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WALKING BEAM STRUCTURE

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2 Sheets-Sheet 1

FIG. 1.

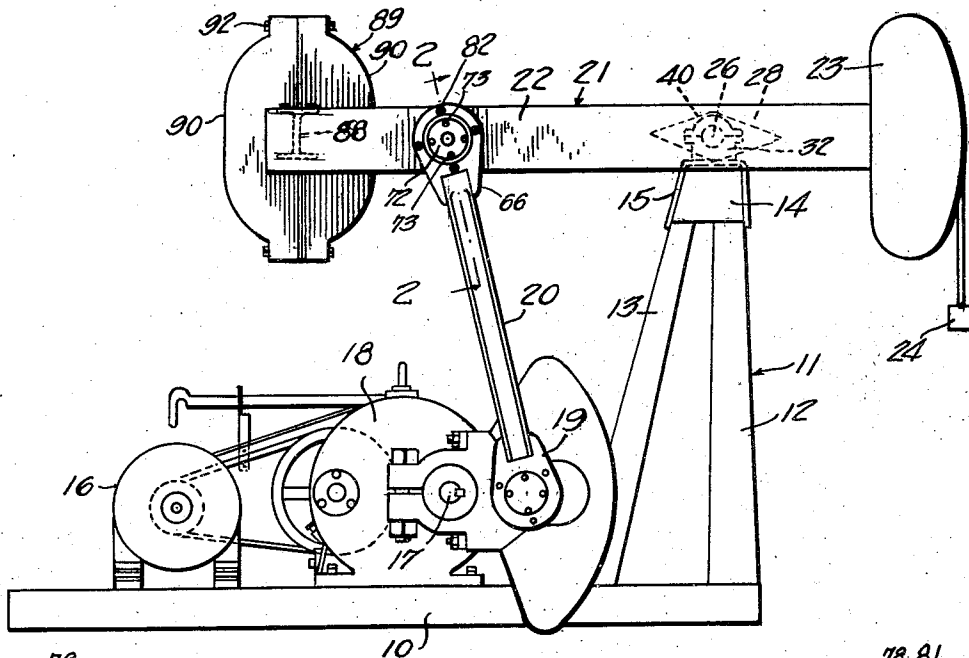
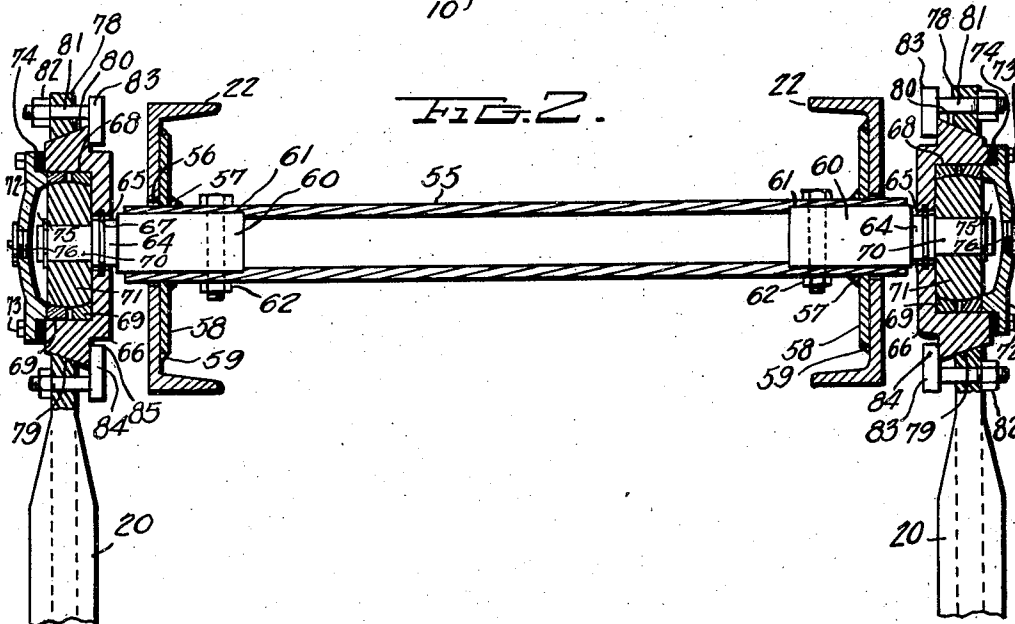


FIG. 2.



