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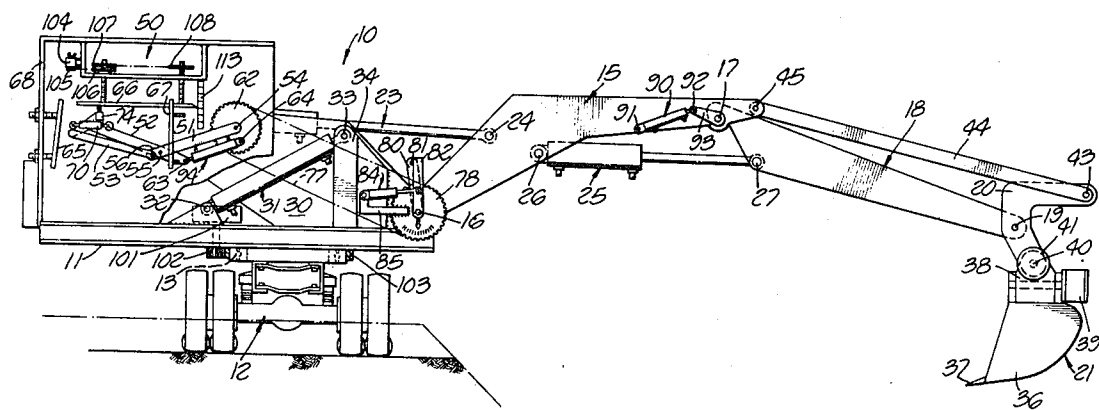
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[54] **BACK HOE OR GRADER**
10 Claims, 12 Drawing Figs.

[52] U.S. Cl..... **214/138**
[51] Int. Cl..... **E02f 3/75**
[50] Field of Search..... **214/138,**
762, 763, 764, 135

[56] **References Cited**
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3,463,335 8/1969 Brownell et al..... **214/138**

ABSTRACT: A back hoe or grader has a base member pivotally supporting a boom, and a dipper pivotally mounted at the end of the boom. Hydraulic devices swing the boom about its pivotal support and swing the dipper relative to the boom. Motions of the boom and the dipper are communicated to a control mechanism having adjustable parts to limit the extent of forward and rearward movement of the work implement as well as to control its maximum depth. The control mechanism acts through said hydraulic devices to limit the extent of their movements. A link controlling the attitude of the work implement is connected to one of two pivot locations on the boom, so that the attitude of the work implement carried by the dipper may remain constant with respect to the dipper from back hoe operations, or constant with respect to the grade being cut for grading operations. A subframe is mounted for pivotal movement coaxial with the pivotal support for the boom, and this subframe supports the hydraulic device for swinging the boom. An additional hydraulic device swings the subframe relative to the base member.



