Sept. 9, 1969 E. C. WILSON 3,465,903

EXCAVATOR SHOVEL APPARATUS

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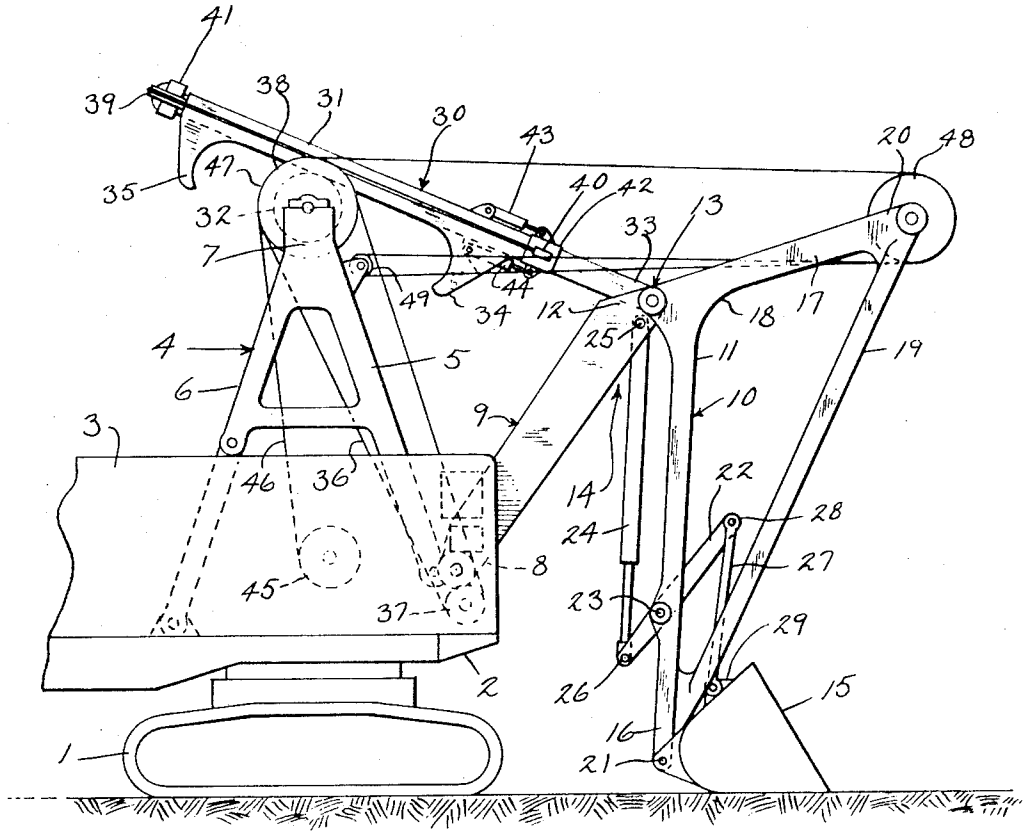
Fig. 1



