Feb. 11, 1969 C. F. NOVOTNY 3,426,916

BOOM RETRACTING MACHINERY

Filed June 29, 1967 Sheet 1 of 2

Fig. 1

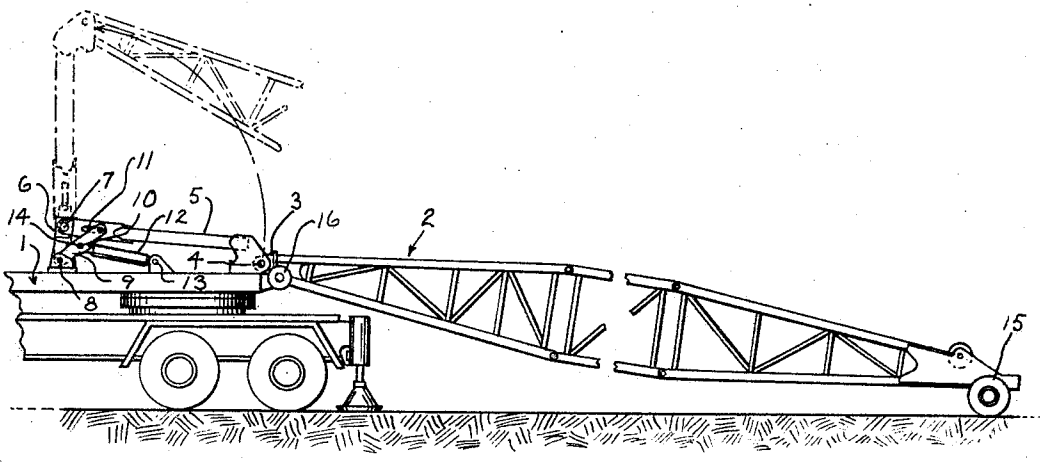
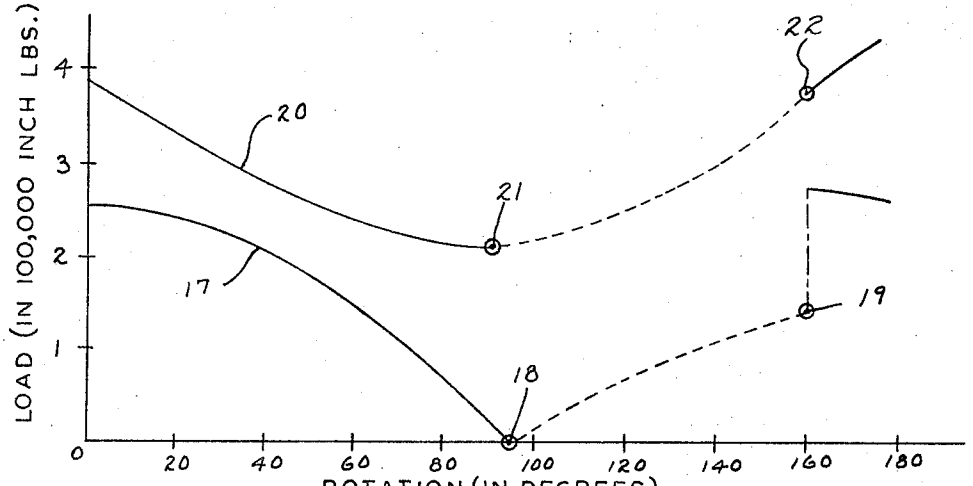


