This invention relates to the separation of minerals from gangue by the use of a liquid of specific gravity between that of the mineral and the gangue. The invention will be described as it is applied to the separation of coal from its indigenous impurities, particularly slate, a separation in which the process and apparatus are of particularly great value, but it is to be understood that this description is illustrative, not limitative.

Coal appears to have been known to, and to some small extent used by, the ancients. Its use in China at about the year 1200 is described by Marco Polo and about 1500 Agricola described a process of freeing minerals from their gangue which is the direct progenitor of the jig process of coal cleaning, which has the widest use today. In the early days of coal mining in Europe and in the United States only the thick seams were mined. Hand methods were largely in vogue and the need for anything except hand cleaning, or the most crude of mechanical methods was unnecessary. As the thick seams were used up, however, it became necessary to use thin seams and seams containing veins of rock, which entailed the necessity of removing the rock before the coal could be sold. The method which came most prominently into use and which is today the standard of separating coal and slate depends upon the rates at which bodies of different densities sink through a liquid such as water. It is known that bodies sink through a liquid at rates which are functions of their respective densities, the denser sink the more swiftly. The standard jig washer of the industry takes advantage of this principle, but instead of permitting the solids to sink through the liquid, the liquid is forced through a screen on which the solids rest at a rate which lifts the layer of coal off the heavier slate, the coal being carried with the rush of liquid over a weir and the slate being discharged at a lower point from the screen. Jigs are highly developed and are of excellent capacity and performance. However, the competition of oil has driven coal producers to find means of cleaning coal which will be more accurate in separating useful from useless lumps and producers and inventors have turned their thoughts to those processes of separation which depend upon the parting action of a liquid having specific gravity between that of coal and that of slate.

The use of a parting liquid is to be distinguished from froth flotation. Froth flotation alters the apparent specific gravity of a body by encasing it within a bubble. Parting processes, however, depend upon the use of a parting liquid in which one ingredient of the mixture will sink down and another ingredient of the mixture will rise to and float on the top. Certain phases of the parting liquid process are affected by the phenomenon of altered specific gravity but they are distinguished from froth flotation.

The suggestion was made toward the middle of the nineteenth century that ferrie chloride 1856 or sulfuric acid could be used as a parting liquid for the separation of coal and slate and attempts were made in England to run the ferrie chloride process in competition with the jigs, but the jigs were highly developed, the use of a parting liquid was a bare suggestion and the attempt was a failure because of the undeveloped state of the new process, the highly developed state of jig separation, and the inability of experimenters to make the parting process a success in itself. The original attempt having been made, however, subsequent inventors worked with the suggested process and a host of patents have been issued, particularly in England and in the United States, dealing with processes of the parting liquid type. To the best of our knowledge and belief, however, the only such process that has been used successfully is one that depends upon the parting effect of a suspension of solids such as sand or clay in water. The art with respect to parting media of homogeneous character is in the industry today as it was in the nineteenth century, unable to compete. The parting liquids are worth more than the coal and the losses thereof are so great that they outweigh the theoretical advantages of more accurate separation. The processes themselves, being crude and undeveloped, are incapable of competing with the highly developed processes already in use in the industry. They are incomplete processes, lacking a number of elements essential to success.

It is an object of this invention to separate coal from slate, and other minerals from their gangues or from each other, by a process which depends upon the parting effect of a liquid of intermediate specific gravity. It is another object of this invention to provide efficient apparatus to accomplish such separation. Other objects of the invention will be in part apparent and in part more fully hereinafter set forth.

The objects of the invention are accomplished by inserting the materials to be separated into a moving liquid of specific gravity intermediate those of the materials which are to be separated, by dividing middlings between the mineral and gangue according to the value of the middlings, by effecting the separation under hermetical seal,
Figure 1 is an apparatus capable of carrying out the parting step of the process; Figure 1a is a vertical section through the apparatus; Figure 1b is a cross-section on the broken line 1a, 1c of Figure 1a; Figure 1c is a preferred modification of wedge 335–337; Figure 3c is a section on Figure 1b; Figure 1d is an elevational view partly in phantom and partly in section showing the parting apparatus; Figure 1e is a section of line 1e, 1f of Figure 1d and Figure 1f is a section on line 1g, 1h of Figure 1e; Figure 1f is a section on line 1h, 1i of Figure 1; Figure 1i is a section on line 1j, 1k of Figure 1; Figure 1j shows means for operating the preferred embodiment of Figures 1b and 1c; Figures 1k and 1l show a preferred method of operating the apparatus of Figures 1b and 1c.

