April 30, 1940. H. C. HEATH 2,198,816

ORE SEPARATOR

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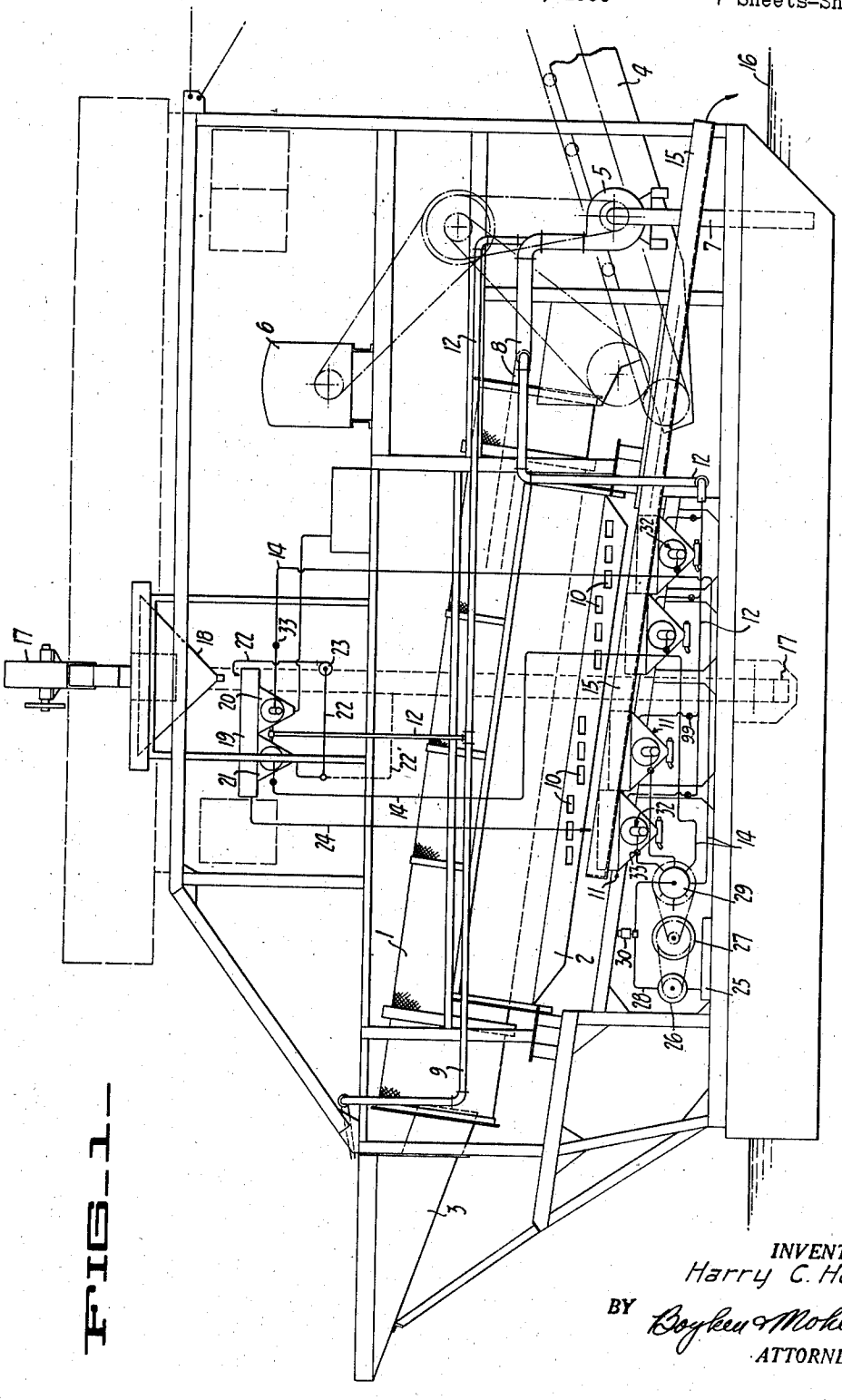


FIG. 1.

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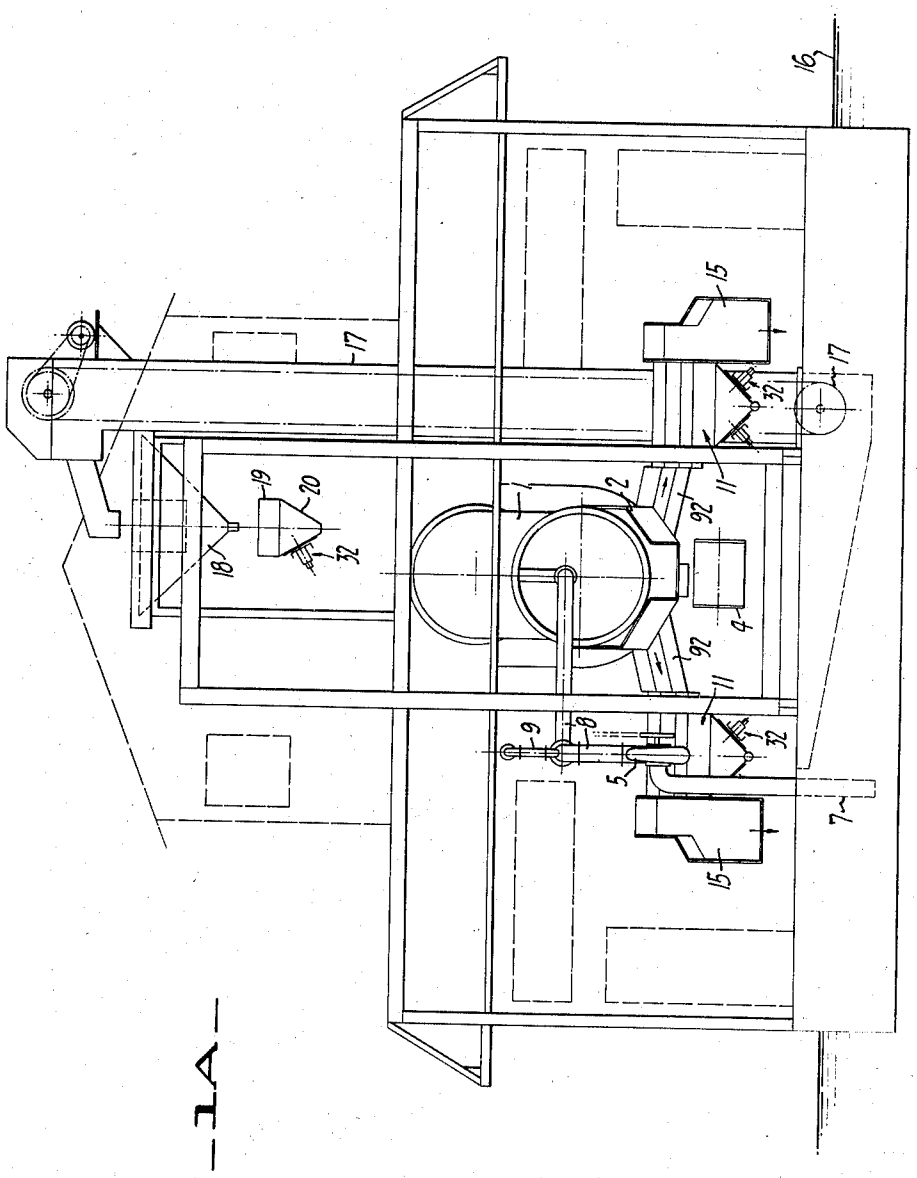



FIG. 1A.

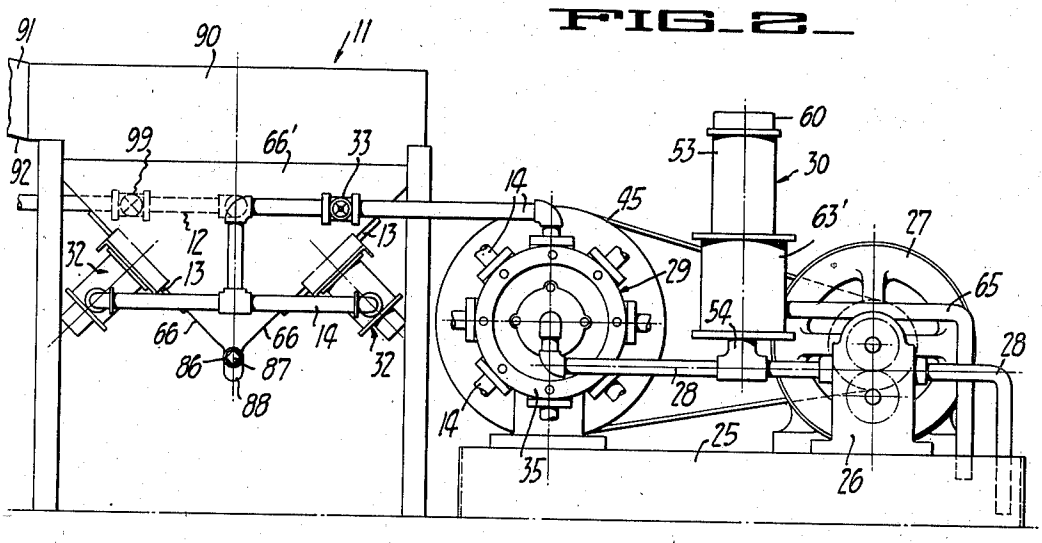
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ORE SEPARATOR

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FIG_2_



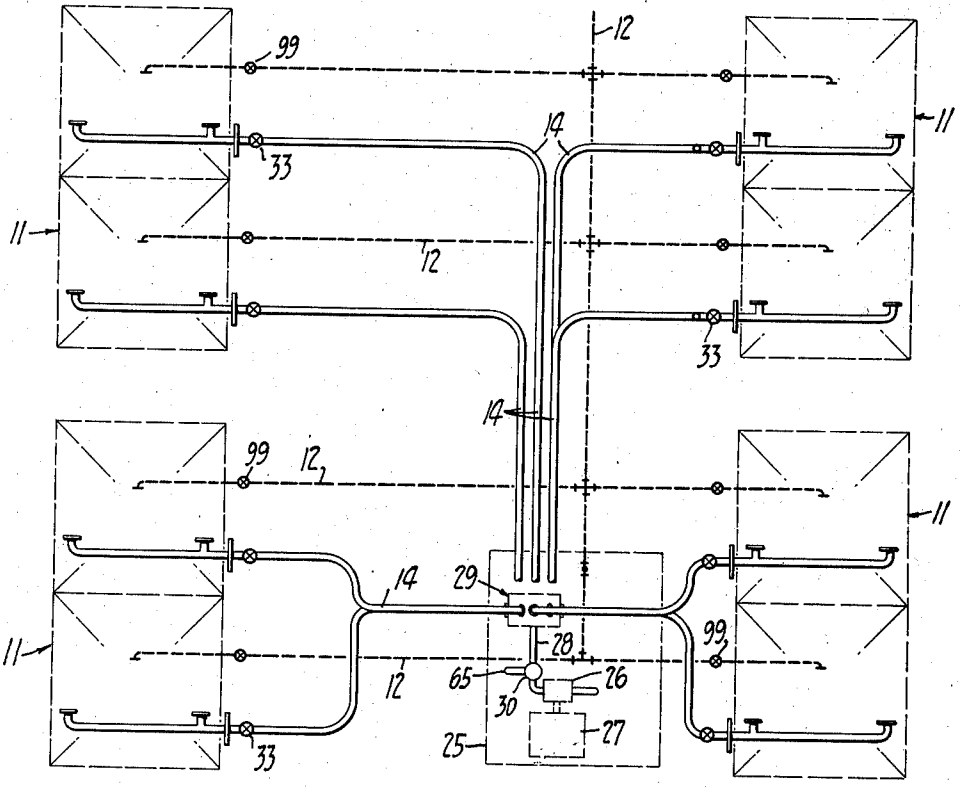




FIG_3_

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ORE SEPARATOR

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FIG. 5

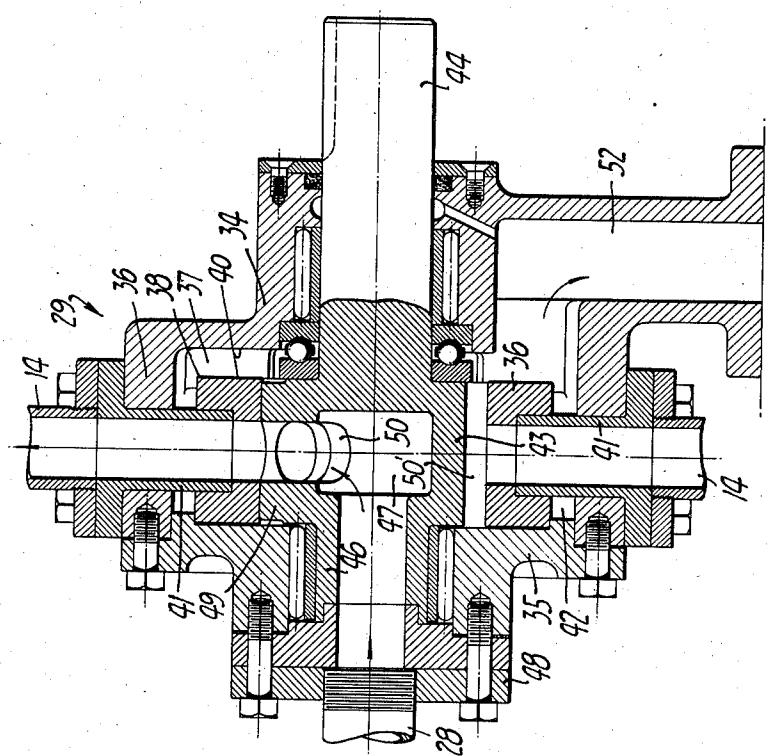
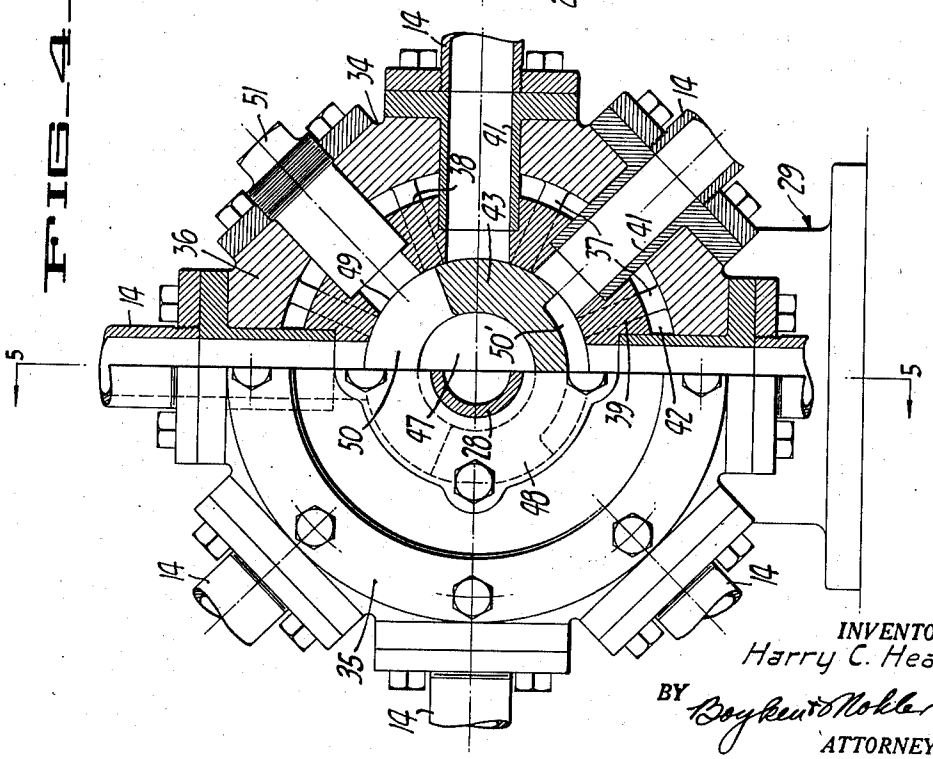



FIG. 4




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ORE SEPARATOR

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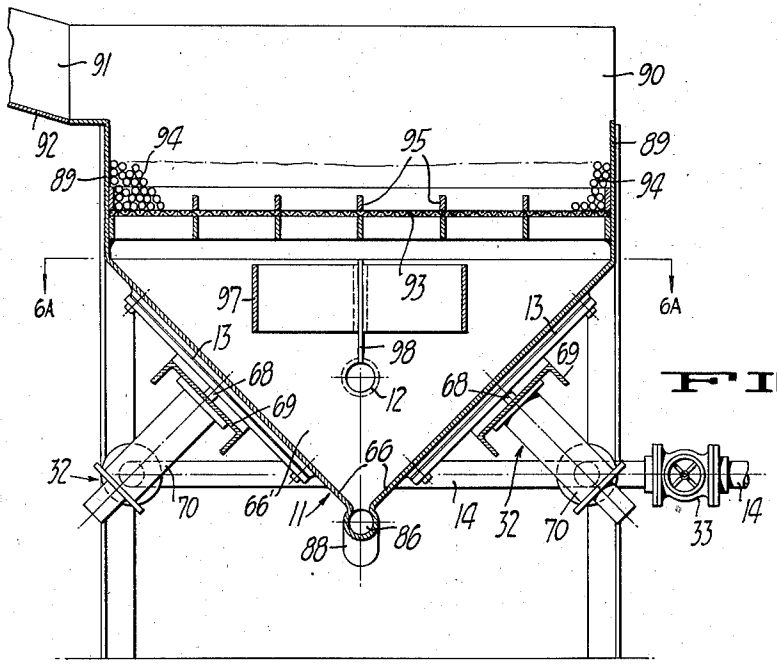



FIG_6_

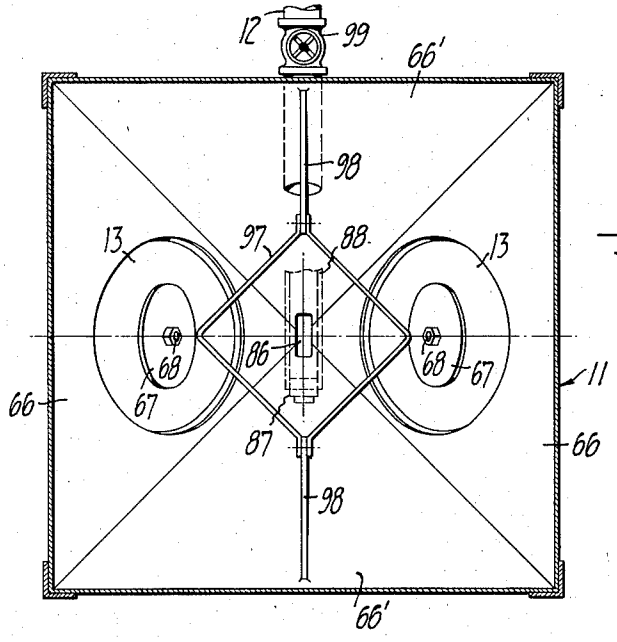



FIG_6A_

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FIG-7-

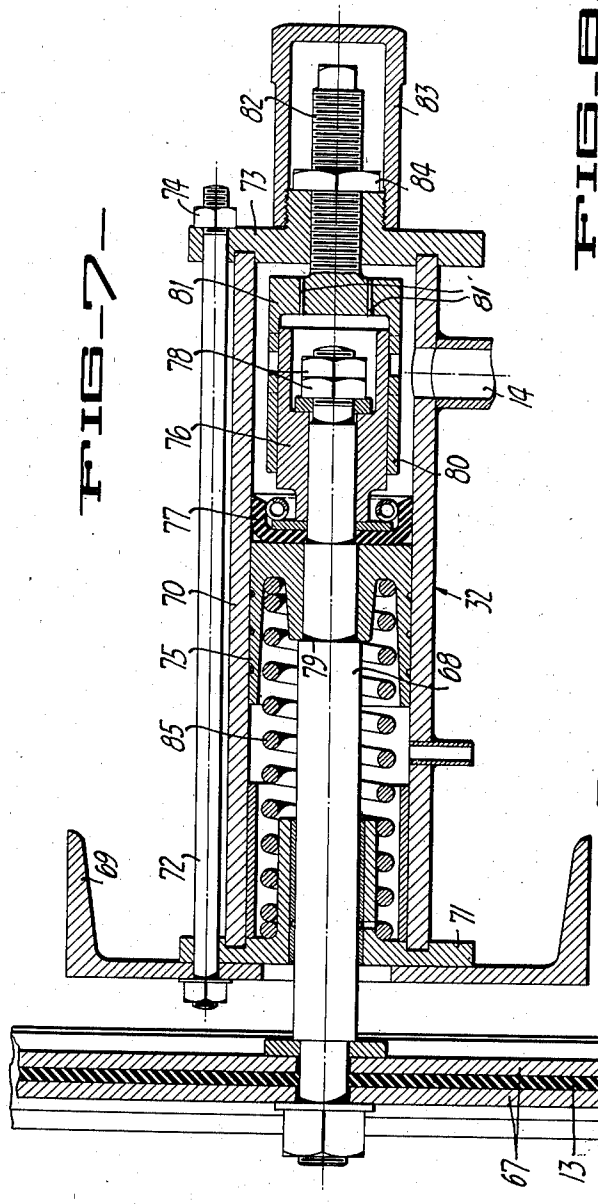
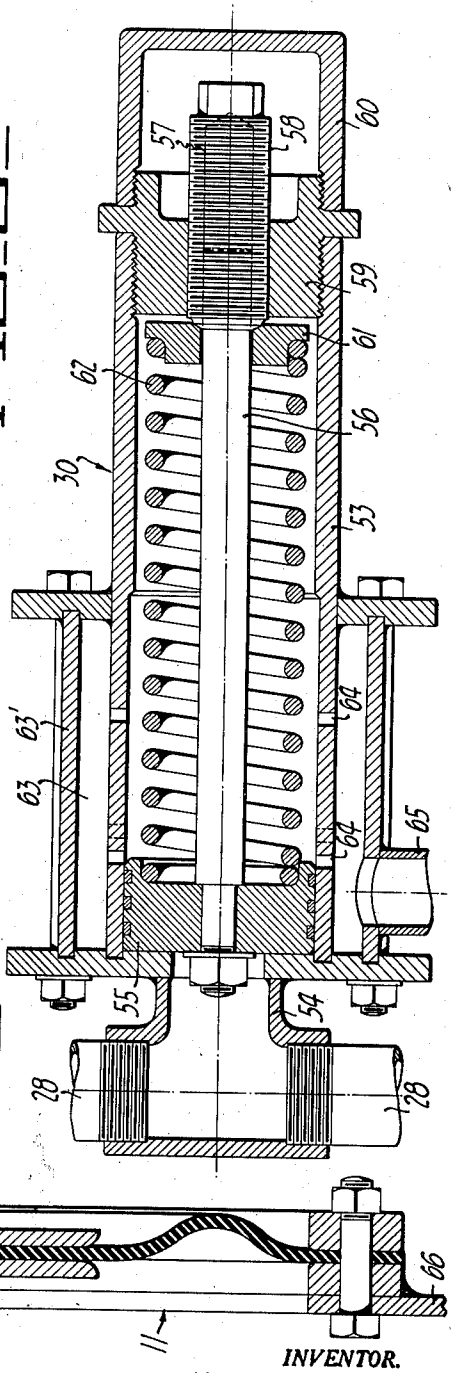



FIG-8-




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ORE SEPARATOR

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FIG. 10

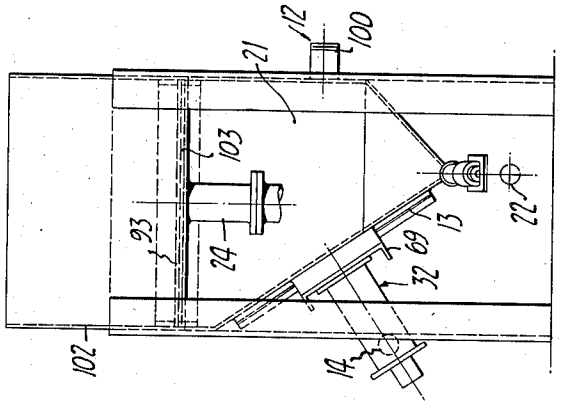



FIG. 11

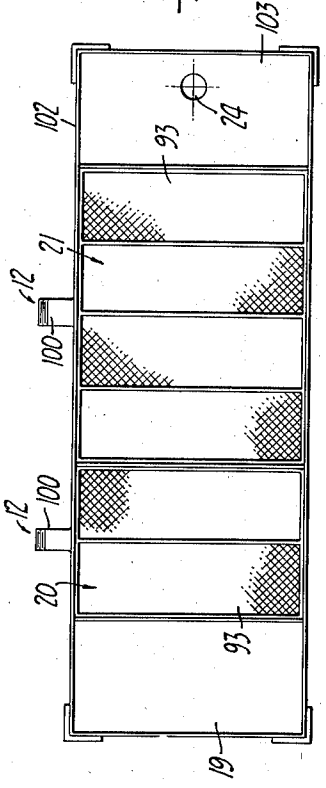
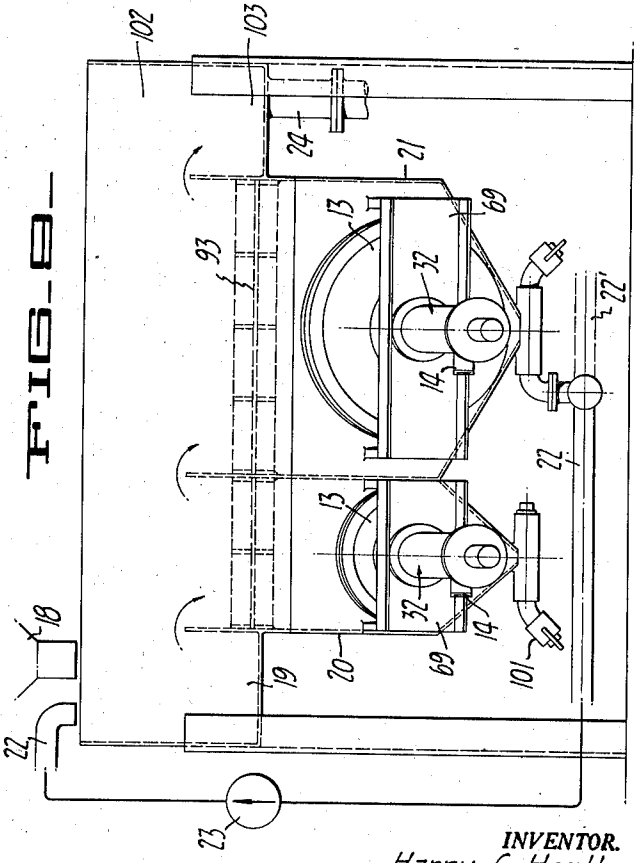



FIG. 9




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Patented Apr. 30, 1940 2,198,816

# UNITED STATES PATENT OFFICE

2,198,816

## ORE SEPARATOR

Harry C. Heath, San Francisco, Calif.

Application June 20, 1938, Serial No. 214,676

10 Claims. (Cl. 209—455)

This invention relates generally to ore separators in which the values are separated from the ore and has for its objects improved apparatus for efficiently and economically effecting such separation and which apparatus includes improved jigs in which the water and material therein including the ore is subjected to pulsations caused by alternate applications of fluid pressure transmitted to the jigs and the characteristics of which pressure may be varied in a single jig or differently in several or many jigs as may be desired, and in which the several or many jigs are operated from a single source of fluid pressure. Other objects are the provision of improved means for removing practically values only from this ore at one point in the separating process and thereafter completing the separation of values from the remainder.

Still further objects and advantages will appear in the specifications and drawings annexed hereto.

In the drawings, Fig. 1 is an elevational diagrammatic view of a dredge to illustrate the general relationship of the jigs to the other elements of the dredge as well as their relationship to each other.

Fig. 1A is a semi-diagrammatic end view of the screen and jigs of Fig. 1.

Fig. 2 is a simplified elevational semi-diagrammatic view showing the oil circuit for actuating the jigs, only one jig being shown, and the remaining elements being illustrated in a simple manner for clearly showing said circuit and the various elements.

Fig. 3 is a semi-diagrammatic plan view of the oil distributing system, indicating the positions of the main jig hutches therein.

Fig. 4 is a part sectional, part elevational view of the oil distributing valve.

Fig. 5 is a sectional view of the valve of Fig. 4 taken along the line 5—5 thereof.

Fig. 6 is a vertical sectional view taken through the jig hutch of Fig. 2.

Fig. 6*a* is a horizontal sectional view taken along the line 6*a*—6*a* of Fig. 6.

Fig. 7 is an enlarged sectional view of one of the diaphragm actuating elements of one of the jigs.

Fig. 8 is an enlarged sectional view of the pressure relief valve in the oil system.

Fig. 9 is an elevational view of the pair of cleaner jigs indicated at the top of the dredge in Fig. 1.

Fig. 10 is an elevational view of the jigs of Fig. 10 as seen at right angles to the view in Fig. 9.

Fig. 11 is a plan view of the jigs of Figs. 9, 10.

In detail, referring to Fig. 1, the apparatus herein disclosed comprises a conventional, generally horizontally extending, but longitudinally inclined revolving screen 1 having therebelow the usual stationary pan or housing with a channel-like bottom 2 extending longitudinally of the screen for catching the smaller particles of ore passing through the screen. The ore is fed into the upper end of the screen from a hopper 3, which hopper may receive the ore from any conventional loading means, such as a shovel, bucket, etc., not shown. The coarser material passes out of the lower open end of the screen onto a conveyor 4 by which it is conducted to any desired point for dumping therefrom.

A water pump 5 driven from motor 6 draws water through conduit 7 and forces the same into conduit 8, a portion of which conduit 8 extends into and longitudinally of screen 1, said portion being disposed within said screen in a position spaced on appreciable distance above the lower inner side of said screen. The under side of said portion is apertured to discharge the water therein downwardly onto the material passing through the screen, and the water thus discharged passes through the screen and onto the channel bottom, facilitating the flow of the finer ore downwardly on said bottom toward the lower end thereof. Also a branch conduit 9 extending from the main conduit 8 discharges water into the hopper 3 for providing sluice water for sluicing the material in the hopper into the screen.

The finer material within the channel 2 is diverted laterally through openings 10 and onto the top of conventional shot beds in the upper portions of jigs 11, said jigs being arranged in rows along opposite sides of the channel 2, so as to provide a battery of jigs along said opposite sides of said channel. The jigs are filled with water conducted thereto by pipe 12 which is connected with the discharge side of pumps, which pipe is broken in length in Fig. 1 for more clearly showing the jigs along one side of the channel 2, it being understood that a water pipe 12 extends along both rows of jigs. Branch lines (not shown in Fig. 1) extend from said pipe 12 to each jig, each of which lines is suitably valved for regulating the flow of water to each jig.

The finer material from the channel 2, therefrom passes into the water filled jigs, which material, and shot beds, are subjected to intermittent pulsations caused by contracting and expanding

the lower portions of the jigs by means of flexible diaphragms 13 forming parts of the sides of said portions respectively, the diaphragms themselves being reciprocated by intermittent pulsations in oil lines 14 operatively connected with the diaphragms, as will later be described. These pulsations that are so transmitted to the water in the jigs causes the lighter ore above the shot beds to rise, but the heavy values will pass downwardly through water, shot bed, and screen supporting the latter, to within the lower portions of the jigs from which they are withdrawn through suitably valved openings, or conduits.

The lighter, surplus material, or "tailing", and overflow water, passes over the jigs into a discharge chute 15 and back into the pond 16 that provides the water for pump 5.

The material drawn from the lower ends of the jigs is carried by any suitable means to a bucket conveyor 17 or any other suitable conveyor means, to a de-watering cone 18 wherein the ore is permitted to settle for drawing off through an opening in the apex of the cone, said cone being disposed with its apex lowermost. The overflow water in the cone is permitted to pass back into the pond or is conducted to the revolving screen or any other desired point.

The material drawn from said cone is, of course, relatively rich in values, and said material is discharged into a receptacle 19 adjacent the top of a jig 20, which I term a "finishing cell", which jig is operated in substantially the same manner as jigs 11, except that it is smaller. From the finishing cell 20 the surplus ore passes into a second larger jig 21, which I term a "scavenging cell". The material drawn from the lower discharge opening in the finishing cell 20 is substantially pure gold free from impurities, but the material drawn from the scavenging cell, while relatively rich in values, does contain an appreciable amount of impurities. This material is passed through a conduit 22' (indicated in dotted line) back to the elevator 17, or through conduit 22 that has any suitable pump 23, back into the finishing cell, thus maintaining a relatively rich concentrate at all times in the finishing cell, for a purpose later described.

The tailing from the scavenging cell may be conducted by any suitable conduit 24 back to one of the jigs 11 for repassage and there passed to completely remove the values therefrom, or they may be received for further treatment as may be desired.

The foregoing describes the system relatively complete as incorporated in a dredge and it is this combination and method that constitutes a portion of the invention as well as the structure in the individual elements.

In Fig. 2 is a simplified semi-diagrammatic view showing the oil circuit for actuating the diaphragm in the lower portions of the jigs. Also certain details of the jig are shown. The oil system is as follows:

A tank 25 contains a supply of oil, which oil is drawn therefrom by means of a gear pump 26, or other pump capable of delivering the oil under pressure. The pump 26 is connected with motor 27 for actuation thereby, and said pump is in a pipe line 28 that delivers the oil to a rotary valve 29. A pressure relief valve 30 is connected in line 28 at a point between the valve 29 and the pump 26.

The rotary valve has a plurality of outlets therefrom, each of which is or may be connected by a pipe line 14 with the diaphragm actuating devices 32, that are carried on each of the jigs 11.

A valve 33 is disposed in each of the pipe lines 14 for regulating the flow of oil to said devices 32, and ordinarily each jig carries two diaphragms on opposite sides of the jig, each of which diaphragms has its separate device 32, the pipe 14 being divided at one end to provide a branch line leading to each of devices, as seen in Fig. 2.

The rotary valve 29, as will later be described more in detail, is adapted to intermittently open the several lines 14 respectively connecting with the separate jigs, and the devices 14 are each provided therein with a movable part connected with the flexible diaphragms, which part is responsive to the intermittent pressure in line 14 for causing reciprocation of the diaphragm, as will later be described more in detail.

Fig. 3 is a diagrammatic view showing the various lines extending to the jigs from valve 29, and this arrangement is generally indicated in Fig. 1 as well.

The rotary valve 29 is best illustrated in Figs. 4, 5, which valve comprises a drum-like housing with spaced opposed ends 34, 35 (Fig. 5). The end 34 is formed to provide the generally annular sides 36 of the housing connecting the ends thereof, and which sides are ported at spaced points therearound for passing oil to the several lines 14, which are connected to the sides by bolts as indicated in Fig. 4. The side of end 34 that faces toward end 35 is formed with ribs 37 that extend radially outwardly of the central axis of the drum, which ribs are radially inwardly cut away longitudinally thereof from points 38 equally spaced inwardly of their outer ends thus providing a seat for positioning an annular ring 39 within the housing spaced from end 34 to provide a space 40 between said ring and said end. (Fig. 5). The ring 39 extends across the housing from the ribs to engage at its opposite side with end 35, which end is similarly engaged to support the ring concentric with the central axis of the drum and to seal the engaging surfaces of the ring and end 35 against leakage of oil therepast. The ring 39 is provided with ports therearound in axial alignment with the ports in the sides 36 of the valve housing and the pipes 14 are provided with extensions 41 that pass through the ports in said sides 36 to within the ports in the ring, the outer sides of the ring being spaced at 42 from the inner surfaces of sides 36. Thus, where pipes 14 lead from the valve, said pipes extend across the space 42 and a continuous conduit thus leads from the annular inner face of ring 39 to the jigs respectively.

Within ring 39 is a hollow rotor 43, which rotor is secured to the end of a shaft 44, and shaft 44 rotatably extends through a bearing formed in end 34 of the housing. A pulley and belt 45 (Fig. 2) or any other suitable conventional connection between shaft 44 and motor 27 serves to rotate the shaft and rotor 43. Projecting from the side of rotor 43 (Fig. 5) opposite shaft 44 and in axial alignment with the shaft, is a tubular extension 46 formed with a passageway opening into the chamber 47 that is formed within the rotor, and the outer open end of said passageway registers with the open end of the oil inlet conduit 28 (Fig. 2), said conduit being connected with the rotor housing by any suitable means, such as plate 48.

The outer peripheral sides of the rotor are spaced from the ring 39, as at 50', except at one side where the rotor side is with a radially out-

wardly extending projection 49 to form a sliding fit between the outer surface of said projection and the inner side of the ring. This projection is formed with a through passageway 50 from the chamber 47 to the outside thereof, the length of which outer open end circumferentially of the rotor, is such as to extend over at least three of the open ends of the pipe lines 14 while the relieved side of the rotor on the opposite side from the passageway will extend over substantially 90 degrees of the circumference of the rotor.

In Fig. 4 I show one of the openings in the sides of the housing closed by a plug 51, which is illustrative of the use of my rotor in the event it is desired that less than eight jigs be connected with oil line 14. It will be noted that said plug will close off the communication between the space between the peripheral side of the rotor and the ring.

In operation of the rotary valve, the oil under pressure from pipe line 28 enters the rotor chamber 47 while the rotor is being revolved by the motor connected therewith. As the open end of passageway 50 comes in registration with the ports in the ring 39 said oil passes into the lines 14 and to the diaphragm actuating devices 32 that are at the opposite end of said lines 14 thereby actuating the diaphragms 13 in one direction. As the rotor continues to revolve, the oil in lines 14 is permitted to flow into space 37 alongside the ring for passing back into the tank 25 through a passageway 52 formed on end 34 of the housing.

Passageway 50 as shown, registers with three ports to lines 14 and discharge recess 50' opposite thereto registers with a central port and about half of each port at opposite sides thereof. When the rotor revolves, the pressure impulse to the leading port comes both from the gear pump and from the oil bled back into the rotor from the two ports already passed, since with the exhaustion of the inertia supplied by the initial impulse, the pressure in lines 14 reverses and the quickest relief is into the latest port registering with passageway 50. This reverse pressure comes from the jigs.

Since the oil line is completely filled at all times, it is necessary to provide some relief means to relieve any excessive pressure that may be caused by eliminating or restricting the movement of the diaphragm actuating means. This means is the relief valve 30 which is in line 28 between the pump 26 and the rotary valve 29 and which I will now describe.

In Fig. 8 the relief valve is shown in detail, which valve comprises a cylinder 53 secured at one end to the leg 54 of a T-fitting that is connected in pipe 28 thereby providing a passageway through the leg opening into the one end of the cylinder. A piston 55 having suitable sealing rings therein, is mounted within the cylinder and is normally positioned at the end thereof adjacent said fitting. A rod 56 secured at one end to said piston extends longitudinally thereof to the opposite end of the cylinder where it is slidably mounted within a cylindrical recess 57 in one end of an externally threaded bolt 58, which bolt is closed at its opposite end and threadedly extends through the head 59 of the cylinder. The head 59 is threaded into the upper end of the cylinder and a cap 60 is threaded onto the outer end of the head for enclosing the outer end of the bolt and head. Said bolt is formed with a square head at its one end for adjusting the bolt longitudinally of the cylinder and piston rod and the outer end of the piston rod normally spaced an appreciable distance from the closed end of the recess into which it extends to permit movement of the piston and said rod.

Engaging the end of bolt 58, within the cylinder, is a washer 61, and a relatively stiff coil spring 62 reacts between the piston and washer for forcing the piston to the lower end of the cylinder. The tension of said spring is adjustable by screwing the bolt 58 downwardly or upwardly according to the tension deserved.

Surrounding and enclosing the lower end of said cylinder 53 is a tubular housing 63' providing an annular enclosed chamber 63 between the walls of the cylinder and housing and the cylinder walls enclosed by the said housing are ported at 64 at points therearound and at points spaced longitudinally of the cylinder and above the piston when the latter is at the lower end of the housing.

Extending from the lower end of the housing and opening thereinto, is a pipe line 65 which line opens at its opposite end into tank 25.

It will be seen from the foregoing, that upon excessive oil pressure in the oil beyond the pump 26, such pressure will force piston 55 upwardly in the cylinder until the pressure is relieved, and the piston will then force the oil entering the cylinder back into the oil line 28, but if the pressure is sufficient to raise the piston above the lowermost openings 64, the oil will be by-passed back into the tank through line 65. Thus my rotary valve may have any desired number of lines 14 leading therefrom, according to the size of the same, or some may be eliminated, without interfering with its operation, and some or more of the lines 14 may be closed or restricted as desired, all while the oil pump is being operated. This restriction in lines 14 is desirable since it permits any desired modification in the actuation of any desired number of the diaphragm actuating devices, which devices will now be described in detail.

Figs. 6, 7 best show the diaphragms and their actuating devices, as well as the positions of the diaphragms relative to the walls of the jigs.

The main jig hutches are preferably substantially square in shape with their four sides convergingly extending downwardly to an apex at their lower ends. In each of two of the opposite converging sides 66 is provided a relatively circular flexible diaphragm 13, of rubber or the like which may be reinforced by fabric therein in th usual manner. Said diaphragms are secured at their marginal edges to marginal edges of openings in said sides of the jig, the area of each of the openings is preferably about as large as the side of the jig having said opening, will permit, thus it might be said that said two converging sides of each of the main jig hutches are flexible, since the diaphragms comprise the major portions thereof. Each diaphragm is centrally clamped between plates 67 Fig. 7 and the diaphragm actuating rod 68 extends axially outwardly of the diaphragm and outwardly of the side of the jig carrying the diaphragm. A channel bar 69 extends transversely across the outer side of the diaphragm and spaced therefrom, and which bar is secured at its ends to the side of the jig carrying the diaphragm. The bar 69 is centrally apertured to pass rod 68, and after passing through the bar, said rod extends centrally into a cylinder 70 through a head 71 at one end of the cylinder, which head is secured to bar 69. Bolts 72 connect head 71 to

said bar and extend longitudinally of the cylinder to its opposite end where they pass through the outwardly projecting margins of the opposite head 73 of said cylinder, and nuts 74 on the outer ends of the rods thus clamp the heads against the ends of the cylinder and clamp the cylinder and heads to bar 69.

The rod 68 terminates at its outer end within the cylinder and on the rod spaced from said end is secured to a piston 75 that is slidably fitted within the cylinder. The rod extends through said piston and then passes directly from the piston into a tubular member 76 that clamps a leather cup washer 77 between the same and piston. The outer end of said member 76 remote from the piston is recessed to receive nut 78 that clamps the member against the piston and which nut also functions to clamp the piston against a shoulder 79 on the rod. The tubular member 76 slidably extends into a dash-pot cylinder 80 that is closed at one end by a head 81 that carriers an axially outwardly projecting rod-like member 82 thereon, which member threadedly extends through head 73 of the main cylinder. A cap 83 threadedly secured on head 73 covers the outer end of member 82, which member may be locked at any desired position axially of the head 73 by a lock nut 84 on said member outwardly of said head 73, and by adjusting member 82 in or out, the stroke of diaphragm 13 is controlled. A relatively stiff coil spring 85 reacts between the piston 75 and head 71 to normally hold the diaphragm in outwardly expanded position relative to the inside of the jig hutch. The oil line 14 opens into the outer end of cylinder 70 adjacent the head 73 and outwardly of piston 75.

In operation, upon the oil under pressure from pump 26 being admitted to line 14 through the rotor valve, said oil will pass into cylinder 70 outwardly of the piston 75 and cup washer 77, thus causing the rod 68 and diaphragm 13 to move axially toward the inside of the jig hutch and compressing spring 85. Immediately upon the oil pressure in line 14 being released by the passage of the rotor port 50 past the opening to pipe line 14, the spring 85 plus the weight of the water and material in the jig hutch will cause the oil to pass back to tank 25 through passage 42 and passage 52 and the diaphragm will move to its outermost position.

The valve 33 in the pipe line 14 will, of course, permit closing down of the jig for the repairs without affecting the other jigs in the system. Also head 81 is preferably ported as at 81' for permitting oil to enter the dash-pot.

As already described, each of the main jigs 11 is provided with two diaphragms in generally opposed relation in opposite tapered lower sides of the hutch, but with their central axes convergently directed upwardly to intersect centrally within the jig hutch. In the battery of jigs, some of the diaphragms may be actuated to provide longer strokes than others, as desired to thereby enable a very accurate control of the separation of material fed to the jigs along the sides of the revolving screens, or to meet varying conditions due to different characteristics of the ore or material being handled.

The main jigs themselves, are described in detail, as follows, the construction being best illustrated in Figs 2, 6, and 6a.

Two of the converging sides 66 of the jigs have been generally described, and at right angles to these sides are similar sides 66'. The four sides, 66 and 66' meet at their lower convergent ends in an apex where an opening is provided in the form of a horizontal tubular passageway 86 opening upwardly at a side into the jig and one of the ends of the passageway being fitted with a clean-out plug 87 while the opposite end opens into a chute or conduit 88 leading to the lower end of an elevator 17 (Fig. 1).

The upper ends of the jigs are of generally box-like form comprising a frame of vertical sides 89 two opposed sides of which are provided with upwardly projecting plates 90, which plates provide partitions that are co-extensive in a general horizontal direction with partitions 91 or guide plates on the chutes 92 leading from the channel 2 below the revolving screen 1 to said jigs. See Fig. 1A. The sides 89 form the sides of a shot bed in which there is a screen 93 adapted to support a bed of shot 94 and spaced vertical partition plates 95 extending between the sides that carry extension 90 rest at their lower edges on the screen, thus preventing the shot from shifting, since the flow of material over the bed is transversely of the plates 95, passing over their upper edges. The partition plates 95, also catch and hold a certain amount of the ore above the shot. The tailing, or lighter waste materials and surplus water passes over the shot bed and into an inclined chute or channel 15 from which it may be carried to any desired point for dumping.

Below the screen 93 is a substantially square, open-ended frame 97 in which the four sides are vertical and members 98 connect between two opposed corners of the frame and the upper ends of sides 66', which members position and support the frame in a horizontal plane centrally within the jig. Each of the water pipes 12 from pump 5 connects with one of the jigs at a side 66' for passing water to within the jigs and each water inlet to each jig is positioned at a level just below the frame 97, and one of the plates 98. These frames serve as baffles permitting free lifting of the water body within the jigs under the influence of the diaphragm while evenly distributing the incoming water to prevent greater lifting force at one point within the jig than at another by the water due to the dynamic pressure of the water entering the jig. This is a highly important feature.

Valves 99 on each of pipes 12 serve to control the flow of water to the jigs.

The cleaner jigs, shown on top of the apparatus in Fig. 1 and illustrated more in detail in Figs. 9 to 11 comprise what I termed the finishing cell 20 and scavenging cell 21. These cells respectively have only one diaphragm on one of the converging lower sides of the cells. The diaphragms respectively vary in size in proportion to the sizes of the cells, the cell so having a smaller diaphragm than cell 21, but the construction of the diaphragm actuating devices 32 are identical with those described for the jigs 11. Each cell 20, 21 has a water inlet 100 that enters the side opposite the diaphragm and the tailings from the scavenging cell passes back to jigs 11. All of the value bearing material drawn from the jigs 11 is fed from the de-watering cone 18 into the cell 20 by way of the nugget box 19 at the side of cell 20 opposite cell 21 and valve 101 at the lower end of cell 20 is for drawing off the values from cell 20.

The screens and shot beds within cells 20, 21 are similar to those in jigs 11 and the path of

the ore from nugget box, to cell 20, then to cell 21, then to the tailing box 103 is indicated by the arrows in Fig. 12, the side plates 102 serving to retain the material in the cells.

The values drawn from cell 20 are practically pure by reason of the fact that the openings in the screen carrying the shot bed are practically filled with values to the exclusion of waste due to the extreme richness of the material fed to cell 20. This material is kept up to its high degree of values by returning to said cell the rich concentrate that are permitted to pass over into cell 21. Were the concentrates to become sparse in cell 20, obviously the opportunity for lighter particles to become arranged next to the screen in said cell and to pass through the screen, would become greater than where a heavy bed of values is retained therein. It is immaterial in my process how much of the heavier values pass to the scavenging cell so long as there is a good bed of values against the screen in the cell 20, and the action of the cells can be varied, as desired, to produce this result.

The general process and means has already been described earlier in the description, but it will be apparent from the description, as a whole, that by the very accurate control of the means operative on the value bearing material, a high efficiency is possible in the use of the apparatus.

It is, of course, obvious that the conduit 22 and pump 23 may be substituted by a downwardly inclined conduit 22′ (indicated in dotted line) leading to the elevator for continuously feeding the material by gravity into the elevator for returning the material including values back to cell 20.

The use of the word "ore" in the foregoing description and in the claims, refers principally to placer sands and all mineralized sands where it is desirable to separate the values from value bearing earth.

Having described my invention, I claim:

1. In apparatus of the character described, a generally box-like jig hutch open at its upper end, said hutch provided with a generally horizontal ore supporting screen adjacent said upper end, and walls disposed below the screen extending convergently from opposite edges thereof enclosing the space therebelow, at least one of said walls including a flexible diaphragm and means mounting said diaphragm on the hutch for reciprocating movement inwardly and outwardly relative to the center of said enclosed space, means for causing reciprocation of said diaphragm comprising a liquid pressure line having a rotary valve therein, said rotary valve being arranged and adapted to cause intermittent pulsations of liquid in said line and means connecting between the liquid pressure line and diaphragm arranged and adapted to transmit said pulsations to said diaphragm.

2. In a construction as defined in claim 1, means for varying the pulsations in said liquid pressure line independently of the rotary valve to thereby modify the degree of movement of the diaphragm caused by said pulsations.

3. In a construction as defined in claim 1, the liquid in said liquid pressure line being oil, and the means connecting between said liquid pressure line and diaphragm comprising a stationary cylinder having a piston movable therein connected with said diaphragm, said liquid pressure line opening into said cylinder at one side of the piston.

4. In apparatus of the character described, a jig hutch open at its upper end and provided with an ore supporting screen adjacent said upper end, sides on the hutch enclosing the space below said screen two of which are in generally opposed relation and a flexible diaphragm in each of said two sides disposed in planes extending convergently downwardly from said upper end, means for supplying water to said space and over the generally opposed sides of said diaphragms, means for simultaneously reciprocating said diaphragms inwardly and outwardly relative to said space thereby causing generally upwardly movement of the water through said screen, and means for controlling the degree of reciprocation of said diaphragms.

5. In a construction as defined in claim 4, the means for reciprocating said diaphragms, including an oil pressure line operatively connected with said diaphragms and means for causing the oil in said line to flow alternately in opposite directions in said line.

6. A jig hutch having an open upper side and an ore-supporting screen extending across said open side, and walls extending from said open side enclosing a water chamber below said screen; a flexible diaphragm forming a portion of one of the walls of said chamber; means for reciprocating said diaphragm in a direction inwardly and outwardly of said chamber for causing water in said chamber to rise and fall through said screen, said means comprising a cylinder and piston therein arranged for reciprocable movement relatively and operatively connected with said diaphragm for causing reciprocation of the diaphragm upon said movement, adjusting means connecting between said cylinder and diaphragm movable for varying the degree of said movement as desired, said adjusting means being normally stationary during said reciprocable movement whereby adjustment thereof may be effected during said reciprocable movement, and an oil pressure line communicating with said cylinder for causing said reciprocable movement.

7. In a construction as defined in claim 6, said adjusting means including a dash-pot enclosed within said cylinder and said adjusting means comprising a member accessible from outside the cylinder and connected with the dash-pot for moving the dash-pot to various positions within the cylinder.

8. In apparatus of the character described, a jig open at its upper end and provided with a screen adjacent said upper end for supporting value bearing ore therein, said jig provided with sides enclosing the space below said screen, means for supplying water to said space, two of said sides including flexible diaphragms disposed with sides facing inwardly and upwardly relative to said space arranged and adapted to partially support the water in said space, means for reciprocating said diaphragms for causing general upward movement of the water, and baffles in said space above said diaphragms and within the water in said space arranged and adapted to modify the directional movement of said water.

9. In a construction as defined in claim 8, the means for reciprocating said diaphragms, including a movable element reciprocably mounted within an enclosed chamber connected to said diaphragm for movement therewith and fluid pressure means intermittently operative against said element for reciprocating said element and diaphragm.

10. In apparatus of the character described, a plurality of jig boxes, means for supplying water

to within said boxes, a diaphragm mounted on each box for reciprocation relative thereto, and positioned to provide a support for water in the box, separate hydraulically actuated means connected with each diaphragm for reciprocating the latter upon intermittent admission of liquid under pressure to said hydraulically actuated means, a single source of liquid under pressure, a liquid conduit communicating with each of said hydraulically actuated means for conducting said liquid thereto, a rotary valve connecting each conduit with said source for intermittently admitting said liquid to said conduits and to said hydraulically actuated means equal rates per minute, means for rotating said valve, means on each of said hydraulically actuated means for varying the length of stroke of any diaphragm independently of the others whereby the degree of movement of water in any jig box may be varied relative to the movement of the water in such other while maintaining the number of oscillations per minute of the diaphragm equal.

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