United States Patent

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[54] **MOTOR GRADER APPARATUS**
11 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** 172/785, 172/792, 172/292, 180/23, 180/50, 180/51, 180/66, 180/77, 172/435
[51] **Int. Cl.** E02f 3/76, A01b 51/02, B62d 5/00
[50] **Field of Search** 172/785, 435, 786—793, 780—784, 292; 37/129; 180/77 (S), 50, 51, 23, 66

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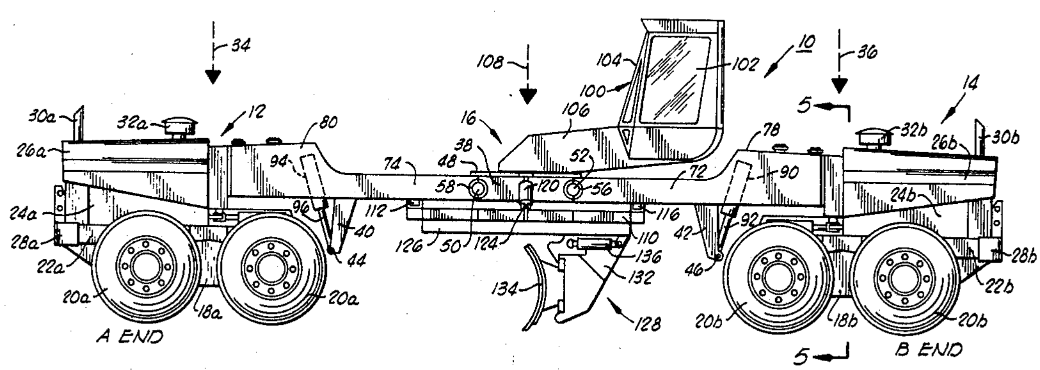
ABSTRACT: Apparatus for earth working which consists of two similar mobile assemblies including drive engine and traction elements and which are oriented in back-to-back manner to support a main frame therebetween in articulated suspension. The main frame is adapted to carry a subframe which further supports one or more earth working implements in adjustable manner therebelow, and the operating cab is movably supported by a support arm which is rotatably affixed at a central position on the main frame.



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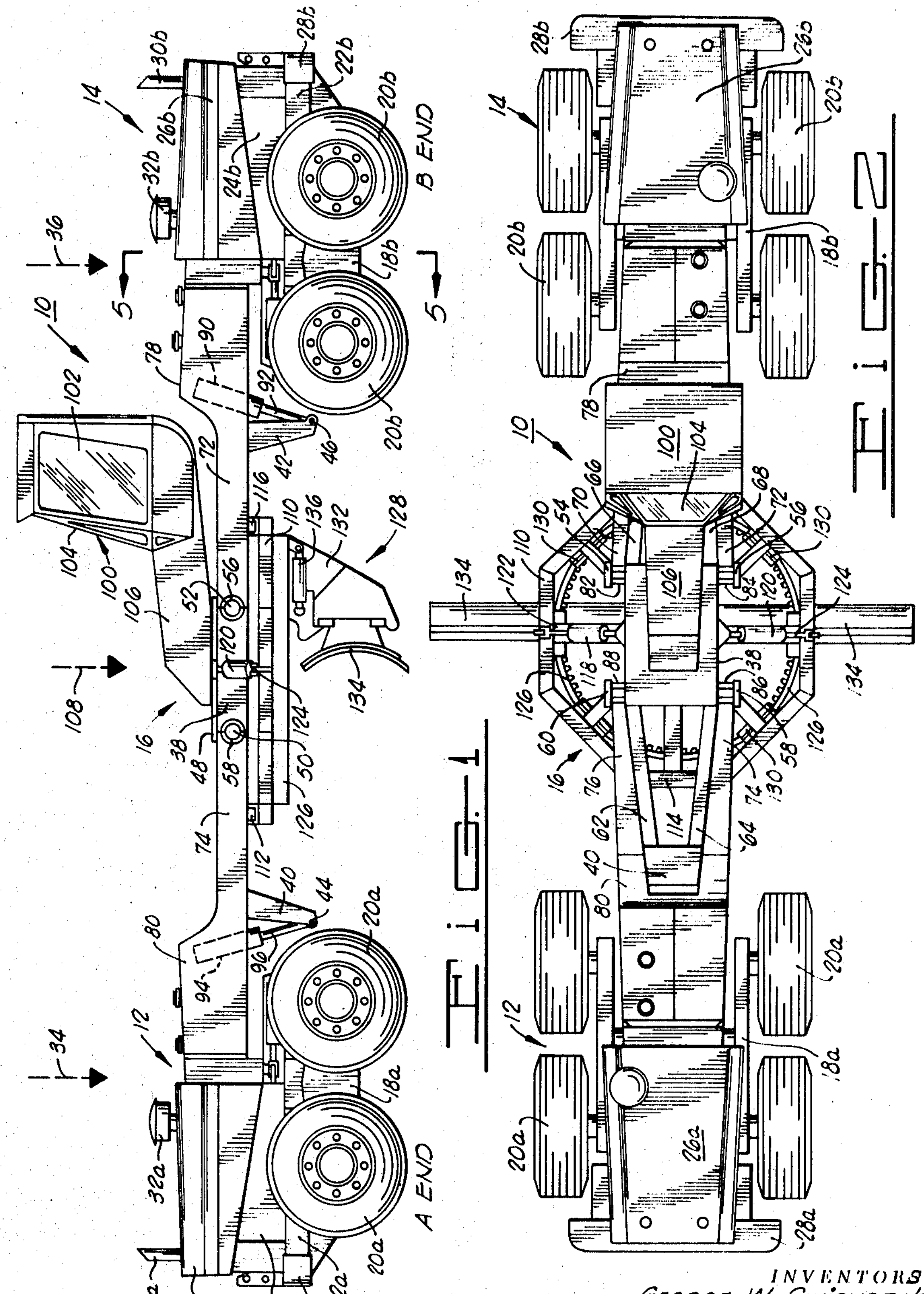

