

Dec. 26, 1967

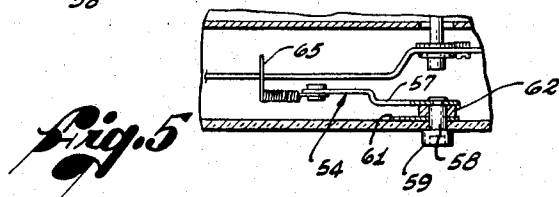
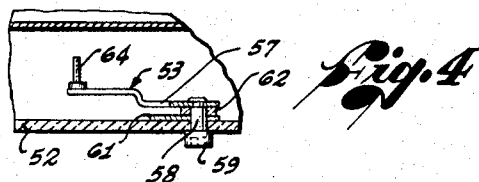
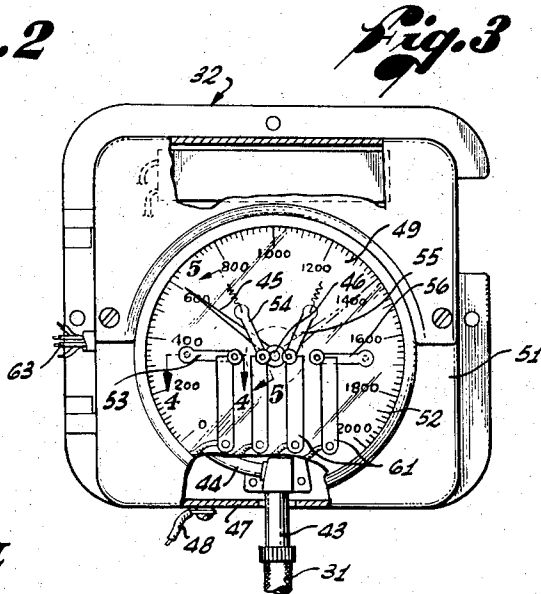
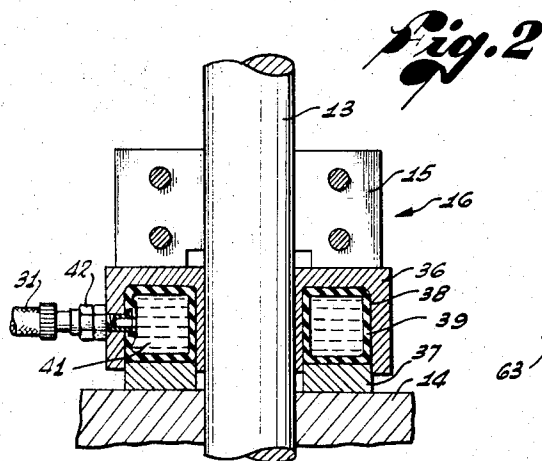
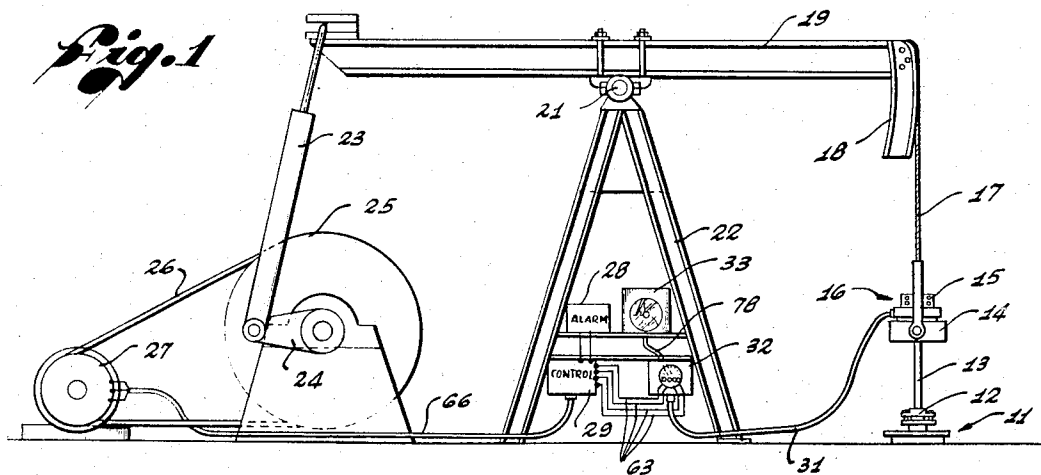
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3,359,791

