Jan. 1, 1957 H. W. ROCKWELL 2,775,831

TOOL ADJUSTMENT FOR EARTH WORKING MACHINES

Filed Oct. 23, 1953 4 Sheets-Sheet 1

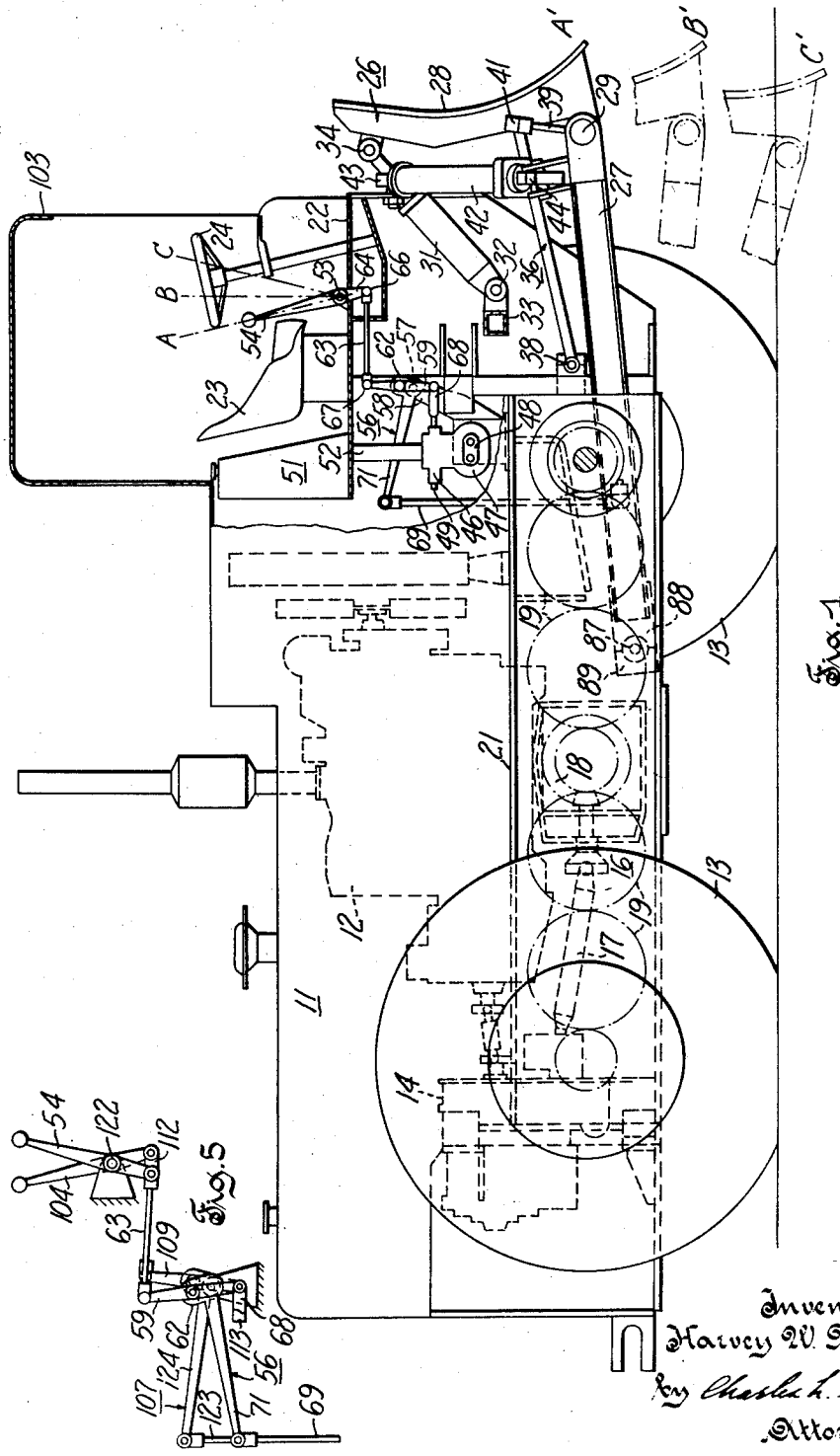


Fig. 1

Fig. 5

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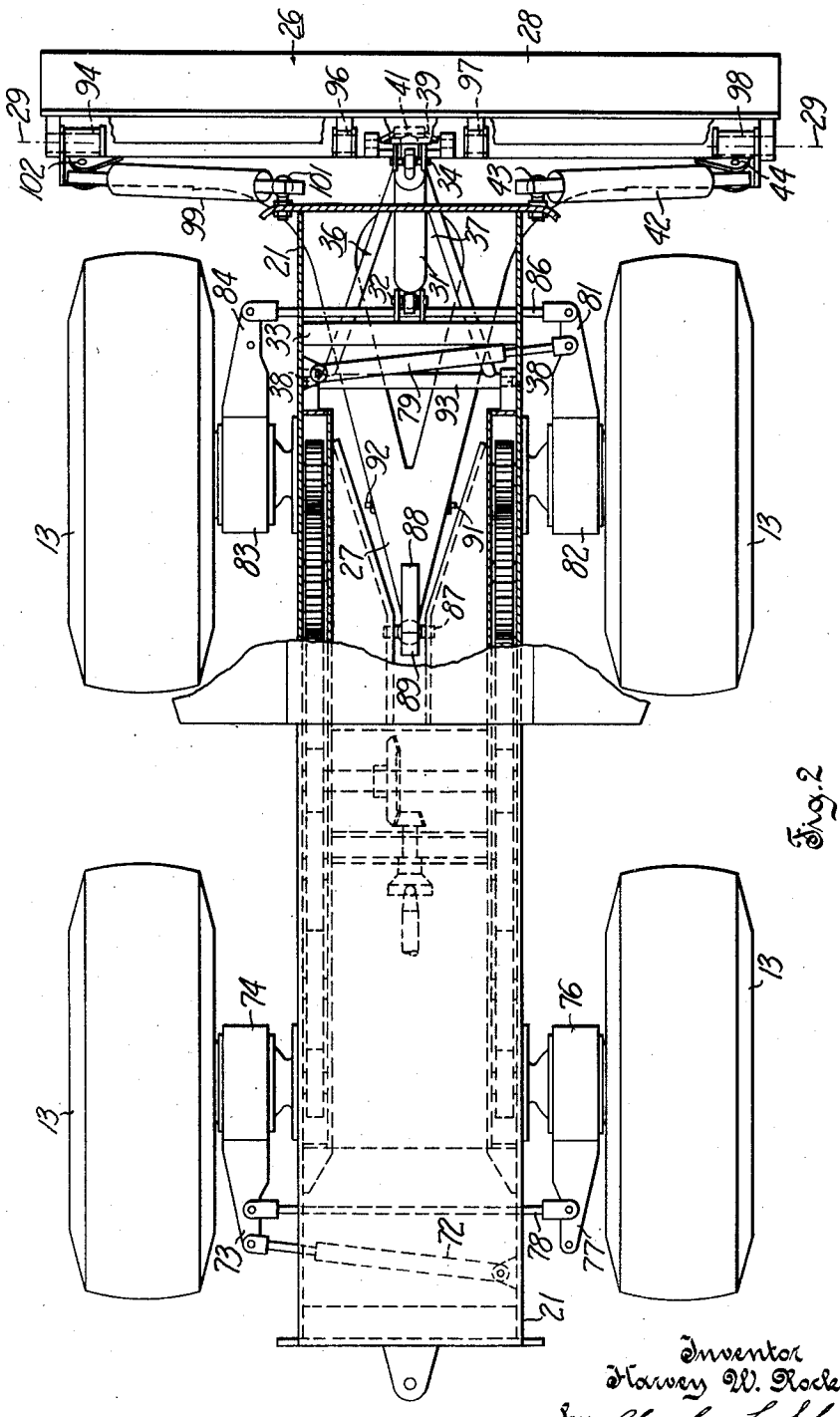


