

Dec. 28, 1954

H. J. PANKRATZ
WELL CONTROL DEVICE

2,697,984

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2 Sheets-Sheet 1

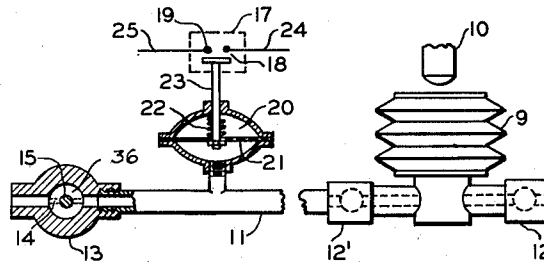


FIG. 2

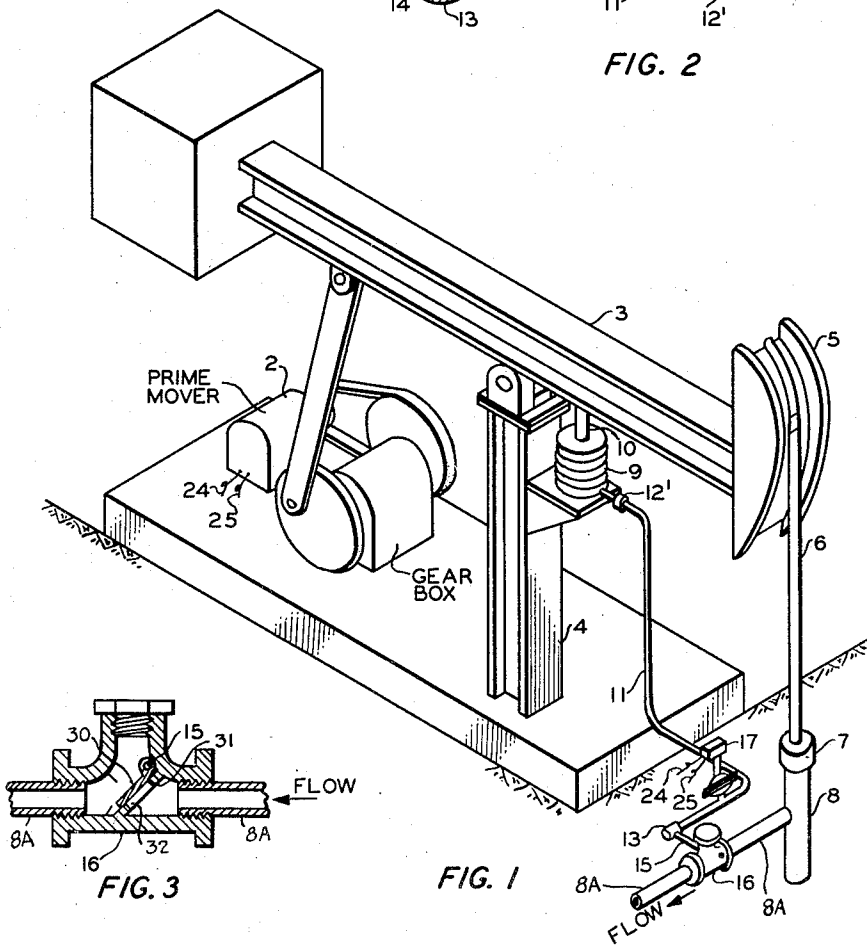


FIG. 1

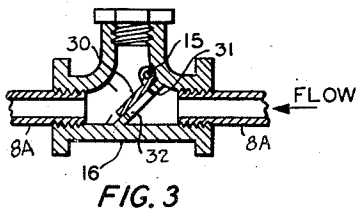


FIG. 3

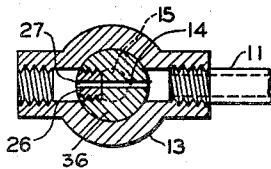


FIG. 4

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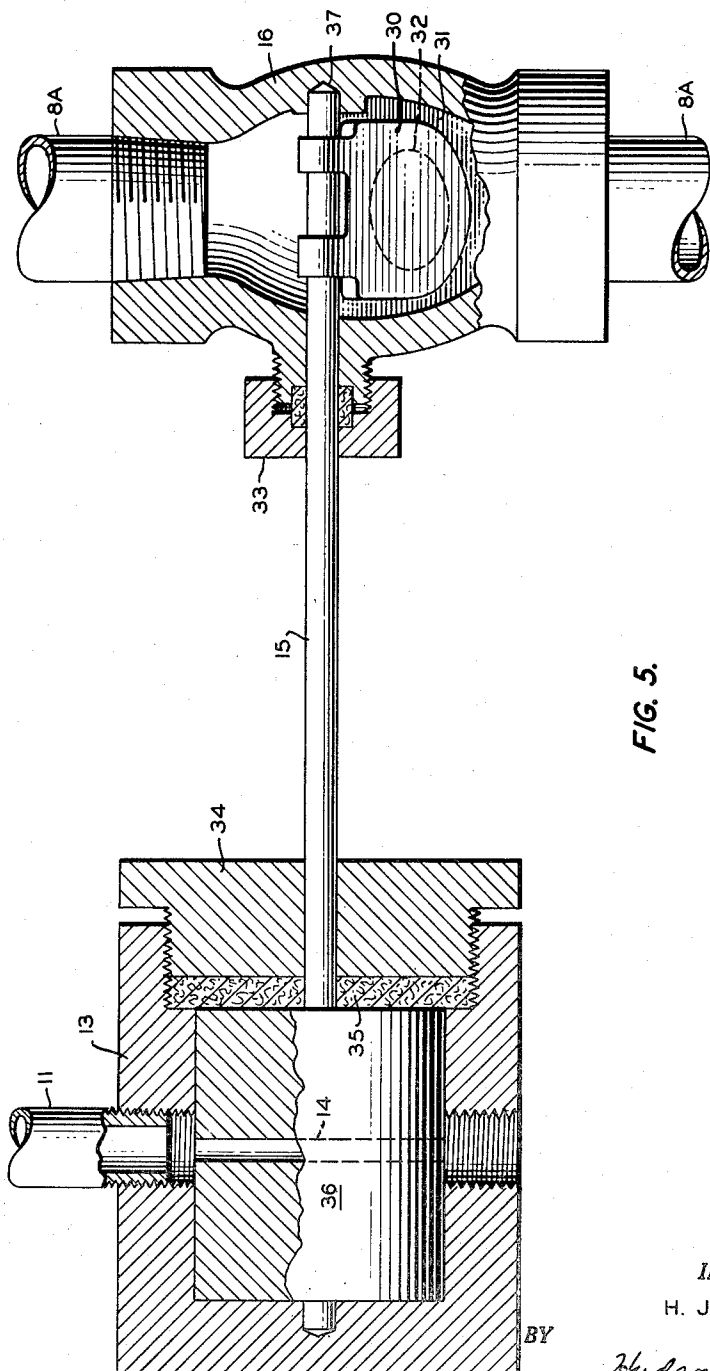


FIG. 5.

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2,697,984

WELL CONTROL DEVICE

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4 Claims. (Cl. 103—22)

This invention relates to a shut-down device. In one of its aspects the invention relates to a shut-down device for fluid pumping means, for example a well pump such as an oil-well pump. In another aspect the invention relates to a shut-down device applicable to a fluid moving means which moves fluid unidirectionally through a fluid check valve. In one of its embodiments and for illustrative purposes the invention will be set forth and described in its relation and application to a walking beam actuated oil well pump.

The prior art provides many types of controls which can be adapted to cause the shut-down of a pumping unit such as a walking beam actuated oil well pump unit. Inertia-type switches have been adapted to cause immediate shut-down whenever the walking beam has departed from a predetermined pattern or standard, for example, upon the breaking of a sucker rod or change of the driving force or speed of the driving engine. Shut-down devices responsive to fluid pound are also known and have been adapted to shut down a pumping unit when the pump has lost suction. Time switches have also been adapted to shut down pumping units after a certain predetermined time interval. The time interval may be determined by either a timepiece or a stroke counter. Furthermore, shut-down devices sensitive to the sag of a rod line have also been used to shut down a pumping unit. A sagging line denotes a high fluid level in the well whereas a taut line denotes a "pumped off" condition in the well.

