United States Patent [19]

Manor

[11] **3,924,689**

[45] **Dec. 9, 1975**

[54] **HYDRAULICALLY CONTROLLED GRADER-LEVELER ADAPTED FOR TRAILING BY TRACTORS**

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[73] Assignees: **Technion Research and Development Foundation, Ltd.; Aharon Kipnis**, both of Haifa, Israel

[22] Filed: **Dec. 20, 1973**

[21] Appl. No.: **426,522**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 266,078, June 26, 1972.

[30] **Foreign Application Priority Data**

July 4, 1971 Israel 37217

[52] **U.S. Cl.** **172/780;** 172/261; 37/DIG. 20; 91/390

[51] **Int. Cl.**[2] **E02S 3/76**

[58] **Field of Search** 172/4.5, 4, 780, 781, 172/796, 263, 261; 39/DIG. 20, 108; 91/390

[56] **References Cited**

UNITED STATES PATENTS

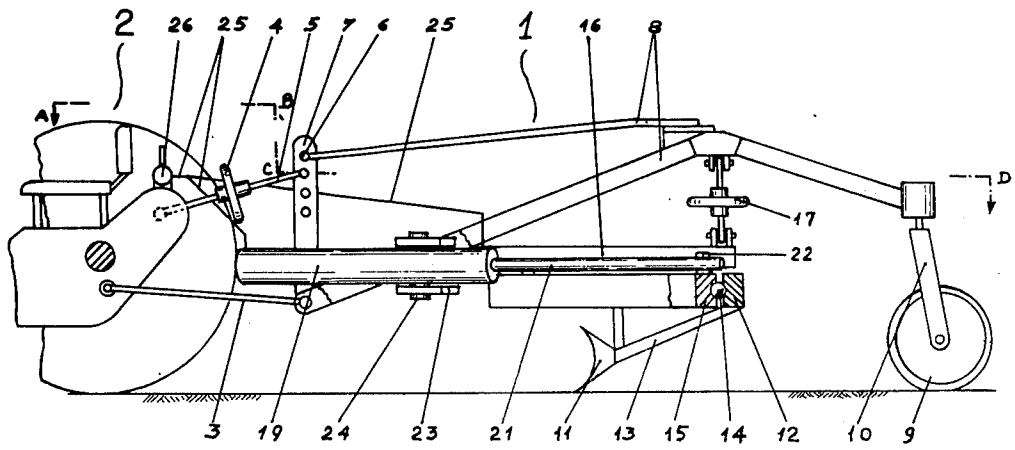
1,396,038	11/1921	Ghent	172/780 X
1,844,058	2/1932	Dean	172/796
2,720,716	10/1955	White, Jr.	37/DIG. 20
3,716,105	2/1973	Hallam	172/781 X
3,736,845	6/1973	Weiste	91/390

Primary Examiner—Stephen C. Pellegrino
Attorney, Agent, or Firm—Flynn and Frishauf

[57] **ABSTRACT**

A chassis, adapted to be connected to a farm tractor, supports a blade for grading and levelling; the blade is rotatable with respect to the chassis. The angle of the blade is set by a hydraulic transmission, such as a linear or rotary hydraulic motor controlled by a direction controlled valve. Mechanical output from the hydraulic motor is connected to the blade support, typically a turntable, to set the blade angle as determined by the application of hydraulic pressure. The blade can be fixed in position by engaging tooth-and-detent elements, one of them being respectively fixed to the chassis and the other formed on a turntable which is rotatable with the blade.

