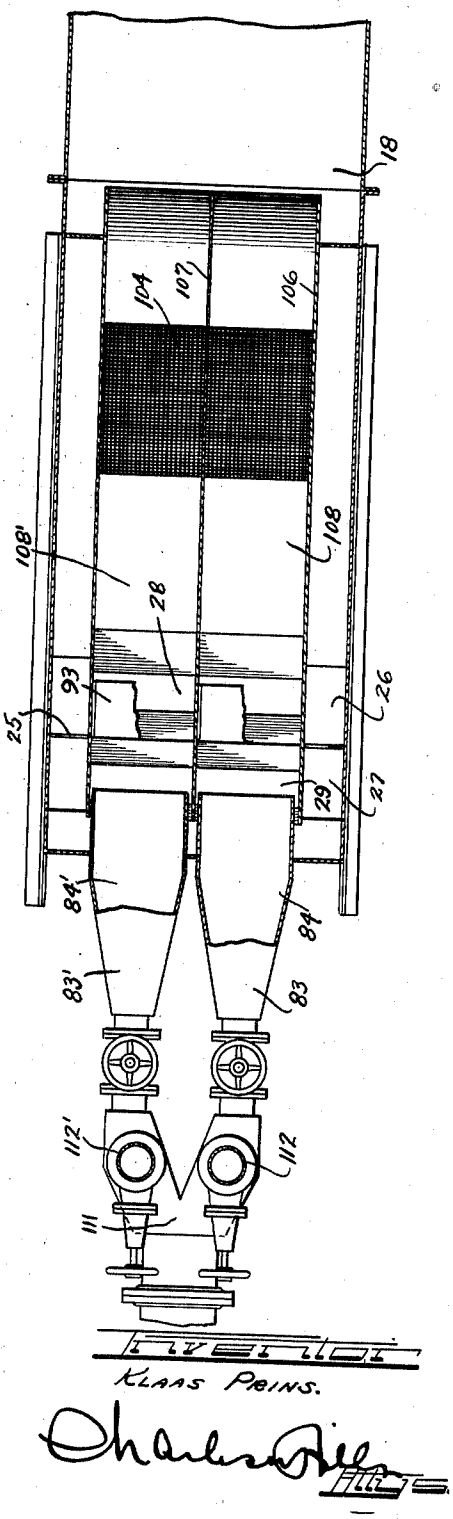


Fig. 6.

Fig. 7.

Fig. 5.



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Patented June 24, 1941 2,246,532

UNITED STATES PATENT OFFICE

2,246,532

COAL CLEANING APPARATUS

Klaas Prins, Chicago, Ill.

Application April 17, 1940, Serial No. 330,081

5 Claims. (Cl. 209—18)

My invention relates to cleaning apparatus adapted particularly for washing and cleaning coal of its refuse matter and other impurities, but which apparatus may be used with equal efficiency for the separation and cleaning of other materials such as metals from ores.

My invention may be considered to embody improvements over the structure, arrangement, and operation of the coal cleaning apparatus disclosed in my Patent No. 2,082,467 granted July 1, 1937.

In apparatus of the type referred to, a mass of coal is washed and separated from refuse matter by the cooperation of the force of gravity, the buoyant and flow effect of water properly applied to the mass, and agitation of the mass produced by oscillation or jigger movement of a trough or jigger frame through which the water and the mass to be cleaned travel.

An important object of the invention is to provide a number of water streams for application to the traveling mass of material to be cleaned, with the streams individually controllable and applied to the mass at the most effective points and direction for accomplishing the most efficient separation and cleaning.

A further important object is to provide improved means and arrangement for supporting in a water tank a jigger structure through which the water and the mass to be cleaned travels, and with the operating means for the jigger structure readily adjustable for the desired oscillation or vibration of the jigger structure or the bodily movement thereof through predetermined orbits, depending upon the agitation desired for the most efficient separation and washing operations.

Another important object is to provide improved means and arrangement for adjusting for the proper relative flow and travel of the water and the material to be cleaned thereby.

Another important object, particularly in the washing of coal, is to provide means for efficiently separating both heavy gravity material and near gravity material from the coal and directing the heavy material and the near material to separate outlets from the washing apparatus for reception by separate conveyors.

Still a further important object is to provide a comparatively long chute structure for feeding coal to the washer and utilization of one of the water streams for effecting a preliminary separation of the mass while traveling down the chute to the washer.