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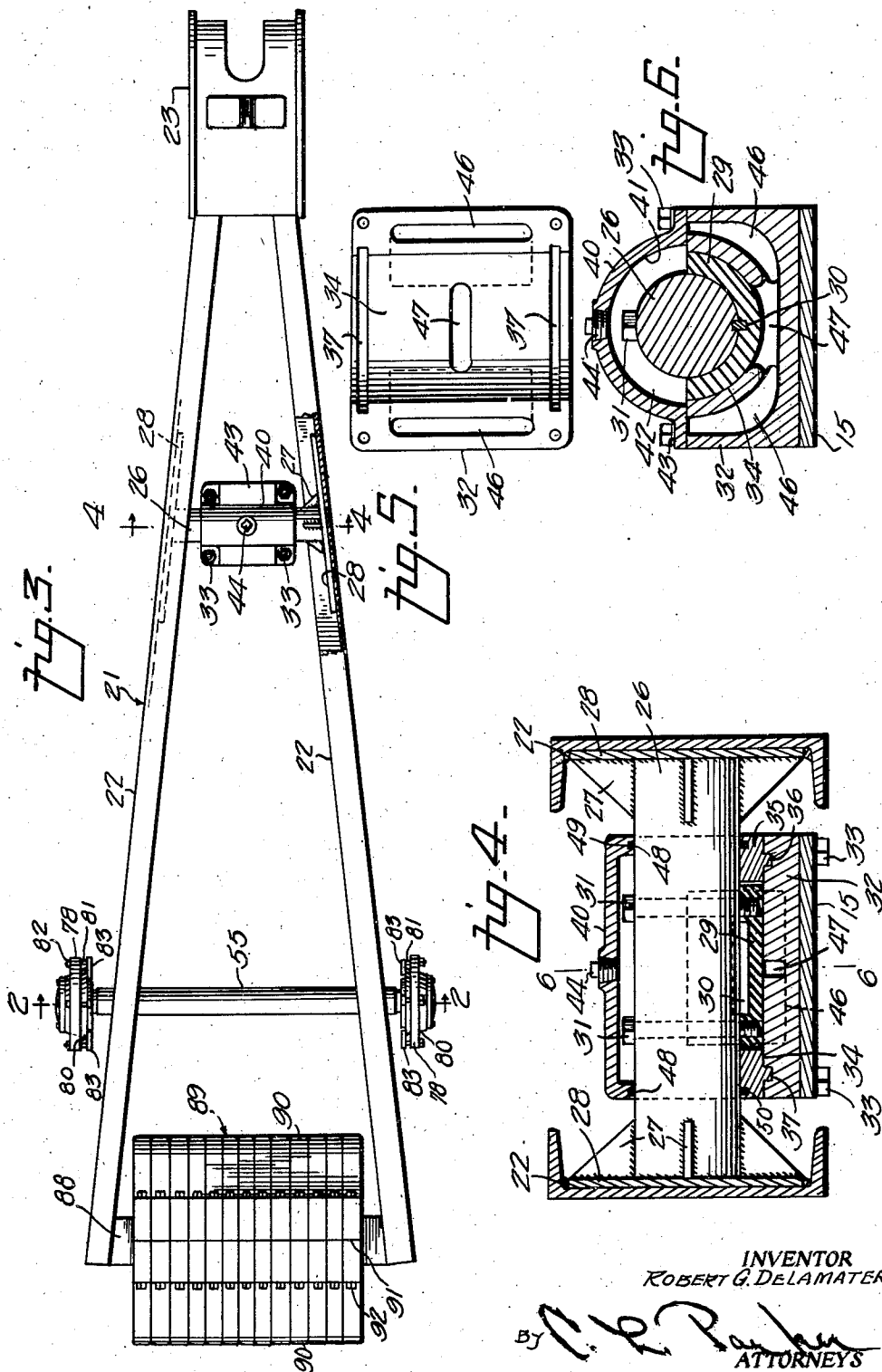
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2 Sheets-Sheet 2



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WALKING BEAM STRUCTURE

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10 Claims. (Cl. 74-41)

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This invention relates to walking beam structures, and more particularly to a walking beam for oil well pumping units.

In oil well pumping units it is the common practice to make a walking beam of a single rolled beam section with a compensator or other means at the front end to obtain a relatively straight line motion of the pump rod. A Samson post is located intermediate the ends of the beam and is provided with a rocker bearing in which is arranged a trunnion connected to the walking beam. At the back or tail end of the beam is mounted the upper pitman assembly through which the walking beam is rocked, such assembly usually including a horizontal cross beam with pitman stems extending downwardly from the beam to the wrist pin bearings to which they are connected.

It is desirable in an apparatus of this character to employ a construction generally referred to as a "three point in line beam," i. e., a beam arrangement wherein the center lines of the upper pitman bearing and the Samson post bearing and the center line of travel over the compensator at the front of the beam are all in the same horizontal plane when the walking beam is horizontal. This is the ideal arrangement but its use is not always practicable without incurring excessive expense in manufacture, and the fabricating problems are often such as to render the selling price of the unit excessive.

The advantages of the "three point in line beam" are well known in the art. With any other arrangement, a different pumping motion will be obtained, depending upon whether the crank shaft is rotated clockwise or counterclockwise; i. e., greater angular rotation of the crank shaft will be required on the upstroke than on the downstroke, or vice versa, and the acceleration and deceleration at the top and bottom of each stroke will differ. With a "three point in line beam" and with the center line of the crank shaft directly below the upper pitman bearing when the walking beam is horizontal, the unit can be operated in either direction without changing the character of the pumping stroke.

With the ideal arrangement referred to, it is the practice in some cases to arrange the Samson post bearing so that its axis passes through the center line of the beam, in which case it is necessary to provide space between the legs of the Samson post and to support separate bearings on each side of the beam for clearance with the walking beam, or to shorten the Samson post and use a bearing at each side of the beam with

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the boxes of the bearings extending at a considerable distance above their bases to secure the same clearance. Neither arrangement adds to the stability and rigidity of the assembly, although such location of the Samson post bearing axis is theoretically highly desirable.

Moreover, the capacity of a walking beam of conventional I-beam or wide flanged rolled sections is definitely limited by the ratio of the unsupported length of the beam to the width of compression flange thereof, and with a single rolled section for a walking beam there is no possible way of reducing the unsupported length of the beam between working centers. It is also impossible to obtain rolled beam sections without the usual rolling tolerances for out-of-squareness or parallelism of the flanges and without camber or out-of-straightness in their lengths. Consequently, in the fabricating of a conventional walking beam it is necessary in the fitting up of the bearings to compensate for these conditions. For example, where the Samson post bearing is bolted to the bottom flange of the beam it is necessary to provide some self-aligning feature in the pitman assembly and also to fabricate the nose and make necessary adjustments in the fabrication so that the pump rod hanger will travel in a plane at right angles to the Samson post bearing. Even with the most careful fabrication, further distortion sometimes occurs in the beam after a unit is put into operation. Consequently, it is not unusual for the tail end of a walking beam to travel up and down in a slightly elliptical or figure 8 path, instead of in a vertical line. The same thing is true of the nose or front end of the beam.

In machining the keyways in crank shafts of pumping units and in the cranks a manufacturing tolerance must be allowed, and accordingly one crank usually leads the other to a slight extent. Consequently, particularly at the mid-position of the stroke, one wrist pin usually is slightly higher than the other, thus requiring the use of compensating means to avoid the imposing of stresses in the pitman assembly.

As is well known it is the conventional practice to counterweight the walking beams of oil well pumping units and such counterweights usually are arranged adjacent each other along the walking beam. Such counterweights are at varying distances from the axis of the Samson post bearing and are consequently not uniformly effective. When adding beam weights to such a walking beam it is necessary to refer to a table or to know the proper ratios with respect to beam

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lengths so that the effective counterbalancing of the walking beam can be provided.

An important object of the present invention is to provide a novel walking beam construction which departs substantially from conventional practice, the beam structure being such as to facilitate a "three point in line" arrangement.

A further object is to provide a walking beam formed of two structural members diverging from the nose end of the beam and effectively laterally braced to each other, thus greatly improving the general performance characteristics of the beam over a conventional single I-beam or H-beam arrangement, the present invention providing for a walking beam of greater capacity and rigidity with the same weight of steel.

A further object is to provide such an improved walking beam wherein the loads are equally and uniformly transmitted to the two beam members without imposing any concentrated stresses.

A further object is to provide a walking beam of the character referred to which possesses such characteristics as to make it possible, in fabricating the structure, to adjust for any camber or out-of-squareness of the two beam members, and also to make all necessary provisions to obtain true alignment of the three working points of the beam.

A further object is to provide novel arrangement wherein the use of self-aligning bearings at the upper ends of the pitman stems provides for a greater degree of self-alignment than is possible with conventional arrangements.

A further object is to provide a beam structure of the general character referred to wherein all of the counterweights employed which are of the same size provide the identical amount of effective counterbalance weight.

Other objects and advantages of the invention will become apparent from the course of the following description.

In the drawings I have shown one embodiment of the invention. In this showing—

Figure 1 is a side elevation of a pumping unit showing a walking beam constructed in accordance with the present invention,

Figure 2 is an enlarged fragmentary transverse sectional view on line 2—2 of Figure 1,

Figure 3 is a plan view of the walking beam and associated elements, parts being broken away,

Figure 4 is a transverse sectional view on line 4—4 of Figure 3,

Figure 5 is a plan view of the Samson post bearing saddle, and

Figure 6 is a transverse sectional view on line 6—6 of Figure 4.

Referring to Figure 1, the numeral 10 designates the base of a pumping unit at one end of which is arranged an upstanding Samson post indicated as a whole by the numeral 11 and comprising opposite vertical legs 12 and opposite inclined legs 13 converging toward the legs 12 and fixed at their upper ends by welded or similarly attached plates 14. A cap plate 15 is arranged over the top of the Samson post and extends downwardly along the sides thereof and is welded or otherwise secured to the plates 14 and to the legs 12 and 13. The base 10 is provided with a prime mover 16 driving conventional cranks 17 through any suitable type of reduction gearing 18, the free ends of the cranks being connected to the bearings 19 at the lower ends of pitman stems 20.

The walking beam forming the subject matter of the present invention is indicated as a whole

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by the numeral 21 and comprises opposite beam sections 22 preferably of rolled channel section as shown in Figures 2 and 4. The beam sections 22 converge toward the front or nose end of the beam and are rigidly fixed with respect to each other by the attachment thereto of any suitable type of compensator 23 for providing a straight line vertical motion of a rod hanger 24.

The means for mounting the walking beam with respect to the Samson post is shown in Figures 1, 3, 4 and 6, most of the details of such mounting being shown in Figure 4. Referring to such figure, a horizontal relatively heavy shaft 26 is provided at each end with web plates 27 welded thereto, and these plates and the ends of the shaft 26 are welded in turn to preferably diamond-shaped plates 28. In the fabricating of the beam, the edges of each plate 28, the preferably diamond-shape of which is shown in dotted lines in Figure 1, are welded along spaced lines following the profile of each plate 28, the welding preferably being discontinuous to avoid any possible weakening of the channel sections 22. Centrally of its length, the shaft 26 fits within a half-bushing 29 and is keyed thereto as at 30, bolts 31 extending through the shaft 26 to secure it to the half-bushing 29. It will become apparent that the member 29 rocks with the shaft 26. The half-bushing 29 rocks in a bearing saddle 32 mounted on the cap plate 15 and secured thereto by bolts 33 (Figures 3 and 6). The bearing saddle 32 has an inner semi-cylindrical bearing surface 34 engaged by the half-bushing 29 and the latter terminates at points spaced from the longitudinal ends of the bearing surface 34 as shown in Figure 4. The spaces at the ends of the half-bushing 29 are filled by semi-cylindrical filling and sealing elements 35 each of which is provided with a peripheral flange 36 seating in a corresponding groove 37 formed in the saddle 32 (Figure 4).

A bearing cap 40 is arranged over the shaft and is substantially semi-cylindrical in shape with its inner surface 41 of greater radius than the outer surface of the half-bushing 29 to provide a semi-cylindrical space 42 (Figure 6) in which the ends of the half-bushing 29 are free to rock during the rocking of the beam structure. The cap 40 is flanged as at 43 and the bolts 33 pass through these flanges. A removable plug 44 is carried by the cap 40 for the introduction of lubricant into the space 42.

