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HYDRAULIC CLASSIFYING APPARATUS SIPHON CONTROL

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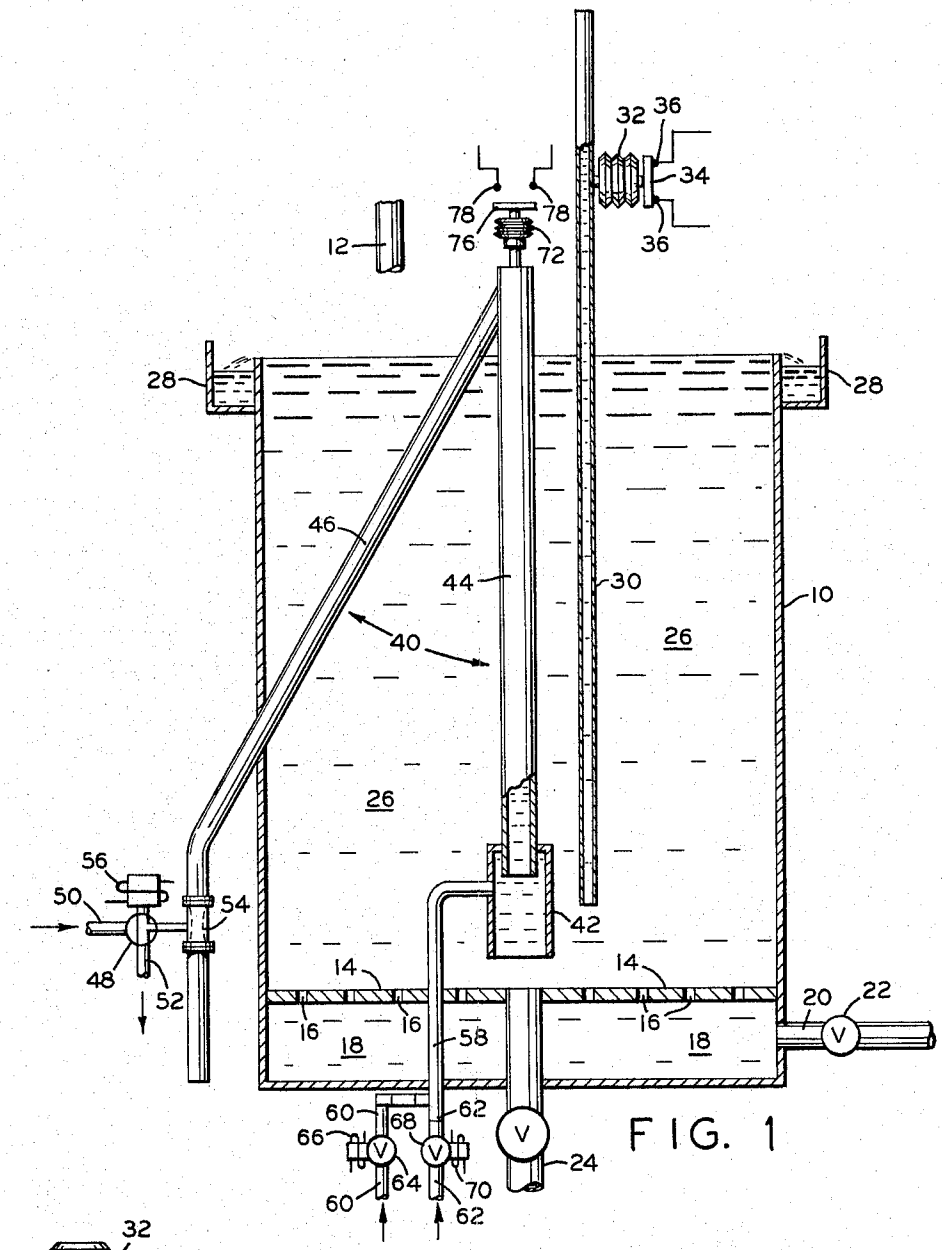


FIG. 1

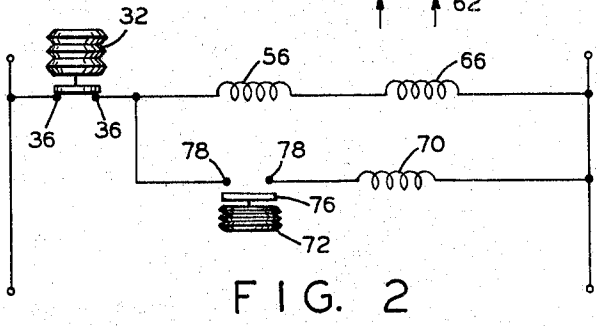


FIG. 2

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HYDRAULIC CLASSIFYING APPARATUS SIPHON CONTROL

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This invention relates generally to hydraulic classifying apparatus and more particularly to hydraulic classifying apparatus for the sizing and classification of solids which provides automatic control for the discharge of the coarse material from the apparatus through a siphon.

