United States Patent [19]

Baron

[11] **3,856,161**

[45] **Dec. 24, 1974**

[54] **POWER SHOVEL**

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[73] Assignee: **Marion Power Shovel Company, Inc.,** Marion, Ohio

[22] Filed: **Nov. 2, 1973**

[21] Appl. No.: **412,257**

[52] **U.S. Cl.** **214/138**

[51] **Int. Cl.** **E02f 3/00**

[58] **Field of Search** ..... 214/138 R, 135 R, 770, 214/772

[56] **References Cited**

UNITED STATES PATENTS

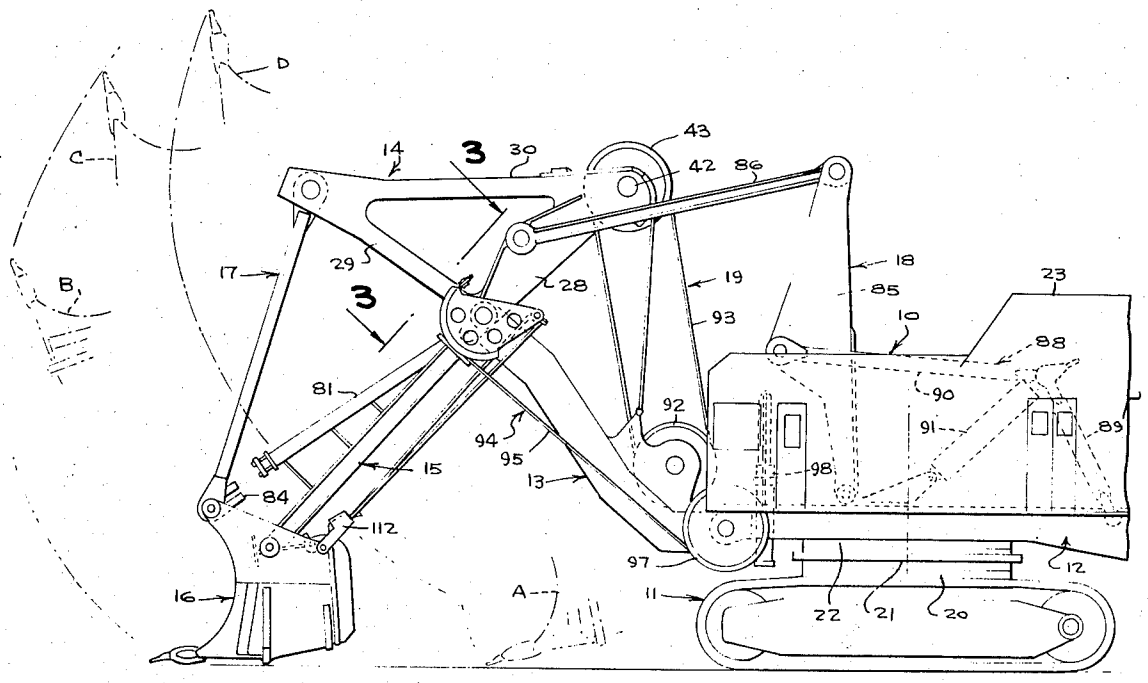
3,080,076	3/1963	Randall	214/138
3,291,328	12/1966	Brocklebank	214/138
3,501,034	3/1970	Baron	214/138
3,648,863	3/1972	Baron	214/138

Primary Examiner—Robert J. Spar
Assistant Examiner—Ross Weaver
Attorney, Agent, or Firm—Mason, Fenwick & Lawrence

[57] **ABSTRACT**

A power shovel generally including a body, a stiffleg pivotally connected at a lower end thereof to the body, a hoist frame pivotally mounted on the upper end of the stiffleg, a dipper handle pivotally connected at its inner end to the hoist frame, a dipper pivotally connected to the outer end of the dipper handle, a hoist link pivotally connected at one end to the hoist frame and at the other end thereof to the dipper, means for crowding the dipper and means for hoisting the dipper.

34 Claims, 6 Drawing Figures



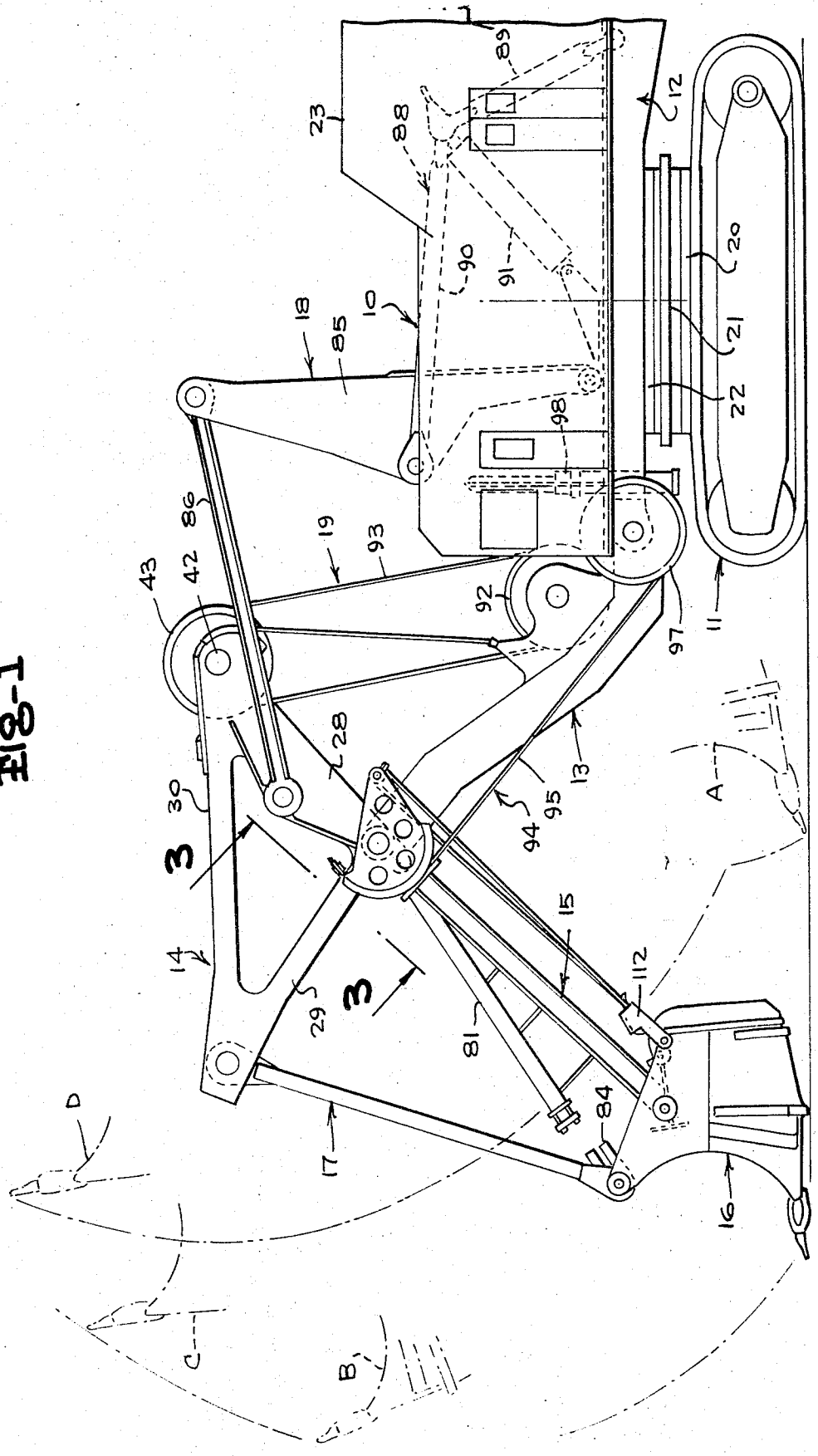

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Fig-1

Fig-2

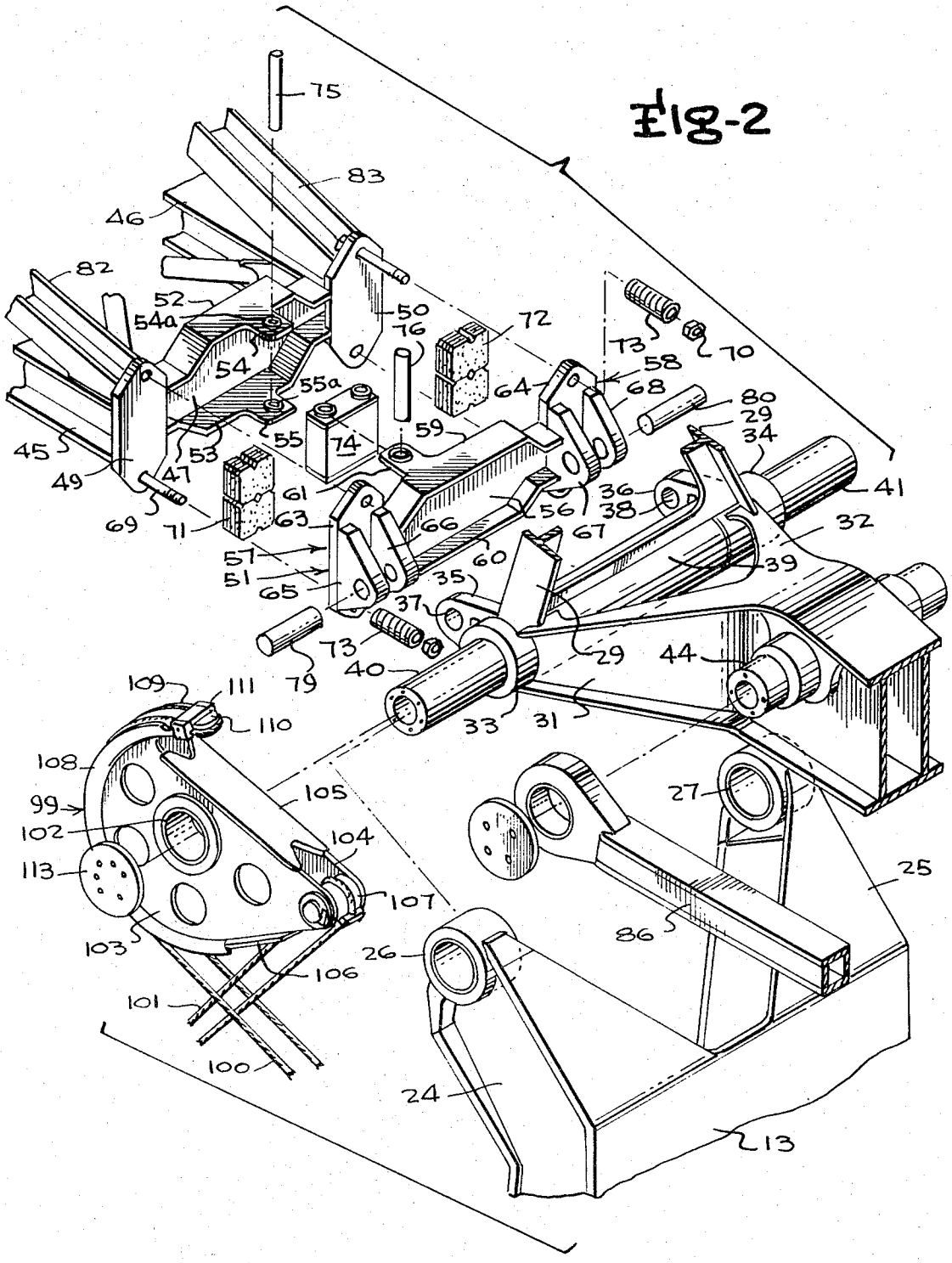
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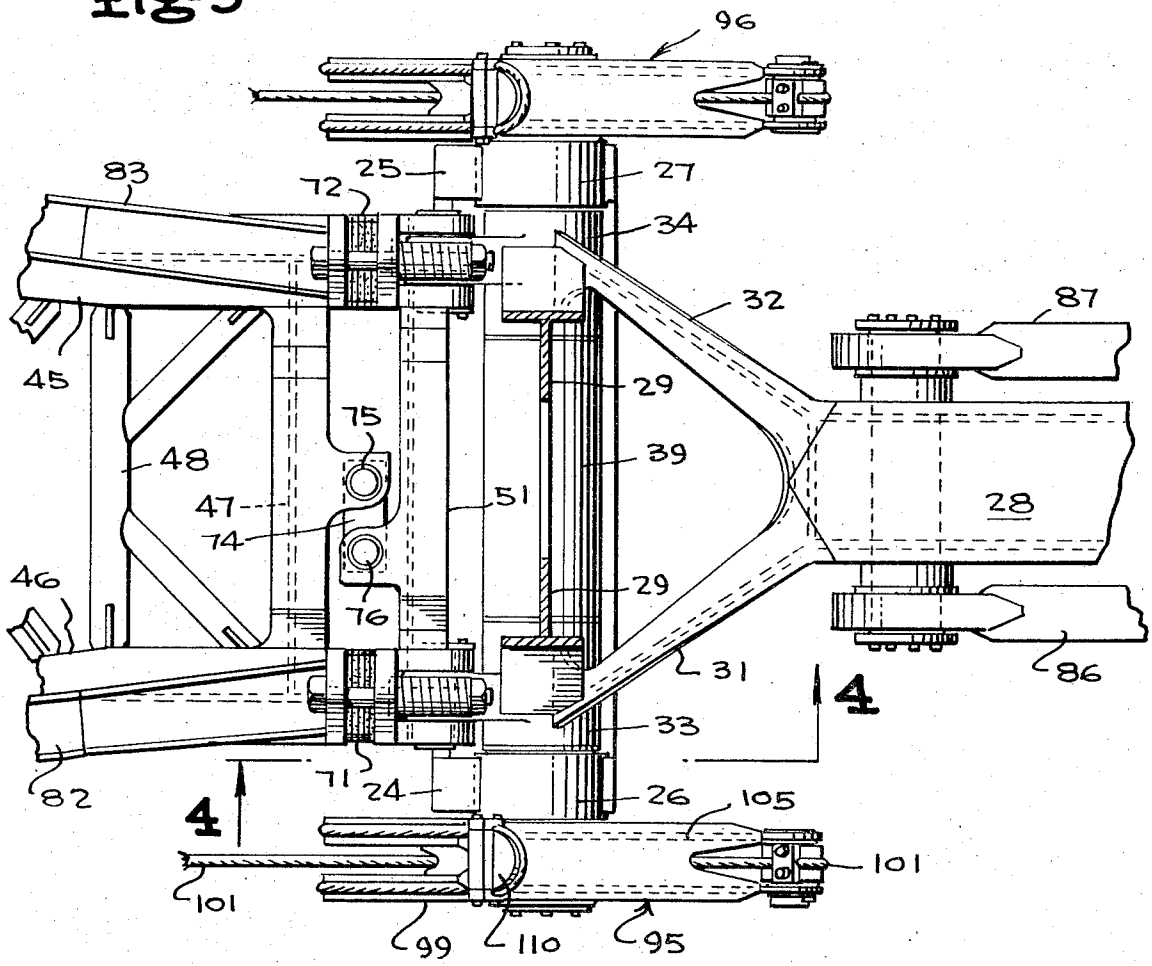
Fig-3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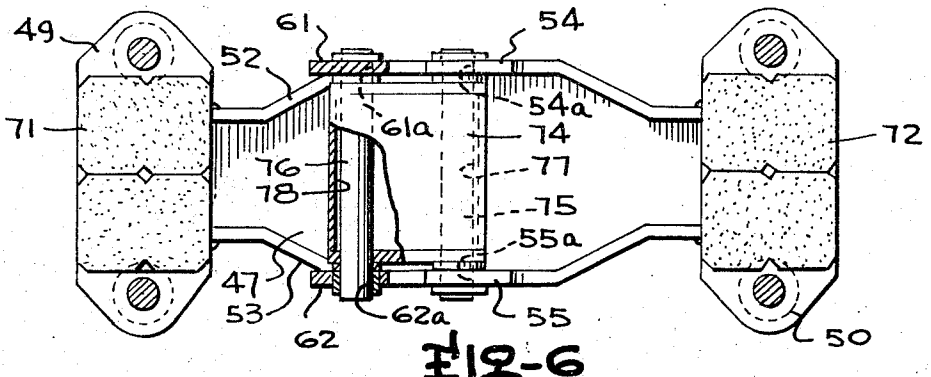
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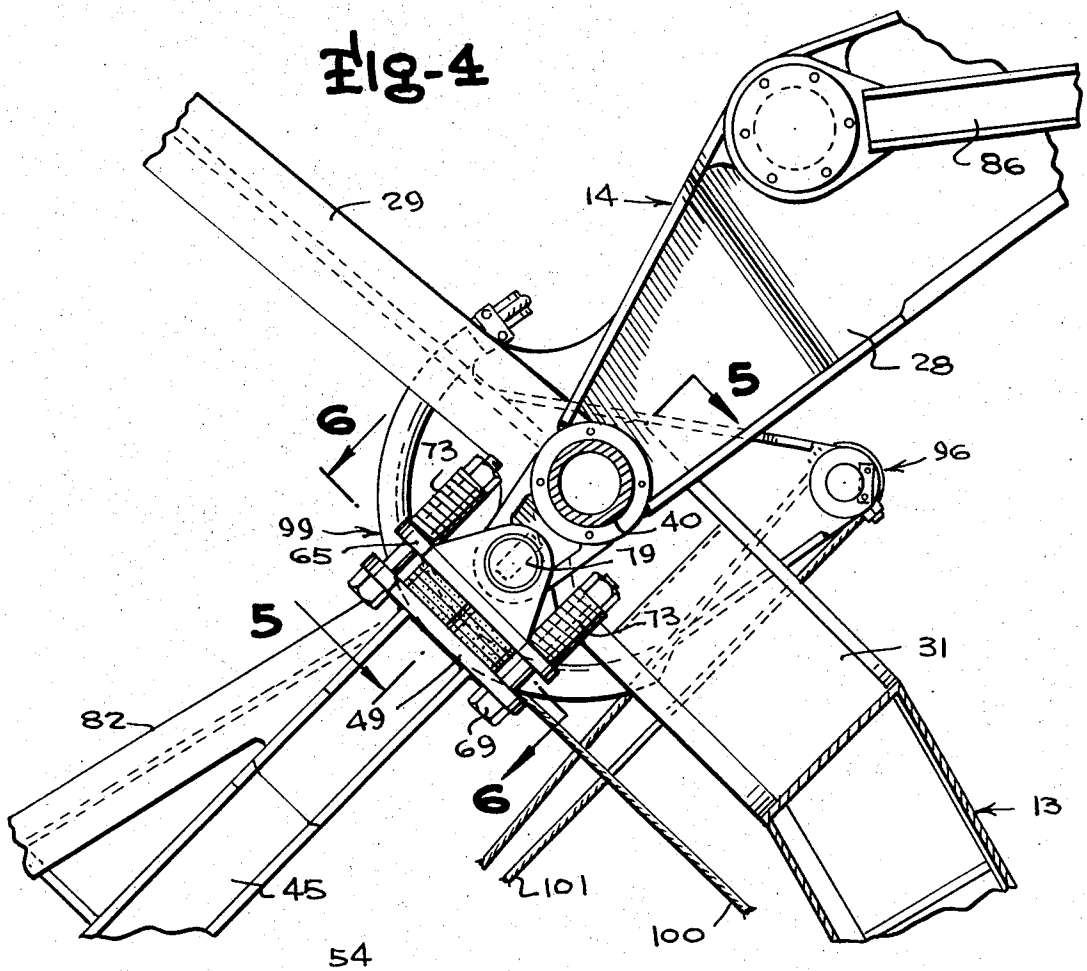
Fig-6

Fig-4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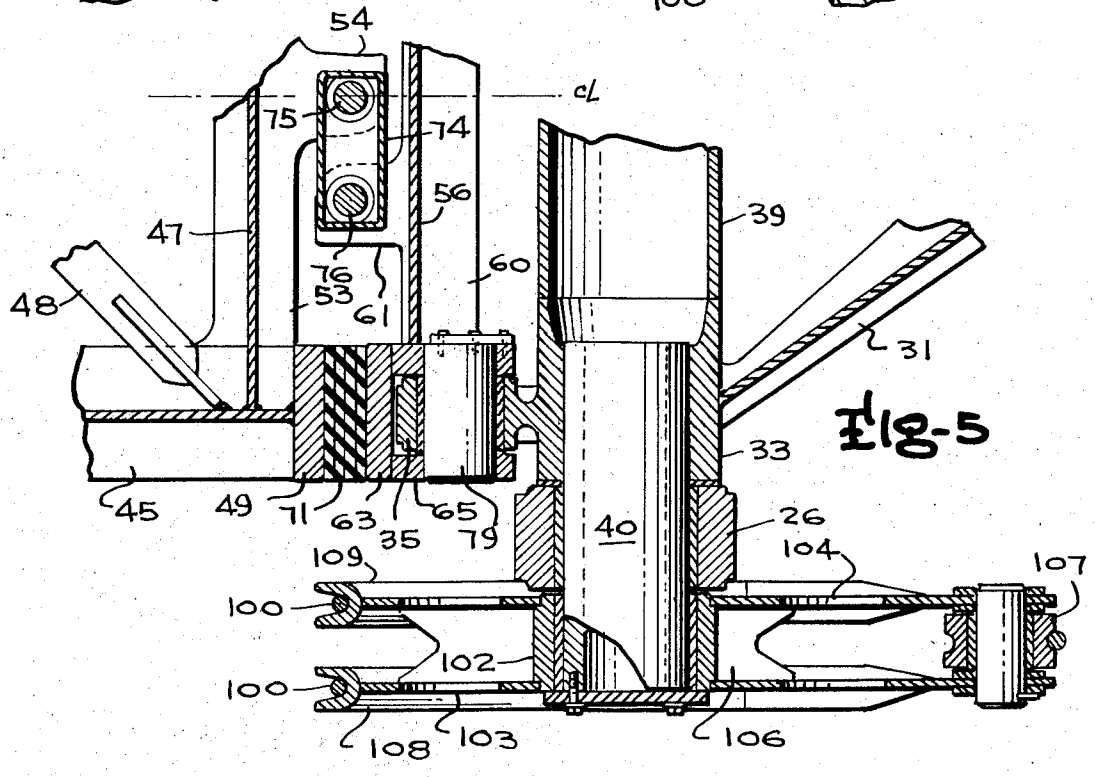
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Fig-5

POWER SHOVEL

In the prior art, there has been developed a type of power shovel which generally consists of a main frame rotatably mounted on a crawler unit, a stiffleg pivotally connected at its lower end to the main frame, a head shaft mounted on the upper end of the stiffleg, a dipper handle pivotally connected at its inner end to the head shaft, a dipper pivotally connected to the outer end of the dipper handle, a hoist frame mounted on the head shaft, a pitch link pivotally connected to the hoist frame and the dipper, and systems mounted on the main frame and operatively connected to the hoist frame for crowding and hoisting the dipper. In addition, a dipper pitch control mechanism may be provided which might include a pair of bell cranks also mounted on the head shaft. Such type of shovel is illustrated in U.S. Pat. Nos. 3,501,034 and 3,648,863.

In such type of shovels, forces applied by the various members of the front end assembly thereof, particularly during the digging phase of operation, impose substantial bending moments on the head shaft. In shovels of relatively small size, such bending moments are not so severe that they feasibly cannot be coped with through the application of conventional design engineering. However, in similar shovels of relatively large design, intended for heavier duty, the bending moments imposed on the head shaft feasibly cannot be provided for through the application of conventional design engineering in that the increased weight of the front end assembly which inevitably would result would have an adverse effect on the payload of the machine. It therefore has been found to be desirable to provide a power shovel of the type described in which the bending moments imposed on the head shafts of relatively large shovels can be provided for without sacrificing the payload of such machines.

Accordingly, it is the principal object of this invention to provide a novel power shovel.

Another object of the present invention is to provide a novel power shovel of the type wherein a hoist frame, dipper handle and dipper are supported on a head shaft mounted on the upper end of a stiffleg.

A further object of the present invention is to provide a power shovel of the type described wherein bending moments imposed on the head shaft by the hoist frame and dipper handle are alleviated.

A still further object of the present invention is to provide a power shovel of the type described wherein the bending moments imposed on the head shaft by the hoist frame and the dipper handle are alleviated without adversely affecting the payload of the shovel.

Other objects and advantages of the present invention will become more apparent to those persons having ordinary skill in the art to which the present invention pertains, from the following description taken in conjunction with the accompanying drawings wherein:

FIG. **1** is a side elevational view of an embodiment of the invention;

FIG. **2** is an enlarged perspective view of the head shaft and related components of the embodiment shown in FIG. **1**, illustrating the components in exploded relation;

FIG. **3** is an enlarged cross-sectional view taken along line **3—3** in FIG. **1**;

FIG. **4** is an enlarged cross-sectional view taken along line **4—4** in FIG. **3**;

FIG. **5** is an enlarged cross-sectional view taken along line **5—5** in FIG. **4**; and

FIG. **6** is an enlarged cross-sectional view taken along line **6—6** in FIG. **4**.

Referring to the drawings, there is illustrated a power shovel **10** generally including a crawler unit **11**, a main frame **12** rotatably mounted on the crawler unit, a stiffleg **13** pivotally connected at its lower end to the main frame, a hoist frame **14** pivotally connected to the upper end of stiffleg **13**, a dipper handle **15** pivotally connected to hoist frame **14**, a dipper **16** pivotally connected to the outer end of dipper handle **15**, a hoist link **17** pivotally connected to hoist frame **14** and dipper **16**, a crowd system **18** mounted on main frame **12** and operatively connected to hoist frame **14**, and a hoist mechanism **19** mounted on main frame **12** and operatively connected to hoist frame **14**.

Crawler unit **11** may be of any conventional design and has mounted thereon a lower frame **20** which supports a conventional roller circle **21**. An upper frame **22** is seated on the roller circle and is adapted to support the main frame **12**. Appropriate machinery is provided on main frame **12** to drive the crawler unit and rotate upper frame **22** with main frame **12** about a center journal relative to lower frame **20** and the crawler unit, as is conventional in the prior art. Such propelling and rotating machinery is housed in a cab structure **23** provided on main frame **12** which also houses other machinery and components of the shovel as later will be described.

The lower end of the stiffleg **13** is bifurcated, providing a pair of feet which are pivotally connected to main frame **12** by means of a pair of foot pins thus permitting the stiffleg to be pivoted in a vertical plane. As best illustrated in FIGS. **2** and **3**, the upper portion of stiffleg **13** is bifurcated providing a pair of arm portions **24** and **25**. Rigidly mounted on the ends of arm portions **24** and **25** is a pair of axially aligned bearings **26** and **27**.

Hoist frame **14** has substantially a triangular configuration and includes a base member **28**, a post member **29** being disposed substantially perpendicular to base member **28** and having the lower end thereof integrally connected to the front end of the base member, and a tension member **30** integrally interconnecting the upper end of post member **29** and the rear end of base member **28**. The forward end of base member **28** is bifurcated, providing a pair of forwardly projecting, diverging arm portions **31** and **32** on which there is rigidly mounted a pair of axially aligned bearings **33** and **34**. Rigidly mounted on bearings **33** and **34** and projecting forwardly therefrom is a pair of brackets **35** and **36** provided with a pair of axially aligned pin receiving openings **37** and **38**. Bearings **33** and **34** are interconnected by a tubular bracing member **39**, and have press fit therein split sections **40** and **41** of a head shaft. The split head shaft sections are journaled in the bearings **26** and **27** provided on the upper bifurcated end of the stiffleg to pivotally mount the hoist frame on the upper end of the stiffleg.

As best illustrated in FIG. **1**, a shaft **42** is provided at the rear end of base member **28** on which there is rotatably mounted a hoist sheave **43** for operatively connecting the hoist system to the hoist frame as later will be described. Also mounted on the base member sub-

stantially intermediate the head shaft and hoist sheave support shaft is a rigidly mounted connecting pin **44** for operatively connecting the crowd system to the hoist frame as also subsequently will be described.

Dipper handle **15** generally consists of a pair of transversely spaced, longitudinally disposed beams **45** and **46** pivotally connected at the outer ends thereof to the side walls of the dipper, interconnected at the inner ends thereof by a cross-plate member **47** and interconnected along the lengths thereof by bracing members **48.** As best illustrated in FIG. **2,** a pair of transversely aligned bearing plates **49** and **50** are rigidly mounted on the ends of beams **45** and **46** on which there is supported a connecting member **51.** The upper and lower edges of cross-plate **47** are provided with flange portions **52** and **53** having outwardly projecting portions **54** and **55** having axially aligned, pin receiving openings **54a** and **55a.**

Connecting member **51** is provided with a cross-plate **56** having rigidly mounted on the transverse ends thereof a pair of clevises **57** and **58.** The upper and lower ends of cross-plate **56** are provided with flanges **59** and **60** having longitudinally projecting portions **61** and **62.** Projecting portions **61** and **62** are provided with axially aligned, pin receiving openings **61a** and **62*a*.** Clevises **57** and **58** are provided with bearing cap portions **63** and **64** which have substantially the same configuration as and are longitudinally aligned with bearing plates **49** and **50.** As best illustrated in FIG. **2,** a pair of transversely spaced, longitudinally disposed ears **65** and **66** are mounted on the rear face of cap portion **63,** and inner ear **66** is rigidly connected on the end of cross-plate **56** so that clevis **57** forms an integral part of connecting member **51.** Similarly, a pair of transversely spaced, longitudinally disposed ears **67** and **68** are provided on the rear face of cap portion **64** and inner ear **67** is rigidly secured to the end of cross-plate **56** so that clevis **58** also is an integral part of connecting member **51.** Connecting member **51** is secured to bearing plates **49** and **50** by means of a plurality of bolts **69** which pass through aligned openings in bearing plates **49** and **50** and cap portions **63** and **64** and a plurality of nuts threaded on the ends of the bolts projecting through the openings in cap portions **63** and **64.** It will be noted that a pair of rubber cushioning pads **71** and **72** are interposed between the opposed surfaces of bearing plates **49** and **50** and cap portions **63** and **64,** and disc springs **73** are provided on bolts **69** between the rear faces of cap portions **63** and **64** and locking nuts **70** to provide a resilient cushioning joint in the dipper handle.

As best illustrated in FIG. **6,** flange portions **54** and **55** and the axis of aligned openings **54*a*** and **55*a*** are disposed intermediate bearings plates **49** and **50.** When connecting member **51** is mounted on bearing plates **49** and **50,** longitudinally projecting flange portions **61** and **62** of the connecting member are offset laterally relative to longitudinally projecting flange portions **54** and **55** of cross-plate **47** and the axis of aligned openings **61*a*** and **62*a*** is disposed parallel and offset laterally relative to the axis of aligned openings **54*a*** and **55*a*.** Such relationship of components permits connecting member **51** to be pivotally connected to the main body of the dipper handle by means of a link block **74** and a pair of connecting pins **75** and **76** which are disposed in aligned openings **54*a*** and **55*a*** and an opening **77** in link block **74,** and aligned openings **61*a*** and **62*a*** and an opening **78** in link block **74,** respectively. It thus will be noted that with such a joint between connecting member **51** and the main body of the dipper handle, compressive, tensile and torsional loads applied to the main body of the digging handle will be cushioned by the rubber cushioning pads **71** and **72** and disc springs **73.** Furthermore, it will be noted that the connection provided by link block **74** permits limited side sway of the main body of the dipper handle but resists angular displacement of the main body of the dipper handle relative to the connecting member in a vertical plane. Longitudinally disposed ears **65** through **68** are provided with transversely disposed, axially aligned pin receiving openings so that when brackets **35** and **36** are inserted through pairs of ears **65** and **66** and **67** and **68,** respectively, and openings **37** and **38** in brackets **35** and **36** register with such openings, connecting pins **79** and **80** may be inserted through the registered openings to pivotally connect the inner end of the dipper handle to the front end of the base member of the hoist frame. Under such conditions, the dipper, dipper handle, base and post members of the hoist frame and the hoist link form a four bar linkage wherein the hoist frame, a portion of which constitutes a bar of such linkage, also acts as a bell crank pivotally mounted on the upper end of the stiffleg and capable of pivoting in the dipper about the head shaft. As further best seen in FIG. **1,** during all phases of operation, the dipper handle is disposed in substantial longitudinal alignment with the base member of the hoist frame and the post member of the hoist frame is disposed substantially perpendicular to the dipper handle and base member.

Dipper **16** is substantially of a conventional construction including a pair of transversely spaced side walls, a bottom wall, a plurality of digging teeth detachably mounted on the front lip of the bottom wall and a releasable door pivotally connected at its upper end to the side walls of the dipper. The center of gravity of the dipper is disposed rearwardly of the intersection of the extended centerlines of the dipper handle and hoist link so that unrestrained by the dipper pitch control system, the digging teeth of the dipper will be caused to pitch upwardly. Such upward pitch of the dipper, however, is limited by a pitch stop **81** mounted on the upper side of the dipper handle. The pitch stop consists of a pair of beams **82** and **83** mounted at an angle on side beams **45** and **46** of the dipper handle. The ends of such beams are engagable with abutment pads **84** rigidly mounted on the side walls of the dipper adjacent the pivotal connection of the dipper with hoist link **17.**

The front end assembly of the shovel thus far described, has a sufficient weight so that when the stiffleg is permitted to pivot downwardly, the weight of the system will crowd the dipper into the material being excavated. During the operating cycle when it is desired to retract the dipper, such action is provided by crowd system **18.** Such system includes a mast **85** pivotally connected at its lower end to main frame **12** for movement in a vertical plane, a pair of crowd links **86** and **87** pivotally connected on opposite sides of base member **28** to the ends of connecting shaft **44** and pivotally connected at the rearward ends thereof to the upper end of mast **85,** and a crowd drive assembly **88.** The assembly **18** generally consists of a pair of support links **89** pivotally connected at lower ends thereof to a rearward portion of main frame **12,** a pair of connecting links **90** pivotally connected at the rear ends thereof to

the upper ends of support links **89** and pivotally connected at the forward ends thereof to the mast at a point intermediate the upper and lower ends thereof, a pair of fluid actuated piston and cylinder assemblies **91** having the lower ends of the cylinders thereof pivotally connected to main frame **12** intermediate the pivotal connections of the mast and support links to the main frame and having the free ends of the pistons thereof pivotally connected to the pivotal connections between support links **89** and connecting links **90**, and a fluid supply system (not shown) having appropriate controls, operatively connected to the cylinders of assemblies **91** for selectively extending the pistons of the assemblies. Whenever the pistons of assemblies **91** are extended, support links **89** and mast **85** will be caused to pivot rearwardly, and simultaneously through the action provided by crowd links **86** and **87** the entire front end assembly of the shovel will be caused to pivot rearwardly about the foot pins of the stiffleg.

Hoist mechanism **19** is substantailly conventional in design and generally includes a hoist drum and drive (not shown) mounted on the main frame within the cab structure, a sheave **92**, hoist sheave **43** and a hoist line **93** operatively interconnecting the hoist drum and sheaves **92** and **93**. As in the conventional manner, whenever the hoist line is either played out or taken in, hoist frame **14** and correspondingly dipper handle **15**, dipper **16** and hoist link **17** will be caused to pivot about the head shaft mounted on the upper end of the stiffleg.

During the crowding phase of operation of the shovel, the pitch of dipper **16** can be maintained fixed relative to the main frame of the shovel by means of a pitch control system **94** consisting of a pair of pantograph linkages **95** and **96** mounted on opposite sides of the stiffleg and dipper handle, a pair of sheaves **97** mounted on the foot pins connecting the lower end of the stiffleg to the main frame of the shovel, and a pair of fluid actuated piston and cylinder assemblies having the cylinders thereof rigidly secured to the main frame. The pantograph linkages **95** and **96** are substantially identical in construction and operation. As best illustrated in FIGS. **1, 2** and **5**, linkage **95** consists of a pitch bell crank **99** pivotally mounted on the outer end of head shaft section **40**, a pitch link **100** connected at one end thereof to the forwardly disposed end of the pitch bell crank, reeved about a sheave **97** and connected at the opposite end to the piston portion of a cylinder assembly **98**, and a pitch link **101** connected at one end thereof to a rearwardly disposed point on the pitch bell crank and connected at the opposite end thereof to a side wall of the dipper.

Bell crank **99** consists of a bearing member **102** mountable on head shaft section **40** on the outboard side of bearing **26** of the stiffleg, a pair of transversely spaced plates **103** and **104** mounted on bearing **102**, upper and lower cover plates **105** and **106** and a collar **107** mounted on a pin interconnecting the rearward ends of the side plates. The forward and bottom edges of side plates **103** and **104** are provided with arcuate configurations on which a pair of arcuate rope guides **108** and **109** is mounted. The upper edges of the side plates on which the cover plate **105** is secured, intersect the front edges of the side plates as secants, and the rearward edges of the side plates are disposed substantially tangential to the arcuate bottom edges of the side plates, intersecting the upper edges of the side plates at a point adjacent the position of collar **107**.

Pitch link **100** consists of a rope dead-ended at one end thereof on the piston of an assembly **98**, reeved about a sheave **97**, arcuate guide **108** on the bell crank, an arcuate guide **110** mounted on a frame **111** bridging the upper ends of arcuate guides **108** and **109**, arcuate guide **109** and a sheave **97**, and dead-ended at the opposite end thereof on the piston of assembly **98**. Pitch link **101** similarly consists of a rope having one end thereof secured to a fixture **112** pivotally connected to a side wall of the dipper, passing over and secured to collar **107** on the bell crank, and being dead-ended at the opposite end thereof on the fixture **112**. Pitch bell crank **99** is prevented from being displaced outwardly along head shaft section **40** by means of an end plate **113** secured to the end of the head shaft section **40** and engagable by the outer end of bearing **102**.

As set forth in greater detail in the aforementioned patents, the dipper pitch control system as described operates in a manner whereby whenever the pistons of cylinder assemblies **98** are permiteted to float freely, the pitch of the dipper will be permitted to change with respect to the forces imposed by its own weight or contact of the dipper with the ground or material being excavated. However, upon locking the pistons of the cylinder assemblies **98**, the pantograph linkages will cause the pitch of the dipper to become fixed until such pistons are released and again permitted to float freely.

In the operation of the embodiment as described, the front end assembly of the shovel is positioned at the beginning of the digging cycle by operating the crowd system to pivot the stiffleg to its upward, rearmost position, operating the hoist system to pay out the hoist line and permit the dipper handle to pivot downwardly and rearwardly to a position adjacent the stiffleg, and rendering inoperative the holding means of the dipper pitch control system so that the dipper will swing freely and assume a position as designated by the reference letter A in FIG. **1**, adjacent the foot pins of the stiffleg. With the front end assembly thus positioned, fluid under pressure is permitted to be discharged from the lower ends of the cylinders of assemblies **91** at a controlled rate so as to permit the stiffleg to pivot downwardly. Simultaneously, the hoist mechanism is operated to take in hoist line and permit the dipper handle to pivot forwardly, away from the stiffleg to provide a knee-type action characteristic of the type of shovel described. As such knee action progresses, the dipper will be caused to pivot so that the bottom wall thereof will be seated on the ground in a horizontal position. The operator then actuates certain controls to lock the pistons of cylinder assemblies **98** whereupon as the knee action of the front end assembly progresses, the dipper pitch control system will cause the pitch of the dipper to remain fixed and the dipper to be crowded into the material being excavated, along a horizontal line of travel to a position as illustrated by the solid lines in FIG. **1**.

At such point in the digging cycle, the operator actuates appropriate controls to supply fluid under pressure to the lower ends of the cylinders of assemblies **91** thus operating the crowd system to retract the stiffleg, and to release the pistons of assemblies **98** thus permitting the dipper to pitch upwardly until pads **84** on the dipper engage pitch stop **81**. As such action takes place,

the hoist line continues to be taken in thus causing the dipper to be hoisted along positions designated by the reference letters B and C in FIG. 1 until it reaches a dump position as designated by the reference letter D. In such position, the dumping door of the dipper will be disposed substantially horizontal and the dipper will be filled with a maximum load of material ready to be dumped. The propelling and rotating mechanisms on the shovel may then be operated to position the dipper over the location where the material is to be dumped, and the door may be unlatched to discharge the material. From such point on, the hoist mechanism is operated to pay out hoist line and the propelling and rotating machinery on the shovel are operated to return the front end assembly into position to begin the next digging cycle.

During the crowd phase of the digging operation of the embodiment as described, compressive loads applied by the hoist frame on the head shaft substantially are counteracted by the compressive loads applied on the head shaft by the dipper handle thus eliminating certain bending moments which in such type of shovel in the prior art otherwise would be imposed on the head shaft. Such advantageous condition is made possible in the embodiment described by virtue of (a) the dipper handle pivot axis being spaced adjacent and parallel to the hoist frame pivot axis, (b) such axes lying in a plane substantially including the longitudinal center line of the base member of the hoist frame, (c) the plane including the longitudinal center line of the dipper handle and the dipper handle pivot axis lying in a plane displacable angularly to opposite sides of the plane including the dipper handle and hoist frame pivotal axes, within predetermined limits of approximately 10°, and (d) the connections of the arm portions **31** and **32** with the head shaft sections being substantially in longitudinal alignment with brackets **35** and **36** to which the dipper handle is connected.

The resilient joint provided in the dipper handle by rubber cushioning pads **71** and **72** and disc springs **73** also functions to absorb sudden high impact loads incurred during the crowd phase of the digging cycle and which are transmitted by the dipper handle to the head shaft. In addition, such resilient joint and the pivotal connection between the main body of the dipper handle and connecting member **51** permit a limited amount of side sway of the dipper handle without adverse loads being transmitted to the head shaft, imposing undesirable bending moments thereon.

From the foregoing detailed description, it will be evident that there are a number of changes, adaptations and modifications of the present invention which come within the province of those skilled in the art. However, it is intended that all such variations not departing from the spirit of the invention be considered as within the scope thereof and as limited solely by the appended claims.

I claim:

1. A power shovel comprising a body, a stiffleg pivotally connected at the lower end thereof to said body, a hoist frame pivotally mounted on said stiffleg, a dipper handle pivotally mounted on said hoist frame, a dipper pivotally connected to said dipper handle, a hoist link pivotally interconnected to said hoist frame and said dipper, said stiffleg and the components supported thereon having sufficient weight to provide a self-crowding action of said dipper when said stiffleg is permitted to pivot downwardly, means for pivoting said stiffleg upwardly to retract said dipper and means for hoisting said dipper.

2. A power shovel according to claim **1** wherein said dipper handle, hoist frame, hoist link and dipper form a four bar linkage and the configuration of such linkage is such that compressive forces imposed by said hoist frame on the pivotal connection between said hoist frame and said stiffleg substantially are counteracted by compressive forces imposed by said dipper handle on said pivotal connection between said hoist frame and said stiffleg during crowding of said dipper.

3. A power shovel according to claim **1** wherein the axes of the pivotal connections between said hoist frame and said stiffleg and between said dipper handle and said hoist frame are spaced parallel, and the configuration of the four bar linkage consisting of said dipper handle, said hoist frame, said hoist link and said dipper, and the relative positions of the axes of the pivotal connections between said hoist frame and said dipper handle and between said hoist frame and said stiffleg, are such whereby during the crowd phase of the operation of said shovel, a plane including the longitudinal centerline of said dipper handle and the axis of the pivotal connection between the dipper handle and the hoist frame will be displaced angularly within predetermined limits on opposite sides of the plane including the axes of the pivotal connections between said dipper handle and said hoist frame and between said hoist frame and said stiffleg.

4. A power shovel according to claim **3** wherein the range of angular displacement between said limits is about ten degrees.

5. A power shovel according to claim **1** wherein said hoist frame includes a bifurcated portion provided with a head shaft, said head shaft is journaled in said stiffleg and said dipper handle is pivotally connected to the bifurcated portions of said hoist frame.

6. A power shovel according to claim **5** wherein said stiffleg includes a bifurcated upper end provided with bearings in which said head shaft is journaled.

7. A power shovel according to claim **6** wherein the bearings provided on the bifurcated portion of said stiffleg are disposed outwardly of the bifurcated portion of said hoist frame.

8. A power shovel according to claim **1** wherein said hoist frame includes a bifurcated portion provided with bearings in which coaxially disposed split sections of a head shaft are journaled and on which there are secured outwardly projecting brackets, said stiffleg includes a bifurcated portion provided with bearings in which the split sections of said head shaft are journaled to provide the pivotal connection between said hoist frame and said stiffleg, and said dipper handle is pinned to the brackets provided on the bifurcated portions of said hoist frame to provide the pivotal connection between said dipper handle and said hoist frame.

9. A power shovel according to claim **1** wherein said dipper handle includes a resilient joint for absorbing compressive, torsional and bending loads applied to the dipper handle during the various phases of operation of said shovel.

10. A power shovel according to claim **1** wherein said means for retracting said stiffleg comprises a crowd system mounted on said body, operatively connected to said hoist frame.

11. A power shovel according to claim 1 wherein said means for hoisting said dipper includes a hoist mechanism mounted on said body, a sheave mounted on said hoist frame and a hoist line operatively interconnecting said hoist mechanism and said sheave.

12. A power shovel according to claim 1 including a dipper pitch control system.

13. A power shovel according to claim 1 wherein said dipper is pivotally connected to said dipper handle in a manner whereby said dipper is biased to pitch the digging end thereof upwardly, and including means to limit the upward pitching movement of the dipper and releasable holding means for maintaining the dipper at predetermined pitches relative to said body during downward pivotal movement of said stiffleg, outward pivotal movement of said dipper handle relative to said stiffleg and forward movement of said dipper.

14. A shovel according to claim 13 wherein said releasable holding means includes a pantograph linkage.

15. A power shovel comprising a body, a stiffleg pivotally connected at a lower end thereof to said body, a hoist frame including a base member pivotally mounted on said stiffleg, a post member rigidly connected to a forward end of said base member and a tension member rigidly interconnecting the rearward end of said base member and the upper end of said post member, a dipper handle pivotally mounted on the base member of said hoist frame, a dipper pivotally connected to said dipper handle, a hoist link pivotally interconnected to the post member of said hoist frame and said dipper, said stiffleg and the components supported thereon having sufficient weight to provide a self-crowding action of said dipper when said stiffleg is permitted to pivot downwardly, means for pivoting said stiffleg upwardly to retract said dipper and means for hoisting said dipper.

16. A power shovel according to claim 15 wherein said dipper handle, a portion of the base member and the post member of said hoist frame, said hoist link and said dipper form a four bar linkage and the configuration of such linkage is such that compressive forces exerted by the base member of said hoist frame on the pivotal connection between said base member and said stiffleg substantially are counteracted by compressive forces exerted by said dipper handle on said pivotal connection between said base member and said stiffleg during crowding of said dipper.

17. A power shovel according to claim 15 wherein the axes of the pivotal connections between the base member of said hoist frame and said stiffleg and between said dipper handle and the base member of said hoist frame are spaced parallel, and the configuration of the four bar linkage consisting of said dipper handle, a portion of the base member and the post member of said hoist frame, said hoist link and said dipper, and the relative positions of the axes of the pivotal connections between the base member of said hoist frame and said dipper handle and between the base member of said hoist frame and said stiffleg, are such whereby during the crowd phase of operation of said shovel, a plane including the longitudinal centerline of said dipper handle and the axis of the pivotal connection between the dipper handle and the base member of said hoist frame will be displaced angularly within predetermined limits on opposite sides of the plane including the axes of the pivotal connections between said dipper handle and the base member of said hoist frame and between the base member of said hoist frame and said stiffleg.

18. A power shovel according to claim 17 wherein the axes of said pivotal connections between said dipper handle and the base member of said hoist frame and between the base member of said hoist member and said stiffleg, and the longitudinal centerline of the base member of said hoist frame, lie in the same plane.

19. A power shovel according to claim 18 wherein the range of angular displacement between said limits is about ten degrees.

20. A power shovel according to claim 15 wherein the base member of said hoist frame includes a bifurcated portion provided with a head shaft, said head shaft is journaled in said stiffleg and said dipper handle is pivotally connected to the bifurcated portions of the base member of said hoist frame.

21. A power shovel according to claim 20 wherein said stiffleg includes a bifurcated end portion provided with bearings in which said head shaft is journaled.

22. A power shovel according to claim 21 wherein the bearings provided on the bifurcated portion of said stiffleg are disposed outwardly of the bifurcated portion of the base member of said hoist frame.

23. A power shovel according to claim 15 wherein the base member of said hoist frame includes a bifurcated portion provided with bearings in which coaxially disposed split sections of a head shaft are journaled and on which there are secured outwardly projecting brackets, said stiffleg includes a bifurcated end portion provided with bearings in which the split sections of said head shaft are journaled to provide the pivotal connection between the base member of said hoist frame and said stiffleg, and said dipper handle is pinned to the brackets provided on the bifurcated portions of the base member of said hoist frame to provide the pivotal connection between said dipper handle and the base member of said hoist frame.

24. A power shovel according to claim 15 wherein said dipper handle includes a resilient joint for absorbing compressive, torsional and bending loads applied to the dipper handle during the various phases of operation of said shovel.

25. A power shovel according to claim 15 wherein said means for retracting said stiffleg comprises a crowd system mounted on said body, operatively connected to the base member of said hoist frame.

26. A power shovel according to claim 15 wherein said means for hoisting said dipper includes a hoist mechanism mounted on said body, a sheave mounted on the base member of said hoist frame and a hoist line operatively interconnecting said hoist mechanism and said sheave.

27. A power shovel according to claim 15 including a dipper pitch control system.

28. A power shovel according to claim 15 wherein said dipper is pivotally connected to said dipper handle in a manner whereby said dipper is biased so that the digging end thereof pitches upwardly, and including means to limit the upward pitching movement of the dipper and releasable holding means for maintaining the dipper at predetermined pitches relative to said body during downward pivotal movement of said stiffleg, outward pivotal movement of said dipper handle relative to said stiffleg and forward movement of said dipper.

29. A power shovel according to claim 28 wherein said releasable holding means includes a pantograph linkage.

30. A power shovel comprising a mobile unit, a main frame rotatably mounted on said mobile unit, a stiffleg pivotally connected at its lower end to said main frame, said stiffleg having a bifurcated upper end portion provided with a pair of axially aligned, transversely spaced bearings, a hoist frame including a base member, a post member rigidly connected at one end thereof to a forward end of said base member and a tension member rigidly interconnecting the outer end of said post member and a rearward end of said base member, said base member having a forwardly disposed bifurcated end portion disposed in substantial alignment with the main body portion of said base member, said bifurcated portion of said base member having axially aligned, transversely spaced bearings, a head shaft consisting of split sections rigidly mounted in the bearings provided on the bifurcated portion of said base member and journaled in the bearings provided on the bifurcated end portion of said stiffleg, brackets mounted on the bearings provided on the bifurcated portion of said base member, said brackets being in substantial longitudinal alignment with the main body portion of said base member, a dipper handle pivotally connected at an upper end thereof to said brackets, a dipper pivotally connected to the outer end of said dipper handle, a hoist link pivotally connected at one end to said dipper and pivotally connected at the opposite end thereof to the post member of said hoist frame, said stiffleg and the components supported thereon having sufficient weight to provide a self-crowding action of said dipper when said stiffleg is permitted to pivot downwardly, means mounted on said main frame and operatively connected to the base member of said hoist frame for pivoting said stiffleg upwardly to retract said dipper, and means mounted on said hoist frame and operatively connected to the base member of said hoist frame for hoisting said dipper.

31. A power shovel according to claim 30 including a dipper pitch control system.

32. A power shovel according to claim 30 wherein said dipper is pivotally connected to said dipper handle in a manner whereby said dipper is biased so that the digging end thereof pitches upwardly, and including means to limit the upward pitching movement of the dipper and releasable holding means for maintaining the dipper at predetermined pitches relative to said body during downward pivotal movement of said stiffleg, upward pivotal movement of said dipper handle relative to said stiffleg and forward movement of said dipper.

33. A power shovel according to claim 32 wherein said releasable holding means includes a pantograph linkage.

34. A power shovel according to claim 33 wherein said pantograph includes pitch bell cranks mounted on the outer ends of the split sections of said head shaft, pitch pendants interconnecting rearward ends of said bell cranks and said dipper and control cables interconnecting forward ends of said bell cranks and the piston portion of a fluid cylinder mounted on said main frame.

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