SYSTEM RESPONSIVE TO WELL PUMPING LOADS

Filed Oct. 19, 1964

2 Sheets-Sheet 1



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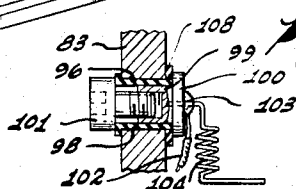
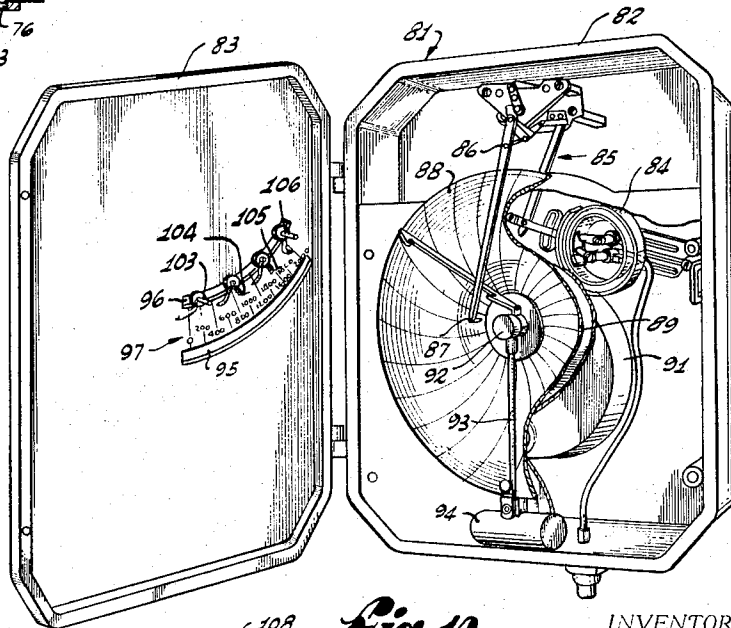
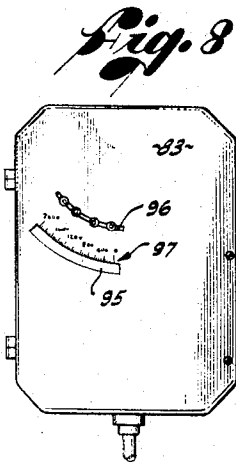
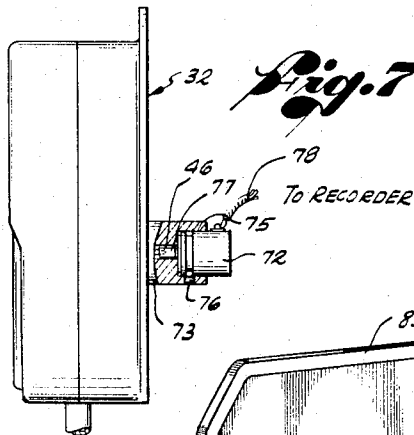
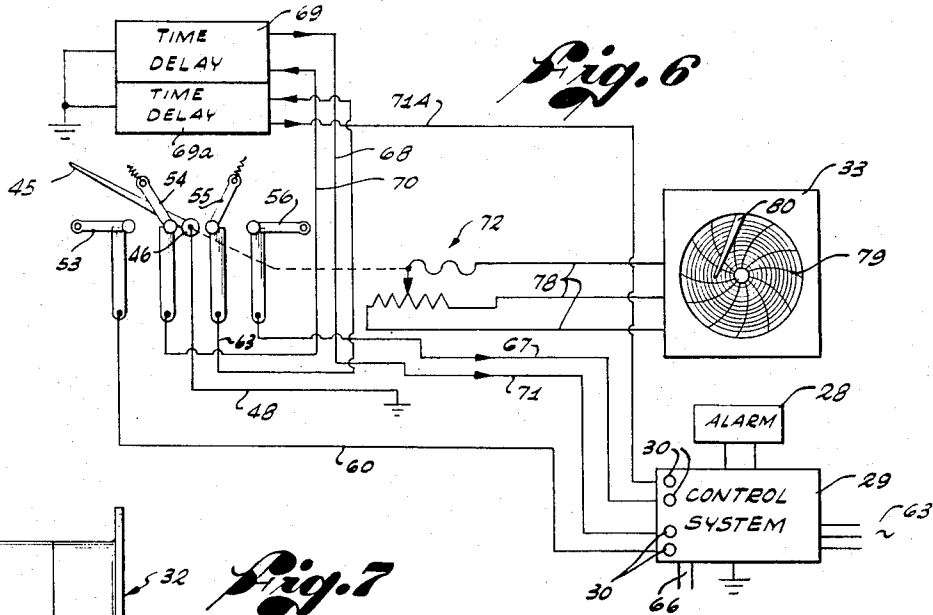
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SYSTEM RESPONSIVE TO WELL PUMPING LOADS

