July 9, 1968 A. A. ZALIS 3,391,643

SUB-SURFACE PUMP

Filed Feb. 7, 1966 2 Sheets-Sheet 1

FIG. 1

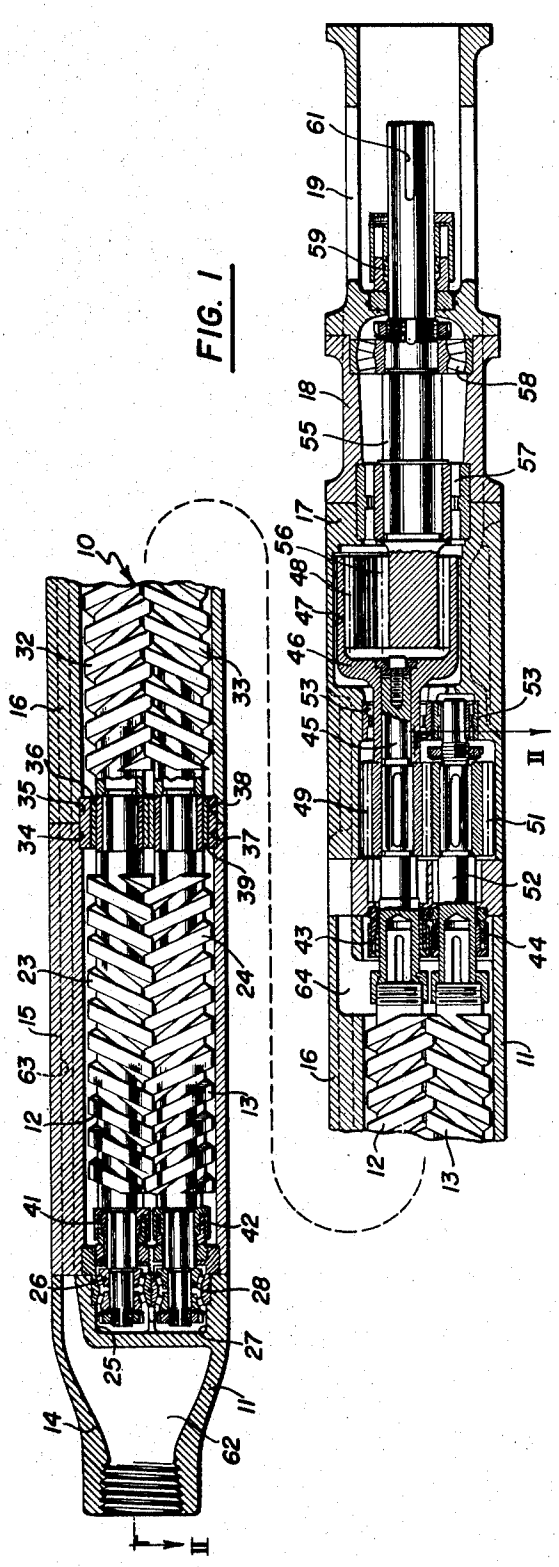
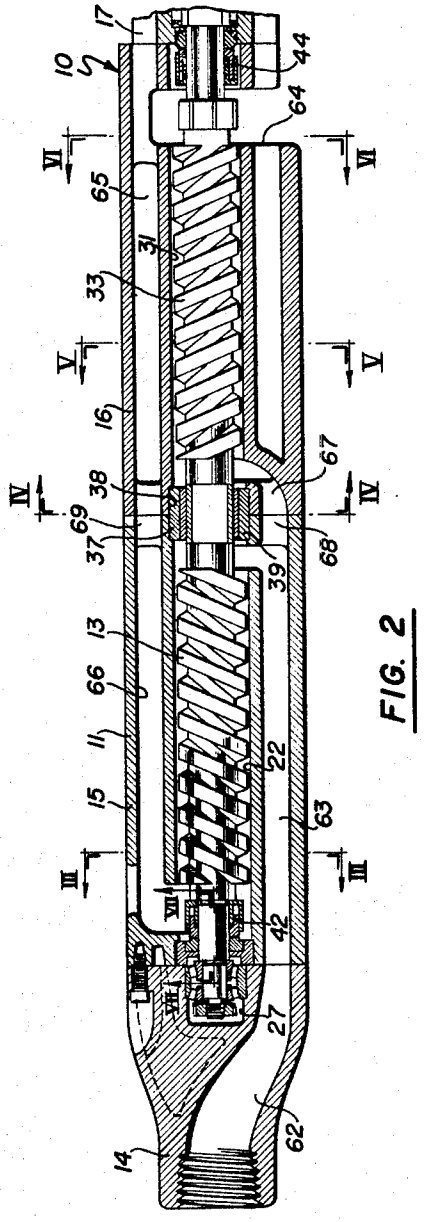


FIG. 2



ALBERT A. ZALIS
INVENTOR.