The above specifically referred to and other features of the invention are incorporated in the structure disclosed on the drawings, in which drawings

Figure 1 is a plan view;

Figure 2 is a section on plane II—II of Figure 1;

Figure 3 is a section on plane III—III of Figure 2;

Figure 4 is an enlarged diagram showing an orbit of jigger movement;

Figure 5 is a view similar to Figure 1 but showing a multi-path jigger structure;

Figure 6 is a section on plane VI—VI of Figure 5; and

Figure 7 is a view similar to Figure 3 but showing the multi-path jigger structure.

The cleaning apparatus shown comprises a rectangular tank 10 having the inlet and outlet end walls 11 and 12, the front and rear side walls 13 and 14, and the bottom wall 15 extending from a refuse discharge outlet 16 adjacent to the inlet end wall 11 to slope gradually upwardly to the outlet end wall 12 to terminate at the inner end of the bottom wall 17 of the discharge chute structure 18 extending from the wall 12 and communicating with the tank.

Mounted within the tank 10 is the generally rectangular jigger structure 19 whose front and rear side walls 20 and 21 respectively parallel and are spaced inwardly from the front and rear walls 13 and 14 of the tank 10, the open upper end of the jigger structure being a distance below the upper edge of the tank and the open inlet end 22 of the jigger structure being spaced a distance from the end wall 11 of the tank. The jigger structure has the sloping bottom 23 substantially paralleling but being spaced upwardly from the sloping tank bottom 15.

Secured to the tank bottom under the refuse outlet 16 therethrough is the outlet frame 24 having the partition wall 25 therein dividing the frame 24 into discharge outlet passageways 26 and 27. The jigger structure is shaped to provide two hopper-shaped outlets 28 and 29 above the passageways 26 and 27 respectively through the frame 24 for discharge into the passageways 26 and 27 respectively of near gravity and heavy gravity refuse material from the jigger structure 19, as will be described more in detail later. At its high end the sloping bottom 23 is shaped to form an upwardly convex sill 30 between the ends of the front and rear walls 20 and 21 of the jigger structure and this end of the jigger structure extends a distance into the discharge chute structure 18.

Describing now the suspension and operating mechanism for the jigger structure, extending across the inlet end of the jigger structure and secured thereto is a bar 31 whose cylindrical ends receive the lower ends of front and rear connecting links 32 and 33 respectively. Above the bar 31 extends a shaft 34 journaled at its ends in bearings 35 and 35' mounted on inclined supports 36 secured to supporting flanges 37 at the upper end of the tank. The shaft 34 has eccentric portions 38 receiving the upper ends of the links 32 and 33. On the rear end of the shaft 34 is a sprocket wheel 39.

At the discharge end of the jigger structure a bar 40 extends across the top of and is secured to the jigger structure, the cylindrical ends of the bar receiving the lower ends of links 41 and 42 whose upper ends have eccentric connections 43 with the shaft 44 journaled in bearings 45 mounted on inclined supports 46 on the supporting flanges 37 of the tank 10. The shaft 44 at its rear end has the sprocket wheel 47.

Extending across the top of the tank between the shafts 34 and 40 is a drive shaft 48 journaled in front and rear bearings 49 on the supporting flanges 37 of the tank. This drive shaft may be driven directly by a suitable motor or by means of a belt engaging the flywheel pulley 50 at the front end of the shaft. A distance inwardly of the link engaged bar 40 on the jigger structure is another bar 51 extending across and secured to the top of the jigger structure, the cylindrical outer ends of the bar receiving the outer ends of a pair of rods 52 and 53 whose inner ends engage eccentric portions 54 on the shaft 48. At its rear end the shaft 48 carries a sprocket wheel 55.