Prior to this invention hydraulic classifying apparatus have been used to size and classify solid material such as ore and other mineral substances. Some of these hydraulic classifiers employ siphons to remove or discharge the coarse material from the classifier. Normally, a constant supply of prime water was supplied to the siphon at all times in order to maintain the prime of the siphon. It has been found that this constant supply of prime water tended to dilute the concentrated coarse material and thereby reduce the overall efficiency of the classifier.

It is, therefore, an object of this invention to provide a hydraulic classifier with siphon discharge which automatically controls the supply of prime water to the siphon.

A second object of the invention is to provide a hydraulic classifier with siphon discharge which automatically supplies prime water to the siphon when required and cuts off the supply of prime water to the siphon when not required.

A third object of the invention is to provide a hydraulic classifier which is automatically and positively controlled to discharge the desired coarse product from the classifier.

A still further object of the invention is to provide a compact and efficient automatically controlled hydraulic classifier to size and classify solids supplied thereto in a liquid solution.

Other objects and advantages of the invention will become apparent as the specification proceeds to describe the invention with reference to the accompanying drawing, in which:

FIG. 1 is a simplified partially schematic representation of a single hydraulic classifier incorporating the hereinafter disclosed siphon automatic control; and

FIG. 2 is a line-line circuit diagram of the control employed in FIG. 1.

In the preferred embodiment the invention is shown and disclosed in relation to a hydraulic classifying apparatus which employs the use of a teeter column wherein conditions of hindered settling are employed. In this type of apparatus the solid material to be divided is supplied into the upper portion of the apparatus as a liquid slurry. In the lower portion of the apparatus an uprising column of fluid is supplied through a constriction area in a direction opposing the supply of the above mentioned liquid slurry with the result that certain particles, which are capable of settling through the uprising flow of fluid in the upper portion of the apparatus, can settle no further than the constriction. With a continuous feed these certain particles will build up above the constriction area and provide a teeter column which will hinder the settling of subsequent particles. The coarser particles will then tend to settle through the teeter column while the finer particles and the liquid in the feed tend to rise due to the greater density of the teeter column. Preferably, then the desired product located above and adjacent the constriction area is withdrawn

by the use of a siphon type ejector with the siphon bell located above the constriction area.

In this type of hydraulic classifying apparatus a predetermined rate of water flow is selected to provide a predetermined teeter rate in order to classify particular size particles. Obviously the rate must stay fairly constant in order to obtain a particular product from the classifier. An excess of undesired water would obviously disturb the teeter rate resulting in the discharge of a product which was not contemplated.

In FIG. 1 there is shown only one hydraulic classifier for the sake of simplicity but it is within the scope of the invention to employ a plurality of such units either in series operation or in parallel operation.

Looking now in particular at FIG. 1 the numeral **10** designates a tank into which a liquid slurry of solid material to be classified is supplied thereto by any suitable means such as conduit **12**. A constriction plate **14** with orifices **16** therein provides a water chamber **18** at the bottom of the tank. Conduit **20** with valve means **22** therein is provided to supply water to water chamber **18**. A valved drain line **24** communicates with upper chamber **26** of tank **10** to afford a means to completely drain the tank **10**, if desired. During operation of the hydraulic classifier valved drain line **24** will be shut off. A launder **28** is provided to collect and carry off the fine fractions which do not settle in the tank **10**.

A hollow tube **30** open to the atmosphere at the top end projects downwardly into the chamber **26** to a point adjacent the constriction plate **14**. The pressure of the denser slurry at this point will cause water to rise in tube **30** to a point which corresponds to the pressure at the lower end of the tube. A bellows member **32** in open communication with tube **30** expands and contracts in response to the level of liquid in the tube **30**. Bellows **32** on expansion or contraction causes switch member **34** to make or break contact with contacts **36**.

To remove the settled product from the tank **10**, a siphon system generally denoted by the reference numeral **40** is provided. Siphon system **40** basically consists of a lower pipe section or siphon bell **42**, an uprising intermediate pipe section **44** of a diameter smaller than the lower pipe section **42**, and a downwardly directed discharge pipe section **46** connected to the upper end of intermediate pipe section **44**. Preferably pipe section **46** is smaller in diameter than pipe section **44**.