11 Claims, 9 Drawing Figures



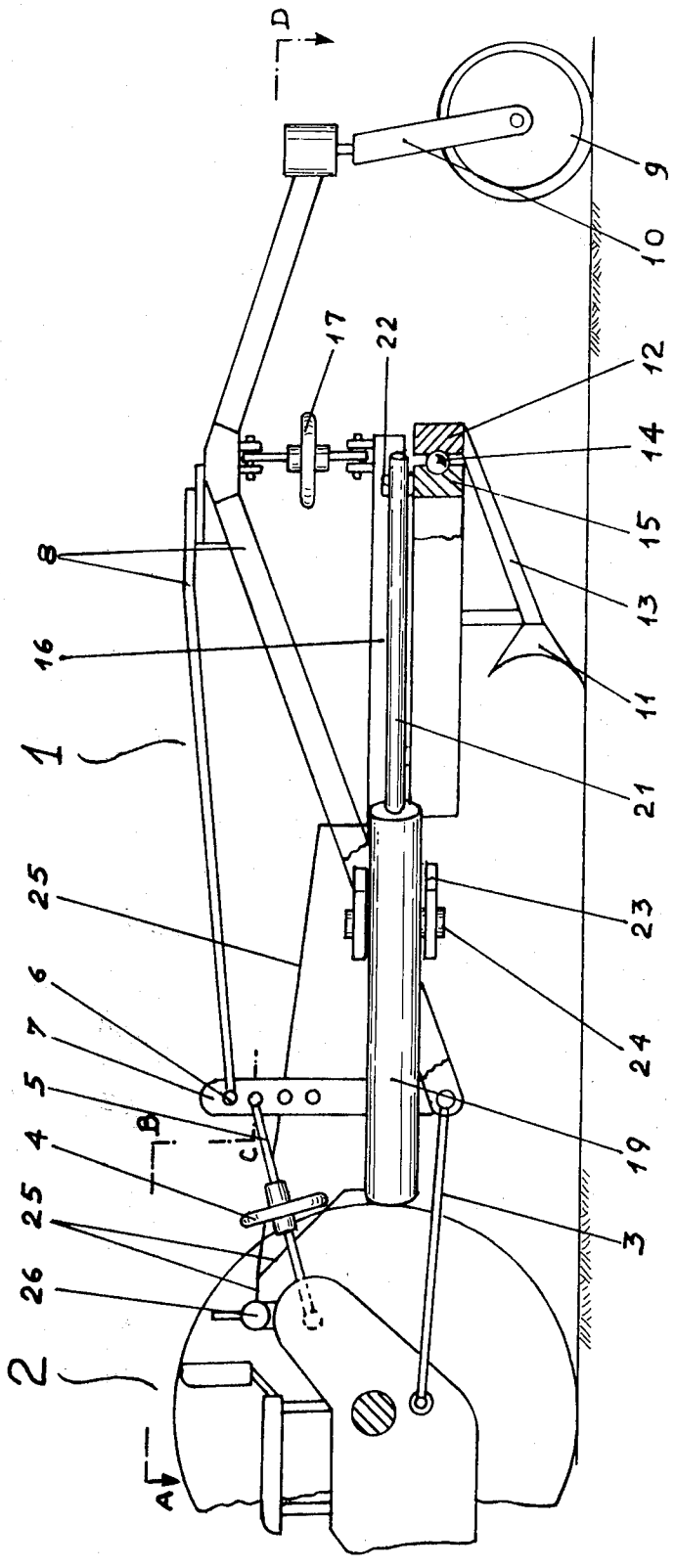


FIG. 1

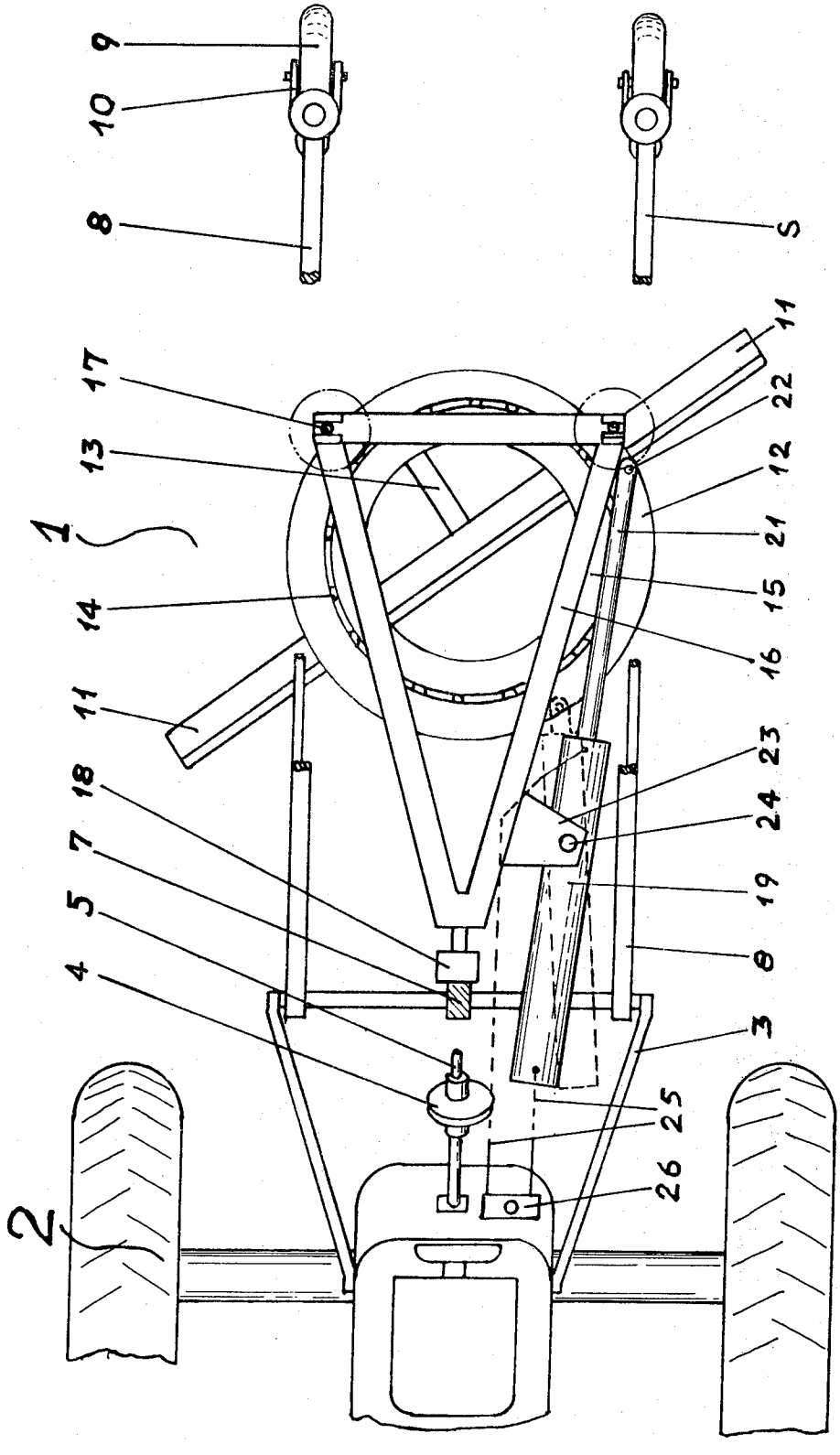


FIG. 2

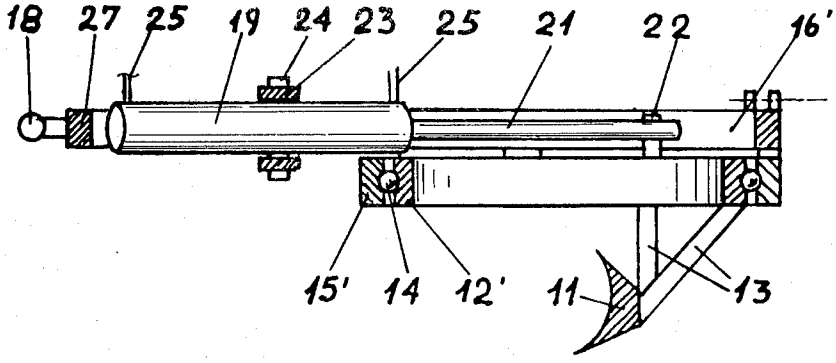


FIG. 3

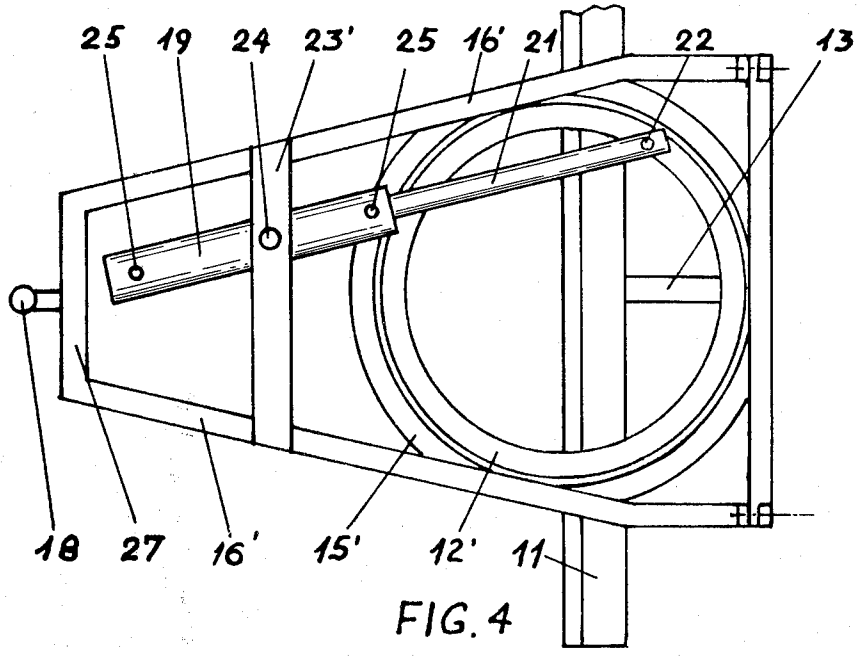


FIG. 4

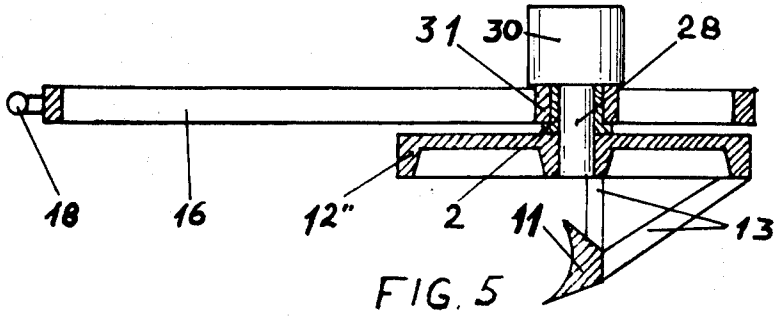


FIG. 5

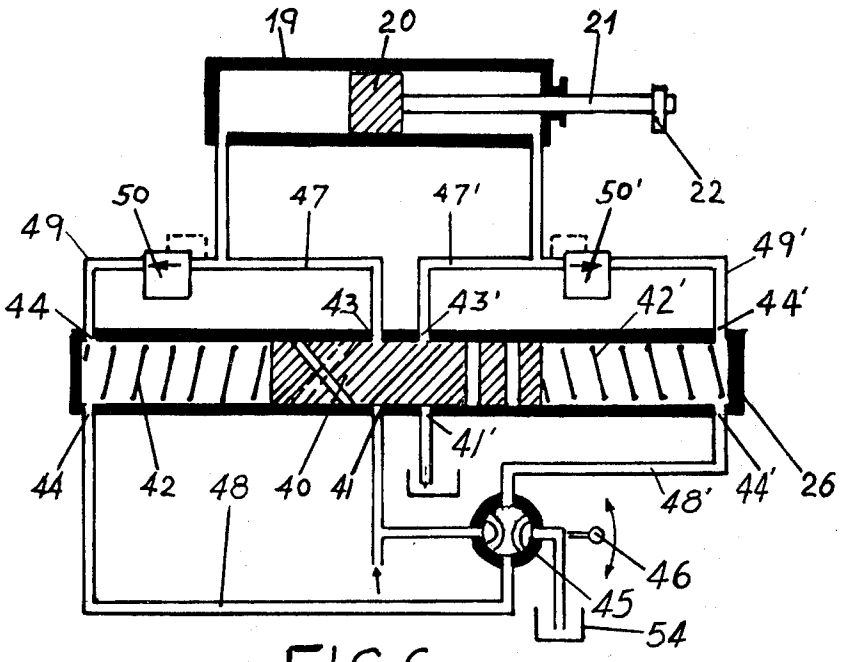


FIG. 6

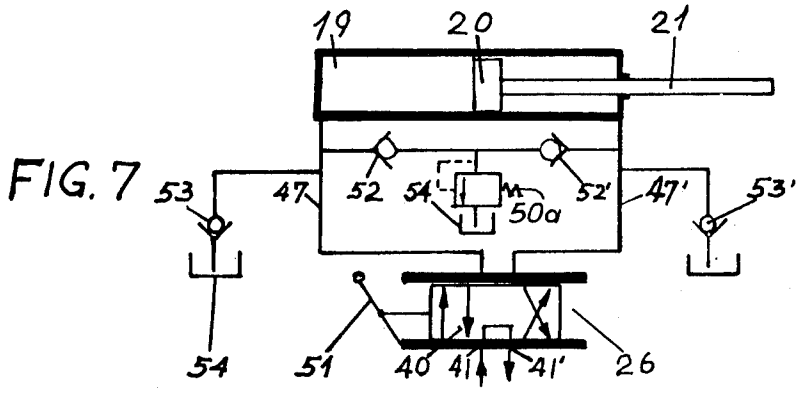


FIG. 7

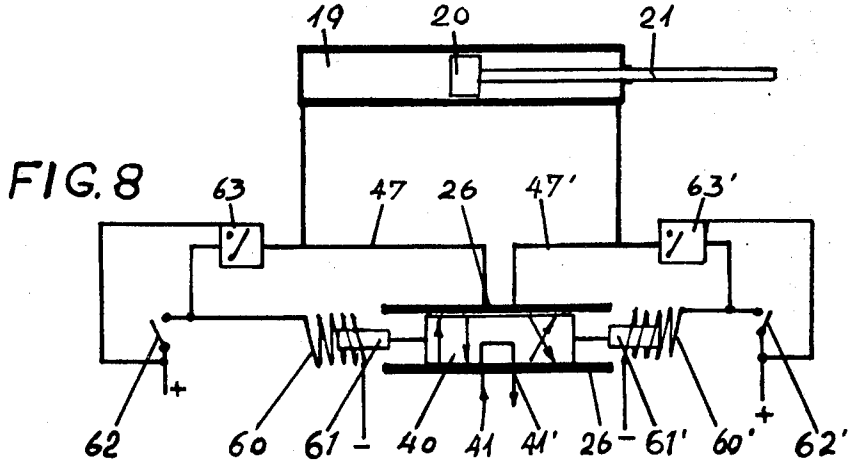


FIG. 8

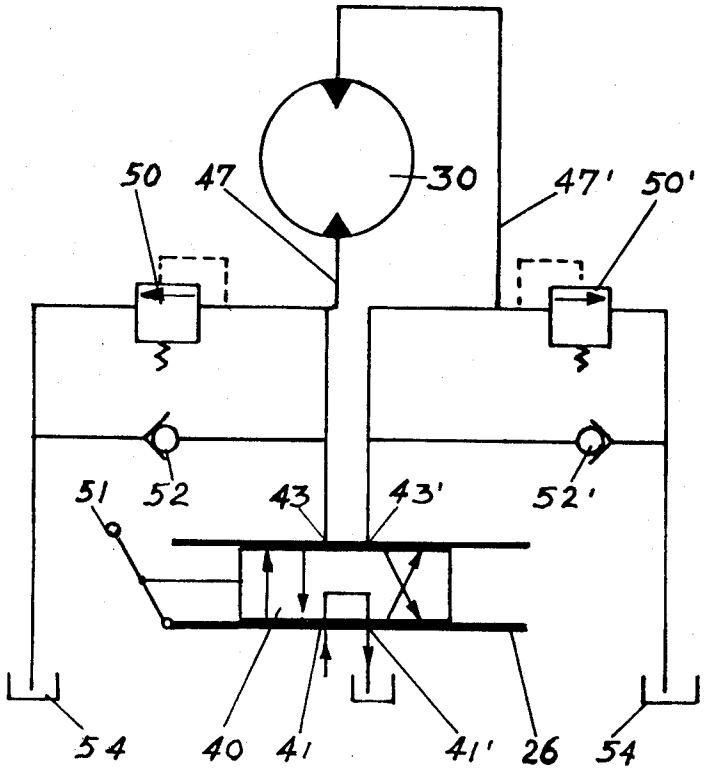


FIG. 9

HYDRAULICALLY CONTROLLED GRADER-LEVELER ADAPTED FOR TRAILING BY TRACTORS

This application is a continuation-in-part of my earlier application Ser. No. 266,078, filed June 26, 1972, and claiming priority of Israeli application Ser. No. 37,217, of July 4, 1971.

This invention relates to an agricultural implement capable of serving both as a grader and as a leveler and adapted to being attached to a farm tractor by a three-point hitch.

Graders consist essentially of a heavy, oblong blade of curved cross-section drawn across uneven ground while fixedly positioned at an angle between zero degrees and a right angle to the direction of movement. The implement casts aside those parts of the soil that protrude above a certain predetermined level. Leveler, on the other hand, consist essentially of a blade similar to that used in the grader but drawn across the ground while at a right angle to the direction of motion, with two rigid aprons or side-shields of strong material on either side of the blade preventing the soil being carried forward during operation from being case aside, thus using it for filling out cavities in the path of the implement, so that a clearly defined strip of land, substantially more level or even than prior to the leveling operation, is obtained.