Fig. 2

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TOOL ADJUSTMENT FOR EARTH WORKING MACHINES

Filed Oct. 23, 1953 4 Sheets-Sheet 3

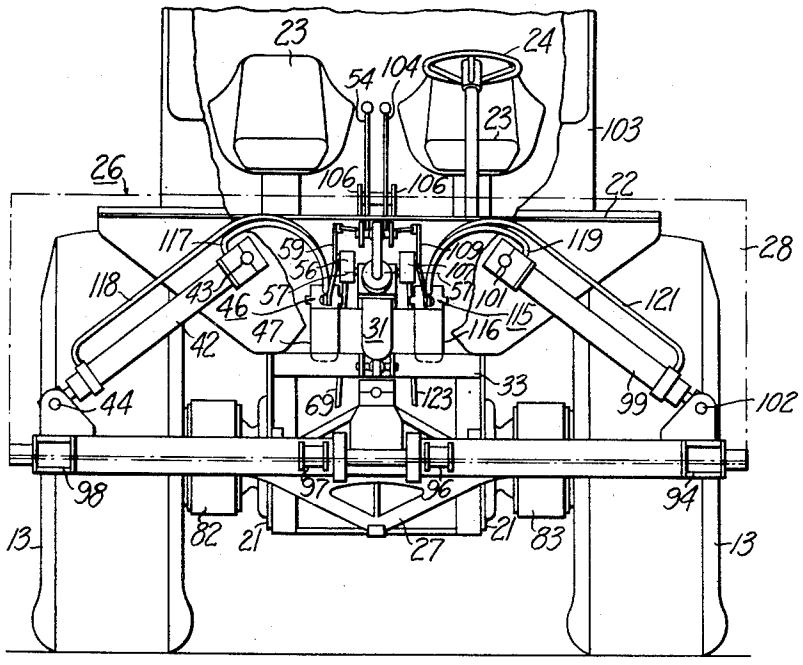


Fig. 3

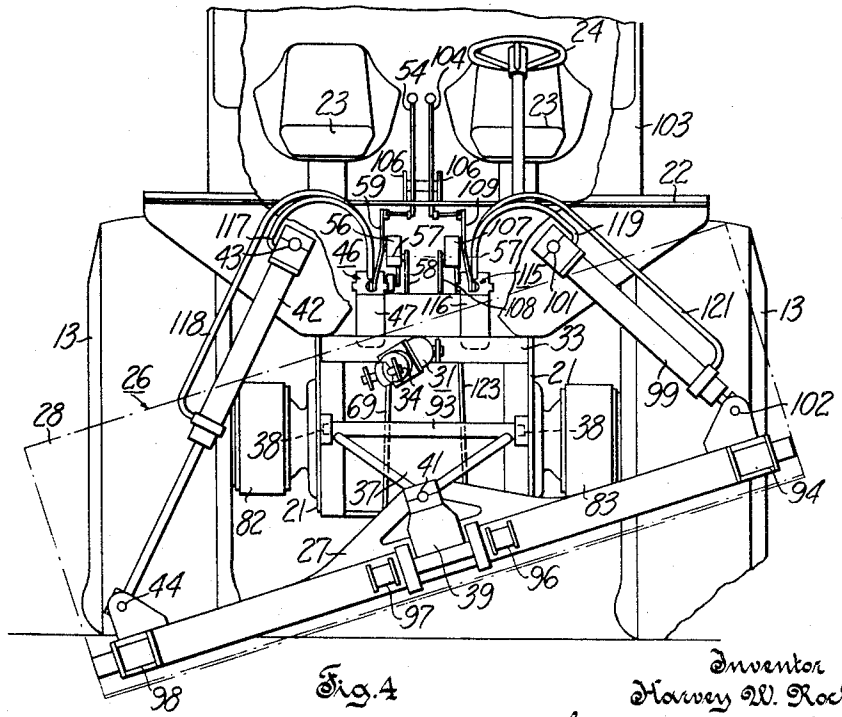


Fig. 4

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TOOL ADJUSTMENT FOR EARTH WORKING MACHINES

Filed Oct. 23, 1953 4 Sheets-Sheet 4

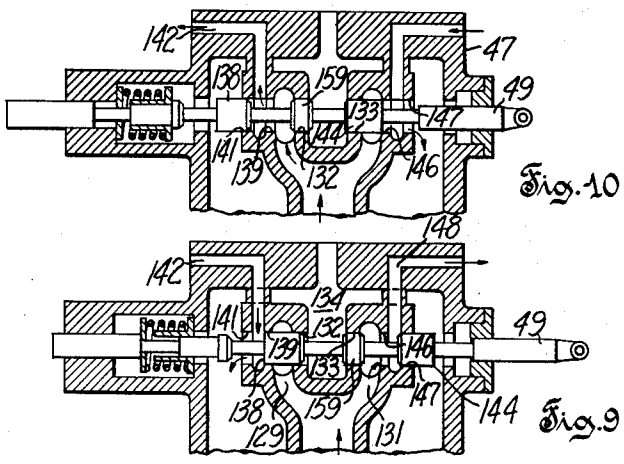


Fig. 10

Fig. 9

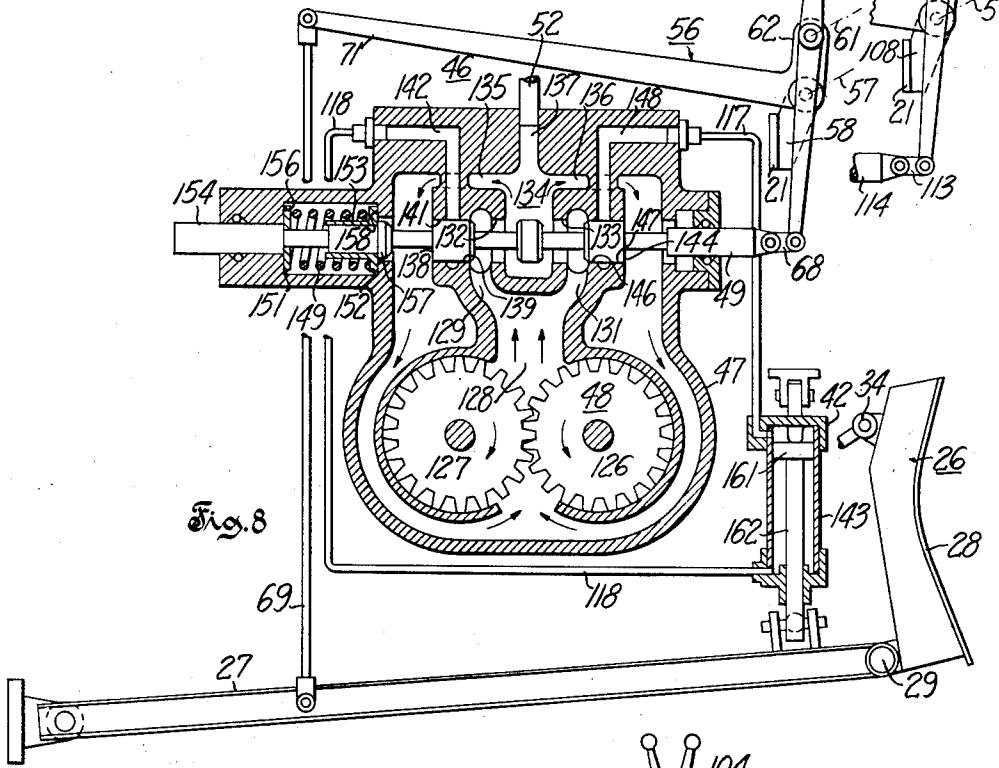


Fig. 8

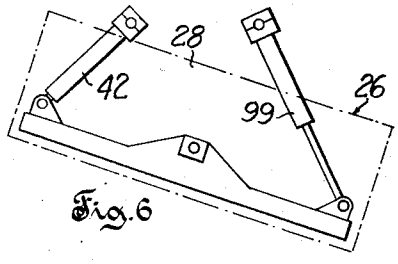


Fig. 6

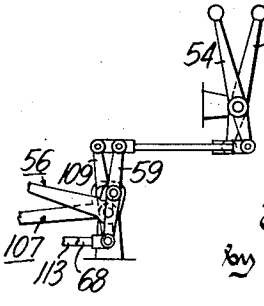


Fig. 7

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2,775,831

TOOL ADJUSTMENT FOR EARTH WORKING MACHINES

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Application October 23, 1953, Serial No. 387,967

6 Claims. (Cl. 37—144)

This invention relates to earth working machines and it is concerned more particularly with a power operated adjusting mechanism for the material handling tool or tool unit of such a machine.

Heretofore, earth working tools have been mounted on earth working machines for vertical and lateral tilting adjustment by a pair of hydraulic rams, and a machine of this type is shown, for instance, in my U. S. Patent No. 2,624,131, issued January 6, 1953.

In the usual earth working machine with an earth working tool at its forward end, the operator's vision is obstructed or is at such an angle that it is difficult or impossible for him to satisfactorily observe the tool. For instance, in the vehicle shown in my U. S. Patent No. 2,624,131, the operator's station is in an elevated position at the forward end of the vehicle above the earth working tool, thereby making it difficult or impossible for the operator to visibly determine the position of the cutting edge of the blade relative to the ground. It is difficult for the operator to judge vertical depth by looking downward from an overhead position and, accordingly, the amount of penetration of the cutting edge cannot be visually determined with the accuracy necessary for many earth working operations. Although there are some dozing operations which do not require precision, there are other operations such as ditching, land leveling and controlled cutting which require accurate determination of the position of the blade by the operator. To accomplish this more precise work, it is desirable that means be provided for aiding the operator to accurately determine the position of the blade relative to the vehicle.

It is the principal object of this invention to provide a mechanism in an earth working machine which will take care of the hereinbefore outlined requirements in a simple, practical and entirely satisfactory manner.

More specifically, it is an object of this invention to provide manually adjustable controls for an earth working machine which by their positions relative to the machine indicate the position of the tool relative to the machine on which it is mounted.

A further object of this invention is to provide in an earth working machine which has a power controlled tool, a pair of manually adjustable control levers which indicate the elevated condition of the controlled tool by their position relative to the machine and which by their position relative to each other indicate the lateral tilt of the controlled tool.

These and other objects of this invention will be evident from the following description when read in connection with the accompanying drawings, in which:

Fig. 1 is a side view of a four wheel, rubber tired earth working machine with the right front wheel and part of the supporting structure removed to more clearly show the installation of the earth working tool and its controlling mechanism;

Fig. 2 is a top view of the machine of Fig. 1 with the operator's station and other parts removed;

Fig. 3 is a front view of the machine of Fig. 1 with the earth working tool in its upper limit position;

Fig. 4 is a front view of the machine of Fig. 1 with the earth working tool tilted laterally to a position in which the left hand side is higher than the right hand side;

Fig. 5 is a schematic view of part of the control mechanism for the tool showing the adjusted position of the mechanism corresponding to the adjusted position of the earth working tool as shown in Fig. 4;

Fig. 6 is a front view of the earth working tool on a reduced scale showing the tool in a laterally tilted condition in which the right hand side is higher than the left hand side;

Fig. 7 is a reduced scale side view of the control mechanism in an adjusted condition corresponding to the adjusted condition of the tool as shown in Fig. 6;

Fig. 8 is a schematic side view showing the tool in a raised condition and showing partially in section the control mechanism corresponding to the raised condition of the tool and also showing the condition of the control levers corresponding to the raised condition of the tool;

Fig. 9 is a schematic sectional view of part of the fluid control unit for controlling adjustment of the right hand side of the tool, Fig. 9, showing the movable valve spool adjusted to a tool lowering position in which its associated fluid motor will be expanded; and

Fig. 10 shows the movable valve member of Fig. 9 adjusted to a tool raising position in which its associated fluid motor will be contracted.

Referring to Fig. 1, there is shown an earth working machine 11 having an engine 12 for driving four rubber tired supporting wheels 13 through a change speed transmission 14 and a power train 16 comprising a drive shaft 17, differential means 18 and power transmitting gears 19. A supporting structure 21 is provided for mounting the engine 12, wheels 13, transmission 14 and power train 16. The supporting structure 21 includes an operator's platform 22 which is in an elevated position at the forward end of the machine. A pair of seats 23 and a steering wheel 24 are mounted on the platform 22. An earth working tool 26 is mounted on the machine for up and down and lateral tilting movement. The tool 26 has a push frame 27 which is universally mounted at its rearward end to the supporting structure. At the forward end of the push frame 27 a dozer blade 28 is pivotally connected on a transverse axis 29. This pivot connection between the blade 28 and the push frame 27 allows the blade to be tipped, that is, pivoted about axis 29. A fluid motor in the form of a double acting hydraulic ram 31 is provided to control the tipped or pivotal adjustment of the blade 28 relative to its push frame 27. A pivot connection 32 is provided for attaching the rearward end of ram 31 to a cross member 33 of the supporting structure 21 and another pivot connection 34 is provided to attach the forward end of the ram 31 to an upper, central portion of the blade 28.

A stabilizer 36 is provided to prevent lateral swinging movement of the forward end of the push frame 27. The stabilizer 36 comprises a triangular member 37 having a base leg which is attached at its opposite ends to the supporting structure 21 by a pair of pivot connections 38 alined on a common transverse axis, and a plate member 39 pivotally connected at one end on a transverse axis to push frame 27 and connected at its other end to the forward apex of triangular member 37 by a ball and socket joint 41. The universal connection at the rear end of the push frame and joint 41 allows the tool 26 to tilt laterally.

A pair of servomotors in the form of fluid motors or hydraulic rams are provided to raise, lower and laterally tilt the earth working tool 26. A double acting hydraulic

ram 42 is pivotally connected at its upper end to the supporting structure 21 by a ball and socket joint 43 and its piston rod is pivotally connected to the push frame 27 by a ball and socket joint 44. Ram 42 supplies lifting and lowering power to the right hand side of the push frame.

A fluid control unit 46 is mounted on the supporting structure 21 and is provided to supply and control fluid flow to and from ram 42. Fluid conduits between the control unit and ram 42 are omitted from Fig. 1 so that other parts of the machine might be shown more clearly; however, the conduits are shown in Figs. 3, 4 and 8. The fluid control unit 46 includes a pump and valve housing 47 in which is located a fluid pump 48 and a valve spool 49, shown in greater detail in Fig. 8, and includes a fluid reservoir 51 connected to the housing 47 by a conduit 52.

A pair of manually adjustable control levers are pivotally mounted on the operator's platform 22 on a common transverse axis 53. Adjustment of the right hand control lever 54 controls raising and lowering of the right hand side of the forward end of the push frame 27 through a control mechanism.

The beforementioned control mechanism includes a follow up lever in the form of a bell crank 56 which is pivotally connected on a transverse axis 57 to a bracket part 58 of the supporting structure 21, a vertically disposed pivot member 59 which is pivotally connected at its central portion on a transverse axis to a short arm 62 of bell crank 56, and a longitudinally disposed link 63 which is attached at its forward end to a lower portion 64 of control lever 54 by a pivot connection 66 and is attached at its rearward end to the upper end of pivot member 59 by a pivot connection 67. Also included in the control mechanism is a valve connecting link 68 which is pivotally connected at its opposite ends to the lower end of pivot member 59 and the valve spool 49, respectively, and a vertically disposed reciprocable link 69 which is pivotally connected at its upper end to a long arm 71 of the bell crank 56 and is pivotally connected at its lower end to the right hand side of push frame 27.

The right hand control lever 54 is shown pivoted rearwardly to a position in which it is aligned on dot dash line A which is indicative of the raised position A' of the right hand side of the tool 26.

In operation the control lever may be moved to alignment on dot dash line B. Such movement rotates pivot member 59 about its pivot connection with bell crank 56 which in turn adjusts the valve spool to a forward position in which fluid under pressure is directed to the upper end of the ram 42 causing the ram to expand. Expansion of the ram 42 lowers the right hand side of the push frame 27 and the blade 28 as well. As the right hand side of the push frame 27 is lowered, the reciprocable link 69 is pulled downwardly thereby rotating the long arm 71 of the bell crank 56 downwardly and the short arm 62 of the bell crank 56 rearwardly. Rearward pivotal movement of short arm 62 of bell crank 56 rotates pivot member 59 about its pivot connection 67 with link 63 thereby effecting a rearward adjustment of the valve spool 49. By the time the right hand side of the tool 26 has been moved downward by the ram 42 to the position shown in phantom and indicated by the character reference B', the valve spool 49 will have been returned to a neutral position in which fluid to and from the ram 42 is blocked. The bell crank 56 and reciprocable link 69 are interposed between the tool 26 and the valve spool 49 so as to act as a follow up mechanism and are proportioned and arranged so that the position of the control lever 54 indicates the position of the right hand side of the tool 26.

In a similar manner when the right hand control lever 54 is pivotally adjusted to a forward position aligned on dot dash line C, the right hand side of the tool 26 will move to the position C' shown in phantom and when

the right hand side of the tool 26 reaches position C' the follow up mechanism for the valve member 49, which controls fluid flow to ram 42, will have been returned to a neutral position in which the fluid will be locked in each of the opposite chambers of the double acting ram 42.

It may be noted that the location of the operator's platform 22 places the operator almost directly above the blade 28 of tool 26. When tthe operator is seated in one of the seats 23 his vision is obstructed to such an extent that it is difficult for him to see the position of the blade 28 relative to the machine. It is this difficulty that is overcome by the provisions of the mechanism including a pair of control levers which indicate the position of the blade. A control lever for controlling and indicating the position of the left hand side of the blade will hereinafter be described in reference to Figs. 3, 4, 5, 7 and 8.

Referring to Fig. 2, the two rear wheels 13 are steered by means of a hydraulic ram 72 which is pivotally connected at one end to a rearward portion of the supporting structure 21 and is pivotally connected at its other end to a steering arm 73 formed on wheel housing 74 for the left rear wheel. The right rear wheel housing 76 presents a rearwardly extending steering arm 77. A tie rod 78 is pivotally connected at its opposite ends to steering arms 73 and 77, respectively, and serves to transmit steering motion from arm 73 to arm 77 in a conventional manner. A similar steering arrangement is provided for the front wheels in which a hydraulic ram 79 is pivotally connected at one of its ends to the supporting structure 21 and is pivotally connected at its other end to a steering arm 81 formed on a wheel housing 82 for the right front wheel. The left front wheel has a wheel housing 83 presenting a steering arm 84. Arm 84 is connected to arm 81 by a tie rod 86. Steering of the front wheels is controlled by steering wheel 24, shown in Fig. 1. Steering of the rear wheels is controlled by means not shown.

As shown in Fig. 2, the upper portion of the forward part of the vehicle, including the operator's platform and the control mechanisms, has been removed to expose the mounting of the push frame 27. A transversely disposed pin 87 having a ball portion is mounted at its opposite ends to the supporting structure 21. A socket is formed on the rearward end 88 of the push frame 27. A cap 89, which is secured to end 88 as by stud bolts, not shown, maintains the ball portion of pin 87 in cooperative engagement with the socket in the rearward end 88 of push frame 27. This construction allows the push frame 27 to pivot vertically and also allows limited lateral swinging of the push frame 27 about the ball and socket joint at its rearward end.

A pin 91 for connecting the lower end of reciprocable link 69 is mounted on the right hand side of the push frame 27. A pin 92 is provided on the laterally opposite side of the push frame for connecting a second reciprocable link which is shown in Figs. 3, 4 and 5. Pins 91 and 92 are spaced from each other in the longitudinal direction of the cutting edge of the blade 28 so that they will transmit lateral tilting movement of the tool as well as vertical movement to the reciprocable links.

The triangular member 37 of stabilizer 36 has opposite ends of its base member 93 connected to the supporting structure 21 by pivot connections 38. The forward apex portion of the triangular member 37 is connected to the plate member 39 by ball and socket joint 41. The plate member 39 is pivotally connected at laterally opposite sides of its lower end to the push frame 27 on a transverse axis which is coincident with axis 29. Pivot connections 94, 96, 97 and 98 connect the blade 28 to push frame 27 on pivot axis 29. Ram 42 for controlling the elevation of the right hand side of the tool 26 is shown to be connected at its upper end

to the right hand side of the forward end of the supporting structure **21** by ball and socket joint **43** and has its piston rod connected to the right hand side of the forward end of the push frame **27** by ball and socket joint **44**. Similarly, a double acting hydraulic ram **99** has its upper end pivotally connected to the left hand side of the forward end of the supporting structure **21** by a ball and socket joint **101** and has its piston rod pivotally connected to the left hand side of the forward end of the push frame by a ball and socket joint **102**. Rams **42** and **99** are provided to control the elevation and lateral tilt of the tool **26**. The tipping of the blade, that is, rotation of the blade above pivot axis **29**, is controlled by ram **31**. The upper end of ram **31** is connected to cross member **33** by a pivot connection **32** which is a ball and socket joint. The piston rod of ram **31** is connected to the upper portion of the blade **28** by a pivot connection **34** which is a ball and socket joint.

Referring to Fig. 3, part of the operator's cab **103** and part of the forward end of the supporting structure **21** has been removed to more clearly show the control mechanisms. The blade **28** is shown in phantom for the same reason. The tool **26** is shown in its highest raised position and in this position, the rams **42** and **99** are in a contracted condition. Manually adjustable control lever **54** for controlling raising and lowering of the right hand side of the tool **26** and a manually adjustable control lever **104** for controlling raising and lowering of the left hand side of the tool **26** are pivotally connected on transverse axis **53** to a pair of ears **106** extending upwardly from the operator's platform **22**. Control levers **54** and **104** may be adjusted conjointly or independently of each other. Bell crank **56** of the control mechanism for the right hand side of the tool and a bell crank **107** for the left hand side of the tool are pivotally connected on a transverse axis **57** to bracket part **58** and bracket part **108**. This connection is more clearly shown in Fig. 4.

Referring generally to Fig. 3 and Fig. 8, vertically disposed pivot member **59** of the right hand control mechanism is pivotally connected to the short arm **62** of bell crank **56** on a transverse axis **61**. A vertically disposed pivot member **109** for the left hand control mechanism is pivotally connected to a short arm of bell crank **107** on a transverse axis **111**. Longitudinally extending link **63** connects the lower end of control lever **54** with the upper end of pivot member **59**. A longitudinally extending link **112** is pivotally connected at its forward end to the lower end of control lever **104** and is pivotally connected at its rearward end to the upper end of pivot member **109**. A valve connecting link **68** is pivotally connected at its forward end to the lower end of pivot member **59** and is pivotally connected at its rearward end to the adjustable control member or valve spool **49**.

The left hand control mechanism is similarly constructed. A valve connecting link **113** is pivotally connected at its forward end to the lower end of pivot member **109** and is pivotally connected at its rearward end to a control member or valve spool **114** of fluid control unit **115**. The valve spool **114** is reciprocably mounted in a pump and valve housing **116**. The pump and valve housing **116**, its associated valve spool **114** and fluid pump are similar to those provided for the control mechanism for the right hand side of the tool as shown in Fig. 8.

A fluid conduit **117** is connected at one of its ends to the front end of housing **47** and is connected at its other end to the upper end of the cylinder of ram **42**. A fluid conduit **118** is connected at one of its ends to the rear end of housing **47** and is connected at its other end to the lower end of the cylinder of ram **42**. Fluid conduits **119** and **121** are similarly connected to pump and valve housing **116** and the cylinder of ram **99** so as to establish fluid communication between the fluid pump, not shown, within housing **116** and opposite ends of the cylinder of ram **99**.

Fig. 4 shows the earth moving machine with its tool **26** tilted laterally so that the right hand end of the cutting edge of the blade **28**, shown in phantom, is in a ground engaging position and the left hand edge is held in a raised position. Ram **42** is in an expanded condition, the piston rod being extended from the cylinder of ram **42** to the limit of its stroke. Ram **99** is in a contracted condition.

Fig. 5 is a schematic showing of the condition of the control levers **54** and **104** when the tool is adjusted to the laterally tilted condition in which it is shown in Fig. 4. The upper end of the right hand control lever **54** has been pivoted forwardly and the associated right hand side of the blade has moved vertically downward to the position shown in Fig. 4. The upper end of left hand control lever **104** has been pivoted rearwardly thereby effecting upward vertical adjustment of the left hand side of the blade to the position shown in Fig. 4

A pivot pin **122** mounts the control levers **54** and **104** on the supporting structure for independent pivotal adjustment on common axis **53**. Bell crank **56** is pivotally adjusted counterclockwise due to the reciprocable link **69** having been pulled downwardly by the right hand side of the push frame **27** as it was adjusted to the position in which it is shown in Fig. 4. The bell crank **107** has been pivoted clockwise from a horizontal position by its reciprocable link **123** to a position corresponding to the raised condition of the left hand side of the push frame. Reciprocable link **123** is pivotally connected at its lower end to pin **92** on push frame **27** and is pivotally connected at its upper end to the end of rearwardly extending long arm **124** of bell crank **107**. Pivot member **59** is pivotally connected intermediate its opposite ends to short arm **62** of bell crank **56**. Link **63** connects the lower end of control lever **54** in motion transmitting relation to the upper end of pivot member **59**. Similarly, longitudinally disposed link **112** connects the lower end of control lever **104** in motion transmitting relation with the upper end of pivot member **109**. The forward end of valve connecting link **68** is pivotally connected to the lower end of pivot member **59** and the forward end of valve connecting link **113** is pivotally connected to the lower end of pivot member **109**. The rearward end of link **113** is pivotally connected to valve spool **114**. When the control mechanisms are in the condition shown in Fig. 5, the pivot connection between link **68** and pivot member **59** and the pivot connection between link **113** and pivot member **109** are aligned on a common transverse axis. Consequently, the control members, or more specifically the valve spools, are in their respective neutral positions.

Thus, the extent of pivotal adjustment of control levers **54** and **104** relative to each other is indicative of the extent of lateral tilt of the tool **26**. As shown in Fig. 5, the forward position of control lever **54** indicates the lowered position of the right side of the earth working tool **26** and the rearward position of control lever **104** indicates the raised position of the left hand side of the earth working tool.

Referring to Fig. 6, the tool **26** is shown tilted laterally in the opposite direction to that in which it is shown in Fig. 4. The ram **42** for controlling the vertical position of the right hand side of the blade **28** is in a contracted condition whereas the ram **99** for controlling the vertical position of the left hand side of the blade **28** is in an expanded condition.

In Fig. 7, adjusted positions of the control levers **54** and **104** are shown and these positions correspond to the laterally tilted condition of the tool as shown in Fig. 6. Control lever **54** has been adjusted to the rear and its position is indicative of the resulting raised condition of the right hand side of the tool **26** as shown in Fig. 6. Control lever **104** in its forward adjusted posi-

tion indicates the lowered position of the left hand side of the tool **26**. Thus when either of the control levers is adjusted forwardly, its associated side of the tool is moved downwardly a distance approximately proportional to the degree of forward rotation of the adjusted control lever. The same correspondence of movement applies between the rearward adjustment of the levers and the raising of the tool. In Fig. 7, as in Fig. 5, the pivot connections between the lower ends of pivot members **59** and **109** and valve connecting links **68** and **113**, respectively, are aligned on a common axis and the associated valve members or spools are both in neutral positions of adjustment.

Referring to Fig. 8, the pump and valve housing **47** of the fluid control unit **46** for controlling the right hand side of the tool **26** is shown in section to show the relationship between the spool valve **49**, the housing **47** and the fluid pump **48**. The following description of control unit **46** is equally applicable to the fluid control unit **115** which is associated with the left hand side of the tool **26**. The fluid pump **48** is a gear type pump having a pair of gears **126** and **127** which rotate in the direction indicated by the arrows thereon. Hydraulic fluid enters the bottom of the pump **48** and leaves the upper side of the pump under pressure entering passage **128**. Passage **128** divides into a pair of pump output passages **129** and **131** which are in communication with valve spool **49**. In the neutral position of valve spool **49** as shown in Fig. 8, pressure fluid flows from passages **129** and **131** through open ports **132** and **133**, respectively, thence into return passage **134**. From passage **134** the fluid is returned to the bottom of the pump by way of pump supply passages **135** and **136**. The flow of the fluid is schematically indicated by arrows. To insure an adequate supply of hydraulic fluid, the reservoir **51**, shown in Fig. 1, is connected to the housing **47** by conduit **52**. A reservoir passage **137** allows fluid from the reservoir to communicate with return passage **134** and pump supply passages **135** and **136**. Land **138** of valve spool **49** closes ports **139** and **141** thereby preventing fluid from entering or leaving ram passage **142**. In this neutral position of the valve spool, fluid is locked in conduit **118** and in the bottom end of the cylinder **143** of ram **42**. Land **144** of valve spool **49** blocks ports **146** and **147** thereby preventing fluid from entering or leaving ram passage **148**. Thus fluid is locked in conduit **117** and the top of ram **42** to which conduit **117** is connected. In Fig. 8 the control lever **54** has been adjusted to the rear and in this position is indicative of the raised position of the right hand side of the tool. Since no friction or latch means have been provided to keep the hand control levers **54** and **104** in a position of adjustment once they have been so moved, the control lever must be manually held in the position corresponding to the desired adjusted position of the associated side of the tool until that side of the tool has been adjusted to the desired position. When the associated side of the tool has reached the desired position corresponding to the adjusted position of the control lever, the valve spool of the associated control unit will have been returned to a neutral position. Each of the control units has a centering spring which urges its spool to occupy a neutral position. In Fig. 8 a centering spring **149** is interposed between a washer **151** and a flange portion **152** of a spacer sleeve **153**. The spring, as shown in Fig. 8, has expanded as much as possible in its installed condition since washer **151** is prevented from moving to the left by the end portion **154** of spool **49** and an outer wall portion **156** of housing **47** and since spacer sleeve **153** is prevented from moving to the right by a circular flange **157** of spool **49** and an interior wall **158** of housing **47**. Thus the spring **149** urges the valve spool **49** to assume the neutral position in which it is shown in Fig. 8 and when that position is occupied by the spool the control lever **54** will be held in its adjusted position without the necessity of manual holding effort.

Referring to Fig. 9, the valve spool **49** has been adjusted to the right to effect lowering of the right hand side of the front end of the tool **26**. Referring to Fig. 8, it is seen that if the control lever **54** is pivoted clockwise the lower end **64** of the lever **54** will rotate the pivot lever **59** counterclockwise through connecting means in the form of link **63**. Counterclockwise pivoting of pivot member **59** about its pivot connection with the short arm **62** of the bell crank **56** on axis **61** moves its lower end to the right. Movement of the lower end of the pivot member **59** to the right adjusts the spool **49** to the right, through connecting means **68**, to the position in which it is shown in Fig. 9. When the spool is adjusted to the right as shown in Fig. 9, it is in a tool lowering position, that is, the associated side of the tool **26** is adjusted downwardly. Land **138** now blocks port **139** and port **132** thereby preventing fluid flow through passage **129**. Port **141** is open so that fluid may flow from the lower end of ram cylinder **143** through conduit **118**, passage **142**, port **141** and thence to the bottom side of pump **48**. A land **159** blocks port **133** preventing flow of fluid from passage **131** to return passage **134**. Port **146** is open thereby allowing fluid under pressure to flow from pump output passage **131** through port **146** to ram passage **148**, thence to conduit **117** and the upper end of ram cylinder **143**. Port **147** is blocked by land **144** preventing pressure fluid supplied through passage **131** from entering the passage leading to the input side of the pump. Thus when the spool is adjusted to the tool lowering position as shown in Fig. 9, the fluid under pressure is delivered to the upper end of the cylinder **143** shown in Fig. 8 and the piston **161** and its rod **162** are moved downwardly. Simultaneously, fluid in the bottom end of cylinder **143** is allowed to flow through open port **141** to the input side of the pump. As the right hand side of the tool moves downwardly, the reciprocating link **69** is pulled downwardly by the push frame **27** to which it is pivotally attached. Downward movement of the link **69** rotates the bell crank **56** counterclockwise about its pivot connection with the supporting structure **21** and since the control lever is being manually held in a forwardly adjusted position the pivot member **59** will pivot about the pivot connection between its upper end and link **63** thus pivoting about axis **67**. In other words, short arm **62** of bell crank **56** rotates rearwardly pivoting the pivot member clockwise about axis **67** causing rearward movement of the lower end of pivot member **59** and rearward movement of the valve spool **49** toward a neutral position. When the right hand side of the tool has moved downwardly to a position corresponding to the position to which the control lever **54** has been adjusted, the follow up mechanism will have returned the valve spool **49** to a neutral position. As previously explained, when the valve spool is in a neutral position the fluid is locked in both sides of the piston of the associated ram. In this condition the ram cannot expand or contract.

Referring to Fig. 10, the valve spool **49** has been adjusted rearwardly relative to its housing **47** to a tool raising position. In this adjusted condition of the valve spool, port **139** is open allowing pressure fluid to flow to the lower end of cylinder **143**, land **159** blocks port **132**, land **138** blocks port **141**, land **144** blocks ports **133** and **146** and port **147** is open to allow fluid from the upper end of cylinder **143** to return to the input side of the pump. Thus as the valve is shown in Fig. 10, the fluid under pressure is delivered to ram passage **142** and fluid from the upper end of the ram cylinder is allowed to return to the input side of the pump through open port **147**.

Summarizing, this invention is shown embodied in an earth working machine of the type wherein a tool **26**, having a cutting edge is adjustably mounted on a mobile supporting structure **21** for up and down and lateral tilt-

ing movement relative to the supporting structure **21**. A pair of servomotors in the form of fluid motors **42** and **99** are operatively interposed between the supporting structure **21** and the tool **26** so as to transmit power to the tool **26** at points spaced from each other in the longitudinal direction of the cutting edge of the tool **26**. A pair of control members or valve members in the form of valve spools **49** and **114** are operatively associated, respectively, with fluid motors **42** and **99** for controlling operation of the motors. These valve spools are each selectively adjustable in opposite directions from a neutral tool holding position, in which fluid is locked in the motors, to a tool raising position, as shown in Fig. 10, and to a tool lowering position, as shown in Fig. 9. A pair of manually adjustable control levers **54** and **104**, which are pivotally mounted on the supporting structure **21**, are operatively associated, respectively, with valve spools **49** and **114** for adjusting the spools to their tool holding position, as shown in Fig. 8, to their tool raising position, as shown in Fig. 10, and to their tool lowering position, as shown in Fig. 9. Adjustment of spool **49** is effected by pivotal back and forth movement of the control lever **54** and adjustment of spool **114** is effected by pivotal back and forth movement of control lever **104**. To allow the control levers to indicate the adjusted position of their associated side of the tool, a follow up mechanism is provided for each valve spool. Each of the follow up mechanisms comprise a follow up lever in the form of a bell crank pivotally mounted on the supporting structure **21**, which is operatively associated with one of the valve members so that pivotal movement of the follow up lever will adjust the valve member. A reciprocable link is pivotally connected at one of its ends to an arm of the follow up lever and is connected at its other end to a pivot pin mounted on one of the lateral sides of the tool so that vertical and lateral tilting movement of the tool will be transmitted to the reciprocable link.

Thus it is seen that there is provided a pair of control levers which indicate the elevation of the forward end of a tool by their pivotal adjustment relative to their support and indicate the lateral tilt of the tool by their pivotal adjustment relative to each other. Operatively associated with the control lever for the right hand side of the tool is a control unit having a valve member and a follow up mechanism, the follow up mechanism being associated with the right hand side of the tool so that vertical movement of the right hand side of the tool effects adjustment of the valve member of the control unit. Similarly, the control lever for the left hand side of the tool has a control unit which includes a movable valve member and has a follow up mechanism which is associated with the left hand side of the tool so as to adjust the associated valve member upon vertical displacement of the left hand side of the tool.

When this invention is incorporated in a machine, it is not necessary that the operator see the actual position of the tool since the positions of the control levers give him a relatively accurate indication of the blade's position. Use of this invention solves the difficulties of control which are encountered in operating a machine in which the operator's view of the controlled tool is insufficient for him to accurately determine the vertical and tilted positions of a tool.