Fig. 4



INVENTOR
CARL F. NOVOTNY

BY Allan W. Leisen

ATTORNEY

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Fig. 2

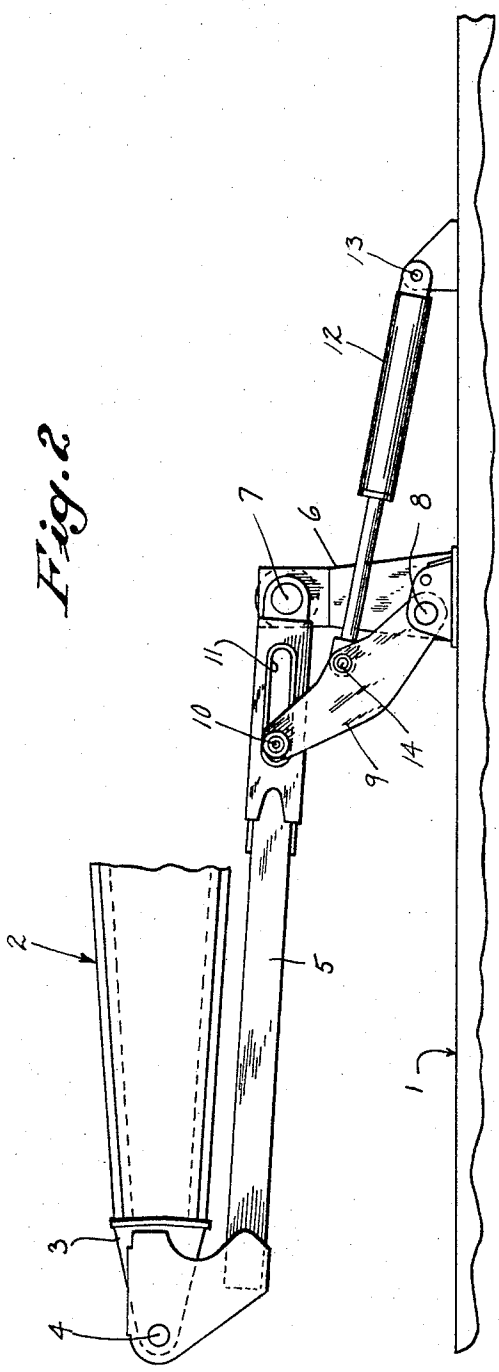
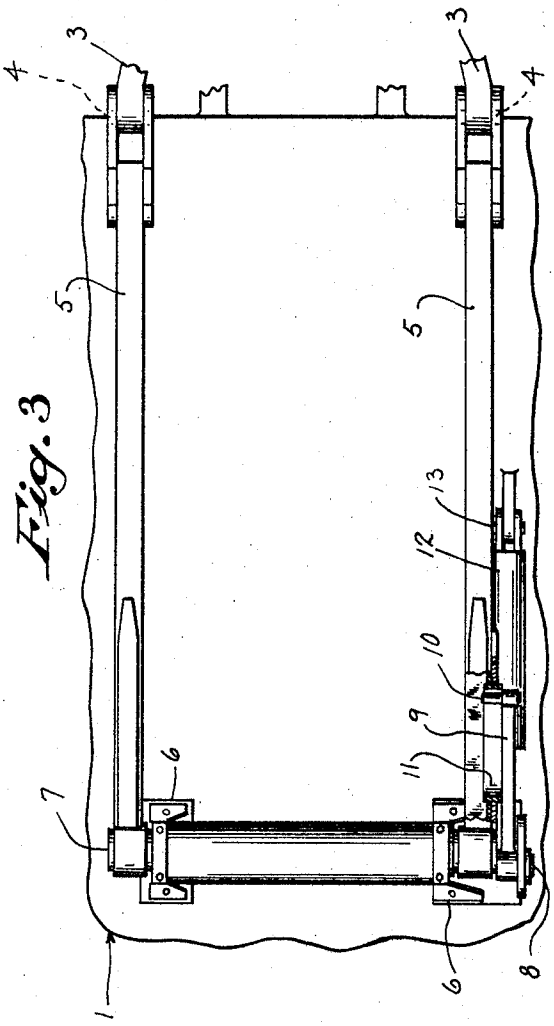


Fig. 3



INVENTOR
CARL F. NOVOTNY

BY Allan W. Heisen

ATTORNEY

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BOOM RETRACTING MACHINERY

Carl F. Novotny, Milwaukee, Wis., assignor to Bucyrus-Erie Company, South Milwaukee, Wis., a corporation of Delaware

Filed June 29, 1967, Ser. No. 650,032
U.S. Cl. 212—46 6 Claims
Int. Cl. B62c 23/62

ABSTRACT OF THE DISCLOSURE

The bifurcated foot of the boom of a truck mounted crane is pivotally attached to respective outer ends of parallel retracting arms, the inner ends of which are fulcrumed on the revolving frame and connected by a torque shaft. The arms are pivotal through 180° to lift and move the boom foot between a retracted position to the rear of the frame and a forward working position. An actuating lever for the arms has an inner end fulcrumed on the frame below the fulcrum of the arms and an outer end which has a pin and slot connection with one arm. A hydraulic actuator cylinder is connected between the frame and a midpoint of the lever and is operable to reciprocally pivot the lever and, therefore, the arms.

Background of the invention

It is desirable in a truck mounted crane or the like to be able to retract the boom to shorten the machine for travel purposes. The copending application of George W. Mork, Ser. No. 600,541, filed Dec. 9, 1966, discloses an embodiment of a truck mounted crane with a retractable boom in which the boom foot is connected to the outer ends of actuating arms which are fulcrumed on the revolving frame. The arms are pivotal through 180° to lift and move the boom foot between a forward working position and a retracted position to the rear of the frame.

The general arrangement shown in the aforesaid Mork application is very satisfactory from the standpoint of simplicity and strength, but it is difficult to provide suitable means for pivoting the arms. The primary problem in this regard is the variability of the torque load as the boom moves from one position to the other. During retraction, for example, the arms pivot between positions in which they extend horizontally forward and horizontally rearward. Since the boom foot is supported at the ends of the arms, the torque load begins at a maximum, goes to zero as the arms pass through vertical and then again becomes a maximum. Further, the torque load changes from positive to negative as the arms pass through vertical. Because of the dramatic changes in degree and character of the torque load, it is extremely difficult to provide an efficient actuating means to pivot the arms.

Summary of the invention

The boom retracting machinery of this invention provides a turning block linkage for retracting and extending the boom. The retracting arms form one moving link, and an actuating lever forms the other moving link, the outer end of the actuating lever having a lost motion or sliding block connection with one of the arms. The fulcrum of the actuating lever is below the fulcrum of the retracting arms so that it is required to move through substantially less angular distance as the arms move through 180°. As a result, it is possible to use a single conventionally mounted hydraulic cylinder as an actuator. Not only does the machinery of the invention allow for an extremely simple but strong apparatus, but its torque capability matches the torque load almost exactly.

Brief description of the drawings

FIG. 1 is a fragmentary schematic view of a truck mounted crane with the boom retracting machinery of this invention incorporated therein, the elements being shown in a working position with an intermediate retracting position being shown in broken lines,

FIG. 2 is an enlarged fragmentary side view of the apparatus of FIG. 1, but with the elements shown in a fully retracted position,

FIG. 3 is an enlarged fragmentary top view similar to FIG. 2 and further illustrating the elements shown therein, and

FIG. 4 is a graph showing torque capability and load curves for the machinery of FIGS. 1–3.

Description of the preferred embodiment

The numeral **1** in the drawings designates the revolving frame of a truck mounted crane, only a portion thereof being shown, and the numeral **2** designates a generally conventional boom mounted thereon. As can be seen in FIG. 3, the foot portion of the boom **2** is bifurcated to define two spaced, rearwardly extending parts **3**. The ends of the parts **3** are pivotally connected at **4** to the respective outer ends of parallel retracting arms **5**, the points **4** serving not only as points of connection, but also serving to define the actual foot of the boom **2**.

A pair of laterally spaced, upstanding supports **6** are provided on the frame **1**, and a transverse tubular torque shaft **7** is journaled therein. The inner ends of the retracting arms **5** are fixed to the respective ends of the tube **7** to pivotally mount them on the frame **1**, with the center of the tube **7** defining a fulcrum for the arms **5**.

Obvious additional elements of the truck mounted crane such as the carrier vehicle, hoist machinery, etc. are not fully shown and described herein since they are well known to those skilled in the art and art not necessary per se to the invention herein. A specific illustrative showing of such a crane, and a showing of a retractable boom of the general type contemplated herein, can be found in the aforementioned copending application of George W. Mork, Ser. No. 600,541.

One of the supports **6**, the one to the front in FIGS. 1 and 2 and below in FIG. 3, also suitably pivotally mounts and defines a fulcrum **8** for the inner end of an actuating lever **9**, the fulcrum **8** being outside, below and just slightly behind the fulcrum **7** of the arms **5**. The actuating lever **9** is pivotal in a vertical plane adjacent and parallel to the plane of pivotal movement of the nearest arm **5**. The outer end of the lever **9** is provided with a transverse pin **10** which is received and movable in a longitudinally extending slot **11** formed in the associated arm **5**, the pin **10** and slot **11** defining a lost motion or sliding block connection between the outer end of the lever **9** and the associated arm **5**, which connection is at any suitable midpoint, i.e., point between the ends, of the arm **5**.

A conventional two-way hydraulic actuator cylinder **12** of suitable form is pivotally connected at one end **13** to the frame **1** and has its other end pivotally connected to the lever **9** at a suitable midpoint **14**. Extension and retraction of the cylinder **12** will cause the lever **9** to pivot reciprocally in a vertical plane about its fulcrum **8**, the transverse pivotal connections **13** and **14** allowing the cylinder **12** to move vertically as required. Because of the connection afforded by the pin **10** and slot **11**, the lever **9** will in turn cause the arms **5** to pivot about their fulcrum **7** to move the boom foot **4**. The lever **9** acts only on the nearest arm **5** of course, but the torque shaft **7** transmits its force substantially equally to the far arm **5**.

