

[54] **PREVENTION OF INFILTRATION OF GAS BUBBLES INTO SLURRY PUMP PARTS**

[75] Inventors: **Toshio Kazama; Kazunori Sek**, both of Nagaoka, Japan

[73] Assignee: **Tamagawa Kikai Kinzoku Kabushiki Kaisha**, Tokyo-to, Japan

[22] Filed: **Apr. 19, 1971**

[21] Appl. No.: **134,945**

[30] **Foreign Application Priority Data**

Sept. 21, 1970 Japan..... 45/82838

[52] U.S. Cl..... 417/54, 417/92, 417/385, 417/388, 417/900, 277/135

[51] Int. Cl. F04b 9/08, B65d 53/06, F16j 15/14

[58] Field of Search..... 417/900, 92, 93, 417/94, 95, 96, 97, 98, 99, 54, 385, 388, 103; 277/135, 68; 137/1, 154

[56] **References Cited**

UNITED STATES PATENTS

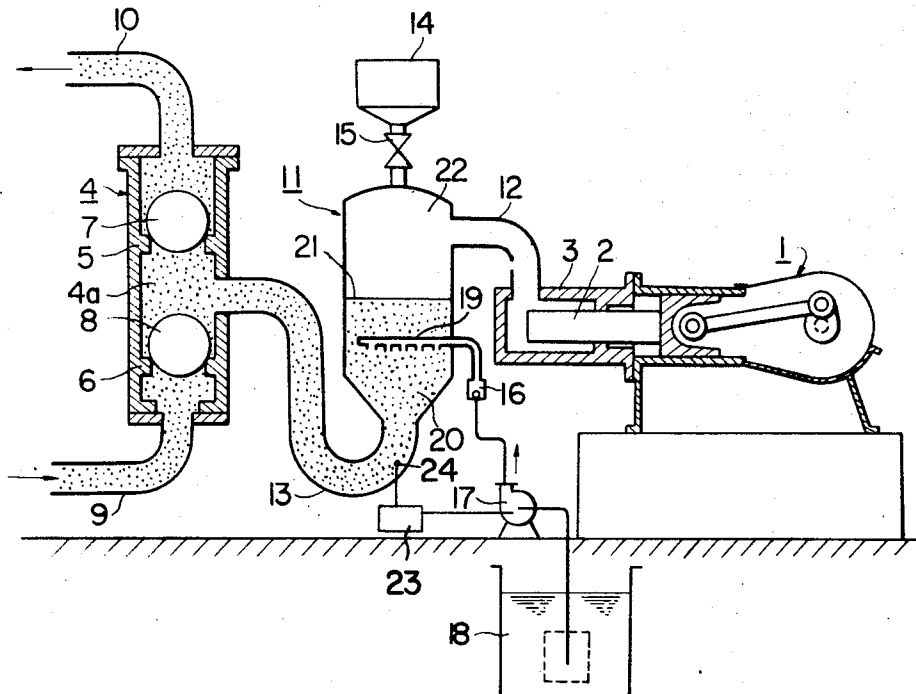
3,241,496 3/1966 Imai et al..... 417/98

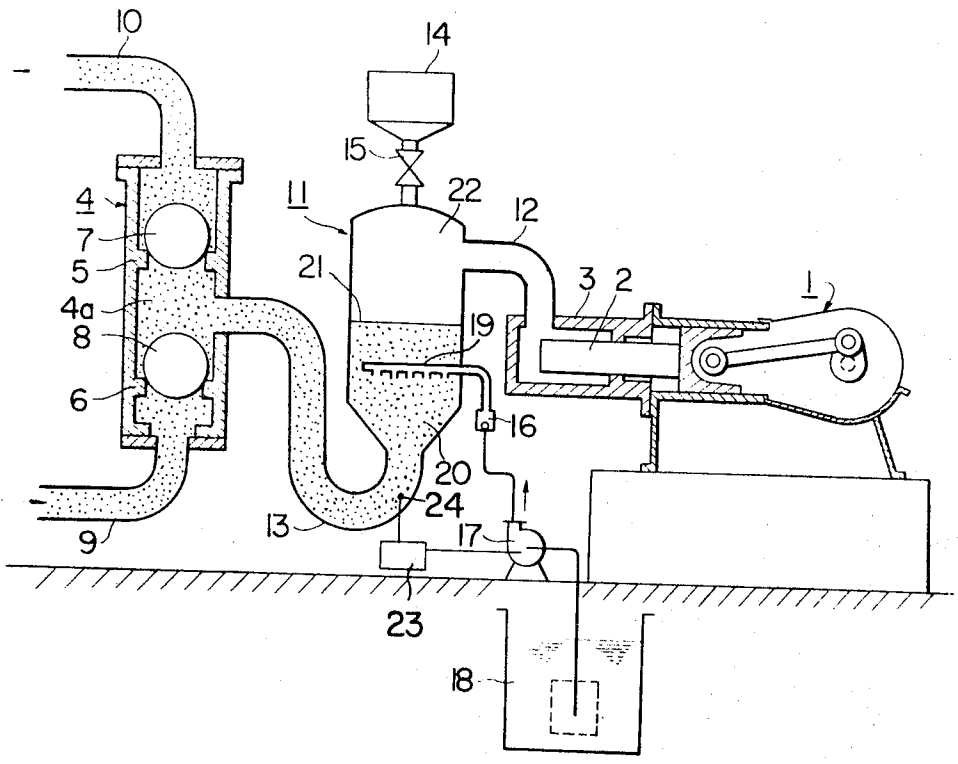
Primary Examiner—Carlton R. Croyle
Assistant Examiner—Richard E. Gluck
Attorney—Robert E. Burns

