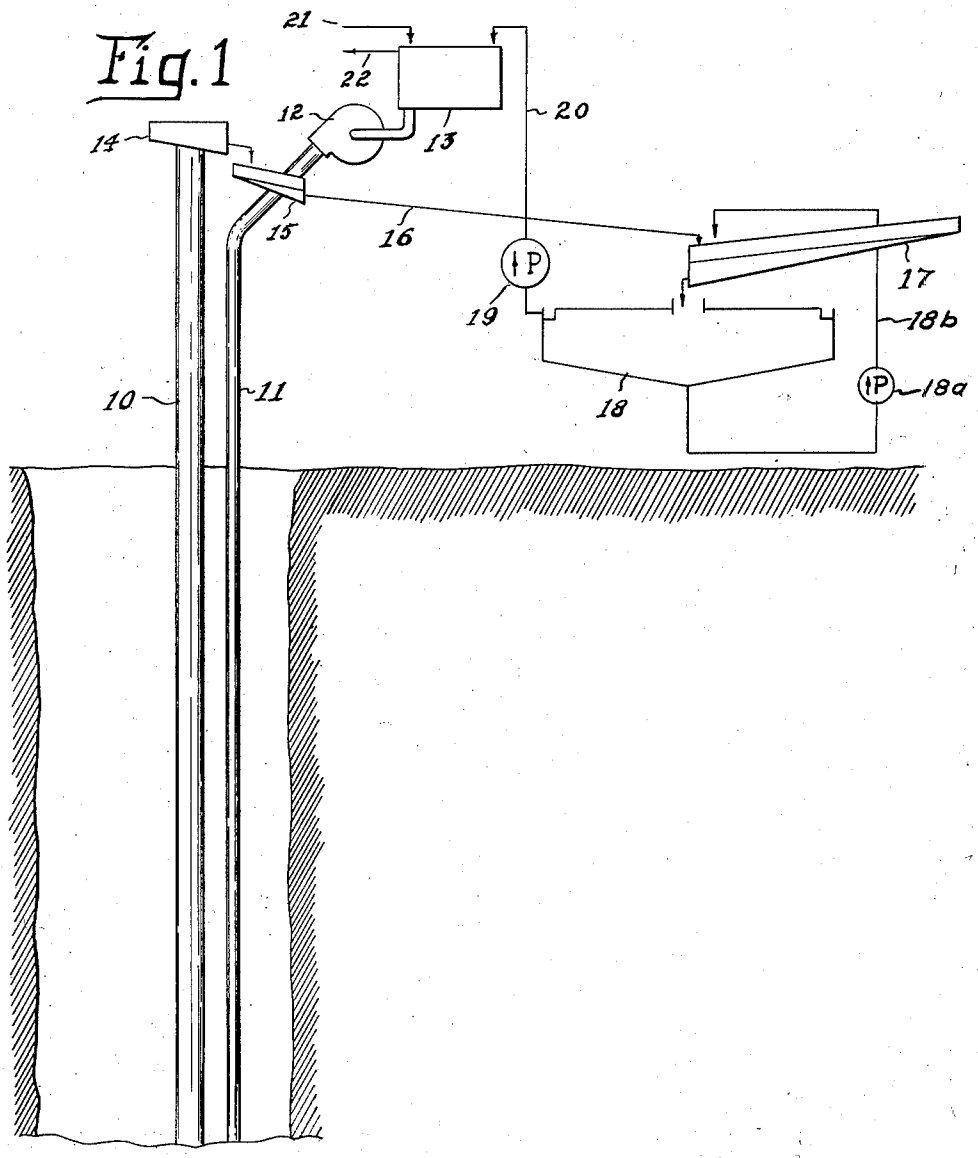
May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 1

