

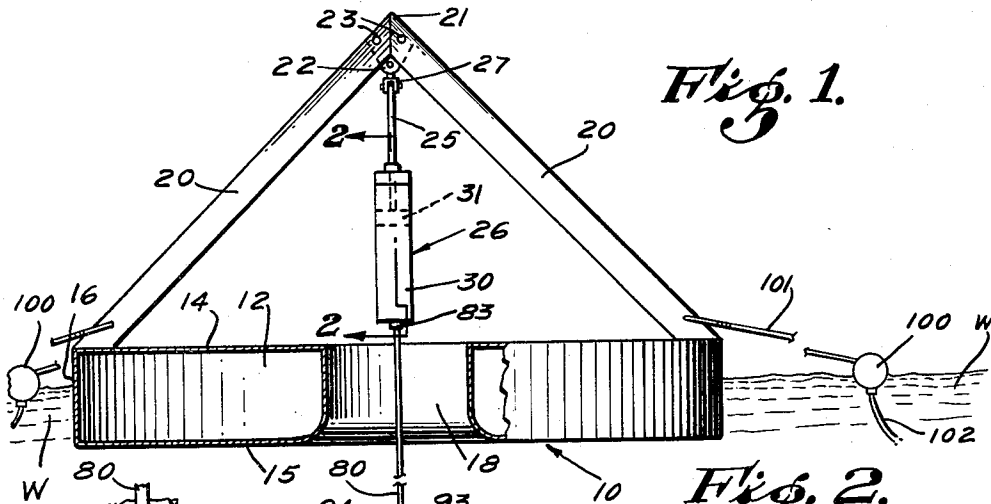
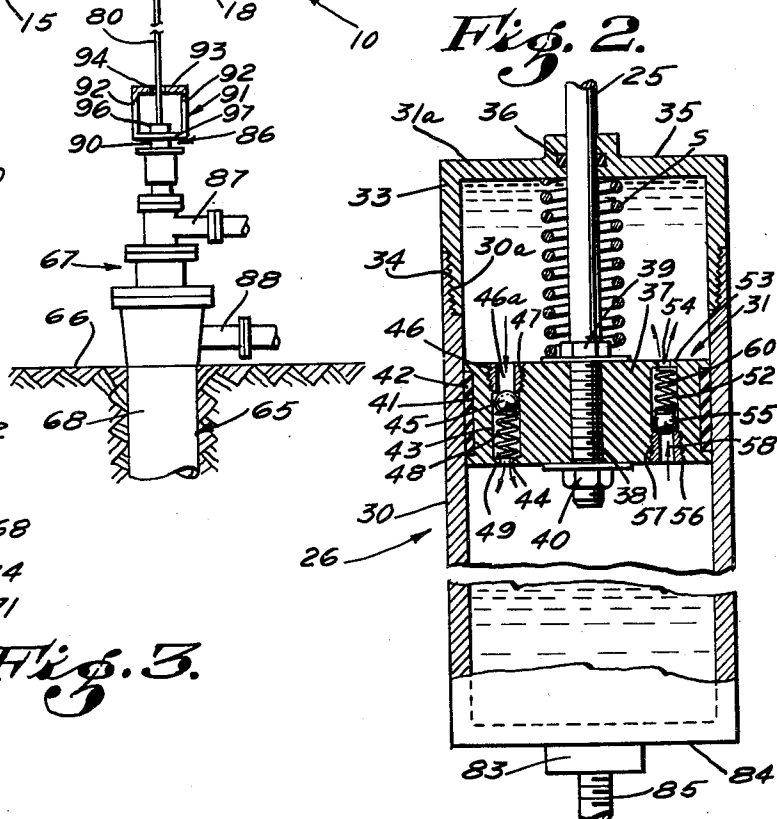
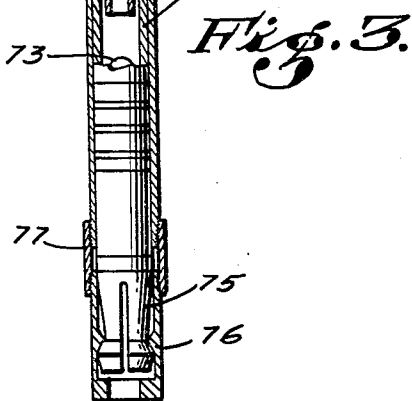
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D. U. SHAFFER

**3,040,667**

WAVE MOTION ACTUATED PUMP

Filed March 24, 1958



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3,040,667

## WAVE MOTION ACTUATED PUMP

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10 Claims. (Cl. 103—70)

This invention relates generally to pumping mechanisms and relates more particularly to wave actuated pumping apparatus.

