United States Patent

Holmes

[15] **3,697,194**

[45] **Oct. 10, 1972**

[54] **METHOD AND APPARATUS FOR REMOVING SAND FROM WELLS**

[72] Inventor: **Fred S. Holmes,** P.O. Box 785, Maricopa, Calif. 93252

[22] Filed: **Sept. 14, 1970**

[21] Appl. No.: **71,693**

[52] **U.S. Cl.** **417/54,** 417/430, 417/547, 166/109

[51] **Int. Cl.**.....**F04b 21/04,** F04b 39/10, E21b 27/00

[58] **Field of Search**.....417/547, 54, 430, 431, 451; 166/109, 108, 68, 73, 87, 68.5

[56] **References Cited**

UNITED STATES PATENTS

188,229	3/1877	Blakslee	417/547
1,545,475	7/1925	Adams	417/430
2,191,223	2/1940	Van Stone et al.	166/109
2,701,020	2/1955	Condra	166/109

Primary Examiner—Robert M. Walker
Attorney—Angus & Mon

[57] **ABSTRACT**

A method and apparatus for cleaning out wells which have a casing subject to intrusion by sand and other detritus. A tubing, which may be the same tubing used in the routine operation of the well for the removal of liquids such as oil or water, is adapted for reciprocal motion for purposes of this invention, and carries a plunger which telescopically fits into a reference tube which is biased by its own weight or otherwise toward the bottom. A sliding seal fits between the reference tube and plunger to form a variable-volume pumping chamber. A check valve is placed at each end of the pumping chamber, so as to provide for unidirectional movement of sand from the reference tube into the tubing, and up to the surface. The result is the pumping of sand and liquid to the surface. Should there be insufficient liquid in the well to provide velocity sufficient to hold the same in suspension, it may be supplemented by dumping more liquid down the well.

9 Claims, 3 Drawing Figures

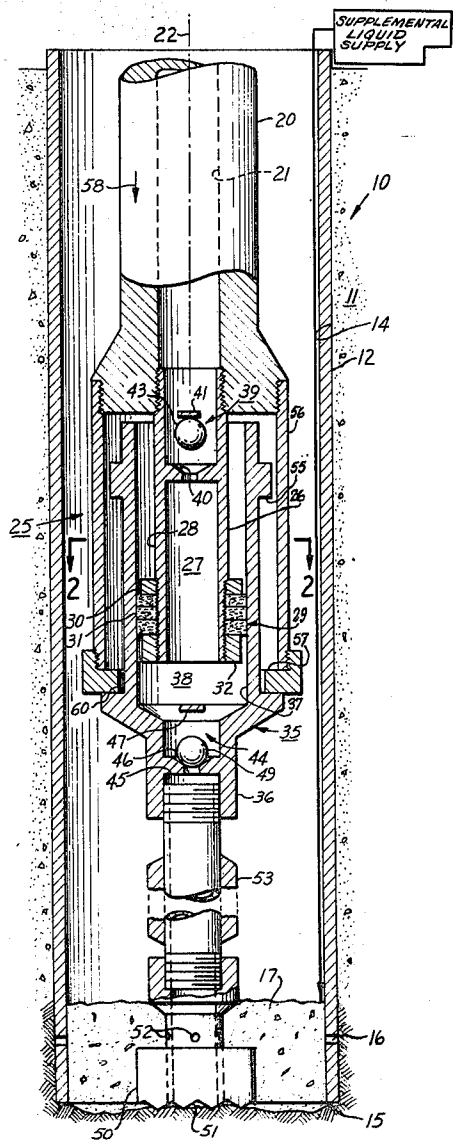


FIG. 1

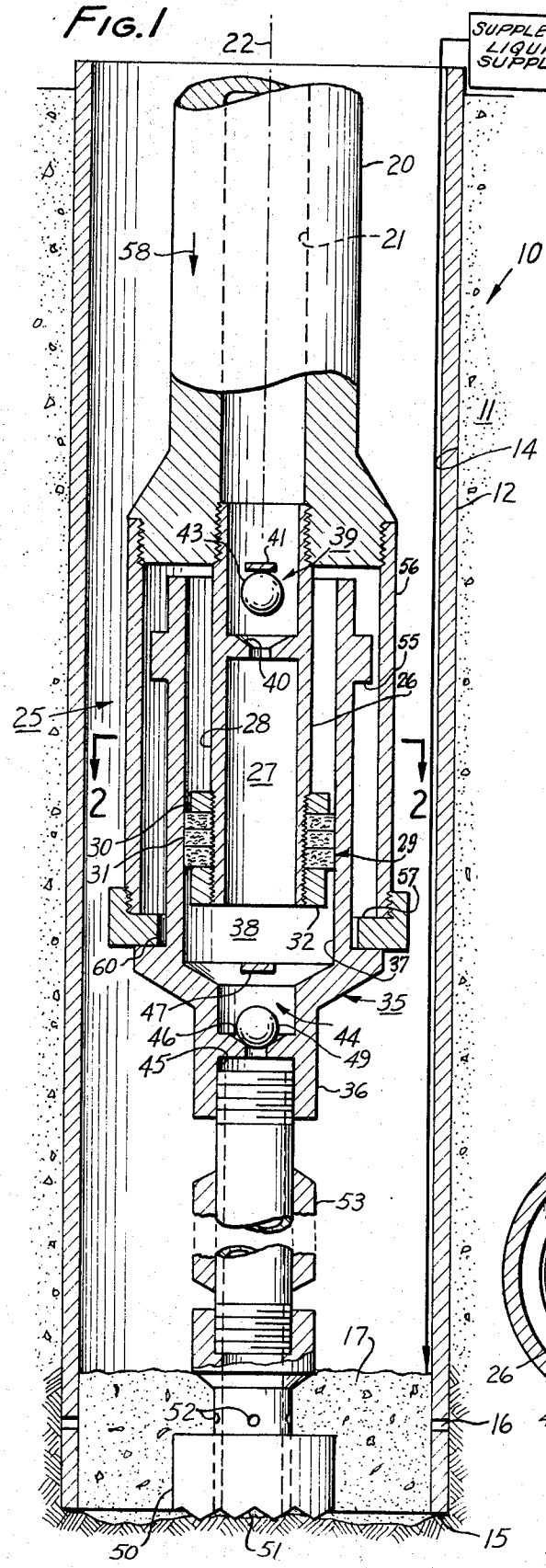
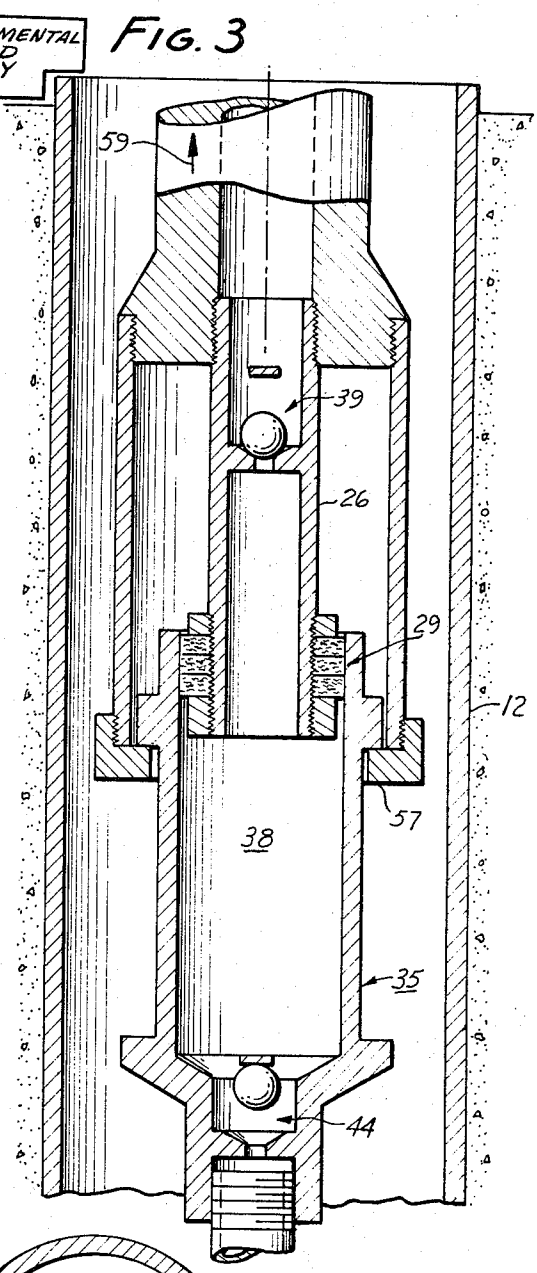


