Oct. 31, 1939. C. E. POOL 2,178,456

METHOD AND APPARATUS FOR SEPARATING MATERIALS

Original Filed April 10, 1937 4 Sheets-Sheet 1

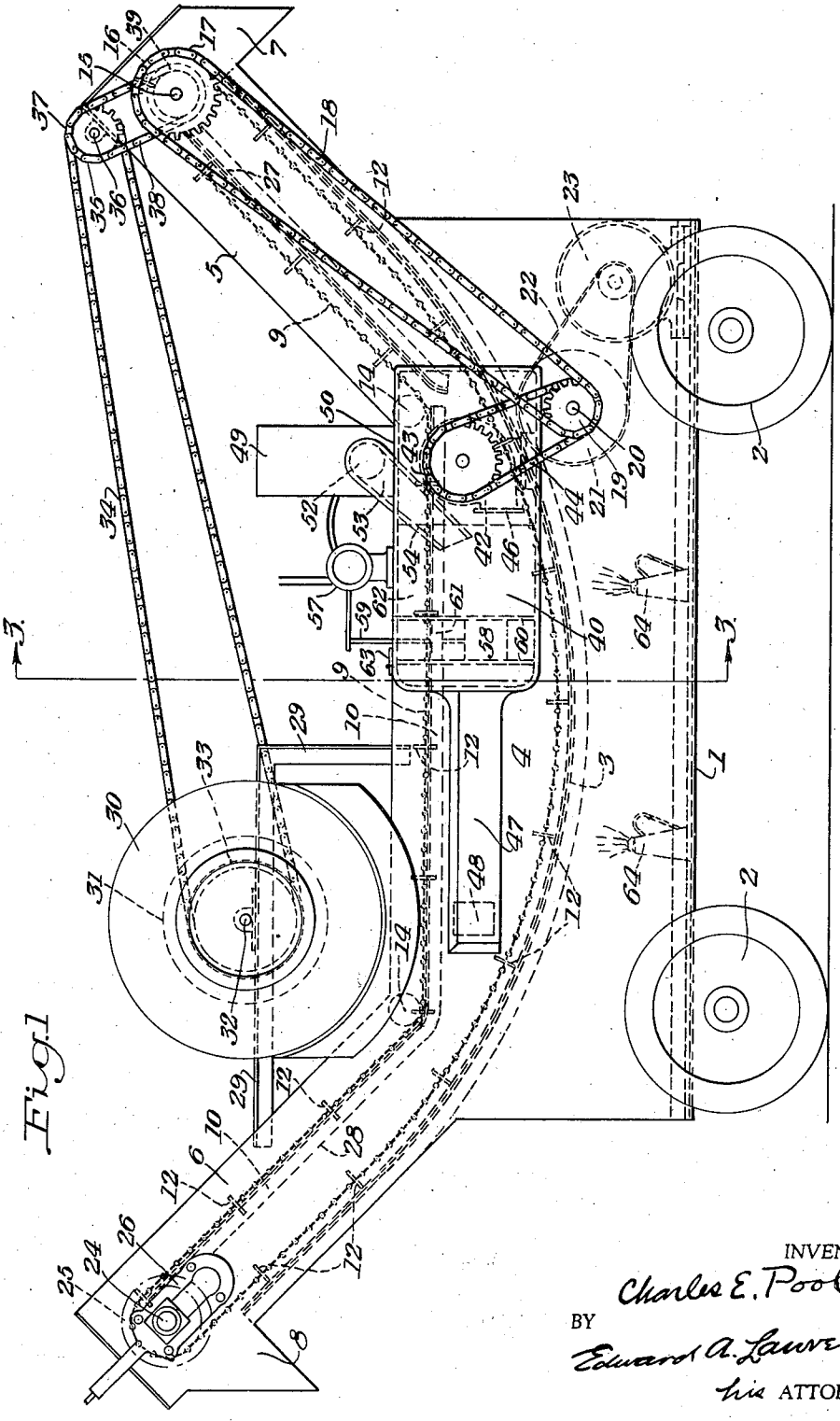


Fig. 1

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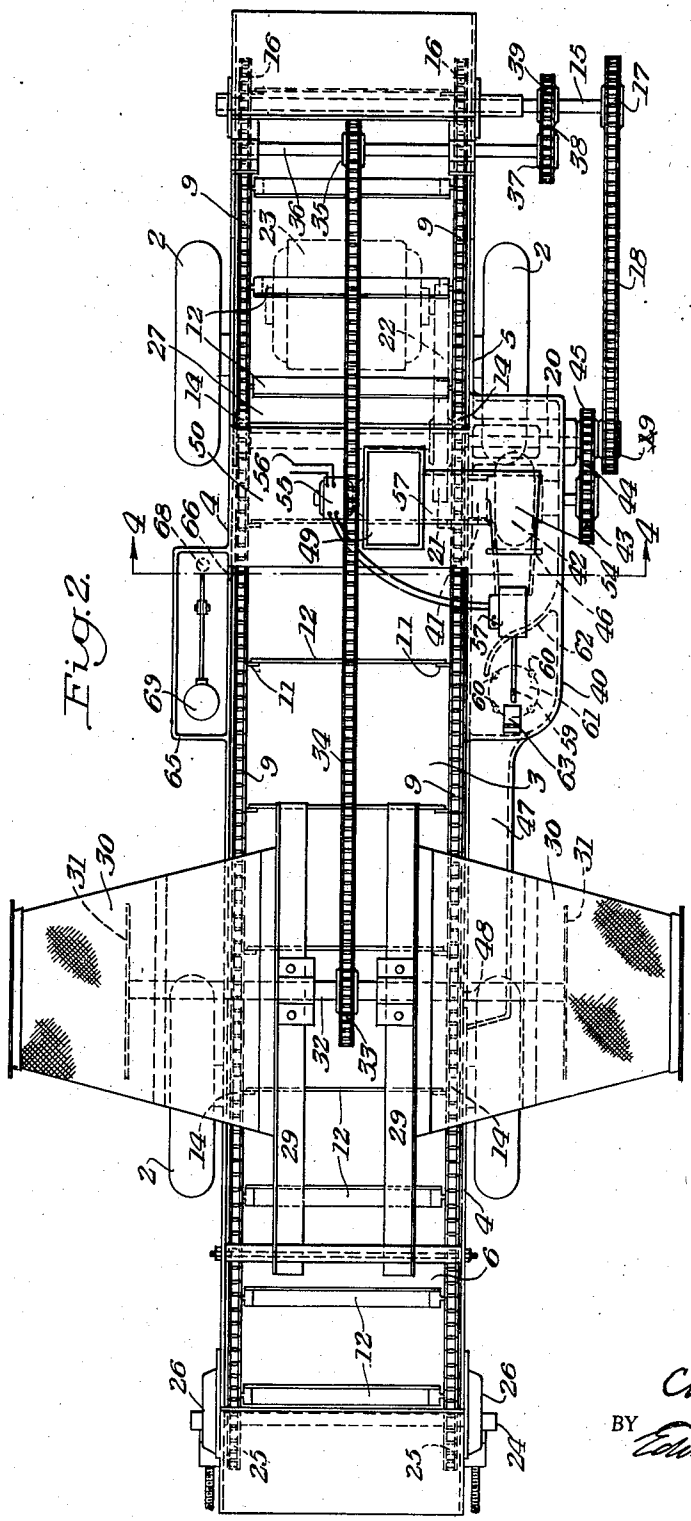


Fig. 2.