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2 Sheets-Sheet 2



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3,359,791

SYSTEM RESPONSIVE TO WELL PUMPING LOADS

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9 Claims. (Cl. 73-151)

The present invention relates generally to systems responsive to the performance of pumping wells, and more particularly to such a system responsive to the load or weight on the pump rod of an oil well. The system may perform any or all of the following monitoring functions: instantaneous load reading, signalling abnormal performance, controlling the operation, and permanently recording the pumping load.

The load on the pump rod of a pumping well such as an oil well will, in normal operation, fluctuate between high and low values as the pump rod moves up and down. These operating values provide valuable information regarding pump efficiency and other conditions, and may be used not only to indicate a serious malfunction of the pumping equipment, requiring shut-down of the operation, but also inefficient operation thereof, such as below-capacity operation for longer than normal periods.

Partial pumping operations of short duration are normal in well pumping, but if the condition does not correct itself within a reasonable period of time, it results in a serious drop in production. Such partial pumping or below-capacity output is indicated when the loads on the pump rod fail to reach normal or average high and low values over a given period of operation and the system according to the present invention responds to such operation to give an electrical signal indicative thereof which may be used in any desired manner, such as to trigger a radio broadcast signal or to control an audible or visual alarm or other indication of the lowered output, while preferably continuing the pumping operation.

On the other hand, should the load on the pump rod go below a predetermined value, it is indicative of a serious malfunction, such as a broken pump rod, and the system desirably responds thereto to give an electrical signal which may be used to effect shut-down of the well. If the load on the pump rod should exceed a predetermined limit, it also will be indicative of a serious malfunction, such as jamming or the like, and will produce an electrical signal which likewise may be used to terminate the pumping operation. In either case, an alarm signal gives notice of the occurrence of the malfunction.

In addition to the above controls, the system provides for a permanent record to be made of the operating loads on the pump rod to which reference can be made at any time to analyze the performance of the well over all or any part of the recording period.

The system according to the present invention contemplates an electrical, mechanical, or hydraulic device for weighing the loads on the pump rod and transmitting the load values to an indicating instrument spaced therefrom, which includes circuit-controlling contacts giving electrical control signals in accordance with the performance of the well as translated by the loads on the pump rod. The pumping rod load may, at the same time, be charted in a recording device forming a part of the same instrument or in a separate recorder electrically or mechanically connected thereto.

The load weighing device is desirably mounted on and movable with the polished rod of the pump, and is connected to remote instrument means by appropriate coupling means determined by the character of the weighing device used. As specifically illustrated in the drawing, the system makes use of a hydraulic transmitter on which the

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weight of the pump rod is supported, but strain gages and other electrical devices could obviously be used and be electrically connected to indicating and recording instruments to effect the indicating, controlling and recording functions of the invention.

It is therefore an object of the present invention to provide an improved system for controlling, indicating and recording the performance of a pumping well.

Another object of this invention is the provision of an improved system operating in response to the performance of a pumping well, as indicated by the load or weight of the pump rod of the well.

Another object of this invention is the provision of an improved system responsive to prolonged operation of a pumping well at below capacity level, as determined by the failure of the load on the pump rod to reach normal high or low values in a predetermined period of operation.

A further object of this invention is the provision of an improved control system for a pumping well responsive to the load on the pump rod to shut down the well when the load on the pump rod reaches either of predetermined high and low levels and to give an alarm when the load on the pump rod fails to reach either an intermediate high level or an intermediate low level over a predetermined period of operation.

A still further object of the present invention is the provision of an improved well performance warning system signalling a below-capacity operation when the load on the pump rod of a pumping well fails to reach a predetermined level in a predetermined period of operation.

Yet another object of the invention is the provision of a system responsive to the load on the pump rod of a pumping well to give instantaneous measurements of well performance, to signal prolonged below-capacity operation, to shut down the well upon the occurrence of a serious malfunction, and to make a permanent record of well performance over an extended period of time.

A still further object of this invention is the provision of a well performance-responsive system in accordance with the preceding object in which the recorder may be readily connected and disconnected so as to be usable at different times on a number of wells whose performances are to be recorded.