As a result of having the shaft **7**, it is unnecessary to provide two levers **9** and actuating cylinders **12**.

The full line showing of FIG. 1 illustrates what is termed a working position in which the boom foot **4** is at the forward end of the frame **1** and the arms **5** are horizontal and extend forwardly from their fulcrums **7**. In this position, the lever **9** extends upwardly and forwardly from its fulcrum **8** and the cylinder **12** is fully retracted. During working, the boom foot **4** will of course be suitably locked in place, and the boom **2** may be luffed in the usual fashion.

When it is desired to retract the boom **2**, it is first fully lowered to the horizontal position shown in FIG. 1 wherein a guiding and supporting wheel **15** provided on the tip of the boom **2** rests on the ground. The cylinder **12** is then extended to cause counterclockwise pivoting of the lever **9** and arms **5**, the elements then moving through the intermediate position shown in broken lines in FIG. 1 to the position shown in FIG. 2 which is termed a retracted position. In retracted position, the boom foot **4** is at the rear of the frame **1** and the arms **5** are horizontal and extended rearwardly from their fulcrum **7**, the lever **9** extends upwardly and rearwardly, and the cylinder **12** is fully extended. As the elements move from working to retracting position, the pin **10** moves from the outer end of the slot **11** to the inner end and then back again to the outer end, thus providing a lost motion connection which compensates for the difference in elevation of the fulcrums **7** and **8**. Having the fulcrum **8** offset behind the fulcrum **7** insures against a dead spot when the arms **5** reach a vertical position. The same effect could of course be had by offsetting the fulcrum **8** forwardly.

As the boom **2** is retracted, the foot **4** moves in a semicircle, and as a result the initial and final phases of its movement are largely vertical with the major horizontal movement occurring between. During the first phase of movement, the boom foot **4** is lifted quickly, and this insures that the underside of the boom **2** will clear the forward edge of the frame **1** during much of the retracting movement. As the boom **2** moves backward during this portion of the process, much of its weight is carried by the wheel **15** which rolls along the ground. As illustrated by the broken line showing in FIG. 1, when the arms **5** are vertical the underside of the boom **2** is spaced substantially above the frame **1**. At some point after the arms **5** pass vertical so that the foot **4** begins to move down, however, the underside of the boom **2** will be moved down far enough to come against the forward edge of the frame **1**, and rollers **16** are provided on the frame **1** and are positioned to engage the underside of the boom **2** at this point. When the boom **2** is against the rollers **16**, further rearward and downward pivotal movement of the arms **5** will cause the boom **2** to pivot about and roll rearwardly on the rollers **16**, and the weight of the boom **2** will be shifted from the wheel **15** to the rollers **16**, the wheel **15** then being lifted off the ground.

The curve **17** shown in FIG. 4 reflects the torque load on the boom retracting machinery shown during a movement from working to retracted position, this load being of course primarily the result of the weight of the boom **2** which is approximately 4500 pounds in this embodiment. At the beginning of a retracting action, the load is maximum in degree and is positive or clockwise in character. When the load is positive, pushing force by the cylinder **12** is required to effect movement. The positive torque load gradually decreases in degree as the arms **5** pivot upwardly toward a vertical position and reaches zero at the point **18** where they are fully vertical. As soon as the arms **5** pass through vertical, the torque load changes from positive or clockwise to negative or counterclockwise, and at this point the cylinder **12** assumes a holding function. (For the sake of clarity, the torque load curve after the zero point is passed is shown in FIG. 4 as being above the abscissa in FIG. 4, but it is drawn in broken lines to indicate that it is negative in character.) As the arms **5** move further, from vertical to fully retracted position, the load gradually increases again in degree. At a point marked **19**, however, the boom **2** comes against the rollers **16**, and at this point the load instantly goes back to positive, a pushing force by the cylinder **12** being required to pivot the boom **2** onto the rollers **16**. This is shown by the phantom vertical line leading upwardly from the point **19**, the continuation of the curve **17** from this line being shown as a full line to indicate its positive character.

