Aug. 29, 1961 J. E. LOTT 2,997,887

MULTIPLE COMPLETION PUMPING UNIT

Filed Aug. 22, 1960 2 Sheets-Sheet 1

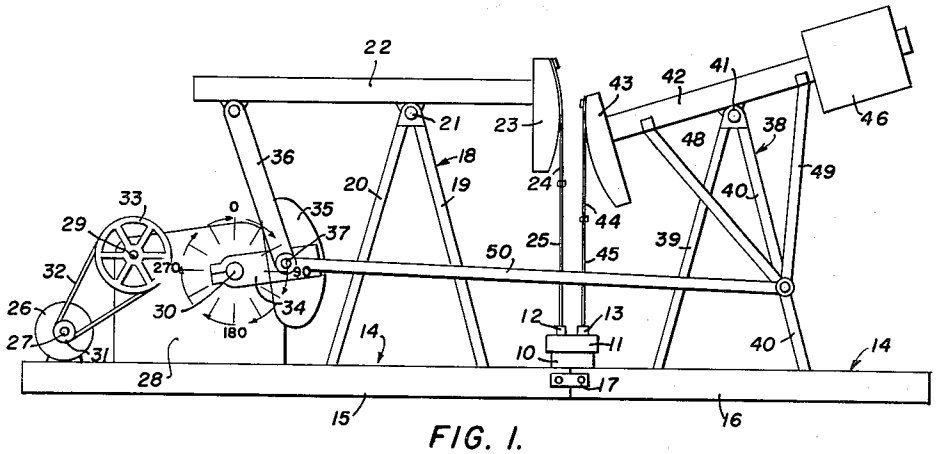


FIG. 1.

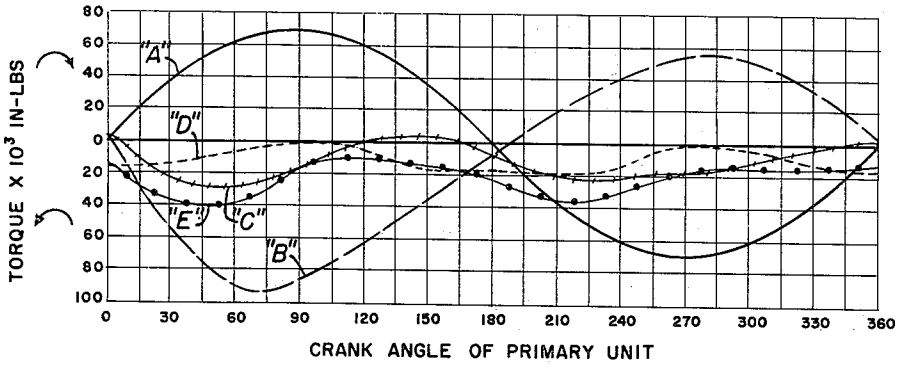


FIG. 2.

JOHN EDWARD LOTT
INVENTOR.

BY Hubert J. Brown
ATTORNEY

Aug. 29, 1961 J. E. LOTT 2,997,887

MULTIPLE COMPLETION PUMPING UNIT

Filed Aug. 22, 1960 2 Sheets-Sheet 2

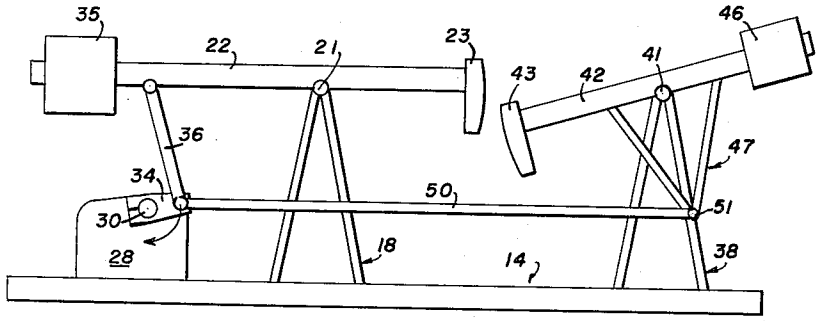


FIG. 3.

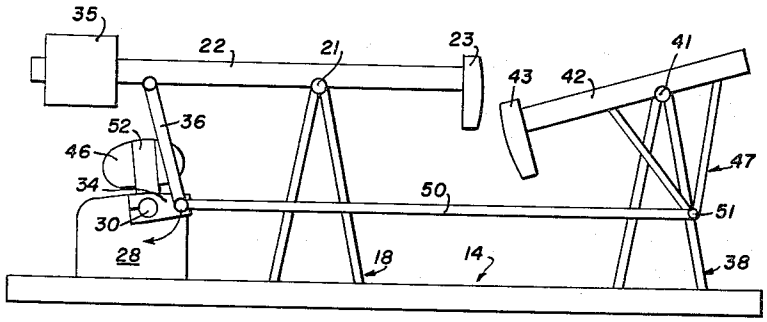


FIG. 4.

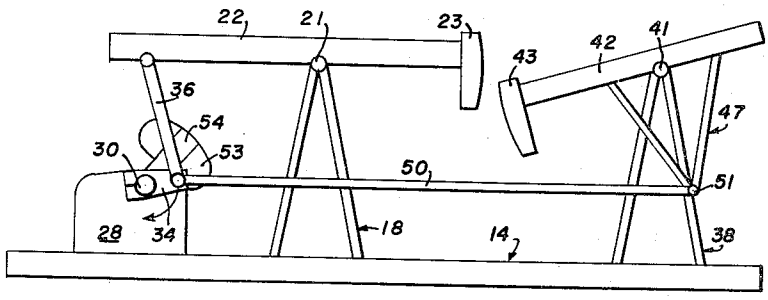


FIG. 5.

JOHN EDWARD LOTT
INVENTOR.

BY Herbert J. Brown
ATTORNEY

United States Patent Office 2,997,887 Patented Aug. 29, 1961

2,997,887

MULTIPLE COMPLETION PUMPING UNIT

John Edward Lott, Fort Worth, Tex., assignor to American Manufacturing Company of Texas, Fort Worth, Tex., a corporation of Texas

Filed Aug. 22, 1960, Ser. No. 50,975
5 Claims. (Cl. 74—41)

This invention relates to pumping units and has reference to a phased unit for pumping a multiple completion well.

Many of the sub-surface structures in the great sedimentary basins encompass a large number of geological formations which may include two or more oil bearing strata. In the geological time scale the occurance of vertical faults and the formation of domes and anticlines is usually antedated by the deposition of sedimentary beds affected thereby. Hence, it is not unusual to find a single geological structure containing two or more earth strata, one above the other, bearing oil in commercial quantities. At such occurances a single well may be drilled through an overlying of formation into a deeper pay before a casing is run and set; the casing is then perforated at both producing horizons. One tubing string is extended to the bottom of the well and a second string is run to the level of the upper pay. A packer is placed about the longer string within the casing at a level slightly below the bottom strand of the shorter string. With seperate pumps and sucker rods each reservoir may then be pumped separately, but the cost of drilling a single well can be amortized through the production of both.

Heretofore it has been the usual procedure to provide a separate pumping unit at the surface for each of the sub-surface pumps. The use of independent pumping units generally results in substantial duplication in reducing gear trains in the two units and requires prime movers having an aggregate reserve power to meet the sum of the maximum peak loads of the two pumping units. While the duplication of gear trains in similar pumping units and the use of seperate motors constitute an extra cost in the completion of a well, it will also be shown that use of the present invention, wherein two pumping jacks are driven in phased relationship with one another by a single motor and gear reducer, results in a reduced peak torque load for the combined units and reduces the peak power requirements of a drive system common to both.

An object of the present invention is to provide means for pumping a well of the dual completion type with a single prime mover and a single gear box.

Another object of the present invention is to provide means whereby two pumps may be operated in coaction on a dually completed well with a peak power expenditure less than the peak power required to operate both pumps independently.

A further objection of the invention is to provide a pumping unit for dual completions and which pumping unit incorporates an advantageous phase relationship in driving reciprocating pumps at different levels within a well.

An important object of the invention is to provide means whereby the momentum and inertia of coactively operated reciprocating pumps of dually completed wells may be phased and mutually compensated to reduce the power requirement of a single prime mover driving both pumps.

Another object of the invention is to provide an economical means for equipping and driving two pumps having different peak polish rod loads.

A particular object of the invention is to provide a coactive drive linkage between phased pumping units which is operative under both tension and compression between loads of the two pumping units.

An additional object of the invention is to provide single drive means for two pumps of a dually completed well and whereby one or both of the pumps may be operated independently.

These and other objects will become apparent from the following description and the accompanying drawing wherein:

FIGURE 1 is a side elevational view of the invention shown in operative connection to the polish rods of a dually completed well.

FIGURE 2 is a graph of torque versus crank angle for static loads in a typical dual completion.

FIGURE 3 is a diagrammatic side elevational view of an alternate embodiment of the invention.

FIGURE 4 is a diagrammatic side elevational view of a second alternate embodiment of the invention.

FIGURE 5 is a diagrammatic side elevational view of a third alternate embodiment of the invention.

With particular reference of FIGURE 1 of the drawings, the casing **10** and casing head **11** of a dually completed well contain and support two tubing strings **12** and **13** having their respective upper ends projecting upwardly in side by side relationship through the casing head at the surface of the well. It is to be understood that the tubing strings **12** and **13** are of unequal lengths and extend to formations at different levels within the well; by way of identification, the tubing string **12** on the left hand side in FIGURE 1 will be designated as the primary tubing string and the other tubing string **13** will be referred to as the secondary tubing string. A surface platform **14** is supported by the surface of the ground adjacent the casing **10** and may be constructed as two coplanar sections **15** and **16** which are substantially rectangular in shape and which are provided with opposed semicircular apertures (not shown) in adjacent ends to admit the casing **10**; the coplanar base members **15** and **16** may be provided with straps **17** bolted to corresponding sides thereof to prevent dislocation of any part of the platform relative to the casing **10**. On one base member **15** a primary samson post **18** including forward and rear leg members **19** and **20** supports a horizontally disposed pivot pin **21** in an elevated position. A primary walking beam **22** is attached to the pivot pin **21** and is positioned in radial alignment with the axis of the primary tubing string **12**. A mule head **23** is attached to one end of the primary walking beam **22** and is positioned in vertical adjacence to the axis of the primary tubing **12**. A bridal **24** depending from the mule head **12** supports the polished rod **25** of a sucker rod string within the primary tubing string **12**; the piston of a submerged pump (not shown) is attached to the lower end of the sucker rod string within the primary tubing. A motor **26** having its shaft **27** disposed parallel to the pivot bar **21** is supported by the platform **14** rearwardly of the primary samson post **18** and the primary walking beam, and a gear reducer box **28** including a driven shaft **29** and a crank shaft **30** is attached to and supported by the platform **14** between the motor **26** and the primary samson post **18**. A drive sheave **31** is carried by the shaft **27** of the motor **26** and engages a belt **32** which is also engaged by a driven sheave **33** attached to the driven shaft **29** of the gear reducer box **28**. A crank **34** is attached to the crank shaft **30** of the gear reducer box **28** and is provided with a counterbalance **35** at its projecting end. A pitman **36** is pivotally connected at one of its ends to the rearward end of the walking beam **22** and is pivotally connected at its other end to a crank pin **37** carried by the crank **34**. On the smaller base member **16** of the platform **14** a secondary samson post **38** including forward and rear leg members

39 and 40 supports a secondary pivot pin 41 which is horizontally disposed. A secondary walking beam 42 is attached to the pivot pin 41 and is positioned in radial alignment with the axis of the secondary tubing 13. A mule head 43 is attached to one end of the secondary walking beam 42 in vertical alignment with the axis of the secondary tubing 13. A bridal 44 depending from the mule head 43 on the secondary walking beam 42 supports the polished rod 45 and sucker rod string (not shown) in the secondary tubing string 13; the piston of a pump (not shown) is attached to the lower end of the sucker rod string within the secondary tubing string. A counterbalance 46 is attached to the rearward end of the secondary walking beam 42. A rocker frame 47 consists of two elongate structural members 48 and 49 each respectively secured to the secondary walking beam 42 at positions spaced thereon oppositely and equidistantly from the pivot bar 41 and extending therefrom to a point of intersection beneath the walking beam and laterally spaced from the secondary samson post 38. A rigid link 50 is pivotally attached at one of its ends to the rocker frame 47 at its lowest extremity by a horizontally disposed pivot pin 51 and is journaled at its opposite end to the crank pin 37. The link 50 lies in the plane of rotation of the outer end of the crank pin 37 and its rigidity provides a substantially constant spacing between the crank pin and the pivot pin 51 on the lower end of the rocker frame 47; it should be noted also that the length of the link 50 is constant under forces of tension and compression.

An understanding of the operation of the invention and the advantages attending its described construction may be gained through consideration of the torque loads involved in independent operation of two conventional pumps and comparison of these loads with the power requirements of the present invention. On the upstroke of a pumping unit the weight of the sucker rods and a fluid column must both be lifted; on the down stroke, however, the weight of the fluid column is supported by a check valve at the base of the tubing and the weight of the sucker rods alone is supported by the walking beam. Since the static load on the polished rod thus varies according to the direction of its stroke the counterbalance is generally made to have an effective weight equaling the weight of the sucker rods plus one-half the weight of the fluid column. For example, if the polished rod load is 5000 pounds on the upstroke and 3000 pounds on the down stroke, then an effective counterweight of 4000 pounds would yield an equal static load of 1000 pounds for both pumping semi-cycles. Considering only static loads, the peak power requirements for a pumping unit are minimized when the loads of opposite cycles are equal. Other factors, such as momentum of the reciprocating parts, may cause deviations from perfectly equalized loads in the construction and operation of a pumping unit. Placing the counterbalance on the crank instead of the walking beam, for instance, reduces momentum fluctuations in the motion of the counterbalance. In FIGURE 2, the curve "A" is a graphical representation of the torque on the crank shaft 30 resulting from one rotation of the crank 34 carrying only the counterbalance 35 of the primary unit. It will be noted that this curve approaches a pure sine wave in form. Curve "B" plots the torque on the crankshaft 30 resulting from reciprocation of the primary walking beam 22 without its counterbalance 35 by the crank 34 and pitman 36; this curve reaches maximum values at points which depend upon angularity between the crank, pitman and walking beam but which do not occur simultaneously with the maximum values of curve "A." Curve "C" is the algebraic sum of curves "A" and "B" and illustrate the torque loads on the crankshaft 30 due to reciprocation of the primary beam for various crank angles through a single revolution. The peak load occurs when the crank 34 is rotated (clockwise as illustrated in FIGURE 1) approximately 60° from its vertical position; this peak load is the principal factor in a determination of the power requirements of the pumping unit. It is easily seen that the total power requirement for two such units operated independently with identical loads and at equal speeds will be exactly twice the power required for a single unit.

In the present invention, the rigid link 50 connecting the crank 34 of the primary unit to the rocker frame 47 of the secondary unit operates the secondary unit and keeps it approximately 90° out of phase with the primary unit. Curve "D" shows the torque loads on the crank shaft 34 resulting from the static loads developed through a complete pumping cycle of the secondary unit. It should be noted that the two torque maxima of the "D" curve are substantially equal and approximately one-half revolution apart and that the peak power load of the secondary unit is less than that of the primary unit although identical polished rod loads are used as a basis of computation; the relatively low peak power requirement of the secondary unit results from the great length of the link 50 as compared to the length of the crank 34 and the consequent proximity of points of perpendicularity of these two members to the two vertical positions (0°+180°) of the crank. It should be remembered that in the previously described embodiment of the invention the link 50 is constructed with longitudinal rigidity to withstand alternate forces of tension and compression. The rigid link 50 not only provides a reduced peak power requirement for the secondary unit but also keeps the torque loads out of phase. Curve "E" is the algebraic sum of curves "C" and "D" and represents the total torque load upon the crank shaft 30 at the various angles of revolution of the crank 34. Whereas the total power requirement for two independently operated units, constructed as the primary unit, would be determined by the maximum torque load of each as indicated in the "C" curve and multiplied by a factor of 2, the total torque upon the crankshaft 30 of the invention is considerably less at its maximum than twice the peak load of the primary unit.

In normal operation of the invention, as applied in a dually completed well, the reduction of peak power requirements in comparison to the power needed for two conventional pumping units may be even more pronounced than in the given example of units operating under equal loads. In the usual dual completion, the pumps are operated at different levels within the well and one of the strings of sucker rods will be considerably heavier than the other. By reciprocating the heavier string with the secondary unit a favorable ratio between the length of the crank 34 and link 50 can be used to achieve a particularly advantageous peak torque load for that unit doing the greater amount of work while the phase relationship maintained between the two units further reduces the combined power requirement.

In many instances oil is produced in identical quantities from separate formations to conform with prorated allowables established by regulatory bodies in various states. In some instances, however, it may be desired to produce more oil from one formation than from another. In the preferred embodiment of the invention, the primary tubing 12 may be pumped separately after disconnection of the rigid link 50 from the crank pin 37. By beam mounting both counterbalances 35 and 46, as illustrated in FIGURE 3, either of the pumping units may be operated separately by selective disconneciton of the link 50 or pitman 36 from the crank pin 37; insofar as the effective force of the counterbalance 35 on the primary walking beam 22 (FIGURE 3) is equivalent to the effect when mounted on the crank 34 (FIGURE 1), the operation of the invention is not substantially altered by this arrangement. Where separate operation of only the secondary walking beam 42 is required, the counterbalance 35 of the primary pumping unit may be mounted

on the primary walking beam **22** whereas the counterbalance **46** of the secondary unit may be mounted on an auxiliary crank **52** attached to the crankshaft **30** and spaced 90° behind the crank **34** with respect to the direction of its rotation; this arrangement of counterbalances is illustrated in FIGURE 4. In instances where there is no need for separate operation of wither pumping unit, a single counterbalance **53** (FIGURE 5) having its weight and position equal to the resultant force of crank mounted counterbalances **35** and **46** (shown in FIGURES 1 and 4, respectively) of the two pumping units may be attached to an auxiliary crank **54** (FIGURE 5) carried by the crankshaft **30** and spaced behind the crank **34** at an angle dependent upon the effective weights of the two pumping units.

The invention is not limited to the exemplary construction herein shown and described, but may be made in various ways within the scope of the appended claims.

What is claimed is:

1. A pumping unit for a multiple completion well including at least two sucker rod strings, said pumping unit comprising: a first walking beam, means pivotally supporting said first walking beam for angular displacement in a vertical plane, means connecting one end of said first walking beam to one of said sucker rod strings, a prime mower having a driven crank disposed for rotation in a plane parallel with the plane of displacement of said first walking beam and positioned therebeneath, said crank being mounted at one end on a driven crankshaft and having a wrist pin in the remaining end thereof, a pitman pivotally connected at its opposite ends to said crank wrist pin and said first walking beam, a second walking beam spaced from said first walking beam, means pivotally supporting said second walking beam for angular displacement in said plane of displacement of said first walking beam, means connecting one end of said second walking beam to the other of said sucker rod strings, a rocker arm attached to said second walking beam and extending therefrom to a point spaced from the axis of displacement of said second walking beam on a line perpendicular to the length of said second walking beam, and a rigid link pivotally connected at its opposite ends to said crank and said rocker arm, the pivotal connection of said link with said crank being within an angle of 60° extending from the center of said driven crank shaft, one side of said angle being defined by the center line extending through the center of said crank shaft and the center of said crank wrist pin.