Several types of both kinds of implement are known to the art: The four-wheeled trailed type has the advantage of being simple and relatively inexpensive, but it is long, heavy and unwieldy especially when taken together with the tractor. The self-propelled motor grader-leveler has an adjustable blade that may be positioned in the two manners appropriate to grading and leveling respectively, the blade being provided with side aprons required for a successful grading action. It is convenient to use, all operations being readily surveyed and manipulated from the driver's seat, but it represents a large investment in an essentially single-purpose aggregate.

The three-point hitched grader seeks to overcome the drawbacks of the implements described above by being shorter, the blade being carried on a wheelless frame and fixed to the tractor by a three-point hitch. This type is relatively inexpensive and its action is continually controllable by hand, but it is inconvenient to use and, due to the lack of a support behind the blade, the results of the operation are of a low quality.

The three-point fixed-blade leveler seeks to overcome some of the drawbacks of the last named implement by being provided with a support behind the blade, and it is also an inexpensive trailer but a single-purpose implement.

All the aforementioned machines or attached implements are fitted with a blade fixed, at different angles, to the supporting structure in rigid attachment. The blade and/or the structure are therefore liable to damage whenever they encounters an unsurmountable obstruction, especially if this latter is met by the blade in an off-centre place whereby a bending moment is exerted on the structural parts.

The present invention is designed to further improve the implement by, on the one hand, permitting the setting of the blade angle from the driver's seat by hydraulic transmission means and, on the other hand providing safety means for letting the blade — together with the turntable — slip and turn about its axis, upon its encountering excessive resistance.

It is, therefore, an object of the present invention to provide a universal leveler and grader which can be trailed by a tractor and constructed to have, with the tractor, an overall length in the order of that of a self-propelled grader, or less, and in which the blade can be set at a desired angle with respect to the forward motion of the implement and yet release when an obstacle insurmountable, by the apparatus, is encountered.

SUBJECT MATTER OF THE INVENTION

Briefly, the invention relates to a combined leveler and grader attachment for a farm-tractor, to which it can be secured, for example, by a three-point hitch in which the blade can be readily set at any angle required for the particular soil working operation. In accordance with a feature of the invention, the combined grader and leveler comprises a base frame or chassis with means — a three-point hitch — for trailing attachment to a farm tractor and, at its rear end, means for supporting it on the ground. A supporting frame may be attached to the chassis by adjustable means so designed as to enable it to be positioned at different distances from, and different angles to, said chassis; a normally horizontal ring or turntable is rotatably attached over the supporting frame to the chassis. A grading and leveling blade is rigidly attached to the said ring or turntable.

The angle of the blade is set by hydraulic transmission means which comprises a hydraulic piston motor or actuator of the linear or rotary type and a direction control valve, for example. The movable force-exerting portion of the hydraulic motor is suitably connected to the turntable or the blade in such a manner that when fluid pressure is applied to one side of the piston or pistons the turntable-and-blade combination is rotated about its axis and brought into the desired position. Fluid release means are provided at each side of the piston housing and are adjusted to open and release fluid from the respective side whenever the fluid pressure exceeds a certain limit corresponding to dangerous load on the blade, thereby permitting the piston or pistons to move freely and to allow the blade to turn about its axis and thereby to evade the obstruction.

In a preferred embodiment of the invention the release means are in the shape of at least one relief valve, which permits the fluid to flow from the piston housing to a collecting vessel.