A solenoid operated three-way diaphragm valve **48** is provided to control the discharge of the coarse settled product through discharge pipe section **46**. That is, an air inlet line **50** and an exhaust conduit **52** are shown connected to two ports of the valve **48** to either supply or exhaust air to or from the area surrounding diaphragm member **54** via conduit **55**. Member **54** acts to cut off flow through pipe section **46** when connected to air supply line **50** and to permit such flow when connected to air vent or exhaust conduit **52**. In both FIGS. 1 and 2 the solenoid coil for the valve **48** is denoted as **56**.

Dilution water and prime water are supplied to siphon bell **42** through conduit **58**. Conduits **60** and **62** are provided to supply dilution water and prime water to conduit **58**, respectively. The flow of dilution water through conduit **60** is controlled by solenoid operated valve **64** with the solenoid coil in FIGS. 1 and 2 designated as **66**. The flow of prime water through conduit **62** is controlled by solenoid operated valve **68** with the solenoid coil designated as **70** in both FIGS. 1 and 2.

Located adjacent the peak of siphon system **40**, that is, near the top of intermediate pipe section **44** of siphon **40** is a bellows member **72** in open communication with siphon **40** to sense the pressure therein. In normal operation of the siphon bellows **72** will be contracted

due to the negative pressure in the siphon keeping the switch member **76** away from the contacts **78**.

Operation

Assuming that the tank **14** is filled with water and water is being continuously supplied through conduit **20** and constriction plate **14** at a desired value and assuming further that the solids to be classified are being supplied through conduit **12**, the conditions in the tank will gradually build up to provide the desired teeter column. The resulting pressure adjacent the lower end of the tube **30** will force water up the tube **30** and into the interior of bellows **32**. Bellows **32** will then expand causing switch member **34** to make contacts **36** thereby energizing the circuit to solenoid valves **48**, **64**, and **68**. Looking at FIG. 2 it can be seen that the making of contacts **36** immediately energizes coils **56** and **66** of solenoid valves **48** and **64**. Energization of solenoid valve **48** will place the valve in the position shown allowing the air around the diaphragm member **54** to exhaust to atmosphere through conduit **52** and thereby open discharge pipe section **46**. At the same time energization of solenoid valve **64** will open conduit **60** and allow the flow of dilution water to the siphon bell **42** to dilute the solids concentration so that the coarse settled particles may be readily siphoned.

As shown it is assumed that the siphon is already primed so that the settled material will discharge from the siphon without the addition of prime as water to prime the siphon. Under his condition it can be seen that the negative pressure in the siphon will keep the bellows **72** contracted thereby maintaining switch member **76** away from contacts **78**. Solenoid valve **68** will then be deenergized closing off prime water conduit **62**.

If at any time during operation of the hydraulic classifier or on start-up the siphon is not primed, bellows **72** will expand due to the higher than desired pressure in the siphon and cause switch member **76** to engage contacts **78** to energize solenoid valve **68** to allow a flow of prime water to the siphon in order to prime same. This flow of prime water is in addition to the normal flow of dilution water. The flow of dilution water alone can be insufficient to prime the siphon because a low flow rate of water up leg **44** of the siphon can just "trickle" out the relatively large diameter leg **46** without expelling the air therein. Therefore, an additional flow of water through priming conduit **62** which may preferably be of larger size than dilution water conduit **60** (see FIGURE 1), is provided to ensure a sufficient flow of water through the siphon to prime it. As soon as the siphon resumes proper operation a negative pressure in the siphon will be reestablished causing bellows **72** to contract pulling switch member **76** away from contacts **78** thereby deenergizing solenoid valve **68** to stop the additional flow of prime water to the siphon bell **42**.

Whenever the pressure adjacent the constriction plate **14**, as sensed in the tube **30**, drops below a predetermined level, the bellows **32** will contract causing switch member **34** to break contact with contacts **36** and thereby deenergizing the circuit which includes solenoid valves **48**, **64**, and **68**. Solenoid valves **64** and **68** will close off conduits **60** and **62** respectively and solenoid coil **56** will be deenergized causing valve **48** to be rotated to the position where air conduit **50** is in communication with the area around diaphragm **54** exerting an air pressure on the diaphragm to stop the flow of solids within the discharge pipe section **46**.

It should be noted that the deenergizing of such circuit insures that no water, either prime or dilution is supplied to the siphon. This prevents the undesirable effect of upsetting the teeter rate of the column due to an excess of undesirable water being supplied. This is especially true when low hydraulic rates are being used to perform the classification.

The herein disclosed control system is preferably electrically controlled but it is within the scope of the invention to pneumatically or hydraulically control the solenoid valves.

As disclosed diaphragm **54** is operated on an on-off basis. This is the simplest and most direct means of control. Obviously though other means can be employed to control the discharge of coarse material through the siphon discharge leg **46**. An example of other controls which can be employed would be to use an additional pressure sensitive switch responsive to the height of liquid in the tube **30**. An inverse modulating type valve would then be substituted for the three-way valve **48**. The pressure, dependent on the density at the bottom of the tube **30**, sensed by the additional pressure sensitive switch will be relayed to the inverse modulating valve to modulate the flow of coarse particles through the siphon leg **46** in response to the density of the coarse particles adjacent the constriction plate. In other words air in conduit **50** will be supplied in increasing amounts to modulate the diaphragm **54** towards the closed position as the density of the coarse material decreases. Conversly, air will be exhausted in varying amounts from around diaphragm **54** as the density of the coarse material adjacent the lower end of tube **30** increases in order to allow diaphragm to modulate towards the open position.

This new and novel control system provides for positive and automatic control of a hydraulic classifying apparatus which automatically primes the siphon discharge conduit, when necessary, and also prevents undesirable dilution of the settled product whenever the use of prime water is not necessary. This invention further provides a control system which is directly responsive to the condition of the system and is efficient in operation. Further, the new and novel hydraulic classifying apparatus control insures that no prime water is supplied to the system whenever the system is shut down or is not operating due to low pressure in the teeter column.

Although we have described in detail the preferred embodiment of our invention, we contemplate that many changes may be made without departing from the scope or extent of our invention, and we desire to be limited only by the claims.

We claim:

1. Hydraulic classifying apparatus comprising: a tank, means supplying solids to be classified into the upper portion of said tank, constriction means in the lower portion of said tank, means adapted to provide a teeter column between said solids supply-means and said constriction means including means supplying a liquid into the lower portion of said tank below said constriction means and providing an upward flow of liquid through said constriction means and said teeter column to accumulate solids of predetermined settling rate adjacent said constriction means, siphon means extending to a point adjacent said constriction means to withdraw said accumulated solids, controllable means to supply prime liquid to said siphon means, controllable means to supply dilution liquid to said siphon means to facilitate the siphoning of said solids, means to control flow of accumulated solids through said siphon means, first control means responsive to fluid pressure in said teeter column to activate said dilution liquid supply means and said siphon flow controlling means to induce flow in said siphon means, and second control means responsive to excessive pressure at the peak of said siphon to activate said prime liquid supply means, said first and said second control means being interconnected to permit said prime liquid supply means to be activated only if said dilution liquid supply means and said siphon flow controlling means are activated.

2. Hydraulic classifying apparatus comprising: a tank, means supplying solids to said tank to be classified, means providing a teeter column in said tank for receiving and classifying the solids according to settling rate, said latter

means including liquid introduction means adjacent the base of the teeter column to provide an upward flow of liquid in the teeter column to accumulate solids of predetermined settling characteristics near the base of the teeter column, siphon means opening near the base of the column to withdraw the accumulated solids, means supplying dilution liquid to said siphon means to facilitate the siphoning of the solids, control means operatively connected to be responsive to the density of solids in the teeter column, said control means being interconnected with said dilution liquid supply means so that said dilution liquid supply means is inoperative and does not supply dilution liquid to said siphon means when the density of solids in the teeter column is below a predetermined minimum, valve means in said siphon means to control the siphonic flow therein by constricting the cross-sectional flow area of said siphon means, said density responsive control means being operatively interconnected with said siphon flow control means to allow flow of solids through said siphon means when the density of the teeter column is above a predetermined minimum.

3. Hydraulic classifying apparatus comprising: a tank, means supplying solids to be classified into the upper portion of said tank, constriction means in the lower portion of said tank, means for providing a teeter column between said solids supply means and said constriction

means including means supplying a liquid into the lower portion of said tank below said constriction means and providing an upward flow of liquid through said constriction means and the teeter column to accumulate solids of predetermined settling rate adjacent said constriction means, siphon means extending to a point adjacent said constriction means to withdraw the accumulated solids, controllable means to supply prime liquid to said siphon means, first control means responsive to an excess pressure in the peak of said siphon means to actuate said controllable means to supply prime liquid to said siphon means, and second control means operatively interconnected with said first control means to prevent siphon priming when the density of said teeter column adjacent the constriction means is below a predetermined value.

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