The prior art shut-down devices, though clearly operable and satisfactory from a number of points of view do not function for many conditions which are encountered in pumping a well. Furthermore, these devices can only protect the unit against a particular well condition. Therefore, several different devices should be installed to fully protect the unit. Moreover, the prior art devices cannot detect, and hence operate for, undesirable well conditions such as leaking tubing, leaky pump, gradually "sanding up" of the pump, etc.

A shut-down system has now been devised which is responsive to the action of a fluid check valve in the pump line. This system will provide positive protection for the pumping unit against undesirable well conditions. This system combines a motor air source, an air-operated shut-down actuating means and a motor-air exhaust means or valve that is controlled by a fluid check valve, for example, a flapper check valve, said air exhaust means being operatively connected with the flapper of said check valve in a manner such that the opening and closing of the flapper and the extent of its opening will open and close correspondingly the said air-exhaust means or valve. The shut-down actuating means requires a certain air pressure to cause it to operate. Motor air of this or a greater pressure is always supplied thereto. During proper operation of the pump, an exhaust air connection with the flapper-operated air-exhaust means or valve, will cause the air to be exhausted thus constantly preventing the air pressure at the shut-down actuating means from reaching the value which is required to operate the shut-down actuating means. Whenever the flapper does not sufficiently open due to improper, or lack of, pumping of fluid, the air exhaust means or valve will also open a lesser number of times or not at all. At least the amount or frequency of opening will differ from the norm. Air pressure will build up in the shut-down actuating means because air is being supplied from the air source but is not being exhausted

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as before. The pressure will, at least after a time, build up until the shut-down actuating means operates and shuts down the pump. This system, it will be noted, is highly advantageous, and particularly so because it provides for an adjustable time lag during the pressure build-up interval. This delay is considered advantageous, at least for the reason that momentary loss of suction or other momentary erratic behavior will not cause the shut-down of the pump. It can also be readily understood that the device will also function for certain conditions of excessive engine speed in which case the flapper check valve and hence the air exhaust valve will be opened for a shorter period of time, consequently the air will not be exhausted as before.

An object of this invention is to provide a shut-down device which is adaptable to a well pumping means.

Another object, of this invention, is to provide a fluid pumping means shut-down device which is responsive to the action of a check valve through which a fluid is pumped unidirectionally.

It is a further object of this invention to provide a fluid pumping system which can be shut down responsive to the action of a check valve through which a fluid is pumped unidirectionally, said shut-down being effected only after an adjustable period of time delay.

Other objects and advantages are evident from this disclosure, the drawings and the appended claims.

According to this invention there is provided a shut-off device responsive to the action of a fluid check valve in a line of fluid being moved by a fluid moving means which comprises, in combination, a motor air source, an air operated shut-down actuating means and a motor air exhaust means or valve, said air exhaust means being operatively connected with said check valve in a manner such that the opening and closing of said check valve and the extent of its opening will cause a corresponding opening and closing and extent of opening of said air exhaust means or valve.

To more fully enable the reader to understand the invention, reference is now made to the drawing in which Figure 1 shows a pumping unit on which is diagrammatically shown an embodiment of the invention. Figure 2 shows a cross-sectional view of a shut-down means, according to the invention, which can be operated responsive to the action of the flapper check valve of Figure 3. Figure 3 shows a cross-section view of a flapper-type check valve. Figure 4 shows one form of the exhaust valve. Figure 5 is a plan view, partly in section, of exhaust valve 13 and flap valve 16, showing, diagrammatically the interconnection and interrelation between said valves.