In another embodiment the hydraulic motor is controlled by a solenoid-operated direction control valve of known design, to be actuated in the required direction by a manual switch, and wherein the release means consist of one pressure switch each connected hydraulically to one side of the piston housing, and electrically to one of the solenoids of the direction control valve, thereby moving the latter into a position allowing the outflow of fluid from the housing on the excess-pressure side and to admit fluid to the opposite side. In accordance with the invention disclosed in parent application Ser. No. 266,078, a positioning and quick-release mechanism may be provided, which includes a tooth with converging surfaces of a shape and size adapted for engagement with notches or serrations formed in the turntable. The mechanism is hingedly or slidingly attached to the supporting frame or the chassis in such a manner that it can be freely moved in or out of said notches. Mechanically, hydraulic, magnetic or

other force means act on the tooth, directly or indirectly, to such an extent that the tooth holds the blade in position under normal working conditions, but can be forced out of the particular notch it is engaged in by the force exerted by an overload on the blade, for example as the result of an off-center obstruction, the lateral force being transmitted from the notch to the inclined contacting surface of the tooth.

Various specific embodiments of the mechanism are shown and described in detail in said application Ser. No. 266,078, the disclosure of which is hereby incorporated by reference.

The invention will be described by way of example with reference to the accompanying drawings, wherein:

FIG. 1 is a side view and part section of a grader-leveler attached to a farm tractor, showing a linear motor as power transmission;

FIG. 2 is a plan and section on line A–B–C–D of the grader-leveler illustrated in FIG. 1;

FIG. 3 is a longitudinal section of the supporting frame, turntable and blade, showing a different mode of blade-setting mechanism;

FIG. 4 is a plan view of the parts shown in FIG. 3;

FIG. 5 shows a supporting frame, turntable and blade combined with a rotary hydraulic motor;

FIG. 6 is a diagrammatic view of a linear hydraulic motor, a direction control valve, the release mechanism and the connecting piping;

FIG. 7 is a diagrammatic view of another hydraulic operating and releasing mechanism;

FIG. 8 is a diagrammatic view of a combined hydraulic and electric operating and release mechanism, and

FIG. 9 is a diagram of a rotary hydraulic motor and hydraulic operating and releasing mechanism.

Referring now to FIGS. 1 and 2 of the drawings a grader-leveler 1 is attached to a farm tractor 2 by a three-point hitch 3, adjusting means being provided in the shape of a hand wheel 4 and a turnbuckle 5 and their connection to different holes 6 in the post 7. The implement comprises a main chassis frame 8 supported at its rear end by two trailing wheels 9 carried in brackets 10.

A curved grader blade 11 is rigidly fixed, by three struts 13, to a turntable 12 which is shaped in the form of the solid outer ring of a ball bearing, also comprising a plurality of balls 14 and on inner ring 15 which latter is rigidly connected to a triangular supporting frame 16. This supporting frame 16 is fastened at its rear end to the main chassis frame 8 by two adjustable turnbuckles 17, and at its front end to the post 7 by a ball joint 18 allowing universal angular movement.

The turntable 12, together with the blade 11 can be rotated about the inner ring 15 by means of a linear hydraulic motor which comprises a cylinder housing 19, a piston 20 (not visible), and a piston rod 21, which latter is pivotally connected at its end to the turntable 12 by a vertical pin 22. The cylinder housing, in order to follow the circular motion of the pin 22 is held pivotally by two vertical pins 24 between two brackets 23 which are integral with the supporting frame 16. Two positions of the hydraulic motor are shown, one in full lines and the other in dotted lines.

The linear motor is hydraulically connected, by flexible pipes 25, to a direction control valve 26 mounted on the rear part of the farm tractor and operable from the driver's seat. It obtains oil under pressure from a hydraulic pump which is standard equipment with tractors.

FIGS. 3 and 4 show a modification of the turntable, its attachment to the supporting frame, and the hydraulic angle-setting mechanism. The turntable 12', in this embodiment, forms the inner ring of a large ball bearing, the outer ring 15' of which is firmly connected to a supporting frame 16'. This is of similar shape as that shown in FIGS. 1 and 2 but possesses a cross-bar 27 in its front part to the center of which cross-bar the ball of a ball joint 18 is fastened. The hydraulic linear motor, in this case, is placed on the inside of the supporting frame 16' where it is well protected against damage. Its cylinder housing 19 is pivotally arranged between two bracket bars 23' and held there by vertical pins 24, while the piston rod 21 is at its end pivotally attached by means of a vertical pin 22 to the turntable 12' at a point on its top surface. Flexible hydraulic connections 25 are fixed to both ends of the piston housing 19. The grader blade 11 is connected to the turntable 12' by three struts 13 similarly as shown in FIGS. 1 and 2.

FIG. 5 shows a different type of turntable and bearing similar to that depicted in FIG. 6 of the co-pending patent application Ser. No. 266,078. Herein the turntable 12'' is in the shape of a solid disc with a reinforced outer rim and a reinforced hub, carried by a vertical drive shaft 28, the upper end of which is mechanically connected to a rotary hydraulic motor 30 positioned on a cross member 31 of the supporting frame 16. The drive shaft passes through a journal bearing 32 fixed in a vertical hole in the cross member 31. The blade 11, as previously shown, is fixed to the turntable by struts 13, while the supporting frame 16 may be shaped similarly to the supporting frame shown in the aforegoing figures.

