W. H. WATKINS.

JIB CRANE AND THE LIKE.

APPLICATION FILED JUNE 14, 1922.

1,434,076.

Patented Oct. 31, 1922.

4 SHEETS—SHEET 1.

Fig. 1.

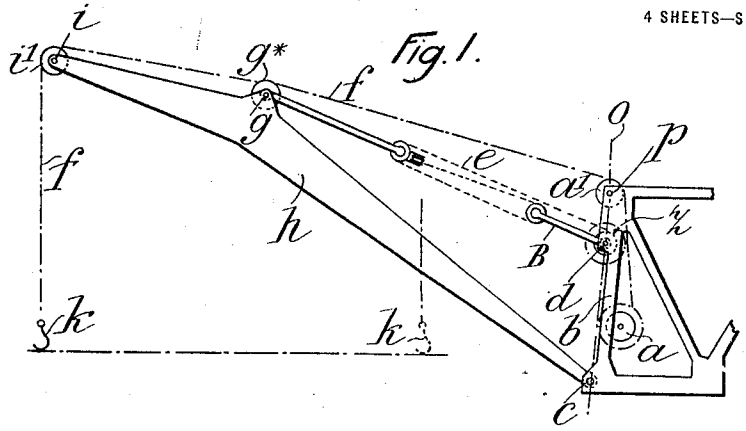


Fig. 2.

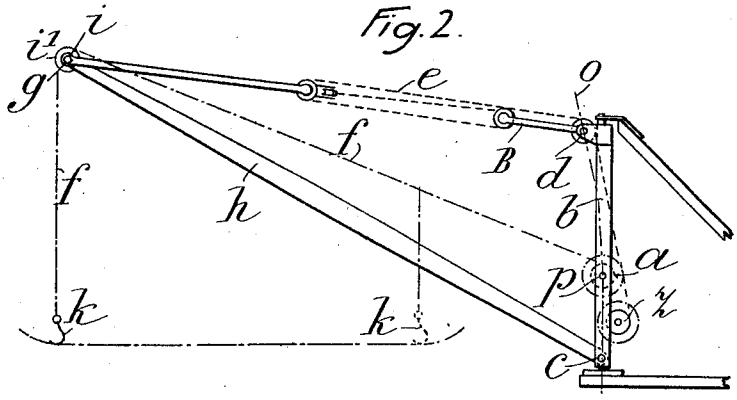
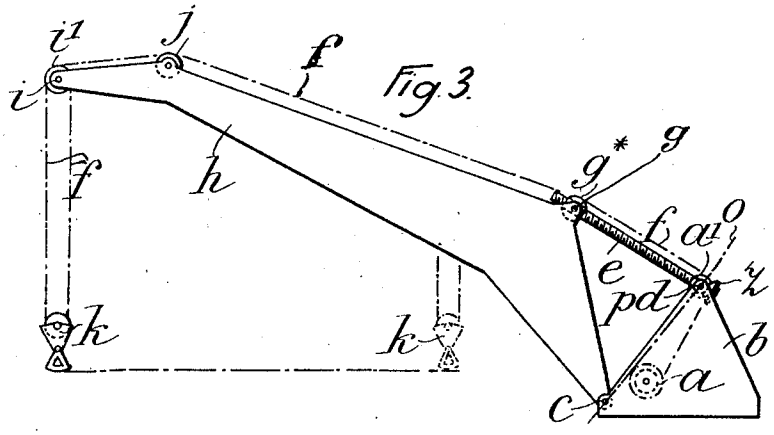


Fig. 3.



Inventor.

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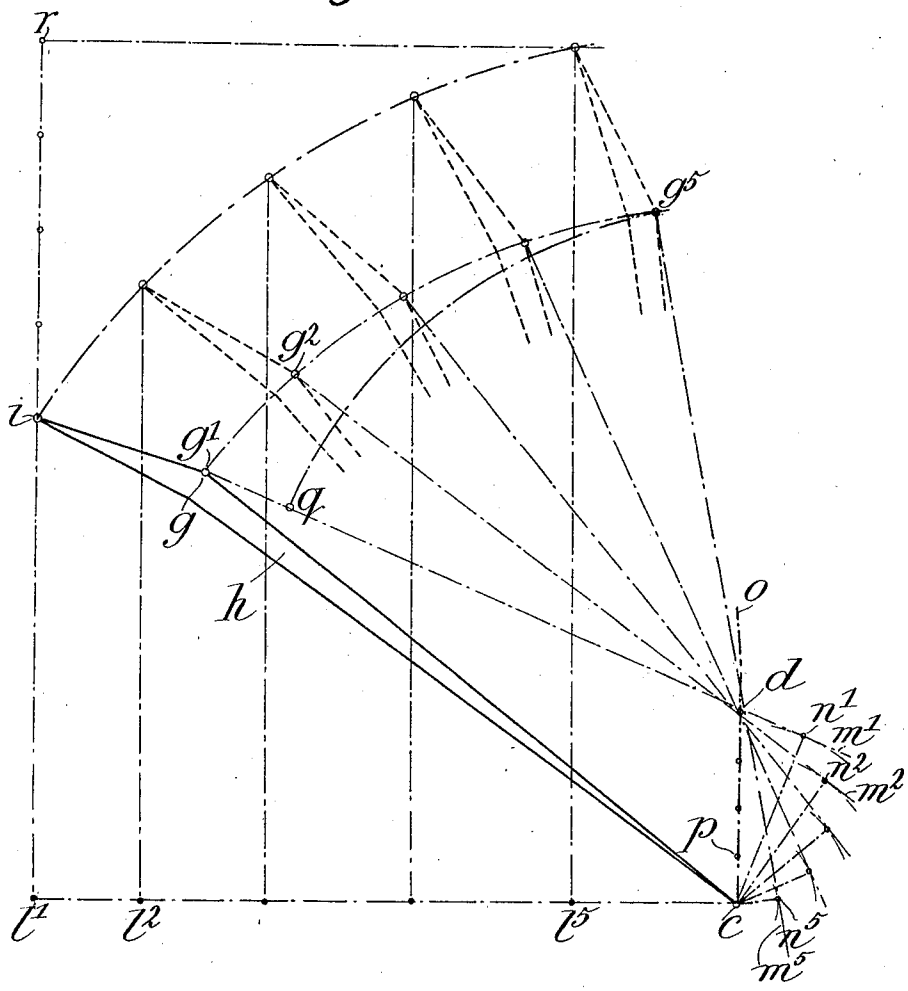
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4 SHEETS—SHEET 2.

Fig. 4.



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4 SHEETS—SHEET 3.

Fig. 5.

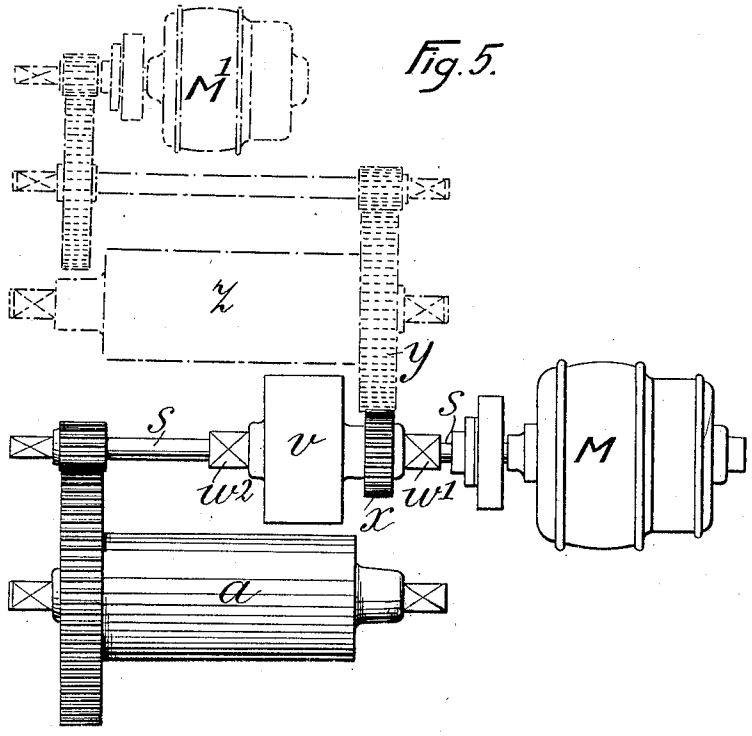


Fig. 6.