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EXCAVATOR SHOVEL APPARATUS

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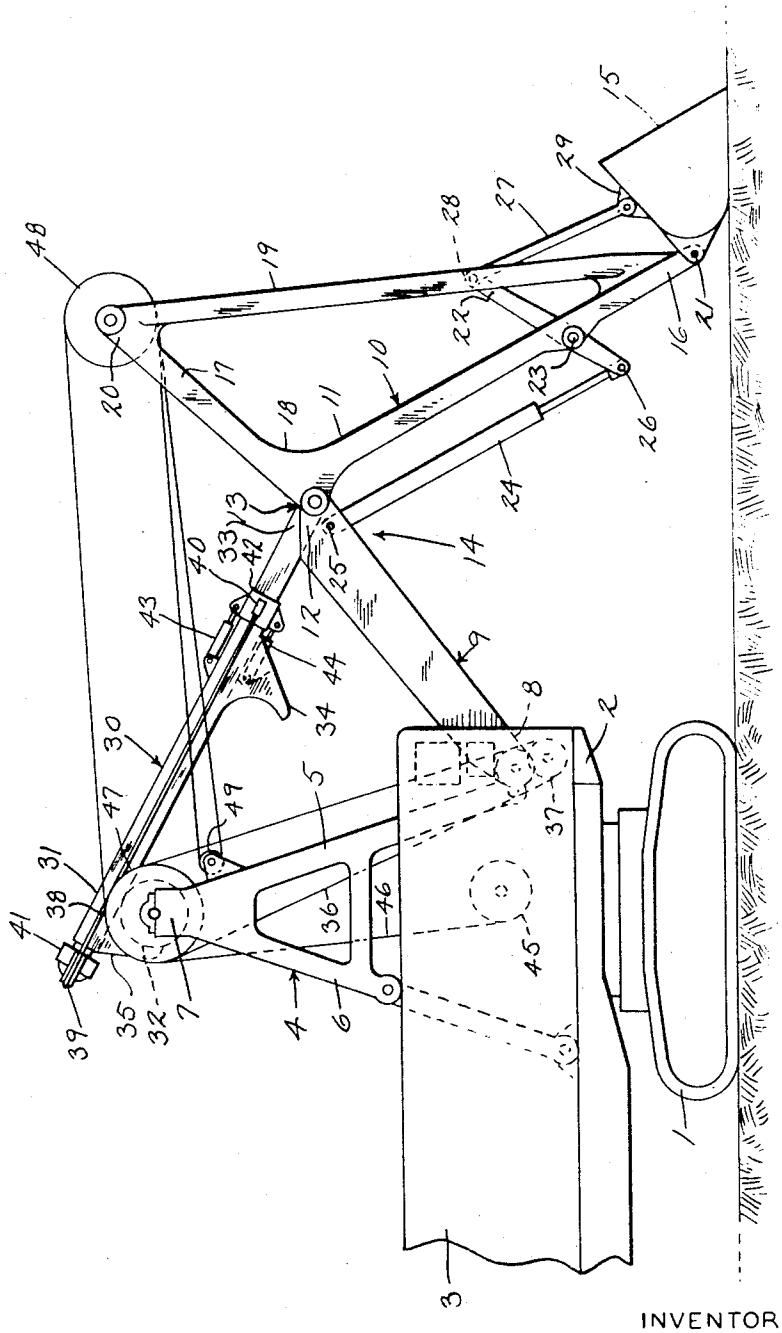
Fig. 2



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EXCAVATOR SHOVEL APPARATUS

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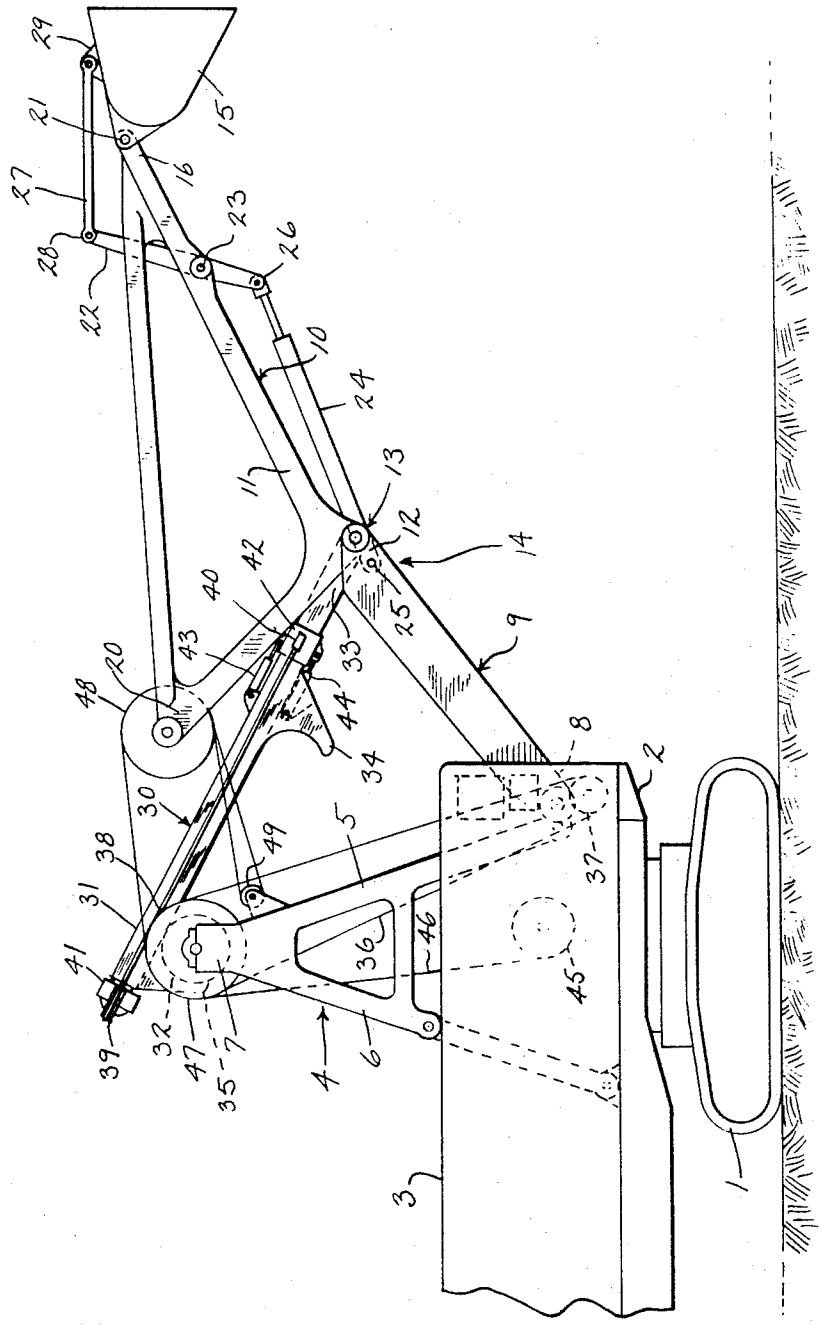
Fig. 3