Three different hydraulic operating and release mechanisms are shown in FIGS. 6, 7 and 8 which are designed for a linear motor, but may be similarly applied to a rotary type hydraulic motor. In these figures the hydraulic motor comprises a cylinder housing 19, a piston 20 and a piston rod 21, the latter transforming the linear movement into rotary movement of the turntable. Also appearing in all three figures is a direction control valve 26 having a sliding spool 40, shown in its neutral position in line with the inlet port 41 and spill port 41'. This spool is so ported that while being moved out of its central position to the right or left, it supplies oil under pressure to one side of the linear motor and allows oil from the other side to escape through the spill port, thereby moving the piston and piston rod 21 in the desired direction into the position required for the grader blade.

Referring now to the diagram in FIG. 6 the spool 40 is held in, and returned to, its central position by two springs 42 and 42' which are arranged within the closed valve housing 26. This housing, in addition to the inlet and spill ports 41 and 41', possesses two supply and return ports 43, 43' situated opposite the above ports, and two ports each 44 and 44' situated near the closed outer ends, which ports serve to admit fluid under pressure to the end faces of the spool with the aim of moving it out of its central position into either of the operating positions. A hand-operated four-way valve 45, which obtains fluid under pressure from the central supply, directs it to the right or left side of the control valve 26 through pipes 48 and 48' respectively, and empties the opposite end into a collecting vessel 54. The supply and return ports of the valve are connected to one side each of the cylinder housing by piping 47 and 47'. From each of these pipes a return pipe 49, 49'

enters the valve housing through one of the ports **44, 44'**, and each pipe is normally closed by a non-return sequence valve **50, 50'**, of known design, which are adjusted to open when the pressure on the respective side of the cylinder housing exceeds a predetermined pressure. Owing to the different face areas on both sides of the piston, the two sequence valves will be set to different pressure.

The operation of the mechanism is as follows: Upon turning the handle of the four-way valve **45**, for instance clockwise, fluid enters the right end of the control valve housing through pipe **48'** and pushes the sliding spool **40** to the left until the right-hand spool ports coincide with, and thus connect, ports **41** and **41'** with ports **43** and **43'** of the valve housing **26** respectively. Thus oil is pressed into the left hand side of the cylinder housing, pushing the piston **20** and the piston rod **21** to the right until the desired blade position is reached. Then the four-way valve **45** is closed and the implement can start on its way. If the blade now encounters excessive resistance at one of its ends, which acts as a force transmitted via the turntable and the piston rod to the piston, pressure is built up in the cylinder housing at one end which eventually opens the respective sequence valve (**50, 50'**) on this side. Assuming that valve **50** has opened then fluid will escape into the left side of the control valve casing and push the spool to the right, thus pressing fluid into the right end of the cylinder housing and draining the left end. This pushes the piston and piston rod further to the left relieving the pressure on the blade. The pressure drop on the left side which is being drained lets the sequence valve **50** close and the blade can now be returned by manual operation of the fourway valve.

The diagram of FIG. **7** shows a hand-operated direction control valve **26** with its operating handle **51** on its left side. It can readily be seen that by moving the spool **40** to the right for instance, the piston **20** is also pushed to the right and vice versa. The overload release mechanism in this case consists of a relief valve **50*a*** placed between the two pipes **47** and **47'** connecting the hydraulic motor to the control valve **26.** Furthermore the pipes **47** and **47'** are protected against shortcircuiting by two check valves **52, 52'**, which allow fluid to pass to and through the relief valve but not between the two pipe lines. Two more check valves, **53, 53'**, are connected to pipe lines **47, 47'** respectively and dip into fluid in the collection vessel **54** thus serving as anticavitation valves for returning fluid into the enlarging space at the other end of the cylinder.

FIG. **8** shows a combined electric-hydraulic mechanism wherein the movement of the valve spool is induced by two solenoid windings **60** and **60'** and two cores **61** and **61'** rigidly fixed to one end each of the spool.

Two electric pressure switches **63, 63'** are hydraulically connected to one side each of the cylinder housing of the hydraulic motor and electrically connected to the respective solenoid windings **60, 60'**. A hand operated switch **62, 62'** transmits current to either solenoid winding which pulls the core and the spool in its direction.

The release mechanism operates by excess pressure, for example on the left side of the piston closing the left hand pressure switch **63** which then causes current to flow to the left solenoid windings **60.** This draws the core **61** and the spool **40** to the left, whereby the left hand ports in the spool allow fluid to enter the right side of the cylinder, the left side being drained at the same time. As soon as the overload ceases to exert pressure the pressure switch, contacts open and the spool is returned to its central position by springs not shown in the diagram. This enables the blade to be reset by operating one of the switches **62, 62'**.

The rotary motor **30** shown in FIG. **9** is actuated by a hand-operated direction control valve **26,** wherein the spool **40** can be moved out of its neutral position to the right or to the left by a handle **51.** Pipe lines **47** and **47'** connect the control valve with the rotary motor which rotates in either direction in accordance with the position of the valve spool. One relief valve (**50, 50'**) each branches off from the connecting pipes (**47, 47'**) and leads into a collecting vessel **54.** In parallel to the relief valves two check valves **52** and **52'** are installed, acting as anti-cavitation valves.