Figures 2 and 2c do not refer to section 2 of the apparatus, but to an apparatus by means of which the efficiency of separation can be expediently determined. Figure 2 is a plan view of a portion of the apparatus partly in section and Figure 2a is a cross-section on the line 2—2, 2—2 of Figure 2. Figure 2b is a drawing of a scoop; Figure 2c is an enlarged detail of the hinge connection.

In Figures 1 to 11 is illustrated the separating chain. Referring to the numerals, 3 is an enclosed tank; 31 are channel-shaped edges to openings in the top of the tank; 32 are covers for the said openings; 33 are flanges on the said covers of size to fit within the said channel-shaped edges of the openings; 34 is a liquid which passes through each said opening forming a hermaphrodite seal; 35 is a vent pipe; 37 is a motor support mounted on the said tank; 38 is a motor of variable speed; 39 is a speed reducing gear of customary construction comprising a chain of large and small driving and driven wheels; 390 is a shaft running crosswise of and projecting somewhat beyond the sides of the tank; 391 and 392 are sprocket wheels keyed to the shaft 390 at opposite ends thereof; 393–394 are chains on opposite sides of the tank deriving power from the said sprocket wheels respectively; 395–396 are sprocket wheels mounted on the ends of shafts 397 and 398, respectively, said shafts passing through the wall of the said tank; 399–399 are stuffing boxes which can be filled with grease from the outside of the tank through the fittings 310; 312 are sprocket wheels keyed to the shaft 390; 313 are wheels mounted on the shafts 314 which are journaled within the tank; 315 is a wedge-operated take-up mechanism whereby one roller 313 can be moved longitudinally of the machine to take up the slack in the chain. One take-up means is placed at each end of the roller. 316 is a screw for operating the wedge and moving the roller; 317–317 are conveyor chains; 318 is a flight of a conveyor which is mounted on the conveyor chains 317; 319 are perforations in the flights of the conveyor; 320 is a conveyor pipe bent at the post and having a discharge lip and chute 322; 323 is a wedge-wire screen forming the bottom of the upper portion of the conveyor pan; 324 is a section of the tank wall spaced considerably away from the said screen to permit liquid to make its way through the said screen and to be collected in the said portion of the tank; 325 is a channel lead- ing from the portion 324 past the outside of the tank and connecting with the interior of the tank at 326; 327 are blow-out connections to permit the forcing of a stream of water or other liquid into the tank at that point; 328 is a chute projecting through the side of the tank; 329 are dividing walls in the chute; 330 is a back plate of the hopper; 331 are perforations in the back part of the hopper; 332–334 are a section of a preferred modification of wedge 335–337; 337 is an inclined plate which is inclined diagonally forward and which contains the perforations 331; 3320–3320 are perforated portions of the said back plate of the hopper which are continued beyond the side plates thereof; 333–334 are sides of the said hopper, both being inclined inwardly to the degree necessary to constrain any material entering through the chute 328 and passing to the bottom of the tank to fall within the conveyor pan; 335 is the front wall of the said chute which is constructed, in the form of the invention shown in Figure 8, as one piece of the front conveyor pan; 336 is a section of the said wall inclined diagonally toward the receiving end, and 337 is a portion of the said wall inclined toward the discharge end whereby to present the wedge face toward the charging end; 338 is a conveyor pan; 339 is a wedge-wire screen forming the bottom of the upper portion thereof; 340 is a discharge chute attached to or forming a part of the said conveyor pan; 341–341 are sprocket wheels on the shaft 307 over which are trained the chains 342–342 of the flight conveyor 343; 345 is a bend in the said flight conveyor 343; 346 is a pan extending from side to side of the machine to catch the drip which passes through the wedge-wire screen 399 and return it to the liquid in the tank; 350 is a drain at the rear and lowest point of the tank, whose bottom is preferably inclined; 351 is a chamber beneath the said screen; 352 are a pipe and valve to permit the draining off of the sludge which may collect and pass through the said screen, the said sludge being passed through the said settling tank to be hereinafter described, the connection of the said pipe not being shown; 353 is a chamber attached to the wall of the tank; 354 is a screw operating in a nut 355 fastened to the tank; 356 is a stuffing box through which the said screw passes; 357 is a cylinder attached to the said screw; 358 is a pipe projecting within the box 353 and within the cylinder 351 having there- with a movable fit made liquid-tight by machining or by the use of a satisfactory sealing material; 359 is a valve pipe leading to the box 353; 360 are openings below the parting liquid level connecting tank 3 and weir box 355; 3601 is an opening connecting weir box and tank above the water level; 361 is an enclosed weir box on the side of the machine; 362 is a pipe weir within the box to control the water level. The pipe 363 is connected to the settling tank. 363 is a pipe leading at 364 and 365 into the tank; 366 is a hollow gauge within the pipe 363 and projecting thereabove. Shaft 366 of the said gauge is preferably calibrated on its outside and its hol- lowness is used for the insertion or withdrawal of shot or other heavy material to its interior so that it can be standardized against the specific gravity of the parting liquid in the apparatus to record correctly its level; 367–368 are oppo-
sitely placed hollow projections on the sides of the apparatus; 369—370 are removable covers held on by bolts or other satisfactory means not shown and designed to abut against and form a hermetical seal with similarly placed flanges or similarly projecting members of that apparatus which accomplishes the washing process. Piping 344 is a chute connected to a suction apparatus not shown and through openings 328 to the chute whereby any escaping gases may be caught; 372 indicates the framework which supports the tank; the line 373 indicates the upper level of the liquids in the tank; the line 374 indicates the interface of the separating liquid and the light liquid; 375 is a pipe opening into the tank whose purpose will be hereinafter described; 377—378 are angle bars supported either from the members 332 and 357 or from the sides of the tank by bars which cover the conveyor chains and prevent them from being damaged by the descending slate; 379 is a screen extending preferably the full depth of the liquid to prevent light materials from being washed back into the path of the coal. The parting liquid flows between wall to wall of the tank between the chute and the outer conveyor and from a point slightly above the level of the liquid to a point just short of the lower conveyor.

This apparatus is operated to accomplish this step of the process as follows: Valve of pipe 359 is opened and heavy liquid is admitted to the tank through openings 360 until the level 371 is indicated on the sight gauge 366. Water is then run into the tank through the orifices 375 until the level 373 is reached. A continuous flow of liquid is maintained in the conduit and pipe 375 and the overflow 362, if it is desired, or water may be added intermittently as needed. The height of the parting liquid in the tank is regulated by the overflow 357. As the liquid is admitted it rises in the tank and in the pipe 353 until it reaches the lower opening of the pipe 359 to the main part of the apparatus. The decreased pressure causes a continuous flow of liquid pass into the chamber and out of the tank through pipe 358, or the operation may be made intermittent, control being kept by observation of the sight gauge.

The tank having been filled to the proper level with liquid, coal is dropped from the conveyor into the chute 328, passing in four streams down the divisions 325 by which it is distributed across the width of the tank. The chute 328 may be placed on either side of the machine as is indicated in Figure 1e, an opening on either side being provided, that not in use being closed by a plate 376. The apparatus is started; the motors drive the two conveyors either at the same or at different speeds depending to some extent upon the quantity of material each has to handle. The coal, slate, and other admixed impurities drop into the water layer while still in the chute so that they are dispersed by the water before reaching the parting liquid; the splash made by their falling is dissipated and entrained gas is removed before they leave the chute. Those of the water layer they enter the parting liquid, whose density has been selected to be between that of coal and that of slate. The coal floats on the surface of the parting liquid, the slate sinks down guided by the hopper 334 and, entering the conveyor pan, is picked up by the scraper conveyor blades and carried toward and onto the conveyor pan 346. The specific gravity of the liquid is preferably chosen to be only slightly lower than that of the middlings. The middlings are those portions of the mixture which contain in part the oil and coal, either as a result of the number of openings in the said scraper blades being variable to secure pumping actions of different intensity. As the outer conveyor sweeps sunken material along its conveyor pan and up the incline toward the discharge, some of the entrained liquid tends to fall back through the orifices in the flights and that which remains is sucked out of the material as it is pushed over the wedge-wire screen 323. The slate is discharged through the hopper 322 into the trough 41 which forms a part of the apparatus herein described. The lower plate of the conveyor pan of the inner conveyor 338 is carried well beyond the pinion 345 and is then bent inwardly as indicated at 3460 so that the floated material will be swept on without jamming between the flights and the pan. By carrying the coal by the scraper conveyor blades beyond the sprocket wheels 345 the chain is enabled to bend upwardly, and enough slack is provided therein so that when coal tends to jam the conveyor by taking up slack it may jump and release it without damage. The conveyor flights then sweep the coal back into the washing apparatus elsewhere described. The liquid which is driven by the outer conveyor passes through the wedge-wire screen 323 down through the discharge 324 outside of the main wall of the tank through the passage 325 and the opening 326 into the chamber which is formed in back of the partition 336—337. The liquid which is entrained by the inner conveyor is swept up the inclined conveyor pan, passes through the wedge-wire screen 336 down the drain board 349, and is carried back to the chamber behind the partition 336—337. Slides 333—334 of the trough, together with the