BY Abram S. Blodgett

July 9, 1968 A. A. ZALIS 3,391,643

SUB-SURFACE PUMP

Filed Feb. 7, 1966 2 Sheets-Sheet 2

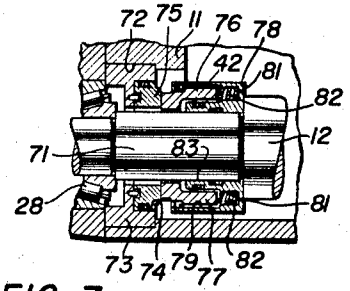


FIG. 7

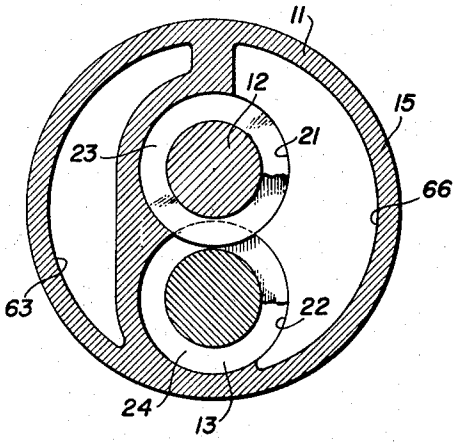


FIG. 3

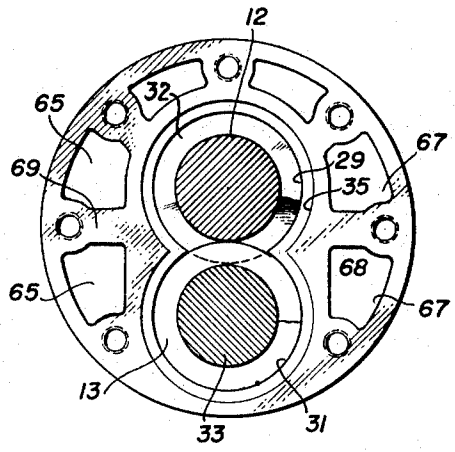


FIG. 4

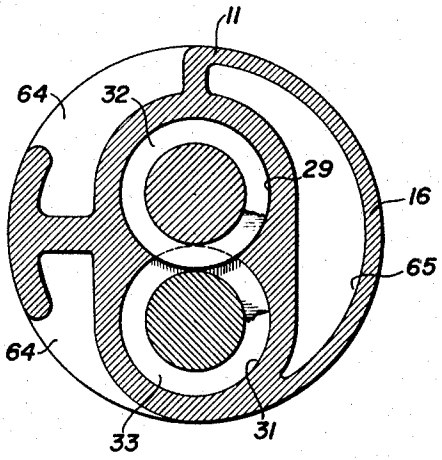


FIG. 5

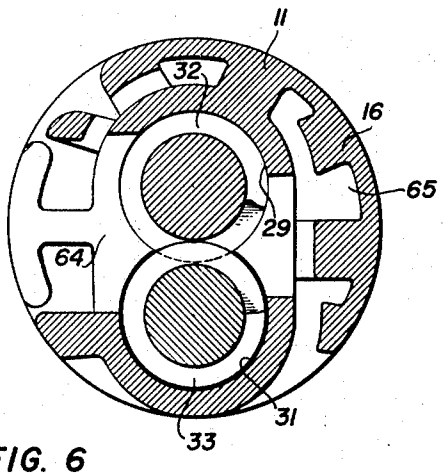


FIG. 6

ALBERT A. ZALIS
INVENTOR.

BY

Albert A. Blodgett

United States Patent Office 3,391,643 Patented July 9, 1968

3,391,643

SUB-SURFACE PUMP

Albert A. Zalis, Warren, Mass., assignor to Warren Pumps, Inc., Warren, Mass., a corporation of Massachusetts

Filed Feb. 7, 1966, Ser. No. 525,418
3 Claims. (Cl. 103—119)

ABSTRACT OF THE DISCLOSURE

This invention relates to a sub-surface pump and, more particularly, to apparatus arranged to move fluid from the bottom of a deep well by the interengagement of two interengaging screws operated by a sealed motor.

It has been common practice in oil wells and the like, after the drilling operation has been performed in the well, to mount a pump on the end of a long string of tube and move it down to the bottom of the well to withdraw fluid from the well. In the past, however, such submerged pumps have been relatively ineffective for a number of reasons. Foremost of all, is the fact that the differential pressures are so large that sealing is a problem and a considerable portion of the power expended in the pump by the drive motor is used in simply recirculating fluid through the seals and joints of the pump. Furthermore, it has been found that the fluid finds its way into the bearings and into the intricate moving parts associated with the pump, causing the assembly to wear out rather quickly. This is especially true where the fluid being pumped contains grit, as for instance, in the case of pumping hot sulphur. In the case of oils some of the chemicals in the raw petroleum are able to attack metal surfaces and destroy them. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a sub-surface pump of a thin, elongated form for operation at the bottom of a narrow well.

Another object of this invention is the provision of a sub-surface pump capable of operating with low loss of power due to leaking seals.

A further object of the present invention is the provision of a sub-surface pump capable of a long life of operation in abrasive or chemically active fluids.

It is another object of the instant invention to provide a sub-surface pump capable of handling high viscosity fluids from the bottom of a well.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to one of its structural forms, as illustrated by the accompanying drawings in which:

FIG. 1 is a sectional view of a sub-surface pump embodying the principles of the present invention,

FIG. 2 is a sectional view of the invention taken on the line II—II of FIG. 1,

FIG. 3 is a view of the invention taken on the line III—III of FIG. 2,

FIG. 4 is a traverse sectional view of the invention taken on the line IV—IV of FIG. 2,

FIG. 5 is a sectional view of the invention taken on the line V—V of FIG. 2,

FIG. 6 is a sectional view of the invention taken on the line VI—VI of FIG. 2, and

FIG. 7 is a sectional view taken on the line VII—VII of FIG. 2.

In the description which follows, directions will be correlated so that the expression "upper" or "top" applies to the vertical position of the pump in the well, while the "down" or "downward" direction is lower in the well, this being true for purposes of description, despite the fact that the pump in the figures is shown in a horizontal condition.

Referring first to FIG. 1, wherein are best shown the general features of the invention, the pump, indicated generally by the reference numeral **10**, is shown as having an elongated housing **11** containing screws **12** and **13**. The housing **11** is provided with a top portion **14** which would normally be uppermost in the well, a top pump portion **15**, a bottom pump portion **16**, a gear portion **17**, and two coupling portions **18** and **19**. Extending longitudinally of the top pump portion **15** are two overlapping bores **21** and **22** (see FIG. 3). In the bore **21** lies an upper portion **23** of the screw **12** and in the bore **22** lies an upper portion **24** of the screw **13**. Extending coaxially into the top portion **14** of the housing coaxially of the bore **21** is a recess **25** carrying a tapered roller bearing **26** in which the upper end of the screw **12** is supported. Similarly, coaxially of the bore **22** the top portion **14** of the housing is provided with a recess **27** in which is mounted a tapered roller bearing **28** which supports the upper end of the screw **13**.

The bottom pump portion **16** of the housing **11** is provided with overlapping bores **29** and **31** which are coaxial respectively with the bores **21** and **22** in the top pump portion **15**. The bore carries the bottom portion **32** of the screw **12**, while the bore **31** carries the bottom portion **33** of the screw **13**. The adjacent ends of the bores **21** and **29** are provided respectively with counterbores **34** and **35**, the counterbore **35** being particularly well shown in FIG. 4. In these counterbores is carried a plain bearing **36** supporting the central portion of the screw **12** between the upper portion **23** and the bottom portion **32**. Similarly, the adjacent ends of the bores **22** and **31** are provided, respectively, with counterbores **37** and **38** which carry a plain bearing **39** which supports the screw **13** between the upper portion **24** and the bottom portion **33**. Associated with the end of the screw **12** adjacent the recess **25** and the top portion **14** of the housing is a seal **41**, while a similar seal **42** is associated with the end of the screw **13** adjacent the recess **27** in the top portion **14**. At the bottom end of the bottom pump portion **16** of the housing the end of the screw **12** is provided with a seal **43** while at the same end the seal **44** is associated with the shaft **13**. Extending through the gear portion **17** of the housing is a shaft **45** whose upper end is connected to the screw **12** in driving relationship. The lower end of the shaft **45** is provided with a pot **46** having a counterbore **47** in which is mounted an internal gear **48**. In the intermediate portion of the shaft **45** is mounted a spur gear **49** keyed to the shaft and mounted in driving relationship with a spur gear **51** keyed to a shaft **52**. The shaft **52** is mounted coaxially of the screw **13** and is connected at its upper end for driving relationship therewith. The other end of the shaft **52** is mounted in a roller bearing **53** mounted in the gear portion **17** of the housing. Similarly, the shaft **45** is provided with a roller bearing **54** mounted in the housing, the bearing being located between the spur gear **49** and the pot **46**. Mounted in the housing **11** and occupying a portion of the gear portion **17** and the coupling portion **18** as well as the coupling portion **19** is a shaft **55**. The upper end of this shaft is provided with a spur gear **56** which engages the internal gear **48**. However, the shaft **55** and the spur gear **56** are exactly coaxial of the cylindrical outer surface of the housing **12** and, therefore, are non-coaxial with the screws **12** and **13**. The shaft **56** is supported in a roller bearing **57** which shares facing counterbores formed in the gear portion **17** and the coupling portion **18**. Similarly, the shaft **55** is mounted in a roller bearing **58** spaced from

the bearing 57 and mounted in a counterbore formed in the downward end of the coupling portion 18. The shaft 55 is provided with a seal 59 associated with the coupling portion 19. The shaft is provided at its lower end with a keyway for connecting it to a submerged-type motor (not shown) attached to the end of the coupling portion. The motor shaft is connected to the lower end of the shaft 55.

As is evident from the drawings, the housing 11 is provided with a number of passages. For instance, the top portion 14 is provided with an outlet passage 62 whose outer end is threaded for attachment to the bottom end of a pipe line extending downwardly into a well. The screws 12 and 13 constitute a double-screw pump which feeds toward the center in the area surrounding the bearings 36 and 39. A passage 63 extends from the center or junction between the top pump portion and the bottom pump portion in the vicinity of the bearing 39 to the outlet passage 62. The passage 63 is shown as being crescent-shaped in FIG. 3 and appears as a dotted line in FIG. 1. The lower end of the bottom pump portion 16 of the housing 11 is provided with an external inlet opening 64 which extends transversely into the housing and appears in FIGS. 5 and 6. As is evident in FIG. 6, this inlet opening 64 has direct admission to the lower end of the bores 29 and 31 for engagement with the screws 32 and 33. The opening 64 also leads into a passage 65 extending entirely through the bottom pump portion 16 and connected to a similar passage 66 extending through the top pump portion 15. As is evident in FIGS. 2 and 3, the upper end of the passage 66 has access to the upper end of the screws 12 and 13 and, particularly, of the upper ends of the upper portion 23 and the upper portion 24 of these screws. The pump elements make up a double-screw-type pump of the general nature shown in the patent to Zalis No. 3,198,132. The upper portions 23 and 24 of the screws 12 and 13 have their leads arranged to feed material from the top toward the center joint between the top pump portion 15 and the bottom pump portion 16. Similarly, the bottom portions 32 and 33 of the screws 12 and 13 have their leads arranged to pump upwardly; that is to say, from the opening 64 to the vicinity of the bearing 39. It is interesting to note that the bearings 39 and 36 are mounted on webs which leave a passage 67 (see FIG. 2) leading from the upper ends of the bottom portions 32 and 33 of the screws to the passage 63 going to the outlet passage 62. It is also interesting to notice from FIG. 4, particularly, that the passage 67 leading from the output of the lower pump is divided by a web 68 which assists in supporting the bearings 36 and 39. It is also evident in FIG. 4 that a web 69 extends across the passage 65 and assists in the support of the same bearings. The webs 68 and 69, of course, are formed by portions existing partly in the top pump portion 15 and the bottom pump portion 16 of the housing.

FIG. 7 shows the details of the seal 42. An extension of the screw 12 is provided with a cylindrical portion 71, the upper end of which provides a shoulder against which the inner race of the bearing 28 rests. The housing 11 is provided with a counterbore 72 which carries an annular block 73. This block is provided with a co-axial counterbore 74 in which is carried an impregnated fabric collar 75. Against this collar is pressed a sleeve 76 slidable on the cylindrical portion 71 and having a coaxial tubular flange 77. Slidable over this flange is a cap member 78 having a deep axial groove 79 in which the flange 77 fits loosely. At the bottom of the groove, the cap member 78 is provided with a plurality of small bores 81 in which reside an equal number of coil springs 82. Each spring pressing at one end against the bottom of its bore and at the other end against the radial end surface of the flange 77 of the sleeve 76. A cap member 78 is provided with a bore 83 which fits slidably over the cylindrical portion 71 of the shaft of the screw 12. A top of the cap member 78 is engaged by a shoulder on the screw 12 which locates it accurately with regard to the ends of the cylindrical portion 71 and the sleeve 76 and the collar 75. Suitable O-ring seals are provided between the engaging surfaces of the cylindrical portion 71, the bore 83 of the cap member 78, and between the surfaces of the cap member and the inner surface of the flange 77 of the sleeve 76.