FIG. 3



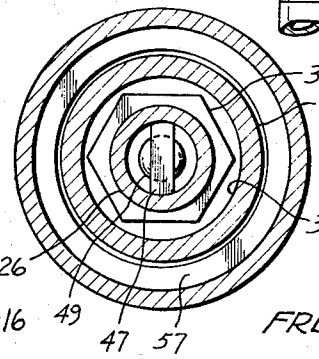


FIG. 2

INVENTOR.
FRED S. HOLMES

BY Agnew & Moore
ATTORNEYS.

METHOD AND APPARATUS FOR REMOVING SAND FROM WELLS

This invention relates to a method and apparatus for removing sand from wells.

Wells such as oil wells conventionally include an outer casing which keeps the hole open to the surface, and its lower regions receive through perforations or the bottom of the casing liquids to be extracted through from the well. These liquids are pumped upwardly through a tubing located within the casing. This tubing does not reciprocate during the conventional operation of the well. Instead, a rod passes through it which does reciprocate so as to actuate a pumping mechanism.

A common problem is that sand and other detritus gets into the casing with the liquids and plugs the well. Then the strings of tubing and rod have to be removed, and a troublesome, slow and expensive bailing operation is carried out to remove the sand. It is an object of this invention to provide a pump which can utilize the tubing of the well itself as motive means, and directly pump the sane as a suspension in liquid without the use of conventional bailing techniques. Such a pumping technique is far more effective in clearing a well than are bailing techniques, requires less skill and technique, and is much faster and cheaper. The equipment is simple and rugged, and utilizes much structure already present at the well, thereby considerably reducing capital requirements for bailing equipment.

This invention is applicable to both high and low pressure wells, even though their problems are significantly different. In some common oil formations in California, the formations are so sandy that the well can be drilled by the stream of water. However, formation pressures are very low, and flow is slow, perhaps on the order of only 40 to 50 barrels per day. Such wells tend to sand up easily, and often conventional bailing techniques clear the well for only a day or so. Pressurized flushing has been tried, but this seems merely to force the sand back into the formation where it clogs it, and then later part of it returns to fill the well with sand.

There are still other problems. The sand cannot, of course, be pumped dry. It can be pumped as a suspension in a liquid, it which it will have a settling rate which must be exceeded in upward flow if the sand is to be removed. Therefore should there be insufficient liquid in the well for this rate to be maintained, then with the use of this invention, supplemental liquid will be poured into the well to supply it. Then the net flow will always be out of the well, and there will be no tendency to drive sand into the formation.

In high pressure wells with adequate flow, the supply of liquid is not a problem, but the pumping rate should be such as to provide a lower pressure in the casing than in the formation to provide for the net flow and for a sufficient upward flow velocity.

This invention is accomplished by fitting to the end of the tubing a plunger with a passage in fluid communication with the tubing. The plunger makes a sliding, fluid-sealing, telescopic fit with a reference tube, there being a sliding seal attached to one of these and slidable relative to the other so as to form a pumping chamber of variable volume. A check valve at each end of the pumping chamber provides for unidirectional movement of the sand. The reference tube projects into the sand so it can be pumped out.

According to a preferred but optional feature of this invention, the reference tube is freely movable, but its restraint is downward on account of its mass. It can therefore follow the top of the sand down as the sand is removed.

According to still another preferred but optional feature of this invention, a shoulder projects from the reference tube, and an overhanging shoulder projects from an extension of the tubing so that they engage before the seal is impacted. This allows the reference tube to be lifted by strong structure rather than merely by a sealing ring.

According to this method of this invention, the linear rate of movement of the pumped sand - liquid suspension is maintained at a value greater than the settling rate of the sand in the liquid, and if necessary in order to maintain this rate, supplemental liquid is fed into the well.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawings, in which:

FIG. 1 is an axial cross-section showing the presently preferred embodiment of the invention in one direction of its pumping stroke;

FIG. 2 is a cross-section taken at line 2—2 of FIG. 1; and

FIG. 3 is a view similar to that of FIG. 1 showing the device in the opposite direction of its pumping stroke.

This invention is intended for use in connection with a well 10 in a formation 11. As is customary in such wells, a casing 12 is provided to hold open a hole 14 which has been drilled through the formation. The casing conventionally may have an open end 15 or perforations 16 in its wall or both in order to admit fluids such as oil to be recovered from the well.

A common problem in wells of this class is that sand and other detritus 17 will ultimately flow into the casing where it may clog the system and impede further efficient recovery from the well. Because such wells usually have a tubing inside the casing through which tubing a pumping element such as a rod is passed to a pump at the bottom, it is necessary to remove the rod and the tubing from the well and then send down bailing equipment to remove the sand from the bottom of the well. Such techniques are quite troublesome, and this invention avoids them.

As a significant advantage, it utilizes the same tubing 20 as was used in the well in the first place. Such tubing has a passage 21 extending along axis 22 of the system. The sand pump 25 is attached to the end of this tubing. For purposes of this invention the tubing is axially reciprocated such as by means of a derrick or other means. In the conventional operation of a well the tubing remains stationary and the pumping operation is accomplished by the rod or other means sent down through it, but with this invention, the existing stationary means is made movable and becomes the motive means for the pump mechanism.

The pump includes a plunger 26 which is attached to the lower end of the tubing. This plunger has a central passage 27 extending from end to end thereof and an outer wall 28. To this outer wall there is attached a sliding seal 29. This seal may conveniently comprise a collar 30, a plurality of sealing rings 31 and a retainer ring 32. It will now be seen that the seal is reciprocal along with the plunger.

A reference tube **35** is axially disposed in the system and extends downwardly from the tubing. It includes a neck **36** and an enlarged portion with an inner wall **37** along which the seal **29** slides. The seal **29** thereby moves with one of the walls and extends between the two of them. In doing so it bounds a pumping chamber **38** of variable volume, the volume depending on the relative axial positions of the two walls, which of course are telescopically disposed. The rings **31** are cylindrical on their outer ends and the inner wall **37** is cylindrical.

A first check valve **39** is disposed in the plunger and includes a seat **40** and a retainer **41**. A ball **43** is adapted to close the valve by closing seat **40** in one position, and to be open by being moved away from seat **40** and bearing against retainer **41** in the condition shown. A second check valve **44** is disposed in the passage **45** in the reference tube and it too includes a seat **46**, a retainer **47**, and a ball **49**. It is shown in its closed condition. It will be noted that these valves are both unidirectional and that they each permit flow only in the upward direction.

Passage **45** extends downwardly through neck **36** and terminates at the bottom end of bit **50**, which bit has teeth **51** which, when the reference tube is dropped onto the sand will aid in penetration of the lower end of the reference tube into the sand to be pumped. Perforations **52** also admit sand and other detritus to the passage **45** for upward pumping. The reference tube is restrained in a downward direction. This does not necessarily mean physical restraint which prevents the reference tube's being pulled upwardly, for ultimately it must be removed from the casing. However, the restraint means is such as to cause the reference tube to remain relatively stationary relative to the bottom of the well as the plunger is moved up and down in order that the pumping action may occur. It own mass is often sufficient for this purpose, but additional restraint means **53** can be provided by means of an external collar such as a heavy-walled piece of tubing welded or otherwise attached to the outer surface of the neck. This is a biasing restraint which will tend to hold the reference tube downward in the material to be removed.

It would be undesirable to pull the reference tube out of the hole or lift it and then drop it again simply by engagement of the sealing rings. Accordingly, a shoulder **55** is formed on the outer wall of the reference tube and an extension **56**, preferably in the form of a piece of tube threaded to the end of the tubing, extends downwardly and engages an inwardly overhanging shoulder **57** formed by a ring threaded onto the end extension **56**. It will be seen that when the tubing is pulled up to a significant extent, the overhanging shoulders will engage each other (this being the intended connotation of the term "overhanging" and of its equivalent term interfering"interfering), and that this strong structure will thereby lift the reference tube, thereby protecting the sealing rings against damage. This enables the reference tube to be withdrawn from the well along with the rest of the pump structure and system, and also enables it be picked up and then be lowered forcibly into the sand should forcible action be considered necessary.

Another shoulder **60** is formed on the outside of the reference tube, and is adapted to be engaged by the lower end of the ring which bears shoulder **57**. Engagement of these surfaces prevents the top of the reference tube from striking the bottom of the tubing, and also provides a means to deliver a downwardly directed blow to the reference tube should it be desired to drive it downwardly.

The operation of the device is as follows: The first pumping stroke is made as shown in FIG. **1** with the tubing lowered in the direction indicated by arrow **58**. This will force the plunger downwardly into the pumping chamber, will close check valve **44** and open check valve **39**. This will cause an expulsion of material from the pumping chamber. Then the direction of motion of the tubing is reversed as in FIG. **3**, indicated by arrow **59** for the next part of the pumping stroke. The condition of the check valves will be reversed, the plunger will be raised increasing the volume of the pumping chamber, and sand and other fluid will flow into the chamber and fill the same. Thereafter the condition is reversed to that of FIG. **1** for the following pumping stroke.

It will be seen that this pump utilizes the surprising step of using the tubing of an oil well which conventionally remains axially immovable, as a pumping element, thus enabling the pump to be a simple telescopic structure attached to the end thereof. Because of the restraint means inherent within or made a part of the reference tube, the system is a free one which tends to follow the lowering surface of the sand, and a continuous one which pumps the sand and liquid out of the bottom of the hole thereby accomplishing a flushing action, opening the well and bailing it out. The capital requirements for this device are not great. The tubing of the well itself is used to get to the bottom of the hole, and the structure of the pump itself is quite simple. In most derrick operations, and in most oil well operations, there are power means which can axially reciprocate the tubing. If there are not, minimal devices can be brought to the well to accomplish the same.

This invention has the merit that sand "flow" is exclusively from the formation to the tubing. The pump creates a low pressure region that causes this result. Accordingly, sand is not driven back into the formation. Should the well be so slow-flowing that insufficient liquid is present to pump the sand suspension at a rate adequate to overcome the settling of the sand, then additional liquid will be dumped into the well from a supplemental liquid supply to provide it, but not so rapidly as to cause the pressure in the casing to exceed that in the formation.

Still another advantage of this invention is that the well is not taken out of service during this "bailing" operation, as is the case in conventional bailing. The fluid in which the sand is brought up is mainly from the producing formation, and production is maintained during this operation, thereby providing economic recovery even during well repair.

The term "sand" is used herein generically to describe the particular matter of the class which tends to intrude into the casing.

This invention is not to be limited by the embodiment shown in the drawings and described in the description which is given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

I claim:

1. A pump for removing sand from a well of the class having a casing subject to intrusion by sand and like detritus, from within which casing liquid is conventionally pumped through a passage in a tubing which passes axially through the casing, said pumping comprising: a plunger attachable to said tubing and movable axially therewith, said plunger having a passage extending axially therethrough and making a fluid connection with the passage through the tubing; an outer wall on said plunger; a reference tube having a passage therethrough and extending in axial alignment with the plunger; an inner wall on said passage in the reference tube, the plunger and reference tube being so disposed and arranged that the walls are telescopic; a sliding fluid seal extending between said walls and attached to one of them, there being formed by the inner wall of the reference tube and the seal a pumping chamber of volume which is varied by moving the tubing and thereby the plunger axially relative to the reference tube; a first check valve in the passage in the plunger; a second check valve in the passage in the reference tube, the check valves being unidirectional and permitting flow only toward the tubing; the mass of the reference tubing biasing itself against motion toward the tubing when the pump is suspended by the tubing, whereby with an opening of the passage in the reference tube located in the sand to be pumped, the plunger may be reciprocated by the tubing to provide a pumping action in the chamber that unidirectionally pumps a suspension of sand in liquid into the tubing; an axially extending extension of the tubing disposed outside the reference tube which is rigidly connected relative to the plunger, and adjacent to the outside of the reference tube; and interfering shoulder means on said extension and on said reference tube which abut one another in one relative axial position thereof so as to prevent further separating sliding movement of the reference tube and the plunger before the sliding seal leaves sealing contact between the inner wall of the reference tube and the outer wall of the plunger, whereby upon lifting of the reference tube by the tubing, the lifting force is exerted on the reference tube through the said interfering shoulder means in abutment without axial contact against the sliding seal.

