Fig. 4

Fig. 5

INVENTOR.
Raymond A. Hanson

BY

INVENTOR.
Raymond A. Hanson

BY

INVENTOR.
Raymond A. Hanson

BY
The present invention relates to improvements in digging and grading apparatus, and more particularly to improvements in means for maintaining digging and grading apparatus on a desired grade.

In digging and grading operations such as the construction of irrigation ditches and channels, the digging and grading operation must be carried out in such a manner that the completed ditch follows very closely to the grade established therefor when the proposed ditch was laid out. When the ditch is constructed through or along ground which varies considerably in elevation and is rough and uneven, this becomes a complicated and difficult operation since the depth of the ditch from the ground level necessary to create the desired grade may vary considerably along the route to be followed. It is the principal purpose of the present invention to provide means to indicate variance of the digging tool or apparatus from the proper established grade line.

A further purpose of the invention is to provide with such means, second means capable of automatically correcting such variances to maintain the proper grade.

In laying out a proposed ditch, it is customary to first survey the route and place at intervals thereafter, surveyor's stakes or "hubs" as they are commonly known in the field, to indicate route and grade. These stakes or hubs are placed so that their tops reflect the proposed grade of the ditch; that is, so that the top of each stake is a fixed distance from the elevation of the proposed ditch bottom at that point. To accomplish the purpose of my invention, I make use of these stakes or hubs to maintain proper grade. My invention comprises primarily a pair of fluid containers joined together with a fluid hose to permit free passage of fluid therebetween. One of these containers is mounted upon the digging apparatus and the other is mounted on a framework or tripod easily movable from one location to another. This second container is placed above the first hub along the ditch route at a height above the proposed ditch bottom elevation equal to the height of the other container above the bottom of the digging mechanism upon which it is mounted. With the containers so placed, the fluid levels in each will only be equal when the digging mechanism has penetrated the ground to such a depth that the container mounted thereon is at the same level as the container positioned above the hub. This will place the bottom of the digging mechanism at the elevation of the proposed ditch bottom. If the digging mechanism is moved through the ground toward the hub in such a manner as to keep the two containers at the same level, the ditch dug thereby will have a level bottom of the elevation that the bottom should occupy at the location of the hub.

When the digging mechanism reaches the first hub, the container positioned above that hub is moved to the next and the process is repeated, the next portion of ditch being dug at the elevation proposed at the location of the next hub. This process is repeated throughout the route of the ditch.

It will be seen that if the process is carried out, the finished ditch will have a stepped bottom which is exactly on grade at the location of each hub, and very close to proper grade between hubs, regardless of the contour, etc., of the ground through which it is dug.

The two fluid containers must be kept at the same level during each digging operation to produce the proper grade, so I provide an automatic leveling means to maintain the digging means at such an elevation, regardless of its position with respect to the ground surface, that the containers are level. This mechanism includes nothing more than a means to raise or lower the digging mechanism with respect to the ground, and a controlling means to operate the raising and lowering means in response to change in liquid level in the containers, or either of them.

The nature and advantages of the invention will appear more clearly from the following description and the accompanying drawings wherein preferred forms of the invention are shown. It should be understood, however, that the drawings and description are illustrative only, and are not intended to limit the invention except as it is limited by the claims.

In the drawings:

Figure 1 is an elevational view illustrating a powered vehicle having a digging mechanism thereon and utilizing my improved means for controlling the grade of the ditch dug by the digging mechanism;

Figure 2 is an enlarged view of the digging mechanism illustrated in Figure 1, showing the means for raising and lowering the mechanism in response to indications from my improved means for maintaining proper grade;

Figure 3 is a view illustrating a completed ditch dug with the aid of my improved grade control means;

Figure 4 is a diagrammatic view illustrating the manner of operation of my improved means;

Figure 5 is a diagrammatic view similar to Figure 4, but showing a modification of the grade control means;

Figure 6 is a view similar to Figure 5, but illustrating a further modification of the invention;

Figure 7 is a vertical cross sectional view of one of the indicating units of my improved means.

Referring now to the drawings, and to Figures 1 and 2 in particular, my invention is shown as incorporated in a ditch digging apparatus generally comprising a powered vehicle such as a tractor 10, having a digging mechanism generally indicated at 11, attached thereto. The mechanism 11 comprises a substantially horizontal framework 12 which rotatably supports a digging wheel 13 having a plurality of digging jaws or buckets 14 on the periphery thereof. The wheel 13 is driven by drive means 15 supported on the framework 12. The drive means 15 receives power either through a universal power take-off shaft 16 as shown, or by any other suitable means, such as an engine mounted on the framework 12. With the construction described, the wheel 13 will be revolved on the framework 12, causing the buckets 14 to scoop dirt from beneath and in front of the wheel 12. The buckets 14 deposit the dirt upon a laterally moving conveyor belt (not shown) which is ordinarily provided to carry the dirt sidewise to one bank of the ditch being dug. Behind the digging wheel 13 a shoe 17 is provided. The shoe 17, often called a "cumber," is secured to the front portion of the framework 12 and is constructed to slide along the bottom of the trench being dug to smooth and level the surface, and to assist in supporting the framework 12. The framework 12, wheel 13, and cumber 17 are all well known in the art, and are not claimed as new herein. It is therefore believed unnecessary to describe these elements in detail.

In order to control the depth of the digging wheel 13
with respect to the tractor 10, the framework 12 is mounted to the tractor 10 for vertical adjustment. As shown in figure 2, the tractor 10 is provided with an auxiliary frame 18 which extends rearwardly therefrom to support the framework 12. The auxiliary frame 18 has at its rear end, a vertical framework 19 which includes spaced apart vertical rails 20. The horizontal framework 12 which supports the wheel 13, is provided at the front end with rollers 21 which are engaged with the rails 20 and mount the frame 12 for vertical movement on the vertical framework 19. Second rollers 22, mounted to braces 23 supported on the framework 12, are also engaged with the rails 20 to assist in supporting the framework 12 in substantially horizontal position. In order to raise and lower the framework 12 on the vertical framework 19, one or more hydraulic jacks 24 are employed. The jacks are mounted to the top member 19a of the frame 19, and depend thereon. The pistons 24a of the jacks 24 are connected to the front end of the frame 13 to move it upwardly or force it downwardly. By operation of the jacks 24, the ditch depth is controlled.

For transportation purposes, the vertical framework 19 is pivoted as shown at 25 to the auxiliary tractor frame 18 so that it may be pivoted forwardly to tilt the framework 12 upwardly above the ground. Hydraulic cylinders 26 are provided for this purpose, and are mounted to the auxiliary frame 18 ahead of the pivot point 25. The cylinders 26 have pistons 27 connected to the top of the frame 19.

It is the purpose of my invention to provide, with a machine such as heretofore described, means for maintaining the digging wheel at such a level with respect to the ground surface that at all times throughout the digging operation, the bottom of the ditch is substantially coincident with the grade previously established therefore, regardless of the roughness or unevenness of the ground surface. In order to control the grade of the ditch, I make use of the surveyor's stakes or hubs which are driven into the ground at intervals along the route of the proposed ditch to indicate route and grade. As illustrated in figure 3, these stakes or hubs, indicated by the numeral 28, are driven into the ground at frequent intervals of, for example, every 50 feet, and are so placed that the tops of the stakes indicate the grade. The bottom of the proposed ditch is intended to be substantially parallel to a line joining the tops of the hubs 28.

In order to control the grade of the ditch being constructed by the digging apparatus 11, I provide a gauge system which indicates the relative elevation of the digging wheel 13 with respect to that hub 28 toward which the wheel 13 is being moved, and an automatic leveling mechanism which operates in response to the level indicating mechanism to maintain the proper level. As best illustrated in figures 1 and 4, the grade maintaining means includes two fluid containers 29 and 30. The container 29 is mounted on the horizontal framework 12 of the apparatus 11 at or very near to the vertical center line of the wheel 13. The container 30, as shown in figure 7, is mounted upon an adjustable tripod 31, and is freely movable to any desired location. The containers 29 and 30 are connected by a flexible fluid line 32 which connects to the containers 29 and 30 at the bottoms thereof and permits free flow of liquid therebetween. A flexible air hose 33 is also connected between the containers 29 and 30 at the upper ends thereof to equalize the pressures therein. The flexible hoses 32 and 33 permit the containers 29 and 30 to be moved toward and away from each other as to maintain a level in each representative of the relative vertical positions of the two containers. That is to say, if both containers are positioned at the same elevation, the liquid levels therein will be the same, while if one is raised above the other, the liquid level of the elevated container will drop while the level in the other will rise.

The container 30, supported on the tripod 31, is mounted atop a vertical threaded shaft 34 which is received by a nut 35 rotatably mounted in the top of the tripod 31. This container 30 is utilized as the reference unit in the system and is moved to a position over the hub 28 toward which the digging wheel 13 is being moved. The tripod 31 is set up straddling the hub 28 so that the container 30 is directly above it, and the nut 35 on the tripod 31 is rotated to raise or lower the container 30. The distance above the hub exactly equal to the distance from the bottom of the digging wheel to the container 29, less the distance from the top of the hub 28 to the proposed bottom of the ditch at the point where the hub 28 is positioned. For example, assuming that the distance from the container 29 on the frame 13 to the lowermost point on the wheel 13, including the buckets, is six feet, and further assuming that the depth of the proposed ditch is to be three feet from the tops of the hubs 28, then the container 30 should be positioned above the hub 28 a distance of three feet, thereby making its height above the proposed ditch bottom at that location six feet.

With the container 30 so placed, the fluid levels in the two containers 29 and 30 will be equal when the wheel 13 has dug into the ground that distance required to place its lowermost point at the same elevation as the proposed ditch bottom at the location of the container 30. If the tractor 10 is driven toward the container 30 while the wheel 13 operates and if the raising and lowering jacks 24 are manipulated to maintain the framework 12 and wheel 13 in position to maintain the fluid level in the container 29 at the desired level in the container 30, then the portion of the ditch being dug will have a horizontal bottom at the elevation indicated by the hub 28. When the digging wheel 13 has reached the position of the container 30, then the tripod is moved to the next hub 28 and arranged as previously described with reference to the top thereof, and the digging operation is resumed, this time at the elevation indicated by the new hub 28. This process is repeated with each hub 28 throughout the route of the ditch.

When the ditch is completed, its bottom surface, indicated by the numeral 36 in figure 3, will consist of a number of stepped horizontal stretches 36a, 36b, 36c, etc., each of which is coincident in elevation with the proposed grade at a point near one end thereof. Thus the ditch bottom 36 will substantially follow the proposed grade, even though the ground surface along the route is rough and uneven.

To facilitate proper and speedy placement of the container 30 with respect to the hubs 28 during the operation, the threaded shaft 34 may be cut to a length equal to the distance above the hub top that the container 30 should be placed. In such a case, no measurements need be taken in placing the container, but the tripod 31 need only be adjusted until the bottom of the shaft 34 rests upon the hub 28 as shown in figure 7. In the example hereinafter given, the proper length of the shaft 34 would be three feet.

In order to control the level of the framework 12 with respect to the tractor 10 to maintain the container 29 at the level of the container 30, I provide means operable in response to changes in the liquid level in the containers 29 and 30. As shown in figure 4, the hydraulic jack 24 is a double acting jack having a positive motion in either direction. The jack 24 has two fluid lines 37 and 38 connected thereto and extending to a valve 39. The valve 39 is shown as a spool valve including a casing 40, and a spool 41b therein. The spool 41b is maintained in central position, as shown, by springs 43 at each end.
Electro-magnets 44 and 45 are provided at the opposite ends of the casing 40. The valve 39 also has connected thereto a hydraulic feed line 46 which connects to a pressure tank 47. The tank 47 is supplied with fluid under pressure from a pump 48 driven from the power take-off of the tractor 10. The pump 48 is connected to a fluid reservoir 49 and pumps fluid through the hydraulic feed line 46 to the pressure tank 47. Fluid return lines 50 and 51 are connected between the valve 39 and reservoir 49 as shown in Figure 4. It will be seen that, with the construction as shown, energization of the electro-magnet 44 will cause the spool 41 to be attracted thereto, and will move the channel 41a and channel 41b in such a manner that the hydraulic feed line 46 is opened to fluid line 38, while the return line 50 is opened to the hydraulic fluid line 37. Thus fluid will flow through lines 46 and 38 to the jack 24 to retract the piston 24a and raise the framework 12. If, on the other hand, the electro-magnet 45 is energized, the spool 41 will be attracted downwardly to open feed line 46 to fluid line 37, and return line 51 to fluid line 38, whereby to extend the piston 24a. When neither electro-magnet is energized, the spool 41 will remain in central position blocking all the fluid lines to lock the jack 24 in place. While I have shown and described a spool valve 39, it will be understood that any other valve capable of performing this function will suffice.

The electromagnets 44 and 45 are energized in response to changes in liquid level in the containers 29 and 30. As shown in Figure 4, the container 29 is provided with a float 52 which carries a contact arm 53 thereon. Above the normal liquid level in the container 29, two vertically spaced contact arms 54 and 55 are secured. The arm 53 on the float 52 is positioned substantially equidistantly between the contact arms 54 and 55 when the liquid in the container 29 is at the same level as the liquid in container 30. A flexible power lead 56 is connected to the arm 53 on the float 52, and is also connected to a power source. A lead 57 is connected to the upper contact arm 54 on the container wall and extends to the electro-magnet 44. A lead 58 connects the lower contact arm 55 with the electro-magnet 45. Both electromagnets 44 and 45 are connected to a common ground.

With the construction just described, the container 30, referenced with respect to a hub 28, acts as a reservoir which supplies or receives fluid from the container 29, according to their relative elevations. Assuming that the ditch is just being started, and the digging wheel 13 rests upon the ground, the container 29 will be positioned considerably above the container 30, and the liquid in the container 29 will be low, allowing the arm 53 to engage the lower contact arm 55 on the container wall. Current will then flow from the power supply line 56 and the lead 58 to energize the electro-magnet 45. As previously described, this causes the spool 41 to be moved downwardly and allows hydraulic fluid under pressure to flow through line 37 to force the piston 24a downwardly. When the digging wheel has reached the proper level, the float 52 will be floated away from the contact 55, and the downward movement will be stopped. The tractor 10 may then be set in motion toward the first hub 28. The means just described will automatically keep the digging wheel 13 at the proper elevation, since if the framework 12 drops too low, electro-magnet 44 will be energized to raise it, and if it raises too high, electro-magnet 45 will be energized to lower it.

In Figure 5, I have illustrated a modified form of the invention, wherein no float is employed to energize the electro-magnet. In this form of the invention, each of the containers 29 and 30 is provided with two electrodes, electrodes 60 and 61 in container 29 and electrodes 62 and 63 in container 30. These electrodes are so positioned that when the liquid in the container is above the level of at least one electrode in each container is above the liquid. The electrodes 60 and 62 are connected by power leads 64 and 65 to the power source. The electrode 61 in container 29 is connected by a lead 57' to the electro-magnet 44, and the electrode 63 in container 30 is connected by a lead 58' to electro-magnet 45. With this construction, the same result as obtained in the main form of the invention is obtained. If the framework 12 is allowed to move too far down, the liquid level in the container 29 will be raised so that contact through the liquid is established between electrodes 60 and 61 to energize electro-magnet 44 and raise the framework 12. If the framework 12 is raised too high, the liquid level in container 30 will be raised and contact between electrodes 62 and 63 is established to energize electro-magnet 45 and lower the framework 12.

Figure 6 illustrates a modified form of the invention wherein the container 29 is provided in the form of a gauge 29' having level indicating marks thereon. In this form of the invention, deviations from proper grade are visually indicated on the gauge 29' and the operator manually controls the jacks 24 to correct the deviations.

My improved grade maintaining means provides the unique result of controlling the grade of the ditch being constructed from a reference point which is entirely disassociated from the digging apparatus, so that no errors or deviations become cumulative, as is the case with gravitational means mounted entirely on the digging apparatus. With my invention, the grade control is accomplished through comparison of actual elevations, rather than horizontal levelling as in other devices, so that the grade of the ditch being constructed is maintained according to the exact elevation desired, and it is impossible to maintain the digging apparatus at an improper level when the mechanism is operated as hereinbefore described.

While I have shown an apparatus which constructs a ditch having a stepped bottom, rather than a continuously sloping bottom, it will be readily understood that this latter result may be obtained by providing any means for gradually lowering the reference container 30 as the digging apparatus 11 is drawn toward it. This may be accomplished either by manual manipulation, or automatic means as desired.

It is believed that the nature and advantages of my invention appear clearly from the foregoing description.

Having thus described my invention, I claim:

1. In a digging and grading apparatus including a powered vehicle, a digging device mounted to the powered vehicle, and means for raising and lowering the digging device with respect to the powered vehicle, means for maintaining the digging device on a pre-selected grade comprising a first liquid level in the container to give the digging device, a second liquid container, an adjustable ground engaging support on the ground spaced from said vehicle and mounting said second container at a selected elevation independent of the digging device, flexible hose means connecting said containers to permit free transfer of liquid from one container to the other whereby to cause the liquid levels in the containers to rise and fall according to the relative elevations thereof, and means in at least one of said containers to indicate rise and fall of the liquid level therein.