Fig. 1



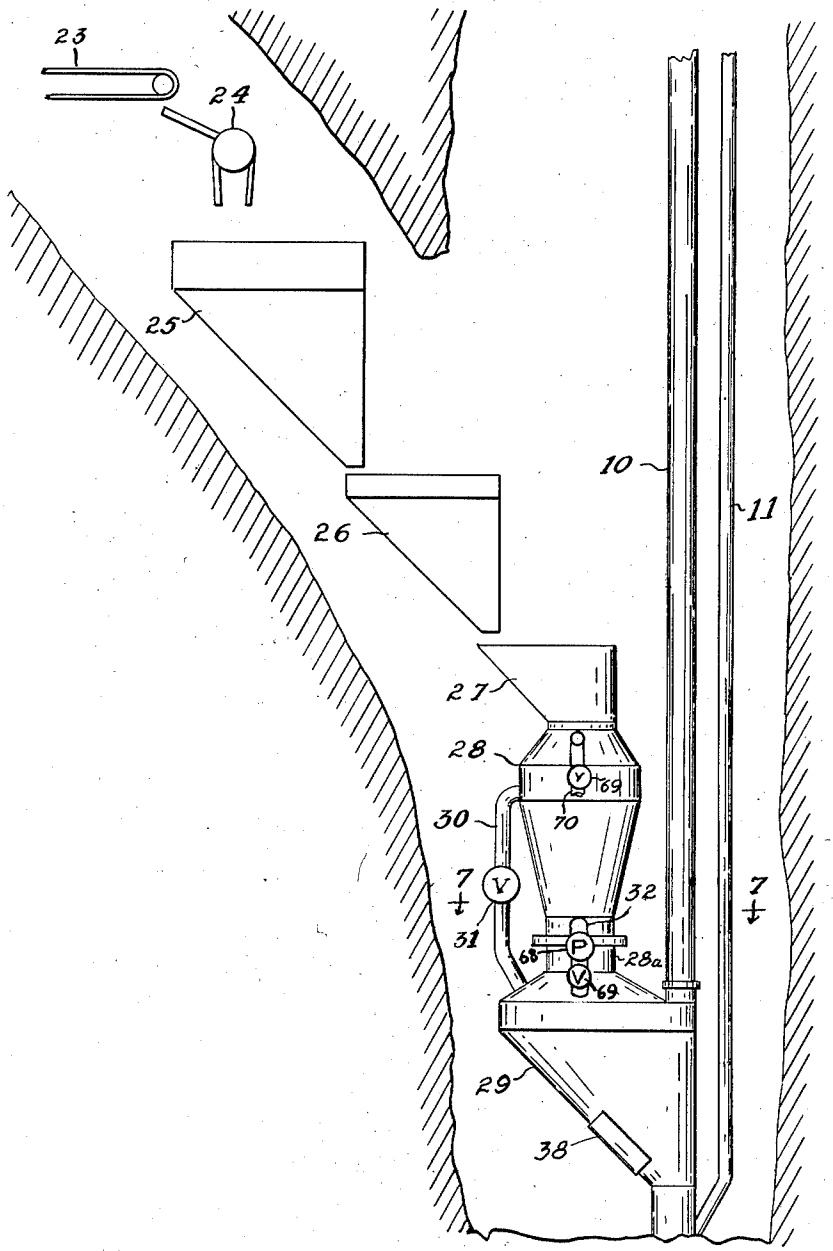
INVENTOR.
Percy S. Gardner Jr.
BY
Gruth Wells ATTY

May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 2

Fig. 2



INVENTOR.
Percy S. Gardner Jr.
BY
Greek Wells
ATTY

May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 3

Fig. 3

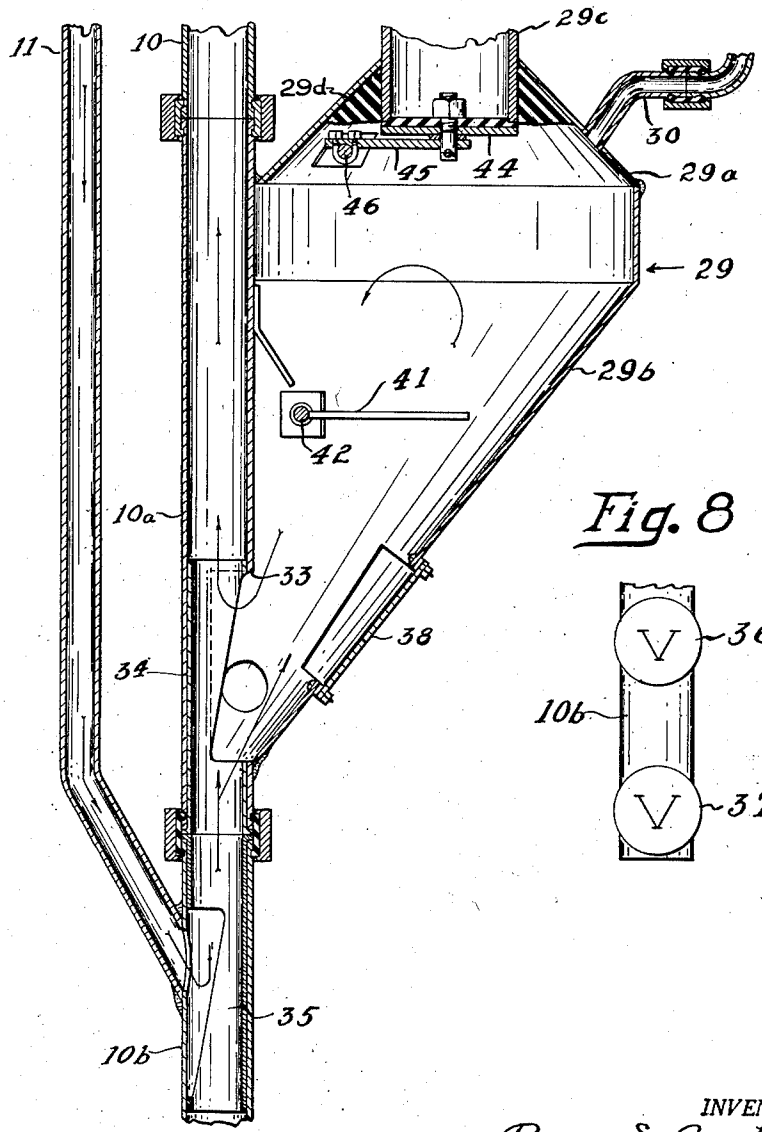


Fig. 8

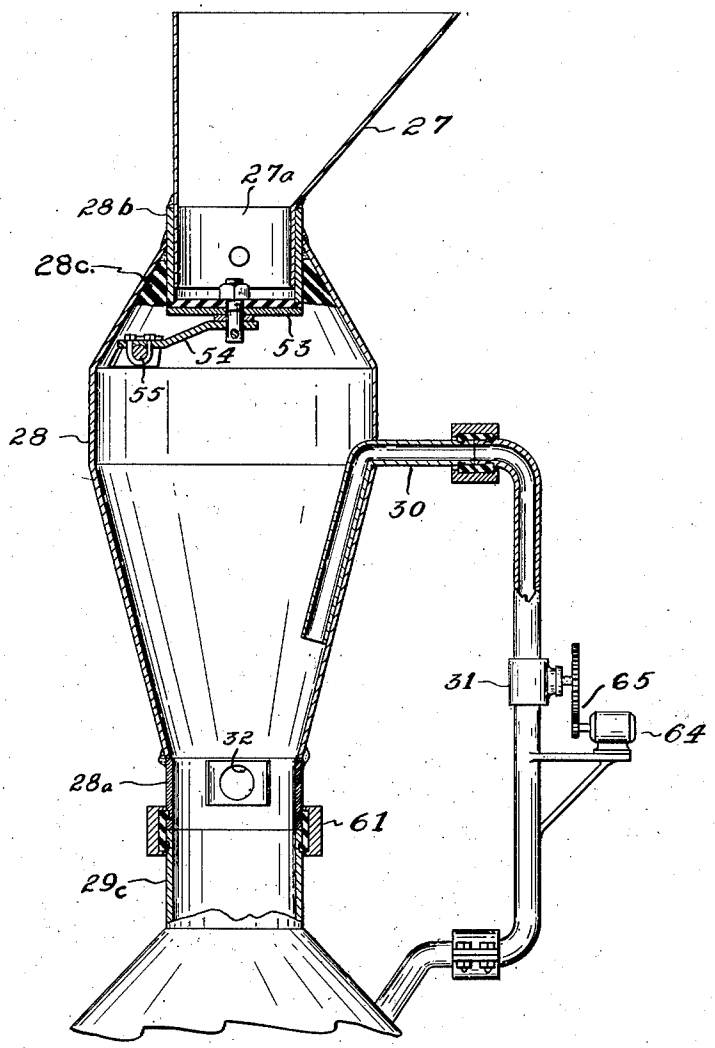
INVENTOR.
Percy S. Gardner Jr.
BY
Greek Wells.
ATTY.

May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 4

Fig. 4



INVENTOR.
Percy S. Gardner Jr.
BY
Greek Wells.
ATTY.