2. A sand pump according to claim 1 in which a bit is attached to the end of the reference tube away from the plunger in order to facilitate the penetration of the reference tube into the material to be pumped.

3. A sand pump according to claim 1 in which the shoulder means on the reference tube is an annular ring, and in which the extension of the tubing is a cylindrical member, the inwardly overhanging shoulder being a ring attached thereto.

4. A sand pump according to claim 3 in which a bit is attached to the end of the reference tube removed from the plunger in order to facilitate the penetration of the reference tube into the material to be pumped.

5. A pump system for removing sand from a well of the class having a casing subject to intrusion by sand and like detritus, comprising: a hollow tubing used in the well for extraction of fluid in normal operation extending from the surface to a region near the sand, there being a passage through the tubing; means axially to reciprocate the tubing; a plunger attached to said tubing and movable axially therewith, said plunger having a passage axially therethrough and making a fluid connection with the passage through the tubing; an outer wall on said plunger; a reference tube having a passage therethrough and extending in axial alignment with the plunger; an inner wall on said passage in the reference tube, the plunger and reference tube being so disposed and arranged that the walls are telescopic and freely slidable relative to one another; a sliding fluid seal extending between said walls and attached to one of them, there being formed by the inner wall of the reference tube and the seal a pumping chamber of volume which is varied by moving the tubing and thereby the plunger axially relative to the reference tube; a first check valve in the passage in the plunger; a second check valve in the passage in the reference tube, the check valves being unidirectional and permitting flow only toward the tubing; the mass of the reference tube biasing itself against motion toward the tubing when the plunger is suspended by the tubing, whereby with an opening of the passage in the reference tube located in the sand to be pumped, the tubing may be reciprocated to move the plunger and provide a pumping action in the chamber that unidirectionally pumps a suspension of sand in liquid into the tubing and to the surface; an axially extending extension of the tubing disposed outside the reference tube which is rigidly connected relative to the plunger, and adjacent to the outside of the reference tube; and interfering shoulder means on said extension and on said reference tube which abut one another in one relative axial position thereof so as to prevent further separating sliding movement of the reference tube and the plunger before the sliding seal leaves sealing contact between the inner wall of the reference tube and the outer wall of the plunger, whereby upon lifting the reference tube by the tubing, the lifting force is exerted on the reference tube through the said interfering shoulder means in abutment without axial contact against the sliding seal.

6. A sand pump system according to claim 5 in which a bit is attached to the end of the reference tube away from the plunger in order to facilitate the penetration of the reference tube into the material to be pumped.

7. A sand pump system according to claim 5 in which the shoulder means on the reference tube is an annular ring, and in which the extension of the tubing is a cylindrical member, the inwardly overhanging shoulder being a ring attached thereto.

8. A sand pump system according to claim 7 in which a bit is attached to the end of the reference tube removed from the plunger in order to facilitate the penetration of the reference tube into the material to be pumped.

9. The method of pumping a suspension of sand in liquid from the bottom to the top of a well, which well produces insufficient liquid to form a stream with a linear velocity in excess of the settling velocity of the sand, said method comprising: installing a pump in suction relationship with the sand; actuating the pump to create a region of reduced pressure so as to exert a pumping action directed away from the sandy region; and supplementing the liquid in the sandy region such that there is sufficient volume of suspension flowing upwardly that its linear velocity exceeds the settling velocity of the sand in the liquid.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,697,194 Dated October 10, 1972

Inventor(s) Fred S. Holmes

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 9 cancel "from"

Col. 1, line 21 "sane" should read --sand--

Col. 1, line 45 "it" 1st occurrence should read --in--

Col. 3, line 36 "It" should read --Its--

Col. 3, line 57 'interfering"interfering' should read --
--"interfering"--

Col. 3, line 63 before "forcible" 2nd occurrence insert --such-

Col. 5, line 5 "pumping" should read --pump--
(Cl. 1, line 5)

Col. 5, line 23 "tubing" should read --tube--
(Cl. 1, line 20)

Signed and sealed this 1st day of October 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE 1969 O—366-334