July 18, 1950 R. P. VAIL 2,515,360

PUMPING UNIT

Filed July 7, 1948 3 Sheets-Sheet 1

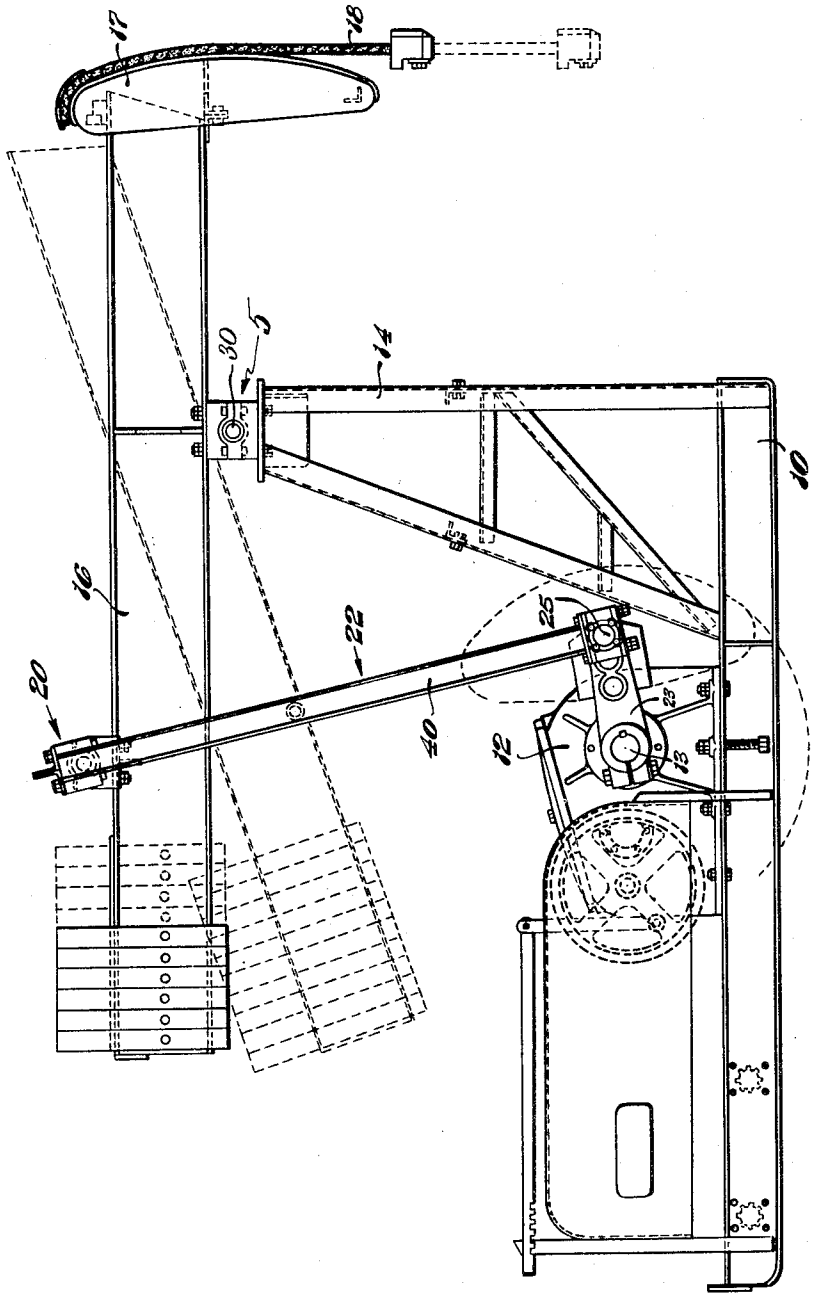


Fig. 1

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By Mulvey, Finney, Watts & Whiteside.