The operation is similar to that of the arrangement shown in FIG. **7** with the difference that two relief valves are installed instead of one unit only. The check valve outlets end below the liquid surface in the collecting vessel, so as to enable them to act as anti-cavitation valves, returning liquid to the opposite side of the pistons whenever one of the relief valves opens and empties one side.

In essence, the present invention permits setting of the blade at practically any desired angle, from transverse to the direction of movement of the implement across a field to practically in line with this movement. The piston motor is provided with an overload relief valve. If pressure on the blade, and hence on the operating rod should exceed a certain safe value, the setting of the blade releases and the blade can freely swing into line with the direction of travel of the implement, thus clearing the obstance, and avoiding damage to the blade, the implement, and the tractor-implement assembly. The driver of the tractor merely need re-actuate the hydraulic motor, which first closes the relief valve, and then repositions the blade to its proper setting, to continue the work intended for the implement.

Various changes and modifications may be made within the scope of the inventive concept, and embodiments shown in any one of the figures, or described in connection therewith, may be used with any embodiment shown or described, as desirable and appropriate.

I claim:

1. Off-center overload protected grader-leveler apparatus comprising

a chassis having means at its forward end for trailing attachment to a farm tractor and, at its rear end, means for supporting the chassis above ground, said tractor having a hydraulic system including a collecting vessel;

a blade support means, and means rotatably securing the blade support means to the chassis to enable the support means to swing about an essentially vertical axis to permit selective positioning of the support means with respect to said chassis;

a grading and leveling blade supported by the support means;

blade positioning means, quick release means including a hydraulic piston motor having a cylinder;

means connecting the movable force transmitting portion of the hydraulic motor to the blade support means;

and means controlling application of pressurized fluid, selectively, to a side of the piston of the motor in order to rotate the blade support means,

and hence the blade about its axis and bring it into a desired position; wherein, to avoid blade damage upon encountering an off-center overload, the improvement comprises

controlled quick fluid release means to open and release fluid from the respective overloaded side of the piston into the collecting vessel whenever the fluid pressure on the piston exceeds a limit defined by an excessive off-center load on the blade, release of fluid permitting the piston to move freely and to allow the blade support means with the blade attached thereto to turn freely about its axis and thereby to prevent damage to the apparatus.

2. Apparatus according to claim **1**, wherein the blade support means comprises a normally horizontal turntable, the blade being secured to the turntable.

3. Apparatus according to claim **1**, wherein

the release means on each side of the cylinder comprises a relief valve which permits, at excess pressure, fluid to be drained from its side and to flow into the collecting vessel;

and an anti-cavitation valve is connected in parallel with the relief valve and permitting fluid from the collecting vessel to enter the other side of the cylinder as the piston is moving under influence of an overload.

4. Apparatus according to claim **3**, wherein the release means comprise

one single relief valve connected to both sides of the piston housing;

one check-valve each connecting the sides of the cylinder to the single relief valve;

and two anti-cavitation valves provided between the two sides of the piston housing and the collecting vessel.

5. Apparatus according to claim **1**, comprising a solenoid-operated direction control valve connected to control the hydraulic motor and to actuate the motor in the required direction by selective energization of the solenoid controlled valve;

and wherein the release means comprises a pressure switch, each, connected hydraulically to one side of the cylinder, and electrically to one of the solenoids of the direction control valve, thereby moving the latter into a position allowing the outflow of fluid from the housing on the excess-pressure side and to admit fluid to the opposite side.

6. Apparatus according to claim **1**, wherein the means for supporting the chassis above ground comprises at least one wheel attached to the rear part of the chassis.

7. Apparatus according to claim **1**, wherein a plurality of wheels are provided, said wheels being directionally self-adjusting caster wheels.

8. Apparatus according to claim **1**, wherein the means for supporting the chassis above ground level comprises at least one roller attached to the rear part of the chassis.

9. Apparatus according to claim **1**, wherein the blade support means comprises a turntable.

10. Apparatus according to claim **1**, wherein the controlled quick fluid release means comprises a relief valve, each, located at either side of the piston to release pressurized fluid from a respective side thereof.

11. Apparatus according to claim **1**, wherein the controlled quick fluid release means comprises a relief valve which permits, at excess pressure, fluid to be drained from its side and to flow into the collecting vessel;

and an anti-cavitation valve connected in parallel with the relief valve and permitting fluid from the collecting vessel to enter the other side of the cylinder as the piston is moving under influence of an overload.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,924,689

DATED : December 9, 1975

INVENTOR(S) : Gedalyahu MANOR

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Title Page, Item 30, change to read:

--July 4, 1971 Israel 37217

March 5, 1973 Israel 41681 --.

Signed and Sealed this

Twenty-sixth Day of October 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,924,689 Dated December 9, 1975

Inventor(s) Gedalyahu MANOR

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 61 (claim 1): delete "quick release means".

Signed and Sealed this

twenty-third Day of *March 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks