Nov. 1, 1932. G. A. McWILLIAMS 1,885,937

BOOM SWINGING APPARATUS

Filed May 2, 1929 2 Sheets-Sheet 1

Fig. 1.

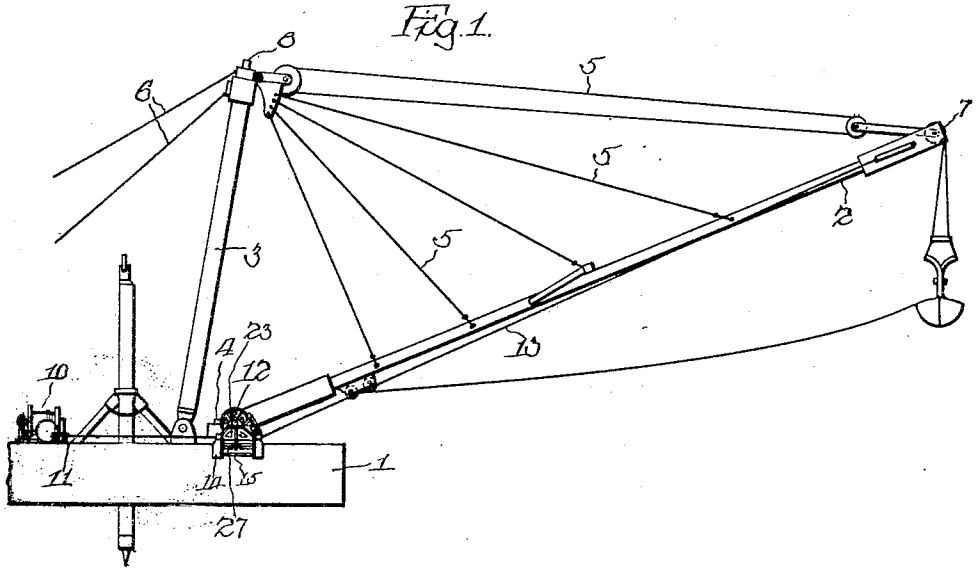
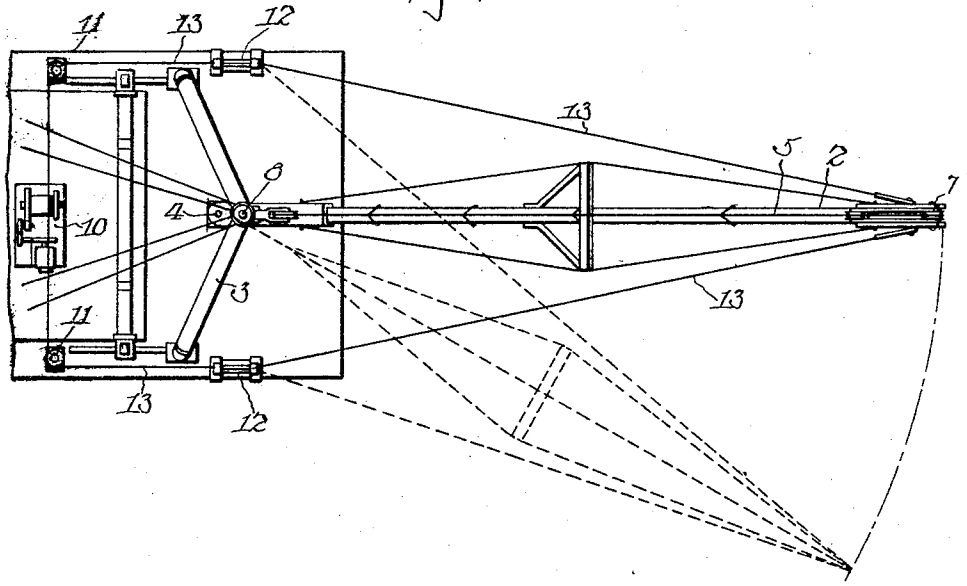


Fig. 2.



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Filed May 2, 1929 2 Sheets-Sheet 2

Fig. 3.

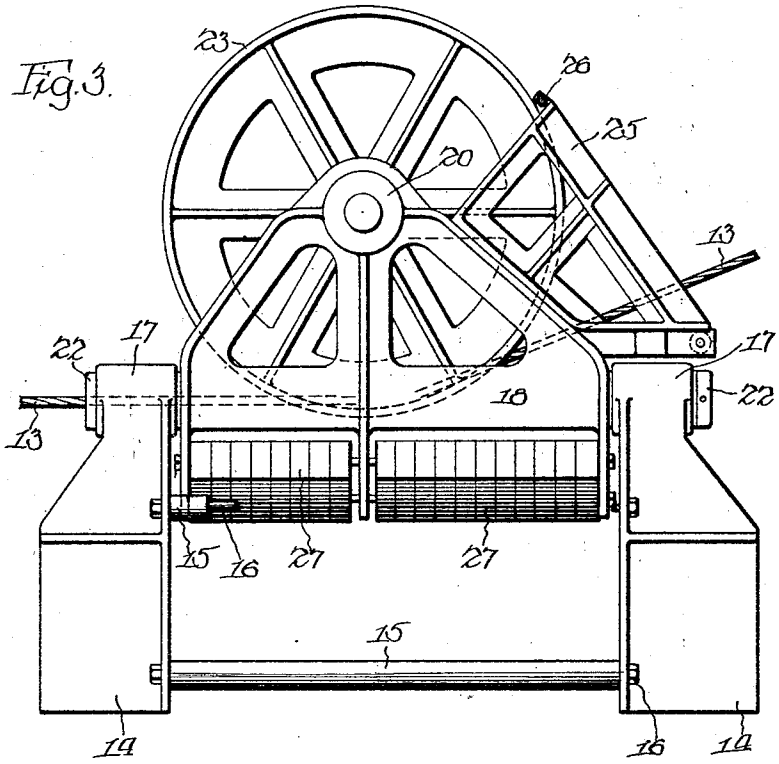
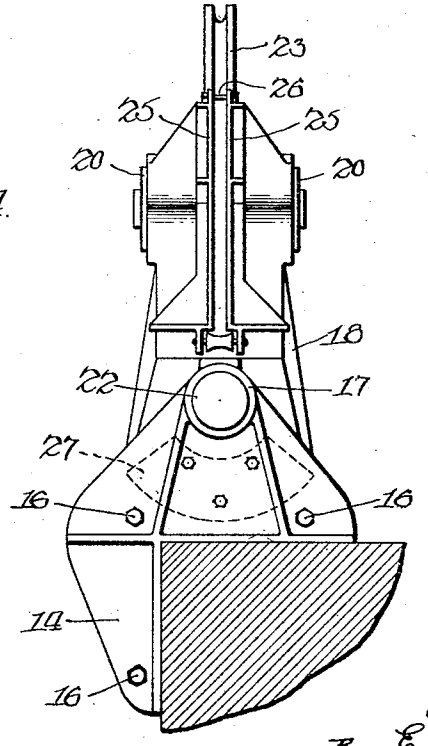


Fig. 4.



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UNITED STATES PATENT OFFICE

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BOOM SWINGING APPARATUS

Application filed May 2, 1929. Serial No. 359,763.

This invention relates to equipment adapted for use on a dredge or other excavating machine and more particularly to means for swinging a boom pivotally mounted thereon.

On those floating dredges which are provided with a boom, it is usual to pivotally mount the boom on the deck and to provide some means for swinging the boom about its pivot so that a load suspended from the boom may be moved angularly with respect to the deck. Certain types of power shovels have a similar arrangement.

Heretofore the most common means for swinging a boom has consisted of a pair of independently operable swinging drums, located on opposite sides of the boom foot and cables or the like connecting the drums to the boom.

Another known form of swinging means employs a circle, fixed to the lower portion of the boom, the circle being rotated in either direction by a reversible engine or a reversible transmission drive.

A third form of boom swinging means, called the "gravity swing", employs a hoisting line and a swinging line, which run to the boom point from opposite sides of the deck or supporting base of the excavator. The weight of the bucket, acting through the hoist line causes the boom to swing as the swinging line is slacked off.

Each of these swinging arrangements has certain disadvantages. The double drum cable arrangement is difficult to operate smoothly, there being a tendency for slack to occur in the cables. This type also requires the use of two swinging engines or two independent clutch arrangements and the controls incidental thereto.

The circle swinging means is satisfactory for short booms, but is unsatisfactory for use with long booms, since it causes excessive strains in the boom which is subjected to bending moments when the circle is rotated. The "gravity swing" has the disadvantage of being able to swing the boom to one side only.

An object of the present invention is to provide boom swinging mechanism which obviates all of these difficulties in that it is capable of swinging the boom in either direction, has only one driving element and does not cause excessive strains in the boom.

A further object is to prevent the occurrence of excessive slack in cables used for swinging the boom so as to facilitate smooth and accurate manipulation of the boom.

Another object is to provide a novel means for guiding and controlling swinging cables so as to cause the cables to pass through points fixed with respect to the deck or supporting base of an excavator even though the cables do not remain in a single plane.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claim, reference being had to the accompanying drawings, forming a part of this specification, and in which:

Figure 1 is a fragmentary side view in elevation of a floating dredge having the present invention embodied therein;

Figure 2 is a fragmentary plan view of the dredge of Figure 1;

Figure 3 is an enlarged side view of a sheave and pivotal mountings therefor used in the boom swinging arrangement of the dredge of Figures 1 and 2; and

Figure 4 is an end view of the device of Figure 3.

Referring to Figures 1 and 2 of the drawings, the reference numeral 1 indicates the hull of a dredge having a boom 2 and an A-frame 3 mounted thereon. The boom is pivotally mounted on the deck of the hull by means of a boom foot 4 and is supported in the inclined position shown in Figure 1 by means of the cables 5 and guys 6, the cables 5 being connected to the A-frame pivot 8. With this construction it will be seen that the boom will swing about an imaginary line drawn through the boom foot 4 and the A-frame pivot 8 as an axis and that the boom point 7 will travel in a circle about some point in that axis.

The parts described above may be of any well known construction and do not form part of the present invention. The novel

features of the dredge shown reside in the means for swinging the boom about the axis referred to.

The means for swinging the boom consists of the swinging engine or other source of motive power 10, horizontal sheaves 11 fixed to the deck at points opposite the swinging engine, swinging sheaves 12 and a cable 13. The swinging sheaves 12 have been specially devised to meet the requirements of the invention and constitute, especially as to their position, a critical feature of the swinging arrangement.

Before proceeding with a description of the operation of the boom swinging means, the construction of the swinging sheaves 12 will be described. As shown in Figure 2, the swinging sheaves are two in number and are secured to the deck on opposite sides and slightly in advance of the boom foot. Figures 3 and 4 show the details of the right hand swinging sheave assembly. It will be understood that the left hand sheave is similar in construction. As shown in these figures, the assembly includes two trunnion brackets 14 adapted to be bolted or otherwise secured to the top and side of the hull. These brackets are maintained in spaced relation by three pipes 15 and three bolts 16 which extend through the pipes and are secured to outwardly projecting flanges of the brackets.

Rotatably mounted in the bearings 17 of the brackets is a trunnion 18. This trunnion is preferably cast in one piece and is U-shaped in cross section, the upper ends being provided with bearings 20 and the front and rear ends being provided with stub shafts 21 which interfit with the bearings of the brackets. The outer ends of the shafts 21 are reduced in diameter and threaded so as to receive threaded retaining collars 22.

Mounted upon a shaft supported by the bearings 20 of the trunnion is a sheave 23. This sheave is of such a diameter that its working or pitch circle is tangent to the axis of the stub shafts 21. The rear shaft 21 is provided with a longitudinal passage, through which cable 13 is reeved. From the rear shaft 21 the cable extends around the sheave 23 and is inclined upwardly through guards 25 to the boom point 7, as shown in Figure 2. These guards 25 are bolted to the trunnion and are secured to each other by a bolt 26, as shown in Figure 4.

Beneath the axis of the stub shafts 21, the trunnion is provided with a plurality of weights 27, these weights being rigidly secured to the trunnion by bolts or otherwise. These weights are preferably of the segmental shape shown in dotted lines in Figure 4.

With this construction it will be seen that the trunnion 18 and sheave 23 are adapted for free swinging movement about the stub shafts 21 under the influence of the angular pull of the cable 13 and that the weights 27 always tend to return the same to a vertical position. It is to be especially noted that no matter what position the boom may take, the cable always passes through the point of tangency to the sheave and in the axis of the stub shafts. As will be evident in view of the following discussion, it is important that the cable always passes through this point which is fixed with respect to the deck.

If desired, the brackets 14 may be provided with wooden blocks projecting into the path of the trunnion so as to limit movement thereof and provide a sort of cushion at the ends of its swing.

As shown in Figure 2, the cable 13 may be one continuous cable extending from the boom point 7 under one swinging sheave 12, around one horizontal sheave 11, the drum of the swinging engine 10 and the second horizontal sheave, and under the second swinging sheave 12 back to the boom point 7. It is preferable to employ two swinging cables however, each extending from the boom point to the drum of the engine.

While the means described above is operative to swing the boom irrespective of the location of the swinging sheaves 12 upon the deck, it is unsatisfactory unless these sheaves are properly located, because of the slack which occurs in the line as the boom is swung from one position to another. It is obvious that if slack occurs in the line, the boom cannot be swung to a given position smoothly and accurately with only one hoisting drum and one brake therefor. That slack will occur in the line under ordinary circumstances is evident from the fact that the cable 13 is taken in by the engine over one sheave 12 as fast as it is let out over the other sheave 12 so that the sum of the distances from the sheaves 12 to the boom point 7 must be constant at all positions of the boom if no slack is to occur in the swinging line. In other words, if no slack is to occur, the point 7 must so move with respect to the sheaves 12 as to satisfy the equation of an ellipse the focal points of which are the sheaves 12.

But, as stated above, the boom point 7 travels in a circle about some point in an axis through the boom foot and A-frame pivot, and hence cannot move in the locus of an ellipse about the sheaves 12 as focal points.

It has been discovered, however, that by properly positioning the sheaves 12, with respect to the boom foot 4, the actual movement of the boom point 7 may be made to very nearly approximate movement satisfying the equation of an ellipse about these sheaves. It is evident that the nearer the actual movement of the boom point comes to satisfying the equation of an ellipse, the less slack will

occur in the swinging cable 13 as the boom moves from one position to another.

In the following discussion the swinging sheaves 12 will be denoted as the focal points, a line through these points as the major axis and a line at right angles to the major axis and through the boom point when the boom is in the forward position, as shown in Figure 2, as the minor axis.

It is evident that solid geometry is involved in determining where to locate the focal points 12 since the boom point does not remain in the plane defined by the major and minor axes.

As illustrated in Figures 1 and 2, the focal points are located a small distance in advance of the boom foot. Where the boom is relatively long with respect to the width of the dredge or distance between the focal points, the following formula may be used in determining how far to advance the focal points:

$$\left(\frac{A}{2}\right)^2 - h^2 = (B-x)^2$$

in which

A=sum of distances from focal points to boom point when boom is swung into a vertical plane above the major axis, the major axis then being through the boom foot.

B=horizontal distance from either focal point to boom point when the boom is in line with the minor axis.

(Note: In measuring these distances, the focal points should be regarded as in line with the boom foot.)

h=vertical distance of boom point above the hull deck; and

x is the unknown horizontal distance the focal points should be in advance of the boom foot.

Where the boom is relatively short with respect to the distance between the focal points the following empirical formula which is believed to be more accurate than the one given above, may be used:

$$4(R-x)^2=[\sqrt{(R-w)^2+h^2}+\sqrt{(R+w)^2+h^2}]^2-4w^2-4h^2$$

in which R=radius of boom point circle, i. e., distance of boom point from axis through boom foot and A-frame pivot.

w=one half the distance between the focal points.

h=the distance from the boom foot along the axis of rotation of the boom to the center of the boom point circle. (It is to be noted that this is a vertical distance only when the A-frame pivot is directly above the boom foot.) and

x=the distance the focal points should be advanced as in the first equation given above. The formula last given takes into account the fact that as the focal points are moved forward, the boom cannot be swung, by the means shown, into the vertical plane having the two focal points therein.

A dredge having swing means constructed in accordance with the above description had the following dimensions:

R=143.5 feet w=25.5 feet h=60 feet

Using these values in determining the values of x in the first formula given above, x was found to be 2.5 feet. It may easily be shown mathematically that slack of only a few inches occurs in the swinging line when the boom travels from its forward position to is maximum side position if the focal points are advanced this distance beyond the boom foot. On the other hand, approximately four feet of slack would occur if the focal points were laterally opposite the boom foot. In practice, with the focal points properly located, no slack at all is noticeable as the boom swings over its working arc.

While the above formulæ are believed to be dependable, it is to be understood that they are merely suggestive and that changes therein may be necessary in determining the best location of the focal points, under a given set of conditions, to prevent the occurrence of slack in the cable. The invention is in no way limited to the use of these formulæ.

It is believed that the principles of the above described invention will be found to be useful for other purposes than swinging a boom. For example, it may be desirable to pivotally mount a dipper stick on a boom and swing it back and forth by means of a single drum and a single cable connected to the top and bottom of the dipper stick. In that case, movement of the dipper stick would be in the same plane with the swinging cable and the problem would resolve itself into the superposing, as near as possible, of a portion of an ellipse upon the arc of a circle.

The invention may also be adapted to entirely different constructions, being useful wherever it is desired to move one pivotally mounted element with respect to another by means of a single cable and without subjecting the parts to bending moments or torque. It is therefore to be understood that the disclosure herein is to be taken only by way of example and that various changes may be made without departing from the spirit of the invention or the scope of the annexed claim.

The invention claimed is:

Apparatus for swinging an element with respect to a base upon which it is pivotally mounted and from which it extends forwardly and upwardly, said apparatus comprising a flexible connector having both ends secured to said element, a single driving member located on said base and operatively connected to said flexible connector and two devices for guiding said flexible connector

mounted on said base and spaced laterally from and on opposite sides of the point where said element is pivotally mounted on said base and slightly in advance of said pivot point, the distance the guide devices are in advance of said pivot point being such as to cause the flexible connector to remain substantially taut as the element swings over an arc of nearly 180 degrees, the distance the guide devices are in advance of the pivot point being substantially that found for X when the known values for a given arrangement are substituted in the following formula:

$$\left(\frac{A}{2}\right)^2 - h^2 = (B - X)^2$$

in which A=the sum of the distances from the guide devices to the point of connection of the flexible connector to said element when said element is swung to a position substantially over said guide devices; h is the vertical distance the point of connection of the flexible connector and said element is above said base; and B is the horizontal distance from either guide device to the point of connection of said flexible connector and said element when said point of connection is equidistant from said guide devices.

In witness whereof, I hereto affix my signature.

GEORGE A. McWILLIAMS.