July 18, 1950 R. P. VAIL 2,515,360

PUMPING UNIT

Filed July 7, 1948 3 Sheets-Sheet 2

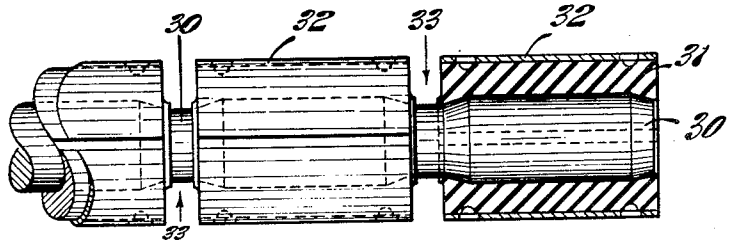


Fig. 2

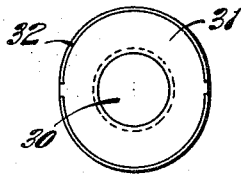


Fig. 3

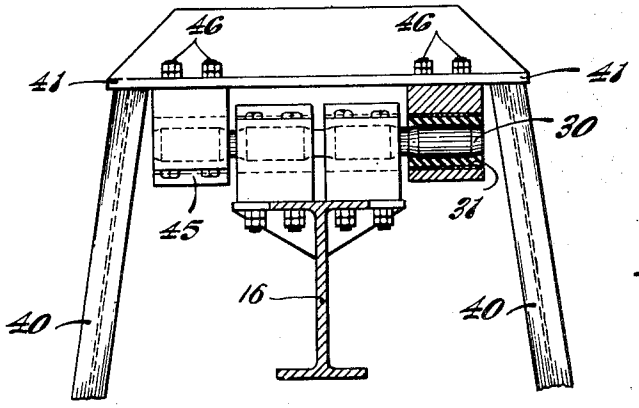


Fig. 4

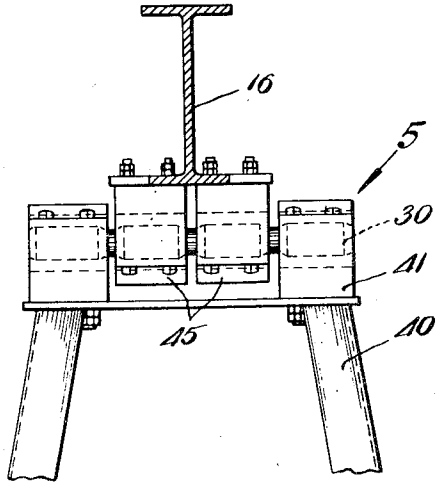


Fig. 5

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July 18, 1950 R. P. VAIL 2,515,360

PUMPING UNIT

Filed July 7, 1948 3 Sheets-Sheet 3

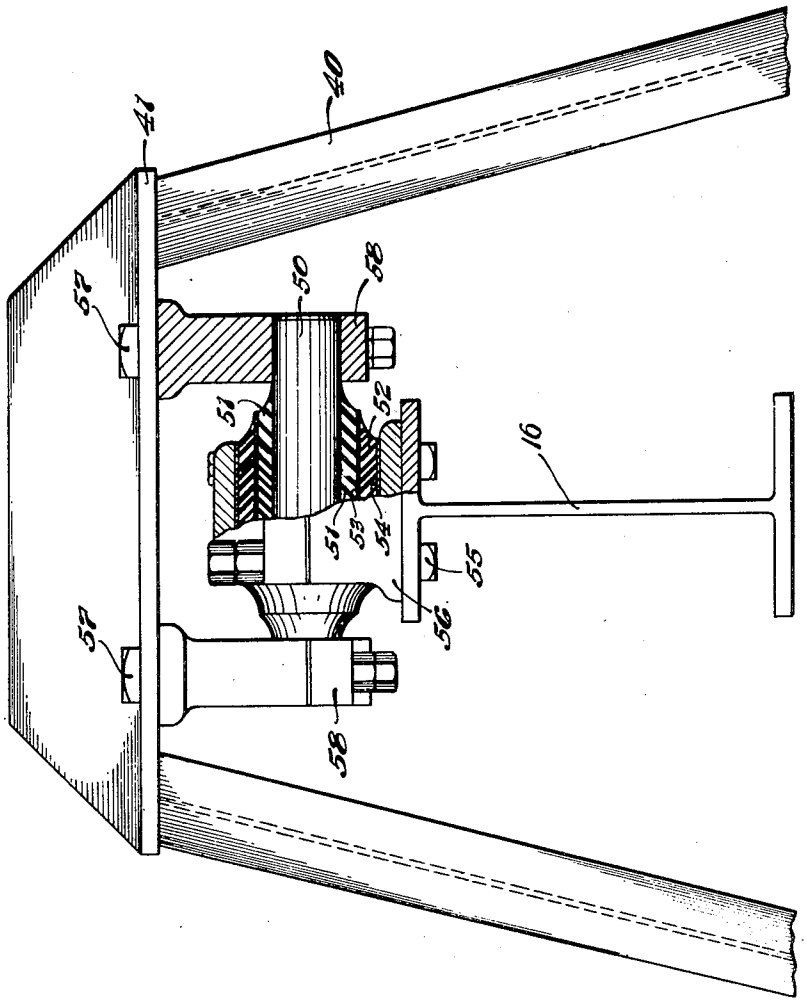


Fig. 6

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Patented July 18, 1950 2,515,360

UNITED STATES PATENT OFFICE

2,515,360

PUMPING UNIT

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Application July 7, 1948, Serial No. 37,385

13 Claims. (Cl. 74—41)

1

This invention relates to pumping units of the reciprocating type commonly used in oil fields and consists in a novel and improved mechanism for movably connecting the crank or pitman arms of a pumping rig to the walking beam without the use of frictionally sliding parts, thus making for smooth and efficient operation and giving long wear.

The main object of my invention is to provide a joint mechanism employing a resilient, shock-resistant equalizer bushing or sleeve which will compensate for uneven stresses and permit substantial torsional rotation in either direction while at the same time allowing for angular displacement in directions other than rotational. It is also an important object of my invention to provide a simplified and relatively inexpensive joint mechanism with low rate of wear and long life to replace the conventional and cumbersome equalizer assembly with its sleeve or needle type bearings, many parts, high rate of wear, and relatively short life.

In pumping units of the reciprocating type, the pitman arms and walking beam can only be connected by means of a joint mechanism permitting deflection of the parts transversely to the plane of working oscillation of the walking beam. A rigid bearing providing for oscillation in one direction only would be destroyed in a very short time because of the uneven stresses caused by misalignment in the working parts of the unit; notably in walking beam and pitman arms. Such misalignment is inevitable for a variety of reasons as, for example, uneven faces of I beams from which walking beams are constructed, exposure of unit to the elements, unequal expansion of pitman arms from disproportionate exposure to the sun's rays, etc.

To compensate for such misalignment and to permit necessary deflection it is generally the practice, as in the well known Cabot pumping unit which is typical, to provide a joint mechanism consisting of an equalizer beam provided with a swivel block and pin at either end for engagement with clevises on the upper ends of the pitman arms and provided with a two directional bearing in the center through which equalizer beam and walking beam are connected. Thus as the pitman arms reciprocate the equalizer beam is raised and lowered, carrying the walking beam with it and being free to rock from side to side without causing binding of the walking beam bearing.

It will readily be apparent that whatever this type of bearing used, it being the practice to use

2

a sleeve type in the smaller units and a needle or roller type in the larger units, the bearings must be lubricated frequently, at least once a week and usually more often; and even with frequent lubrication the bearings will wear and will require replacement of parts. It is an object of my invention to provide a joint mechanism which requires no lubrication nor replacement of parts in long continued use.

It can likewise be seen that the conventional joint mechanism is composed of many parts all of which must be carefully machined and fitted together. In the Cabot unit, for example, the number of component parts in the equalizer assembly range from twenty-six in the smaller units to thirty-five in the larger, the moving parts of which, such as bearing surfaces, journals and shafts, must be machined to a tolerance of within 0.002 of an inch. On the other hand the equalizer joint mechanism of my invention has only six separate parts, none requiring precise machining or fitting.

A further object of my invention is to provide a joint mechanism for oil well pumping units which will replace the cumbersome equalizer assembly and which may be manufactured much more rapidly and at considerably lower cost. For example I have found that the joint mechanism of my invention may be manufactured in about one-fourth of the time required for the manufacture of the conventional assembly and will cost only about one-half as much to manufacture. The increased rate of manufacture also has the added effect of releasing machinery and manpower for work on the other elements of the pumping unit thus increasing the rate of production of the entire unit by about 30%.

A comparison of the pitman arm assembly of my invention with the pitman arm equalizer beam assembly of the conventional pumping unit will further serve to illustrate the saving in manufacturing time, cost and materials effected by my invention. Pumping units vary in size according to the nature of the service for which they are intended, such as depth and conditions of the well, gravity of the oil etc. As the size of the conventional unit increases the size of the equalizer beam must likewise be increased so that for the fifteen Cabot units, for example, equalizer beams of ten different sizes are required. Furthermore, each equalizer beam must be tapered at either end, welded for strength and fitted with swivel blocks. To engage the pins in the swivel blocks clevis plates must be individually welded to the pitman arms. On the other hand, in the

pitman arm assembly of my invention no equalizer beam is necessary. A single cross beam of standard design which may be made in various sizes to accommodate all such pumping units, may be welded to the ends of the pitman arms and no extra fittings are required, either on the beam or on the pitman arms.

An oil well pumping unit in operation is frequently subject to exceptional loads and strains, all of which greatly tend to reduce the useful life of the unit. Such exceptional strains may be caused by fluid pound, gas lock, sanding up of the pump, deposition of paraffin on the pump plunger etc., all or any of which conditions may suddenly cause the addition of thousands of pounds to the load carried by the pumping unit. The resulting shocks, will, of course, tend to impose undue strain upon the various parts of the pumping unit, particularly upon the bearings and gears and increase incidence of breakdown. It is thus an additional object of my invention to provide a resilient equalizer connection constituting a component part of my joint mechanism which is effective to insulate the unit against such shocks. I have found from dynagraph tests run on several units pumping generally normal oil wells and equipped with the joint mechanism of my invention that shock may be reduced by as much as 10% to 15%.

Prior to my invention it was considered impossible to construct a bushing of sufficient strength and resiliency to be utilized practicably as a bearing in oil well pumping units where heavy loads, hard service, repeated and substantial torsional flexing in both directions about the bearing axis are encountered. I have discovered, however, that by constructing a bushing of resilient material disposed in separate sections independent of one another, the amount of torsional deflection to which any given section of resilient material is subject is reduced by one half, thus greatly increasing the flex life of the bushing. By utilizing such a bushing I have produced a joint mechanism which is highly practicable from both a commercial and an operating standpoint and which, under normal conditions will operate for 10 years and even longer without attention of any kind.

I accomplish the objects of my invention by providing an equalizer bushing in the joint mechanism of my invention consisting of several rings or sleeves of rubber or other resilient elastomer, spaced apart along the vulcanized to a rigid metal core or spindle of sufficient strength to sustain the loads encountered in pumping the well. Partially surrounding each sleeve is a thin shell of a metal enclosing the rubber and furnishing a firm surface which may be held firmly by circular clamps. The outer shell of the bushing is non-rotatably secured to the pitman arms or to the walking beams by clamps which engage the perimeter of the metal sheathed sleeves and which are drawn up to impose a pressure of several thousand pounds upon the bushing, the outer sleeves being clamped to the pitman arms and the center sleeves to the walking beam, so that as the pitman arms reciprocate the individual sleeves permit a limited torsional twist or rotation in either direction about the axis of the shaft.

Although I have estimated the life expectancy of this bushing at ten years such estimate is probably conservative as will be apparent from the history of its performance in a test pumping unit. The joint mechanism of my invention was

installed on a Cabot pumping unit model CT-13U of medium size. In place of the sucker rod, weights were attached to the walking beam and the whole unit then operated at the rate of 60 cycles per minute, three times the usual operating speed for well pumping. Although various parts of the unit failed and had to be repaired, such as the walking beam, Samson post and gear box, the bushing and other parts of the joint mechanism showed no disabling deterioration after months of continuous operation.

The objects and features of my invention will be more readily understood and appreciated from the following detailed description of a preferred embodiment thereof, selected for purposes of illustration and shown in the accompanying drawings in which:

Fig. 1 is a view in side elevation of a pumping unit provided with the joint mechanism of my invention,

Fig. 2 is a plan view, partly in section of the shaft and bushing used in the joint mechanism,

Fig. 3 is a corresponding end view,

Fig. 4 is a view partly in elevation and partly in section of the joint mechanism,

Fig. 5 is a view in rear elevation of the joint mechanism used between Samson post and walking beam, and

Fig. 6 is a view partly in elevation and partly in section of the joint mechanism incorporating an alternative bushing.

The general arrangement of the pumping unit shown in Fig. 1 is conventional and comprises a frame 10 of steel beams supported above the ground on any suitable foundation. Bolted to the frame 10 is a gear box 12 in which is journalled a driven shaft 13. The shaft 13 may be rotated from any convenient source of power. Welded to the right hand end of the frame is a pyramidal Samson post or frame 14 of steel or other suitable material serving as a fulcrum on which the walking beam 16 is arranged to rock.

The walking beam is pivotally secured to the top of the Samson post 14 through a connection 5 of the type shown in Fig. 2 or Fig. 6. One end of the walking beam 16 overhangs the ground and carries a conventional horse head 17 to which are secured cables 18 (one shown) by means of which the sucker rod is coupled to and suspended from the walking beam 16. Secured to the walking beam 16 at a point approximately above shaft 13 is the equalizer connection 20 to which is secured a pitman arm assembly 22 (only one arm of which is apparent in this drawing). The lower end of each pitman arm is pivotally connected by a wrist pin 25 to a crank arm 23 fast to the driven shaft 13 and they operate to impart oscillations of predetermined amplitude to the walking beam. Except for the pitman arm assembly and bushings the construction thus far described is all well known commercial equipment.

The joint mechanism as shown in Figs. 2 and 4 consists of a rigid, solid metal shaft or spindle 30 preferably steel, to which a series of rings or sleeves 31 of rubber or other resilient material is secured, as by vulcanizing or by compressing and holding under pressure. The means by which the sleeves are secured to the shaft are unimportant so long as the sleeves are held firmly and will not slip. Each sleeve 31 must be long enough to provide purchase for the clamps by which the bushing is secured to pitman arm cross-bar, Samson post and walking beam, the size being determined by such operating conditions as pumping

load and amount of torsional deflection required.

The shaft 30 need not be uniform in diameter but may be formed with a series of enlargements in its length each defined by tapering shoulders at both ends. Each of the rubber bushings or sleeves 31 encloses one of these enlargements in the shaft and has inwardly tapering shoulders at each end to fit those of the shaft enlargements.

Surrounding each rubber sleeve 31 is a shell 32 of a metal such as steel which is split on opposite sides to allow for compression of the elastic sleeves as the clamps are taken up. Although I prefer to use a concentric shell 32 it is not essential and this can be dispensed with, the clamps bearing directly on the surface of the rubber.

Between each sleeve a space 33 is left, to allow of independent motion for the sleeves without friction between its adjacent sides. It is important that each sleeve be free to twist independently of the other sleeves in order to reduce the amount of torsional deflection in any one section of the bushing. For instance, as the walking beam rocks and the pitman arms reciprocate in every cycle there is a total angular displacement of 20° to 33° in each direction. However, as the two end sleeves are clamped to the pitman arms assembly and the center sleeves are clamped to the walking beam the angular rotation twist of any sleeve will be only ½ of the total or 10° to 17°, thus greatly reducing fatigue in the rubber due to repeated flexing.

It is well known that for any given elastomer, increase in torsional deflection will greatly hasten deterioration and reduce flex life. Thus a resilient material subject to a torsional deflection of 20° may have only about $\frac{1}{7}$ the cycle life of one subject to a torsional deflection of 10°.

In securing the bushing within the joint mechanism of my invention I have found that best results are obtained and the life of the rubber greatly increased when the resilient sleeves 31 are pre-compressed under an initial pressure sufficient to maintain the sleeves on the off side of the load under compression rather than in tension and which will ordinarily be, depending upon the characteristics of the elastomer and load in the neighborhood of about 350 to 400 pounds p. s. i. Although in the practice of my invention I have applied this pressure by means of the clamps, there is no reason why this pre-compression should not be obtained by forcing the sleeves onto the shaft and into the shells under pressure sufficient to effect such pre-compression.

The pitman arms assembly shown in Fig. 4 consists of two opposed arms 40 spaced at the bottom a sufficient width to encompass the crank arms 23 on either side of the gear box 12 and inclined inwardly to provide a lesser space at the top. Welded across the tops of the pitman arms 40 is a beam 41 of a length sufficient to accommodate the connection. Holes are provided at either end and one each side of the beam in order that clamps 45 may be bolted to the beam. Rigidity and added strength may be obtained by means of a spacing bar between the arms (not shown).

Although for convenience I prefer to use the pitman arm assembly shown in Fig. 4, other types of construction may be used as well and with equal convenience. For instance, the top beam and spacing bar could be eliminated completely and each pitman arm secured at either end of the bushing. Nor is it essential that the pitman arms be inclined inwardly, as a bushing of greater length could be used to compensate for additional width between the pitman arms.

Referring again to Fig. 4 in assembling the joint mechanism of my invention circular clamps 45 of approximately the same width as each individual sleeve surround the sleeve and are drawn up to the pitman arm beam 41 and to the walking beam 16 by bolt and nut assembly 46. The space between the opposing sides of each clamp unit is such as to permit pre-compression of the resilient sleeves without interference between them. When the clamps 45 are so tightened the bushing is firmly secured against rotation within the clamps so that the only motion possible is through the elastomer itself.

Although as I have said I prefer to use the bushing construction shown in Fig. 2 it should be readily apparent that bushings of different construction wherein total torsional deflection is distributed through more than one rubber bushing may be used as well. For example, in the bushing shown in Fig. 2 the two center sleeves could be merged as one. Or the bushing could be constructed as shown in Fig. 6 where two concentric rubber sleeves 51 and 52 separated by concentric metal shell 53 would serve to divide the torsional twist between them. Sleeve 51 may be vulcanized to the shaft 50 as previously described and the outer sleeve 52 encompassed on its perimeter by a shell 54 likewise as previously described. A shaft 50 which extends beyond the ends of the rubber is clamped to the pitman arm beam 41 by means of bolt and clamp assembly 57 and 58. The clamp on the walking beam 16 is secured around the shell 54 by means of bolt and clamp assembly 55 and 56 under pressure.

It will clearly be seen that the elastomer bushing used in the joint between pitman arm and walking beam may be used to good advantage in the joint between the Samson post and walking beam and such use is within the contemplation of my invention.

Having thus disclosed my invention and described in detail illustrative embodiments thereof, I claim as new and desire to secure by Letters Patent:

1. In a pumping unit, a joint mechanism between an oscillating walking beam and pitman arms, consisting of a transverse shaft having a plurality of resilient sleeves spaced apart out of contact with one another and permanently secured at their inner surfaces thereto, half of said sleeves being clamped at their outer surfaces to the walking beam and the other half being clamped at their outer surfaces to the pitman arms, all of said sleeves being clamped under sufficient pressure to prevent slipping between the outer surfaces of the sleeves and the inner surfaces of the clamps and thus being subjected to a twist of only one-half the amplitude of the oscillations imparted to the walking beam.

2. In a pumping unit having a walking beam and pitman arms operating to impart oscillations of predetermined amplitude to the walking beam, an equalizing connection comprising a transverse shaft having a series of spaced four shouldered enlargements in its length, a sleeve of resilient material permanently secured at its inner surface to each enlargement of the shaft, the two outer sleeves being permanently secured at their outer surfaces to the pitman arms and the two inner sleeves being permanently secured at their outer surfaces to the walking beam, whereby each sleeve is subjected to a twist of only one-half the amplitude of the oscillation imparted to the walking beam by the pitman arms.

3. In a pumping unit having as principal elements a post, a walking beam supported thereon,

and pitman arms operating to impart oscillation of predetermined amplitude to the walking beam, an equalizing connection between the post and walking beam, and between the walking beam and pitman arms comprising in both cases a transverse shaft having a series of longitudinally spaced sleeves of resilient material all permanently secured at their inner surfaces to said shaft, one-half of said sleeves being permanently secured at their outer surfaces to one of said principal elements and the other half of said sleeves being permanently secured at their outer surfaces to another of said principal elements, whereby each sleeve is subjected to a twist of only one-half the amplitude of oscillation imparted to the walking beam.

4. In a pumping unit, an equalizer assembly for movably connecting pitman arms and a walking beam, comprising a shaft disposed transversely of the walking beam, a series of sleeves of resilient elastomer spaced longitudinally apart along and secured permanently at their inner surfaces to said shaft, metal shells surrounding the elastomer sleeves and secured permanently to the outer surface thereof, the metal shells of the outer sleeves being secured to pitman arms and the metal shells of the inner sleeves being secured to the walking beam, the spacing of the elastomer sleeves permitting free and independent torsional flexing of each sleeve without contact with adjacent sleeves and each sleeve being subjected to one-half only of the relative angular movement of the pitman arms and walking beam.

5. In a pumping unit, an equalizer assembly for movably connecting pitman arms and a walking beam, comprising a rigid shaft and a plurality of sleeves of resilient elastomer secured to the shaft and maintained under radial pressure, the outer sleeves of the series being connected to the pitman arms and the inner sleeves being secured to the walking beam thereby providing a shock absorbing connection in which the elastomer sleeves are subjected to torsional distortion to a degree only one-half the relative angular displacement of the walking beam and pitman arms.

6. A joint for connecting the walking beam to the pitman arms of a reciprocating pumping unit comprising a plurality of resilient elastomer sleeves, at least one of which is clamped to the walking beam and the others to the pitman arms, all of said sleeves being spaced apart along and permanently secured at their inner surfaces to a common metal shaft and being clamped about their peripheral surfaces under sufficient pressure to prevent slipping within the clamps, whereby rotation at the connection is permitted by torsion of said sleeves, each sleeve being thus subjected in operation to a twist less than the amplitude of total twist.

7. A joint for equalizing thrust from a pair of pitman arms oscillating the walking beam of a pumping unit in which pitman arms and walking beam are joined by means of a bushing consisting of a plurality of resilient elastomer sleeves spaced apart along and bonded around a common metal shaft, clamps for certain of said sleeves encircling their periphery and securing them to the driven end of the walking beam, similar clamps for other of the sleeves securing them to the pitman arms, all of said sleeves being under sufficient pressure to prevent slipping between the contacting surfaces of sleeves and clamps, whereby total torsion in operation is divided between the sleeves secured to the walking beam and those secured to the pitman arms.

8. The joint of claim 7 further characterized by the elastomer sleeves having bonded around their peripheral surfaces cylindrical metal half-shells which shells bear directly on the inner surfaces of the clamps.

9. A pumping unit: in combination a walking beam, Samson post and pair of pitman arms and and equalizing connection between walking beam and each pitman arm comprising a rigid metal shaft having bonded thereto a plurality of resilient elastomer sleeves spaced longitudinally out of contact with one another and held radially compressed, said sleeves being clamped to said walking beam and each pitman arm respectively and means to reciprocate said pitman arms.

10. The pumping unit of claim 9 further characterized in that the shaft has a section of reduced diameter between each pair of elastomer sleeves.

11. In a pumping unit, a walking beam mounted for oscillation, a pair of crank-operated pitman arms, and a connection between the walking beam and the pitman arms comprising a rigid shaft, longitudinally spaced sleeves of elastomer fast on the shaft, and clamps for securing at least one of the sleeves to the walking beam and the remaining sleeves to the pitman arms, whereby the total torsional deflection in operation is divided between the sleeve secured to the walking beam and those secured to the pitman arms.

12. In an oil pumping unit, a walking beam, pitman arms operable to impart oscillations of predetermined amplitude to the walking beam, a plurality of spaced torque-resisting elastomer sleeves, means operatively connecting one of said sleeves to said walking beam, means operatively connecting the other of said sleeves to said pitman arms, and means for mechanically interconnecting said aforementioned sleeves so that when torque is applied to said sleeves by said arms in oscillating said walking beam each sleeve is twisted less than the amplitude of oscillation of said walking beam.

13. A joint for connecting the walking beam to the pitman arms of a reciprocating pumping unit comprising a plurality of mechanically interconnected, spaced resilient elastomer sleeves, each of said sleeves being permanently secured at its inner surface to a metal shaft and having a clamp about its peripheral surface engaging the sleeve under sufficient pressure to prevent rotation of the sleeve within the clamp, at least one of said sleeves being secured to the walking beam and at least another to the pitman arms, whereby rotation in the joint is permitted by torsion of said sleeves, each sleeve being thus subjected in operation to a twist less than the amplitude of a total twist.

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