May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 5

Fig. 5

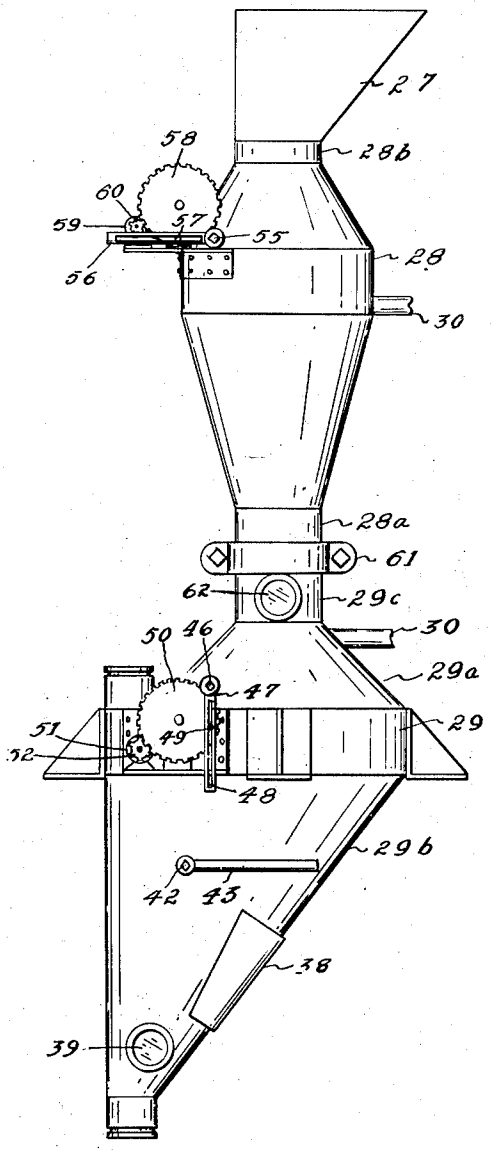
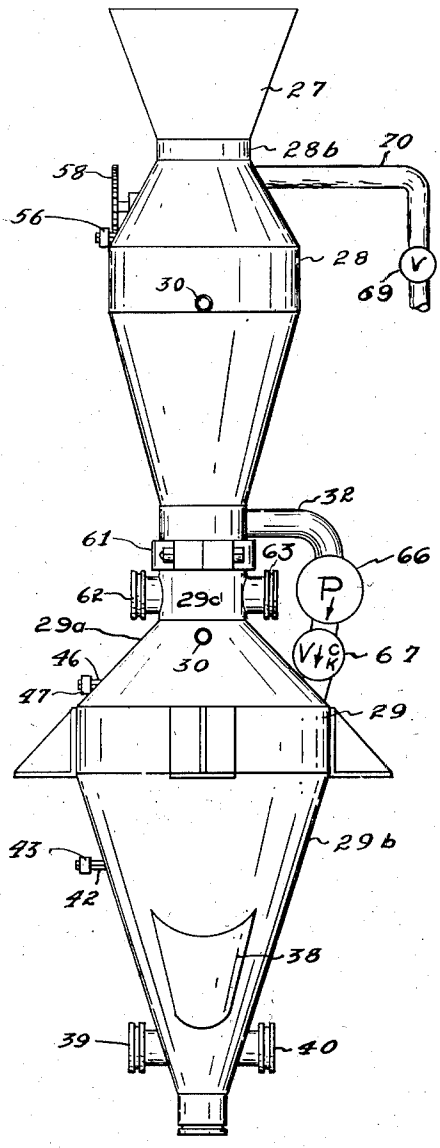


Fig. 6



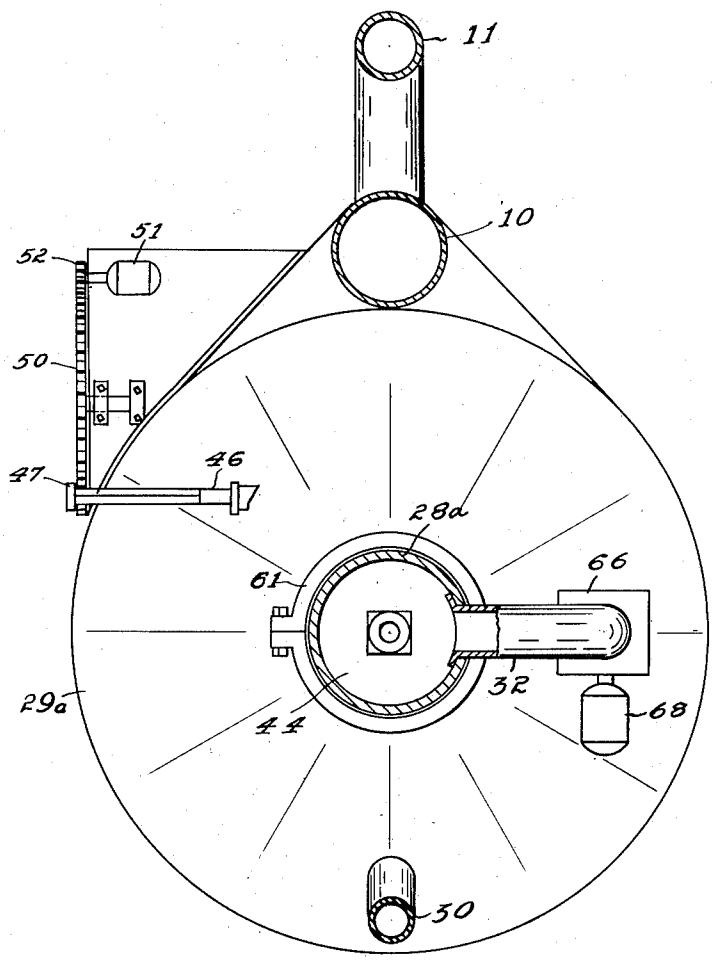
INVENTOR.
Percy S. Gardner Jr.
BY
Gruk Wells
ATTY.

May 21, 1957 P. S. GARDNER, JR 2,793,082

ORE HOIST

Filed Jan. 9, 1950 6 Sheets-Sheet 6

Fig. 7.



INVENTOR.
Percy S. Gardner Jr.
BY
Gruck Wells
Atty.

United States Patent Office 2,793,082 Patented May 21, 1957

2,793,082

ORE HOIST

Percy S. Gardner, Jr., Wallace, Idaho

Application January 9, 1950, Serial No. 137,583

3 Claims. (Cl. 302—14)

The present invention relates to improvements in an hydraulic ore hoist.

It is the purpose of the invention to provide an hydraulic hoist or conveyor utilizing a continuously rising column of water to lift particles heavier than the water wherein the construction is such that the static head of liquid is counter balanced so that the pump circulating the water at the required velocity need only supply the power necessary to overcome the friction head and the additional power necessary for lifting the ore itself.

The invention contemplates the provision of an hydraulic ore hoist wherein two columns of water are confined in two vertical or sloping pipes of suitable diameters which are connected at the bottom through a closed chamber to thereby produce a static balance of water in both columns. A centrifugal pump or other source of pressure head is provided at the top of one column to impart a downward velocity to the water in the pump column, and an upward velocity in the other column. A system of locked chambers is provided at the lower end of the columns for introducing particles of ore and the like into the upwardly flowing liquid against the static pressure thereof without releasing any water to the atmosphere at the bottom of the columns. The construction preferably embodies means at the top of the water columns for separating the water from the solid particles and returning the water to the pump for recirculation.

A further and more detailed object of the invention is to provide a novel system for introducing particles of ore and the like from a source at atmospheric pressure into a liquid column at a much higher pressure with no liquid loss and with a minimum disturbance to the flow of liquid in the column. Also, should a release of liquid be desirable, that such release be accomplished without disturbance to the flow of liquid in the columns and without preventing the introduction of ore from a source at atmospheric pressure into the rising columns of liquid at higher pressure.

It is known that hydraulic lifts for ore, ashes, etc. have heretofore been used, examples of this type of hoist are shown in U. S. patent to Hanigman No. 616,537 and U. S. patent to See No. 368,691. The present invention constitutes a distinct improvement on these prior hoists in that for the purpose of lifting it avoids expenditure of power to overcome the static head of liquid in the columns. It is well known that a rising column of liquid will lift particles of solid material heavier than the liquid when the velocity of the liquid exceeds the free falling velocity of that material in water. It has also been experimentally determined that particles of ore of the same specific gravity and ranging in size from 1 to 8 inches will require approximately the same lifting velocity in a confined stream of liquid. Smaller particles of course, are more easily lifted.

The nature and advantages of the invention will appear more fully from the following description and the accompanying drawings illustrating a preferred form thereof. The drawings and description however, are illustrative only and should not be considered as limiting the invention except insofar as it is limited by the claims.

In the drawings:

Figure 1 is a somewhat diagrammatic view of the surface portion of a hydraulic hoist embodying my invention;

Figure 2 is a similar view to Figure 1 illustrating the the lower or underground portion of the hoist;

Figure 3 is a vertical sectional view through the lower end of the hoist illustrating the manner in which the ore is introduced into the rising column of liquid;

Figure 4 is a sectional view similar to Figure 3 illustrating the upper lock chamber into which the ore is introduced prior to being brought up to the static pressure head existing in the liquid column;

Figures 5 and 6 are views taken at right angles to each other showing the ore lock chamber in side elevation;

Figure 7 is a plan sectional view taken substantially on the line 7—7 of Figure 2 and on an enlarged scale; and

Figure 8 is a fragmentary view in side elevation of the lower end of the liquid column illustrating the valve construction for clean out purposes.

Referring now to the drawings and particularly to Figures 1 and 2, the numerals 10 and 11 refer to the ore hoisting pipe column and the liquid supply column by which the liquid is carried down to the loading level. The supply pipe is fed by a pump 12 which preferably is driven by a suitable motor with a fly wheel which are not shown. A tank 13 is provided to supply water to the pump 12. Additional equipment at the surface of the ground usually comprises a discharge box 14 at the top of the hoisting column 10, a vibrating screen 15 where the larger particles are collected and the smaller particles and the water are carried by a conduit 16 to a de-watering conveyor 17. The water and extremely fine materials are discharged downwardly into a settling or thickening tank 18 where the solid material may settle out and the water may be recovered. A pump 19 and a conduit 20 serve to return the recovered water to the supply or surge tank 13 for the main pump 12. Fresh water may be supplied by a conduit 21 and any overflow may be taken away by a conduit 22. Pump 18*a* and conduit 18*b* return the thickened material to the top of de-watered bed on the conveyor 17 for filtering.

At the loading level in the mine the ore is brought by a conveyor 23 to a grizzly or crusher 24 from which the ore is delivered to a storage bin 25. The storage bin 25 has its outlet positioned to fill a loading cartridge 26 where a measured amount of ore may be held until the proper time to drop it into a guide hopper 27. The guide hopper empties into a upper loading chamber 28 where the pressure is alternated between atmospheric pressure during the time the ore is supplied to it, and the static pressure in the columns 10 and 11 during the time the ore is being dropped into a lower loading chamber 29. A pressure equalizing conduit 30 provided with a valve 31 connects the chamber 29 with the upper chamber 28 for equalizing the pressures of these two chambers. A conduit 32 is utilized to draw off enough water from the upper chamber 28 to admit the ore load each time the upper chamber is charged. The details of the manner of drawing off the water will be described later.

Referring now to Figures 3 and 4, the construction of the lower chamber 29 will be described. This lower chamber has an upper conical portion 29*a* and a lower tapered portion 29*b*. A section 10*a* of the pipe 10 is fitted to the side of the chamber 29 and is cut away as indicated at 33 to communicate with the interior of the chamber 29. A lining sleeve 34 is also provided in the conduit portion 10*a*. Below the portion 10*a* the

conduit 10 is provided with a second portion 10*b* into which the supply pipe column 11 opens. A liner 35 is provided in the portion 10*b*. Below the lining 35 the portion 10*b* is provided with two valves 36 and 37 to establish a trap chamber where material that settles out for any reason may be withdrawn.

The chamber 29 is provided with a door 38 which may be removed for cleaning out purposes. It is also provided with ports 39 and 40 for observation purposes. A breaker screen 41 consisting of a series of bars is mounted within the chamber 29 and can be adjusted by means of a shaft 42 and a handle 43. The breaker screen functions to break up slugs of ore particles before the ore is caught up by the rising liquid at the lower end of the chamber 29.

It is evident that ore in the chamber 29 will be mingled with the upwardly flowing column of water as it falls down to the opening in the liner 34. The static pressure in the section 10*a* in the pipe column 10 will be substantially equal to that in the chamber 29 at all times. As the water travels upwardly at the necessary velocity it will entrain the ore particles from the chamber 29 and carry them upwardly through the pipe column 10 where they will be discharged in the box 14. As the supply of ore in the chamber 29 is depleted it becomes necessary to recharge this chamber. The means by which the recharging is accomplished will now be described.

It will be noted from Figure 3 that a sleeve 29*c* connected to the loading chamber 28 extends into the cone shaped portion 29*a* of the chamber 29. The space around the sleeve 29*c* is filled with a waterproof yielding filler 29*d* of rubber or the like so that air will not be trapped in this space. A valve 44 is adapted to close the lower end of the sleeve 29*c*. This valve is carried by an arm 45 which is supported by a shaft 46 that extends through the wall of the portion 29*a*. On the exterior of the chamber 29 the shaft 46 carries a lever 47 that is slotted as indicated at 48 throughout its length. The crank pin 49 on a wheel 50 operates to swing the lever arm 47 from a horizontal to a vertical position to close the valve 44. The wheel 50 is driven from a motor 51 by a pinion 52.

The upper chamber 28 is best illustrated in Figures 4, 5 and 6 of the drawings. The guide hopper 27 has a portion 27*a* extending down into a sleeve 28*b* in the upper end of the chamber 28. The space around the sleeve 28*b* is filled with a rubber filler 28*c* to prevent trapping of air at this point. A valve 53 closes the lower end of the sleeve 28*b*. This valve is carried by an arm 54 on a shaft 55. The shaft 55 extends through the wall of the chamber 28 and has a slotted lever arm 56 fixed thereon outside of the chamber. This slotted lever arm is adapted to be operated by a crank pin 57 on a wheel 58 that is driven by a motor 59 and a pinion 60. The portion 28*a* of the chamber 28 is coupled by a coupling 61 to the sleeve 29*c*. This portion 28*a* is provided with ports 62 and 63 for observation purposes. In order to provide means to bring the chambers 28 and 29 to the same pressure the pressure equalizing conduit 30 is provided. The valve 31 in this conduit is adapted to be opened and closed by a motor 64 and gearing 65 connecting the motor to the valve stem. It will be appreciated that if the chamber 28 is at atmospheric pressure when it receives a charge of ore it will be necessary if the valve 53 is closed, to bring the pressure in the chamber 28 to the pressure in the chamber 29 before opening the valve 44 to pass the ore charge down into the chamber 29. This is accomplished by opening the valve 31. Since the ore charge has raised the water level in chamber 28 to exclude air when valve 53 is closed, by-pass 30 will provide complete equalization of pressure without flood water and without shock. The valve 44 can then be opened to discharge the ore into the chamber 29 and closed again leaving the chamber 28 filled with water.

Before an additional load of ore can be placed in the chamber 28 it is necessary to remove a sufficient volume of water from the chamber 28 to permit the ore charge to be received without overflowing the chamber 28. This is accomplished by means of the chamber pump mechanism illustrated best in Figures 2 and 6 of the drawings. A pump 66 and a check valve 67 are inserted in the conduit 32. A motor 68 operates the pump 66 and is suitably controlled to draw off the required amount of water. The check valve serves to prevent flow from the chamber 29 through the conduit 32 to the chamber 28. This particular means for drawing off the water may be replaced with any equivalent mechanism for the purpose. The pump, of course, has to force the water into the chamber 29 against the static head in the chamber. Where it is not objectionable the excess water in the chamber 28 may be drained off at the bottom by opening a valve 69 in a drain pipe 70.

In prior efforts in this field the lifting has been attempted by introducing air into the lift column to give the liquid velocity thus causing a lower pressure in the lift column than in the down flow column at the same level. The specific gravity of the air and liquid in the lift column is naturally less than that of the liquid alone, hence greater velocity must be used to effect lifting of the heavy particles. As a practical matter the addition of air to create velocity in the lift column must be very limited. Otherwise air pockets occur which cannot carry the particles. For particles much heavier than the liquid, putting air into the rising liquid column is ineffective, alone, as a lift. Homogeneous liquid solid mixtures where the solids are so fine that they do not settle readily can be handled with an air lift. Large particles substantially heavier than the liquid cannot be so handled.

It is essential to maintain the liquid columns in balance. The pump should move all the liquid so that a continuous, unbroken stream of liquid in the carrier and the whole stream rises at a continuous given velocity exceeding the free falling velocity, in the liquid, of the particles to be lifted.

If the system is open at the bottom to atmospheric pressure the advantages of static balance are lost. Energy must then be supplied, in some other fashion, to carry the weight of the lift column. This additional energy makes such systems too costly and too difficult for practical operation.

It is well known that finely divided particles of heavier than water solids can be mixed with water and suspended therein so that the mixture acts substantially as a homogeneous liquid of increased specific gravity. The present hydraulic hoist, however, is applicable to lifting coarse particles that do not increase the density of the liquid medium which carries them because of its velocity. These coarse particles do not change the static balance of liquid in the two columns. The hoist described herein passes all of the liquid through the pump. Air is excluded from the system. No additional liquid is added at the bottom to be pumped up. All of the pump effort is directed downwardly in the column 11.