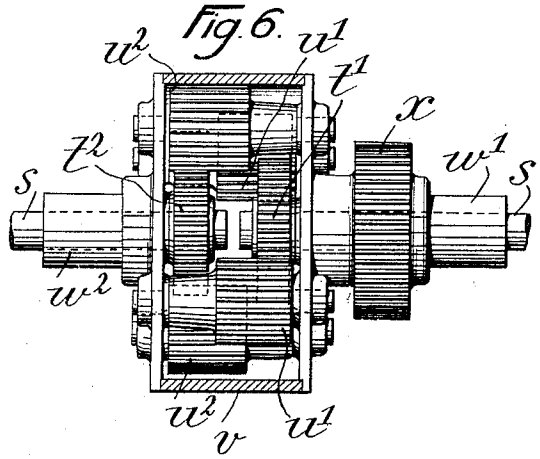
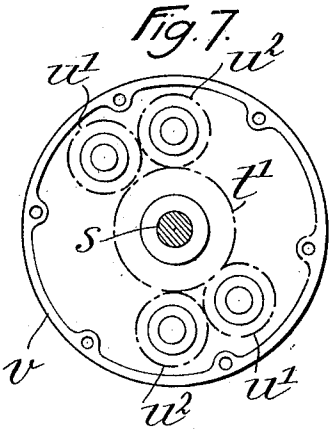


Fig. 7.



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4 SHEETS—SHEET 4.

Fig. 8.

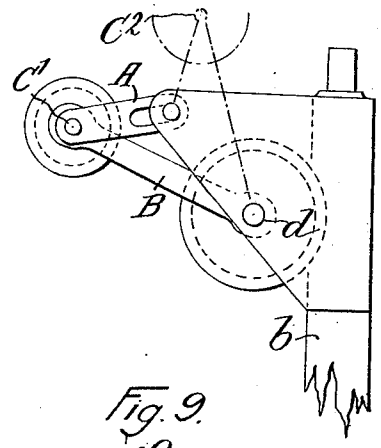


Fig. 9.

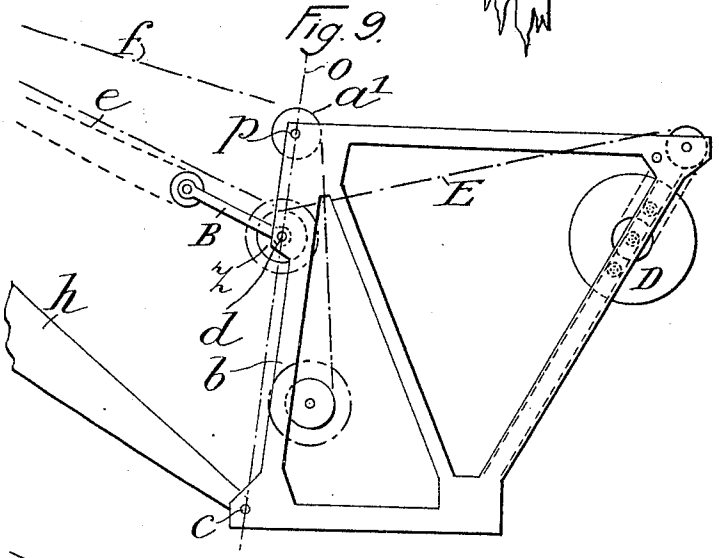
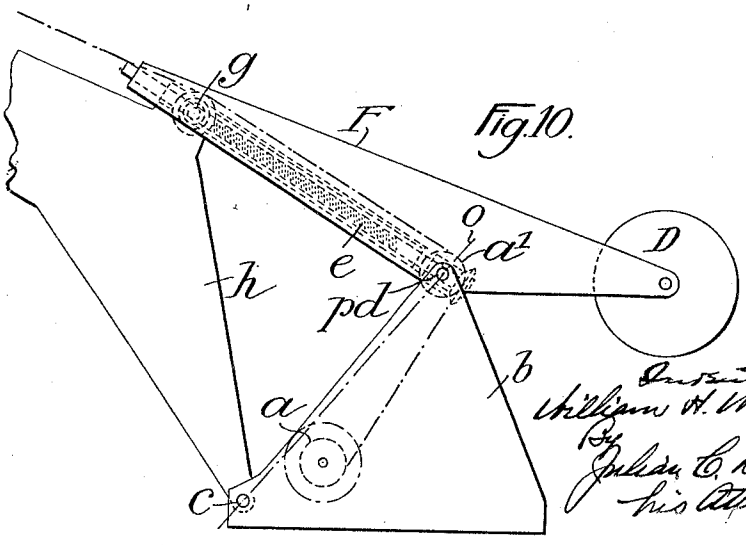


Fig. 10.