2. In a digging and grading apparatus including a powered vehicle, a digging device mounted on the powered vehicle, and means for raising and lowering the digging device with respect to the powered vehicle, means for maintaining the digging device on a pre-selected grade comprising a first liquid container supported on the digging device, a second liquid container, adjustable ground engaging support on the ground spaced from said vehicle and mounting said second container at a selected elevation independent of the digging device, flexible hose means connecting said containers to permit free transfer of liquid from one container to the other whereby to cause the liquid levels in the containers to rise and fall according to the relative elevations thereof, means in at least one of said containers operably responsive to rise and
fall of the liquid level therein, and means connecting said last named means to said digging device raising and lowering means operable to raise and lower said digging device under control of said operably responsive means.

3. In a digging and grading apparatus including a powered vehicle, a digging device mounted to the powered vehicle, and means for raising and lowering the digging device with respect to the powered vehicle, means for maintaining the digging device on a pre-selected grade comprising a first liquid container supported on the digging device, a second liquid container, an adjustable ground engaging support of the ground spaced from said vehicle and mounting said second container at a selected elevation independent of the digging device, flexible hose means connecting said containers to permit free transfer of liquid from one container to the other whereby to cause the liquid levels in the containers to rise and fall according to the relative elevations thereof, float means in one of said containers, switch means operable upon movement of said float means, control means connected to said digging device raising and lowering means and operable by operation of said switch means to raise and lower the digging device upon movement of the float caused by rise and fall of the liquid level in the container.

4. In a digging and grading apparatus including a powered vehicle, a digging device mounted to the powered vehicle, and means for raising and lowering the digging device with respect to the powered vehicle, means for maintaining the digging device on a pre-selected grade comprising a first liquid container supported on the digging device, a second liquid container, an adjustable ground engaging support of the ground spaced from said vehicle and mounting said second container at a selected elevation independent of the digging device, flexible hose means connecting said containers to permit free transfer of liquid from one container to the other whereby to cause the liquid levels in the containers to rise and fall according to the relative elevations thereof, float means in the container supported on the digging device, switch means operable upon vertical movement of said float means, control means connected to said digging device raising and lowering means and operable by operation of the switch means to raise the digging device upon upward movement of the float caused by a rise in the liquid level of the container and to lower the digging device upon downward movement of the float means caused by a fall in the liquid level in the container.

5. In a digging and grading apparatus including a powered vehicle, a digging device mounted to the powered vehicle, and means for raising and lowering the digging device with respect to the powered vehicle, means for maintaining the digging device on a pre-selected grade comprising a first liquid container supported on the digging device, a second liquid container, an adjustable ground engaging support of the ground spaced from said vehicle and mounting said second container at a selected elevation independent of the digging device, current conducting liquid in said container, flexible hose means connecting said containers to permit free transfer of liquid from one container to the other whereby to cause the liquid levels in the containers to rise and fall according to the relative elevations thereof, a pair of spaced apart electrodes mounted in each container, at least one of said electrodes in each container being spaced above the liquid in the container when the liquid levels in the containers are equal, electrical control means connected with said electrodes and to the digging device raising and lowering means, said electrical control means operable to cause the raising and lowering means to lower the digging device when the liquid level in one container rises sufficiently to immerse both electrodes in that container, and said electrical control means operable to cause the raising and lowering means to lower the digging device when the liquid level in the other container rises sufficiently to immerse both of the electrodes in that container.

6. In an apparatus for bringing an earth surface to a predeterimined grade having an earth moving device, a powered vehicle supporting and moving said device, and mechanism on the vehicle for lowering and raising the device with respect to the powered vehicle, means for maintaining the device while moving on said predetermined grade comprising a first liquid container affixed to said device, a second liquid container, a fixed ground engaging support spaced from the device and vehicle and supporting said second container on the ground at a selected elevation above grade independent of the device, flexible hose means connecting said containers and providing free transfer of liquid from one container to the other whereby to cause the liquid levels in the respective containers to rise and fall in accordance with the relative elevations thereof, means in one of said containers operable responsive to rise and fall of liquid level therein, and connections from said means to said mechanism operable to cause said mechanism to raise and lower the device in response to rise and fall of liquid in said one container.

References Cited in the file of this patent

UNITED STATES PATENTS

946,660 Deslottes Jan. 18, 1910
1,099,385 Tonga June 9, 1914
2,477,927 Hanson Aug. 2, 1949
2,494,069 Steffen Jan. 10, 1950
2,720,716 White Oct. 18, 1955
2,789,564 Selleck Apr. 23, 1957