2. In a multiple completion well having at least two sucker rod strings, a first pumping unit of the walking beam type having its bridal engaging one of said sucker rod strings within the same well bore, a second pumping unit of the walking beam type positioned in opposed relationship to said first pumping unit with respect to said well and having its bridal engaging the other of said sucker rod strings, a prime mover including a driven crank positioned beneath the walking beam of said first pumping unit, said crank being mounted at one end on a driven crank shaft and having a wrist pin in the remaining end thereof, a pitman pivotally connected at its opposite ends to said crank wrist pin and to said walking beam of said first pumping unit, a rocker arm attached to the walking beam of said second pumping unit and extending to a point perpendicularly aligned with said walking beam of said second pumping unit and spaced from the axis of angular displacement thereof, a link pivotally connected at its opposite ends to said crank and said rocker arm, the pivotal connection of said link with said crank being within an angle of 60° extending from the center of said driven crank shaft, one side of said angle being defined by the center line extending through the center of said crank shaft and the center of said

crank wrist pin and means counterbalancing said pumping units.

3. A pumping unit for two sucker rod strings, said pumping unit comprising: a first samson post, a first walking beam pivotally supported by said first samson post, means connecting one end of said first walking beam to one of said sucker rod strings, a prime mover including a crank positioned beneath the other end of said first walking beam, said crank being mounted at one end on a driven crank shaft and having a wrist pin in the remaining end thereof, a pitman pivotally connected at its opposite ends respectively to said other end of said walking beam and to said crank wrist pin, a second samson post positioned in alignment with said first samson post and said sucker rod strings, a second walking beam pivotally supported by said second samson post, means connecting one end of said second walking beam to the other of said sucker rod strings, a rocker arm affixed to said second walking beam and extending therefrom to a point laterally spaced from said secondary samson post, a link pivotally connected at its opposite ends respectively to said crank and said rocker arm, the pivotal connection of said link with said crank being within an angle of 60° extending from the center of said driven crank shaft, one side of said angle being defined by the center line extending through the center of said crank shaft and the center of said crank wrist pin, and means counterbalancing said walking beams.

4. A device for reciprocating two sucker rod strings, said device comprising: a first pumping unit engaging one of said sucker rod strings, a prime mover including a crank positioned beneath the walking beam of said first pumping unit, said crank being mounted at one end on a driven crank shaft having a wrist pin in the remaining end thereof, a pitman pivotally connected at its opposite ends respectively to said crank wrist pin and said walking beam of said first pumping unit, a second pumping unit engaging the other of said sucker rod strings and disposed in alignment with said first pumping unit and said sucker rod strings, a rocker arm affixed to the walking beam of said second pumping unit and extending therefrom to a point spaced from the axis of displacement of said walking beam of said second pumping unit and spaced from the plane of displacement of said walking beam of said second pumping unit, a rigid link extending between and pivotally connected to said crank and said rocker arm, the pivotal connection of said link with said crank being within an angle of 60° extending from the center of said driven crank shaft, one side of said angle being defined by the center line extending through the center of said crank shaft and the center of said crank wrist pin and means counterbalancing said pumping units.

5. A pumping unit for a multiple completion well including at least two sucker rod strings, said pumping unit comprising: a first walking beam, means pivotally supporting said first walking beam for angular displacement in a vertical plane, means connecting one end of said first walking beam to one of said sucker rod strings, a prime mover having a driven crank disposed for rotation in a plane parallel with the plane of displacement of said first walking beam and positioned therebeneath, a pitman pivotally connected at its opposite ends to said crank and said first walking beam, a second walking beam spaced from said first walking beam, means pivotally supporting said second walking beam for angular displacement in said plane of displacement of said first walking beam, means connecting one end of said second walking beam to the other of said sucker rod strings, a rocker arm attached to said second walking beam and extending therefrom to a point spaced from the axis of displacement

of said second walking beam on a line perpendicular to the length of said second walking beam, and a rigid link pivotally connected at its opposite ends to said crank and said rocker arm, said link being connected with said crank at a point relative to the crank pin thereof so that said walking beams are substantially 90° out of phase with each other.

References Cited in the file of this patent

UNITED STATES PATENTS

1,780,933	Martois et al.	Nov. 11, 1930
2,179,649	Trout et al.	Nov. 14, 1939
2,265,379	Lyne	Dec. 9, 1941
2,271,594	Kanalz	Feb. 3, 1942