These and other objects and features of the invention will be readily apparent to those skilled in the art from the following specification and the appended drawings, in which:

FIGURE 1 is a side elevational view of a well pumping load responsive system according to the present invention;

FIGURE 2 is a partial vertical sectional view through a hydraulic load weighing and transmitting device used in the system of the invention;

FIGURE 3 is a front elevational view, with parts broken away, of an indicating and electrical signalling instrument used in the system;

FIGURE 4 is a detail sectional view on the line 4-4 of FIGURE 3;

FIGURE 5 is a detail sectional view on the line 5-5 of FIGURE 3;

FIGURE 6 is a simplified wiring diagram for the indicating, controlling, signalling and recording elements of the system;

FIGURE 7 is a side elevational view of the instrument of FIGURE 3, showing a potentiometer mounted thereon for connection to a recorder;

FIGURE 8 is a front elevational view of a modified component for the system in which the responsive instrument and recorder are combined in a unitary device;

FIGURE 9 is an enlarged view of the component of

FIGURE 8, with the cover open and parts broken away; and

FIGURE 10 is a detail sectional view showing the mounting of an electrical contact on the component of FIGURES 8 and 9.

Referring first to the over-all system arrangement shown in FIGURE 1, the well cap 11 includes a bushing 12 through which reciprocates the polished rod 13 at the end of the well pump rod. The polished rod 13 extends loosely through a hanger bar 14 and has a clamp 15 mounted rigidly on its upper end. A hydraulic load-weighting transmitter unit 16 is mounted between the clamp 15 and the hanger bar 14 so that the weight of the pump rod is borne directly thereby. The hanger bar 14 is connected by flexible cables 17 to a head 18 mounted on one end of a walking beam 19 which is pivotally mounted at 21 at the upper end of a supporting structure 22. The opposite end of the walking beam 19 is connected by a crank arm 23 to a crank 24 which rotates with a flywheel 25. The flywheel 25 is represented as a large pulley driven through a belt 26 by an electric motor 27.

An alarm device 28, which may take any form—audible, visual, radio broadcast etc., is mounted at the well site and the motor 27 and the alarm device 28 are energized from a control 29. The hydraulic transmitter 16 is connected by flexible hydraulic tubing 31 to a responsive instrument 32, exemplified as a pressure gage and switching device in the hydraulic embodiment selected for specific illustration. The electric circuits from the instrument 32 are fed to the control 29, as will be hereinafter explained. The instrument 32 may also be used to control the position of a potentiometer whose output is fed to a recorder 33 where a continuous, permanent chart is made of well performance in terms of the loads on the pump rod.

FIGURE 2 illustrates the construction of the hydraulic load-weighting transmitter 16 which supports the load on the polished rod 13. This transmitter comprises a pair of cooperating annular members 35 and 37, the member 36 being hollowed out to provide an annular recess or cavity 38 into which the member 37 fits in telescoping relation. In the annular recess or cavity 38 is disposed a hydraulic cushion in the form of a hollow, annular, doughnut shaped envelope 39 of flexible material, such as neoprene or the like, containing oil or similar hydraulic fluid 41. A connector 42 leads through openings in the outer walls of the member 36 and envelope 39 into the interior of the latter and serves to connect to a flexible tube 31 of conventional high-pressure construction, the tube 31 being connected to a pressure inlet 43 for the instrument 32 (FIGURE 3).

The inlet 43 connects to the fixed end of a pressure-responsive element within the instrument 32, specifically illustrated as a Bourdon tube 44, whose free end is connected through suitable levers or gearing (not shown) to effect rotation of a shaft 46 having a pointer 45 rigidly mounted thereon. The Bourdon tube 44 effects rotation of the pointer 45 in response to increase and decrease in the pressure therein supplied by the hydraulic liquid 41. The pointer 45 thereby moves to continuously indicate the load or weight on the polished rod 13. The pointer 45 is desirably of conducting material to serve as a movable electrical contact and is connected through its shaft 46 and the casing 47 of the instrument 32 to a circuit conductor 48 which may be connected to ground, as in the diagram of FIGURE 6. The pointer 45 rotates in front of a circular scale 49 whose indicia give continuous readings of the instantaneous load or weight on the polished rod 13. The instrument 32 has a front cover 51 cooperating with the casing 47 to close the same, and the cover 51 has a front window 52 of glass or transparent plastic through which the position of the pointer 45 relative to the scale 49 may be viewed.

