

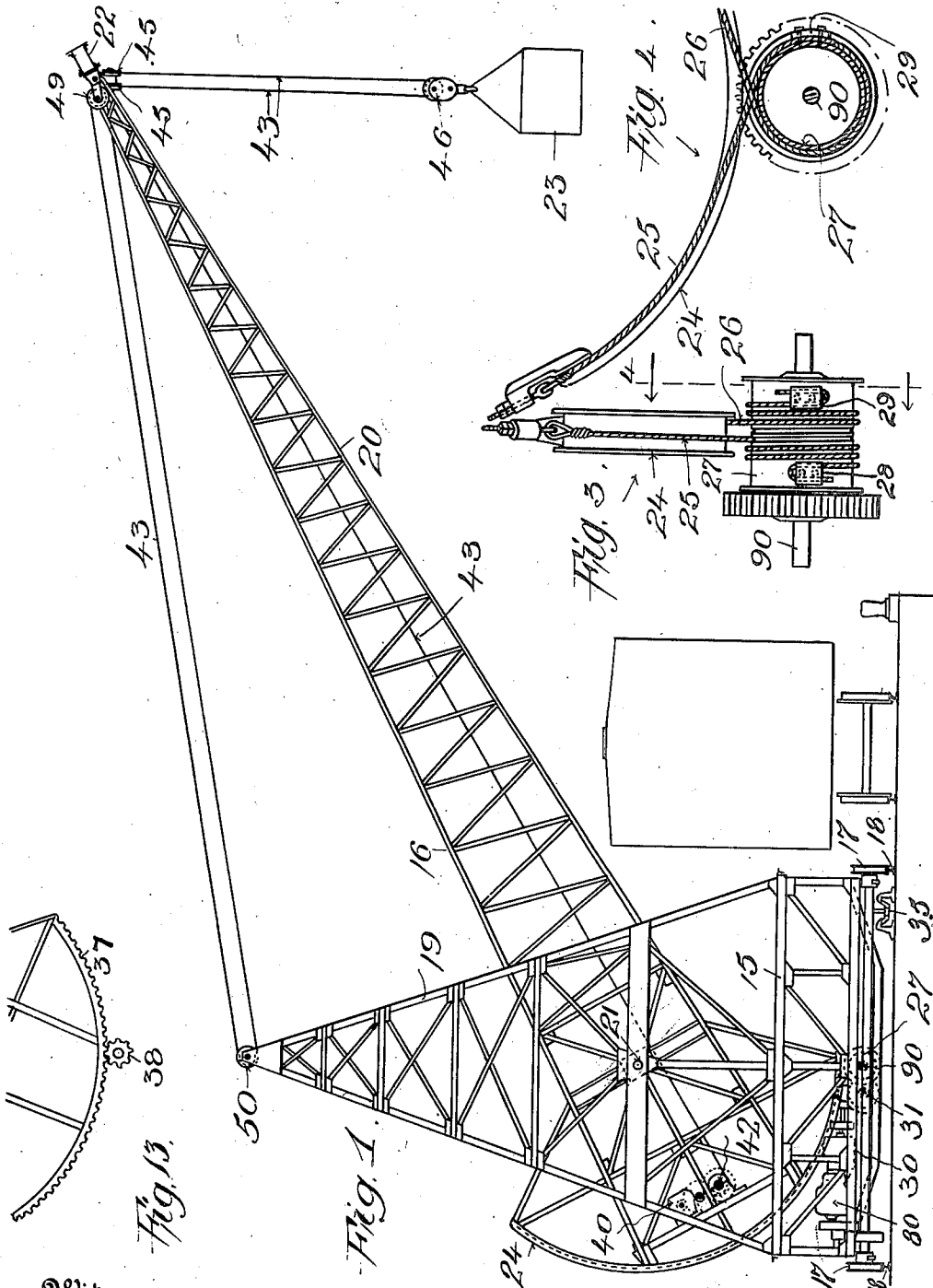
H. SAWYER.  
CRANE.

APPLICATION FILED JULY 11, 1913.

Patented Sept. 22, 1914.

1,111,101.

5 SHEETS—SHEET 1.



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5 SHEETS—SHEET 2.

1,111,101.