sides of the tank, form tubes 380—381 through which liquid from channel 325 and the chamber beyond 336—337 may travel to the receiving end of the machine, entering again into the separating chamber through the orifices 331 of the plate 330. There is thus maintained a constant motion of separating fluid and its superimposed sealing liquid from the receiving toward the discharge end of the machine. The length of the separating chamber, namely, the distance between the plate 330 and the wedge 336—337 is such that the pieces of coal will have risen to the top of the separating liquid and the pieces of slate will have dropped to the bottom before the wedge has been reached, but the middlings, due to the selection of a parting liquid of only slightly lighter specific gravity, form a heavy sludge, slowly sinking. The middlings rich in coal sink at a slower rate than the middlings poor in coal, due to their different densities, and a classification of the middlings takes place before the wedge is
reached. The wedge then directs the richer middlings upward into the coal and the coal-poor middlings downward into the sate.

11 The chief means of varying the proportion of middlings which is thrown into the coal and a means which materially contributes to the production of coal with a standard ash content. In those figures 346 is the bottom of the conveyor pan; 383 is a plate; 382 is a hinge plate; 381 is a hinge connecting the plate 382 to plate 383; 381 and 382 are hooked-shaped members which underlap the edges of the channel irons 371 for sliding movement. On the plate 386 there is connected a lifting rod or cable 387 which extends upwardly between the conveyors and the wall of the tank and through a water seal box 388 mounted in the side of the tank to a point on the outside from which it may be manipulated. 389 are rods. By pulling up on one said rod the plate 383 will be lifted, and the plate 385 will swing toward the receiving end of the machine, the edge 386 of the wedge will have been raised and a greater proportion of the middlings will have been directed into the slate, producing a coal of decreased ash content. If, on the other hand, a coal of increased ash content is desired, a second rod attached at the lower end of plate 385 and projecting through the wall of the tank in the same manner may be manipulated to draw the plate 385 rearwardly and lower the angle 386. As shown in Figure 1b enough room exists between the edge of the conveyor flights and the wall of the tank to permit the passage of a rod, and by stationing and sealing tank 388 entirely outside of the wall 3 no interference between the conveyor and the rods will be experienced. The lower end of the rod may be attached to the wedge by a cable, as shown.

In Figures 1k and 1l is shown another means of adjusting the wedge. In those figures 3 refers to the tank; 390—399 are elongated boxes on the outside thereof (a corner of which is shown in dotted lines in Figure 1); 381 are slots connecting the interior of the tank with the said boxes; 392—392 are links attached to the lower corners of the wedge; 393—393 are pins attached to the links, passing through the slots 391 and mounted in movable blocks 394; 395—395 are rods attached to the links and forming a screw-threaded block 396—396 are reversible screws mounted in bearings attached to the sides of the boxes bearing at their heads pinsion which mesh with pinions on shaft 388 which is mounted in the sides of the tank and projects through the wall of the box and a stuffing box 391; 399 is a hand wheel to turn the rod.

The operation of this apparatus is as follows:

60 The hand wheel 399 is turned, rotating the intermeshed pinions and the rods 396 which extend or restrict the blocks 394 by reason of their screw fit with the interior of portions 395. As the blocks 394 are moved along the boxes, they push the link 392, which being attached to the corners of the wedge 385 move the wedge as indicated in part by the dotted lines of Figure 1k.

