

April 9, 1940.

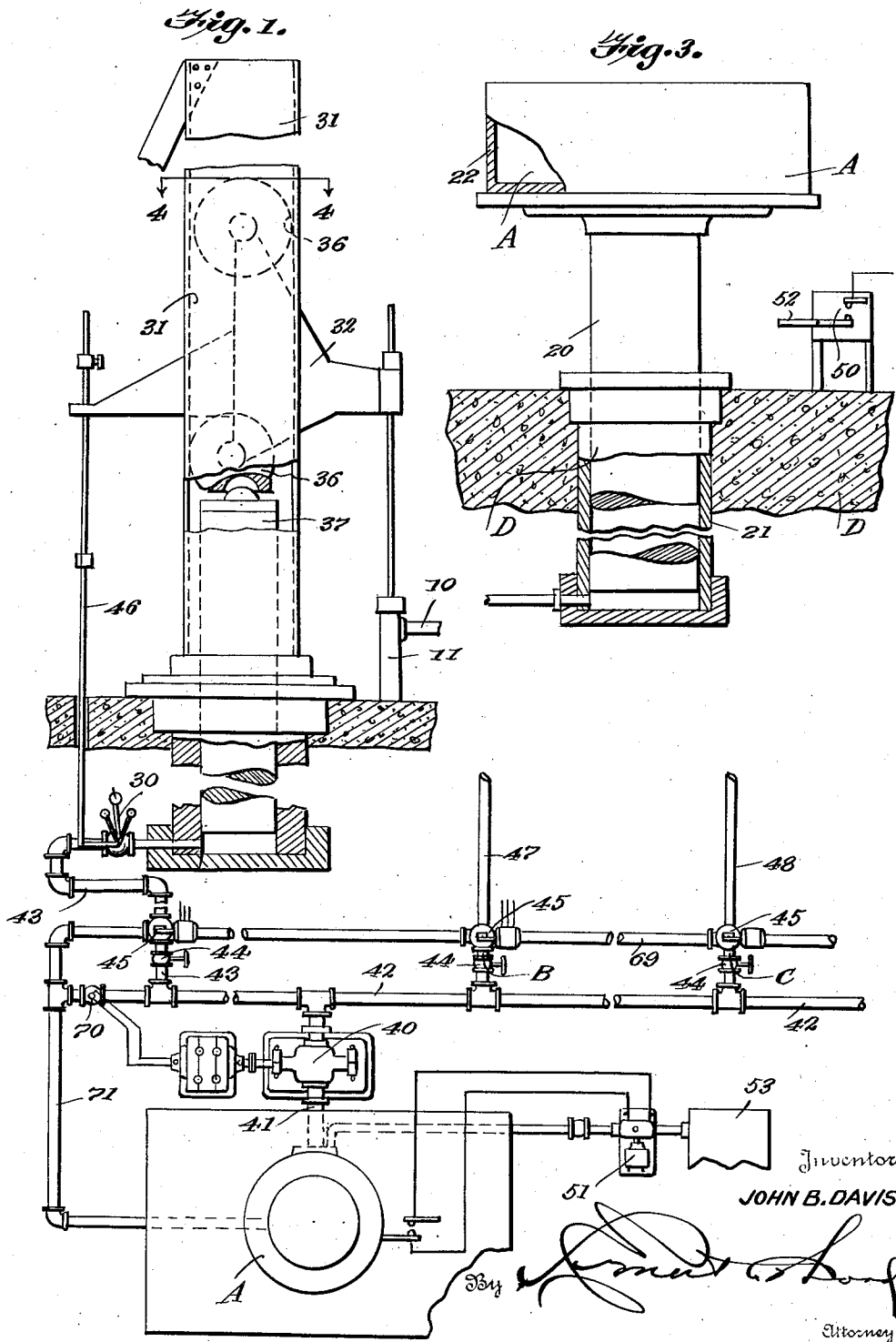
J. B. DAVIS

2,196,522

HYDRAULIC TRANSMISSION

Filed May 8, 1939

3 Sheets-Sheet 1



April 9, 1940.