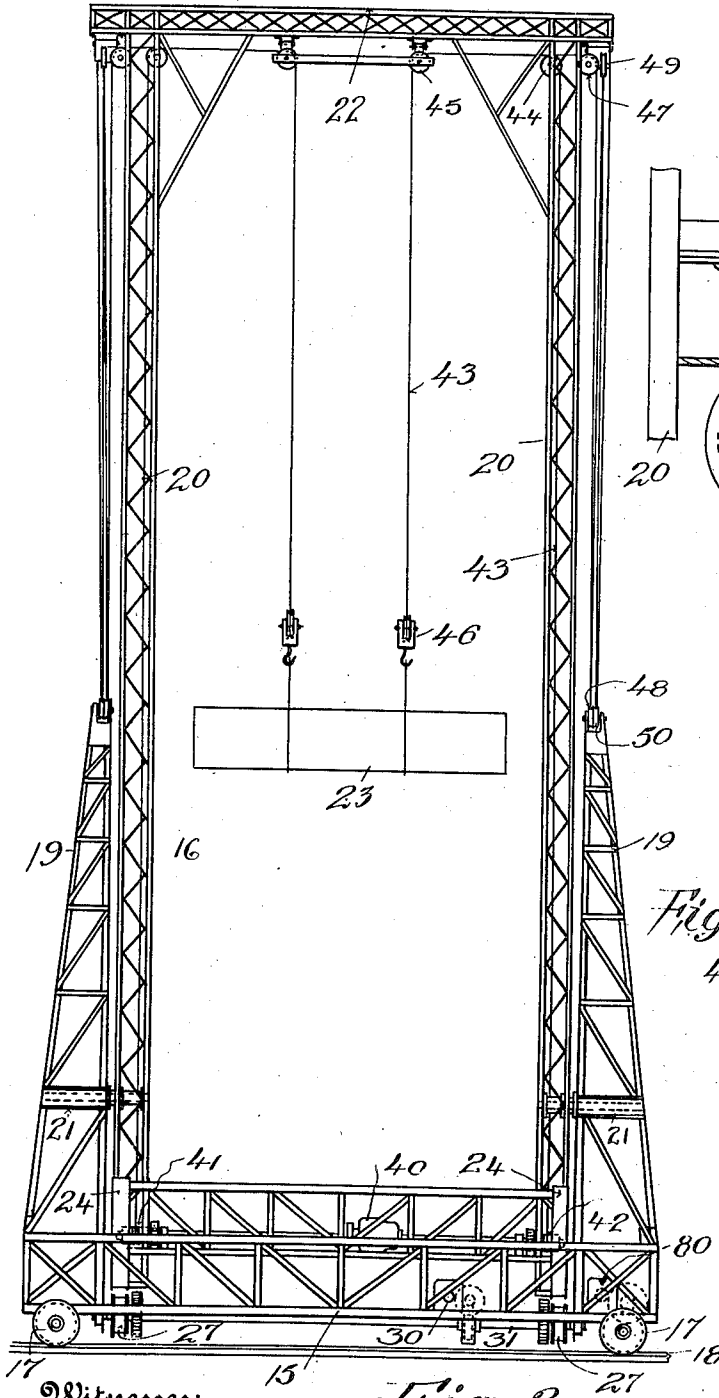


Fig. 5.

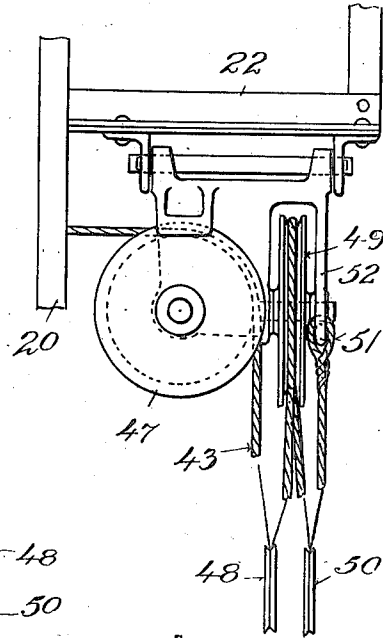


Fig. 6.

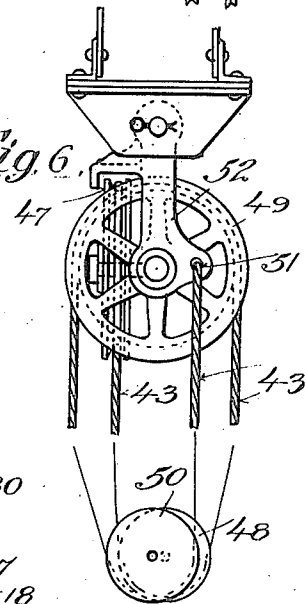


Fig. 2.

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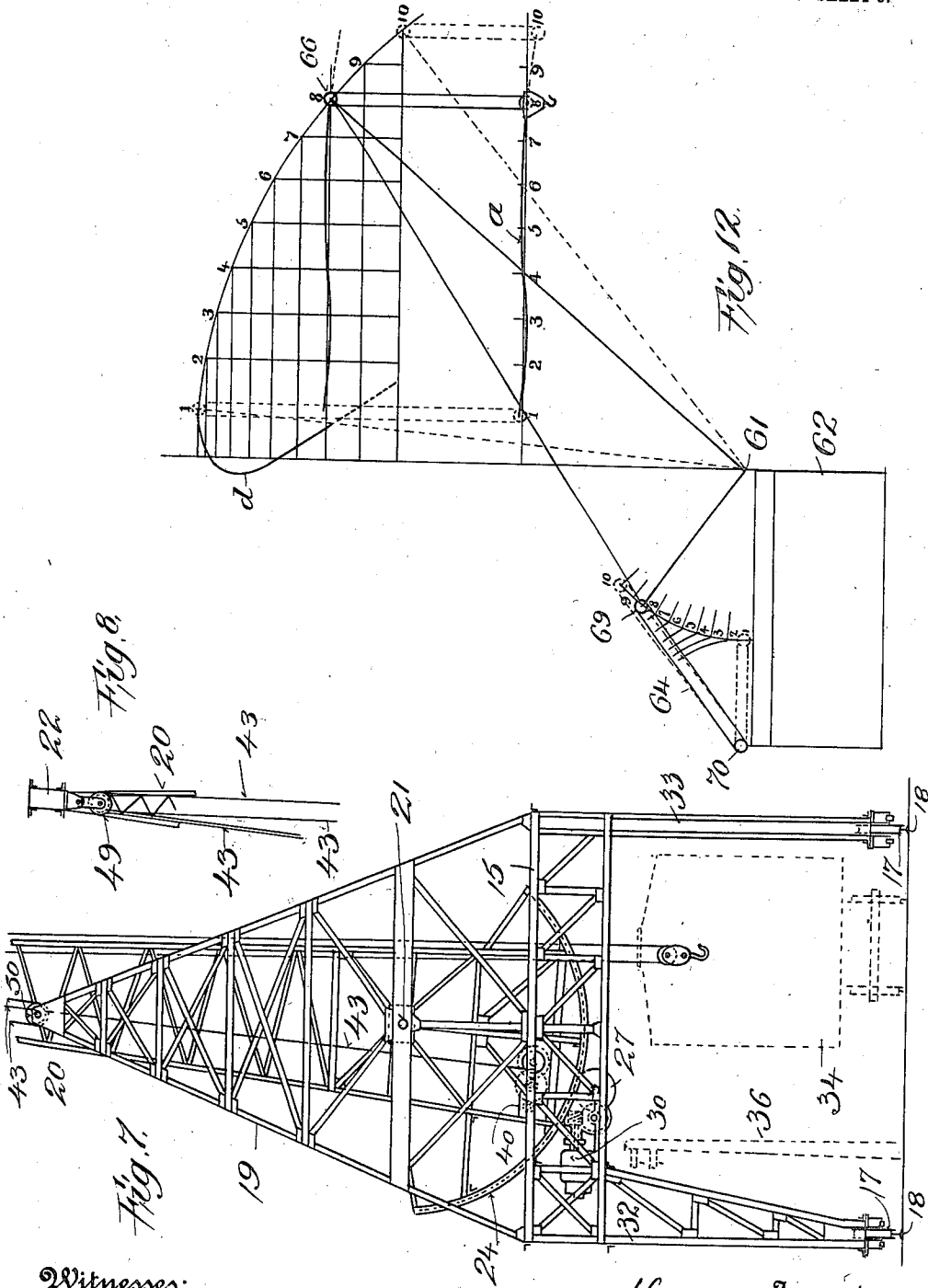
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5 SHEETS—SHEET 3.

1,111,101.



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5 SHEETS—SHEET 4.

1,111,101.

*Fig. 10.*

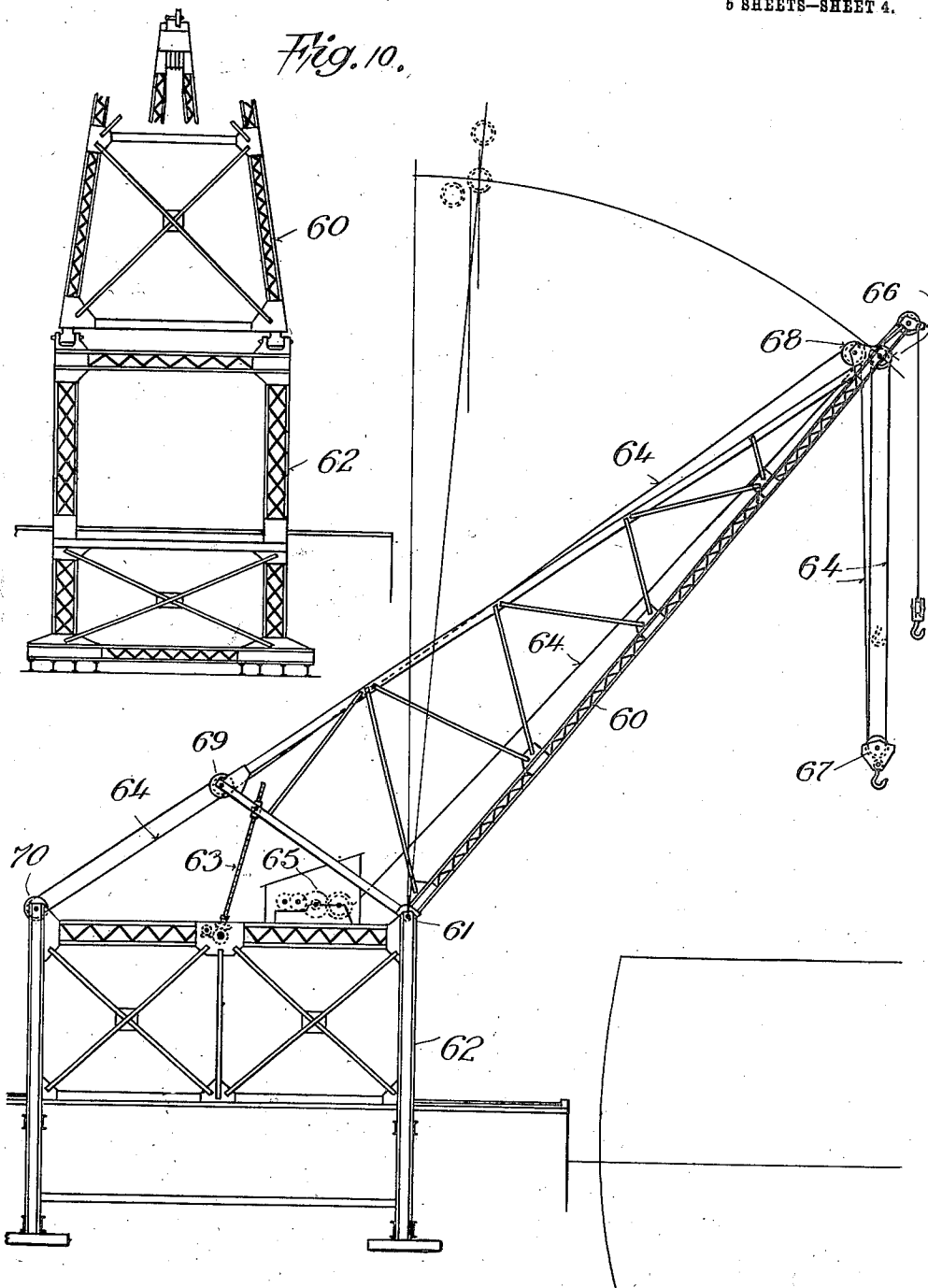


*Fig. 9.*

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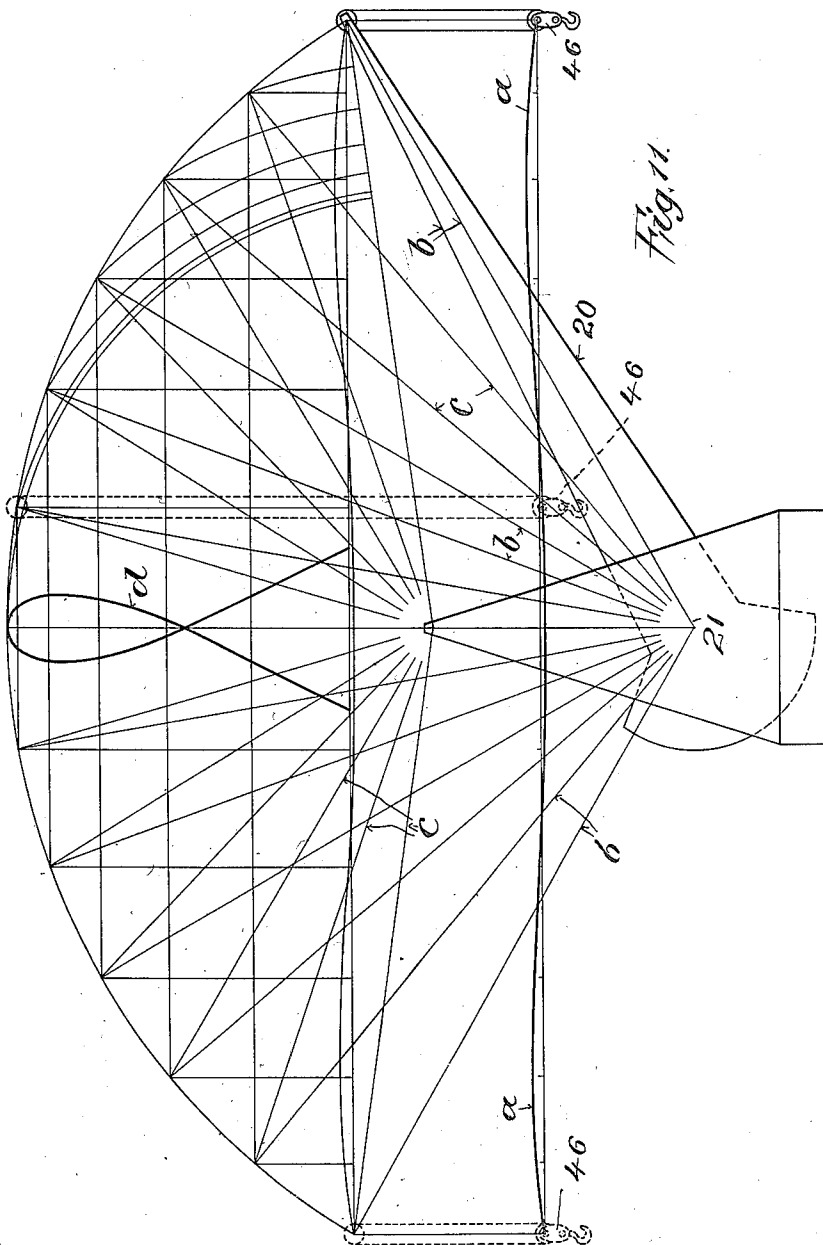
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5 SHEETS—SHEET 5.

1,111,101.



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# UNITED STATES PATENT OFFICE.

HARRY SAWYER, OF MUSKEGON, MICHIGAN.

## CRANE.

1,111,101.

Specification of Letters Patent.

Patented Sept. 22, 1914.

Application filed July 11, 1913. Serial No. 778,424.

*To all whom it may concern:*

Be it known that I, HARRY SAWYER, a citizen of the United States, residing at Muskegon, county of Muskegon, State of Michigan, have made a certain new and useful Invention in Cranes, of which the following is a specification.

This invention relates to cranes, and particularly to cranes of the rocking boom type.

The object of the invention is to provide a crane having a rocking boom and wherein the boom, in operation is rocked from one side of a supporting structure to the other.

Another object of the invention is to provide means for automatically preventing the load from rising as the crane boom rocks upwardly and the load from lowering as the boom rocks downwardly, whereby the overhang of the load is compensated and the power mechanism employed to rock the boom is relieved of the extra duty of raising and lowering the load as the boom rocks.

Other objects of the invention will appear more fully hereinafter.

The invention consists substantially in the construction, combination, location and relative arrangement of parts, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally pointed out in the appended claims.

Referring to the accompanying drawings and to the various views and reference numerals appearing thereon:—Figure 1 is a view in side elevation of a crane embodying the principles of my invention, the boom being shown in inclined position. Fig. 2 is a front elevation of the same, the boom being in vertical position. Fig. 3 is a broken detail view showing cable connections for rocking the boom. Fig. 4 is a view in section on the line 4, 4, Fig. 3 looking in the direction of the arrows. Figs. 5 and 6 are broken detail views showing portions of the compensating means. Fig. 7 is a view similar to Fig. 1, showing a different arrangement of supporting base for the crane boom, the upper end of the boom being broken off. Fig. 8 is a broken view showing the upper end of the boom of Fig. 7. Figs. 9 and 10, are, respectively side and front elevations of a form of derrick crane showing the application thereto of a compensating means embodying the principles of my invention. Fig. 11 is a diagram illustrating the effect of the compensating arrangement embody-

ing my invention, as applied to the types of cranes shown in Figs. 1, 2 and 7. Fig. 12 is a view similar to Fig. 11 showing the effect of the compensating arrangement of my invention as applied to the type of derrick crane shown in Figs. 9 and 10. Fig. 13 is a broken view showing a modified arrangement of gearing for rocking the boom.

The same part is designated by the same reference numeral wherever it occurs throughout the several views.

In the form shown in Figs. 1 and 2, the crane is composed of two principal parts, namely, the supporting base structure 15, and the rocking boom 16. The base structure may be provided with wheels 17 adapted to operate along track rails 18 and is desired, driven therealong by a motor indicated at 80, whereby the crane may be moved from one point to another as exigency may require. The base structure is provided with vertical uprights or tower portions 19 which are preferably spaced apart a sufficient distance to permit the boom to rock and the load to be transferred or handled to pass therebetween. The boom is composed of the side members 20 which are connected together at both their upper and their lower ends. These side members are suspended on trunnions 21, in the tower portions 19 and preferably at points intermediate the top and base of the tower portions. Preferably the trunnions axis of the boom side members is nearer the lower end portions of said members than the upper ends thereof. At their upper ends these boom side members 20, are connected together by a cross beam structure 22, from which the load to be handled indicated at 23, Figs. 1 and 2 is suspended. The lower ends of the boom side members are widened and provided with channel members 24 bent into the form of drum segments concentric with the trunnions 21. Cables 25, 26, are connected to the respective ends of each channel member, and at their other ends are wound in reverse direction upon a drum 27, and respectively secured to said drum, as indicated at 28, 29, see Figs. 3 and 4. The drum 27 may be driven in any suitable or convenient manner. A simple arrangement of power mechanism for this purpose is shown wherein a motor 30, is mounted on the base structure 15, and is suitably geared to a shaft 31, which drives the shafts 90, on 110

which the drums are mounted, it being understood of course, that, if necessary, and preferably a drum is provided for each side of the rocking boom. My invention, however, as defined in the claims, is not to be limited or restricted in respect to this detail.

By the arrangement above described it will be seen that through the power mechanism provided for that purpose the boom may be rocked about its trunnions 21, so as to swing its long arm portion from one side of the supporting structure to the other, by rotating the drums 27 which causes the members of the pairs of cables 25, 26, to respectively wind upon and unwind from the drums.

As above indicated, other forms of gearing for rocking the boom may be employed with equal facility without departure from the spirit and scope of my invention as defined in the claims.

By the power mechanism as above indicated, the boom can be rocked from the inclined position thereof shown in Fig. 1, into an upright or vertical position, as seen in Fig. 2, and then on into a corresponding inclined position on the other side of the supporting base structure.

A rocking boom crane having the structure and arrangement above described is adapted for general use where freight or cargo is to be handled or transferred from one point to another, and especially is such a crane advantageous for use in loading or unloading boats, vessels, freight cars or the like. In a crane for serving a marine terminal such as the loading or unloading of boats or other vessels lying alongside a dock, any part of the crane which overhangs the boat must be raised or withdrawn to clear the masts or yard arms of the boat when the boat is docking or sailing or when the crane structure is being shifted from one to another position relative to the boat. In the type of crane above described since the boom rocks backward and forward with each load handled it is unnecessary to provide a separate movement for withdrawing the boom from the path of any part of the boat.

In the form shown in Figs. 1 and 2, a low type of supporting base structure is employed. In this type of crane of course, the space between the tracks 18, on which the base travels is not available for any other purpose. If desired, therefore, and in order to secure economy of ground area, the base portion of the crane may be supported at an elevation by means of a gantry comprising vertical leg portions 32, 33, the wheels 17 where used, being mounted in the lower ends of said legs, as shown in Fig. 7. By this means the base of the supporting structure may be raised to a sufficient height to permit the ground area beneath it and between

the legs 32, 33, to be utilized, as, for instance, for the passage of freight cars, as indicated at 34.

Where electric motors are employed for the power mechanism used for rocking the boom and for hoisting the load or cargo, current may be supplied thereto in any suitable or convenient manner. In the low base type of crane shown in Figs. 1 and 2, current may be supplied in a manner similar to the third rail system of supplying current for the operation of electric railways, as indicated at 35, Fig. 1. In the case of the gantry type of base the current conductors may be carried on poles as indicated at 36, Fig. 7. It will be observed that in the arrangement shown in Fig. 7 the motor 30 for rocking the boom as well as the drums 27, are placed to one side of the space between the legs 32, 33. This is for the purpose of leaving the space free as much as possible for handling freight to and from cars on the railroad tracks which are not placed centrally underneath the crane.

In the foregoing description I have referred to drums and cable connections for securing the rocking movements of the boom. It is obvious, however, that my invention as defined in the claims is not to be limited to this particular construction as other forms and arrangements are equally well adapted for this purpose. For instance, segment racks 37 and gears 38 meshing therewith may be employed as indicated in Fig. 13.

I will now describe the arrangement for securing an automatic compensation of the load imposed on the power mechanism employed to rock the boom by the weight of the freight or other cargo being handled. A common practice in cranes is to reave the hoisting cable from the hoisting mechanism through a sheave fixed at the outer or free end of the boom, thence down to the lower hoisting block and back and forth through sheaves fixed at the end of the boom and in the lower block a sufficient number of times to secure the desired lifting power, the end of the cable, if desired, being finally anchored or secured either to the end of the boom or to the lower hoisting block. In the use of such an arrangement in connection with a crane having a rocking boom where the outer end of the boom is raised or rocks upwardly there is no change in the distance between said outer end of the boom and the lower hoisting block with the result that the load will be raised through the same distance of travel or range as that of the upward movement of the outer end of the boom, when the latter is rocked. Thus, if the boom in moving with a load from its extreme position of inclination into a substantially vertical position, causes its outer end to rise through

a vertical distance of, say, thirty feet, in order to transfer a load of cargo from a boat to a dock or freight car, for instance, then the weight of the load of cargo being transferred will be necessarily raised through the same vertical distance by the act of rocking the boom, and after being raised through this vertical distance the load must then be lowered again. This work of raising the load is thus imposed on the motor which rocks the boom in addition to its normal work of merely rocking the boom, while the work of again lowering the load is imposed on the load hoisting motor which work is done in the form of brake application. The same results follow if the load is transferred in the reverse direction, that is, from a position corresponding to the substantially vertical position of the boom into a position corresponding to the position of extreme inclination of the boom. In this case the load would have to be raised by the hoisting motor a vertical distance thirty feet greater than the height thereof required in the extreme inclined position to be ultimately assumed by the boom in completing the transfer, in order to make up for the lowering process due to the rocking of the boom downwardly into its inclined position. In this case there is the increased hoisting work imposed on the hoisting motor and the increased braking work on the boom rocking motor. It may be true that the two movements, namely, the hoisting and lowering or the lowering and hoisting movements, as the case may be, of the load may be carried on simultaneously so as to cause the load to move in substantially a horizontal plane but the fact remains, nevertheless, that whether these movements of the load are accomplished consecutively or simultaneously, unnecessary or increased work is being done by one motor and is being used up in the brake application of the other motor. In other words, in transferring a load removed from the base frame into position contiguous thereto the boom rocking motor must draw current from the line supply to hoist the load the extra height required, and this work is converted into heat by the application of the hoisting motor brakes when the load is again lowered and similarly if the load is to be transferred from a position contiguous to the base into a position remote therefrom, then the load hoisting motor must draw current from the line in order to hoist the load through the required vertical distance, and the work of again lowering the load as the boom swings downwardly into its extreme inclined position is converted into heat in the brake which controls this movement. It is among the special purposes of my present invention to provide means for compensating this unnecessary extra

work imposed upon the load hoisting and boom rocking motors. In carrying out my invention in this respect I preferably locate the hoisting motor, indicated at 40, upon the rocking boom at the lower or base end thereof while the boom rocking mechanism is located upon the base frame, as above described. By locating the hoisting motor on the boom it forms a counterbalance for the boom while at the same time a more direct and advantageous reaving of the hoisting cable is permitted. The hoisting drums, 41, 42, operated by the motor 40, are duplicated, that is, a drum is located at each side of the boom, as shown. As the reaving of the hoisting cable is the same at each side of the boom a description thereof for one cable will answer for both.

The hoisting cable 43, leads from the hoisting drum 41 or 42, mounted on the rocking boom at its base, along the boom arm 20 to and around a sheave 44 at the outer or free end of the boom, thence inwardly toward the centerline of the cross beam 22, to and around one of a pair of sheaves 45 carried by said beam, thence down and around a sheave in the lower hoisting block 46, thence up and around another of the pair of sheaves 45 on the beam 22, thence outwardly to and around a sheave 47, thence downwardly to and around a sheave 48 mounted in the upper ends of the base tower 19, above the journal axis 21 of the rocking boom, thence upwardly to and around a sheave 49 carried by the overhanging end of the beam 22 at the upper end of the boom, thence downwardly to and around a second sheave 50 and thence upwardly and the end of said cable is anchored or otherwise suitably secured, as indicated at 51, to a bracket or other convenient part at the upper end of the boom. It is obvious that the sheaves respectively at the upper ends of the boom and the base tower may be increased as desired to secure any desired number of runs or legs of the hoisting cable between these points. Since the effective leverage of the runs or legs of the cable between the said pulleys respectively at the top of the boom and tower acting about the trunnions on which the boom rocks, is less than the overhang of the load, the number of runs or legs of the cable between said sheaves must be proportionally greater than the number of runs or legs of the portion of the cable carrying the load. In the particular arrangement of crane which I have shown to illustrate my invention the effective leverage of the compensating cable acting about the fulcrum of the rocking boom, is only about one half of the overhang of the load so the number of legs or runs of the cable between the sheaves at the tops of the boom and tower is twice as many as those supporting the load.

With the compensating arrangement as above described the operation is as follows: As the boom rocks upwardly from its extreme inclined position, the overhang of the load as well as the effective leverage of the compensating portions of the hoisting cable is gradually reduced so that by the time the boom attains its vertical position, both the overhang of the load and the effective leverage of the compensating portion of the cable is reduced to zero. Similarly, when the boom moves from its vertical position toward its extreme inclined position the overhang of the load as well as the effective leverage of the cable increases from zero to the maximum with the result that in the one case there is a gradual lengthening of that bight or portion of the cable which carries the load, and in the other case there is a gradual shortening of said bight or portion and consequently, in either case the load travels in a substantially horizontal line and without imposing any material or substantial load on the motors either in hoisting or braking work. Since gravity always acts in vertical and consequently parallel lines while the direction of pull of the compensating cable is constantly changing as the boom rocks in one direction or the other the overhang of the load and the effective leverage exerted by the cable do not increase or decrease in exact proportional relation and consequently there is a failure to secure absolute and perfect compensation. The compensation secured, however, in the arrangement described, is sufficient for all practical purposes.