While the invention has particular utility in connection with pumping oil from oil wells and the like, and is shown and described in such connection, it is to be understood that its utility is not confined thereto.

A recent development in the petroleum industry is the exploration for oil in formations underlying bodies of water such as the ocean and the drilling of oil wells into such formations for the removal of oil from subterranean oil pockets or formations.

It is, therefore, an object of the present invention to provide efficient apparatus for pumping oil from such wells.

It is another object of the invention to provide apparatus of this character utilizing waves in the water as a source of inexpensive energy or power to effect the pumping operation.

It is still another object of the invention to provide apparatus of this character that will accommodate itself to variations in the tides of a body of water such as the ocean.

It is a further object of the invention to provide apparatus of this character that is simple in construction.

It is a still further object of the invention to provide apparatus of this character that is effective and efficient in operation.

It is another object of the invention to provide apparatus of this character that is relatively inexpensive to manufacture.

It is still another object of the invention to provide apparatus of this character embodying mechanical pumping means.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings which represent one embodiment. After considering this example, skilled persons will understand that variations may be made without departing from the principles disclosed and I contemplate the employment of any structures, arrangements, or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings:

FIG. 1 is a diagrammatic side view of apparatus embodying the present invention;

FIG. 2 is a longitudinal section of the tide compensating device of the present apparatus; and

FIG. 3 is a longitudinal section of the lower end of an oil well with a pump installed therein.

Referring more particularly to the drawings, there is shown a float, indicated generally at 10, in a body of water W, said float comprising an annular ring-like water tight compartment 12 having upper and lower walls 14 and 15, and an annular peripheral wall 16, there being a central cylindrical wall defining an axial opening 18 through said float. While the float is shown herein as being annular in form, it is to be understood, of course, that it may have other shapes and the walls of the float may be of metal or any other suitable material. It is also to be understood that the float may be a hull that is not necessarily air tight, the top wall being merely a protection which will prevent water washing over the float from entering the interior of the hull.

A superstructure is provided and is shown as compris-

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ing a pair of support beams 20 having their lower ends secured by any suitable means, not shown, to the top wall 14 of the float adjacent the edge thereof and at diametrically opposite points. The beams 20 are inclined upwardly and inwardly and are joined at the apex 21. The upper ends of said beams at said apex are secured together by any suitable well-known means such as bolts, not shown, and there is a plate 22 which is secured to the apex part of said support beams by bolts 23 or the like. Plate 22 has a depending ear to which the upper end of a piston rod 25 of a tide compensating device, indicated generally at 26, is pivotally secured by means of a universal joint or swivel 27.

Device 26 is provided with a cylinder including a lower member 30 having an internally threaded upper end portion 30a and an upper member 33 having an externally threaded lower end portion 34 screwed into the internally threaded portion 30a. Piston rod 25 extends through the upper wall 35 of the upper cylinder member 33 and there is provided a packing 36 which seals about the piston rod to prevent escape of pressure fluid therepast. Operable within the cylinder is a piston 31 which includes a cylindrical body portion 37 having an axial opening therethrough for reception of the externally threaded lower end portion 38 of the piston rod 25. Nuts 39 and 40 on said threaded end portion 38 secure the piston 31 on the lower end of said rod 25. The parts of the cylinder above and below the piston are filled with oil or other suitable hydraulic fluid. Piston body 37 is provided with an external annular groove 41 in which is disposed a sealing member 42 for sealing engagement with the inner wall of the cylinder. Piston body 37 is also provided with a bore 43 having a lower end wall 49 in which is a reduced diameter port 44 communicating with the cylinder at the under side of said piston. At the upper end of the bore 43 there is a ball valve 45 adapted to seat on the lower end of a plug 46 which is externally threaded and screwed into an internally threaded upper end socket 47 of said bore 43. Plug 46 has a bore 46a controlled by the ball 45. A spring 48 reacts between the ball 45 and the lower end wall 49 of the bore 43. The valve arrangement comprises a check valve which permits fluid to pass downwardly through the piston but prevents upward flow of fluid through said piston.

The piston is provided with a second bore, 52 which has a wall 53 at the upper end in which is provided a port 54 of reduced diameter relative to said bore 52 and communicating with the cylinder at the upper end of the piston 31. A ball valve member 55 is provided in the bore 52 and seats at the upper end of a plug 56 which is externally threaded and screwed into an internally threaded socket 57 at the lower end of said bore 52. Plug 56 is provided with a passage 58 therethrough which the ball valve 55 normally closes, said valve being urged onto its seat by a spring 60 which reacts between said valve 55 and the bottom wall 53 of the bore 52. This check valve permits fluid to pass upwardly through the bore 52 into the upper portion of the cylinder but prevents reverse flow therethrough.

As the fluid in the cylinder of the device 26 completely filling the cylinder parts above and below the piston 31 is noncompressible and the check valves 45 and 55 are calibrated to remain closed under normal pressure conditions, described hereinafter, the piston 31 and cylinder of the device 26 will move together as a unit, but under higher pressures of a predetermined value, said valves will open to permit relative movement between said cylinder and piston. The cylinder and piston arrangement 26, which comprises an adjustable connection, also includes a spring S which reacts between the piston 31

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and the upper end wall 31a of the cylinder, 30, 33, and urges the latter upwardly relative to said piston. Spring S is of such strength as to counterbalance the weight of the means connecting the piston 72 of the well pump with the cylinder 30, 33, of the adjustable connection 26 and the column of oil below the piston.

The float mechanism is centered above a well 65 in an underwater formation 66 and having a wellhead, indicated generally at 67. Within the casing 68 of the well and adjacent the lower end thereof there is a pump, indicated generally at 70. In view of the fact that the pump may be of any suitable well-known type, said pump is shown diagrammatically and with only certain of the operable parts thereof. There is a tubular barrel 71 in which is operably disposed a pumping piston 72. The pump includes a check valve 73 within the barrel 71 and a check valve 74 in the plunger. At the lower end of the barrel 71 there is a lock hold down mandrel 75 locked in a lock hold down shoe 76 which is secured to the lower end of the casing 68 by means of a tubing coupling 77. The upper end of the piston is provided with a piston rod 79 connected to the usual sucker rod string 80 by any suitable means such as the coupling rod 81. The upper end of the sucker rod string 80 is connected to the lower end of the cylinder of the tide compensating device 26. Any suitable means may be provided for this connection such as, for example, an internally threaded socket, not shown, in an external boss 83 on the lower end wall 84 of the compensating device cylinder, and an externally threaded upper end portion 85 of said sucker rod string. The sucker rod string 80 passes upwardly through the wellhead and is provided with the usual packing means, indicated generally at 86, said wellhead having the usual outlets 87 and 88.

The packing nut 90 of the packing means 86 is provided with a generally O-shaped frame 91 having side arms 92 and closed at the top by a cross member 93 having an opening 94 therein through which the rod string 80 is loosely received so that said rod may freely move upwardly and downwardly limited, however, by engagement of the upper member 93 of the frame 91 by a collar 96 secured to the sucker rod string 80 and engagement by said collar with the upper end 97 of said nut 90 carrying said frame. The maximum operating stroke of the pump is therefore limited by the above described engagement of the collar 96 with the members 93 and 97 of the frame although the normal range of the operating stroke generally will be less than the maximum stroke permitted by the above described limiting means.

In operation of the mechanism, oil is raised by the piston 72 of the well pump when the float rises and said piston is moved downwardly by the weight of the sucker rod and associated parts when the float moves downwardly. It is to be noted that while a sucker rod string 80 is used to connect the piston with the adjustable connection 26, a cable may also be used, particularly from a point above the wellhead to said adjustable connection 26. It is also to be noted that the cylinder may be connected to the super structure and the piston rod connected to the sucker rod string 80 or cable.

In order to compensate for variations in the height of the tide, the cylinder of the compensating device 26 is substantially longer than the operating stroke of the pump. When the device is operating at substantially low tide, the piston 31 will be adjacent the lower end of the cylinder and the operating stroke thereof will occur in the lower end portion of said cylinder. As above pointed out, the normal range of the pumping stroke will not be interfered with by engagement of the collar 96 with either the end 93 or end 97 of the frame 91. Under these normal pumping conditions, the check valves 45 and 55 will remain closed. However, as the tide begins to rise, the sucker rod string 80 will be pulled upwardly to a point whereat the collar 96 will engage the upper end member 93 of the frame 91 when the upper end

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of a pumping stroke is reached. Upon such engagement of the collar 96 with member 93, additional upward pressure will be exerted by the rising float and the pressure in the upper end of the cylinder, above the piston 31, will increase sufficiently to cause the check valve 45 to open and permit flow of fluid downwardly through said piston into the lower portion of the cylinder and at the same time permit said piston to move upwardly in the cylinder. This action will continue as long as the tide rises. After high tide, the float will move downwardly with the dropping of the tide and as the pumping action continues, the collar 96 will engage the lower end of the frame 91 whereupon the spring S will be relieved of the weight of the connecting means (sucker rod string 80), so that said spring S will be effective to exert sufficient force between the piston 31 and cylinder 30, 33 to effect opening of the check valve 35 and move the cylinder upwardly relative to the piston until the weight of said connecting means between the well pumping piston 72 and the cylinder 30, 33 is taken by said spring S and normal pumping conditions established, whereupon the valve 55 closes and the piston 31 and cylinder 30, 33 move together in the newly adjusted relationship.

The float is held against drifting or displacement relative to the well by any suitable means such as, for example, the buoys 100 which are secured to the float beams 20 by means of cables 101 and to any well-known anchor means, not shown, by means of cables 102. The buoys may be distributed about the float in any suitable manner to retain same in substantially one spot but there is sufficient slack in the anchoring means to permit the float to rise and fall with the tide as well as with the waves.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it is thought that it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing all of its material advantages, the embodiment hereinbefore described being merely for the purposes of illustration.

I claim:

1. Apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston, comprising: an annular float having a central opening therethrough; a super structure for said float comprising a pair of support beams secured at their lower ends to the float and extending upwardly and inwardly to an apex disposed over said central opening in the float and in upwardly spaced relation thereto; a relatively long cylinder closed at the bottom and having an upper end wall with an axial opening therein, a piston rod operably disposed in said axial opening and extending into the cylinder; a piston secured to the inner end of said rod and operably disposed in said cylinder, said piston having a pair of passages therethrough from one end to the other; a check valve in one of said passages permitting fluid flow from the upper to the lower side of said piston but preventing fluid flow in the opposite direction; a check valve controlling the other of said piston passages, permitting fluid flow from the lower side of said piston to the upper side but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each side of said piston; means operably securing the upper end of the piston rod to the super structure at the apex thereof; a sucker rod having the upper end thereof secured to the lower end of the cylinder and extending downwardly into the well and having the lower end thereof connected with the pump piston; a wellhead; packing means for sealing about said sucker rod to prevent escape of fluid therepast; means secured to the wellhead for limiting the reciprocating stroke of the sucker rod both upwardly and downwardly; a spring reacting between the first mentioned piston and the upper end of said cylinder and substantially counterbalancing the weight of the sucker rods and liquid in said

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cylinder; and means for anchoring said float above the wellhead while permitting said float to rise and fall with the tide.

2. Apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston, comprising: a float having an opening therethrough; a super structure for said float having a part disposed over said opening in the float and in upwardly spaced relation thereto; adjustable means including a relatively long cylinder closed at the bottom and having an upper end wall with an axial opening therein, a piston rod operably disposed in said axial opening and extending into the cylinder; a piston secured to the inner end of said rod and operably disposed in said cylinder, said piston having a pair of passages therethrough from one end to the other; a check valve in one of said passages permitting fluid flow from the upper to the lower side of said piston but preventing fluid flow in the opposite direction; a check valve controlling the other of said piston passages, permitting fluid flow from the lower side of said piston to the upper side but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each side of said piston; means operably securing the upper end of the piston rod to the part of the super structure disposed over said opening; a sucker rod string having the upper end thereof secured to the lower end of the cylinder and extending downwardly into the well and having the lower end thereof connected with the pump piston; a wellhead; packing means for sealing about said sucker rod to prevent escape of fluid therepast; a spring reacting between the first mentioned piston and the upper end of said cylinder and substantially counterbalancing the weight of the sucker rods and liquid in said cylinder; and means secured to the wellhead for limiting the reciprocating stroke of the sucker rod both upwardly and downwardly.

3. Apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston comprising: a float; a super structure for said float; adjustable connecting means including a relatively long cylinder closed at the bottom and having an upper end wall with an axial opening therein, a piston rod operably disposed in said axial opening and extending into the cylinder, the upper end of said piston rod being connected to said super structure; a piston secured to the inner end of said rod and operably disposed in said cylinder, said piston having a pair of passages therethrough from one end to the other; a check valve in one of said passages permitting fluid flow from the upper to the lower side of said piston but preventing fluid flow in the opposite direction; a check valve controlling the other of said piston passages, permitting fluid flow from the lower side of said piston to the upper side but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each side of said piston; a sucker rod string having the upper end thereof secured to the lower end of the cylinder and extending downwardly into the well and having the lower end thereof connected with the pump piston; yielding means in said adjustable connecting means counterbalancing the weight of said sucker rod string; and means for limiting the reciprocating stroke of the sucker rod both upwardly and downwardly.

4. In apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston: a float; a relatively long cylinder closed at the bottom and having an upper end wall with an axial opening therein, a piston rod operably disposed in said axial opening and extending into the cylinder, the upper end of said piston rod being operably connected to said float; a piston secured to the inner end of said rod and operably disposed in said cylinder, said piston having a pair of passages therethrough from one end to the other; a check valve in one of said passages permitting fluid flow from the upper to the lower side of said piston but preventing fluid flow in the opposite direction; a check valve controlling the other of said piston passages, permitting fluid flow

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from the lower side of said piston to the upper side but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each side of said piston; connecting means having the upper end thereof secured to the lower end of the cylinder and having the lower end thereof connected with the pump piston; yielding means counterbalancing the weight of said connecting means; and means for limiting the reciprocating stroke of the rod and pump piston both upwardly and downwardly.

5. In apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston: a float; a cylinder closed at the bottom and having an upper end wall with an axial opening therein, a piston rod operably disposed in said axial opening and extending into the cylinder, the upper end of said piston rod being operably connected to said float, a piston secured to the inner end of said rod and operably disposed in said cylinder; means operable by fluid pressure of a predetermined value permitting fluid flow from the upper to the lower side of said piston but preventing fluid flow in the opposite direction; means operable by fluid pressure of a predetermined value permitting fluid flow from the lower side of said piston to the upper side but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each side of said piston; connecting means having the upper end thereof secured to the lower end of the cylinder and having the lower end thereof connected with the pump piston; means substantially counterbalancing the weight of said connecting means; and means for limiting the reciprocating stroke of said pump piston both upwardly and downwardly.

6. In apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston: a float; an automatically adjustable operating connection between said float and said pumping piston including a cylinder closed at the bottom and having an upper end wall with an axial opening therein; a piston rod operably disposed in said axial opening and extending into the cylinder, the upper end of said piston rod being connected to said float; a piston secured to the inner end of said rod and operably disposed in said cylinder; means operable under fluid pressure of a predetermined value permitting fluid flow from the upper to the lower end of said piston but preventing fluid flow in the opposite direction; means operable under fluid pressure of a predetermined value permitting fluid flow from the lower end of said piston to the upper end but preventing fluid flow in the opposite direction; liquid filling the cylinder portions at each end of said piston; and means for limiting the stroke of said piston in both directions.

7. The combination of a float, and a pump with an automatically adjustable connection between said float and pump, said connection including: a cylinder closed at one end and having a wall with an axial opening therein at the opposite end; a piston rod operably disposed in said axial opening and extending into the cylinder; a piston secured to the inner end of said rod and operably disposed in said cylinder; liquid filling the cylinder portions at each end of said piston; means operable under pressure of a predetermined value permitting a transfer of fluid between the end portions of said cylinder at opposite ends of said piston; and means limiting the relative movement of said piston and cylinder.

8. In apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston: a float; an automatically adjustable operating connection between said float and said pumping piston including a cylinder closed at one end and having a wall with an axial opening therein at the opposite end; a piston operably disposed in said cylinder; a piston rod connected to said piston and extending outwardly through said axial opening, said piston rod being operably connected to said float; liquid filling the cylinder portions at each end of said piston; and means permitting transfer of fluid be-

tween the portions of said cylinder at opposite ends of said piston under predetermined pressure conditions.

9. In apparatus for pumping fluid from a well having a pump therein with a reciprocating pumping piston, the combination of a float; an automatically adjustable operating connection between said float and said pumping piston including a cylinder; a piston operably disposed in said cylinder and having a piston rod connected thereto; liquid filling the cylinder portions at each end of said piston; and means permitting transfer of fluid between said portions under predetermined pressures.

10. The combination of a float, and a pump with an automatically adjustable connection between said float and pump, said connection including: a cylinder member closed at one end and having a wall with an axial opening therein at the opposite end; a piston rod operably disposed in said axial opening and extending into the cylinder; a piston member secured to the inner end of said rod and operably disposed in said cylinder member; liquid filling the cylinder portions at each end of said piston member, said cylinder and piston normally movable to-

gether as a unit; means operable under pressure of a predetermined value permitting a transfer of fluid between the end portions of said cylinder member at opposite ends of said piston member; and means limiting the movement of one of said members to a predetermined range of movement.

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**UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION**

Patent No. 3,040,667

June 26, 1962

Donald U. Shaffer

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 11, for "Datly" read -- Daily --; line 12, for "Skirton" read -- Skirtun --; same column 8, line 21, for "Apr. 15, 1958" read -- Apr. 15, 1953 --.

Signed and sealed this 20th day of November 1962.

(SEAL)

Attest:

ERNEST W. SWIDER  
Attesting Officer

DAVID L. LADD  
Commissioner of Patents