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Patented Oct. 31, 1922. 1,434,076

UNITED STATES PATENT OFFICE.

WILLIAM HUGH WATKINS, OF LONDON, ENGLAND.

JIB CRANE AND THE LIKE.

Application filed June 14, 1922. Serial No. 568,246.

To all whom it may concern:

Be it known that I, WILLIAM HUGH WATKINS, a subject of the King of Great Britain and Ireland, residing at London, England, have invented Improvements in or Relating to Jib Cranes and the like (for which I have filed application for patent in Great Britain, Patent No. 179,635 complete accepted May 8, 1922), of which the following is a specification.

This invention relates to that class of compensated load path jib crane in which the outreach of the load suspension means is varied by adjusting the length of a direct jib-tie system, that is to say, a jib tie directly connected to the jib and to the crane frame, compensation for the raising or lowering of the jib-head, when luffing, being effected by the hoisting barrel paying out or winding in the requisite amount of load-rope, and it consists in improved constructions and arrangement of parts which permit of a less restricted choice and a more economical arrangement of the crane elements than hitherto.

In carrying out the invention, the centre of the hoisting drum for the load rope or chain, or of a guiding element or pulley over which the rope or chain passes to the hoisting drum, is arranged in any convenient position along a line that passes through the centre of the jib foot pivot and the centre of rotation of the jib-tie in the crane frame, the line being determined in a manner such as hereinafter described. This line, as will hereinafter appear, is substantially a straight line passing through the center of the jib foot pivot and the centre of rotation of the jib tie in the crane frame. By thus arbitrarily locating the centre of the hoisting drum, or the guiding pulley, as the case may be, it is possible for the jib-tie and the load rope or chain (hereinafter called for brevity the load rope) to proceed either from the jib-head pulley centre to separated points on the determined line, or from a common centre lying between the jib-head pulley centre and the jib-foot pivot, either to separated points on the said line, or to a coincident point on the the said line.

I am however aware that it has been previously proposed in a jib crane of the class above referred to to lead the load rope from the jib-head pulley to a hoisting drum over a stationary guide pulley the centre of which is located at a point in the crane-frame, the position of the centre of the guide pulley being always coincident with the centre of rotation of the jib-tie, and the position of the jib-tie connection with the jib being coincident with the centre of the jib-head pulley. In my arrangement however restriction in the position of the centre of the guide pulley and the position of the jib-tie connection to the jib, is no longer necessary.

According to the present invention, any usual form of pivoted jib, whether bent or otherwise, may be employed, together with, as means for its sustainment and for varying its outreach, the usual lengthwise adjustable means directly connecting the jib to the crane-frame; for example, a jib-tie incorporating pulley tackle comprising a rope or chain reeved around pulleys, a screw-and-nut arrangement or other length adjustment means.

With a view to eliminate the use of clutch gear, which has been usual in known jib cranes of the above class for co-operation with the hoisting and luffing barrels, and to permit of concomitant action of the hoisting and luffing mechanism, the hoisting mechanism according to the present invention essentially includes a device, such as, for instance, a "differential gear." In any case, one element of the said device is at all times mechanically connected to the adjustable jib-tie, or to the mechanism associated therewith, the arrangement being such that when luffing, the amount of shortening or lengthening of the adjustable jib-tie system, and the amount of rope respectively paid out or hauled in by the hoisting barrel, are substantially in a constant ratio. For single rope load suspension from the jib head this ratio is made substantially to equal the ratio of the vertical component of the displacement of the load suspension means to the change in length of the jib-tie, assuming the hoisting barrel to be at rest.

With the foregoing conditions satisfied, the load suspension means can be caused to move in a substantial horizontal path, when luffing.

Any desired path of the load-hook, is however obtainable, at will, whilst special paths can be obtained automatically by the provision of simple devices. The invention is equally applicable to multiple rope load-suspension from the jib-head.

Balancing of the jib can be effected by a

counterpoise suspended for example by a tail rope leading from the luffing or outreach varying barrel, or rigidly attached to a lever system connected to, and actuated by, the jib.

The invention will now be further described with reference to the accompanying drawings, in which

Figs. 1, 2 and 3 show in side elevation and diagrammatically, alternative arrangements of crane elements.

Fig. 4 is a diagram showing the general method adopted to obtain proportional displacements of the crane elements.

Fig. 5 shows in side elevation, a preferred arrangement of hoisting mechanism connected to gearing for association with a direct jib-tie, Fig. 6 shows partly in central section and partly in side elevation and Fig. 7 in end view, differential gearing forming part of such mechanism:

Fig. 8 shows in side elevation, a device for modifying the load path.

Figs. 9 and 10 show in side elevation and diagrammatically, alternative jib counterbalancing systems.

Referring to these drawings, in which like letters of reference indicate corresponding parts in the several figures, and considering first the Figures 1, 2 and 3, the centre of the hoisting barrel a, or alternatively of a rope guide pulley a^1, at the crane-frame b, is located at any convenient position on or near a line (hereinafter described with reference to Fig. 4) which proceeds from the pivot c of the jib-foot and passes through the centre of rotation d of the lengthwise adjustable jib-tie e.

The load-rope f is led from the said barrel a, to a guide pulley i^1 at the jib-head centre i (Fig. 2) or, alternatively, it is led from the barrel a over the guide pulley a^1 (Fig. 1), to a pulley g^* centered at the jib-tie fastening g (which is located at any convenient point in the jib structure h) and thence proceeds to the pulley i^1 at the jib-head centre i, or, is intermediately guided thereto, as for instance by a pulley j (see Fig. 3).

From the pulley i^1 at the jib-head centre i, see also Fig. 2 (wherein the jib-tie fastening g and the centre of the said pulley i^1 at the jib-head are coincident), the load-rope f depends direct to the load-hook k, (Figs. 1 and 2), or equivalent load suspension means, or is suitably reeved thereto as in Fig. 3.

In order to impart to the jib-tie e and the load-hook k, displacements which shall substantially be in a constant ratio throughout the desired range of luffing, so that the load-hook shall move in the desired horizontal path by reason of the hoisting mechanism being mechanically connected to the jib-tie system, the centre of rotation d of the jib-tie e, and the centre of the hoisting barrel a, or alternatively of the guide pulley a^1 (Fig. 1) are respectively located by the following general method, reference being had to Fig. 4.

The jib-head centre i and the jib-tie fastening g are plotted for as many positions of the jib h, between the maximum and minimum outreaches l^1 and l^5 inclusive, as may be desired.

For the position corresponding to the maximum outreach l^1 of the jib, a line $g^1 m^1$ is drawn from g^1 at an angle convenient for the direction of the jib-tie system e (see Figs. 1, 2 and 3), and from the said line $g^1 m^1$ and at right angles thereto, a line $n^1 c$ is drawn passing through to the center of the jib-foot pivot c.

In the particular example illustrated by the diagram, the ratio of the maximum outreach $l^1 c$ to the length of the line $n^1 c$, which can be designated the fundamental ratio, is 4. The fundamental ratio, however, is quite arbitrary and can be a whole or mixed number.

For the position corresponding to the outreach l^2 of the jib, the path or arc is described of a line $n^2 c$ whose length is equal to the outreach $l^2 c$ of the jib divided by the fundamental ratio, and the line $g^2 m^2$ is drawn tangentially to the said arc from g^2. The lines $g^1 m^1$ and $g^2 m^2$ may be called for distinction "elemental" lines and the lines $n^1 c$ and $n^2 c$ may, for a similar reason, be called "normal" lines.

Likewise, for each successive outreach, a normal line is described and an elemental line drawn tangent to its path or arc.

Interpolation of the points of intersection of these elemental lines gives, approximately, the centre d about which the jib-tie e should be arranged to rotate.

The change in height of the jib head, during the luffing movement, can now be represented by the distance $i—r$. Likewise, the change in length of the jib-tie e can be represented by the distance $g—q$, as ascertained by describing the arc $g^5—q$ from centre d, and it will be apparent on inspection, that the ratio of $l^1—c$ to $n^1—c$ is substantially equal to the ratio of $i—r$ to $g^1—q$ and that this ratio is substantially constant for all phases of the luffing movement.