The operation of the apparatus will now be readily understood, in view of the above discussion. The submerged pump 10 is inserted in a well containing petroleum or other viscous material with the top portion 14 of the housing extending upwardly. The outer surface of the housing 11 is substantially the same shape as the well hole in which the pump is inserted and may in a conventional oil well have a diameter in the order of six inches. Normally, the entire housing and motor would be submerged in the liquid. With the motor operating and mechanically connected to the lower end of the shaft 55 by means of the keyway 61, a liquid would enter the pump through the opening 64, pass directly into the bores 31 and 29 and in between the engaging surfaces of the screws 32 and 33. At the same time, liquid entering the inlet opening 64 would pass through the passage 65 into the passage 66 of the top pump portion 15 and enter the bores 21 and 22 at the top portions 23 and 24 of the screws 12 and 13. In both cases, the fluid would be pumped by the engaging screw surfaces toward the common point between the top pump portion 15 and the bottom pump portion 16. The fluid leaving the upper portions 23 and 24 would leave that section of the pump and enter directly into the passage 63 leading to the outlet passage 62. The fluid leaving the upper end of the bottom portions 32 and 33 of the screw pump would flow through the passage 67 and into the passage 63 in the same direction. The upper end bearings 26 and 28 are protected by the seals 41 and 42. Any fluid back pressure from the upper portion of the screw pumps would tend to reinforce the action of the seals in protecting the bearings against the admission of the pumped fluid. Similarly, the seals 43 and 44, which are similar to the seal 41 described above, protect the bearing and gear elements in the gear portion 17 of the housing and, as in the case of the seals 41 and 42, the high pressure of the oil will make the seal operate more effectively. Furthermore, the high pressure side of each half of the pump is in the center, so that the lower pressure in the system is in the vicinity of the bearings and gears. The high pressure passage 63 is entirely isolated from these sensitive portions of the apparatus. A seal 59 is provided in the coupling portion 19 to protect the other opening into the gears and bearings, particularly to protect the bearing 58 at the downward end of the shaft 55.

It can be seen, then, that the present submerged pump provides a thin pump which will operate effectively in a very narrow well and which is constructed to permit the protection of the bearings, even though the entire apparatus is submerged in the liquid and is not readily available for the purpose of maintenance. The seals are particularly constructed to operate to increase their resistance to leakage with increase in fluid pressure.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. A sub-surface pump, comprising

(a) an elongated housing of limited transverse dimension adapted to lie vertically in a narrow well, the housing having an outlet passage at its upper end and an inlet opening at its lower end,

(b) a first screw extending through the housing and causing fluid to flow from adjacent the upper end to an intermediate position,

(c) a second screw extending through the housing and causing fluid to flow from adjacent the lower end

to the said intermediate position, two sets of first and second screws being provided, each set being mounted on a shaft, the shafts being parallel and coextensive,

(d) a pair of gears joining the shafts in driving engagement,

(e) bearings for the screws located at the said upper and lower ends, and

(f) passages extending through the housing from the inlet opening to the lower end of the second screw and the upper end of the first screw, one of the shafts being joined to one end of a driver shaft which is independently mounted, the other end of the driver shaft having a pot with an axial counterbore containing an internal gear, the internal gear being engaged by a spur gear mounted on one end of a shaft which is carried in bearings coaxially of the housing, the other end of the last-named shaft being adapted to be connected to the shaft of a motor mounted on the lower end of the housing.

2. A sub-surface pump as recited in claim **1**, wherein a seal is provided for each bearing, each seal including

two spring-biased telescoping members which press against a deformable collar.

3. A sub-surface pump as recited in claim **1**, wherein each set of screws is mounted on a common shaft and are separated at the intermediate position, wherein a bearing is mounted in the intermediate position to support the shaft between the screws, and wherein webs extend transversely of the housing through the passages to support and define the passages.

References Cited

UNITED STATES PATENTS

1,430,894	10/1922	Fay	103—128
1,687,399	10/1928	Simmons	103—119
1,896,108	2/1933	Simmons	103—119
2,640,430	6/1953	Sennet	103—128
3,056,355	10/1962	Brun	103—126

FRED C. MATTERN, JR., *Primary Examiner.*

WILBUR J. GOODLIN, *Examiner.*