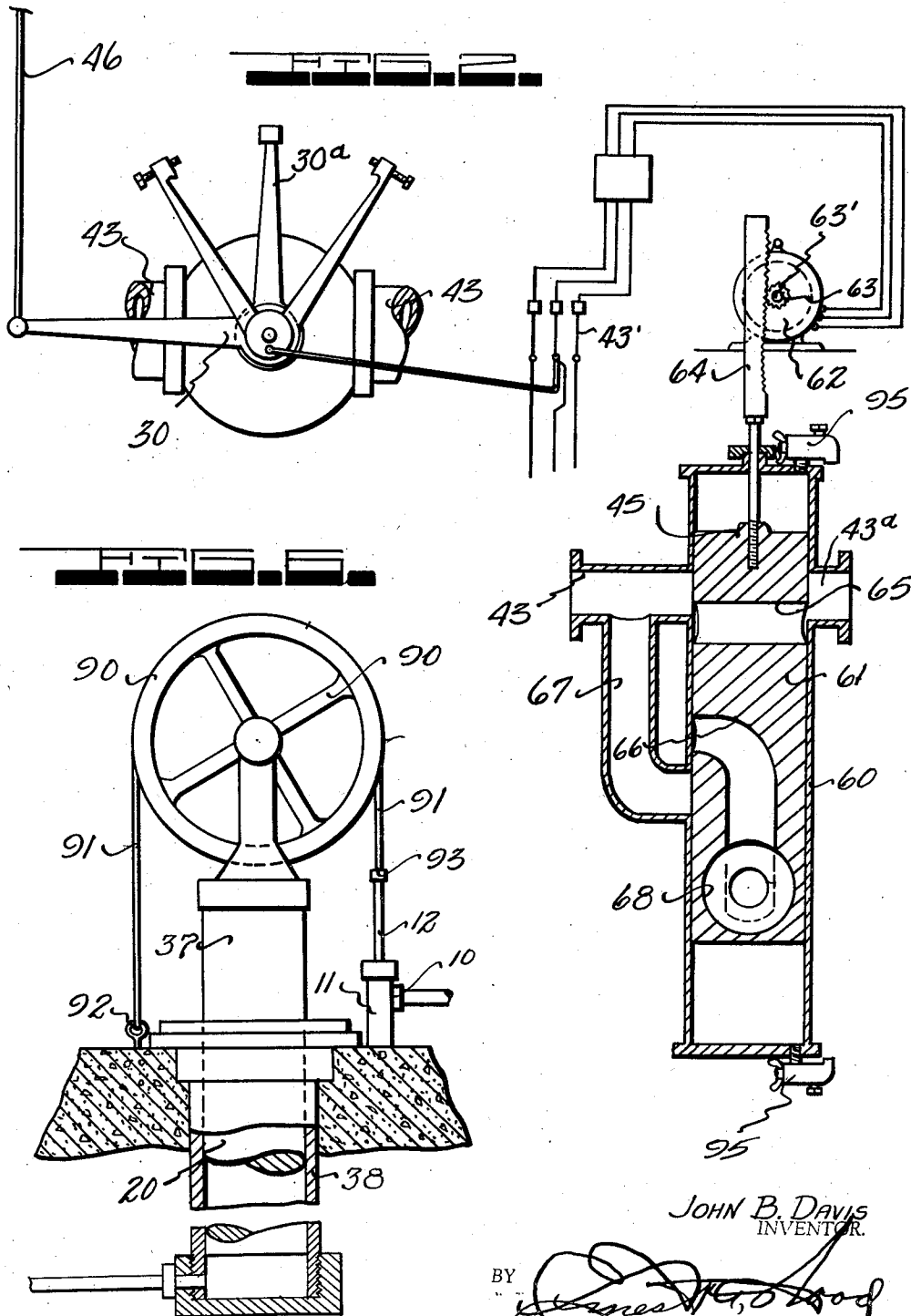
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HYDRAULIC TRANSMISSION

Filed May 8, 1939

3 Sheets-Sheet 2



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HYDRAULIC TRANSMISSION

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Fig. 4.

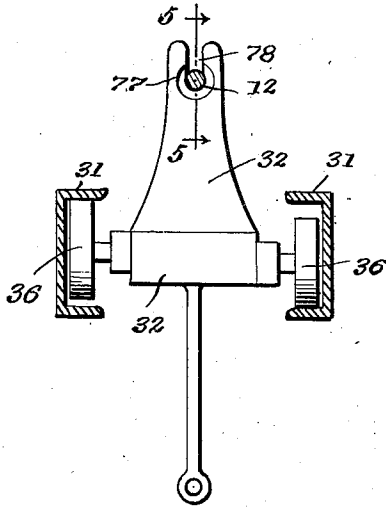


Fig. 7.

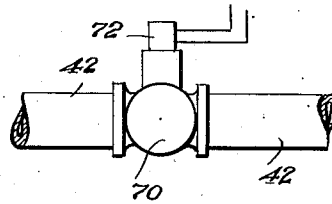


Fig. 8.

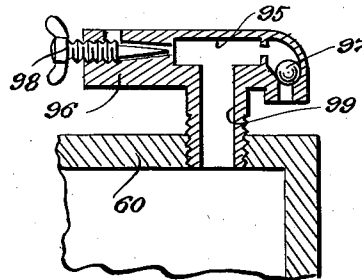
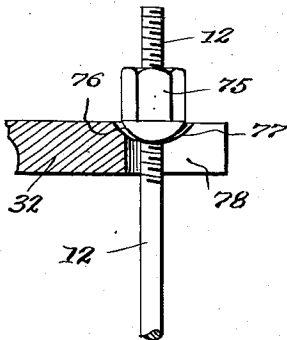


Fig. 5.



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UNITED STATES PATENT OFFICE

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HYDRAULIC TRANSMISSION

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Application May 8, 1939, Serial No. 272,488

1 Claim. (Cl. 60—52)

This invention relates to new and useful improvements in pumping units of the balanced type particularly adapted to the pumping of oil wells or other similar heavy pumping operations.

5 One object of this invention is to provide a principle or system of balanced pumping operation which system may pump one or more wells from a central plant wherein the speed of operation of each well may be individually controlled.

10 Another object of the invention is to provide a balanced pumping unit which may be controlled remotely.

Still another object of the invention is to provide a balanced pumping unit wherein all means 15 for counterbalancing the weight of sucker rods, or other similar units, are completely eliminated.

Another object of this invention is to provide a hydraulically controlled balancing means which will overcome all "rod loads" to decrease wear on 20 the gear box and gear equipment thereby providing a thoroughly satisfactory harmonic motion.

Another object of the invention is to provide an automatic balanced pumping unit to offset 25 any rod load regardless of depth or load to completely eliminate any means for counterbalancing weighted cranks or beam weights.

Another object of the invention is to provide automatic means for overcoming rod loads whereby the only weight to be handled by the pumping 30 equipment is that of the live fluid loads which occur only on the up stroke of said pumping units.

Another object of the invention is to provide a simplified universal movement between the 35 sucker rods of an oil well pump, the beam actuating mechanism and the improved automatic hydraulic balancing means whereby only a true vertical movement of said sucker rods is had in the pumping operation.

40 Still another object of the invention is to provide an extremely simplified connection means between the automatic hydraulic balancing means as well as to eliminate most of the pumping equipment now required to operate a pro- 45 ducing well.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood 50 from a reading of the following specification and by reference to the accompanying drawings, in which an example of the invention is shown, and wherein:

Figure 1 is a view partly in elevation and partly in plan to illustrate one form of pumping means

as well as connections from a number of wells to the master cylinder.

Figure 2 is a view partly in section and partly in elevation showing details of the trip switch and automatic control valve.

Figure 3 is a view partly in elevation and partly in section of the master cylinder.

Figure 4 is a horizontal cross-sectional view taken on the line 4—4 of Figure 1.

Figure 5 is a detail sectional view taken on the 10 line 5—5 of Figure 4.

Figure 6 is a view of a slightly modified form of the invention.

Figure 7 is a detailed elevation of the safety or blow-off valve.

Figure 8 is an enlarged vertical sectional view of the vent.

In the drawings the numeral 10 designates the usual Christmas tree mounted on the upper end of a well casing 11. The usual sucker rods 12 are 20 connected to the reciprocating means either as shown in Figure 6 or the conventional walking beam, not shown.

The present invention comprises primarily a hydraulic plunger 20 which plunger is slidably mounted in a cylinder 21 whereby the plunger may be reciprocated by hydraulic means. A suitable receptacle 22 is mounted on the upper end of the plunger 20, said receptacle being capable of retaining any substance sufficient to carry out the purpose of the present invention. This receptacle is filled with iron or lead weights of such combined weight as to counter-balance the rod load in a well to which its operating cylinder 21 is connected.

A trip switch 30, is provided as shown in Figure 2. This switch serves no valve function in its application as in Figure 1, but is effective, as will be later explained, as a means for electrically operating a valve for controlling the flow of fluid in the system. A fluid passage through the switch housing 30 is assured at all times regardless of the position of the arm 30a.

By observing Figure 1 it will be seen that channel bars 31 are provided (Fig. 4) which bars serve as a guide for "off center rollers" 36. A hydraulic plunger 37 within a cylinder 38 is provided to accomplish a reciprocable movement of the sucker rods 12 as will be hereinafter described in detail. A member 32 is provided with rollers 36 at its 50 upper and lower ends which rollers, as has been stated, are confined within the channel bars 31. The sucker rods 12 of the well 11 are universally secured to the member 32 as will hereinafter be explained, while the opposite end of the member

32 is so arranged as to actuate the trip switch 30 as may clearly be seen by observing Figure 1.

To clarify the operation of the mechanism thus far, it is believed that a brief operating description may be included at this time.

By observing Figure 1, which figure discloses a complete "set-up" of the present invention, it may be seen that the hereinbefore described reciprocating means 32 and its accompanying units are connected in series with a master balancing unit A and in this series a pump 40 is employed. This pump is suitably connected to the master balancing unit A by means 41 as well as being connected to a pressure line 42. The pressure line 42 is connected directly to the cylinder 38 containing the plunger 37 by means 43. The trip switch 30 as well as a throttle valve 44 are mounted in the means 43 intermediate the pressure line 42 and cylinder 38. An automatically controlled valve 45 is also mounted in the connecting means 43 which valve 45 contains a by-pass means, which will hereinafter be explained.

As the member 32 is forced upwardly by the combined fluid pressure of the pump 40 and balancing means A in cooperation with the plunger 37, a rod 46 will be actuated. This rod 46 is slidably connected to the member 32 at its upper end while it is suitably connected to the trip switch 30 at its lower end. Thus, when the sucker rod has reached its maximum up-stroke the trip switch, due to connections therewith to the valve 45, will relieve the flow of hydraulic pressure through valve 45 to allow the member 32 to travel downwardly, which member, as has been explained, is guided in its downward course by means of channel bars 31 and rollers 36. At such time as the member 32 reaches its maximum downward point of travel the member 46 will again be actuated to operate the trip to electrically change the position of the valve 45 to again exert pressure into the cylinder 38 to raise the plunger 37.

In Figure 1 connecting units B and C are shown for purposes of illustration. The portions 47 and 48 of units B and C, respectively, may be connected to any suitable actuating well mechanisms (not shown).

By observing Figure 3 an elevation of the unit A may be seen. As has been explained the receptacle 22 is mounted upon a plunger 20, which plunger is confined within the cylinder 21 which cylinder contains a predetermined amount of hydraulic fluid (not shown). The weight of the substance within the receptacle 22 is sufficient to compress the fluid to such an extent that said fluid will exert a pressure only a few pounds less than that pressure exerted upon the pumping unit by the "rod load." Thus, for example, if the rod load be three thousand pounds the pressure exerted by the balancing unit may be two thousand seven hundred and fifty pounds. With this amount or percentage of balancing it will be necessary for the pump 40 to actually produce but two hundred and fifty pounds, or more, to attain a reciprocating movement of the member 32 whereas in operation heretofore the pump 40 had to be of a sufficient size and capacity to overcome the complete theoretical three thousand pound rod load. Thus the advantages of this principle and system may very clearly be seen in that this improved balanced pumping unit will reduce actual exertion of the pumping unit employed to one sixth of that normally required.

By observing Figure 3 it will be seen that the

receptacle 22 of the unit A must be permanently suspended, that is, the receptacle 22 can at no time be lowered to such a degree that said receptacle may rest on any portion of the cylinder mounting D. If this were to occur the weight of the substance within the receptacle 22 would bear against said mounting D and, therefore, could not exert its weight upon the hydraulic fluid within the cylinder 21.

To overcome any possibility of this occurring a safety switch 50 is provided. This switch is so arranged as to close the contact to an auxiliary pump 51 in the event that the receptacle 22 is lowered to the horizontal plane of said switch 50. At such time as the member 22 is lowered to such a degree as to strike a pivoted contact arm 52 of the switch 50, a direct circuit will be closed to the auxiliary pump. This pump is connected to a hydraulic fluid reservoir 53 whereby when at such time as a circuit is closed to the pump, additional fluid will be introduced, by the pump, to the cylinder 21 to raise the plunger to a sufficient height whereby a permanent suspension of the substance within the receptacle 22 is had.

By observing Figure 2, details of the trip switch 30 and automatic valve 45 may clearly be seen. Figure 2 discloses a completed circuit between the trip valve 30 and automatic valve 45 through switch 43'. The valve 45 comprises a housing 60 having a plunger 61 slidably mounted therein. Sliding movement of this plunger is had through the medium of a torque motor 62 which motor has a circular gear 63 mounted on the drive shaft 63' thereof. The gear 63 is arranged to mesh with a gear rack 64, which gear rack is suitably connected to the slidable plunger 61. To eliminate any possibility of vacuum or compression within the member 60 above and below the slidable plunger 61, vent valves 95 are provided in the upper and lower ends of the member 60. By observing Figure 8 the enlarged details of the valve may be clearly seen. The valve comprises a housing 96 closed at one end by a ball valve 97 and by a needle valve 98 at its other end. A communicating port 99 is provided between the members 97 and 98 which port communicates with the interior of the cylinder 60. The purpose of this valve, as has been stated, is to eliminate any possibility of vacuum or compression which may possibly interfere with the operation of the valve 45. It is to be noted that adjustment of the needle valve 98 will regulate the speed of the slidable plunger 61 as well as preventing said plunger from "banging" against the housing 60 at the termination of the strokes of said plunger. A horizontal port 65 is provided near the upper end of said plunger while an arcuate port 66 is disposed within the lower end of the plunger. The horizontal port 65a as shown in Figure 2 is so arranged as to be connected with the pressure line 42 (Fig. 1) whereby when the pump 40 is exerting pressure this pressure will pass through the valve 45 by way of the horizontal port 65 and eventually force the vertical plunger of a pump unit upwardly. At such time as the rods have reached their maximum upward stroke, the connecting medium 46 is so arranged as to actuate the trip switch 30 to close contacts between said trip switch 30 and the torque motor 62 to reverse the same. Reversal of this motor will cause the gear 63 to rotate in a counter clockwise motion whereby the gear rack 64 will be lowered. Downward movement of the gear rack will change the position of

the horizontal port 65 and arcuate port 66. This change in position of ports will prevent passage of hydraulic fluid through the connecting medium 43 from pressure line 42 to the plunger cylinder 38. Prevention of flow of fluid under pressure to the cylinder will effect a release of the pressure within the cylinder 38 to allow the same to escape through the valve 45 into return line 69 through the medium of the arcuate port 66 in cooperation with an additional connection 67 communicating with said arcuate port whereby the weight of the sucker rods will lower the member 32 shown in Figure 1. A horizontal port 68 disposed at right angles to the port 65 is provided whereby an exhaust is attained in the event that the use of the units B and C (Fig. 1) connected to the wells (not shown) is desired. The discharge lines 69 of the units B and C (not shown) are connected so as to communicate with this horizontal by-pass port 68 within the valve 45.

It will be understood that since the discharge lines connected to units A, B and C are joined together so as to employ a common operating or master cylinder, there will be a pressure differential in the discharge from the cylinders of the units, due to differences in rod loads, sand conditions and the like. This condition may be met in any suitable manner as by varying the diameters of cylinders employed to accord with the requirements of each individual well.

The throttle valves 44 mounted in the lines 43 are provided so that in the event the well connected to the unit B is desired to be operated with a very slow reciprocable movement, the valve 44 may be closed to acquire the desired movement; whereas the well connected to the unit C, being entirely free of sand or like retarding substances may be actuated to its fullest operating capacity. In this event the valve 44 mounted in the unit C would be opened to its fullest extent to allow hydraulic fluid to pass therethrough from the pressure line 42 with its highest velocity.

In Figure 7 an enlarged detail of the blow-off valve 70 is shown. This valve is mounted as shown in Figure 1. The purpose of this valve is to accommodate a too great an increase in pressure in the line 42 in the event that the valves 44 would be closed. When sufficient pressure is built up in the line 42 to actuate the valve 70 the fluid will pass through a line 71 back into the cylinder unit A. It is to be noted especially that actuation of this relief valve 70 will close a switch 72 which switch is connected to the pump 40 and so arranged as to discontinue operation of the pump at such time as the valve is actuated.

In Figures 4 and 5 the universal movement between the sucker rods 12 and the unit 32 is shown. A nut 75 having its lower end rounded as at 76, is threaded on the rod 12. The member 32 is counter sunk at 77 to receive the rounded portion 76 of the nut. A slot 78 is provided in the member 32 to receive the rod 12.

In Figure 6 the plunger 37 is confined within the cylinder 38 and is actuated by pressure supplied by unit A as has hereinbefore been described, and a rotatable wheel 90 is substituted for the member 32. A cable 91 fixedly secured at one end, as shown at 92, is arranged over the wheel 90 and connected at its other end 93 to the sucker rods 12. It will be noted that with this arrangement of cable and wheel to the rod load that a compound ratio is had; for example: the rod 75 line or cable 91 will move two feet to raise or

lower the sucker rod 12 two feet while the actual travel of the plunger 20 and its attached wheel 90 is but one foot.

Special attention is called to the fact that, although a number of wells are operated through the medium of the master balancing unit A each well is individually controlled. Any one of a number of wells in the system may have the actuating speed thereof increased or decreased or may be completely cut off without interfering in any way with the operation of the other wells. This is a feature of the invention which is very important as this procedure has heretofore been unobtainable in the units now on the open market and in use.

Further when an operator desires to operate an additional number of wells it is only necessary to add additional pumping means to the pump 40 to compensate for the additional rod load weight of the added wells. By being able to do this, the operator may at all times use the original equipment regardless of the number of wells he desires to operate, as well as being able to operate three wells or thirty wells with the same master balancing unit. Thus a highly flexible unit is had.

It is also to be noted that the valve 44 is provided whereby any one well may be cut out without interrupting the operation of any of the other wells in the system. This has also been impossible in the past. Also, in the mechanical units now used all wells must operate at the same speed and the same length of stroke. The connecting mechanism hereinbefore described enables an operator to adjust the stroke as well as the speed of the pumping mechanism of each individual well.

From the foregoing it may clearly be seen that a balanced pumping unit extremely simple in construction and economical in manufacture may be had. Not only is the installation of this unit highly economical but this unit also greatly decreases the cost of operating an oil well pumping unit. This economy also includes the initial purchase of an oil well pumping unit. Further the automatic hydraulic balancing means serves to relieve the load imposed upon the beam actuating mechanism. Thus not only is installation but also the operating costs greatly decreased.

Manifestly, the construction as shown and described is capable of some modification and such modification as may be construed within the scope and meaning of the appended claim is also considered to be within the spirit and intent of the invention.

What is claimed is:

A hydraulic transmission for operating the rod string of a well pump comprising a hydraulic motor cylinder and a piston therein, a reciprocable member above and actuated by said piston comprising a body having a laterally extending projection connected to the rod string, spaced pairs of rollers carried by the upper and lower ends of said body, an arm on said body extending oppositely from said projection, a guide frame for said body comprising confronting channels receiving the rollers on said body; a second cylinder and a weighted piston therein, a first pump connected to feed liquid to said second cylinder beneath the piston therein, means controlled by the position of said weighted piston in said second cylinder for starting and stopping said first pump, a motor driven main pump having its suction line connected to said second cylinder,

- and its discharge line connected to said motor cylinder below the piston therein, a control valve in said discharge line, said valve being constructed and arranged in one position to direct 5 flow from said main pump to the motor cylinder, and in another position to cut off flow from the main pump to said motor cylinder and to connect said motor cylinder to said second cylinder, means actuated by said arm on said reciprocable 10 member for shifting said control valve from one position to the other as the motor piston reaches the end of its respective strokes; fluid pressure means to accelerate and decelerate said motor piston at the limit of travel in each direction, means for regulating the number and speed of 5 strokes of said motor piston, and a pressure responsive by-pass valve for the main pump, said valve when open breaking the circuit for the main pump motor.

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