A brief description of the apparatus is as follows: The material to be separated enters through the chute into the receiving end of the apparatus and is collected by the hopper which encircles the section of the apparatus in which the actual parting of mineral and gangue takes place. The pumping action of the conveyors keeps the liquid in continuous circulation from the receiving end of the parting chamber to the discharge end thereof. The upper conveyor sweeps the floats onto the conveyor pan, and the looseness of the conveyor permits the coal to jump and free themselves from any particles which tend to jam against the lip of the conveyor pan. The lower flight gathers the sinks and carries them out of the separating chamber. The middlings are carried by the current toward the wedge which forms the discharge end of the separating chamber and are divided according to the proportion of slate and coal they contain, those heavy because of large quantities of slate being thrown into the refuse, and those light because of usable quantities of coal being gathered in the floats. The separated materials are pushed by their respective conveyors over wedge-wire screens, or other suitable draining mechanism, which remove the majority of entrained liquids, and the materials themselves are discharged by the conveyors onto the collecting pans or troughs of the screen to be hereinafter described. The parting liquid which passes through the wedge-wire screens is returned along the sides of the machine and outside the separating chamber to the charging end of the machine and a continuous circulation is maintained. A level of heavy liquid is maintained at any desired point by the adjustable sealed weir at the end of the machine and the level of sealing fluid is maintained by the weir box on the side of the machine. Continuous addition and removal of liquid through the machine is thus possible with intermittent additions as additions become necessary.

Means are provided for blowing out the space beneath the conveyor pans and means are also provided for the removal of sludge from the bottom of the tank.

In Figures 2, 2a, and 2b is illustrated an apparatus for determining the percentage of coal in the sinks and the percentage of slate in the floats, in other words, for determining the ash content of the clean coal as delivered by the system so that the middlings may be divided to the best advantage. In these figures 75 indicates generally a long trough, made preferably of some chemically resistant metal; 750—750 are walls which divide the trough into a series of chambers; 751—751 are trays having foraminous bottoms 752 and preferably solid sides, the shape of the trays conforming substantially to the shape of the compartments of the trough. Each compartment of the trough is provided with a tray. The trays are pivoted at one end to the trough, conveniently by a method shown in Figure 2c. 753 are U-shaped members attached by welding or otherwise to the outer edge of the tray 751; 754 is a pipe or other circular member attached to or forming the edge of the trough 75; 755 are bolts passing through the ends of U-shaped members 753; 756 are handles attached to the lip of the tray 751 opposite to the pivot; 757 are stops so placed that they contact the edge of the said trays and prevent their making contact with the bottom of the trough 75; 758 are pipes and valves leading to each compartment for drainage purposes; 759 are stop bars placed approximately midway of and running the length of the sides of the trays; 760 is a scooping having a foraminous bottom 761 and a handle 762; 763 are means for supporting the trough; 764 is a shelf running lengthwise of and before the trough and having an edge 765 to prevent the escape of liquid and a drainage channel 766 and pipe 767 for such liquid; 768 is a screen to prevent the escape of 75
Solids down the drain. 710 is a means, such as a steam line, to regulate the temperature of the bath.

In normal operation the apparatus will have possibly ten compartments. Each compartment will be filled to equal depth with a liquid. 769 shows a liquid level. For example, the first compartment may contain a liquid of specific gravity 1.9; the next will have a specific gravity of 1.85; the next 1.8; the next 1.76; the next 1.76; etc., the specific gravities being chosen to give the maximum information with the particular coal or other mineral being treated in the process at the moment. A sample of the bottom of the coal which is discharged from the water-sealed conveyer and a weighed portion thereof is put into the first compartment. Assuming that the specific gravity of the compartment has been correctly chosen for the first test, a considerable portion of the charge will sink and the remainder will float. The operator then takes scoop 760, inserts its nose within the tray, as shown in Figure 24, slides it across the runners which are at equal depth in each compartment and withdraws the floats. The liquid is allowed to drain back through holes 752 in the foraminous bottom of the scoop and the floats are placed in the next tank, whose specific gravity is somewhat lower. This procedure is continued until the sample has been divided according to specific gravities. By pulling on the handle of the trays 754, the tray 752 may be escorted through holes 754 back into the trough 75 and the sunken material may be dumped into a pan or other suitable means placed on the table 763.