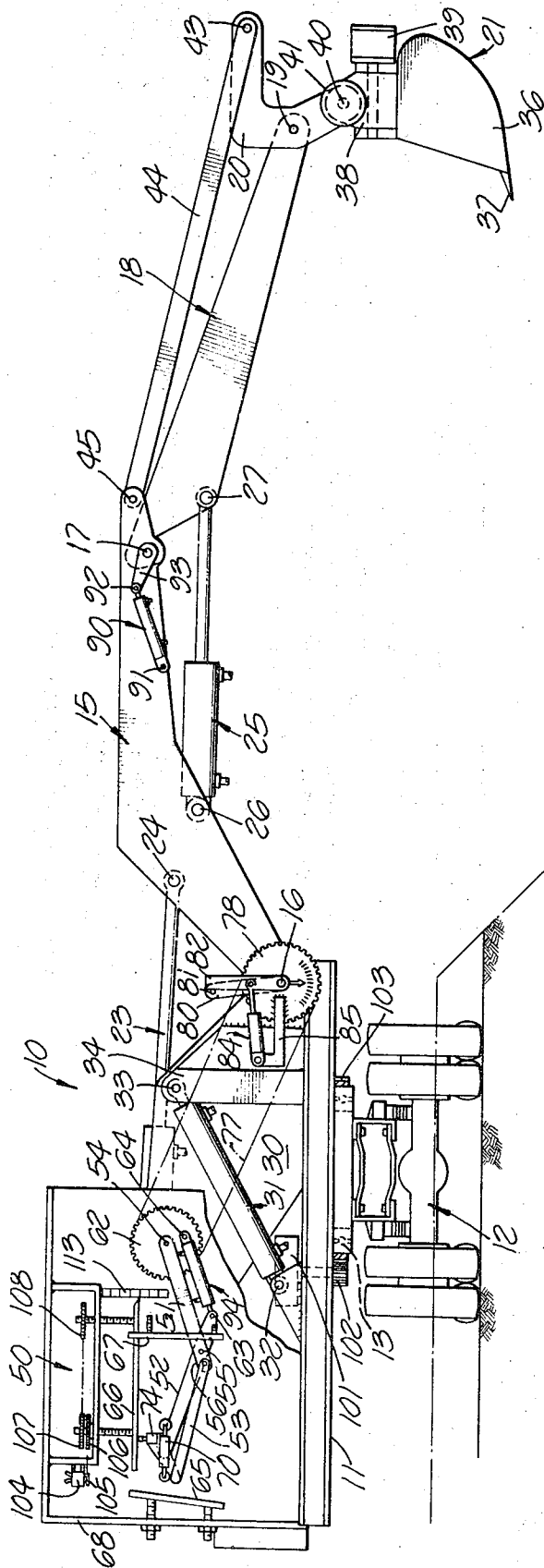


FIG. 1.

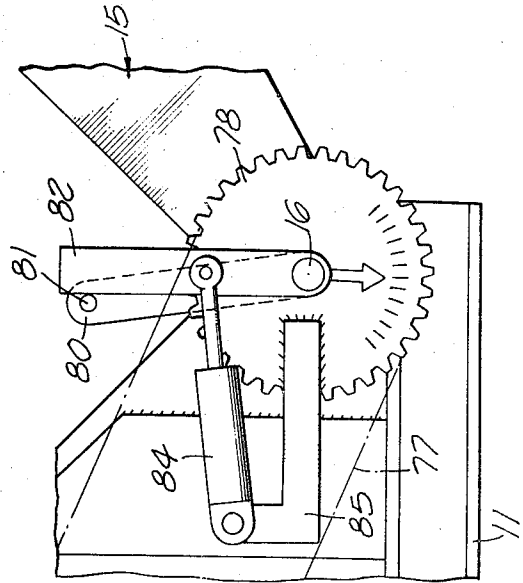


FIG. 4.

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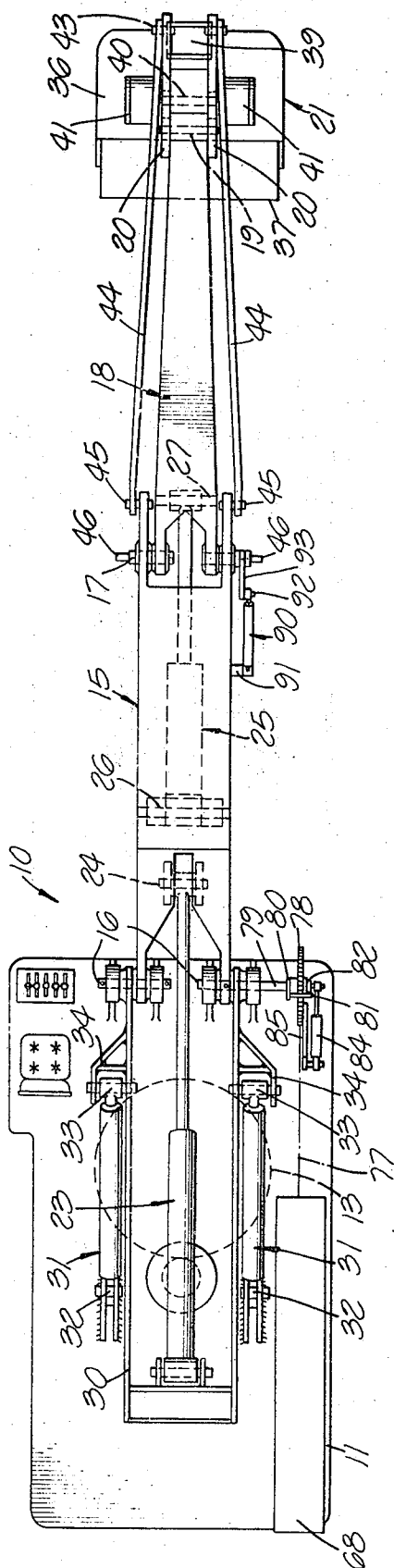
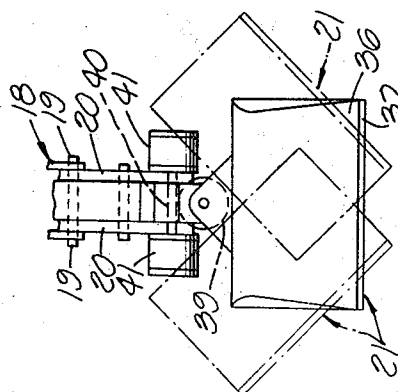
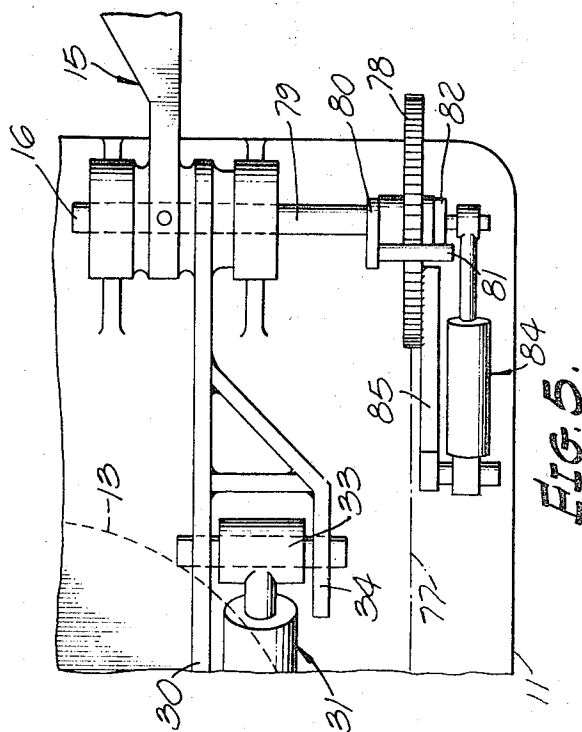


Fig. 2.



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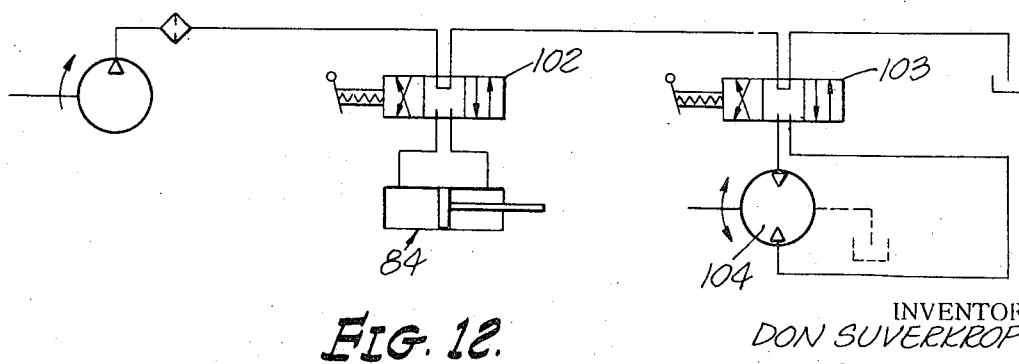
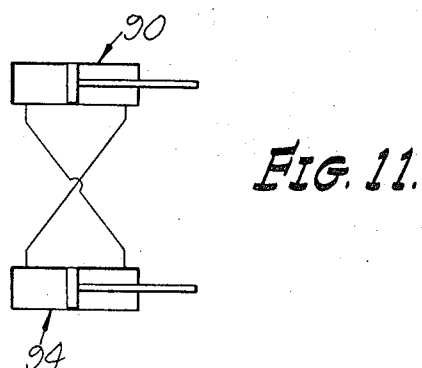
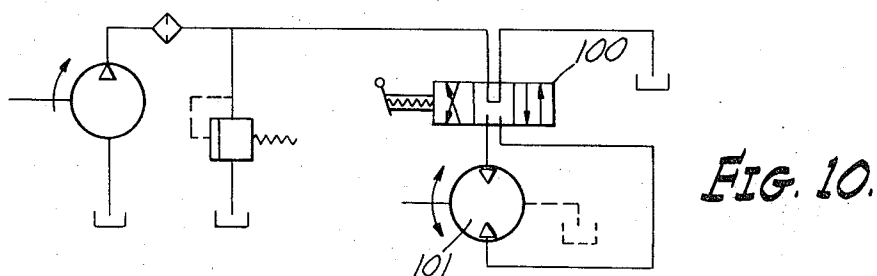
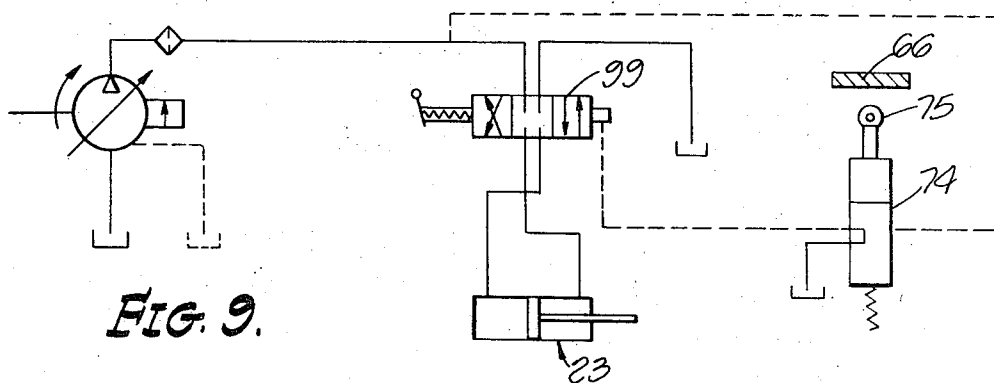
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BACK HOE OR GRADER

This invention relates to earthmoving apparatus and is particularly directed to improvements in devices known as back hoes or graders. Such devices commonly employ an earth-engaging implement such as a bucket mounted on a lever at the swinging end of a dipper. The dipper in turn is pivotally mounted on the swinging end of a boom. A link extending between the boom and the lever swings the bucket when the dipper swings relative to the boom. The boom is pivotally mounted on a base member. In conventional devices of this type, separate controls are provided for moving the dipper and for raising and lowering the boom. Therefore, the digging of a trench with a straight horizontal bottom surface or the grading of a surface to form a desired contour, for example, requires a high degree of skill of the operator in manipulating both of the controls simultaneously. It is an object of this invention to provide a back hoe or grader of the boom and dipper type in which an adjustable control mechanism limits the extent of motions of the boom and dipper to prevent the ground-engaging implement from moving beyond the desired contour.