Referring now to Figure 1, a prime mover 2 and gearbox are used to move up and down the walking beam 3 supported on the Sampson post 4. At the front end of the walking beam is attached the horse head 5 from which is suspended polished rod 6 which extends through stuffing box 7 and actuates the pumping means in the well tubing 8. Referring now to both Figures 1 and 2, a bellows type air pump 9 actuated by extension 10 attached to walking beam 3, pumps air into line 11. The air suction to the pump as well as the air discharge therefrom are equipped with check valves 12 and 12'. Thus, by suitably choosing extension 10 it is possible to deliver a predetermined desirable quantity of motor air into line 11 which can be kept under a certain desired pressure when the pumping unit is operating satisfactorily. Also on line 11, there is provided a motor air exhaust plug type valve 13, the core of which is provided with a bore 14 which can be aligned with the axis of line 11 to permit escape of air therefrom. The plug valve core is extended to shaft 15 which also serves as the pivot for the flapper of check valve 16 shown in Figure 3. It is now obvious that the action of the flapper will oscillate shaft 15 and operate the air exhaust valve 13 thus controlling the air pressure in line 11 responsive to said action. If the pump should deviate from the operation desired, in that it no longer produces a sufficient quantity of oil to pass through the flapper of valve 16, air exhaust valve 13 will not release a sufficient quantity of air the pressure of which will gradually build up and become sufficient to operate shut-down actuating means

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17 (Figure 2) which, here, is a short of the current being supplied to prime mover 2, across poles 18 and 19. If the prime mover 2 is an internal combustion engine, the short will ground the magneto to stop the engine. If the prime mover 2 is an electric motor, the short will actuate a relay to open the power circuit of the electric motor. The means 17 is pressed up against poles 18 and 19 whenever the air pressure attains a predetermined value in the space below diaphragm 21 which is urged downward by spring 22 in compartment 20. The movement of diaphragm 21 is translated to means 17 through rod 23. Wires 24 and 25 connect the actuating means 17 with the prime mover 2.

As shown in Figure 5, flap valve 16 and exhaust valve 13 are mechanically connected by means of shaft 15. Valve 16 comprises flap closure member 30 which is adapted to seat upon seat 31 thereby closing opening 32. Flap closure means 30 is fixedly attached to rotatable shaft 15. Shaft 15 extends into the housing of valve 16 through a suitable stuffing box or packing gland indicated diagrammatically at 33 and rests in a suitable bearing means indicated at 37.

Exhaust valve 13 is shown as a plug-type valve comprising plug 36 having opening 14. Plug 36 is fixedly attached to rotatable shaft 15. Valve 13 is provided with a suitable packing means comprising packing 35 and packing nut 34.

From the foregoing description, it will be clear to those skilled in the art that equivalents which can mechanically cause valve 13 to operate as described, can be employed in place of flap valve 16.

From the foregoing description of the drawings, it will be clear that when oil is flowing through pipe 8A at a suitable predetermined rate, valve closure 30 will be pushed away from seat 31 and shaft 15 will thereby be rotated to such a position that plug 36 in valve 13 will be rotated to open position, as indicated in Figures 2 and 4. Conversely, when the rate of flow through pipe 8A has decreased below a predetermined minimum, valve closure 30 will seat upon seat 31, as a result of back pressure in pipe 8A, thus rotating rotatable shaft 15 to such a position that plug 36 is rotated to closed position, thus closing valve 13 and causing pressure to accumulate and build up under diaphragm 21, as previously described.

In order to adjust the sensitivity of the device without replacing the entire exhaust valve 13, a readily replaceable orifice screw 26 with an opening 27 smaller than opening 14 may be used. The orifice screw is slotted so that it can be removed with a suitable screw driver.

Although as shown, air pump 9 is actuated by an extension 10 from the walking beam 3, the extension 10 could be attached to any portion of the gear box system that rotates or moves in the same cycle as the oil well pump. Likewise, it is realized that the pressure motor air source 9 could be powered by a separate motor or even tied in to the exhaust of the prime mover 2, however, for the best operation, the air pump should be powered by means that have a frequency of stroke or application equal to the frequency of the stroke of the oil well pump.

The invention is particularly adapted for operation in an oil field where a large number of pumps function virtually unattended.

Reasonable variation and modification, such as a piston type pump for the bellows type pump and a sliding or reciprocating check valve with a corresponding sliding or reciprocating exhaust valve for the flapper type check valve and rotating type exhaust valve, are possible within the scope of the foregoing disclosure and the appended claims to the invention the essence of which is that a shut-off device responsive to the action of a fluid check valve in a line of fluid being moved has been provided comprising, in combination, a source of air pressure to operate a shut-down actuating means and an air pressure exhaust means operated by said fluid check valve in a manner that whenever the fluid passing through the valve does not cause it to act as it does under normal conditions, its abnormal action will result in an increase in said air pressure which will cause operation of the shut-down actuating means.

I claim:

1. A shut-down device responsive to the action of a fluid check valve in a line of fluid being moved by a fluid moving means which comprises, in combination, a fluid

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moving conduit and a fluid check valve, in said conduit, adapted to respond to the flow of said line of fluid being moved, a motor air pressure source, an air pressure-operated shut-down actuating means, operated by air pressure supplied from said motor air pressure source, operatively connected to said fluid moving means, and a motor air pressure exhaust means operative to exhaust from said air operated shut down actuating means motor air pressure supplied thereto from said motor air pressure source, said air exhaust means being operatively connected with said check valve in a manner such that the change in position of said check valve and the extent of its opening responsive to alteration in the flow of fluid moved by said fluid moving means will cause a corresponding extent of opening of said air pressure exhaust means and the functioning of said air operated shut down means to shut down said fluid moving means whenever insufficient fluid is being moved through said fluid check valve to keep it sufficiently open to enable it in turn to keep said motor air pressure in said air operated shut down actuating means below a predetermined maximum pressure.

2. In a shut-down switch device, responsive to the action of a fluid check valve in the fluid flow line of a pumping unit, means comprising a fluid flow line, a fluid check valve in said line, adapted to respond to the flow of said fluid in said flow line, an air compressor; a compressor actuating means operatively attached to said pumping unit, the operation of said compressor actuating means being synchronized with the pumping motion of said pumping unit; an air-pressure accumulating reservoir receiving air from said compressor, an air pressure discharge upon said reservoir, connected to and adapted to be actuated by the action of said check valve in a manner corresponding to the manner and extent of the opening and the closing of said check valve so that when said check valve is held open by flow of fluid in said line under normal pumping conditions a predetermined air pressure will obtain in said reservoir; and an air-pressure actuated shut-down switch, operatively connected to and operated by air-pressure from said reservoir, which switch is adjusted to respond to a predetermined pressure higher than said first mentioned predetermined air pressure in said reservoir, and said switch being mounted in and controlling the power flow which actuates said pumping unit.

3. A shut-down device responsive to a flow of fluid being produced by a fluid moving means which comprises, in combination, a fluid moving means; means to actuate said fluid moving means; a source of power, to drive said means to actuate said moving means; a conduit, to conduct fluid being moved by said fluid moving means; means within said conduit, responsive to motion of the fluid being moved therein; a fluid pressure actuated means, to stop flow of power from said source of power; a fluid pressure generating means, operated by said fluid moving means when it is in operation; a fluid pressure accumulating means; a fluid pressure release means, operatively connected with said fluid pressure accumulating means and with said means within said conduit and adjusted to release fluid pressure from said pressure accumulating means to maintain therein, whenever said fluid moving means is desirably moving fluid in said conduit, a predetermined maximum pressure insufficient to operate said fluid pressure actuated means but to cause an increase in pressure above said predetermined maximum pressure whenever said fluid moving means is undesirably functioning.

4. A well control device comprising, in combination: a pumping mechanism comprising a walking beam, a prime mover adapted to actuate said walking beam, which is, in turn, adapted to operate a pump, said pump being adapted to move fluid from a well into a conduit; a check valve in said conduit adapted to be held open when a predetermined rate of flow of fluid through said conduit is produced by said pump; a fluid compressor positioned below said walking beam and adapted to be actuated by a descending stroke of said beam and thus to force a fluid into a reservoir; a diaphragm exposed to fluid in said reservoir; a connecting member attached to said diaphragm and provided with a contact member adapted to actuate a shut-off switch, subsequently described, when said diaphragm moves responsive to fluid pressure in excess of a predetermined maximum in said

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reservoir; an exhaust valve, in communication with said reservoir, and fixedly connected with said check valve so that said exhaust valve opens when said check valve opens and closes when said check valve closes; and a shut-off switch adapted to stop said prime mover when said switch is actuated by said contact member.

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