On the outside of the rear wall of the tank 10 is a supporting bracket 56 for the bearing 57 which journals a shaft 58 having at its rear end a sprocket wheel 59. The sprocket wheels 39, 47, 55 and 59 are in a common plane and are engaged by a chain belt 60. When the shaft 48 is rotated, the eccentric connection thereof through the rods 52 and 53 with the jigger structure will result in longitudinal oscillation or vibration of the jigger structure which is suspended by the four links 32, 33, 41 and 42, and the belt driven by the sprocket 55 will effect simultaneous rotation of the shafts 34 and 44 which have eccentric drive connection with the links so that the links will effect a vertical reciprocation or vibration of the jigger structure. The bearings for the shafts 34 and 44 are adjustable on their inclined supports 36 and 46 respectively and by such adjustment of the bearings the eccentric links can be given any operating pitch. In the adjustment shown on Figure 2, the links incline toward the right from the vertical. By adjustment of the shaft bearings the links can be brought to operate closer to the vertical line or closer to lines at the left of the vertical for the desired oscillation movement of the jigger structure. The adjustment could be such that the jigger structure would bodily travel through an elliptical orbit such as shown on Figure 4, and by proper adjustment other movements of the jigger structure could be determined. The sprocket wheel 59 engaged by the chain belt serves as an idler sprocket and its bearing 57 is adjustable on a support 56 so that adjustment of the bearing may be made in accordance with adjustment of the bearings for the eccentric shafts 34 and 44 and the chain belt held properly taut.

The material, such as coal, to be washed is fed from a charging chute 61 to the outer end of an inclined trough 62 whose inner end 63 projects a distance into the jigger structure 19 between the front and rear walls thereof. An auxiliary trough 64 within the stationary trough 62 is adjustable for obtaining suitable velocity of the coal stream through the trough. As shown the auxiliary trough is pivoted at its inner end as indicated at 65 and its side wall has slots 66 receiving clamping means such as bolts 67 for securing the auxiliary trough to the trough 62 at any desired inclination.

At the inlet end 22 of the jigger structure a cross frame 68, which may be formed of sheet metal, extends between and is secured to the front and rear side walls 20 and 21 of the jigger structure and presents the downwardly inclined inner end 69 for supporting a discharge and guide plate 70 below the outlet of the feed trough inner end 63. This plate 70 extends between the front and rear walls of the jigger structure and its side flanges have slots 71 for receiving securing means such as bolts 72 whereby the plate may be secured in desired positions of adjustment.

Extending between the front and rear walls of the jigger structure between the outlet end of the trough end 63 and the outlet of the jigger structure is a guide plate structure formed of plates 73 and 74 which are adjustable longitudinally by slot and bolt connections of their sides with the front and rear walls of the jigger structure so that the location of the guide structure relative to the feed trough and the jigger structure outlet, and the longitudinal extent of the guide plate structure, may be adjusted.

Describing now the water supply and flow, a water distributing box 75 in front of the tank and jigger structures and below the feed trough 62 is connected by a main 76 with a water supply source (not shown) which is usually a tank to which the water discharged from the washing apparatus is returned for recirculation through the apparatus. From the distributing box a supply branch 77 extends upwardly to the outer end of the feed trough 62 and the flow through this branch is controllable by a suitable valve 78.

Extending longitudinally from the distributor box 75 are upper and lower supply branches 79 and 80 through which the flow is controllable by suitable valves 81 and 82 respectively. The outer end 83 of the branch 79 extends through the end wall 11 of the tank 10 and projects a distance into the inlet end of the jigger structure below the outer end of the cross frame 68. The outer end 84 of the branch 80 extends through the tank wall 11 and projects a distance into the inlet end of the jigger structure as shown on Figure 2. The ends 83 and 84 constitute nozzles and are of rectangular cross section so that their ends within the jigger structure will extend substantially between the side walls of the jigger structure with enough clearance so as not to interfere with the jigging operation of the jigger structure. The nozzle structures 83 and 84 are also of increasing cross section as shown on Figure 3 for the desired stream flow, and perforated cross walls 85 and 86 are provided near their outlet ends for producing uniform velocity flow.

Between the discharge ends of the nozzle structures 83 and 84 a guide plate 87 is hinged at its outer end between the front and rear walls of the jigger structure and by means of slot and bolt adjusting means 88 the plate may be kept at any desired angle, the inner end of the plate terminating above and between the hopper outlets 28

and 29 on the jigger structure as clearly shown on Figure 2.

Inwardly of the discharge end of the upper nozzle structure 83 and below the guide plate 70 is a guide and directioning frame 89 which extends between the front and rear walls of the jigger structure and may be formed of sheet metal. The top wall 90 of this frame is substantially in alignment with the bottom wall of the nozzle structure 83 and is inclined slightly upwardly toward the discharge end of the jigger structure, and at its discharge end the wall 90 has preferably an extensible apron 91 mounted thereon. The bottom wall 92 of the frame is convexed downwardly as clearly shown on Figure 2.

On the inner side of the hopper outlet 29 a guide plate 93 extends between the front and rear walls of the jigger structure, this plate partially overhanging the hopper outlet 28 and being slightly inclined upwardly toward the outlet end of the jigger structure and being located below the inner end of the guide plate 87 and the inlet end of the guide frame 89 as clearly shown on Figure 2.

The refuse discharge outlet frame 24 communicates with a conveyor frame 94 through which travel the conveyors 95 and 96 for receiving respectively the refuse products discharged from the jigger structure through the hopper outlets 28 and 29. In order that the water may not escape from the tank and jigger structure through this conveyor structure, the conveyor frame is carried upwardly to a height above the level of the water in the washer structure before the refuse material is discharged from the conveyor.

Across the outlet end of the stationary feed trough 62 an adjustable baffle or sill plate 97 is provided. On the front end of the guide plate 73 a directioning and baffle plate 98 is provided and at the rear end of the plate 74 a directioning and baffle plate 99 is provided extending diagonally upwardly.

Describing now the operation, raw coal to be washed flows down the chute 61 and through the auxiliary trough 64 to the outlet end 63 of the stationary trough 62. The water flow from the supply branch 77 is deflected by the inclined end 61' of the chute 61 for flow against and along the bottom of the auxiliary chute, and the stream and buoyancy effect of this water flow will effect a preliminary stratification of the coal mass, the heavier refuse material traveling closer to and along the bottom of the trough while the lighter coal is carried by the stream at a higher level, the coal particles being indicated on the drawings by the heavier shading and the refuse particles by the lighter shading.

As the heavier refuse pieces reach the baffle sill 97 they will be retarded and more or less accumulated and the lighter coal will be floated with the water stream over the sill and across the gap 100 toward the guide frame formed by the plates 73 and 74. The heavy refuse escaping over the sill 97 will in greater part drop down through the gap 100 onto the plate 70 to be further guided and directioned. Some of the coal may also drop through the gap 100 and refuse pieces may be projected across the sill 97 but will be drawn down by gravity through the gap 100 or will strike the baffle plate 98 to be deflected downwardly. Refuse pieces which jump the gap 100 will land on the guide plates 73—74 and travel along these plates while the lighter coal tends to float with the stream at a higher level and the coal will further be directed upwardly by accumulation of refuse at the baffle wall 99.

Some of the water flowing down the feed trough 62 will escape through the gap 100 but this water and coal and refuse flowing down from the plate 70 will be met by the stream of water from the upper nozzle structure 83, this stream being guided by the inclined bottom wall of the frame 68 and the top wall of the guide frame 89 and also the inclined plate 70 so that the stream from the nozzle structure 83 will issue through the throat 101 between the guide plate 70 and frame 89 and will encounter the coal and refuse flowing down from the plate 70 to effect further separation, the lighter coal being directed diagonally toward the gap or throat 102 to meet the stream of coal from the guide plate structure 73—74. The lighter refuse pieces may be carried away with the stream from the nozzle structure 83 but will soon move downwardly toward the bottom 23 of the jigger structure.

The stream from the lower nozzle structure 84 is guided by the plate 89 to be directed through the throat 103 below the guide frame 89 so as to flow diagonally along the sloping bottom of the jigger structure above the refuse material on the jigger bottom and through coal which may have escaped the stream from the upper nozzle structure 83, such coal being directed toward the throat 102 to mix with the other coal for discharge into the discharge chute 18 across the sill 30.

In addition to the water stream through the coal mass, the mass and the water in the jigger structure are subjected to the jigger or vibration movement which materially assists in the efficient separation of the refuse from the coal. Adjustment is preferably made for jigging or vibration movement which will cause the refuse on the bottom 23 of the jigger structure to be urged continually toward the discharge outlet 28.