The saddle 32 is formed with cored-out lubricant reservoirs 46 (Figure 6) and the saddle 32 is grooved as at 47 to connect the reservoirs 46 to each other and open them to access to the outer or bottom surface of the half-bushing 29. When the apparatus is assembled, the reservoirs 46 are filled with lubricant before the cap 40 is placed in position. To prevent the loss of lubricant endwise of the shaft 26, a sealing ring 48 surrounds the shaft and is arranged in complementary grooves 49 and 50 formed in the cap 40 and in the sealing members 35 respectively.

The structure shown in Figures 3 and 4 greatly assists in the proper fabrication of the walking beam and increases the efficiency of the operation and maintenance of the apparatus. It will be noted that the relatively heavy shaft, with the bracing plates 27 and attaching plate 28, serves to form a rigid connection between the beam sections 22, thus greatly increasing the stability of the walking beam. Moreover, in the fabrication of these elements, any out-of-trueness of the beam elements 22 in themselves and

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with respect to each other can be wholly or almost wholly corrected. Inasmuch as all of the forces on the beam at the Samson post are downward, only a half bushing 29 and its bearing surface 34 need be employed, and the bearing surfaces between these elements are adequately lubricated. It also will be noted that the construction shown provides for the placing of the rocking axis intermediate the depth of the walking beam, as is desirable, without the necessity for straddling the beam in some manner as in prior constructions, as referred to above.

A highly advantageous method of connecting the beam sections and transmitting pitman forces to the beam is shown in Figures 2 and 3. At a point spaced from the rear end of the beam (Figure 3) a relatively heavy steel tube 55 extends transversely across the beam and through openings 56 formed in the respective beam sections 22. This tube is welded as at 57 to an attaching plate 58 which, in turn, is welded as at 59 to the web of each beam section 22. These parts may be fabricated for the rigid connection and truing of the beam sections 22 at the points where the tube 55 passes therethrough prior to the placing of a shaft 60 in each end of the tube. The ends of the tube are drilled out as at 61 for the press fitting of the shafts 60 and the latter are positively secured in the tube 55 by bolts 62.

Each shaft 60 has self-aligning motion-transmitting connection with one of the pitman stems 20 and since these connections are identical, only one need be described. Referring to Figure 2, it will be noted that each shaft 60 is reduced as at 64 to pass freely through a somewhat larger opening 65 formed in a housing 66 and a sealing ring 67 prevents the escape of lubricant past the shaft section 64. Within the housing 66 is formed a cylindrical recess 68 and complementary sections 69 form a spherical bearing which is arranged in the recess 65. The complementary sections 69 are normally spaced from each other for a purpose to be described. Beyond the section 64, the shaft 60 is further reduced in size as at 70 and such reduced shaft section carries a bearing member 71 formed as a section of a sphere and mounted in the complementary bearing sections 69 to rotate and rock therein.

A cap 72 is secured to the housing 66 by bolts 73 and interposed shims 74 limit the inward movement of the cap 72 upon the tightening of the bolts 73. As the bearing surfaces of the elements 69 and 71 become worn, one or more shims 74 may be removed, whereupon the replacing of the cap 72 and the tightening of the nuts 73 will move the outer complementary member 69 toward the other such member to take up play between the parts. The cap 72 is bowed out to provide a lubricant space 75 and a removable plug 76 provides access to the space 75 for the introduction of lubricant therinto.

The upper end of the associated pitman stem 26 carries a ring 78 having a conical inner surface 79 fitting the corresponding radially outer surface 80 of the housing 66. A plurality of bolts is employed for tightening the ring 78 on the surface 80. Each bolt is indicated by the numeral 81 and is provided with a conventional nut 82 and with a head 83, one end of which projects radially inwardly as at 84 to engage the surface 85 of the housing 66 whereby the nuts 82 may be tightened. Obviously, the loosening of the nuts 82 and the swinging of the heads 83 permits the ring 78 to be detached from the housing 66 when desired, and the cap 72 may be removed for any

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purpose without disturbing the connection of the ring 78 to the housing 66.

As previously stated, it is the common practice to arrange counterweights along a walking beam, and each such counterweight is a different distance from the rocking center and accordingly of different effectiveness. In the present case, the rear ends of the beam sections 22 are rigidly connected by a cross member 88 which serves not only as a rigid connection between the beam members and to true these members when the elements are fabricated, but also as a support for a plurality of counterweights 89. Each counterweight is preferably formed of complementary sections 90 divided centrally as at 91, the sections of each counterweight being secured together by any suitable means, as by bolts 92. In practice, the counterweights are specifically designed to facilitate their connection to the cross member 88, but the particular form of the counterweights is of no importance per se in connection with the present invention.

The operation of the walking beam structure will be largely apparent as a result of the foregoing description. Instead of using a single rolled structural beam for the walking beam, two lighter structural members are employed, these members preferably but not necessarily being of channelled cross section. The beam structure is generally triangular in shape, the beam elements 22 converging toward the nose end of the beam to permit the efficient mounting of the pump rod hanger. The beam elements 22 are sufficiently spread at the Samson post to permit the bearing of the latter to be placed between the beam sections. The spread at the plane of connection of the pitman assemblies is substantially greater, being sufficient so that the pitman stems may extend directly downwardly to the wrist pins at their conventional positions while still transmitting forces to the walking beam at points in proximity to the respective beam sections 22.

The arrangement of parts is further advantageous in that the counterweights are mounted on a cross member which acts as a tie between the beam sections 22 at the rear end thereof. With this arrangement, each set of beam weights of the same size provides the same amount of effective counterbalance weight, as distinguished from the prior arrangement referred to.

The present construction also facilitates the "three point in line" arrangement, the axis of the shafts 60, the axis of the shaft 26 and the point of hanging of the well rod weights being in a common plane when the beam is horizontal and the center line of the crank shaft 17 (Figure 1) being directly below the axis of the shafts 60. Accordingly the unit can be operated with equal effectiveness in either direction of rotation of the crank shaft 17.

The two structural members forming the principal elements of the beam, namely the members 22, are laterally braced at the nose, at the Samson post, at the upper pitman assembly, and at the rear end of the beam by the member 88. As a consequence, length/flare width ratio is materially improved over that obtained by means of a single I-beam or H-beam arrangement and greater capacity and rigidity can be obtained with the same weight of steel.

The trunnion for the Samson post bearing and the pitman assembly are so designed and welded into the complete beam assembly that the loads are very equally and evenly distributed to the two beam members without the imposing of

any concentrated stresses. From the Samson post trunnion 26 and the pitman trunnions 60, the uniform distribution of forces to the beam sections 22 is assisted by the use of the plates 28 and 58 welded to the beam sections. The welding of the parts in the manner described makes it possible to adjust for any camber or out-of-squareness of the rolled channel sections and also makes it possible to obtain true alignment of the three working points of the beam.

The construction described adds greatly to the lateral stiffness of the beam assembly and substantially eliminates weaving during operation. With the present arrangement the necessity for a complete self-aligning arrangement of the pitman assemblies is somewhat alleviated, it being unnecessary to employ the usual cross member to which the upper pitman assemblies are connected and mounted to rock on an axis coincident with or parallel to the plane of the walking beam.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same and that various changes in the shape, size and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

I claim:

1. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced substantially throughout their lengths and fixed with respect to each other at the well end of the beam, and rigid means fixed to said structural members at a point substantially spaced from the well end of the beam, said rigid means being arranged within the space between said structural members and projecting there-through for connection with pitman means, and a trunnion arranged in the space between said structural members and rigidly connected at its ends thereto between said rigid means and the well end of the beam to form a part of a rocking support for the beam.

2. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced substantially throughout their lengths and fixed with respect to each other at the well end of the beam, and rigid means fixed to said structural members at a point substantially spaced from the well end of the beam, said rigid means being arranged within the space between said structural members and projecting therethrough, and a trunnion arranged in the space between said structural members and rigidly connected at its ends thereto between said rigid means and the well end of the beam, a Samson post bearing receiving said trunnion to support the beam for rocking action, and self-aligning bearing means having connection with the projecting portions of said rigid means and through which power is transmitted to the beam to rock it on the axis of said trunnion.

3. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced substantially throughout their lengths and fixed with respect to each other at the well end of the beam, and rigid means fixed to said structural members at a point substantially spaced from the well end of the beam, said rigid means being arranged within the space between said structural members and projecting therethrough, and a trunnion arranged in the space between said structural members and rigidly connected at its ends thereto between said rigid means and the well end of the beam, a Samson post bearing re-

ceiving said trunnion to support the beam for rocking action, a spherical element fixed to said rigid means outwardly of each side of the beam, and a spherical socket receiving each spherical element for transmitting power therethrough to the beam to effect a rocking movement thereof.

4. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other at the well end of the beam, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam at a point spaced from the well end of the beam and arranged between said structural members, and plates rigidly fixed to the ends of said trunnions, said plates lying against the webs of the respective structural members and fixed thereto, said trunnion forming a part of the means for supporting the beam for rocking movement.

5. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other at the well end of the beam, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam at a point spaced from the well end of the beam and arranged between said structural members, plates rigidly fixed to the ends of said trunnions, said plates lying against the webs of the respective structural members and fixed thereto, said trunnion forming a part of the means for supporting the beam for rocking movement, and rigid means arranged in the space between and rigidly fixed to said structural members at a point spaced longitudinally along the beam from said trunnion, said rigid means having portions projecting through said structural members and extending outwardly beyond opposite sides of the beam for connection with pitman means.

6. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam and arranged between said structural members, plates rigidly fixed to the ends of said trunnions, said plates lying against the webs of the respective structural members and fixed thereto, a bushing member carried by said trunnion, and a bearing in which said bushing member is adapted to rock, said bearing having a lubricant cavity therein extending through the bearing face of said bearing to supply lubricant to said bushing member.

7. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam and arranged between said structural members, plates rigidly fixed to the ends of said trunnions, said plates lying against the webs of the respective structural members and fixed thereto, a half-bushing fixed against the bottom of said trunnion, a bearing member having a semi-cylindrical bearing face rockably supporting said half-bushing, said bearing terminating approximately in the horizontal plane of the axis of said bushing when

the beam is horizontal and having a lubricant cavity opening through the top face of the bearing member radially outwardly of said half-bushing and having an opening through said semi-cylindrical face to supply lubricant to said half-bushing, and a cap for said bearing having a portion normally closing the open top of said cavity and having an inner face concentric with and at least as large in diameter as the radially outer face of said half-bushing to provide a space in which the edge portions of the latter are adapted to swing.

8. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other at the well end of the beam, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam at a point spaced from the well end of the beam and arranged wholly between said members, attaching plates rigidly fixed to the ends of said trunnions, each plate being parallel to and lying against the adjacent portion of the web of the adjacent structural member and secured thereto, and web plates fixed to said trunnion adjacent each end thereof and to the adjacent attaching plate to brace the latter and the associated structural member relative to said trunnion, said trunnion forming a part of the means for supporting the beam for rocking movement.

9. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam and arranged wholly between said members, attaching plates rigidly fixed to the ends of said trunnions, each plate

being parallel to and lying against the adjacent portion of the web of the adjacent structural member and secured thereto, web plates fixed to said trunnion adjacent each end thereof and to the adjacent attaching plate to brace the latter and the associated structural member relative to said trunnion, said trunnion being arranged approximately midway of the height of the beam, a bushing fixed against the bottom of said trunnion, and a bearing receiving said bushing to support the beam for rocking movement.

10. A walking beam for oil well pumping rigs and the like comprising a pair of structural members spaced from each other substantially throughout their lengths and fixed with respect to each other at the well end of the beam, each member comprising a vertical web, a trunnion arranged perpendicular to the horizontal axis of the beam at a point spaced from the well end of the beam and arranged wholly between said members, attaching plates rigidly fixed to the ends of said trunnions, each plate being parallel to and lying against the adjacent portion of the web of the adjacent structural member and secured thereto, web plates fixed to said trunnion adjacent each end thereof and to the adjacent attaching plate to brace the latter and the associated structural member relative to said trunnion, said trunnion forming a part of the means for supporting the beam for rocking movement, a rigid member arranged wholly within the vertical limits of said structural members at a point spaced longitudinally along the beam from said trunnion, said rigid member extending through and beyond both structural members, an attaching plate fixed against the inner web of each structural member and surrounding said rigid member and secured thereto, and means for transmitting forces to the projecting portions of said rigid member to rock the beam.

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