It will be noted that throughout the loading cycle there is no time in which the chamber 29 is open to atmospheric pressure. The pressure in this chamber is always the static pressure that exists in the columns at the level of the chamber. When the pump 66 is used there is no loss of water at the bottom of the hoist. The operation of the various loading and by-pass valves is controlled by a suitable interlock control mechanism so that all valves are opened and closed at the proper time. The hoist need not be drained of water when it is not in operation. It is always ready for instant use and requires no preparation at the top or bottom prior to hoisting ore.

It will be noted that at all times the pump is free of

the static head load. There is a static balance of water between columns **10** and **11**. The loading chambers at the bottom of the columns serve to introduce the ore into the upwardly flowing column against the static pressure without releasing any water to the atmosphere at the bottom of the columns. The pump handles water only and no ore goes through it. It is advisable when installing the pump **12** and motor to provide a fly wheel in the pump and motor assembly for smooth operation. This fly wheel serves to prevent the lifting velocity from falling off too rapidly when it is desired to stop the pump. In case of power failure there will be ample time to empty the column of ore before it can settle to the bottom.

It is believed that the nature and advantages of the invention will be apparent from the foregoing description.

Having thus described the invention, what is claimed as new is:

1. A hoist for ore and other solids, comprising two vertically extending water columns, extending from substantially the same level at an upper delivery point, downwardly to a lower loading point and so joined together at the bottom as to produce a static balance of the water in one column with the water in the other column, a pump at the top of one water column, operable to impart a downward velocity to the water in said column and a resultant upward velocity of the water in the other column, means for introducing solids into the upward flowing column at a point below the top, comprising a first chamber having a valved inlet through which a charge of solids is introduced at atmospheric pressure, a second chamber below the first chamber, open to the upward flowing column such that the solids will enter the rising stream without mechanical assistance, a valved passage extending downwardly from the first chamber to the second chamber through which the charge is moved by gravity from the first chamber to the second chamber, means to equalize pressure in said first and second chambers when the valved passage and valved inlet are closed, and means to draw water from the first chamber when the valved passage and valved inlet are closed to make room in the first chamber for the charge and to equalize pressure in the first chamber with the atmosphere when the valved passage and valved inlet are closed so that the valved inlet will open freely.

2. A hydraulic hoist having two pipes of substantially equal height joined at their lower ends to provide a continuous passage downward in one pipe thence upward in the other pipe for the purpose of providing a static balance, a pump at the top of one pipe operating to pump

liquid down in that pipe and thereby force it up the other pipe, said other pipe having an inlet opening adjacent to its lower end for the introduction of solid particles, a container opened at its lower end to said inlet opening in said pipe, a second container over the first named container, a passage leading from the bottom of the second container into the lower container, a valve in said passage, a particle hopper having a bottom outlet opening into the second container and a valve in said outlet, a valved bypass operable, when both of said valves are closed, to equalize the pressure in said containers, and means operable to remove a portion of the liquid from said second container while the outlet in the second container is closed and to equalize pressure in said container with the atmosphere.

3. In a vertical pump column where water is being pumped in large quantities upward through a vertical pipe, at a rate to exceed the free-falling velocity of ore and rock in water, means for introducing ore and rock into said column at a point beyond the pump and in the vertical section of pipe, such means comprising a lower chamber in communication with said vertical pipe through a side opening in the pipe, an upper chamber connected to the lower chamber by a valved passage leading from the bottom of the upper chamber to the top of the lower chamber and having a valved inlet for the introduction of ore and rock and a hopper over the inlet such that when the valved passage is closed and the valved inlet is open the material will enter the upper chamber at atmospheric pressure by gravity from the hopper thereby raising the water level in the upper chamber as material enters the chamber so that the valved inlet remains under water at all times, means to equalize pressure in said upper and lower chambers when the valved passage and valved inlet are closed, and means to draw water from the upper chamber when the valved passage and valved inlet are closed to make room in the upper chamber for the charge and to equalize pressure in the upper chamber with the atmosphere when the valved passage and valved inlet are closed so that the valved inlet will open freely.

References Cited in the file of this patent

UNITED STATES PATENTS

616,537	Honigmann	Dec. 27, 1898

FOREIGN PATENTS

268,276	Germany	July 19, 1915
399,726	Germany	Nov. 27, 1921
572,009	Germany	Feb. 14, 1931
110,609	Great Britain	Oct. 26, 1917
184,237	Great Britain	July 31, 1922