FIG. 1

FIG. 2

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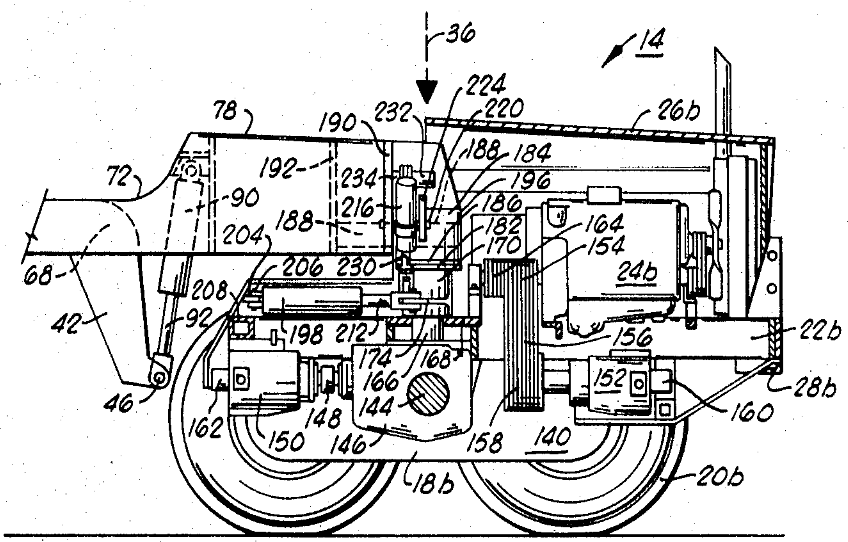

Fig. 3

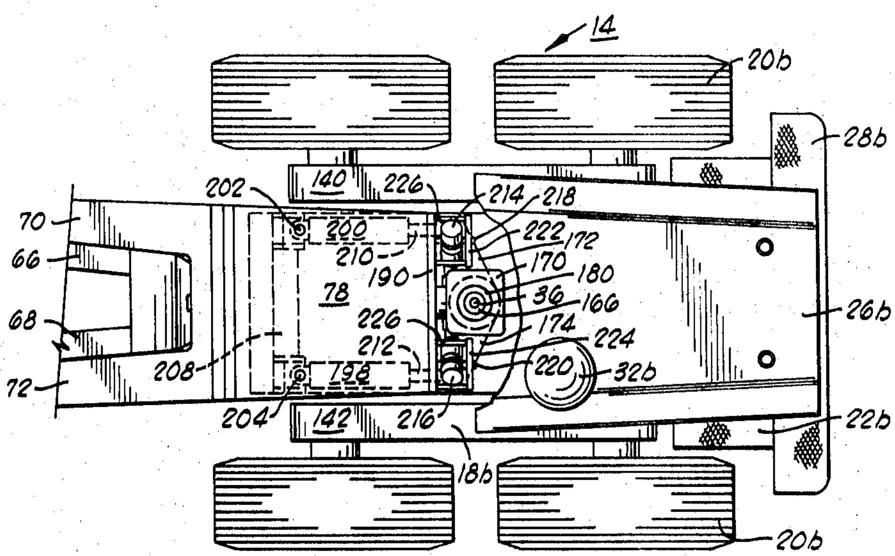

Fig. 4

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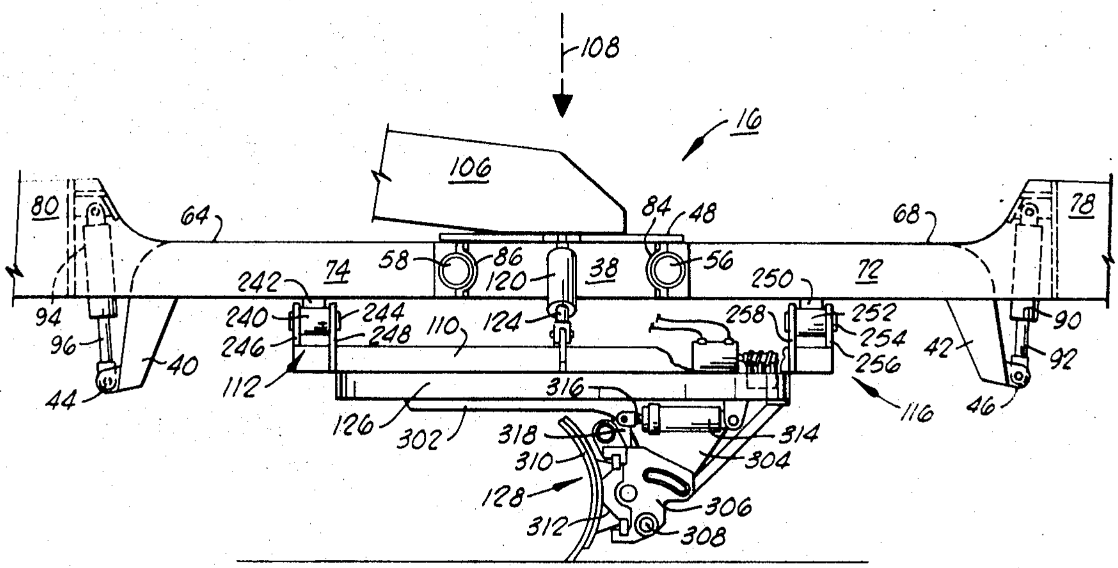

Fig-6

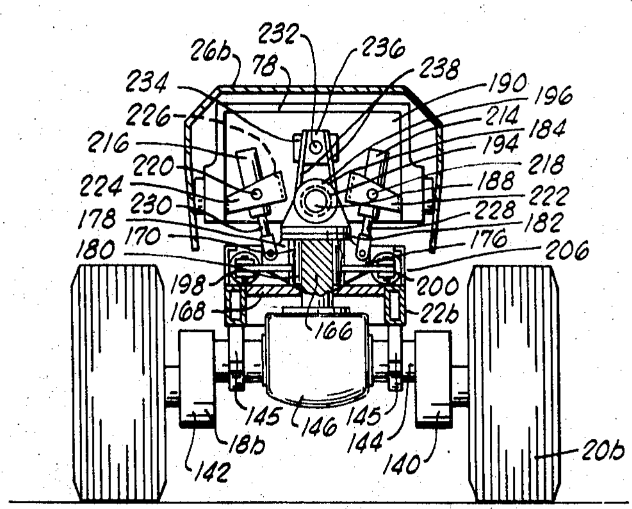

Fig-5

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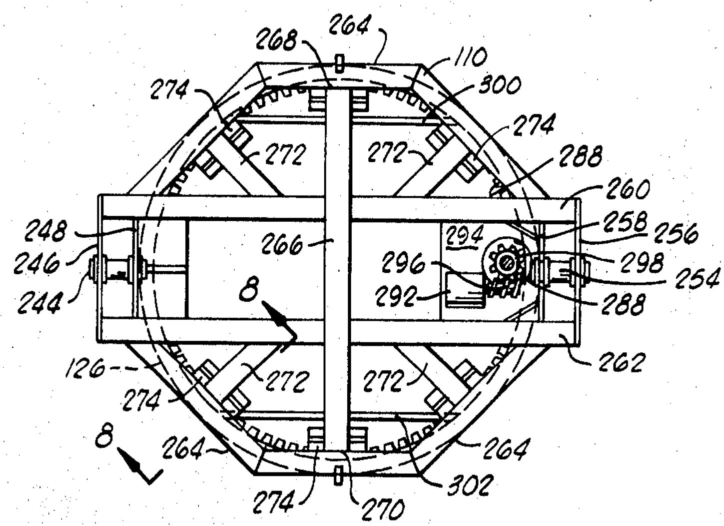

FIG. 7

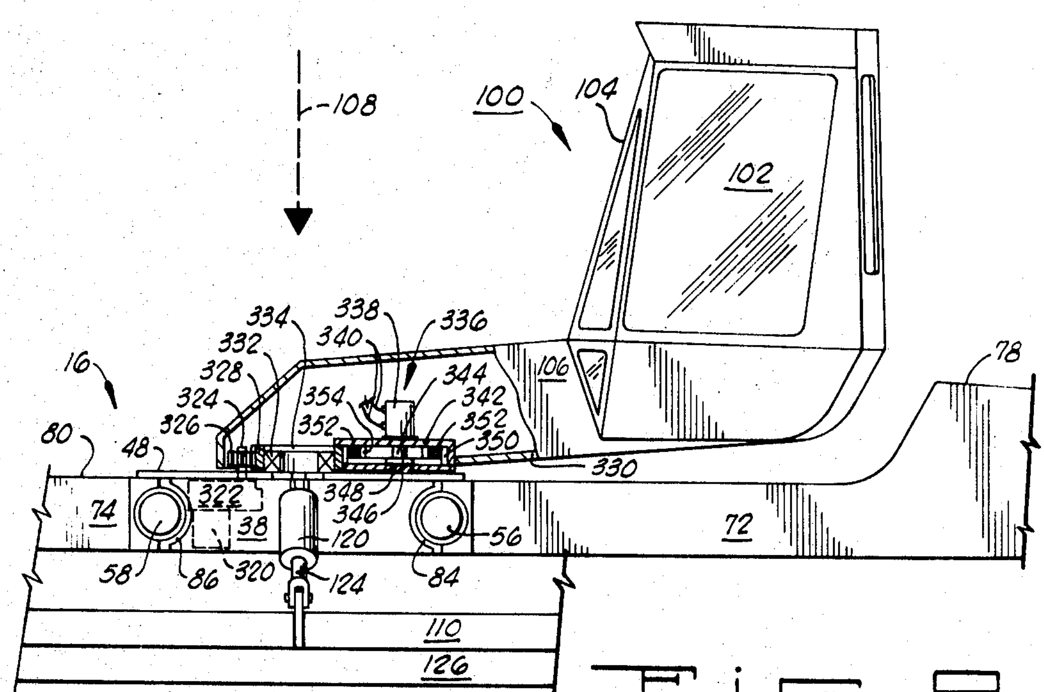

FIG. 9

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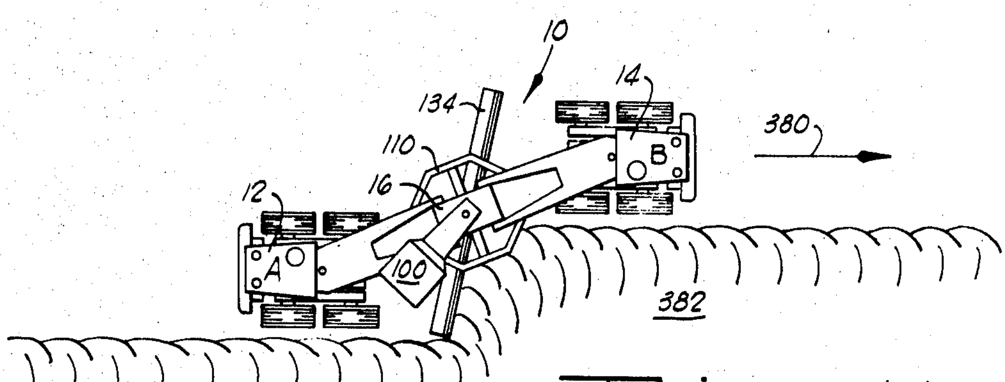

FIG. 11

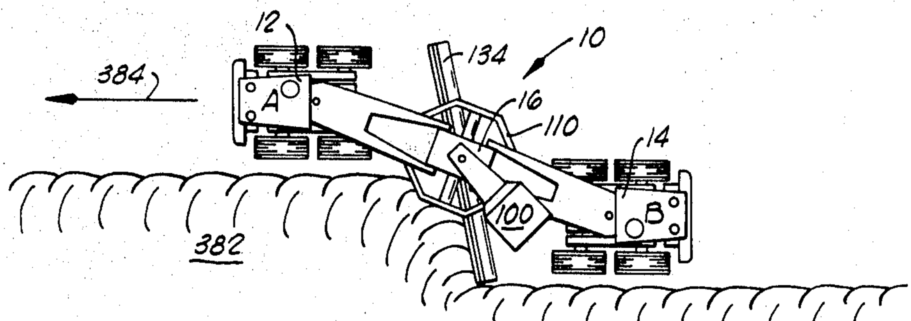

FIG. 12

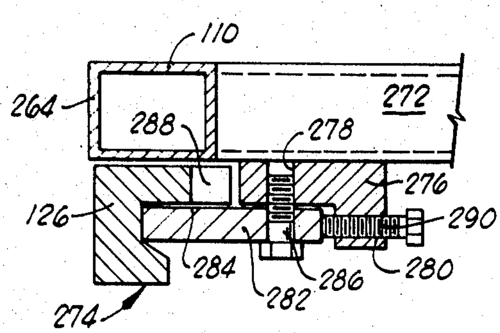

FIG. 8

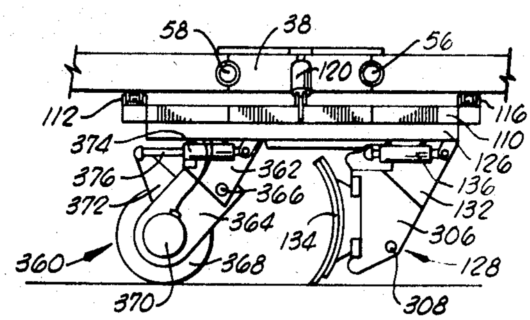

FIG. 10

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MOTOR GRADER APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to earth working apparatus, and, more particularly, but not by way of limitation, it relates to improved motor grader machinery having increased power capabilities.

2. Description of the Prior Art

The prior art includes various types of grading machinery utilizing differing forms of articulation and drive systems. The bulk or prior art teachings have been directed toward improvements relating to the classic type of motor grader, that having a rearward situated drive assembly and utilizing front guide wheels with an implement drawbar supported therebetween. The overall design of such graders has changed but very little over a long period of time and the technology has been directed largely toward various improvements on that existing type of structure. There are a few prior designs directed to double-articulated machinery and these are exemplified by two prior art U.S. patents, a patent to Wright, U.S. Pat. No. 2,494,324, now expired, and a patent to Harris, U.S. Pat. No. 3,324,583. While such prior art teachings do provide the double-ended power approach coupled with double-articulation of an earth working midportion, the prior teachings disclose little more than this basic structure and then are lacking in various control and structural aspects which have been found to be extremely important in enabling a most advantageous grading function.

SUMMARY OF THE INVENTION

The present invention contemplates a double-ended, double-articulated motor grader assembly which includes a fully controllable main frame and working elements as well as a movable operating cab. In a more limited aspect, the invention consists of first and second mobile assemblies each having similar drive power source and mobile elements, and each supporting opposite ends of a main frame which carries a subframe and working elements as well as the rotatable operating cab; the construction being such that the motor grader assembly is fully operable in either direction along its axis of alignment. The apparatus includes power apparatus for controlling steering, main frame tilt, main frame longitudinal attitude, and operating cab position, such control being interactive to provide proper, continual operation of the motor grader assembly along a work path.

Therefore, it is an object of the present invention to provide a motor grader assembly having fully operational capability when oriented in either direction along a longitudinal alignment axis.

It is also an object of the invention to provide motor grader apparatus having increased power and traction capabilities which enables the use of a working implement of increased size with greater precision and ease of handling.

It is still further an object of the present invention to provide a double-articulated motor grader assembly which can be controlled from a selected external reference source to perform automated profile grade cutting.

Finally, it is an object of the present invention to provide a motor grader assembly of much increased power which is capable of performing various grading operations ranging from more simple maintaining functions through difficult grade cutting operations.

Other objects and advantages of the invention will be evident from the following detailed description when read in conjunction with the accompanying drawings which illustrate the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a motor grader assembly constructed in accordance with the invention;

FIG. 2 is a top plan view of the motor grader assembly as shown in FIG. 1;

FIG. 3 is an enlarged elevation with parts shown in cutaway of a mobile assembly of the invention;

FIG. 4 is an enlarged top plan view of a mobile assembly of the invention with parts shown in cutaway;

FIG. 5 is a section taken along lines 5–5 of FIG. 1;

FIG. 6 is an enlarged side elevation of the main frame of the invention with parts shown in cutaway;

FIG. 7 is a top plan view of the subframe of the invention;

FIG. 8 is a section taken along lines 8–8 of FIG. 7;

FIG. 9 is an enlarged side elevation of the main frame and operating cab of the invention with parts shown in cutaway;

FIG. 10 is a side elevation of an alternative form of working element which may be used with the invention;

FIG. 11 is an operational plan view of the motor grader assembly in one form of use; and

FIG. 12 is an operational plan view of the motor grader assembly in reversed position.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 and 2, a motor grader assembly **10**, consists of an A END mobile assembly **12** and an oppositely oriented B END mobile assembly **14** with a frame assembly **16** pivotally supported therebetween. The A END and B END mobile assemblies **12** and **14** respectively, may be identical units supported on tandem wheel assemblies **18*a*** and **18*b*** bearing on rubber-tired wheels **20*a*** and **20*b***, respectively. While motor grader assembly **10** is shown as being supported on pluralities of tandem arrayed rubber-tired wheels **20*a*** and **20*b***, it should be understood that various other forms of ground supporting mobile means such as traction units, single or plural wheel assemblies, etc., may be employed in the mobile ground supporting function.

Each of mobile assemblies **12** and **14** further consists of a chassis **22*a*** and **22*b*** supported atop tandem wheel assemblies **18*a*** and **18*b*** at a central point (to be further described below) and a suitable power source or engine **24*a*** and **24*b*** is supported thereon. Prototype motor grader units are presently designed to include 225 horsepower diesel engines of a type which is commercially available from the Caterpillar Tractor Co., of Peoria, Ill. The engines **24*a*** and **24*b*** function with hydraulic pumps and motors which are utilized for various purposes about motor grader assembly **10** as will be further described below. Hood cowls **26*a*** and **26*b*** are affixed over respective engines **24*a*** and **24*b*** in secure manner relative to chassis **22*a*** and **22*b*** while conventional bumper structure **28*a*** and **28*b***, exhaust stack **30*a*** and **30*b***, and air cleaners **32*a*** and **32*b*** are suitably adapted.

The main frame assembly **16** is pivotally supported on the A END mobile assembly **12** about a point indicated by vertical axis designation **34**, and it is supported at its other end of the B END mobile assembly **14** about a vertical axis designation **36**. The main frame assembly **16** consists of a central frame **38** having each end extending into a downward curve, i.e. central frame ends **40** and **42** each including a respective pivot eye **44** and **46** formed in the downward extremity thereof. Central frame **38** has a mounting plate **48** securely affixed as by welding across its upper, horizontal surface and a pair of bearing shafts **50** and **52** are secured therethrough in parallel, transverse disposition to form a plurality of quadrature arrayed support shafts **54**, **56**, **58** and **60** therefrom. Support shafts **54** and **60** extend outward in parallel, spaced and horizontal disposition from one side of central frame **38** while support shafts **56** and **58** extend in respective opposite dispositions on the other side of central frame **38**.