The system is first calibrated by making ash determinations with the particular type of coal which is being separated, a determination being first made of the specific gravity of the incoming matter to determine the specific gravity of the parting liquid to be used in the tank 3. After operation has commenced, samples are taken of both the sinks and the floats and ash determinations are run to calibrate the system. Thereafter, determination of specific gravities is made by plotting subsequent tests against the control. In this way the coal content of the slate and the slate content of the coal may be determined and from the information obtained adjustment is made to vary the percentage of slate as described. In each instance there will be an accurate check on the distribution of middlings since it will be understood that, if the specific gravities range between that in which pure coal alone will float and that in which slate alone will sink, the specific gravities of the samples which sink in succeeding baths will be in direct relation to their respective quantities of coal and slate. Zinc chloride solution is a satisfactory agent for use in this apparatus because it can be easily diluted to precise specific gravities, but any other satisfactory liquid may be used. Having determined the distribution of the middlings as actually distributed by the apparatus, a prompt change can be made in the setting of the apparatus so that another and more favorable distribution can be made if such proves desirable.

The apparatus which has been described offers an excellent method of accomplishing the process. In the past step of the process the liquid used is preferably organic and of the halogenated hydrocarbon type. However, the process is not limited to such agents since any separating agent which has proper specific gravity and is properly inert to the materials which are to be separated may be used. The factors which are desirable are that a material shall have high boiling point in order that there shall be low vapor pressure at working temperatures, low melting point in order that a material may be liquid at working temperatures and the expense of keeping the compound fluid by specific gravity 1.9; the next will have a specific gravity of 1.85; the next 1.8; the next 1.76; the next 1.76; etc., the specific gravities being chosen to give the maximum information with the particular coal or other mineral being treated in the process at the moment. A sample of the bottom of the coal which is discharged from the water-sealed conveyer and a weighed portion thereof is put into the first compartment. Assuming that the specific gravity of the compartment has been correctly chosen for the first test, a considerable portion of the charge will sink and the remainder will float. The operator then takes scoop 760, inserts its nose within the tray, as shown in Figure 24, slides it across the runners which are at equal depth in each compartment and withdraws the floats. The liquid is allowed to drain back through holes 752 in the foraminous bottom of the scoop and the floats are placed in the next tank, whose specific gravity is somewhat lower. This procedure is continued until the sample has been divided according to specific gravities. By pulling on the handle of the trays 754, the tray 752 may be escorted through holes 754 back into the trough 75 and the sunken material may be dumped into a pan or other suitable means placed on the table 763.

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the capacity of the conveyors which were working at utmost capacity and could not handle a higher rate. The ultimate capacity of the system is at present unknown. Within comparatively leisurely speeds of operation its capacity is ten times that of any previous system, comparison being made on a basis of separating surface areas.

Coal may be prepared by this process with any degree of ash content the operator desires, some- 10 thing has previously been accomplished. Heretofore systems of coal cleaning had made a rough division between coal and slate but the percentage of coal in the slate and the percentage of slate in the coal varied from minute to minute. The idea of producing coal of standard ash content was a desideratum without a means of obtaining it. 95% efficiency has been considered good for coal cleaning processes and many of the mountainous waste banks found in the coal regions contain 15% to 35% of usable fuel. By our invention these waste piles may be reclaimed. No previous method was capable of economically extracting the coal from such waste piles.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that we claim the specific embodiments thereof except as defined in the appended claims.

We claim:
1. Apparatus for the classification of minerals of different specific gravities which comprises a tank, means to admit liquid to the tank, means to admit the level of the liquid to the tank, a separating chamber having receiving and discharge ends, said separating chamber being at least in part below the liquid level and having an opening in the lower part thereof, means to admit a second liquid above the level of the first, means for discharging solids to the separating chamber at the receiving end thereof beneath the level of the upper liquid, conveying means to withdraw sinking solids from beneath the separating chamber, means to draw from the said solids the entrained liquid, means to discharge the said solids from the apparatus, conveying means to remove floating materials from the said lower liquid, means to draw off entrained liquid from the said floated solids, means to discharge the said floated solids from the apparatus, said conveying means moving the liquid continuously from the receiving to the discharge end of the separating chamber, means to return the liquids to said separating chamber adjacent said receiving end, means to drive the said conveying means, and means for draining said tank.

2. Apparatus for the classification of minerals of different specific gravities which comprises a tank, means to admit liquid to the tank, means to maintain the level of the liquid, a separating chamber having receiving and discharge ends, said separating chamber being at least in part above the liquid level and having an opening in the lower part thereof, means to admit a second liquid above the level of the first, means for admitting solids to the separating chamber, beneath the level of the upper liquid conveying means to withdraw sunken solids from beneath the separating chamber, conveying means to collect materials floating in and withdraw them from the said lower liquid, means to draw off entrained liquid from the said withdrawn solids, means to discharge the said solids from the apparatus, said conveying means operating to move the said liquids continuously from the receiving to the discharge end of the separating chamber, and means permitting the return of the liquids back to said separating chamber adjacent said receiving end.

3. In an apparatus for effecting gravity classification of divided solids containing parts of mixed composition, a moving stream of liquid of gravity intermediate the gravities of some of said solids and capable of temporarily suspending some of said parts of mixed composition, an overlying second body of liquid, a channel for confining said stream of liquid to a predetermined path, a wedge-shaped element positioned in said channel and immerge in said moving stream of liquid, said wedge-shaped means serving to effect horizontal classification of the mixed composition materials suspended by said moving stream of liquid.

4. The process of classifying a mass containing separate constituents and pieces of mixed constitution which comprises inserting the said mass in a moving stream of liquid having a specific gravity more than one said constituent, slightly lighter than the average specific gravity of the pieces of mixed constitution, and less than the heavy constituent, transporting the floating pieces and pieces of mixed constitution into the specific moving liquid until a gravity classification has been effected, and gathering pieces of mixed constitution having a useful quantity of the floating constituent into the floating constituent, and gathering pieces of mixed constitution having a lower percentage of the floating constituent into the sunken constituent by horizontally splitting the stream that carries them.

5. In the beneficiation of minerals the process of isolating the better from the poorer middlings which comprises inserting a crushed, roughly sized mass containing the minerals and middlings in a moving stream of liquid having a specific gravity slightly lighter than the average specific gravity of the middling mass, transporting the middlings in the said moving liquid until a gravity classification has been effected, and separating the better middlings from the poorer middlings by mechanically forcing the moving better middlings in the upper zone of the stream and separating the said zone from the remainder of the stream.

6. In the beneficiation of coal according to the process defined in claim 5 the steps of determining the ash content of the materials withdrawn from the top zone of the stream and the ash content of the materials withdrawn from the bottom zone of the stream, and including in the upper zone of the stream all the solids above a certain level thereof, said level being selected to include within the said upper zone a selected quantity of ash producing ingredients whereby to produce a combustible product of uniform ash content.

7. A channel, means to convey liquid from one to the other end thereof, means to fill said channel with liquid, upper and lower conveyors operating in the same direction at a speed which will permit gravity classification of middlings in the said channel, means to admit crushed minerals to said channel in the range of operation of the conveyors, and means to separate the material moved by the upper conveyors from that moved by the lower conveyors comprising adjustable means between the conveyors horizontally partitioning the stream of liquid, and means associated with the said adjustable means to effect the classified lighter middlings into the zone of
the upper conveyor, and the classified heavier middlings into the zone of the lower conveyor.

8. Apparatus for the separation of solids of different specific gravities which comprises a tank, means to admit liquid to the tank, means to maintain the level of the liquid, a separating chamber having receiving and discharge ends, said separating chamber being at least in part below the liquid level and having an opening in the lower part thereof, means to admit a second liquid above the level of the first, means for admitting solids to the separating chamber, conveying means moving in one direction along the channel to withdraw sinking solids from the lower part of the separating chamber, conveying means operating along the channel in the same direction as said conveying means to collect and withdraw materials floating in the said lower liquid, means to draw liquid off from the said solids, and means to discharge the said solids from the apparatus, and a by-pass from the discharge to the receiving end of the separating chamber to permit the liquid to circulate under the impulse of the conveyors.

WILLING B. FOULKE.
WILLIAM A. WILLIS.
CERTIFICATE OF CORRECTION.


WILLING B. POUKE, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 9, for "30" read 10; page 5, first column, line 45, for "specific" read specific; same page, second column, line 57, for "1,2" read 1,1; line 68, for "methylene" read methylene; page 6, first column, line 7, for "1,3" read 2,3; line 9, for "2-ido-" read 3-ido-; line 17, for "dibromothene" read dibromoethene; page 7, first column, lines 67 and 68, claim 2, strike out the words "beneath the level of the upper liquid"; same page, second column, line 62, claim 7, for the word "conduit" read conduct; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of June, A. D. 1939.

Henry Van Arsdale

(Seal)

Acting Commissioner of Patents.