In the diagram of Fig. 11, I have shown the compensating action secured in the use of the arrangement above described. The line *a*, indicates the line of travel of the load from one extreme limit of inclination of the rocking boom 20 to the other, the lines *b*, indicating the various positions of the boom, and the lines *c*, the lines of inclination of the compensating portions of the cable, and *d*, the line indicating the shifting of the effective center of gravity of the load. In explanation of this line *d*, it will be understood that, without compensation, when the load is imposed on the end of the boom when the latter is in its extreme inclined position, the leverage through which the load acts is the distance between the vertical lines respectively containing the axis of the boom and the load block 46. But the compensating cables exert a moment in the opposite direction with the result that the net leverage through which the load acts is correspondingly shortened. This net leverage varies as the boom rocks from its extreme inclined position on one side, to that on the other side. The line *d*, which I call the line indicating the shifting of the effective center of gravity

of the load, represents this varying net leverage exerted by the load. It will be seen that the line *a*, rises more rapidly from the extreme inclined positions of the boom. This is the time when there is the greatest effective overhang of the load, that is, the time when the compensation is less complete. As the line *a*, reaches a point where it is strictly horizontal it indicates perfect compensation action, and at that point the line *d*, crosses the vertical center of the crane. As the lower hoisting block 46 approaches the vertical center line of the crane it is slightly lowered below the true horizontal line, thereby indicating over compensation as shown by the loop in the center of gravity curve *d*.

From the foregoing it will be readily understood that the portions of the hoisting cable which extend between the sheaves at the upper ends, respectively, of the boom and tower exert a leverage or movement on the boom in opposite direction to and practically equal to that exerted by the overhanging load with the result that as the boom rocks the load is maintained at a substantially horizontal line without imposing any additional duty upon either the hoisting or the boom rocking motors.

The advantages and benefits of the compensating arrangement above set forth are not confined to the application thereof to the structure of crane above described but are attainable with equally useful results in other types and structures of cranes. In Figs. 9 and 10, I have shown another form of crane wherein a boom 60 is pivotally mounted to rock or swing upon a fulcrum 61, on a base frame 62, the rocking of the boom being secured in any suitable manner, as, for instance, by the pivoted screw rod 63. In this arrangement the hoisting cable leads from the hoisting mechanism, carried by the base frame, over sheaves 66 at the upper end of the boom, thence to and around a sheave in the hoisting block 67, thence back over sheaves 68 at the upper end of the boom to and over sheaves 69, at the base of the boom and to and over sheaves 70 on the base frame, the runs or legs of the portion of the cable operating over the sheaves 69 and 70 varying in the proportional relation to the number of runs or legs in the bight which carries the block 67 in the same manner and with the same compensating result as above described with reference to the structure shown in Figs. 1 and 2. The diagram of Fig. 12 illustrates the compensating action of the crane structure shown in Figs. 9 and 10, the lines *a* and *d* thereof corresponding to the lines *a*, and *d* of the diagram of Fig. 11.

While I have shown the hoisting motor as carried by the swinging boom it is to be understood that my invention, in its broad-

est scope as defined in the claims, is not to be restricted or limited in this respect. It is also to be understood that the particular reeving of the hoisting ropes as well as other details shown and described may be varied within a wide range without departure from the broad principles of my invention.

It will be seen from the foregoing description that the load is prevented from rising with the boom as the latter rocks upwardly, and from lowering with the boom as the latter rocks downwardly thereby automatically compensating the overhang of the load and relieving the boom rocking motor of the extra duty of raising and lowering the load as the boom rocks. It will be understood, of course, that with the arrangements shown, this compensation is always proportional to the load and consequently is equally efficient whether the load be heavy or whether it be light.

Having now set forth the object and nature of my invention, and various constructions embodying the principles thereof, what I claim as new and useful and of my own invention and desire to secure by Letters Patent is:—

1. In a crane, a supporting base, a vertically rocking boom carried thereby to rock from one side of the base to the other, load supporting devices mounted on the boom, means for operating said devices, means carried by the base to rock said boom and means to cause the load to move in a substantially straight line during the rocking movements of the boom.

2. In a crane, a supporting base carrying trunnions, a vertically rocking boom having bearings for said trunnions, load supporting devices carried by said boom, a hoisting motor mounted on and arranged to counterbalance said rocking boom, connections operated by said motor and leading to said supporting devices to operate the same, and means carried by the supporting base to rock said boom.

3. In a crane, a supporting base, a vertically rocking boom pivotally mounted on said base, to rock from one side of the base to the other, load supporting devices carried by the boom, means for operating said devices, a motor carried by the base, connections operated by said motor to rock said boom and means to cause the load to move in a substantially straight line during the rocking movements of the boom.

4. In a crane, a supporting base, a vertically rocking boom pivotally mounted intermediate its ends on said base to rock from one side of the base to the other, a motor mounted on the lower end of the boom, load supporting devices carried by the boom, connections actuated by said motor for control-

ling said devices, and means for rocking said boom.

5. In a crane, a supporting base, a vertically rocking boom pivotally mounted on said base to rock from one side of the base to the other, load supporting devices carried by the boom, means for operating said devices, including cable connections, guides for said connections operating to cause the same to move the load in a substantially straight line during the rocking movements of the boom and power operated mechanism for rocking said boom.

6. In a crane, a supporting base having an upright or tower portion, a boom pivotally suspended intermediate its ends upon said tower portion, load supporting devices carried by said boom, means for operating said devices, means to rock said boom from one side of the base to the other and means operating automatically during the rocking movements of the boom to cause the load to travel in a substantially straight line.

