May 29, 1945. P. T. ROBIN 2,377,184

AUTOMATIC GRAB BUCKET

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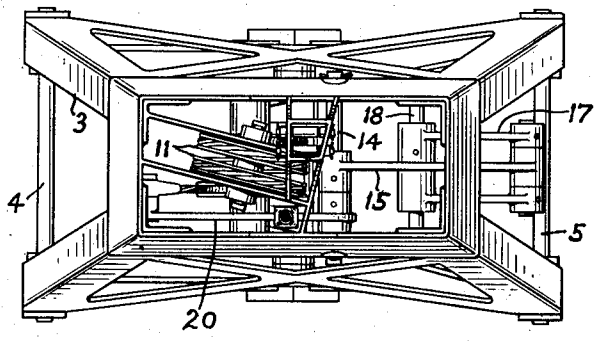
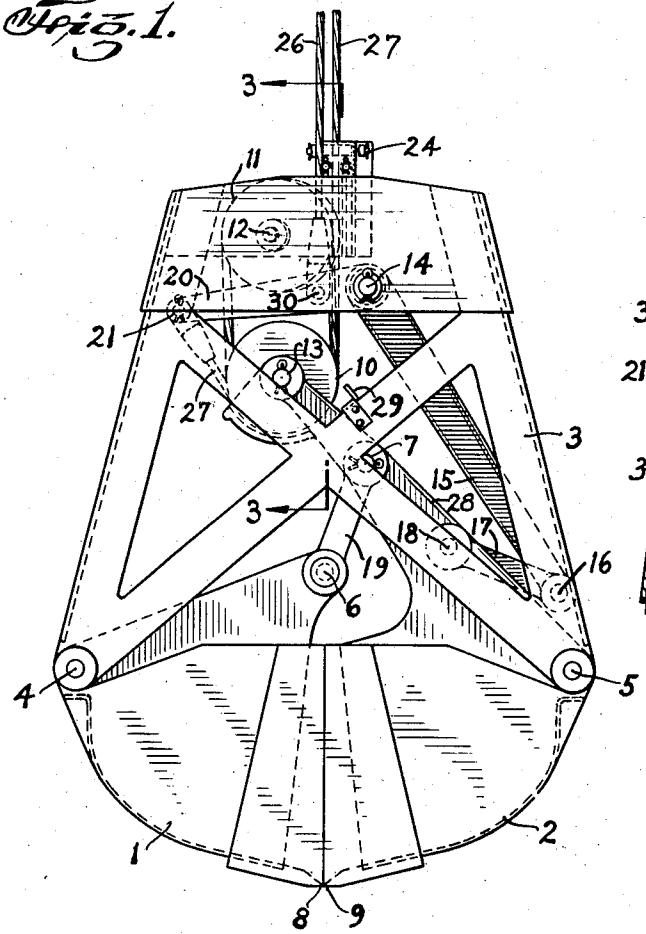


Fig. 2.

Fig. 1.



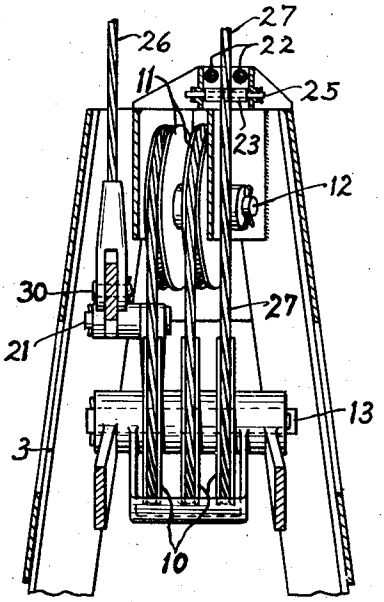


Fig. 3.

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Fig. 5.