Cooperating with the movable contact pointer 45 are adjustable stationary contacts 53, 54, 55 and 56. Each of the contacts 53-56 comprises a conducting arm 57

mounted on the end of a pin 58 extending through, and whose head 59 is accessible at the front of, the cover window 52. Conducting strips 61 are mounted on the back face of the window 52 and are electrically connected to the contact arms 57 through conducting washers 62. The pins 58 are rotatably mounted on the window 52 so that the arms 57 rotate into adjusted positions upon rotation of the pin heads 59. To the ends of the conducting strips 61 are mounted control circuit wires leading to the control 29.

Upon the ends of the outer contacts 53 and 56 are mounted conducting pins 64 in the path of the pointer 45 and engaged thereby to complete controlling circuits, as explained hereinafter. Inner or intermediate contacts 54 and 55 have spring fingers 65 mounted thereon in the path of the pointer 45 so that the pointer not only engages the fingers 65 but is free to move past the fingers in both directions. Instead of the spring fingers 65, an arcuate contact engaged by a sliding contact on the pointer 45 might be used.

The control 29 is fed from a suitable power source 63 and effects energization of the motor 27 through a cable 66. Circuits effecting shut-down of the well are established by the engagement of the pointer 45 with either of contacts 53 or 56 to send a controlling electrical signal to control 29 upon the occurrence of a series malfunction evidenced by extremely low or high loads on the well pump rod. Upon shutting down the well, the control 29 desirably also engages the alarm device 28 to signal the occurrence of the malfunction at the well.

It is also desired to give an alarm signal when the well operates outside of its normal load limits for a predetermined period of time, but without shutting down the operation. Such an alarm signal is triggered by the failure of the pointer 45 to engage either of the fingers 65 over a predetermined period of well pumping operation. It will be readily understood that either of these contacts may be used alone so as to effect the signalling operation only when the load does not reach either a normal high or normal low, without reference to the value at the other end of the scale.

A simplified wiring diagram for the system is shown in FIGURE 6. Contact 53 is individually connected by line 60 to the control 29. Contact 56 is individually connected by line 67 to the control 29. Contact 54 is individually connected by line 68 to a time delay device 69. Contact 55 is individually connected by line 70 to a time delay device 69A. Time delay device 69 is connected by a line 71 to the control 29. Time delay device 69A is connected by a line 71A to the control 29. The control 29 is provided with a plurality of indicators which may be of the "pop-up" type and which are individual to the lines 60, 67, 71 and 71A to indicate, until reset, the receipt of an electrical control signal over the line with which they are associated. The control 29 operates in response to a control signal over either of lines 60 and 67 to deenergize the motor cable 66, give an alarm by a radio broadcast, audible or visual signal at 28, and activate the indicator 30 which is associated with the line over which the control signal was given. The control 29 operates upon receipt of a control signal over either of lines 71 and 73 to activate the alarm 28 and to activate the appropriate indicator 30, while maintaining the motor cable 66 energized.

The time delay devices 69 and 69A may take many forms, both mechanical and electrical, and their functions are to signal the control 29 to energize the alarm 28 in the event the associated contacts 54, 55 is not engaged by the pointer contact 45 over a predetermined period of time. A simple arrangement in an electrical time delay device would include a condenser charging over a predetermined time interval to a triggering value, at the attainment of which it sends a control signal to the control 29. The contacts 54 and 55 are in this example connected to discharge the capacitors of their respective time

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delay devices so that if contact is made at any time during the charging period, a new time delay period starts, and it is only when contact is *not* made throughout the entire charging period that the condensers charge to their triggering values to signal the control 29 to activate the alarm 28.

It will be understood that the alarm 28 may be of any character, such as a flashing light, a siren or horn, or a radio broadcast signal, as in my copending application Ser. No. 359,140, filed Apr. 13, 1964, for Remote signaling of Oil Well Pumper Malfunction.

FIGURE 7 shows a manner in which the potentiometer 72 may be mounted on the instrument 32 to be operated by the shaft 46. The shaft 46 extends through the plane of the back of the instrument 32 to be enclosed within a bore in a hub 73 extending therefrom. The hub 73 is counterbored at 75 to receive the body of the potentiometer 72 which is secured in place by a stud or like element 76. The potentiometer has an axial shaft which is connected to the instrument shaft 46 by a simple flexible tube 77. The potentiometer 72 is thereby readily assembled with and removed from the instrument. The potentiometer is connected by wires 78 to the recorder 33 and, with the movable slide element of the potentiometer oscillating with the pointer 45, the recorder 33 will trace upon its chart 79, by means of a conventional ink pen stylus 80, the continuous loading on the pump rod during the pumping period being examined.