[57] **ABSTRACT**

In a slurry pump of liquid-diaphragm type having a diaphragm chamber containing a portion of slurry being pumped and a lighter diaphragm liquid, gas bubbles existing in large concentration in the slurry are prevented from infiltrating into the diaphragm chamber by the injection of a seal liquid without bubbles into the slurry in the chamber to cause a flow of liquid counter to the direction of infiltration of the gas bubbles. For this purpose, a seal-liquid-injection pipe is installed in the slurry in the chamber and supplied by a pump with the seal liquid from a reservoir through a check valve.

19 Claims, 1 Drawing Figure





PREVENTION OF INFILTRATION OF GAS BUBBLES INTO SLURRY PUMP PARTS

BACKGROUND OF THE INVENTION

This invention relates generally to slurry pumps of the liquid-diaphragm type and more particularly to a new method and apparatus for preventing gas bubbles in a slurry being pumped from infiltrating into the diaphragm and piston parts of a slurry pump.

Slurry pumps with which this invention is concerned are of the class described in Japanese Pat. publication No. 12131/1960, U.S. Pat. No. 3,241,496, patented Mar. 22, 1966, British Pat. No. 1,187,912, patented Aug. 12, 1970, and South African Pat. No. 68/0753, patented May 30, 1969.

Among the various fluid substances referred to as slurries, there are those, such as caustic bauxite slurries and limestone slurries containing viscosity-reducing agents, which contain a large number of gas (air) bubbles. When a liquid of this nature is handled by means of a slurry pump of the liquid-diaphragm type, a portion of the bubbles contained in the liquid separate out and accumulate in the liquid-diaphragm chamber and thereby give rise to the following inconveniences and difficulties.

1. Frequent extraction of the accumulated gas (degasification or deaeration) becomes necessary, whereby the pump operation requires additional labour.

2. The bubbles carry solid particles into the diaphragm liquid (oil), whereby the liquid becomes contaminated, and the particles tend to cause wear of the piston parts.

3. The gas (air) causes a reduction in the pump delivery, while clogging due to settling of the particles easily occurs.

Accordingly, it is necessary to prevent the bubbles from passing from the pump valve box through the connecting pipe and infiltrating into the liquid-diaphragm chamber and to cause the bubbles to move rapidly from the suction valve through the discharge valve and be promptly discharged therefrom without stagnating or slowing down within the pump.

SUMMARY OF THE INVENTION

It is an object of this invention to fulfil the above stated requirement in slurry pumps of the liquid-diaphragm type. More specifically, an object of the invention is to provide a method and apparatus for preventing gas bubbles in a liquid containing a large quantity of bubbles and being pumped by a liquid-diaphragm slurry pump from infiltrating into the diaphragm chamber.

According to the present invention, briefly summarized, there are provided a method and apparatus for preventing infiltration of gas bubbles as described above, wherein a seal liquid without gas bubbles is injected into the slurry in the liquid-diaphragm chamber thereby to create a liquid flow counter to the direction of the infiltration of gas bubbles into the diaphragm chamber.

The nature, principle, and utility of the invention will be more clearly apparent from the following detailed description with respect to a preferred embodiment of the invention when read in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing, the single FIGURE is a diagrammatic side elevation, in vertical section, showing the essential parts of a slurry pump of liquid-diaphragm type and indicating an example of practice of the invention.

DETAILED DESCRIPTION

The principal components of the slurry pump illustrated in the drawing are a plunger pump 1, a valve box 4, and an oil-diaphragm chamber 11 connected between the plunger pump and the valve box.

The plunger pump 1 has a cylinder 3 filled with oil and connected by way of an oil connecting pipe 12 to the upper part of the chamber 11 and a plunger 2 driven by means not shown and operating as a piston within the cylinder 3. The valve box 4 has a slurry suction pipe 9 and a slurry discharge pipe 10 and is provided internally with spaced apart valve seats 5 and 6 for cooperatively operating with ball valves 7 and 8, respectively, acting on the downstream sides of their valve seats to function as check valves for preventing reversal of slurry flow. A middle chamber 4a is formed between the two ball valves and communicates by way of a slurry connecting pipe 13 to the bottom of the oil-diaphragm chamber 11.

The chamber 11 is provided thereabove with an oil reservoir tank 14 communicating through a shut-off valve 15 to the upper part of the chamber 11. The upper part of this oil-diaphragm chamber 11 contains oil 22 communicating integrally with the oil in the pipe 12 and cylinder 3, while the lower part of the chamber 11 contains slurry 20 communicating integrally with the slurry in the pipe 13 and chamber 4a, an interface 21 being formed naturally between the oil 22 and slurry 20 because of the difference in the specific gravities thereof.

The liquid-diaphragm slurry pump of the above described organization is known, and the organization and operation thereof are disclosed in greater detail in the aforementioned references.

In accordance with this invention there is provided a method and apparatus for preventing infiltration of gas bubbles into the oil-diaphragm chamber 11. One example of this apparatus, as illustrated in the drawing, comprises a reservoir tank 18 for storing the mother liquor of the slurry not containing any bubbles and constituting a seal liquid, a liquid injection pipe 19 disposed in the lower part of the oil-diaphragm chamber 11, a booster pump 17, driven by motive power means (not shown), for pumping the seal liquid from the tank 18 into the injection pipe 19, a check valve 16 disposed between the pump 17 and the injection pipe 19 for preventing reversal flow of the seal liquid, and necessary piping and pipeline accessories (not shown).

This apparatus is operated, during the pumping operation of the slurry pump, to inject at a low flowrate the seal liquid without bubbles into the slurry 20 in the lower part of the oil-diaphragm chamber 11 thereby to force back gas bubbles traveling through the slurry pipe 13 and tending to enter into the chamber 11. The bubbles are thus inhibited from traveling toward the chamber 11 and caused to be discharged through the slurry discharge pipe 10.

During the suction stroke of the plunger pump 1, the check valve 16 permits the seal liquid to flow freely into the chamber 11. During the discharge stroke of the

plunger pump 1, the check valve 16 operates to prevent reverse flow or return of the injected liquid or entrance of slurry into the injection pipe 19, whereby the slurry 20 is sent in the normal manner toward the slurry pipe 13. Since the seal liquid is thus injected a little at a time into the chamber 11 during the suction stroke of the plunger pump 1, a net flow of liquid is created through the slurry pipe 13 from the oil-diaphragm chamber 11 toward the valve box 4, whereby the quantity of gas bubbles tending to enter the chamber 11 becomes progressively less.

Thus, the present invention provide a method and apparatus which, when applied to a slurry pump of liquid-diaphragm type, afford a saving in operational labour, eliminate the possibility of excessive wear of the slurry pump parts due to contamination of the diaphragm liquid, and enable the pump to operate stably with a steady delivery without the possibility of settling of particles to cause clogging even when the slurry pump is operated to pump slurry containing a large quantity of gas bubbles.

It should be understood, of course, that the foregoing disclosure relates to only a specific embodiment of the invention and that it is intended to cover all changes and modifications of the example of the invention herein chosen for the purposes of the disclosure, which do not constitute departures from the spirit and scope of the invention. For example, instead of the booster pump 17 used in the above described example, a driving pressure generating source of another kind can be used. In addition, the apparatus according to the invention may include control means 23 to control automatically the flowrate of the seal liquor supplied into the chamber 11 and means 24 to detect the concentration of gas bubbles in the slurry 20 and to generate corresponding signals in response to which the control means can operate to control the flowrate accordingly.

We claim:

1. For use in a slurry pump of the type having a liquid-diaphragm chamber containing in operation a slurry and a diaphragm liquid in contact therewith defining an interface therebetween, a method of preventing gas bubbles entrained in said slurry from infiltrating into said diaphragm liquid comprising injecting a seal liquid without gas bubbles into the slurry in said chamber to create a liquid flow counter to the direction of said infiltration of gas bubbles.

2. A method as claimed in claim 1 in which said seal liquid is the mother liquor without gas bubbles of the slurry being pumped.