As heretofore mentioned, the "fundamental ratio" is quite arbitrary. Therefore, if a progressive series of "fundamental ratios" were chosen and a number of points d determined by the foregoing method, and a line be drawn through these points, the flattened curved line $c—o$ would result; but since the curve is practically straight, throughout the length demanded by usual practice, it can at once be drawn through the points c and d already determined.

According to the invention, a point p is located along this line $c—o$, at any convenient position, for the centre of the hoisting

barrel a, (see Fig. 2) or, alternatively for the centre of the guiding pulley a^1 (see Figs. 1 and 3).

It will be observed that the relative position of the point p to that of c and d governs the ratio of the vertical component of the movement of the load-hook k to the length adjustment of the jib-tie, when luffing, and that for causing the load hook to move in a horizontal path, this ratio, which may be called the "displacement ratio," is made equal to the ratio of mechanical purchase which is required in the entire connected system lying between the jib-tie fastening to the jib and the load-rope at the hoisting barrel.

This will be apparent if the displacement or change in length of the jib-tie is represented by unity. Then, with the centre p of the guide pulley a^1 at d, as in Fig. 3, the load-rope f also has unit lengthwise displacement between the centres p and g; but with the centre p at centre c there would be no displacement of the load-rope between the centre p and g.

It follows that for any intermediate position of the centre p, as in Fig. 2, the displacement of the load-rope can approximately be represented by the fractional distance which the centre p occupies between and from the centre c to d.

Further, with the centre p above centre d, as in Fig. 1, the displacement of the load-rope is approximately unity plus the fraction which the distance of the centre p above the centre d is of the distance between the centres c and d. For instance, and as represented in the diagram, Fig. 4, the "displacement ratio", or, the required ratio of mechanical purchase, equals $3\frac{3}{4}$, being the chosen "fundamental ratio" 4 less $\frac{1}{4}$ for the selected position of the centre p which is approximately $\frac{1}{4}$ of the distance from c to d.

It will be readily understood that if it is desired to reeve the load-rope f between the jib-head pulley i and the load-hook k (see Fig. 3), the ratio of mechanical purchase to be realised would be substantially as for single rope-load-suspension as in Figs. 1 and 2, multiplied by the reeving purchase ratio.

Since the whole of the foregoing procedure is applicable to types of cranes having lengthwise adjustable jib-tie systems directly connected to the jib and crane frame, the invention is not confined solely to the particular types of cranes illustrated.

In a preferred arrangement of hoisting and luffing mechanism (see Figs. 5, 6 and 7), a shaft s or its equivalent is made in two discontinuous parts and a driving and a driven gear t^1 and t^2 respectively are fixed to its respective separated ends. These gears are connected together through the meshed idler pinions u^1 and u^2 (in duplicate) which are carried by the casing v or its equivalent. The casing v is rotatably mounted in bearings w^1 and w^2 and has fast with it a gear x which engages a gear y forming part of the luffing mechanism (shown dotted in Fig. 5). M is the hoisting motor for rotating the shaft s s. In this arrangement, the lengthwise adjustment of a rope or chain reeved jib-tie e such as shown in Fig. 1 and in Fig. 2, is accomplished by a winding barrel z driven by a motor M^1 but in the case of a screw-and-nut jib-tie, as in Fig. 3, the equivalent of the winding barrel z would be the rotatable unit, either the screw or the nut.

It will be observed that the foregoing device shown in Figs. 6 and 7, constitutes an ordinary "differential gear" and therefore the invention is not solely confined to this particular type of gear or the manner of connecting the respective driving, driven and idler elements thereof, as such gear is subject to modification.

Appreciating that the turning effort of the luffing mechanism at the "differential gear" substantially balances the turning effort of the hoisting mechanism, by virtue of the ratio of mechanical purchase in the entire connected system equalling the displacement ratio, the action of the foregoing "differential gear" when luffing only, hoisting only, and when luffing and hoisting conjointly, will be readily understood from the following:—

When hoisting only, by motor M, and with the casing v held by the gear y of the stationary luffing mechanism, the hoisting barrel a will be driven by the gear t^1 rotating the gear t^2 through the medium of the meshed idler pinions u^1 and u^2.

When luffing only, movement of the barrel z by the motor M^1 rotates the casing u through the gears y and x. The meshed idler pinions u^1 and u^2 are thus caused to roll around the stationary gear t^1 and drive the gear t^2. Consequently, the hoisting barrel a winds in or pays out the proportional amount of rope, or practically so, to cause the load suspension means to move in a horizontal path.