This general object is achieved by means of a control mechanism having pivoted arms duplicating the lengths and proportions of the boom, dipper and link, respectively, but on a smaller scale, and providing means for transmitting the respective angular motions of the boom and dipper to them. Pilot valves at the swinging end of the arms are actuated by contact with preset adjustable profile bars, and the pilot valves are connected hydraulically with the manually operated controls for the hydraulic devices which move the boom and the dipper. The shape and position of the profile bars thus limits the extent of movement of the work implement.

Other objects and advantages will appear hereinafter.

In the drawings, FIG. 1 is a side elevation showing a preferred embodiment of this invention.

FIG. 2 is a top plan view thereof.

FIG. 3 shows an end elevation of a portion of the apparatus of FIG. 2, shown on an enlarged scale.

FIG. 4 is an enlargement of a portion of FIG. 1.

FIG. 5 is an enlargement of a portion of FIG. 2.

FIG. 6 is an enlargement of another portion of FIG. 1, showing details of the control mechanism.

FIGS. 7, 8, 9, 10, 11 and 12 are hydraulic circuit diagrams.

Referring to the drawings, the back hoe or grader device generally designated 10 includes a base member 11 which may be mounted on a truck 12 for turning movement about the axis of the supporting bearing 13. The boom 15 is pivotally supported at 16 on the base member 11. The boom 15 carries a second pivot 17 which connects the boom 15 to the dipper 18. A third pivot 19 at the swinging end of the dipper 18 to the levers 20 of the work implement generally designated 21.

The first power cylinder assembly 23 is pivotally connected to the boom 15 at 24 and serves to swing the boom 15 around the pivot 16. A second power cylinder assembly 25 is pivotally connected to the boom 15 at 26 and is pivotally connected to the dipper 18 at 27, and serves to swing the dipper 18 with respect to the boom 15 around the pivot 17.

A subframe 30 is pivotally mounted on the base member 11 for pivotal movement around the axis of the pivot 16. Duplicate hydraulic cylinder assemblies 31 are mounted on opposite sides of the subframe 30 and each has one end pivotally connected to the base member 11 at 32 and has the other end pivotally connected at 33 to a bracket 34 fixed to the subframe. Accordingly, the angular position of the subframe 30 with respect to the base member 11 is controlled by the hydraulic cylinder assemblies 31.

The work implement 21 is of conventional construction and includes a bucket 36 having a digging edge 37 and mounted for swinging movement about the longitudinal axis of the block 38. This swinging movement is controlled by a rotary hydraulic device 39. The block 38 is pivotally supported on the lower ends of the levers 20 and turning motion of the block 38 about the transverse axis 40 is controlled by means of

the rotary hydraulic devices 41. Conventional hydraulic hoses communicating with the devices 39 and 41 have been omitted from the drawings for clarity of illustration.

The parallel levers 20 are pivotally connected at 43 to the links 44 which serve to control the attitude of the work implement 21 during operation of the device. The rearward end of each link 44 is connected by pin 45 fixed to the boom 15. Also, the links 44 may be connected to the pins 46 which are coaxial with the pivot 17. For grading operations, the pins 45 are employed so that the links 44 tend to hold the work implement 21 in approximately the same attitude with respect to the surface being cut. For back hoe operations, it is desirable that the implement 21 remain in fixed attitude with respect to the dipper 18, and for this purpose the links 44 are connected to the pins 46. Mechanism for shifting the location of the pins 45 to a position coaxial of the pivot 17 is disclosed in my copending application filed of even date herewith, and entitled "Back Hoe or Grader."