3. In a slurry pump of the type having a liquid-diaphragm chamber containing in operation a slurry and a diaphragm liquid in contact therewith defining an interface therebetween, an apparatus for preventing gas bubbles entrained in said slurry from infiltrating the diaphragm liquid, said apparatus comprising a reservoir containing a seal liquid without gas bubbles, liquid-injection means for injecting said seal liquid into the slurry in the liquid-diaphragm chamber, means defining a flow path from said reservoir to said liquid-injection means, liquid-transfer means for transferring seal liquid from said reservoir through said flow path to said liquid-injection means, and a check valve disposed between the liquid-transfer means and liquid-injection means for preventing reverse flow in said flow path.

4. Apparatus as claimed in claim 3 in which said seal liquid is the mother liquor without gas bubbles of the slurry being pumped.

5. Apparatus as claimed in claim 3 in which there are provided detecting means for detecting the concentration of gas bubbles in the slurry in the liquid-diaphragm chamber to generate corresponding signals and control means operating in response to said signals to control the flowrate of the seal liquid through the flow path.

6. In combination, a slurry pump having a liquid-diaphragm chamber for containing in operation a slurry and a diaphragm liquid thereabove defining an interface therebetween, an apparatus for preventing gas in a gaseous phase entrained in said slurry from infiltrating into said diaphragm liquid, said apparatus comprising means to apply under pressure a seal liquid free of entrained gases to said slurry in said liquid-diaphragm chamber in a counter flow path directed away from said interface and in an area effective to substantially prevent infiltration of said gas into said interface.

7. Apparatus as claimed in claim 6, in which said means for applying said seal liquid comprises a reservoir containing said seal liquid, liquid-injection means for injecting said seal liquid into said slurry in said liquid-diaphragm chamber, liquid-transfer means to supply said seal liquid from said reservoir to said liquid-injection means.

8. Apparatus as claimed in claim 7, including a check valve disposed between said liquid-transfer means and said liquid-injection means to prevent reverse flow toward said liquid-transfer means.

9. Apparatus as claimed in claim 7, including sensing means detecting the concentration of said gas entrained in said slurry, control means responsive to said sensing means to control the flow rate of said seal liquid to said liquid-injection means.

10. Apparatus as claimed in claim 6, in which said seal liquid comprises the component liquid of said slurry.

11. For use in conjunction with a slurry pump having a liquid-diaphragm chamber for containing in operation slurry and a diaphragm liquid thereabove defining an interface therebetween, an apparatus for preventing gas in a gaseous phase entrained in said slurry from infiltrating into said diaphragm liquid, said apparatus comprising means to apply under pressure a seal liquid free of entrained gases to said slurry in said liquid-diaphragm chamber in a counter flow path directed away from said interface and in an area effective to substantially prevent infiltration of said gas into said interface.

12. The apparatus as claimed in claim 11, in which said seal liquid comprises the component liquid of said slurry.

13. The apparatus as claimed in claim 11, in which said means for applying said seal liquid comprises a reservoir containing said seal liquid, liquid-injection means for injecting said seal liquid into said slurry in said liquid-diaphragm chamber, and liquid-transfer means to supply said seal liquid from said reservoir to said liquid-injection means.

14. The apparatus as claimed in claim 13, including a check valve disposed between said liquid-transfer means and said liquid-injection means to prevent reverse flow toward said liquid-transfer means.

15. The apparatus as claimed in claim 13, including sensing means detecting the concentration of said gas

5

entrained in said slurry, control means responsive to said sensing means to control the flow rate of said seal liquid to said liquid-injection means.

16. A method of preventing infiltration of gas bubbles into a liquid defining an interface with a mixture of a liquid with insoluble matter comprising, applying a seal liquid free of bubbles under pressure to said mixture in the vicinity of said interface as a counter flow directed to flow away from said interface and in an area effective to substantially prevent infiltration of said gas into said interface.

17. A method as claimed in claim 16, in which said seal liquid comprises the component liquid of said liquid mixture.

18. For use in a slurry pump having a liquid-

6

diaphragm chamber for containing in operation a slurry and a diaphragm liquid thereabove defining an interface therebetween, a method of preventing gas bubbles entrained in said slurry from infiltrating into said diaphragm liquid comprising, applying under pressure a seal liquid free of bubbles to said slurry in said liquid-diaphragm chamber in the vicinity of said interface and directed to flow away from said interface and in an area effective to substantially prevent infiltration of said gas bubbles into said interface.

19. A method as claimed in claim 18, in which said seal liquid comprises the component liquid of said slurry.

* * * * *

20

25

30

35

40

45

50

55

60

65