The end **40** of central frame **38** includes a pair of beams **62** and **64** (see FIG. 2) and the other end **42** is similarly formed by a pair of tapering beams **66** and **68**. The support shafts **54**, **56**, **58** and **60** provide support connection for the central frame **38** as they are each pivotally affixed to respective arm ends **70**, **72**, **74** and **76** for movement about a transverse axis. The arm ends **70** and **72** form part of a bifurcated frame **78** while the arms **74** and **76** form part of an oppositely disposed bifurcated frame 80. Each of bifurcated ends 70, 72, 74 and 76 receives a semicircular bearing bracket 82, 84, 86 and 88 in secure affixture for the purpose of movably seizing each of the respective support shafts 54, 56, 58 and 60.

The opposite or outer ends of the respective bifurcated frames 78 and 80 are each mounted to respective mobile assemblies 14 and 12 for pivotal affixture about vertical axes 36 and 34. The hydraulic cylinder 90 is connected within bifurcated frame 78 to extend a piston arm 92 into pivotal connection with pivot eye 46 of central frame end 42. Similarly, the hydraulic cylinder 94 is affixed upwardly within bifurcated frame 80 to extend a piston rod end 96 downward into pivotal connection with pivot eye 44. Actuation of hydraulic cylinders 90 or 94 enable movement of the central frame 38 relative to each of the bifurcated frames 78 and 80 which motion must necessarily extend through to effect counterbalance at respective tandem assemblies 18b and 18a.

The mounting plate 48 of central frame 38 actually provides a smooth plate about which operating cab 100 is supported. The operating cab 100 consisting of operator's space 102 and having windshield area 104 is supported on one end of a support arm 106 which, in turn, has its other end pivotally affixed on mounting plate 48 for movement about a vertical axis 108. The support arm 106 includes drive and braking mechanism, as will be further described below, which operates in conjunction with mounting plate 48 to position the operator's cab 100 in any desired position relative to main frame 16.

A subframe 110, exemplarily shown as being octagonal in construction, is supported beneath main frame 16 in laterally pivotal manner. Thus, subframe 110 is pivotally affixed at a first pivot assembly 112 which is rigidly secured beneath a crossmember 114 extending between frame arms 62 and 64. Similarly, the opposite end of subframe 110 is pivotally affixed to a pivot assembly 116 which is secured beneath a crossmember (not shown), secured as by welding between the opposite bifurcated frame arms 66 and 68. Pivotal or attitude control of subframe 110 relative to main frame 16 is exercised by control of a pair of hydraulic cylinders 118 and 120, each of which is pivotally affixed to opposite sides of central frame 38 to extend respective pistons 122 and 124 into a suitable pivotal connection at the opposite sides of the subframe 110.

The subframe 110 provides further movable support of a rotatable ring member 126 which supports a working implement, e.g. a blade assembly 128, therebeneath. Ring member 126 is supported for circular movement within a plurality of support blocks 130 beneath subframe 110, and suitable drive means (as will be further described) are mounted on subframe 110 to provide circular rotation of ring member 126. The working element, such as blade assembly 128, is secured beneath ring member 126 to rotate therewith. Thus, blade assembly 128 may consist of a connecting frame 132 supporting an earth cutting blade 134 which is movable as to angle of attack by means of a hydraulic cylinder 136, such structure to be further described in greater detail.

FIGS. 3, 4 and 5 depict elements of the B END mobile assembly 14 in greater detail. It should be understood that the A END mobile assembly 12 may be constructed in identical manner. The tandem assembly 18b is actually a commercially available mechanical unit which enables four-wheel drive of tandem arranged wheels, e.g. a separate-type final drive utilizing a tandem axle. Casings 140 and 142 of tandem assembly 18b each include a separate sprocket and chain drive for each of the respective front and rear wheels 20b. The tandem assemblies include a transverse axle 144, and a pair of oppositely disposed clamping brackets 145 are welded beneath chassis 22b to provide secure engagement for support upon transverse axle 144. The tandem axle 144 receives drive rotation from a straight-through gear drive assembly 146 which is connected to receive rotational input through a coupling 148. The rotational input coupling 148 is taken from the output of a suitable hydraulic motor 150, e.g. a Series 27 Sundstrand hydraulic motor as driven from a suitable hydraulic pump 152, e.g. a Series 25 Sundstrand hydraulic pump. While specific hydraulic pump and motor equipment is identified, it should be understood that a great many combinations of differing power and type might be utilized to provide the drive power.

Hydraulic pressure generated in hydraulic pump 152 is also utilized in conventional manner to drive various of the hydraulic control elements disposed about the motor grader assembly 10, as will be further described. The hydraulic pump 152 is energized from diesel engine 24b as rotational engine output applied to a parallel array of flywheels 154 is transmitted on a plurality of V-belts 156 to a plural belt pulley 158 which, in turn, applies rotational input to hydraulic pump 152. Hydraulic pump 152 working in concert with conventional reservoir means (not shown) provides pressure output from a coupling 160 for conduction to an input coupling 162 for energization of the hydraulic motor 150. An additional plurality of flywheel pulleys 164 may be used to provide an additional rotational output from engine 24b for connection to other auxiliary pump means (not shown) which might be employed for powering auxiliary implement control mechanisms and such, as will be further described below.

A vertical pivot shaft 166 is rigidly secured through a floor plate 168 of chassis 22b, and into rigid connection on top of gearbox 146 such that it extends vertically from the center of tandem assembly 18b, i.e. straight up from the intersection of drive axle 144 through gear drive 146. Pivot shaft 166 is inserted upward through a pivot bearing 170 which is formed to have oppositely disposed yoke arms 172 and 174 extending outward for steering connection as will be described. The pivot bearing 170 is also formed to have two oppositely disposed connecting tabs 176 and 178 (FIG. 5) and these serve to provide a connection for tilt control hydraulics as will also be described below.

The pivot bearing 170 is mounted on pivot shaft 166 by means of a Timken bearing 180 of conventional type interposed concentrically therebetween to provide necessary ease of the relative movement. The pivot bearing 170 is formed to have a flange 182 about its upper end, and a frame support bearing 184 having a bottom flange 186 is securely affixed thereon, the placement of support bearing 184 also serving to position and retain the Timken bearing 180.

The support bearing 184 provides a rotational support for the frame end 78. A steel support rod 188 of suitable size and strength is securely affixed as by welding through the front plate 190 of end frame 78, and suitable reinforcing such as lateral plate 192 is also provided. Various heavy construction techniques may be utilized to assure a strong bond between rod 188 and frame end 78 since the outer end of rod 188 must support the entire end of the main frame 16 upon mobile assembly 14. The outer end of rod 188 is rotationally retained within support bearing 84 in similar manner as that utilized for pivot shaft 166 within pivot bearing 170. That is, a Timken bearing 194 is interposed within the annular space between support rod 188 and the inner surface of support bearing 184 and a retaining plate 196 is secured over the end of support bearing 184 in such manner as to assure secure positioning of Timken bearing 194.

Steering control is effected by means of hydraulic cylinders 198 and 200 which are connected at pivot ends 202 and 204 to a connecting frame 206 which is rigidly secured through transverse beam 208 to the chassis 22b. Hydraulic pistons 210 and 212 are connected to respective yoke arms 172 and 174 of pivot bearing 170, and energization in concert of hydraulic cylinders 198 and 200 will provide rotation of yoke arms 172 and 174 (pivot bearing 170) relative to the pivot shaft 166 which is also secured to chassis 22b of mobile assembly 14.

Tilt control of main frame 16 is effected by control of hydraulic cylinders 214 and 216. Hydraulic cylinders 214 and 216 are each pivotally mounted by means of respective pivot pins 218 and 220 which are affixed thereto and pivotally interconnected within bracket plates 222 and 224 which are secured through suitable spacers 226 or front plate 190 of the bifurcated frame end 78. Hydraulic cylinders 214 and 216 extend respective pistons 228 and 230 downward into pivotal connection with connecting tabs 176 and 178 as disposed on opposite sides of pivot bearing 170. Coordinated control of hydraulic cylinders 214 and 216 effects tilting of frame end 78 and, therefore, main frame 16 about the longitudinal axis established by the bearing of support rod 188 within support bearing 184.

Frame locking is provided by a hydraulic cylinder 232 which may be selectively actuated to extend its piston rod (not specifically shown) into a locking hole which is formed within a locking block 234. Locking block 234 consists merely of a block of steel with a hole therethrough and which is secured at a front center point of forward plate 190 of end frame 78. Hydraulic cylinder 232 is then supported in longitudinal relationship by a mounting plate 236 suspended by a pair of support plates 238 each rigidly secured above the support bearing 184. The operator can effect control of cylinder 232 to extend the piston into locking block 234, this serving to maintain continuous positioning of the hydraulic locking cylinder 232 in vertical alignment, said vertical alignment assuring lateral horizontal positioning of frame end 78.

Referring now to FIG. 6, the main frame 16 is provided with unique adjustability through pivotal connection of end frames 78 and 80 to the central frame 38. The subframe 110 is secured from pivot assemblies 112 and 116 from opposite ends of central frame 38. This is, a bearing sleeve 240 secured from a sleeve hanger 242 as rigidly affixed beneath transverse member 114 (FIG. 2), a part of the main frame 38, is secured about the bearing pin 244 as supported by plates 246 and 248. Pivot assembly 116 at the opposite end is similarly constructed and supported from the opposite end of main frame 38 with a hanger 250 supporting a bearing sleeve 252 for pivotal support about a bearing pin 254 as secured between vertical plates 256 and 258. As shown to better advantage in FIG. 7, subframe 100 is constructed from two parallel, longitudinal beams 260 and 262 which are integrally connected with spaced, vertical plates 256 and 258 at one end and 246 and 248 at the opposite end. A plurality, e.g. six, of frame beams 264 are then welded into a generally equisided polygonal frame, and a transverse beam 266 supports across subframe 110 as secured at opposite lateral points 268 and 270. Further diagonal beams 272 are welded into the framework in supporting manner as shown.

A plurality of adjustable ring support bearing assemblies 274 (support blocks 130, FIG. 2) are disposed at approximately equal distances about the underside of subframe 110 to support the ring 126 moveably therearound. As shown more particularly in FIG.. 8, each of ring bearing assemblies 274 consists of right-angle block 276 welded to the underside of crossbeam 272, and each contains a plurality of vertical, threaded adjustment holes 278 as well as a plurality of horizontal, threaded adjustment holes 280. A bearing plate 282 having a suitably flame-hardened bearing surface 284 is secured within the block 276 by means of a plurality of threaded fasteners 286 such that the outer end or bearing surface 284 of bearing plate 282 supports a concentric, gear-toothed inner flange 288 of ring 126. An additional plurality of horizontal threaded fasteners 290 are inserted through threaded holes 280 for the purpose of laterally positioning the respective ring bearing plate 282. Thus, proceeding around the subframe 110 and adjusting, consecutively, each ring bearing assembly 274, threaded fasteners 286 can be positioned to set the level of ring 126 and threaded fasteners 290 can be positioned to set proper centering of ring 126.

Referring again to FIG. 7, a ring drive hydraulic motor 292 is suitably mounted on a mounting plate 294 as rigidly secured between parallel beams 260 and 262. Hydraulic motor 292 is disposed to work into a worm gear 296 which transmits rotational force to a drive gear 298. Drive gear 298 is positioned in engagement with the inner, gear-toothed flange 288 of ring 126 to transmit motion therethrough.

A pair of implement support plates 300 and 302 are rigidly affixed in parallel disposition across opposite sides of ring 126. Referring to FIG. 6, each of the implement support panels 300 and 302 has a similarly shaped and downward extending panel 132 which serves to pivotally support an adjusting plate 306 about a pivotal connection 308. A blade 134 is secured by a suitable form of connection 312 to said adjusting plate 306 for movement therewith. Hydraulic cylinders 136, pivotally connected to ring 126, extend a piston 316 into pivotal connection with a lever mechanism 318 which exerts positioning control on the blade 134. The hydraulic adjusting cylinder 136, adjusting plate 306, connecting mechanism 312 and other related components are duplicated on each side of the ring 126, i.e. as associated with each of implement support panels 300 and 302 (FIG. 7).

Referring now to FIG. 9, the operating cab 100 can be controlled for disposition at any position relative to main frame 16. The cab support arm 106 is rotatable about vertical axis 108 as driven by the suitable motor 320. Motor 320 may be any suitable powering device, e.g. a conventional model of Racine Hydraulic Torque motor, and motor 320 provides rotational input into a suitable gear drive box 322 which provides a stepped down rotational output on shaft 324 to pinion gear 326. The pinion gear 326 is in mesh with a ring drive gear 328 which is rigidly secured in conventional manner to bottom panel structure 330 of support arm 106 such that it is integral with the structure of support arm 106.