In accordance with this invention, control mechanism is provided limiting the extent of forward and rearward movement of the work element 21 as well as to control its maximum depth. As shown in the drawings, this control mechanism generally designated 50 employs three pivoted arms 51, 52 and 53 which duplicate the length and proportions of the boom 15, dipper 18 and links 44, respectively, but on a smaller scale. The arm 51 is pivoted at 54 at one end and is connected by pivot 55 to the arm 52. The arm 53 is connected by pivot 56 to the arm 51 and is connected by pivot 57 to the carrier 58. Pivot 59 connects the carrier 58 to the swinging end of the arm 52. The effective length of the arm 51 is the distance between the axes of the pivots 54 and 55. Similarly, the effective length of the arm 52 is the distance between the axes of the pivots 55 and 59. The arm 51 is fixed to the sprocket 62 and turns therewith about the axis of the pivot 54.

From this description it will be understood that the pivot 54 corresponds to the pivot 16, the arm 51 corresponds to the boom 15, the pivot 55 corresponds to the pivot 17, the arm 52 corresponds to the dipper 18, the pivot 59 corresponds to the pivot 19, the arm 53 corresponds to the links 44, and the carrier 58 corresponds to the levers 20.

Three profile bars 65, 66 and 67 are shown in the drawings, and each is adjustably mounted with respect to a support 68 fixed to the base member 11. While these profile bars are illustrated as being straight from end to end, any desired shape may be used to produce a desired contour, as will appear. Profile bar 65 limits longitudinal movement of the carrier 58 in one direction, and the profile bar 67 limits such movement in the opposite direction. The profile bar 66 limits transverse movement of the carrier 58 in an upward direction. A four-way spring-centered pilot valve 70 is mounted on the carrier 58 and is provided with a plunger projecting from both ends and having contract rollers 71 and 72 mounted on opposite ends of the plunger. The profile bar 65 is positioned for contact with the roller 71, and the profile bar 67 is positioned for contact by the roller 72. A second four-way pilot valve 74 is mounted on the carrier 58 and is actuated by a plunger carrying contact roller 75 at its outer end. The profile bar 66 is positioned for contact with this roller 75.

The driven sprocket 62 is connected by endless chain 77 to the sprocket 78 which is mounted to turn about the axis of the pivot 16. A pivot shaft 79 fixed to the boom 15 carries an integral crank arm 80, having an axially extending pin 81. A control arm 82 is mounted to turn on the pivot shaft 79 and is adapted for engagement by the pin 81. Means are provided for adjusting the angular position of the control arm 82 relative to the driving sprocket 78, and as shown in the drawings this means includes the hydraulic power cylinder assembly 84 mounted on the bracket 85 fixed to the sprocket 78. The sprockets 78 and 62 are of the same effective diameter so that they turn in a 1:1 ratio.

When the pin 81 engages the control arm 82, pivotal motion of the boom 15 causes the same degree of pivotal motion of the arm 51. Also, means are provided for causing pivotal mo-

tion of the dipper 18 to effect pivotal motion in the same degree of the arm 52. The means for producing this equal angular movement may be mechanical or electrical, but for simplicity of illustration this means is shown to comprise the slave cylinder assembly 90 hydraulically connected to the slave cylinder assembly 94. The assembly 90 comprises a hydraulic cylinder assembly pivoted at 91 to the boom 15 and pivoted at 92 to a crank arm 93 turning with and comprising an extension of the dipper 18. The slave cylinder assembly 94 is connected to the arm 52 at pivot 63 and is connected to the driven sprocket 62 at pivot 64. The slave cylinder assemblies 90 and 94 are duplicates, and they are hydraulically connected so that the extension and retraction of cylinder assembly 90 is duplicated by cylinder assembly 94.

The hydraulic diagram of FIG. 7 shows how the manually operable valves 95 and 96 are connected to control turning movement of the hydraulic devices 39 and 41, respectively, which devices are employed for swinging or tilting the bucket 36. FIG. 8 shows the four-way double ended pilot valve 70 and its connection to the double acting power cylinder 97, which in turn is connected to the four-way manually operable valve 98. The effect of the pilot valve 70 is to override the manual positioning of the valve 98 whenever contact rollers 71 or 72 engage the profile bars 65 or 67, respectively, and thereby limit motion of the power cylinder assembly 25 which swings the dipper 18. It will be noted that the cylinder ports of pilot valve 70 are open to each other in the centered position, and therefore the power cylinder assembly 97 does not "lock up" manually operable valve 98. FIG. 9 shows how the pilot valve 74 overrides the manual positioning of the valve 99 when the contact roller 75 engages the profile bar 66, to limit the motion of the power cylinder assembly 23 which swings the boom 15. In practice the power cylinder assembly 23 is connected in parallel with the power cylinder assemblies 31 which control the angular position of the subframe 30.

The manually operable valve 100 shown in FIG. 10 controls operation of the swing motor 101 which drives the pinion gear 102 in mesh with the ring gear 103, to turn the entire device about the supporting bearing 13. FIG. 11 shows the hydraulic connections between the slave cylinder assemblies 90 and 94. In FIG. 12, the manually operable valve 102 controls the hydraulic cylinder assembly 84 for setting the desired angle of slope, and the manually operable valve 103 controls the operation of the grade set motor 104. As shown in FIG. 6, this grade set motor 104 drives through sprockets 105, 106, 107 and 108 through chains 109 and 110 for turning of the nuts 111, thereby causing axial movement of the screws 112 for raising and lowering the profile bar 66. The depth of cut may be shown on an indicator 113.

The device illustrated in the drawings and set forth in the foregoing description permits independent operation of the boom 15 and dipper 18 simultaneously until such time as the desired maximum depth is reached, or until the forward or rearward limit of travel of the bucket is reached. Thus, the vertical limits on the bucket position are accomplished through controls on the power cylinder assembly 23, and the horizontal limits are accomplished through controls on the power cylinder assembly 25.

The device is particularly useful for digging the vertical walls of a cellar, side contours of a swimming pool, a sloping canal bank, etc. When it is desired to dig a sloping trench, the control arm 82 is swung by means of the power cylinder assembly 84, to change the angular position at which it is contacted by the pin 81 on the crank arm 80. This has the effect of changing the angular position of the driving sprocket 78 with respect to the shaft 79 and boom 15. The pilot valve 74 actuated by a contact between the roller 75 and profile bar 66 continues to control the depth of the cut, but the angle of the bottom of the cut is set by the angular position of the control arm 82 with respect to the driving sprocket 78.

I claim:

1. In a back hoe or grader, the combination of: a base member, a boom having a pivotal support on the base

member, a dipper having one end pivotally connected to the other end of the boom, means at the remote end of the dipper for connection to a work implement, power means for swinging the boom about its pivotal support, second power means for swinging the dipper with respect to the boom, control mechanism including a first arm corresponding to the boom and a second arm corresponding to the dipper, pivot means connecting said arms, the effective lengths of the arms being proportional to the respective effective lengths of the boom and dipper, respectively, but on a smaller scale, means for turning the first arm in accordance with pivotal motion of the boom, means for turning the second arm in accordance with pivotal motion of the dipper, at least one profile bar adjustably mounted with respect to the base member, at least one pilot valve supported at the remote end of the second arm, said pilot valve having a contact element for engagement with said profile bar, and means including said pilot valve for actuating one of said power means.

2. The combination set forth in claim 1 in which the profile bar faces downward and wherein the latter said power means swings the boom about its pivot.

3. In a back hoe or grader, the combination of: a base member, a boom mounted on the base member for movement about a first pivot, a dipper mounted on the boom for movement about a second pivot, a lever mounted at the swinging end of the dipper for movement about a third pivot, a work implement carried by the lever, a link pivotally connected at one end to the boom and pivotally connected at the other end to the lever, whereby the work implement is caused to swing about the third pivot when the dipper is moved relative to the boom, power means for swinging the boom with respect to the base member, second power means for swinging the dipper with respect to the boom, control mechanism including three pivoted arms duplicating the lengths and proportions of the boom, dipper and link, respectively, but on a smaller scale, a carrier pivotally connected to the second and third arms, means for turning a first arm in accordance with pivotal motion of the boom, means for turning the second arm in accordance with pivotal movement of the dipper, at least one profile bar adjustably mounted with respect to the base member, at least one pilot valve supported on the carrier, said pilot valve having a contact element for engagement with said profile bar, and means including said pilot valve for actuating one of said power means.

4. The combination set forth in claim 3 in which two pilot valves are mounted on the carrier, each provided with a contact element, and wherein two profile bars are independently mounted for adjustment relative to the base member, each profile bar being positioned for contact by one of said contact elements, respectively, one of the pilot valves affecting operation of one of the power means, and the other pilot valve affecting operation of the other power means.

5. The combination set forth in claim 3 in which one double acting pilot valve is mounted on the carrier are provided with oppositely extending contact elements, and wherein two profile bars are independently mounted for adjustment relative to the base member, and each being positioned for engagement with one of said contact elements, respectively, said double acting pilot valve affecting operation of said second power means.

6. The combination set forth in claim 3 in which one double acting pilot valve is mounted on the carrier and provided with oppositely extending contact elements, a second double acting pilot valve is mounted on the carrier and provided with a single contact element, three profile bars are independently mounted for adjustment relative to the base member, and each being positioned for engagement with one of said contact elements, respectively, said double acting pilot valve affecting operation of said second power means, and the other pilot valve affecting operation of the first-mentioned power means.

7. In a back hoe or grader, the combination of: a base member, a boom having a pivotal support on the base member, a dipper pivotally connected to the boom, means at

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the remote end of the dipper for connection to a work implement, first hydraulic means for swinging the boom about its pivotal support, second hydraulic means for swinging the dipper with respect to the boom, control mechanism including a first arm corresponding to the boom and a second arm corresponding to the dipper, pivot means connecting said arms, the effective lengths of the arms being proportional to the effective lengths of the boom and dipper, respectively, but on a smaller scale, first turning means for turning the first arm in accordance with pivotal motion of the boom, second turning means for turning the second arm in accordance with pivotal movement of the dipper, at least one profile bar adjustably mounted to the base member, a pilot valve supported at one end of the second arm, and having a contact element for engagement with said profile bar, and means including said pilot valve for actuating one of said hydraulic means.

8. The combination of claim 7 wherein said first turning means includes a first member connected to turn with the boom about its pivotal support, a second member mounted to turn coaxially of the first member, means connecting the second member to turn said first arm, drive means whereby the first member may turn the second member in one direction, and means for adjusting the angular position of the second member at which the drive means becomes effective.

9. In a back hoe or grader, the combination of: a base member, a boom having a pivotal support on the base member, a dipper pivotally connected to the boom, means at

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the remote end of the dipper for connection to a work implement, first hydraulic means for swinging the boom about its pivotal support, second hydraulic means for swinging the dipper with respect to the boom, control mechanism including a first arm corresponding to the boom and a second arm corresponding to the dipper, pivot means connecting said arms, the effective lengths of the arms being proportional to the effective lengths of the boom and dipper, respectively, but on a smaller scale, first turning means for turning the first arm in accordance with pivotal motion of the boom, second turning means for turning the second arm in accordance with pivotal movement of the dipper, a stationary element adjustably mounted relative to the base member, a pilot valve supported at one end of the second arm, and having a contact element for engagement with said stationary element, means including a four-way control valve for operating said first hydraulic means, and a hydraulic operator connected for actuation by said pilot valve and adapted to operate the control valve.

10. The combination of claim 9 wherein said first turning means includes a first member connected to turn with the boom about its pivotal support, a second member mounted to turn coaxially of the first member, means connecting the second member to turn said first arm, drive means whereby the first member may turn the second member in one direction, and means for adjusting the angular position of the second member at which the drive means becomes effective.

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