When hoisting or lowering and luffing conjointly, movement of the barrel z rotates the casing v in a similar manner to that in which it is moved when luffing only. The meshed idler pinions u^1 and u^2 are thus caused to roll around the driving gear t^1 which is being driven by the motor M, and to add to or subtract from the rotations of the gear t^2. The hoisting barrel a consequently winds in or pays out a compensated amount of rope when hoisting or lowering.

To effect a slight raising of the path of the load suspension means at its two extremes, as indicated in Fig. 2, a device, such as a slotted link A, shown in Fig. 8, can be attached to the crane frame. The said link A whilst permitting of uninterrupted radial

movement of the jib-tie anchorage link B, throughout the desired range of load-path compensation, arrests any further movement; consequently, when the said range is exceeded in either direction, the centre of rotation d of the jib-tie system, is shifted to C^1 or C^2, and causes the displacement ratio to be decreased and increased respectively at the maximum and minimum out-reaches of the load suspension means. This deviation of the "displacement ratio" from the mechanical purchase ratio, results, as will be readily understood, in the load path being modified as heretofore mentioned.

Referring now to Figs. 9 and 10, which illustrate alternative systems of jib counterbalancing gear, a balance weight D is either suspended by a tail rope E leading from the luffing barrel Z and fixed at its other end to the crane frame, as in Fig. 9, which shows a crane like that illustrated in Fig. 1, or alternatively, is rigidly attached to a lever F having its fulcrum at d, and slidably actuated by the jib h at g, as in Fig. 10, which shows a crane like that illustrated in Fig. 3.

What I claim is:—

1. In a crane of the class referred to, a frame, a jib the foot of which is pivoted to the frame, a lengthwise adjustable jib-tie extending from the jib to a centre of rotation upon the frame determined substantially as herein before set forth, a load rope, a device around which the said rope passes direct from the jib, said device being located about a centre which occupies a position at some point in the length of a substantially straight line extending through the jib-foot and jib-tie centres of rotation, and at a distance from the said centre of rotation of the jib-tie, jib-tie adjusting means, hoisting means for said load rope and a constant-ratio gear connection between said jib-tie adjusting means and said hoisting means, substantially as described.

2. In a crane of the class referred to, a frame, a jib the foot of which is pivoted to the frame, a lengthwise adjustable jib-tie extending from the jib to a centre of rotation upon the frame determined substantially as hereinbefore set forth, a load rope proceeding from the jib at the same point as the jib-tire proceeds therefrom, a device around which the load rope passes, located about a centre which occupies a position as some point in and intermediate of the length of a substantially straight line extending through and joining the jib-foot and jib-tie centres of rotation, and at a distance from the said centre of rotation of the jib-tie, jib-tie adjusting means, hoisting means for said load rope and a constant-ratio gear connection between said jib-tie adjusting means and said hoisting means, substantially as described.

3. In a crane of the class referred to, a frame, a jib the foot of which is pivoted to the frame, a lengthwise adjustable jib-tie extending from a point in the jib between the head and foot thereof to a centre of rotation upon the frame determined substantially as hereinbefore set forth, a guide device mounted at a second centre of rotation on the frame located upon a substantially straight line extending through the jib-foot and first named centre of rotation, the said two centres of rotation being displaced from each other, a load rope proceeding from the same point in the jib as the said jib-tie to said guide device, jib-tie adjusting means, hoisting means for said load rope and a constant-ratio gear connection between said jib-tie adjusting means and said hoisting means, substantially as described.

4. In a crane of the class referred to, a frame, a jib the foot of which is pivoted to the frame, a lengthwise adjustable jib-tie extending from a point in the jib between the head and foot thereof to a centre of rotation upon the frame determined substantially as hereinbefore set forth, a guide device mounted at a second centre of rotation on the frame located upon and intermediate of the length of a substantially straight line joining the jib-foot and first named centres of rotation, a load rope proceeding from the same point in the jib as that from which the jib-tie proceeds, jib-tie adjusting means, hoisting means for said load rope and a constant-ratio gear connection between said jib-tie adjusting means and said hoisting means.

Signed at London, England, this second day of June, 1922.

WILLIAM HUGH WATKINS.