A suitable form of bearing 332 is secured on the top center of mounting plate 48. Bearing 332 may be any acceptable form of bearing, consonant with proper design, for bearing upward against the underside of a bearing plate 334 which is secured as by welding across the upper annulus of ring gear 328. In a prototype form of the invention, the bearing 332 consists of a concentric race ball bearing assembly which supports ring gear 328 and support arm 106 rotatably and slightly displaced above the upper surface of mounting plate 48.

Operative alternatively with cab drive motor 320 is a brake assembly 336. Brake assembly 336 is actuated by a hydraulic cylinder 338 which is controlled by pressure lines 340. Hydraulic cylinder 338 is end-mounted over the top center of a generally round brake housing 342 which is affixed integrally with bottom panel structure 330, ring gear 328 and other of the frame structure of support arm 106. A piston 344 from hydraulic cylinder 338 extends downward into rigid affixture with a circularly shaped pressure pad 346 which carries a layer of brake lining material 348 thereon for braking contact at selected positions around mounting plate 48. A retaining ring 350 is formed of a size to fit under the brake housing 342 and slightly larger than pressure plate 346 such that it retains a plurality of compression springs 352 around a circular comb 354 which is secured about the upper surface of pressure plate 350.

Thus, compression springs 352 act in concert against pressure plate 346 to urge the brake liner material 348 into secure, braking contact at a selected position on mounting plate 48. Actuation of hydraulic cylinder 338 will serve to withdraw piston 344 to release the grip of brake lining material 348 during those times when positioning control of operating cab 100 is being effected by operation of drive motor 320.

FIG. 10 discloses an alternative form of working implement which can be employed instead of the blade implement 128 as shown in FIG. 6. Thus, the implement of FIG. 10 includes the similar blade assembly 128 as well as an auger distribution assembly 360. The auger assembly 360 may be similarly hung from ring 126 by supporting it on each side by means of a hanger panel 362 and pivot plate 364 as attached at pivotal point 366. An auger element 368 is rotatably supported by the pivot plates 364 and an end-mounted hydraulic motor 370 of suitable size and capacity is affixed thereto in rotational driving connection. A lever arm 372 is secured as by welding to pivot plate 364 and a hydraulic cylinder 374 and piston 376 function to raise and lower auger 368 relative to the work surface.

The various control and power functions about the motor grader assembly have been effected by the use of hydraulic equipment in prototype equipment; however, it should be understood that these functions can be performed by any of the conventional powering methods such as electrical, pneumatic, mechanical, or any combination of such power transmission methods. Control functions are readily regulated by the operator in the operating cab and, in addition to manual control, it is often desirable to enable automatic control of certain level and steering functions so that the motor grader assembly 10 can be controlled totally or in part from an external grade reference such as a stringline.

In operation, the motor grader assembly 10 may be employed for any of a large number of diverse grading or scraping operations and the operator can exercise a very high degree of control over the entire structure even though it is quite large. The main frame 16 is controllable as to lateral or sideways tilt relative to either one or both of the A END and B END mobile assemblies 12 and 14, respectively. Thus, (see FIG. 5) operation of hydraulic cylinders 214 and 216 in concert will enable such tilt control to whatever the desired tilt angle, and this also imparts tilt angle to the subframe 110 and working implement 128 suspended underneath main frame 16.

In some operations, it is desirable to allow lateral tilt articulation between the forward mobile assembly and main frame 16 while locking the main frame 16 to the rear mobile assembly. This is effected by actuating the hydraulic cylinder 232 of the rear mobile assembly into locking engagement within the respective locking block 234. Thus, for the example as shown in FIG. 1, the B END mobile assembly 14 would be in the locked attitude with hydraulic cylinder 232 energized while the forward or A END mobile assembly 12 would be free to rock laterally relative to bifurcated frame end 80 of main frame 16.

Steering is effected by concerted control of hydraulic cylinders 198 and 200 (see FIG. 4) on each of the A END and B END mobile assemblies 12 and 14. Control of hydraulic cylinders 198 and 200 turns the respective mobile unit relative to main frames 16 in order to effect an overall machine turning action. It should be noted too, however, that necessity for turning the motor grader assembly 10 is lessened by a great margin since it is effectively a double-ended machine capable of equal degrees of reliability and efficiency of operation in either direction.

Thus, as shown in FIGS. 11 and 12, the motor-grader assembly can make continual grading passes along a work path without the necessity for turning the entire machine around. As shown in FIG. 11, the motor grader assembly 10 is proceeding in the direction of arrow 380 with B END mobile assembly 14 in front and the A END mobile assembly 12 at the rear. The main frame 16 is canted at an optimally adjusted angle between the A END and B END units 12 and 14 so that blade 134 can be brought into contact with the rough earth mass 382 at the best grading angle. Note too that the operating cab 100 is positioned at a place where the operator will have the best view of the grading path, i.e. maximum ability to see not only the work path but in front of the forward mobile assembly 14 and behind the rear or A END mobile assembly 12. Operating cab 100 is readily adjustable at any time to gain advantage of a better view.

Upon completing the grading pass in the direction of 380, the motor grader assembly 10 can, with slight adjustment, be reversed to proceed back along the work area, rough earth mass 382, in the direction of arrow 384. Thus, as shown in FIG. 12, the A END mobile assembly 12 leads while the operator has steered the B END mobile assembly 14 leftward to reverse the cant of main frame 16 relative to A END mobile assembly 12. At the same time, the operator has repositioned his operating cab 100 at a most optimum viewing position relative to the work area. The blade 134 is continuously rotatable under subframe 110, and it is here readjusted for its grading function in the direction of arrow 384.

In addition to steering and tilt control of main frame 16 relative to the A END and B END mobile assemblies 12 and 14, main frame 16 embodies additional positioning control for effecting height and/or level control of central frame 38. Hydraulic cylinders 90 and 94 can be operated to alter the relative position of respective end frames 78 and 80 with respect to the central frame 38. For example, if both of cylinders 90 and 94 are operated to withdraw pistons 92 and 96, the general level of central frame 38 will be raised. Countermovement to or compensation for the raising of central frame 38 results in a clockwise (as shown in FIG. 1) movement of chassis 22*b* of B END mobile assembly 14 about the support center of tandem assembly 18*b*, and it results in counterclockwise movement of chassis 22*a* of A END mobile assembly 12 about the supporting center of tandem assembly 18*a*. The hydraulic cylinders 90 and 94 can be operated varying amounts to adjust subframe 110 and the working element or blade assembly 128 to an optimum position.

In addition to the movement along the lengthwise axis of main frame 16, hydraulic cylinders 118 and 120 can be operated to exercise control tilt of subframe 100 relative to main frame 16. Thus, as subframe 110 rests pivotally from pivot assemblies 112 and 116, it can be adjusted hydraulically to a desired attitude of transverse angle or level, and this placement carries through for coarse positioning of the blade 134 of blade assembly 128.

The alternative structure of FIG. 10 depicts a working unit which includes both a blade 134 and an auger distributing assembly 360. This is only one of many forms of working element which may be compatible for use with the motor grader assembly 10. It is contemplated that various other forms of rotary cutter, cutter-moldboard combinations, snow attachments, asphalt ripping implements, subsoil plows, etc. are readily adaptable for mounting below the subframe 110. Motor grader assembly 10 may also be readily used in a form of automatic profile grading wherein both the steering and working implement level control are controlled from an external reference such as a stringline.

The foregoing discloses a novel motor grader apparatus which is more powerful and more efficient for a wider range of applications than any of the existing types of similar equipment. The motor grader is capable of manual, automatic, or combined manual-automatic control for use in a variety of applications ranging from surface maintaining to rough grade cutting. The machine enjoys particular advantages from the operators viewpoint in that it embodies a readily movable cab which is easily controllable by the operator for positioning at a point which renders the most advantageous view of the work area, machine components, etc.

Changes may be made in the combination and arrangement of elements as heretofore set forth in the specification and shown in the drawings; it being understood that changes may be made in the embodiments disclosed without departing from the spirit and scope of the invention as defined in the following claims.

We claim:

1. Earth working apparatus comprising:

first mobile means, including a drive power source, a tandem wheel assembly, and support means supporting said drive power source and being connected to said tandem wheel assembly at a point which is central with respect to the tandem wheel assembly;

second mobile means, including a drive power source, a tandem wheel assembly, and support means supporting said drive power source and being connected to said tandem wheel assembly at a point which is central with respect to the tandem wheel assembly;

first frame end means having a bifurcated end and a single end and being pivotally affixed to said first mobile means;

second frame end means having a bifurcated end and a single end and being pivotally affixed to said second mobile means;

central frame means having elongated form and being pivotally affixed at first and second points along its long dimension to respective bifurcated ends of said first and second frame end means;

subframe means pivotally supported from said central frame means;

earth working means supported beneath said subframe means; and

an operating cab enclosure rotatably affixed on top of said central frame means for selected positioning thereon to gain optimum surveillance.

2. Earth working apparatus as set forth in claim 1 wherein said earth working means comprises:

ring means supported in generally horizontal attitude beneath said subframe means in rotatable manner; and

an earth working implement supported beneath said ring means in adjustable manner at an earth working position.

3. Earth working apparatus as set forth in claim 2 which is further characterized to include:

a second earth working implement supported from said ring means to function in coaction with said first earth working implement.

4. Earth working apparatus as set forth in claim 1, wherein said first mobile means is further characterized to include:

first hydraulic means connected centrally on said mobile means and to a side position of said central frame means;

actuating means for controlling said first hydraulic means to effect tilt positioning of said central frame means;

second hydraulic means connected centrally of said first mobile means and to the opposite side of said central frame means; and

second actuating means for controlling said second hydraulic means to effect opposite tilt positioning of said central frame means.

5. Earth working apparatus as set forth in claim 4, which is further characterized to include:

third hydraulic means secured on said first mobile means and including a piston for extension into locking engatement in said central frame means; and

third actuating means to extend said piston to lock said central frame means in a predetermined position of alignment relative to said first mobile means.

6. Earth working apparatus as set forth in claim 1, which is further characterized to include:

pivot bearing means including first and second steering levers affixed to said first frame end means such that said first and second steering levers extend outward on opposite sides thereof;

first hydraulic means connected between said first steering lever and said first mobile means to effect pivotal movement between said first mobile means and said first frame end means; and

second hydraulic means connected between said second steering lever and said first mobile means to effect opposite pivotal movement between said first mobile means and said first frame end means.

7. Earth working apparatus as set forth in claim 4, which is further characterized to include:

pivot bearing means including first and second steering levers affixed to said first frame end means such that said first and second steering levers extend outward on opposite sides thereof;

first hydraulic means connected between said first steering lever and said first mobile means to effect pivotal movement between said first mobile means and said first frame end means; and

second hydraulic means connected between said second steering lever and said first mobile means to effect opposite pivotal movement between said first mobile means and said first frame end means.

8. Earth working apparatus as set forth in claim 5, which is further characterized to include:

pivot bearing means affixed to each of said first and second frame end means to extend steering levers outwardly on each side;

first and second hydraulic steering means, each connected to opposite sides of said first and second mobile means and to opposite ones of said steering levers to effect reciprocal steering action.

9. Earth working apparatus as set forth in claim 1, which is further characterized to include:

first power means affixed on said central frame and controllable to move said first frame end means relative to said central frame means to raise and lower said central frame means;

second power means affixed on said central frame and controllable to move said second frame end means relative to said central frame means to raise and lower said central frame means; and

control means energizable to control said first and second power means in coaction to control raising and lowering of said central frame means.

10. Earth working apparatus as set forth in claim 1 which is further characterized to include:

first power means connected between a first end of said central frame means and an end of said first end frame means such that said first power means can be actuated to vary the angle of joinder of said central frame means and first end frame means at said respective pivotal connection; and

second power means connected between a second end of said central frame means and an end of said second end frame means such that said second power means can be actuated to vary the angle of joinder of said central frame means and second end frame means at said respective pivotal connection.

11. Earth working apparatus as set forth in claim 1 wherein said operating cab enclosure comprises:

support arm means having first and second ends and having the first end rotatably affixed atop said central frame means;

operating cab means including seat space and controls rigidly affixed to the second end of said support arm means; and

control means including drive and brake structure for positioning said support arm means and operating cab means at a selected position relative to said central frame means.