Although the invention is shown embodied in a four wheel dozer unit, it should be understood that it is not intended to limit the invention to that particular installation and that the invention may be embodied in such other forms and modifications as are embraced by the scope of the appended claims.

It is claimed and desired to secure by Letters Patent:

1. In an earth working machine of the type wherein the elevation and lateral tilt of a tool having a cutting edge is controlled by a pair of servomotors, the combination of a pair of adjustable control members operatively associated, respectively, with said servomotors for controlling transmission of lifting power to said tool; a pair of manually adjustable levers operatively connected, respectively, with said control members for selectively adjusting the latter either conjointly or independently of each other; a pair of follow up mechanisms operatively connected, respectively, with said control members; and means connecting said tool in vertical and lateral tilting movement transmitting relation with said follow up mechanisms so that the adjusted positions of said levers will indicate the elevated and laterally tilted condition of said tool.

2. In an earth working machine of the type wherein a bulldozer blade is adjustably mounted on a tractor forwardly of an operator's station for up and down and lateral tilting movement relative to said tractor, the combination of a pair of servomotors operatively interposed between said tractor and said blade in lift force transmitting relation to the latter at points spaced from each other in the longitudinal direction of said blade; a pair of adjustable control members operatively associated, respectively, with said servomotors for controlling operation of the latter; a pair of manually adjustable levers pivotally mounted on said tractor within reach from said operator's station for back and forth movement independently of each other between blade raised and blade lowered positions; means operatively connecting said levers, respectively, with said control members for actuating the latter by said back and forth movement of said levers so that opposite lateral ends of said blade will be raised and lowered in response to said back and forth movement of said levers; a pair of follow up mechanisms operatively connected, respectively, with said control members; and means connecting said blade in vertical and lateral tilting movement transmitting relation with said follow up mechanisms so that the adjusted positions of said levers will indicate the elevated and laterally tilted condition of said blade.

3. In an earth working machine of the type wherein a bulldozer blade is adjustably mounted on a tractor forwardly of an operator's station for up and down and lateral tilting movement relative to said tractor, the combination of a pair of servomotors operatively interposed between said tractor and said blade in power transmitting relation to the latter at points spaced from each other in the longitudinal direction of said blade; a pair of adjustable control members operatively associated, respectively, with said servomotors for controlling operation of the latter; a pair of manually adjustable levers pivotally mounted on said tractor within reach from said operator's station for back and forth movement independently of each other between blade raised and blade lowered portions; means operatively connecting said levers, respectively, with said control members for actuating the latter by said back and forth movement of said levers so that opposite lateral ends of said blade will be raised and lowered in response to said back and forth movement of said levers; a pair of follow up mechanisms operatively connected, respectively, with said control members and each including a reciprocable link; and a pair of pivots operatively connecting said links, respectively, with said blade at points spaced from each other in the longitudinal direction of said blade.

4. In an earth working machine of the type wherein a rigid tool unit including a blade and push frame is adjustably mounted on a tractor for up and down and lateral tilting movement relative to the latter and wherein said push frame is universally connected at its rear end in underlying relation to said tractor, the combination of a pair of servomotors operatively interposed between said tractor and transversely spaced portions, respectively, of said push frame in lift force transmitting relation to the latter; a pair of adjustable control members operatively associated, respectively, with said servomotors for controlling operation of the latter; a pair of manually ad-

justable levers pivotally mounted on said tractor for back and forth movement independently of each other between tool raised and tool lowered positions; means operatively connecting said levers, respectively, with said control members for actuating the latter by said back and forth movement of said levers so that opposite lateral ends of said blade will be raised and lowered in response to said back and forth movement of said levers; and a pair of follow up mechanisms each comprising a reciprocable link having one end pivotally connected to said push frame, a bell crank pivotally mounted on said tractor and having a first arm pivotally connected to the other end of said link and a second arm operatively associated in motion transmitting relation with one of said control members, said pivot connections between said reciprocating links and said push frame being spaced from each other in the longitudinal direction of said blade.

5. In an earth working machine of the type wherein a rigid tool unit including a blade and push frame is adjustably mounted on a tractor for up and down and lateral tilting movement relative to the latter and wherein said push frame is universally connected at its rear end in underlying relation to said tractor, the combination of a pair of fluid motors operatively interposed between said tractor and transversely spaced portions, respectively, of said push frame in lift force transmitting relation to the latter; a hydraulic circuit associated with said fluid motors and including a pair of valve members each selectively adjustable in opposite directions from a neutral position to first and second actuating positions so that opposite ends of said blade may be maintained in any vertically adjusted position and raised and lowered from such position by adjustment of said valve members to said neutral and actuating positions; a pair of manually adjustable levers pivotally mounted on said tractor for back and forth adjustment independently of each other between tool raised and tool lowered positions; means operatively connecting said levers, respectively, with said valve members for selectively adjusting the latter to either of said neutral, first actuating and second actuating positions by said adjustment of said levers; a pair of reciprocable links pivotally connected, respectively, to laterally spaced portions of said push frame; a pair of follow up levers mounted for pivotal movement on said tractor and operatively associated with said valve members, respectively, for adjusting the latter upon pivotal movement of said follow up levers; and a pair of pivots operatively connecting said links in vertical motion transmitting relation with said follow up levers, respectively.

6. In an earth working machine of the type wherein a rigid tool unit including a blade and push frame is adjustably mounted on a tractor for up and down and lateral tilting movement relative to the latter and wherein said push frame is universally connected at its rear end in underlying relation to said tractor, the combination of a pair of fluid motors operatively interposed between said tractor and transversely spaced portions, respectively, of said push frame in lift force transmitting relation to the latter at points spaced from each other in the longitudinal direction of said blade; a pair of valve members operatively associated, respectively, with said fluid motors for controlling operation of the latter and each being selectively adjustable in opposite directions from a tool holding to tool raising and tool lowering positions, respectively; a pair of manually adjustable control levers pivotally mounted on said tractor and operatively associated, respectively, with said valve members for adjusting the latter to said tool holding, tool raising and tool lowering positions by pivotal back and forth movement of said control levers; a pair of follow up levers pivotally mounted on said tractor and operatively associated, respectively, with said valve members for adjusting the latter by pivotal movement of said follow up levers; a pair of reciprocable links pivotally connected, respectively, to said follow up levers; and a pair of pivots mounted on laterally spaced portions of said push frame in cooperative engagement, respectively, with said links for connecting said push frame in vertical and lateral tilting movement transmitting relation with said links.

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