With the arrangement described, the recorder 33 can service any number of individual pumping well installations, since it is readily portable to and from the various well sites. The potentiometer 72 may be moved with the recorder or an individual potentiometer may be provided at each instrument 32, as desired.

In the operation of the system, the load on the well pump rod is directly applied to the hydraulic transmitter 16 and the pressures on the hydraulic fluid therein are continuously transmitted to the pressure-responsive Bourdon tube 44 in the instrument 32. The loads on the well pump rod will vary in lifting and down strokes of the pump and the pointer 45 will oscillate to follow these load changes. The contacts 53 and 56 are set in positions of limiting loads which will occur only upon serious malfunction in the pumping operation which make shutdown of the well desirable. Should this limiting value of the load occur on the low side, the pointer 45 will engage contact 53 to complete a circuit to the control 29 over line 60 and the control will operate to: (1) deenergize the motor cable 66 and stop the well pumping operation; (2) energize the alarm device 28 to carry out its function of radio, visual or audible signalling; and (3) activate the appropriate indicator 30 to show that the shutdown occurred because of the occurrence of the abnormal low pump load value.

Should the load on the pump rod reach the predetermined maximum to which contact 56 is set, the pointer 45 will complete the circuit through contact 56 and line 67 to the control 29 which operates in the same manner, but now activates the indicator 30 associated with the line 67 to apprise the operator of the nature of the malfunction—that is, the maximum overload which caused the shutdown.

The contacts 54 and 55 are set at intermediate values between the contacts 53 and 56, which values are for normal or average low and high loads, respectively, which should be sustained by the pump rod during normal pumping operation. These intermediate load values are such that they may not be reached by the pump rod through many strokes and over a considerable period of time, but if either is not reached for the prolonged periods of time for which the time delay devices 69, 69A may be independently set, it is indicative of impaired or low production operation. Such operation, while not serious enough to require shutdown of the well, still makes it desirable for an alarm signal to be given so that the

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well may be inspected and attention given to correcting whatever is causing the abnormal performance. For the present explanation, let it be assumed that the time delay devices 69 and 69A are both set for a delay time of eight hours, that is, unless contact is made to their respective contacts 54 and 55 within eight hours, a control signal will be given over the appropriate line 71, 71A.

In normal operation, the contact pointer 45 periodically engages contact 54, and each time it so engages, the delay period of the time delay device 69 is restarted. If it be assumed now that the pointer 45 starts operating entirely above the contact 54, meaning that the load on the well pump rod does not go down to the value at which contact 54 is set, the delay period of the time delay device 69 continues to time out. If, for the assumed eight hour period, the pointer 45 never engages contact 54, the time delay device 69 times out and sends a control signal over line 71 to the control 29 to effect the following operations: (1) activate the alarm device 28 to perform the signalling operation for which it is designed; and (2) activate the indicator 30 associated with the line 71 to inform the operator, when he responds to the alarm signal, that the pump operation has been such as not to reach the normal or average low value for which contact 54 is set, for a period of eight hours.

If the well is operating on the low load side, that is, without the pointer 45 engaging the contact 55, a similar operation will be performed when the timing period of time delay device 69A runs out, except that the appropriate indicator 30 will be activated to inform the operator answering the signal that it was given because of a prolonged low load condition. In the cases of extreme settings of contacts 53 and 56, an alarm of such abnormal operation is given but the pumping operation is continued to secure at least the curtailed production of such operation.

Instead of a separate recorder 33 connected to the instrument 32 and separable therefrom to be used at different wells, a combined pressure-responsive, indicating, controlling and recording instrument may be used such as is illustrated in FIGURES 8 through 10 at 81. This combined instrument is enclosed within a casing 82 having a swinging cover 83 hingedly mounted thereto. The actuating element of the instrument is in the form of a flattened spiral tube 84 having one end fixed and connected to the tube 31 from the pressure transmitter 16. The free end of the actuator 84 is connected through suitable lever mechanisms 85 to effect oscillation of a pivoted indicating arm 86 carrying a marking pen 87 at its end which makes a trace record on a paper chart 88 mounted on a disc 89 which is rotated by a spring or electric motor 91. The disc, chart and motor are removably mounted in casing 82 and maintained therein by a socket 92 mounted on the end of an arm 93 at the axis of rotation of the disc 89, with the arm 93 biased inwardly by a torsion spring 94. Thus, while the instrument 81 is a combined indicating, controlling and recording instrument, the motor 91 and disc 89 thereof are removable for use in like instruments, where desired.