The gap 100 at the end of the trough 63 is of such width that it may be jumped by lighter refuse pieces, but cannot be jumped by the heavier refuse pieces. Such heavier refuse pieces will drop rather abruptly onto the plate 70 after escaping over the sill 97 and will travel down the plate 70 and drop rather abruptly from the end thereof to be intercepted by the apron 91 on the guide frame 89 and will then flow along the top of the frame 89 against the guide plate 87 and guide plate 93 for discharge into the discharge passageway 27 for reception by the conveyor 96. Any lighter refuse pieces dropping through the gap 100 and passing down the plate 70 will not drop so abruptly and will flow past the inner end of the intercepting apron 91 on the frame 89 and will reach the sloping bottom of the jigger structure to be impelled downwardly by the jigger action for discharge through the hopper outlet 28 into the discharge passageway 26 for reception by the conveyor 95. The adjustment of the various parts can be made such that practically all of the heavy gravity refuse will drop down through the gap 100 for interception and travel thereof to the heavy gravity refuse conveyor 96. The lighter refuse will reach the jigger structure bottom for discharge to the conveyor 95. Thus with my improved washing apparatus the refuse which is heavier than coal is separated from the coal and then the heavier and lighter refuse pieces are separated from each other and discharged to separate conveyors.

A section 104 of the jigger bottom below the outlet throat 102 may be perforated so that during the jigging operation a water stream will pulse upwardly toward the throat 102 and will carry with it any coal which may have escaped the streams from the nozzle structures 83 and 84.

The capacity of washing apparatus thus far described may be increased by increasing the width of the jigger structure for greater width of water stream and coal mass flow. However, with such increased width, eddy currents or other disturbances might arise which would interfere with the smooth and regular stream flow of the water and coal mass and impair the efficiency of the apparatus. I therefore prefer to provide a multi-path jigger structure in which the width of each path is such as to assure smooth regular flow of the water and coal mass to be cleaned. Such multi-flow path arrangement is shown on Figures 5, 6, and 7. With such multi-path arrangement, the tank structure, except for greater width, remains substantially the same as in the structure shown on Figures 1 to 3 inclusive.

Two separate jigger structures each of the proper width could be secured together to form a jigger unit. As shown the rectangular jigger frame 106 has the central longitudinally extending partition wall 107 dividing the frame into two flow paths 108 and 108'. The arrangement as to guide plates, baffles etc. in each of the paths 108 and 108' is the same as that in the single path of the jigger structure disclosed on Figures 1 to 3, and the two path jigger structure 106 is suspended in the tank and operated by the same jigger means as shown on Figures 1 to 3, the various supporting bars and shafts being merely lengthened to extend across the top of the jigger structure and the tank respectively so that both paths 108 and 108' are subjected to the same jigger action. The discharge chute 18 extends across the tank to receive the discharged products from both of the jigger paths and the refuse material discharge outlets 26 and 27 extend across the tank bottom to receive the low and high gravity refuse pieces separated from the coal.

As shown on Figure 5, separate troughs 109 and 109' are provided for the paths 108 and 108' and where the same grade of coal is to be washed in both jigger paths, a common coal chute 110 would be provided. With such multi-path jigger structure different grades of coal could be washed in each of the paths and then each coal feeding trough would be provided with a separate chute. The washed coals are discharged from the separate paths through the discharge chute 18 and the heavy and low gravity refuse from both paths is delivered to the respective conveyors 95 and 96 (Figure 2).

The water supply arrangement for each path may be the same as that shown on Figures 1 to 3. Referring to Figure 7 a water distributing box 111 supplies water to upper and lower nozzle structures 83 and 84 for the jigger path 108 and the upper and lower nozzle structures 83' and 84' deliver the water to the path 108', the flow from each nozzle structure being controlled by a separate valve as illustrated on Figure 2.

A valve controlled pipe 112 supplies water to the outer end of the trough 109 and the valve controlled pipe 113 supplies water to the trough 109'. With such individual valves, the water flow through each jigger path may be accurately adjusted for the most efficient washing of the particular grade of coal traveling through the jigger path.

As shown on Figure 6, the sloping bottoms of the jigger paths may be concave or inclined toward their longitudinal center line so as to keep the refuse pieces out of the corners and to cause more even flow of the refuse pieces to the refuse outlets.

When the washing apparatus is in operation, the water level in the tank will be above the outlet ends of the nozzle structures which deliver water into the jigger structures, and this water in the tank will serve as a seal around the nozzle outlets.

I thus produce a comparatively simple, economically manufactured coal cleaning apparatus which will operate efficiently at low cost, and by virtue of its multi-path individually controlled water flow adjustment may readily be made to adapt the apparatus to the individual requirements of mines and different characters of coal.

I have shown practical and efficient embodiments of the features of my invention but I do not desire to be limited to the exact construction, arrangement, and operation shown and described as changes and modifications may be made without departing from the scope of the invention.

