

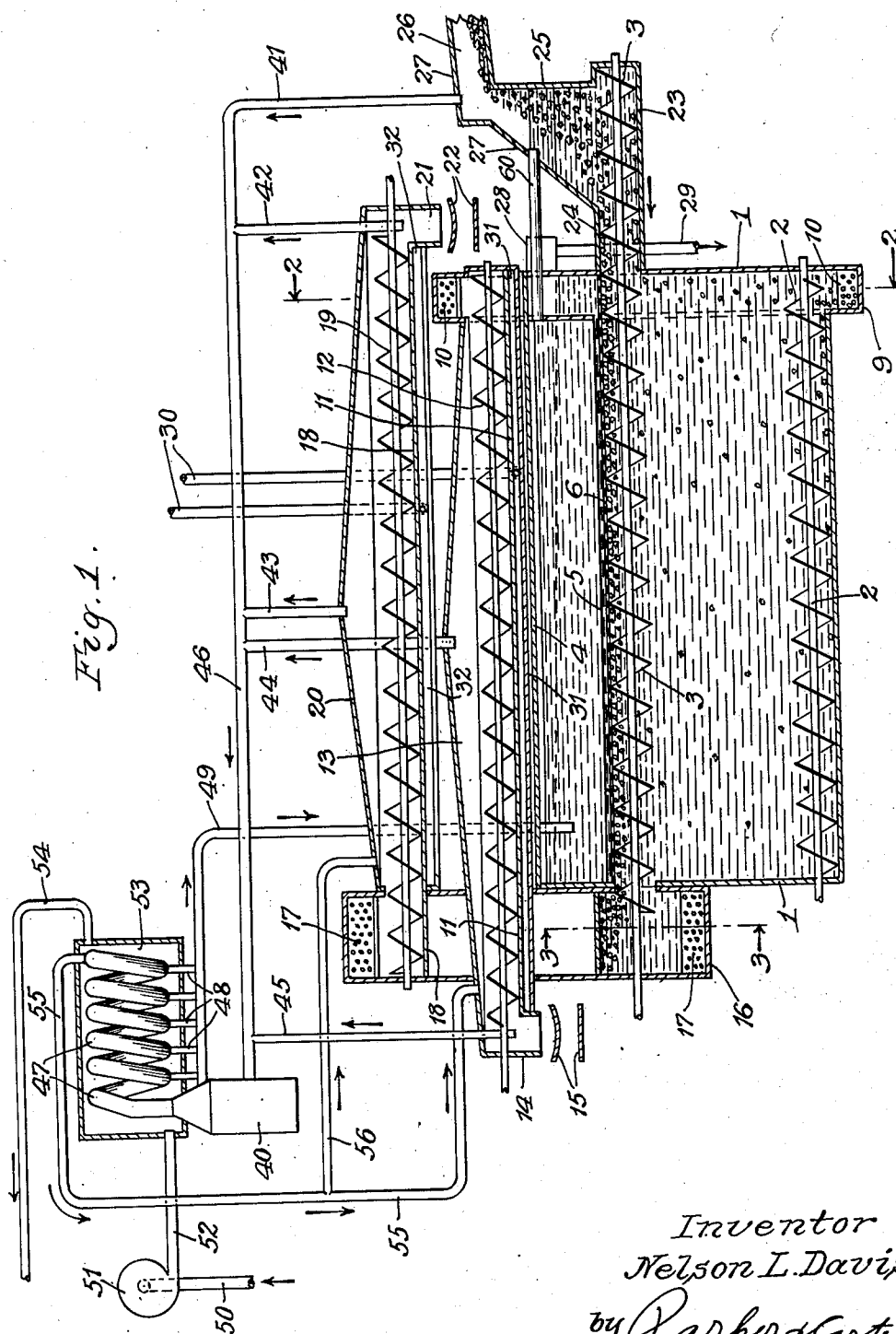
Feb. 23, 1954

N. L. DAVIS
METHOD AND APPARATUS FOR SEPARATING
AND DRYING COMMINUTED SOLIDS

2,670,078

Filed Jan. 12, 1949

2 Sheets-Sheet 1



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Fig. 2.