Cover 83 is provided with a pair of concentric arcuate slots 95 and 96. Suitable scale indicia 97 are provided at the edge of the slots 95 and the indicating arm 86 is visible through this slot to provide a direct, continuous reading at the scale 97 of the instantaneous load on the pump rod. Within the slot 96 are adjustably mounted stationary contacts 103, 104, 105 and 106 corresponding in function and operation to the contacts 53-56, respectively, of the instrument 32. The circuit connections are the same as for instrument 32 and correspond to the simplified showing of FIGURE 6, with the indicating arm 86 performing the function of the pointer 45 and being likewise conducting to complete control circuits when it engages the respective contacts 103-106, all as previously described for the contacts 53 through 56. The contacts 104 and 105 are spring arm contacts, as illustrated in FIG-

URE 10, to provide for passage of the arm 86 therepast, similarly to contacts 54 and 55 in instrument 32.

FIGURE 10 is a cross-section through contact 104 to show an insulating bushing 98 extending through the slot 96 and elongated along the slot to prevent turning of the bushing within the slot. A socket element 99 having a head 100 extends partially through the bushing 98, from the back toward the front of the cover 83, and a clamping stud 101 with an exteriorly accessible head is threaded into the socket member 99 to tighten the contact assembly in adjusted position. The spring contact 104 and a control conductor 102 are soldered to the socket member 99, as at 107. An insulating washer 108 is placed beneath the head 101 to complete the insulation of the conducting parts from the cover 83. When the stud 101 is loosened, the contact assembly may be adjusted along the slot 96 to a desired position where it will be held by tightening of the stud. The positions of the contacts 103 and 106 correspond to those of the contacts 53 and 56, that is, the low and high pump rod load limits which are indicative of malfunctions so serious that it is desired to shut down the pumping operation. The positions of the contacts 104 and 105 correspond to the positions of the contacts 54 and 55 wherein an alarm signal is to be given, without shutting down the pumping operation, where the indicating arm 86 fails to engage either of contacts 104, 105 for a predetermined time delay period as explained in the operation with the instrument 32.

In the system according to the present invention the various indicating, controlling and recording features combine to monitor the performance of a pumping well. The system provides safety control to shut down the well pumping operation upon the occurrence of a serious malfunction at either the high or low side, and also for signalling where abnormal operation occurs over a prolonged period where a predetermined normal or average high or low load value is not reached within a timed period. The system gives a continuous reading of the instantaneous load on the pump rod and may also make a permanent record of continuous pump rod loads over an extended period to provide for analysis of the well performance. The extreme load values for shutdown and the intermediate values for alarm may be adjusted as desired, and where any control circuit is energized, a relatively permanent indicator is actuated to apprise the operator at a later time of the nature of the abnormality which caused the control to be energized.

While the above features all combine in over-all control and measurement of well performance, any of the individual features and its functions may be omitted without departing from the invention. For example, the contact 54, time delay device 69, and the portion of the control 29 connected thereto may be entirely omitted and the intermediate alarm be made responsive only to a low capacity operation of the type where the load does not reach the value for which contact 55 is set within the timing period of time delay device 69A. Likewise, the potentiometer 72 may be omitted from the instrument 32, and whether or not the potentiometer is used, the recorder 33 may not be connected to make a permanent record of the pump rod loading. It is apparent that many other variations and modifications may be made in the specific embodiments of the invention shown and described herein, and the invention is not to be limited thereto but is to be given its broadest interpretation within the terms of the following claims.

I claim:

1. A system responsive to the performance of a pumping well comprising: load-measuring means connected to a well pump rod so as to be continuously responsive to the load thereon; instrument means remote from and connected to said load-measuring means; control means for the well pumping operation; means on said instrument means responsive to the attainment of either a predetermined high load value or a predetermined low load

value for activating the control means to discontinue the well pumping operation; and additional means on said instrument responsive to failure of the pump rod load to reach a predetermined intermediate value over a prolonged interval for activating a signal means to indicate abnormal performance of the well but without terminating the pumping operation.