7. In a crane, a supporting base having vertically extending tower portions spaced apart from each other, a vertically rocking boom pivotally supported intermediate its ends between said tower portions, load supporting devices carried by said boom, means for operating said devices, means for rocking said boom and means operating automatically during the rocking of the boom to cause the load to travel on a substantially straight line.

8. In a crane, a supporting base having vertically extending towers spaced apart from each other, a vertically rocking boom including side members respectively journaled intermediate their ends on said tower portions and connected together at their respective ends, load supporting devices carried by said boom, cable connections for operating said devices, means for rocking said boom and means to automatically pay out and take up said cable connections by the rocking movements of the boom.

9. In a crane, a supporting base having vertically extending tower portions spaced apart from each other, a vertically rocking boom including side members respectively journaled intermediate their ends on said tower portions and connected together at their upper and lower ends, a hoisting motor carried by the boom at its lower end, load supporting devices including cable connections actuated by said motor, and means for rocking said boom.

10. In a crane, a supporting base having vertically extending tower portions spaced apart from each other, a vertically rocking boom including side members respectively journaled intermediate their ends on said tower portions and connected together at their upper and lower ends, load supporting

devices carried by said boom, and including cable connections, means carried by the lower end of the boom for operating said devices, and power operated devices for rocking said boom.

11. In a crane, the combination with a supporting base, a boom pivotally mounted thereon to rock from one side thereof to the other and load supporting devices carried by said boom, of means made effective by the rocking movements of the boom to cause the load to move in a substantially horizontal line when said boom is rocked.

12. In a crane, a supporting base, a boom pivotally mounted thereon, load supporting devices carried by said boom, and means for rocking said boom vertically from one side of the base to the other in combination with means made effective by the rocking movement of the boom for automatically causing the load carried by the boom to move in substantially a horizontal line when said boom is rocked.

13. In a crane, a supporting base, a boom pivotally mounted thereon, load supporting devices suspended from the upper end of said boom, and means for rocking said boom vertically from one side of the base to the other, in combination with means for automatically preventing the load from rising as the boom rocks from an inclined toward an upright position.

14. In a crane, a supporting base, a boom pivotally mounted thereon, supporting devices suspended from the upper end of said boom, and means for rocking said boom vertically from one side of the base to the other in combination with means for automatically raising the load relative to the upper end of the boom, as the boom rocks from an upright toward an inclined position.

15. In a crane, a supporting base, a boom pivotally mounted to rock thereon from one side thereof to the other, and load supporting devices carried by said boom, said load supporting devices having connection with said supporting base to automatically vary the effective leverage of the load as the boom is rocked.

16. In a crane, a supporting base, a boom pivotally mounted to rock thereon from one side thereof to the other, load supporting devices carried by the boom including a cable, and pulleys carried by the supporting base over which said cable operates, and located so as to vary the effective leverage of the load as the boom rocks.

17. In a crane, a supporting base having a tower portion, a boom pivotally suspended from said tower portion, load supporting devices carried by the boom and including a cable, pulleys respectively located at the upper ends of the boom and tower portion over which said cable operates, means to

operate the cable and means for locking said boom from one side to the other of said tower portion.

18. In a crane, a supporting base having a tower portion, a boom pivotally supported upon said tower portion, load supporting devices carried by the boom and including a cable, means to operate the same, pulleys respectively located at the upper ends of the boom and tower portion over which the cable operates, the tower pulley being located above the pivotal axis of the boom, and means for rocking said boom from one side to the other of said base.

19. In a crane, a supporting base having tower portions, a boom pivotally suspended intermediate its ends between said tower portions to rock from one side thereof to the other, pulleys respectively located at the upper ends of the boom and tower portions, load supporting devices carried by the boom and including a cable, said cable operating over said pulleys, the pulleys on the tower portions being located above the pivotal axis of the boom, means for operating the cable, and means for rocking said boom.

20. In a crane, a supporting base, a boom pivotally mounted thereon to rock or swing vertically from one side of said base to the other, a load supporting device suspended from the end of said boom and means made effective by the rocking movements of the boom for automatically moving said device relatively to the end of the boom as said boom swings.

21. In a crane, a supporting base, a boom mounted thereon to swing in a vertical plane from one side of the base to the other, sheaves respectively carried by said boom and base, a load supporting device, and a cable for suspending said load supporting device, said cable operating over said respective sheaves to effect a moment in opposite direction and substantially equal to that exerted by the load.

22. In a crane, a supporting base, a boom pivotally mounted thereon to swing in a vertical plane from one side thereof to the other, means for rocking said boom, sheaves respectively carried by said boom and base, a load supporting device, a cable for suspending said device from the end of the boom, said cable operating over said respective sheaves to effect a moment in opposite direction and substantially equal to that exerted by the load and a hoisting motor connected to said cable.

23. In a crane, a base, a boom pivotally mounted thereon to swing in a vertical plane from one side thereof to the other, sheaves respectively carried by said boom and base, a load supporting device, a cable suspending the same from the end of the boom, said cable operating over said respective sheaves,

said sheaves being so relatively arranged  
that the sheaves on the boom approach a  
line drawn through the pivotal axes of the  
boom and the base sheaves as the load sup-  
5 porting device approaches the vertical line  
through the pivotal axis of the boom.

In testimony whereof I have hereunto set

my hand in the presence of the subscribing  
witnesses, on this 7th day of July A. D.,  
1913.

HARRY SAWYER.

Witnesses:

OTTO ALBERT,  
P. J. KUIPERST.