I claim as follows:

1. Coal cleaning apparatus of the class described comprising a frame of U-shaped cross section providing a path for the flow of water and coal mass therethrough, a coal feed trough projecting into said frame for feeding coal mass thereto, a guide plate structure within said frame separated from the end of said trough by a gap and cooperating with the trough to define an upper path for the flow of water and coal mass, means for applying a stream of water for flow down said trough with the coal mass to effect a preliminary separation of refuse from the coal and for flow of clean coal across said gap and along said guide plate structure and with the refuse falling through said gap, means for directing a lower stream of water into said frame along the bottom thereof and toward the frame outlet, means for directing an intermediate stream of water into said frame between said lower stream and the upper stream along said upper path, means for individually controlling said water streams, guide plate structure between said intermediate and lower streams for receiving the refuse falling through said gap and for cooperating with said streams to separate the heavier refuse from the lighter refuse, and separate outlets from said frame for the heavier refuse and lighter refuse.

2. Cleaning apparatus for the purpose described comprising a jigger structure of U-shaped cross section, means suspending said jigger structure for jigging movement, means for effecting such jigging movement, a feed trough for coal mass to be cleaned extending into the inlet end of said jigger structure, a guide plate within said jigger structure between the structure outlet end and the end of said trough, said plate being separated from said trough by a gap and with said trough defining an upper flow path, means for directing a stream of water to flow through said path with coal mass to effect a preliminary separation of refuse as the mass flows down said trough and a further separation as the mass passes over said plate, means for directing a lower stream of water into said jigger structure along the bottom thereof and toward said outlet, means for directing an intermediate stream of

water through said jigger structure between said lower stream and upper stream, said lower and intermediate water streams effecting separation from the refuse of coal escaping through said gap and directing such coal to the jigger structure outlet, means for independently controlling said stream flows, the bottom of said jigger structure sloping downwardly from its outlet end to its inlet end and being there provided with an outlet for the precipitated refuse.

3. In a washing apparatus of the class described, a jigger frame of U-shaped cross section and means for effecting jigging motion thereof, means for feeding coal mass to be washed to the inlet end of said frame, means for directing streams of water into the inlet end of said jigger frame for urging clean coal toward the outlet end of the jigger frame, said jigger frame having a bottom sloping downwardly from its outlet end toward its inlet end and having two outlets at its inlet end, means within said jigger frame cooperable with said water streams for separating falling heavy refuse and lighter refuse and for conducting the heavier refuse to one of said refuse outlets and the lighter refuse to the other of said refuse outlets.

4. In coal washing apparatus of the type described, a jigger frame of generally U-shaped cross section, means for suspending said frame and for imparting jigging motion thereto, a feed trough for feeding coal to be washed into the inlet end of said jigger frame, means for applying individually controllable streams of water to the coal mass for separation of refuse from the clean coal and for floating the clean coal to the outlet end of said jigger frame, the bottom of said jigger frame sloping downwardly from the frame outlet end toward the frame inlet end and at the inlet end having two outlets for refuse, baffle and guide means within said jigger frame between the outlet of said trough and said refuse outlets for cooperating with said streams to separate the heavy refuse from the lighter refuse and guiding the heavier refuse to one of said refuse outlets and for causing the lighter refuse to be directed to the sloping bottom of the jigger frame for delivery to the other of said refuse outlets whereby the heavier and lighter refuse will be separately delivered from said jigger frame.

5. In coal washing apparatus of the class described, a jigger frame of substantially U-shaped cross section, means for imparting jigging motion to said jigger frame, a supply trough for delivering coal mass to be cleaned to the inlet end of said jigger frame, guide means within the jigger frame forming a continuation of said trough but separated therefrom by a gap, means for directing a stream of water to flow down said trough with the coal mass to effect a preliminary separation of the refuse from the coal mass and to direct clean coal across said gap for flow over said guide means and toward the outlet of said jigger frame, the bottom of said jigger frame sloping downwardly from the outlet end of the frame to the inlet end thereof and there provided with two refuse outlets, means for directing separately controllable water streams into the inlet end of said jigger frame for effecting separation of refuse from coal escaping through said gap, and baffle and guide means within said jigger frame between said gap and said refuse outlets for directing the heavier gravity refuse to one of said refuse outlets and the lighter gravity refuse to the other of said refuse outlets whereby said heavy and lighter gravity refuse will be separately delivered from said jigger frame.

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