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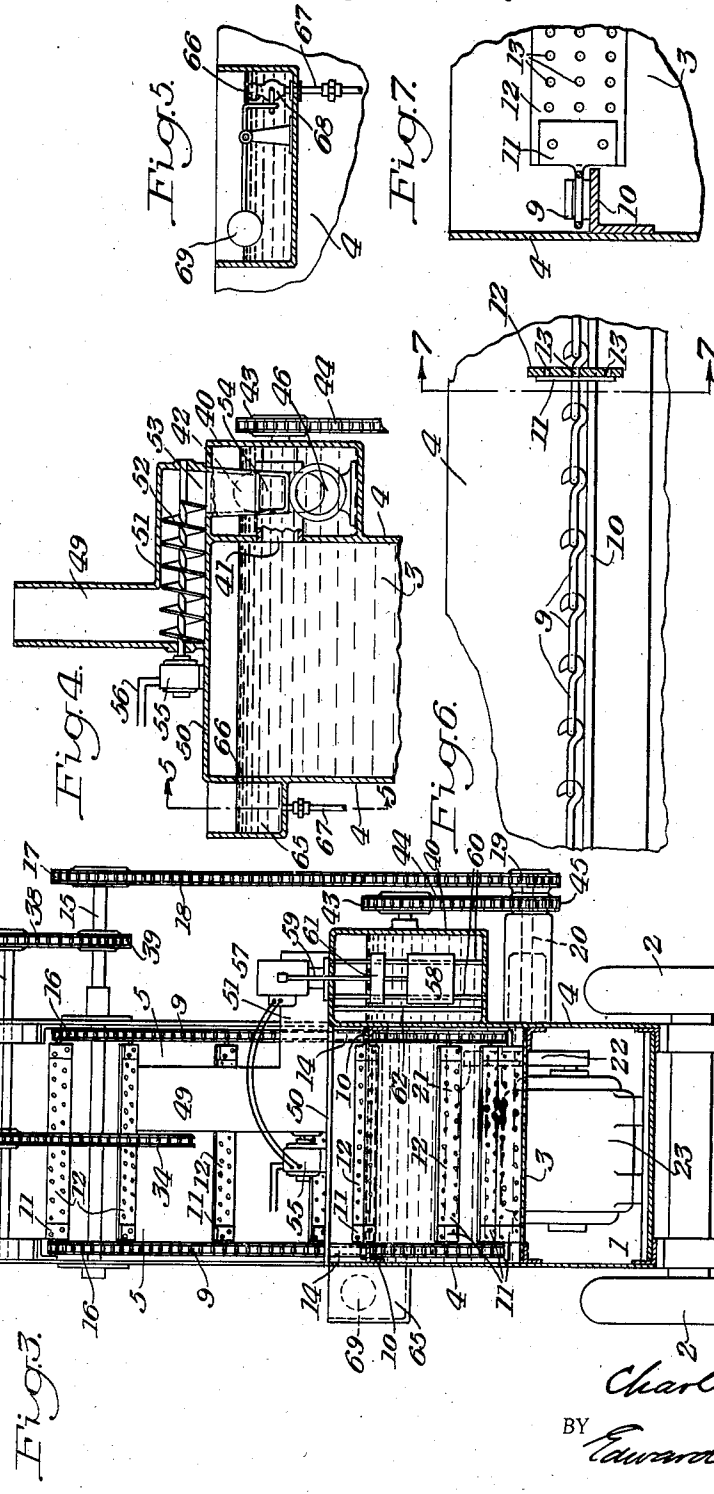


Fig. 3.

Fig. 5.

Fig. 7.

Fig. 4.

Fig. 6.

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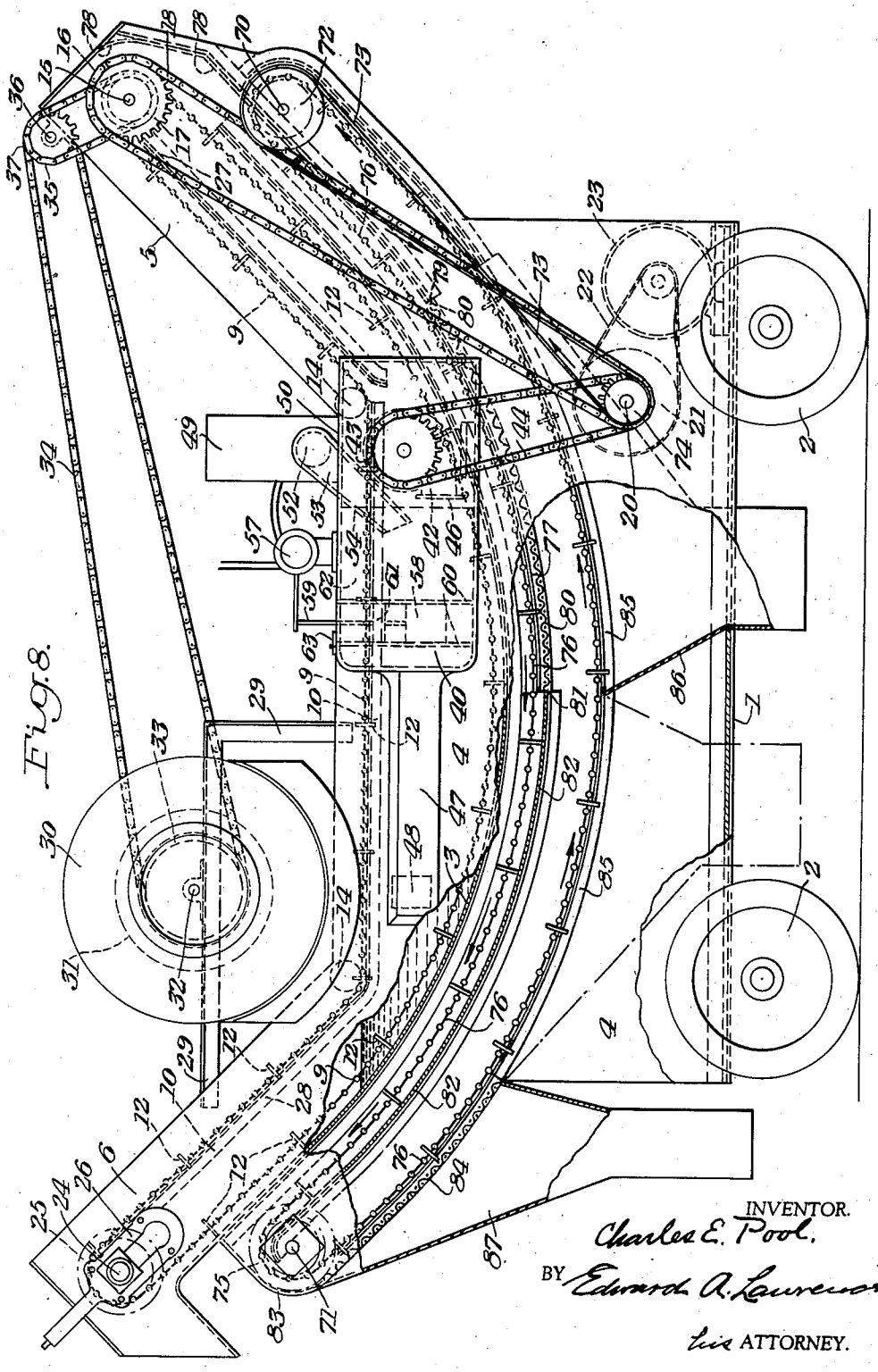


Fig. 8.

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UNITED STATES PATENT OFFICE

2,178,456

METHOD AND APPARATUS FOR SEPARATING MATERIALS

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Application April 10, 1937, Serial No. 136,111
Renewed August 4, 1939

3 Claims. (Cl. 209—17)

My invention relates to the separation of intermingled materials having different specific gravities.

While it may be employed for the segregation of materials of any kind having such characteristics, it is more especially intended for the separation of coal from slate or other impurities and of coke from cinders or other impurities.

Thus, for instance, in the coke regions there are great piles of materials containing usable coke particles of relative small size, say down to a quarter inch, mixed with the incombustible portion of the coal from which the coke was manufactured and which have no fuel value but may be used for other purposes.

The principal object which I have in view is the provision of an improved method and apparatus by means of which the cost and time required for the separation of materials may be reduced and the values may be recovered to a greater degree and in a purer and more usable condition.

Another object which I have in view is the automatic control of the buoyancy of the bath whereby the materials may be readily separated in accordance with their specific gravity.

Another object which I have in view is the improvement in fuel values which are recovered. Thus in the case of coal and coke particles, I impregnate or coat the same, during the separation operation, with substances which will improve their fuel values. For this purpose I may employ various combustible substances, such as crude petroleum, fuel oil, used crank-case oil or other lubricants, powdered coal such as sea coal facing, and the like.

The fuel values may be impregnated or coated with these materials by mixing the latter with the bath which is employed in the process of separation.

Another object which I have in view is the provision of a compact and portable mechanism for the purposes described which may be constructed at a relative small cost and which will be inexpensive to operate.

Another object which I have in view is the provision, in such an apparatus, for the division or grading of the materials having the greater specific gravity in accordance with the sizes of their particles.

Other objects will appear from the following description.

All of the objects above referred to are accomplished by my improved method and apparatus which form the subject matter of the present invention.

In the accompanying drawings, wherein I have illustrated a practical embodiment of the principles of my invention, Fig. 1 is a side elevation with portions broken away in section to show parts which otherwise would be concealed.

Fig. 2 is a plan view of the same.

Fig. 3 is a vertical sectional view taken along the line 3—3 in Fig. 1.

Fig. 4 is a broken horizontal section taken along the line 4—4 in Fig. 2, certain parts being omitted.

Fig. 5 is a detail in vertical section, taken along the line 5—5 in Fig. 4, illustrating the constant level mechanism.

Fig. 6 is a broken elevation on enlarged scale showing one of the conveyers.

Fig. 7 is a detail in section along the line 7—7 in Fig. 6.

Fig. 8 is a view similar to Fig. 1 but showng a modification.

Referring to the drawings, 1 represents a base which is preferably provided with four wheels 2 so that the mechanism may be readily portable and may be moved from location to location as needed.

Supported on said base is a tank having an upwardly curved or concaved floor 3 and vertical sides 4 which may be formed by the upwardly extending vertical side walls of the base. The top edges of the side walls of the intermediate portion of the tank are horizontal but the floor and sides of the tank are extended upwardly and outwardly at either end to form conveyor chutes, the one at the right in Fig. 1 indicated at 5 being used for the carrying away of the values having lesser specific gravity and the one at the left, 6, for carrying away the heavier materials.

At their outer ends said chutes are provided with discharge spouts 7 and 8, respectively.

I provide an endless conveyer, the preferred construction of which is illustrated in Figs. 6 and 7. Thus 9 are the two parallel side chains which slide on ledges 10 mounted on the side walls 4 of the tank. At spaced intervals the chains are provided with rigidly attached and inwardly extending plates 11 to which are attached as by riveting the ends of the transversely disposed blades 12, which are preferably provided with perforations 13. The top flight of the blades are substantially half immersed in the bath while the bottom flight slides along or moves adjacent the curved bottom of the tank.

At either end of the tank proper, the idle hold-down sprockets 14 are provided to hold the center top flight of the conveyer horizontal. At

the upper end of the chute 5 I provide a cross shaft 15 upon which is mounted a pair of sprockets 16 which are engaged by the conveyer chains 9 and around which the chains extend. One end of the shaft 15 protrudes from the chute 5 and is provided with a sprocket 17 connected by a drive chain 18 with a sprocket 19 on a horizontal shaft 20 journaled in the base 1. The shaft 20 is provided with a second sprocket 21 which in turn is connected by a chain 22 with a source of power, such as the motor 23.

At the upper end of the chute 6 a like shaft 24 is provided having mounted thereon the sprockets 25 around which the conveyer chains run. The shaft 24 is provided with suitable means 26 for adjustment to regulate the tautness of the conveyer.

Underneath the rise or upper flight of the conveyer in the chute 5 is an upwardly inclined floor 27 over which the blades 12 slide. A like upwardly extending floor 28 is provided by the upper flight of the conveyer in the chute 6.

It is apparent that materials having sufficiently low specific gravity to float at or adjacent the surface of the bath in the tank would be swept by the upper flight of the conveyer up along the floor 27 of the chute 5 and discharged through the spout 7, while the materials having higher specific gravity and thus sinking to the bottom of the tank would be swept up along chute 6, under the floor 28 and be discharged through the spout 8.

The agglomerated materials are introduced into the bath at a point adjacent the inner end of the chute 6.

I prefer to first separate these materials from dust and fine particles which are of such inconsiderable value as to be unsuited for profitable separation.

Thus I show mounted on the frames 29 erected on the tank, the conical screens 30 which may be of any suitable construction, and into the outer ends of which the agglomerates are shovelled or otherwise introduced. The finer materials are screened out and fall down at either side of the tank, while the coarser materials are discharged into the tank through the inner and discharge end of the rotary screens.

The rotary blades 31 of the screens are mounted on a common shaft 32. At the center of the shaft 32 is mounted a sprocket 33 connected by a chain 34 with a sprocket 35 mounted on the shaft 36 journaled in the upper end of the chute 5. The protruding end of the shaft 36 is provided with another sprocket 37 connected by a chain 38 with a sprocket 39 on the shaft 15. Thus the screens are operated from the motor 23.

It is necesary in the separation of materials in accordance with my invention to so regulate the density of the liquid in the bath that a proper and economic separation in accordance with specific gravities may be effected. In separating such material as coal or coke from other and heavier materials, water alone would not serve as a separation both, since the coal and coke would sink with the slate and cinders.

It is therefore necessary to add substances to the water to provide the proper buoyancy of the lighter materials.

Thus I may mix with the water of the bath such substances as finely divided clay, loam, fuller's earth, fire clay, salt, lime, carbide, slime or chalk.

Again in the case of the separation of coal or coke from impurities, I may mix with the water of the bath such materials as crude petroleum, fuel oil, lubricating oil, such for instance as used crank case oil, mixing the same with the water preferably before the latter is introduced into the tank, thus forming what might be termed an emulsion which will provide the proper buoyancy and impregnate the particles of coal or coke, thus adding to their combustible values and preventing the retarding of their combustion owing to the inclusion in the particles of water from the bath.

Again I may substitute for the clay or other inert substances to densify the water of the bath or I may use in connection therewith a solid which will increase the combustible values of the recovered coal or coke. Thus for this purpose I may use powdered coal such as is generally termed "sea coal facing". This powdered coal tends to float on the bath and thus as the lighter values are skimmed from the bath they are coated with the powdered coal which fills all interstices of the lumps of coke or coal.

Where such inert substances as clay, loam or fuller's earth are employed to produce the proper density of the bath, I provide means for introducing such materials into the tank and for mixing the same with the water of the bath. I also provide means for continuously regulating and maintaining the selected density of the bath during the operation of the apparatus.

Thus 40 represents a chamber or boxing closed at its sides and top and bottom and mounted on or formed against the side wall of the tank and extending longitudinally of the latter.

41 is a port in the side wall of the tank adjacent the base of the chute 5 which connects the interior of the tank below the water line with the inlet of a vortex pump 42 mounted in the chamber 40 and driven by means of a sprocket 43, mounted on the protruding shaft of the pump, and connected by a chain 44 with a sprocket 45 on the shaft 20.

The outlet 46 of the pump is directed toward the other end of the chamber 40. This end of the chamber 40 is connected by a duct 47 with a port 48 in the side wall of the tank adjacent the base of the chute 6 and below the water line.

It is evident that when the pump is operated, liquid will be continuously withdrawn from the bath through port 41 and returned thereto through port 48, thus maintaining a circulation of the liquid in the bath in the direction of the movement of the top flight of the conveyer.

49 represents a vertically disposed container mounted on a cross member 50 which spans the top of the tank. Leading from the base of the container 49 is a tubular casing 51 in which works the conveyer worm 52 arranged to discharge the contents of the container 49. The discharge end of the worm 52 is over a port 53 which leads vertically through the top wall of the chamber 40 and connects to an inclined spout 54 whose lower end is above and in front of the outlet 46 of the pump.

The shaft of the worm 52 extends through the other or inlet end of the casing 51 and is operatively connected to the motor 55 whose feed circuit 56 is connected through a switch 57, preferably a mercury switch such as that known by the trade name "Mercoid", to a suitable source of electric current, not shown.

The switch 57 is operated to close and open the circuit of the motor 55 by means actuated by the relative density of the bath liquid as it flows through the chamber 40.

Thus I show a hydrometer, preferably of the Baumé type comprising a float 58 mounted on a stem 59 and slidable on vertical guides 60. The

upper end of the stem 59 extends through the top of the chamber 40 and is connected to the switch 57 to open and close the same. Also mounted on the stem 59 is a cup 61 to receive suitable weights, such as shot, so that the buoyancy of the float may be regulated to respond to the desired density in the bath liquid.

To prevent the turbulence of the liquid at the outlet of the pump from disturbing the proper response of the hydrometer to the density of the liquid, I prefer to provide the curved baffle 62 which extends from the top to the bottom of the chamber 40 and directs the outflow from the pump around the hydrometer.

In operation the container 49 is filled with clay, loam, fuller's earth, sea coal facing or other material to be added to the bath, and the hydrometer is adjusted to the buoyancy which is desired in the bath.

Until sufficient densifying material has been added to the bath by the operation of the screw conveyer and the pump, the float of the hydrometer will be depressed and the switch 57 will remain closed, thus operating the screw conveyer and adding the densifying substance to the bath liquid as the latter is circulated through the chamber 40. As soon as the selected density has been attained, the hydrometer float rises and opens the switch, thus stopping the feed of material to the chamber 40. In case the density of the bath liquid drops below that desired, the float sinks and starts the motor and more material is added to the bath, and as soon as the desired density is restored, the float rises and interrupts the operation of the motor.

It is thus evident that I am enabled to continuously maintain the desired density.

Where oils or other combustible liquids are to be added to the bath, I prefer to mix the same with the water before the introduction of the latter to the bath, but if desired the same may be introduced into the flow in the chamber 40 and thus added to or intermingled with the water.

The automatic control of the density of the bath is of great impotrance. I am thus enabled to adjust the density of the bath to the buoyancy of the lighter values, such for instance coal or coke, to be separated from the heavier values, and am thus enabled to obtain with great accuracy the desired grades of recovered material, and these results I am able to continuously maintain throughout the prolonged operation of the apparatus. It is evident that if no means for the automatic establishment and maintenance of the desired density were provided, the density of the bath would vary within relatively wide limits and the products of separation would lack uniformity.

To enable me to accurately adjust the buoyancy of the hydrometer while the apparatus is in operation, I may provide a hinged trapped door 63 so that weights may be added to or removed from the cup 61 as may be required.

To enable the apparatus to be operated without interruption in freezing weather, I provide means for heating the bath. Any suitable means may be provided for that purpose. Thus I have shown the torch flares 64 mounted on the base 1 beneath the curved floor 3 of the tank.

I provide means for maintaining a constant level of water in the tank. Thus 65 represents a shallow float tank mounted on the side of the main tank and connected therewith by an open port 66 so that the level of liquid in the float tank will be the same as that in the main tank. 67 represents a pipe for supplying water under pressure or head from a suitable source and controlled by a valve 68 controlled by a float 69 in the tank 65. Thus at all times the water will be maintained at proper level in the bath.

If desired, instead of employing clay or other densifying substances to provide the necessary buoyancy to support the lighter materials in the bath I may inject compressed air through jets connected to the bottom or lower portion of the tank, thus adding to the buoyancy of the lighter materials.

Referring now to Fig. 8, I therein show a modification of the apparatus comprising means for sorting and separating in accordance to sizes the recovered materials of the lesser specific gravity. Thus I show a second endless conveyer mounted beneath the tank and so associated with suitable screens as to sort and separate the materials delivered through the chute 5 by the main conveyer which operates in the tank.

In this modification 70 and 71 refer to a pair of transversely disposed shafts mounted between downward extended side walls of the chutes 5 and 6, respectively. The shaft 71 is arranged for movement toward and away from the shaft 70 to provide for adjustment of the tautness of the sorting conveyer. The shaft 70 is prolonged outside of the side wall and provided with a pulley 72 connected by a belt 73 to a smaller pulley 74 on the shaft 20. The shafts 70 and 71 are provided with sprockets 75 which carry the endless conveyer 76, which may be of any suitable construction but preferably the same as that of the main conveyer. The direction of movement of the sorting conveyer is as shown in the arrows and the belt 73 is preferably twisted for this purpose. The upper flight of the sorting conveyer is supported by the ledges 77 which may be formed by angle irons attached to the inner surfaces of the side walls 4 and similar angle ledges are provided for the lower flight of the sorting conveyer.

At the outer end of the chute 5, the spout 7 is omitted and in its place a floor 78 runs under the upper flight of the sorting conveyer to a point indicated at 79 where a screen bottom 80 extends under such upper flight to an intermediate point such as 81 whence a solid floor 82 extends to the shaft 71. 83 is a curved end wall substantially concentric with the shaft 71 and sufficiently spaced therefrom to provide clearance for the transverse blades of the sorting conveyer and to give clearance for the material being conveyed to the lower flight. Beneath the adjacent portion of the lower flight is the screen floor 84 and then the conveyer is supported by the curved angle irons or ledges, as shown at 85, to the sprockets on the shaft 70.

The screen 80 is provided with interstices or openings of proper size to permit the free passage down therethrough of particles or lumps up to the size of say 1½ by 2½ inches, while the larger lumps are carried along by the conveyer until they reach the screen 84 where larger lumps drop through. The still larger lumps are carried past the screen and drop down on the base 1.

Suitable chutes 86 and 87 are provided to carry off the lumps falling through the screens 80 and 84, respectively. A similar chute may be provided for carrying off the larger lumps falling down through the open bottom of the conveyer beyond the screen 84.

It is evident that by means of my invention separation in accordance with the different specific gravities of intermingled material may be accomplished quickly and with improved accu-

racy of segregation. By automatically maintaining the selected density of the bath uniformity and purity in the recovered materials are assured. Again I am enabled to conveniently sort the product in accordance to sizes and thus more readily prepare the materials for use.

By coating or impregnating the recovered coal and coke with substances having the property of improving their combustible values, I am enabled to produce better fuel materials.

My apparatus is shown to be embodied in an inexpensive compact and readily portable form which enables it to be shifted from lacality to locality and thus avoids the expense of transporting or hauling the intermingled materials from their original site to the separation plant.

I claim:

1. The method of treating and segregating fuel such as coal and coke from materials having greater specific gravity which comprises separating the materials in a bath the specific gravity of which is intermediate of the specific gravities of the fuel and the foreign material, removing the fuel from the upper level of the bath, adding powdered coal to the bath to form a top layer of coal on the surface of the bath, and coating the fuel with powdered coal as it is being removed from the bath by withdrawing it through the added layer of powdered coal floating on the bath.

2. In apparatus for segregating materials having different specific gravities, the combination of a tank containing a liquid bath the specific gravity of which is intermediate of the specific gravities of the materials to be separated and into which the materials are introduced, a by-pass connected to opposite ends of said tank, propelling means for withdrawing a portion of the bath from one end of said tank and forcing it through said by-pass and discharging it into the other end of said tank, means for introducing a densifying material into the by-pass adjacent said propelling means and into the by-passed stream of bath liquid, and a baffled chamber in said by-pass creating agitation to place said densifying material in suspension, whereby to maintain the bath at the predetermined density while maintaining the body of the bath at the required tranquility to permit the proper separation of the materials by gravity.

3. In apparatus for segregating materials, a unitary structure comprising in combination a tank having an arcuately shaped bottom and containing a bath the specific gravity of which is intermediate of the specific gravity of the materials being segregated, a continuous traveling conveyor mounted within said tank to permit its upper flight to withdraw the lighter materials from the upper level of said bath and its lower flight to withdraw the heavier materials from the lower level of said bath, a sorting floor having a plurality of screens of different meshes mounted in an arc conforming to the bottom of said tank and closely geneath the same, a chute extending from said conveyor to said sorting floor for delivering the material to the latter, and a second conveyor for moving the material across the sorting floor where it is separated in accordance with the mesh of the screens.

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