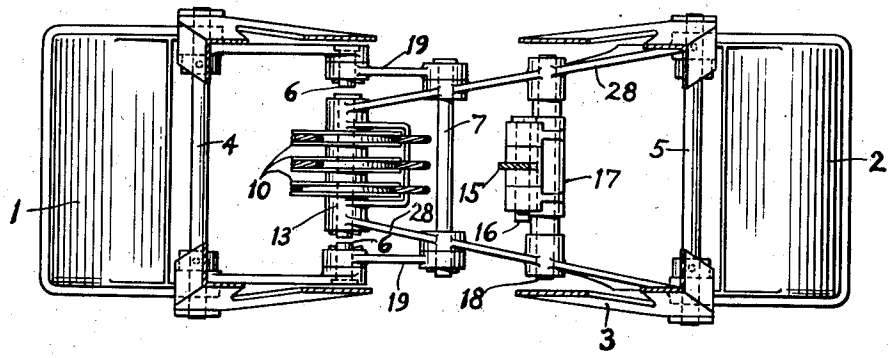
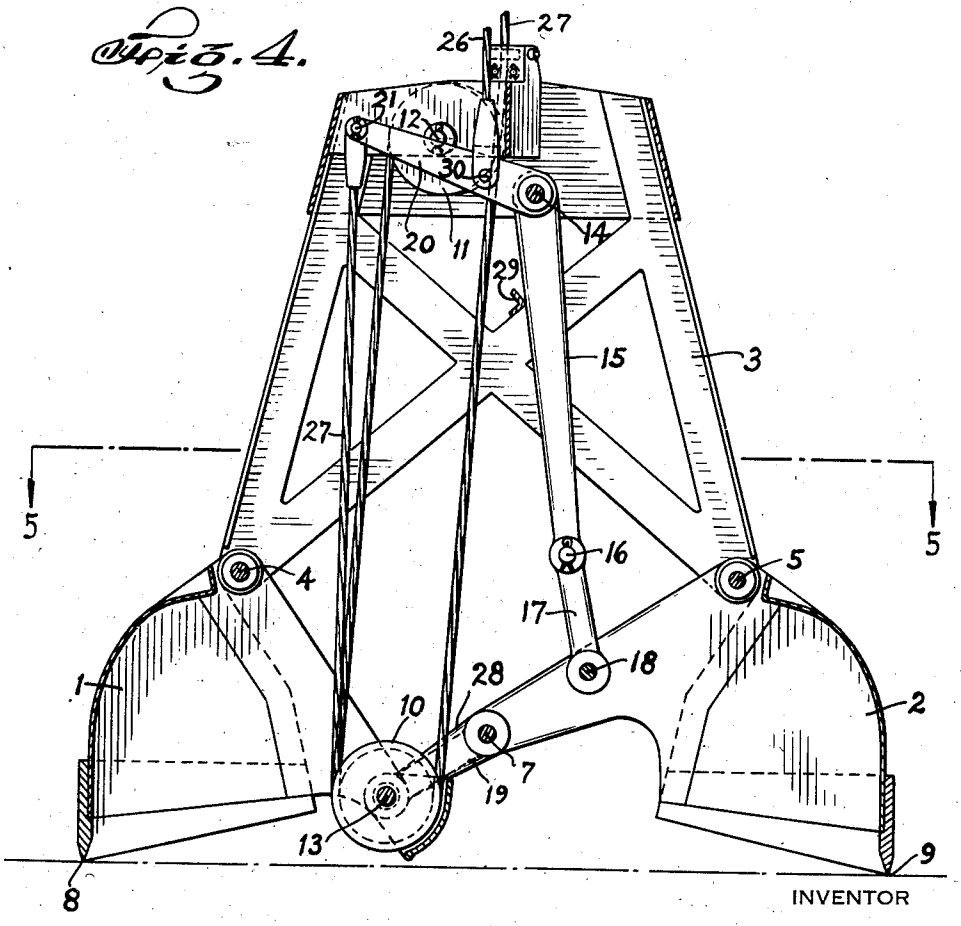


Fig. 4.



INVENTOR

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2,377,184

AUTOMATIC GRAB BUCKET

Philip Theodore Robin, Valley Stream, N. Y.

Application August 25, 1944, Serial No. 551,103

2 Claims. (Cl. 37—187)

My invention relates to automatic grab buckets of the type usually operated by means of closing and opening cables suspended from a crane or other hoist apparatus and aims to provide a device of this character with inherent ability to penetrate, gather and discharge a greater quantity of material in a given space of time than is possible with buckets of comparable size and weight now in common use.

All grab buckets include closing means comprising some form of speed-reducing mechanism by virtue of which the upward pull exerted by the hoist upon the closing cable reeved in the bucket is converted to a force actuating the jaws toward one another in a substantially horizontal direction against resistance offered by the material which is to be handled or excavated. The ratio between the said horizontal force at the cutting edges of the jaws and the said upward hoist pull is a measure of the internal closing power of the bucket, which is the dominant factor governing actual digging performance.

The average power ratio of any bucket may be obtained by dividing the length of closing cable extracted from the bucket while closing by the distance through which the cutting edges travel from wide-open to closed position. However, the importance of proper distribution or allocation of the power ratio at specific points throughout the stroke has not, heretofore, generally been recognized by designers and engineers in the bucket art. After extensive observation and experiment I have discovered that during the first half of the stroke beginning with the jaws in wide-open position, the cutting edges are disposed at a relatively great vertical angle with respect to their direction of movement and hence merely scrape through the material without being able to penetrate or engage the same to any important degree. Therefore, only relatively slight resistance is to be encountered and a low power ratio not only is sufficient but desirable in order that this phase of the stroke may be completed in a minimum of time. Conversely, as the jaws advance through the material during the last half of the stroke and approach the point of closure, the cutting edges are positioned at a relatively small vertical angle with respect to their direction of movement, so that firm engagement with the bed of unloosened material is facilitated. The said engagement, together with the necessity for compression of material already loosened and scraped within the bowls give rise to relatively great resistance and a strong effort of the closing elements is required in order to maintain closing movement of the jaws. Since this effort involves a pull on the closing cable in an upward direction, it will be seen that high power ratio in this last portion of the stroke will result in movement being maintained with minimum effort by the hoist, hence a relatively great portion of the bucket weight will remain to exert the essential downward pressure against the material. Thus it will be appreciated that a bucket having a high power ratio during the first half of the stroke will not scrape together substantially more material than one having a relatively low power ratio, but that the former will require more time for the same movement; whereas a bucket having a high power ratio during the last half of the stroke will attain deeper penetration and secure more material between the bowls than one possessing less favorable power characteristics.

Most grab buckets in common use include a pair of bowls pivotally connected together at their adjacent inner ends, pivotally mounted links at their outer ends, a head block pivotally supported by said links and closing elements of a speed-reducing nature which actuate the head block toward the bowls to close the bucket. It is characteristic of such mechanisms that high power ratio is developed during the first half of the stroke and correspondingly low power ratio in the last half of the stroke, the latter to such a degree that the upward pull on the closing cable may exceed the entire weight of bucket and load, causing the bowls to rise out of the material prior to closing.

The bucket which forms the subject of this application, possesses power ratio characteristics which are directly opposite to those of the buckets described in the paragraph immediately above, so that the several operative deficiencies described therein will be overcome by my invention.

Grab buckets discharge their loads when the opening cable is used to support the head and the closing cable is relaxed by the hoist and permitted to pay back through the reeving apparatus of the bucket. During this operation, friction and inertia of the hoist elements cause resistance to the said reverse movement of the closing cable and considerable effort must be developed by the various parts of the bucket which are adapted to move toward gravity in conjunction with separation of the bowls in order to draw in or overhaul the closing cable with proper dispatch.

In comparison with buckets of the pivoted head-link type previously described, the bucket structure comprising my invention will exert a

relatively stronger overhauling effort on the hoist cable during the first stage of the opening movement but, conversely, in the final stage of the same relatively less overhauling effort will be produced by the said parts moving toward gravity. Therefore, an important feature of my invention is the provision of means for augmenting the opening movement in its final stage by utilization of the weight of the entire bucket in such manner that a strong and substantially uniform overhauling effort may be exerted throughout the opening movement, reaching a maximum and causing the bowls to lock automatically at the extreme wide-open position. The said locking function will be terminated by natural inter-action of the closing and opening cables after the open bucket has been brought to rest upon the material, thus releasing the closing elements automatically for the subsequent cutting stroke. The said opening and locking functions will permit the bucket to be discharged rapidly, then lowered and dropped upon the material with dispatch and sufficient force to assure proper initial penetration.

The advantageous distribution of power ratios which constitutes one of the principal objects of my invention is attained by virtue of the fact that the pivotal connections for the outer ends of the bowls are maintained always at a fixed distance from each other, since the head frame 3 is of rigid, one-piece construction. More specifically, the said connections provide an unyielding reaction by which the closing elements, acting in a substantially vertical direction, are enabled to overcome resistance of the material between the jaws with a minimum of effort during the last half of the stroke. A few grab buckets have been constructed with one-piece head frames and thus possessing power ratio characteristics similar to those attained by my invention. However, in all such buckets, coordination of the inner ends of the bowls has been accomplished by means of vertical guides or a plurality of links and gears, both of which methods are highly undesirable from the standpoint of trouble-free maintenance, whereas the link 19 in the bucket comprising my invention serves to coordinate the inner ends of the bowls in a simple and satisfactory manner.

Having thus described the principal features and objects of my invention, attention is directed to the drawings, in which:

Fig. 1 is a side elevation showing the bucket in closed position.

Fig. 2 is a top plan of the same.

Fig. 3 is a sectional view of the closing elements.

Fig. 4 is a sectional side view of the bucket in wide-open position.

Fig. 5 is a sectional plan view showing the lower elements of the bucket.

Referring more specifically to the drawings, it is seen that 1 and 2 mark the bowls and 8 and 9, respectively, the jaws or cutting edges of the same. The said bowls are pivotally connected to the one-piece head frame 3 by the shafts 4 and 5 and also are pivotally connected to the link 19 by pins 6 and the shaft 7. Lower closing elements comprising a plurality of sheaves 10 are rotatably mounted on the shaft 13, positioned at the outer end of the extension arm 28 which is rigidly attached to bowl 2. (It should be noted that, although the pins 6 and the shaft 13 appear as though axially aligned both in Figs. 4 and 5, this alignment is merely coincidental and of no significance.)

The toggle link 17 is pivotally mounted at an intermediate point on the extension arm 28 by means of the shaft 18 and the toggle link 15 is mounted upon and keyed to the shaft 14, the latter being mounted for turning in the head frame 3. Links 15 and 17 are pivotally connected to each other by the pin 16. A stop or bumper member 29, the precise location of which with respect to the rotative movement of the link 15 is preferably subject to slight adjustment by means of shims or screws, is mounted in the head frame 3 in order to terminate the clockwise rotation of link 15 after the joints 14, 16 and 18 have attained positions substantially in alignment with each other in conjunction with the opening movement of the bowls. The crank 20 also is mounted upon and keyed to the shaft 14, the said crank being adapted for pivotal connection of the closing cable 27 by pin 21 near its outer end and for pivotal connection of the opening cable 26 by pin 30 at a point intermediate its ends.

Upper closing elements consisting of a plurality of sheaves 11 are rotatably mounted on the shaft 12, the latter being mounted in the head frame 3 and positioned at a slight angle in the horizontal plane in order to provide substantially fair leads for the closing cable 27 between the sheaves 10 and 11. Guide rollers 22 and 23 are mounted for turning on the pins 24 and 25 respectively and serve to prevent chafing of the cable 27 as it enters or leaves the head of the bucket.

In operation, the cutting edges of the bowls in wide open position are placed in contact with the material to be excavated. Closing elements and the cable 27 comprise a speed-reducing system which, when actuated by an upward pull on the said cable by the hoist, develops a positive moment tending to cause rotation of the bowls 1 and 2 about the joints 4 and 5 respectively. Resistance of the material to penetration presents a reaction substantially along a plane passing through the lower portions of the cutting edges 8 and 9, thus opposing the tendency of the bowls to rotate as described and developing a resisting moment of a magnitude equivalent to the product of the said resistance and the perpendicular distance between the plane in which it occurs and the joint 4 or 5. The said joints will then be seen to act as fulcrums for interaction of the said positive and resisting moments and it should now be observed that, from mid-stroke to closed position of the cutting edges, the said resistance plane constantly approaches the said fulcrums. Therefore, assuming resistance of the material to remain constant, the said resisting moment will continually diminish during the last half of the closing stroke, requiring progressively less upward pull by the hoist and resulting in effective downward pressure being exerted against the material by the cutting edges in this critical stage of the digging operation. In most buckets of the type now in common use the bowls are pivotally connected together at their adjacent, inner ends on the vertical center line of the mechanism, and the said point of connection acts as a fulcrum for interaction of positive and resisting moments corresponding with those described above. Thus it will appear that, as the cutting edges of the said bowls are moved toward one another, the resistance plane of the material constantly recedes from the said fulcrum and that the resulting resisting moment will increase progressively, mak-

ing necessary a proportionately greater upward pull by the hoist upon the closing cable in order to maintain the closing movement of the cutting edges. It follows that the downward pressure of the cutting edges against the material will be relatively slight and ineffective as compared with the corresponding pressure exerted by a bucket comprising my invention of the same weight, containing a speed-reducing system of equal effectiveness as to devolpment of positive moment from cable pull and being operated in identical material.

The advantage to be gained through favorable digging characteristics cannot, however, fully be realized in terms of maximum output of material in a given period of time if the opening characteristics of the bucket mechanism do not admit of the empty bucket being returned as rapidly as possible and with cutting edges in wide open position, from the point of discharge to contact with the material to be excavated. As previously brought out in this specification, the natural opening action derived from the tendency of the lower, central portions of the mechanism to move toward gravity in conjunction with separation of the bowls of the bucket comprising my invention is inadequate to assure continued, rapid separation of the bowls as they approach the extreme wide open position. Therefore, toggle links **15** and **17** together with the crank **20** are provided and arranged to utilize the force exerted by the opening cable **26** for the purpose of augmenting the said natural opening action. As the bowls reach the wide open position, progress of the joint **16** will be terminated by the stop **29**, in a position slightly beyond the dead center axis which passes through the joints **14** and **18**. Hence premature closing of the bowls from any cause will be obviated, especially that which might result if the bucket were to be set down with the lower, central portions of the mechanism resting upon a projecting mound of material. The mechanism will remain locked securely in the wide open position until released by relaxation of the opening cable **26** and a pull by the hoist on the cable **27**, since by virtue of attachment of the cable **27** to crank **20** by the pin **21**, the latter action will cause the link **15** to be rotated in a counterclockwise direction as viewed in Fig. 4, so that the joint **16** will move through and away from its position of dead center alignment with the joints **14** and **18**.

I am aware that prior to my invention automatic grab buckets have been made with head frames connecting directly with the bowls and also that rigid toggle links have been employed in grab buckets for the purpose of limiting the opening movement. I, therefore, do not claim such a combination broadly; but I claim:

1. The combination, in an automatic grab bucket, of a pair of bowls, a head frame, toggle members connecting the head frame to one of the said bowls, operating means responsive to an opening cable leading to a hoist for actuating the said toggle members toward a dead-center position as the bowls are being opened and responsive to a closing cable leading to a hoist for actuating the said toggle members away from the dead-center position coincident with a closing movement of the bowls, a link member pivotally connecting the inner portions of the said bowls in such manner that one end of the said link member is positioned at a shorter distance to the cutting edge of the bowl to which it is connected than the other end of said link to the bowl to which it is connected.

2. In an automatic grab bucket, the combination of a head frame, a pair of bowls pivotally connected to the head frame at its outer portions, a relatively short hinge member rigidly attached to the inner portion of one bowl, a relatively long hinge member rigidly attached to the inner portion of the other of said bowls, a link member positioned between the said hinge members and pivotally connected to the same, a pair of toggle members pivotally connected to the head frame and to the said relatively long hinge member, means associated with an opening cable operated by a hoist for actuating the said toggle members toward a position of axial alignment as the bowls move toward the open position and associated with a closing cable operated by a hoist for actuating the said toggle members away from a position of axial alignment when the said opening cable is relaxed.

PHILIP THEODORE ROBIN.