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EXCAVATOR SHOVEL APPARATUS

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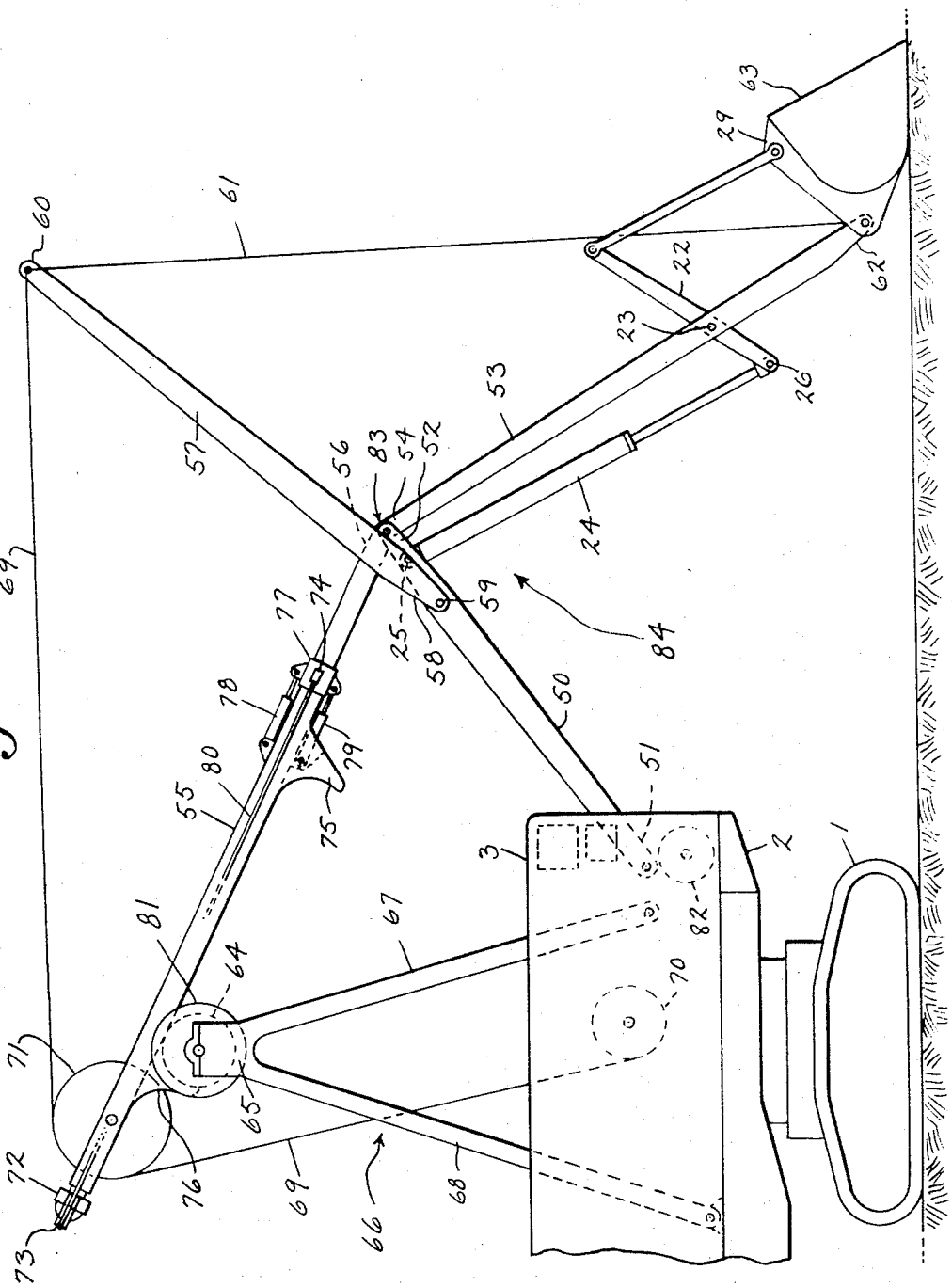
Fig. 4



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3,465,903

EXCAVATOR SHOVEL APPARATUS

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Filed Aug. 11, 1967, Ser. No. 659,970
Int. Cl. E02f 3/00
U.S. Cl. 214—138 11 Claims

ABSTRACT OF THE DISCLOSURE

In both quarry shovel embodiments, the boom is pivoted on the revolving frame, and the crowd handle, mast and bucket handle are pivoted to the boom. The crowd handle operates from the top of the A-frame to effect a toggle action crowd, and a hoist cable operates the mast that is linked to the bucket handle. A hydraulically controlled bucket is pivoted on the bucket handle. In the first embodiment, the bucket handle, mast and link form an integral triangular framework. In the second, the mast and bucket handle are separately pivoted to the boom and linked by a cable.

BACKGROUND OF THE INVENTION

The present invention relates to power shovels ranging in size from giant strip mining machines, such as that disclosed in U.S. Patent No. 3,376,983 issued on the copending application of the same inventor, to the relatively small construction excavators. For years, power shovels of this sort have been made with a long, heavy boom inclined from the front of the revolving frame and supported at the top by suspension cables from an A-frame, or similar structure mounted behind the boom. In these prior art machines, a top opening dipper with a trap door in the bottom is rigidly mounted on the end of the dipper handle, and either the dipper handle is mounted in a saddle block that is pivotally supported on the middle of the boom, or the end of the dipper handle is pivotally fastened to the top of a stiff leg that projects from the revolving frame next to the boom and a crowd handle supported on the A-frame is joined to the stiff leg and dipper handle. In the former arangement, a cowd mechanism in the saddle block acts directly on the dipper handle, and in the latter the crowd mechanism is in the A-frame and acts on the crowd handle. In either case, the hoist cables usually are driven from power driven cable drums mounted on the revolving frame. In the former arrangement, hoist cables pass directly to hoist sheaves at the top of the boom and down to the dipper, and in the latter arrangement, the hoist cables pass over sheaves mounted at the top of the A-frame as well as sheaves mounted in the top of the boom and are connected to the dipper.

These prior art structures have a number of inherent limitations. The heavy boom with the large hoist sheaves at its top end projecting from the revolving frame require a correspondingly heavy counter weight on the back of the revolving frame, and these combined weights result in the generation of tremendous inertial forces during swinging movements and impose limitations on the structure and capacity of the machine. The conventional dipper with its trap door on the bottom is extremely heavy, and its rigid mounting imposes severe restrictions on the operation of the shovel. Efforts have been made to provide a wristing action in the mounting of the dipper, for example, see U.S. Patents Nos. 1,547,533, 2,443,537, and 3,219,213, but the movement achieved is limited, and the necessary additional mechanism greatly increases the weight on the end of the dipper handle.

There are instances in the early prior art where a dipper handle has been pivoted on top of a fixed boom as

in U.S. Patent No. 2,015,629, and subsequently the boom was pivoted, U.S. Patent No. 2,195,007. More recently, the art has developed relatively small excavators that mount a scoop bucket on the end of an articulated handle that is controlled and powered by one or more hydraulic cylinders, and these machines are disclosed in the following U.S. Patents: 2,660,816, 2,775,356, 2,804,701, 2,965,253, 3,080,076, 3,120,315, 3,129,832, 3,189,203, 3,239,083. These devices seem, however, to be inherently limited to relatively small machines and, even in such machines, the reach and dumping heights attainable would seem to be restricted.

SUMMARY OF THE INVENTION

The present invention relates to a power shovel apparatus, and more specifically the invention resides in a power shovel which has a toggle member made up of a boom and a bucket handle connected together at a toggle joint with a mast pivoted to the boom and linked to the bucket handle, and in which a crowd mechanism exerts toggle force on the toggle joint and a hoist cable pivots the mast to control the position and movement of the bucket handle.

This invention eliminates a large part of the weight that had previously projected from the front of the revolving frame to the end so that the overall weight of the machine is greatly reduced and the weight is centralized on the revolving frame resulting in a better balanced machine with minimum swing inertia. In combination with the structure set forth in the previous paragraph, a scoop bucket is pivotally mounted on the outer end of the bucket handle, replacing the heavy dipper used in the past, and a tilt mechanism that automatically maintains desired bucket attitude is provided. This further reduces the weight on the end of the bucket handle and adds great versatility and flexibility to the operation of the shovel. Moreover, the lighter scoop bucket seems to have a longer life and requires less maintenance than does a dipper. The combination has a very long reach and a high dumping height, so that a long level floor may be dug at a broad range of elevations without moving the machine. The ultimate result is a lighter machine with larger payload capacity, greatly reduced operating cycle time, much higher efficiency and substantially less wear and tear on the mechanism as a whole and the running gear in particular. These and other objects and advantages will be manifest in the description that folows:

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, FIGS. 1, 2 and 3 are side elevations showing a preferred quarry shovel embodiment of the invention in various positions of its operating cycle.

FIG. 4 illustrates in side elevation a second embodiment of the invention in a quarry shovel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the preferred embodiments shown in FIGS. 1 through 3 of the drawings, a quarry shovel is illustrated which has a conventional crawler type running gear **1** rotatably supporting a revolving frame **2**. The revolving frame **2** is the main supporting frame for the power source, controls and operating structure of the present invention. A cab **3** on the revolving frame **2** houses the operator, the controls and the power source for the shovel, which may include electric motors, internal combustion engines, hydraulic pumps, reservoirs, circuitry and the like. Rising from the revolving frame **2** above the running gear, an A-frame **4**, which functions as a crowd support frame, is mounted on the revolving frame **2**, and it has front legs **5** and back legs **6** which converge above the revolving

frame 2 and the cab 3 to join at the top 7. Adjacent to the front legs 5 of the A-frame 4, an inner end 8 of a boom 9 is pivotally mounted on the revolving frame 2, though in other embodiments it may be mounted elsewhere. A bucket handle 10 has its inner end 11 articulated to an outer end 12 of the boom 9 by a toggle joint 13. The boom 9 and bucket handle 10, joined together by the toggle joint 13, combine to make up a toggle member 14 whch supports and controls a scoop bucket 15 that is pivotally mounted on an outer end 16 of the bucket handle 10.

The bucket handle 10 is one side of an integral triangular frame which has for a second side, a mast 17, a lower end 18 of which is fastened to the inner end 11 of the bucket handle 10 and hence is pivotally joined to the outer end 12 of the boom 9 by the toggle joint 13. A link 19, which is a structural member, rigidly joins an upper end 20 of the mast 17 to the outer end 16 of the bucket handle 10. The attitude of the scoop bucket 15 about its pivotal mounting 21 on the outer end 16 of the bucket handle 10 is controlled by a tilt mechanism. The tilt mechanism functions through a first class lever 22, which is fulcrumed on a shaft 23 through the bucket handle 10. A hydraulic cylinder 24 is end-mounted between a pin 25 in the outer end 12 of the boom 9 and a posterior end 26 of the first class lever 22 to oscillate the lever 22 about its fulcrum 23. A link 27 joins an anterior end 28 of the first class lever 22 to the bracket 29 on top of the scoop bucket 15 so that as the lever 22 oscillates, the bucket 15 will pivot about its mounting 21.

A crowd mechanism 30 applies force on the toggle joint 13 to effect a horizontal crowd component in the movement of the scoop bucket 15 through the toggle action of the toggle member 14. The crowd force is transmitted by a crowd handle 31 which rides on rollers 32 that are rotatably mounted in the top 7 of the A-frame 4, though the crowd handle 31 could ride on slide plates in yoke or saddle block in other embodiments. The crowd handle 31 has its anterior end 33 connected to the toggle joint 13, and it has a front stop 34 and a back stop 35 extending from its lower side to limit its reciprocating crowd movement on the roller 32. The crowd force is applied by a rope crowd mechanism described in detail and covered by the co-pending application Ser. No. 593,932 filed on Nov. 14, 1966, now Patent No. 3,376,983, entitled "Rope Crowd for a Knee Action Shovel" and owned by the same assignee as the present application. For present purposes it is sufficient to note that a crowd cable 36 extends from opposite sides of power driven crowd cable drums 37 mounted on the revolving frame 2, over crowd sheaves 38 mounted in the top 7 of the A-frame, and around pulleys 39 and 40 mounted in the posterior end 41 and near the anterior end 33, respectively, of the crowd handle 31. The anterior pulley 40 is mounted in a slide block 42 which is held by a pair of cable take-up cylinders 43 and 44 to take up slack that may develop in the crowd cable 36.

A powered hoist cable drum 45 on the revolving frame 2 drives the hoist mechanism for the bucket 15 which imparts a vertical, hoist component to the bucket 15 movement. A hoist cable 46 wound on the cable drum 45 transmits the hoist force from the hoist cable drum 45. The hoist cable 46 extends over a hoist sheave 47 mounted in the top 7 of the A-frame 4, around a hoist pulley 48 mounted in the upper end 20 of the mast 17, and back around a fixed pulley 49 mounted on the front legs 5 of the A-frame 4.

FIGURE 4 illustrates a second embodiment of the present invention which is also mounted on the crawler type running gear 1 that rotatably supports the revolving frame 2 on which the cab 3 is built to house the power source, controls and operator for the excavator. A boom 50 has its inner end 51 pivotally supported on the front end of the revolving frame 2. Two members are separately, pivotally articulated on an outer end 52 of the boom 50, and these are a bucket handle 53, which has its inner end fastened to the boom 50, and a crowd handle 55, which has its front end 56 fastened to the boom 50. A mast 57 has its lower end 58 pivotally mounted on the boom 50 by a shaft 59 that is nearest to, but substantially displaced inwardly from the outer end 52 of the boom 50. The mast 57, which therefore does not pivot about the same point as the bucket handle 53, nevertheless has its upper end 60 linked by a fixed length cable 61 to an outer end 62 of the bucket handle 53, on which is pivotally mounted a scoop bucket 63.

The crowd handle 55 is supported on rollers 64 that are rotatably mounted in a top 65 of an A-frame 66 which has front legs 67 and back legs 68 that diverge downwardly to rest on the revolving frame 2 astraddle the running gear 1, and which serves as a crowd support frame. The crowd force driving the crowd handle 55 forwardly is provided by a hoist cable 69 which is wound on a power driven hoist cable drum 70 mounted on the revolving frame 2, strung about a sheave 71 rotatably mounted near a posterior end 72 of the bucket handle 55, and dead ended on the upper end 60 of the mast 57. A crowd retract mechanism is provided in a rope crowd, such as is shown in the above mentioned co-pending application owned by the same assignee entitled "Rope Crowd for a Knee Action Shovel," Ser. No. 593,932 filed on Nov. 14, 1966, now Patent No. 3,376,983. Since that application may be referred to for a detailed description of the operation of rope retract mechanism, suffice it for present purposes to point out that the mechanism includes crowd pulleys 74 and 73 mounted in the posterior 72 and near the anterior end 56 of the crowd handle 55, and the crowd handle has a front stop 75 and a back stop 76 projecting from its lower side to its crowd travel. The anterior crowd pulley 74 is mounted in a sliding block 77 which is supported by a pair of low pressure, cable take-up cylinders 78 and 79 that are end-mounted between brackets on the sliding block 77 and on the crowd handle 55. A crowd retract cable 80 passes about the crowd pulleys 73 and 74 and on opposite sides of the main crowd sheaves 81 down to power driven crowd cable drums 82 mounted on the revolving frame 2.

As in the first embodiment, the boom 50 and the bucket handle 53, along with a toggle joint 83 connecting them together, combine to form a toggle member 84. The bucket tilt mechanism employed in the second embodiment is the same as that shown in the first so a detailed description of it will not be repeated here. Hence, the second embodiment differs from the first essentially in the source of the crowd force and in the structures of the respective bucket handles 10 and 53, masts 17 and 56, and links 19 and 61.

The mast 17, the bucket handle 10 and the link 19, in the first embodiment, are one integral structure, and the mast 17 and the bucket handle 10 pivot on a common point at the top toggle joint 13. By contrast, in the second embodiment, the mast 57 and the bucket handle 53 are entirely separate, structural members pivoting at separate, substantially spaced apart points 83 and 59, respectively. Moreover, the link 61 in the second embodiment is simply a cable of fixed length, whereas the link 19 in the first embodiment is a rigid, structural member.

In the first embodiment, the force for crowd movement in both directions is provided by the rope crowd mechanism described. However, in the second embodiment the rope crowd mechanism only provides crowd retract and the forward, digging crowd movement is effected through the hoist cable 69 which passes over the sheave 71 on the back end of the crowd handle 55. Hence, when the hoist cable 69 is wound in onto the hoist cable drum 70 to swing the mast 57 about its pivot point 59 and hoist the bucket 63, a crowd thrust on the sheave 71 on the back end of the crowd handle 55 results. The crowd force thus generated through the hoist mechanism is more than sufficient to do the job.

Of course, any number of different types of crowd mechanisms may be employed with the present invention. Reference has already been made to the rope crowd disclosed in claims in the co-pending application owned by the same assignee as the present application entitled "Rope Crowd for a Knee Action Shovel," Ser. No. 593,932 filed on Nov. 14, 1966, now Patent No. 3,376,983. In addition an hydraulic crowd mechanism is disclosed in another co-pending application owned by the assignee of the present application entitled "Hydraulic Crowd Shovel," Ser. No. 563,452 filed on July 7, 1966, now Patent No. 3,375,943. The prior art discloses a variety of different types of rope driven crowd mechanisms in the following U.S. Patents: 1,529,391 through 1,529,399, inclusive, 1,529,499, 1,496,976, 1,564,791 and 2,443,537. Alternatively, rack and pinion types of crowd mechanisms have also been commonly used in the past, such as those in U.S. Patent Nos. 1,536,608, 2,139,255, 2,195,007 and 2,569,458.

FIGURE 1 illustrates the first embodiment with the bucket **15** near the beginning of the long horizontal, level floor stroke that is possible with the present invention. The crowd handle **30** is about in the middle of its length of travel, and the hoist cable **46** is extended. FIGURE 2 illustrates the first embodiment with the bucket **15** at the end of its horizontal, level floor stroke, and the hoist cable **46** is slightly retracted from the FIGURE 1 position. The crowd handle **30** in FIG. 2 is extended as far forward as it can go, and the back stop **35** abuts the rollers **32**. The bucket tilt cylinder **24** remains unactuated, but the toggle action of the toggle member **14** has pivoted the lever **22** to pivot the bucket **15** away from the bucket handle **10** so that the bucket **15** will remain level with the ground.

In FIGURE 3 the handle **30** remains in the same position shown in FIG. 2, but the hoist cable **46** is retracted so that the bucket **15** is lifted to its highest position at its farthest reach. The tilt cylinder **24** is retracted to dump the bucket **15** about its pivotal mounting **21** on the outer end **16** of the bucket handle **10**. The bucket tilt mechanism will operate automatically throughout the entire digging stroke to maintain the bucket **15** in the proper attitude without extension or retraction of the tilt cylinder **24**.

As the toggle member **14**, which is made up of the boom **9**, the bucket handle **10** and the toggle joint **13**, is toggled outwardly by the crowd handle **30**, the tilt cylinder **24** acts as a fixed link, and, due to its blind-end-mounting just below the toggle joint **13**, it draws the posterior end **26** of the first class lever **22** toward the boom **9** so that the anterior end **28** acting through the link **27** pivots the bucket **15** downwardly about its pivotal mounting **21** with respect to the bucket handle **10**. But since the angle between the bucket handle **10** and the ground level is decreasing, the effect of this rotation of the bucket **15** with respect to the bucket handle **10** is to maintain the bucket **15** level throughout the stroke. To achieve a vertical cut when the bucket **15** is hoisted, the tilt cylinder **24** need only be extended to tip the mouth of the bucket **15** upwardly.

These various operating characteristics of the present invention greatly reduce the cycle time, and, to that extent, increase the production capability of the machine. The reduced weight of the structure embodying the present invention permits increased weight in the payload and a decrease in the size of the unproductive counter weight. A power shovel embodying the present invention has far greater versatility and flexibility than the conventional prior art shovel, and the toggle action crowd driven from a crowd handle supported on the A-frame permits an indefinite multiplication of crowd force and allows the invention to be embodied in even the larger strip mining machines.

The second embodiment illustrated in FIG. 4, achieves, through the off-set of the mast pivot **59** from the toggle joint **83**, an increased crowd force at maximum hoist and reach. Also, employing a separate mast **57** and bucket handle **53** with a cable link **61** achieves a much lighter structure that is, for that reason, more readily adaptable to the largest machines. The combination hoist and crowd employed in the second embodiment permits the operator to control the bucket **63** with a single control during the initial portions of the digging cycle, and it simplifies the crowd mechanism, since a separate crowd mechanism need be employed only for the crowd retract. Finally, the off-set of the pivot point **59** for the mast **57** from the toggle joint eliminates erratic movement of the bucket **63** during its horizontal, level floor movement and automatically ensures a smooth, level horizontal movement of the bucket without adjustment of the hoist mechanism during the movement. This relieves the operator to concentrate on fewer controls during movement of the bucket **63** resulting in less chance of operator error and increased safety.

The foregoing description and drawings illustrate but two of a large number of possible embodiments of the present invention. It follows that the invention is not limited to those embodiments, but rather extends to all the many other possible embodiments. Therefore the invention is defined, not by the preceding description, but by the claims that follow.

I claim:

1. A power shovel apparatus comprising the combination of

a main supporting frame;

a boom having an inner end pivotally mounted on said frame and an outer end projecting therefrom;

a crowd support frame mounted on said main supporting frame behind said boom;

a crowd mechanism supported on said crowd support frame and including a crowd handle mounted for reciprocating movement on said crowd mechanism with an anterior end connected to said boom;

a bucket handle having an inner end pivotally connected to said outer end of said boom at a toggle joint and having an outer end with a bucket pivotally mounted on it;

a mast having a lower end pivotally mounted on said boom and an upper end linked to said outer end of said bucket handle;

and a hoist means acting between said crowd support frame and the top of said mast.

2. A power shovel apparatus as set forth in claim **1** wherein

said bucket handle and said mast are linked together by a rigid structural member to form an integral triangular frame.

3. A power shovel apparatus as set forth in claim **1** wherein

said lower end of said mast is pivotally mounted on said boom at a location spaced inwardly from said toggle joint.

4. A power shovel apparatus as set forth in claim **3** wherein

said bucket handle and said mast are linked together by a cable.

5. A power shovel as set forth in claim **1** wherein

said crowd handle has an anterior end and has a crowd sheave mounted on it toward said anterior end;

said crowd mechanism includes a crowd retract mechanism;

and said hoist means includes a powered hoist cable drum; and a hoist cable wound on said drum and extending over said crowd sheave and connected to said mast.

6. A power shovel apparatus comprising the combination of

a revolving frame;

a toggle member including a boom, a bucket handle and a toggle joint connecting said boom and said bucket handle, said boom having an inner end pivotally supported on said revolving frame;

a mast having a lower end pivoted to said boom and being connected to said bucket handle to move with said bucket handle;

a crowd support frame mounted on said supporting means;

a crowd mechanism including a crowd handle reciprocably supported on said crowd support frame and having an anterior end connected to exert force on said toggle joint and power means connected to reciprocate said crowd handle;

a hoist apparatus including a hoist cable connected between said mast and a powered cable drum supported by said revolving frame to pivot said mast on said boom.

7. A power shovel apparatus as set forth in claim **6** wherein

said mast is rigidly connected to an inner end of said bucket handle.

8. A power shovel apparatus as set forth in claim **7** wherein

a rigid link is fastened at one end to an outer end of said bucket handle and at an opposite end to an upper end of said mast to form therewith an integral triangular frame pivoted to said boom by said toggle joint.

9. A power shovel apparatus as set forth in claim **6** wherein

a bucket is fastened on an outer end of said bucket handle on a pivotal mounting;

a tilt mechanism is connected to said bucket to control the attitude of said bucket and includes a lever having posterior end beneath said boom and anterior end above said boom and being fulcrumed on said bucket handle intermediate said ends, a hydraulic

cylinder beneath said boom connecting said posterior end of said lever to said boom below said toggle joint;

and a link connecting the anterior end of said lever to said bucket at a point on said bucket spaced from said pivotal mounting.

10. A power shovel apparatus as set forth in claim **6** wherein

said power means for reciprocating said crowd handle includes a sheave mounted on said crowd handle and a cable passing over said sheave and having one end connected to said mast and another end fastened to a powered cable drum.

11. A power shovel apparatus as set forth in claim **10** wherein

said crowd mechanism includes a crowd handle reciprocably supported by said crowd support frame and connected to exert a toggle force on said toggle joint and having a sheave mounted on it, and a retract mechanism for moving said crowd handle away from said toggle joint;

and said cable passes over said sheave on said crowd handle between said drum and said mast.

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