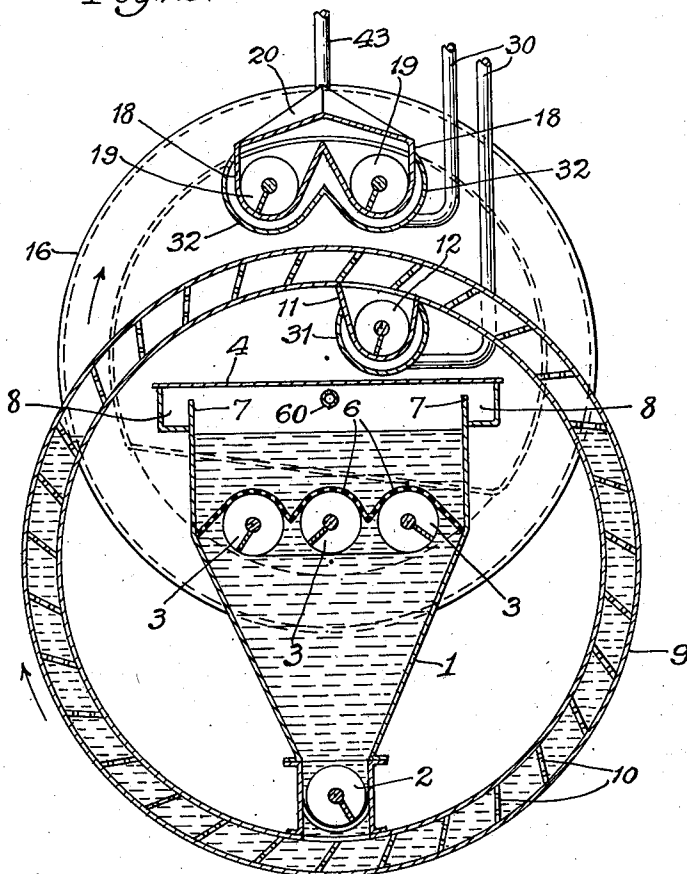
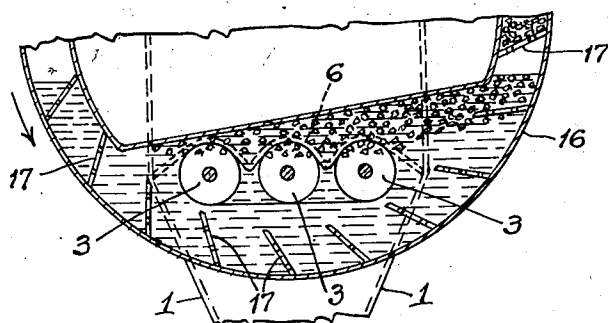


Fig. 3.



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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR SEPARATING AND DRYING COMMUNUTED SOLIDS

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7 Claims. (Cl. 209—172)

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My invention relates to improvements in float and sink separation and drying of solid materials and has for one object to provide an apparatus and process which may be used for the separation or cleaning and drying of coal, ore and the like, by means of a high volatile heavy liquid medium.

Another object of my invention is to provide a float and sink process and apparatus wherein the heavy medium liquid used in the float and sink process is entirely contained within the system and is recirculated in an enclosed apparatus and system without contamination by outside air.

Another object of my invention is to provide a process and apparatus wherein moist or wet coal or ore may be by one single continuous process and in one single apparatus separated according to different specific gravities and dried or freed from water.

Other objects will appear from time to time throughout the specification and claims.

My invention is illustrated more or less diagrammatically in the accompanying drawing, wherein:

Figure 1 is a vertical longitudinal section;

Figure 2 is a section along the line 2—2 of Figure 1; and

Figure 3 is a section along the line 3—3 of Figure 1.

Like parts are indicated by like characters throughout the specification and drawing.

The heavy medium that I propose to use is a high volatile chemical liquid such as chlorinated hydrocarbon which has toxic or poisonous characteristics and it is essential therefore that the medium be so handled that it never escapes from the system and that both the float and sink material, when discharged from the float and sink vessel, be completely freed of the heavy medium.

This medium is heavier than water. It is immiscible with water and when solids wet with water are immersed in a bath of the heavy medium, the water floats to the top of the heavy medium bath and forms a layer of water supernatant on the heavy medium bath. Most if not all of the water associated with the solids will be replaced by the heavy medium and forced upwardly through the heavy medium bath and a solids retaining screen to join the supernatant water layer.

1 is a float and sink vessel having at the bottom a screw conveyor 2 extending longitudinally thereof and above the bottom but below the top

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screw conveyor 3 extending longitudinally thereof. 4 is a cover for the vessel. 5 indicates, as will hereinafter appear, the level of the heavy parting liquid. 6 is a screen extending across the vessel, furnishing a housing for the screw conveyors 3, which conveyors closely fit the screen. 7 indicates weirs formed by the upper edges of the vessel walls which are associated with liquid discharge troughs 8, the weirs and troughs being also enclosed by the cover 4. 9 is an annular refuse boot into which the refuse conveyor 2 discharges. The boot contains an elevating bucket wheel, the buckets 10 of which are perforate. The boot 9 communicates above the vessel cover 4 with a refuse conveyor trough 11 in which is a refuse screw conveyor 12. 13 is a cover for the trough 11 and the outboard end of the trough 11 discharges into a chute 14 and thence into a refuse belt conveyor 15. 16 is an annular boot communicating with the vessel 1, there being an aperture between them so that the screw conveyors 3 discharge into the boot 16. The boot 16 contains an elevating bucket wheel having perforate buckets 17 adapted to discharge into troughs 18 containing screw conveyors 19, the trough 18 being closed by a cover 20. The screw conveyors 19 discharge through a chute 21 onto a belt conveyor 22. 23 is a feed trough extending laterally from the feed end of the vessel 1. The screw conveyors 3 extend outwardly from the vessel into the feed trough. The feed trough is closed at 24 and communicates with a feed hopper 25, which in turn receives the feed through a chute 26. 27 serves as a cover for the chute 26 and hopper 25. 28 is a weir box which receives overflow from the troughs 8 and discharges through the pipe 29.

30 indicates similar pipes forming part of a steam heating system, the details of which are not shown but which communicate with steam jackets 31, 32 about the troughs 11 and 18 so that these troughs may be heated.

40 is a blower. The pipe 41 leads from the feed hopper 25; the pipe 42 from the coal discharge chute 21; the pipe 43 from the coal chute 13, pipe 44 leads from the refuse 11 and the pipe 45 from the refuse chute 14, all through the pipe 46 to the blower 40. The blower 40 discharges through the condenser 47. Bleeder pipes 48 lead from the condenser coils 47 to a return pipe 49 which returns to the vessel below the heavy medium level. Cooling water is drawn through the pipe 50 by the pump 51 and discharged through pipe 52 into the housing 53

which contains the condenser coils and spent cooling water is discharged through the pipe 54. Pipe 55 leads from the upper portion of the condenser to the trough 11 and the pipe 56 to the trough 13.

60 is a pipe joining the feed hopper 25 and the vessel 1 above the heavy medium level.

It will be realized that whereas I have illustrated and described an operative device, still many changes might be made in the size, shape, number and disposition of parts without departing materially from the spirit of my invention. I wish, therefore, that my showing be taken as in a broad sense as diagrammatic and illustrative rather than limiting me to the precise showing.

The use and operation of my invention are as follows:

The vessel is first filled with the heavy medium to the level approximately as indicated at 5. Under these circumstances the heavy medium will stand at the same level in the vessel in the two conveyor boots 9 and 16 and in the feed hopper 25. Water will then be added to cover the heavy medium with a continuous sheet of water. This water level will be equalized through the pipe 60 in the vessel and in the feed hopper 25 but since the level of the heavy medium was above the openings between the vessel and the two boots, no water will enter them but the level of the heavy medium will rise in both boots a distance sufficient to compensate for the added pressure made by the water in the system.

The solids to be treated which for example might well be coal with mixed refuse, slate bone, etc. and which normally have a substantial amount of adhering water, will be introduced into the feed hopper. Some of the solids will sink to the bottom of the hopper, other of the solids will tend to float. The screw conveyors will operate to propel the solids from the feed hopper into the vessel. The continuing supply of solids into the feed hopper will insure the downward movement of both sink and float material to bring it into the range of operation of the screw conveyor. Some of the adhering water will be forced upwardly as the material is immersed in the heavy liquid and there will be a gradual increase of the amount of water in the system as a result of the continuous introduction of water laden solids.

As the solids are fed into the vessel, the heavy material will sink to the bottom while the lighter material will flow up. Its upward movement will be limited by the screen troughs which enclose the upper portions of the screw conveyors 3 and so the float material will be propelled across the tank below the level of the heavy medium and out of contact with the water. The sink material will be propelled in the opposite direction by the conveyor 2. The conveyors will agitate the heavy medium and the solids therein contained sufficiently to permit a continuous upward movement of the water through the heavy medium through the screen to join the supernatant water layer. As the process continues, the vessel will fill until the water is discharged over the weirs 7 from the system and such water will continue to be discharged at the same rate as it is introduced with the solids.

The solids will continuously be discharged by the screw conveyors 2 and 3, the sink material going into the boot 9, the float material into the boot 16. The bucket wheels will raise this material above the level of the heavy medium and altogether out of contact with the water. Because the buckets are perforate, most of the

heavy medium will drain off as the bucket wheel elevates the material above the level of the heavy medium so that both the coal and the refuse when discharged into the troughs 11 or 13 as the case may be, will be generally free of heavy medium except for that relatively small amount adhering to the surface of the solids.

The solids with whatever heavy medium is left adhering to them will be propelled through the troughs 11 and 13. The temperature of these troughs and the material contained therein is raised by the steam jackets 31 and 32 high enough to vaporize the heavy medium and so both refuse and coal is discharged from the troughs in a dry, liquid free, condition.

The drying zones defined by these heated troughs are illustrated as being separate but of course there is no reason why the screw conveyors could not all of them, if desired, be closed in a single housing and forming a single drying zone.

The solids propelled through these drying zones is thus free from heavy medium. It it should happen that some of the water has not been entirely removed from the solids, if an occasional entrapment of water by solids during the passage of heavy medium should occur, such entrapment will be very limited and the temperature in the drying or vaporizing zone will be such as to tend to vaporize some if not all of such small amount of water.

The vaporized heavy medium will of course be mixed with a certain amount of air and perhaps with a certain amount of water vapor and this vapor and air will be drawn up from the heating zone through the blower into the condenser. There the heavy medium will be condensed and the heavy medium and perhaps some water will be returned to the vessel above the level of the heavy medium. If any water is so returned, it will remain in the supernatant water layer while the heavy medium sinks to its level, and thus do no harm.

In order that the blower may not by any chance draw against the vacuum in the heating zones, the air which is returned from the condenser as indicated by pipes 55 and 56 returns freely to the vaporizing zones.

This process and apparatus is directed primarily toward the treatment of fine coal and refuse. If any of the coal, that is any of the float material is small enough to pass upwardly through the screen, it will be mixed with the water as it rises above the level of the heavy medium and will ultimately be discharged over the weir with the water and may be wasted, or recovered by conventional methods.

Another problem, however, rises in connection with the fines which float and that is the danger that they might clog the screen. That danger is minimized by the fact that the screw conveyors immediately beneath the screen set up a zone of agitation sufficient to prevent such clogging, thus if necessary, other means might be used for occasionally freeing the screen or cleaning it.

I have shown screw conveyors and bucket wheel elevators. Other conveying means and other elevating means might be used.

Under some circumstances it might be desirable to have partitions or guides or broken flights fixed in the space between the buckets and the point where they receive the discharge from the screw conveyors to insure a sufficient movement or agitation of the heavy medium and the solids supported therein. Under ordinary

circumstances, however, this will not be necessary.

The float material is held down below the level of the heavy medium by the screens so it never becomes contaminated with water and the problem then is merely to develop enough heat to vaporize the heavy medium which adheres to the coal and refuse, the quantity of which is comparatively small. Since the system is a closed system, heavy medium does not escape either in liquid or vaporized form and the product is dry coal and dry refuse.

The mixed coal and refuse, as it is fed to the system has a certain amount of water in it as a result of separating fine coal from coarse coal by presizing screens operating under water sprays.

Because the heavy medium that I propose to use is heavier than water and because it is immiscible with water, the water adhering to the particles as they go into the system is displaced by the heavy medium, rises to the surface and mixes with the water above the heavy medium so the water whose boiling point and vaporizing point is relatively high, is so to speak, forced away from the coal and refuse by the mechanical action of the heavy medium and is replaced by the heavy medium which, because of its low boiling point and low vapor point, can be easily vaporized so that my apparatus produces clean dry coal.

I have illustrated my invention as applied to a sink and float method for the recovery of coal because that is one of the important uses to which it is put and under these circumstances, the refuse is only a small portion of the weight of the solid material.

The particular arrangement of three screw conveyors for the float material or coal and one screw conveyor for sink or refuse is optional. If I were treating other material where the sink were of higher volume, I might well change the arrangement of the conveyors but the principle is the same in either case. The material as separated passes through a vessel containing the heavy medium which is also the dry medium so far as water is concerned. The sink material goes to the bottom, the float material goes to the top but is held below the heavy medium and so out of contact with the water. Both the sink and float material, after they have been separated or concentrated, are withdrawn from the vessel immersed in water and both the sink and float material are separately conveyed upwardly out of contact with the water in the system, discharged into the heating zone where the heavy medium is vaporized and so separated from the solids. The solids are then discharged separately and the heavy medium is condensed and returned to the system.

There might be circumstances under which I would use a medium lighter than water. In that case, the medium would float on the body of the water. Under these circumstances, the light material would float in the light medium and the heavier material would sink to the bottom of the water bath, the relationship being just reversed, and under these circumstances only the light material would be dry because only the light material with adherent parting medium would be fed to the vaporizing chamber.

It will of course also be understood that so long as the medium I use is immiscible with water and of different specific gravity from the water, that material which is taken out of the

bath out of contact with the water will, so far as the water is concerned, be dry, and when the vaporizable medium is vaporized the solids will be left with little or even no water adherent thereto, thus giving a dry resultant product.

Of course there is always the possibility that some water may remain adhering to the solids even though they have passed out of the water part of the bath into that part of it not mixed with water, but such adherent water will be so low as to be relatively unimportant.

The conveyor I use is preferably an agitating conveyor because this makes it easier for the water to escape from the bed of material and rise upwardly through the bath, thus assisting in the freeing of the material from water.

It will be realized that, whereas I have described and illustrated a practical and operative device, nevertheless many changes may be made in the size, shape, arrangement, number and disposition of parts without departing materially from the spirit of my invention. I wish, therefore, that my showing be taken as in a large sense illustrative or diagrammatic, rather than as limiting me to my precise showing.

I claim:

1. The method of separating and removing water from solids of different specific gravities which consists in providing a bath of liquid heavier than, immiscible with, and more readily vaporized than water, the specific gravity of which is greater than that of some and less than that of other of the solids, maintaining a supernatant layer of water on the surface of the bath, introducing the solids into the bath at a point below the surface thereof and out of contact with the water, conveying the material through the bath to permit the sink material to settle while positively holding the float material below the surface of the bath and without contact with the water, separately withdrawing the sink material and float material from the bath without contact with the water.

2. The method of separating and removing water from solids of different specific gravities which consists in providing a bath of liquid heavier than, immiscible with, and more readily vaporized than water, the specific gravity of which is greater than that of some and less than that of other of the solids, maintaining a supernatant layer of water on the surface of the bath, introducing the solids into the bath at a point below the surface thereof, conveying the material through the bath to permit the sink material to settle while positively holding the float material below the surface of the bath and without contact with the water, separately withdrawing the sink material and float material from the bath without contact with the water.

3. A mineral separating apparatus including a vessel adapted to contain a bath of heavy parting liquid, means for maintaining a layer of water at generally constant level floating on the parting liquid, means for introducing solids to be separated including both float material lighter than the parting liquid and sink material heavier than the parting liquid into the vessel at a point below the level of the parting liquid, means for preventing the rise of the float material to the level of the parting liquid, said means comprising a screen, means for propelling the float component across the vessel beneath and in engagement with the screen, means for separately propelling the sink component along the bottom of the vessel, means for separately withdrawing the

float and sink components from the vessel, at a point below the level of the parting liquid.

4. A mineral separating apparatus including a vessel adapted to contain a bath of heavy parting liquid, means for maintaining a layer of water at generally constant level floating on the parting liquid, means for introducing solids to be separated including both float material lighter than the parting liquid and sink material heavier than the parting liquid into the vessel at a point below the level of the parting liquid, means for preventing the rise of the float material to the level of the parting liquid, means for propelling the float component across the vessel beneath and in engagement with the means for preventing the rise of the float material, means for separately propelling the sink component along the bottom of the vessel, means for separately withdrawing the float and sink components from the vessel, at a point below the level of the parting liquid.

5. A mineral separation apparatus including a vessel, a cover therefor, a feed hopper, two connections between the hopper and the vessel, one above the other, a bath of heavy parting liquid adapted to be contained within the vessel and hopper, the level of the parting liquid being between the two connections between the bath and hopper, means for maintaining a liquid seal within the hopper and the vessel comprising a supernatant layer of water on the bath the level of which is above the level of the upper connection, an elevator boot communicating with the vessel below the level of the heavy liquid bath, a vaporizing chamber, means for heating it to vaporize the liquid, a closed passage leading from the boot to the chamber, means for propelling material through the boot, the passage and the vaporizing chamber and for discharging dried material from the system, a cover for the vaporizing chamber, a condenser, means for drawing vapor from the chamber to and through the condenser to condense it, means for discharging condensed vapor in liquid form to the bath.

6. A mineral separation apparatus including a vessel, a cover therefor, a feed hopper, two connections between the hopper and the vessel, one above the other, a bath of heavy parting liquid adapted to be contained within the vessel and hopper, the level of the parting liquid being between the two connections between the bath and

hopper, means for maintaining a liquid seal within the hopper and the vessel comprising a supernatant layer of water on the bath the level of which is above the level of the upper connection, an elevator boot communicating with the vessel below the level of the heavy liquid bath, a vaporizing chamber, means for heating it to vaporize the liquid, a closed passage leading from the boot to the chamber, means for propelling material through the boot, the passage and the vaporizing chamber and for discharging dried material from the system, a cover for the vaporizing chamber, a condenser, means for drawing vapor from the chamber to and through the condenser to condense it, means for discharging condensed vapor in liquid form to the bath, means for returning gas and air from the condenser to the vaporizing zone, means for withdrawing vapor from the feeding hopper and from the solids discharge to the condenser.

7. The method of separating and removing water from mixed sink and float solids, which consists in immersing them in a bath of liquid heavier than, immiscible with, and more readily vaporized than water, the specific gravity of which is greater than that of some and less than that of other of the solids, permitting the sink material to descend to the bottom of the bath while positively holding the float solids below the level of the heavy liquid, conveying the solids through the bath below the level of the heavy liquid in a continuous moving layer, agitating that layer of material to promote sink and float separation and to promote adherent water to pass upwardly through the bath, withdrawing the solids from the bath and separately withdrawing supernatant water from the surface of the bath.

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