2. A system responsive to the performance of a pumping well comprising: load-measuring means connected to a well pump rod to move therewith and to be continuously and directly responsive solely to the load thereon; instrument stationary means connected to said load-measuring means to give continuous readings of the instantaneous load on the pump rod; control means for the well pumping operation; means on said instrument means responsive to the attainment of either a predetermined high load reading or a predetermined low load reading for activating the control means to discontinue the well pumping operation; signal means; means responsive to activation of said control means for energizing the signal means to indicate the discontinuance of the well pumping operation; and indicators responsive respectively to the attainment of said predetermined high and low load readings for indicating which condition caused termination of the pumping operation.

3. A system responsive to the performance of a pumping well comprising: load-measuring means connected to a well pump rod so as to be continuously responsive to the load thereon; instrument means connected to said load-measuring means to give continuous readings of the instantaneous load on the pump rod; control means for the well pumping operation; means on said instrument means responsive to the attainment of either a predetermined high load reading or a predetermined low load reading for activating the control means to discontinue the well pumping operation; signal means; means responsive to activation of said control means for energizing the signal means to indicate the discontinuance of the well pumping operation; and means on said instrument responsive to the failure of the pump rod load to reach a predetermined value over a prolonged interval for energizing said signal means to indicate such subnormal operation of the pumping well without terminating its operation.

4. The system defined in claim 3 in which said means responsive to the failure of the pump rod load to reach a predetermined value over a prolonged interval includes means responsive to failure to reach either a predetermined high or a predetermined low pump rod low load value within predetermined time intervals.

5. The system defined in claim 4 including four indicators responsive individually to one of the conditions under which the signal means is energized, said indicators remaining activated, until reset at the well site, to apprise an operator of the condition which caused an alarm signal to be given.

6. A system responsive to the performance of a pumping well comprising: load-measuring means connected to a well pump rod to move therewith and to be continuously and directly responsive solely to the load thereon; stationary instrument means connected to said load-measuring means to give an instantaneous reading of the load on the well pump rod; control means for the well pumping operation; means on said instrument means responsive to the attainment of either a predetermined high load reading or a predetermined low load reading for activating the control means to discontinue the well pumping operation; a potentiometer mechanically connected to said instrument means to be varied thereby to provide continuous values indicative of the loads on the well pump rod; and recording means connected to said potentiometer and operable to chart a permanent record of the continuous values of the loads on the well pump rod.

7. A system responsive to well pumping loads comprising: load weighing means mounted to move with the well pump rod to be responsive to the instantaneous load

thereon; a stationary instrument remote from the well pump rod and connected to the load weighing means to be responsive thereto; a pointer in said instrument means movable in response to variations in the load measured by said load weighing means and cooperating with indicia to give a continuous reading of the instantaneous load on the well pump rod; at least a portion of said pointer providing a movable electrical contact; stationary contact means engageable by said movable electrical contact upon the occurrence of an abnormal value of pump rod load to transmit an electrical signal thereof; control means responsive to said electrical signal of abnormal operation for terminating the well pumping operation; additional stationary contact means located intermediate said abnormal high and low contacts; time delay means; circuit means interconnecting said time delay means and intermediate contact means and completed by engagement of the pointer with the intermediate contact means, said time delay means being reinitiated each time said pointer engages said intermediate contact means and timing out when said pointer fails to engage said intermediate contact means within its timing period; and signal means controlled by the time delay means for indicating prolonged abnormal operation.

8. The system defined in claim 7 in which said intermediate contact means comprises: a pair of spaced contacts positioned at both high and low load values reached in normal well performance; and a time delay means controlled by each of the intermediate stationary contacts and operating individually when their timing periods run out to effect the signal means indication.

9. A system responsive to well pumping loads comprising: load weighing means mounted to move with the well pump rod to be responsive to the instantaneous load

thereon; a stationary instrument remote from the well pump rod and connected to the load weighing means to be responsive thereto; a pointer in said instrument movable in response to variations in the load measured by the load weighing means and cooperating with indicia to give a continuous reading of the instantaneous load on the well pump rod; at least a portion of said pointer providing a movable electrical contact; stationary contact means engageable by said movable electrical contact upon the occurrence of an abnormal value of pump rod load to transmit an electrical signal thereof; a potentiometer mounted on said instrument and connected to said pointer so as to be rotatable therewith; and a recorder connected to said potentiometer to chart the continuous values of the potentiometer resistance against time whereby to permanently record the performance of the pumping well in terms of a continuous trace of the loads on the well pump rod.

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