The curve **20** in FIG. 4 defines and illustrates the torque capability of the boom retracting mechanism shown, assuming a five inch cylinder with a two inch piston operated at 2000 p.s.i. The system capability, it will be seen, is also at a maximum when the elements are in working position, decreases to a minimum at a point **21** when the lever **9** is vertical and increases again to a maximum when the elements are in retracted position. The output capability of the system also changes from positive to negative at the point **21** and goes back to positive at a point **22** corresponding to the point **19**, the cylinder **12** changing from pushing to pulling functions and back through suitable circuitry known to those skilled in the art. The minimum point **21** of the curve **20** and the zero point **18** of the curve **17** do not exactly coincide because of the slight rearward spacing of the fulcrum **8** from the fulcrum **7**, but they very closely approximate one another. All in all, it will be seen that the curves **17** and **20** are very similar so that the capability of the system is very closely matched to the requirements put upon it, and the same will obviously be true for a movement back to working position. This close matching provides obvious design advantages in that minimal elements can be used and no substantial capability or work is wasted. The necessity of pivoting the boom **2** onto the rollers **16** affects the symmetry of the curves **17** and **20** to some extent, but does not significantly change the close matching of capability to load. For movement from retracted to working position or vice versa both the load and capability, for all practical purposes, begin at a maximum, go through zero together and end at a maximum.

The curves **17** and **20** assume certain sizes, weights, and other conditions. The general relationships shown, however, will obtain even if these conditions are varied.

It will also be noted from an examination of FIGS. 1 and 2 that whereas the arms **5** pivot through approximately 180° during a retracting action or a return to working position, the lever **9** pivots through a substantially lesser angular distance. This allows for the use of the single fixed cylinder **12** as an actuator. If a cylinder were to be attached directly to the arms **5** to move them through 180°, some provision would have to be made for moving its point of connection with the frame **1** to allow for the full 180° movement required.

Although a preferred embodiment of the invention has been shown herein, it will be obvious to those skilled in the art that variations in the structure shown can be made without departure from the concept of the invention. Further, the invention is not limited in possible use to truck mounted cranes and other applications are obviously feasible. In view of the possible variations in both structure and use, the invention is not intended to be limited by the showing herein or in any other manner except insofar as limitations appear specifically in the following claims.

I claim:

1. In a truck mounted crane or the like having a revolving frame, a retracting arm having an inner end fulcrumed on the frame and an outer end, and a boom having a foot pivotally connected to the outer end of the retracting arm, the combination therewith of: an actuating lever having an inner end fulcrumed on the frame at a point below the fulcrum of the actuating arm and an

outer end connected to a mid-point of the actuating arm with a lost motion connection; and an actuator connected between the frame and a midpoint of the actuating lever, the actuator being operable to reciprocally pivot the actuating lever to in turn cause reciprocal pivotal movement of the actuating arm.

2. The combination of claim 1 wherein the actuator comprises a two-way hydraulic cylinder with transverse pivotal connections at its ends to the frame and actuating lever.

3. The combination of claim 1 wherein there are two parallel retracting arms and the boom foot is bifurcated with its two parts connected to the outer ends of respective arms; and wherein there is a transverse torque shaft connecting the inner ends of the arms; and wherein the actuating lever is connected to only one of the arms.

4. The combination of claim 1 wherein the lost motion connection between the outer end of the actuating lever and the arm comprises a longitudinal slot provided in the arm and a transverse pin at the outer end of the actuating lever this is received and movable in the slot.

5. The combination of claim 1 wherein the fulcrum of the lever is offset from the fulcrum of the arm to prevent a dead spot as the arms go through vertical.

6. The combination of claim 1 wherein the actuator comprises a two-way hydraulic cylinder with transverse

pivotal connections at its ends to the frame and actuating lever; and wherein there are two parallel retracting arms and the boom foot is bifurcated with its two parts connected to the outer ends of respective arms; and wherein there is a transverse torque shaft connecting the inner ends of the arms; and wherein the actuating lever is connected to only one of the arms; and wherein the lost motion connection between the outer end of the actuating lever and the arms comprises a longitudinal slot provided in the arm and a transverse pin at the outer end of the actuating lever that is received and movable in the slot; and wherein the fulcrum of the lever is offset from the fulcrum of the arm to prevent a dead spot as the arms go through vertical.

References Cited

UNITED STATES PATENTS

3,146,893 9/1964 Eckles et al. ---------- 212—8

FOREIGN PATENTS

1,214,066 11/1959 France.

HUGO O. SCHULZ, *Primary Examiner.*

U.S. Cl. X.R.

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(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,426,916 Dated February 11, 1969

Inventor(s) Carl F. Novotny

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 4,	line 75,	"actuating" should be -- retracting --
Column 5,	line 1,	"actuating" should be -- retracting --
Column 5,	line 6,	"actuating" should be -- retracting --

Signed and sealed this 3rd day of April 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents