

[54] **HYDRAULIC TILT AND PITCH CONTROL FOR DOZER BLADE**

[72] Inventor: **David H. Seaberg**, Davenport, Iowa
[73] Assignee: **J. I. Case Company**, Racine, Wis.
[22] Filed: **May 27, 1971**
[21] Appl. No.: **147,514**

[52] U.S. Cl. **172/804, 172/809, 91/413, 37/DIG. 10**
[51] Int. Cl. **C02f 3/76**
[58] Field of Search **172/801-809; 91/411, 413; 37/DIG. 7, DIG. 10**

[56] **References Cited**

UNITED STATES PATENTS

3,581,829 6/1971 Frisbee et al. 172/804
3,589,242 6/1971 Peterson et al. 172/804

Primary Examiner—Robert E. Pulfrey
Assistant Examiner—Stephen C. Pellegrino
Attorney—Cullen, Settle, Sloman and Cantor

[57] **ABSTRACT**

A fluid control system for a load handling implement such as a dozer blade carried by means of a universal joint on a load handling machine which comprises a pair of double-acting fluid cylinders having one end attached to the implement and the other end to a stationary part of the machine; the pair of fluid cylinders are each connected at opposite ends by a pair of fluid lines to a source of fluid under pressure including a main control valve and a selector valve; the main control valve and the selector valve are actuated by a single control lever which when pivoted in one direction positions the main control valve for tilting the implement clockwise and if pivoted in the opposite direction positions the main control valve for tilting the implement counterclockwise; and the control lever is provided with an actuator to condition the selector valve for pitching of the implement in either forward or rearward inclination by actuation of the control lever actuator coupled with pivotal movement of the control lever in one or the other of the tilt-controlling directions.

4 Claims, 5 Drawing Figures

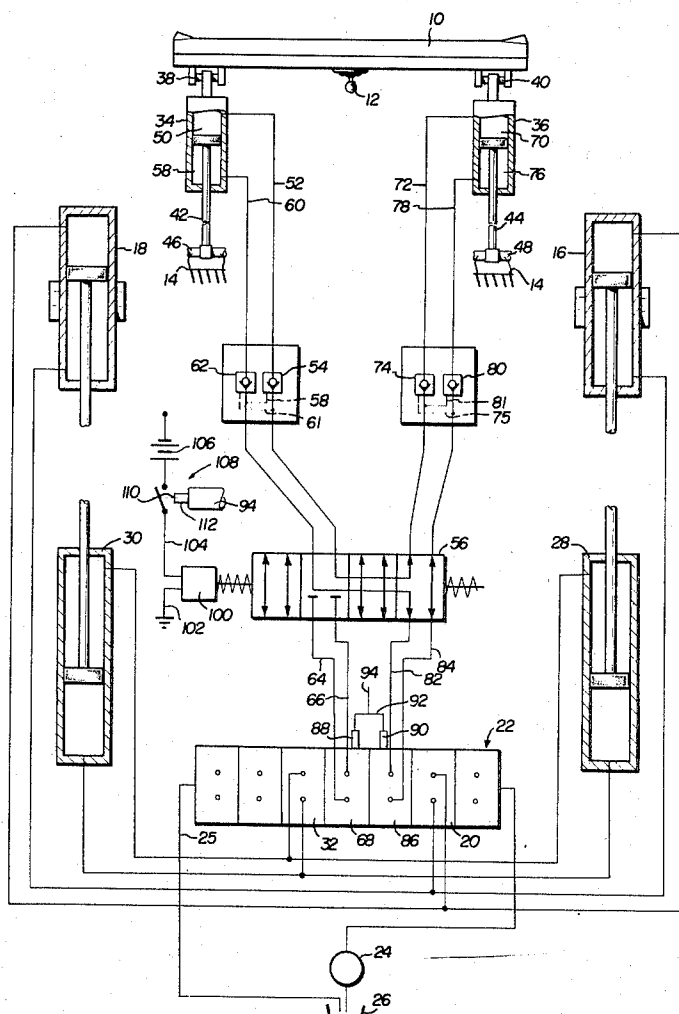
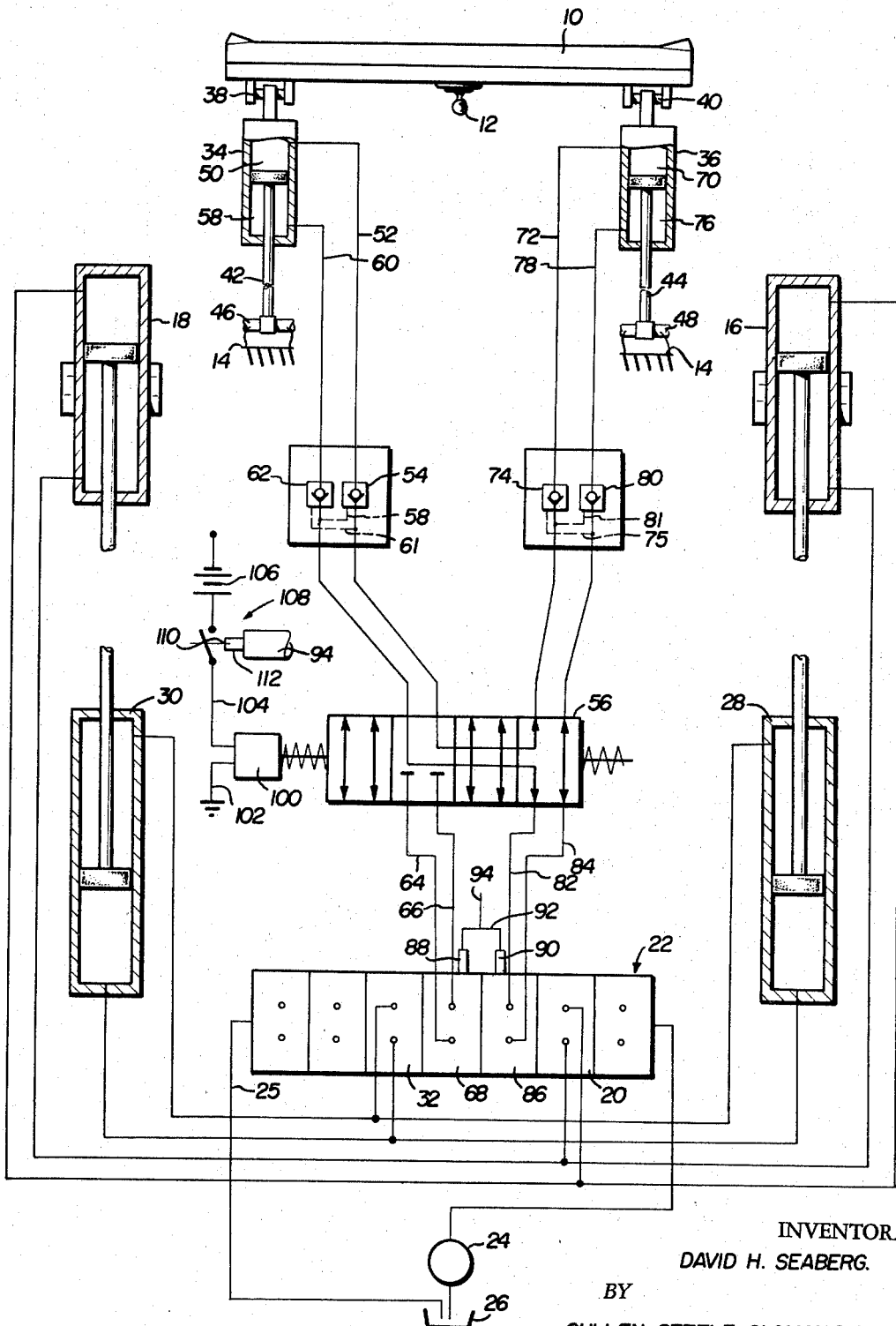


FIG. 1



INVENTOR.
DAVID H. SEABERG.

BY
CULLEN, SETTLE, SLOMAN & CANTOR.

ATT'YS.

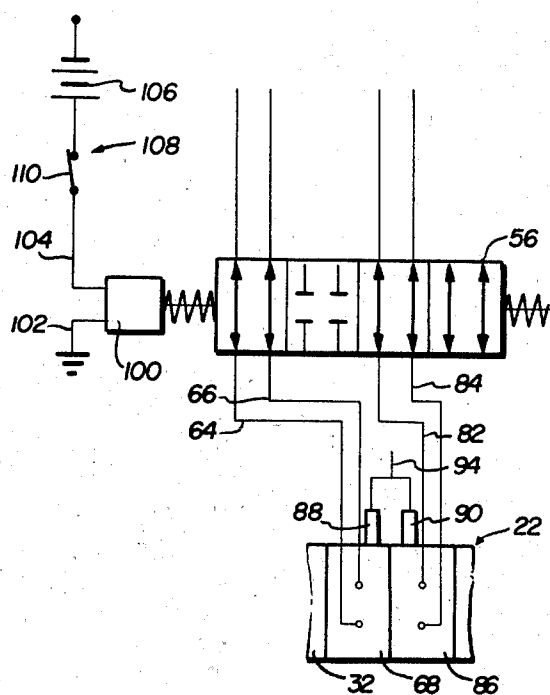


FIG. 1a

INVENTOR
 DAVID H. SEABERG.
 BY
 CULLEN, SETTLE, SLOMAN & CANTOR.
 ATT'YS.

FIG. 2

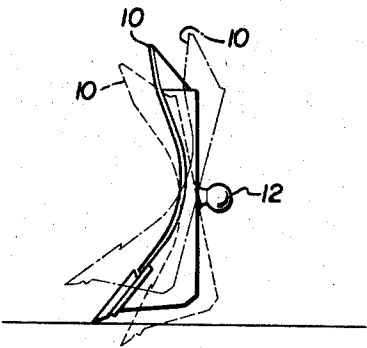


FIG. 3

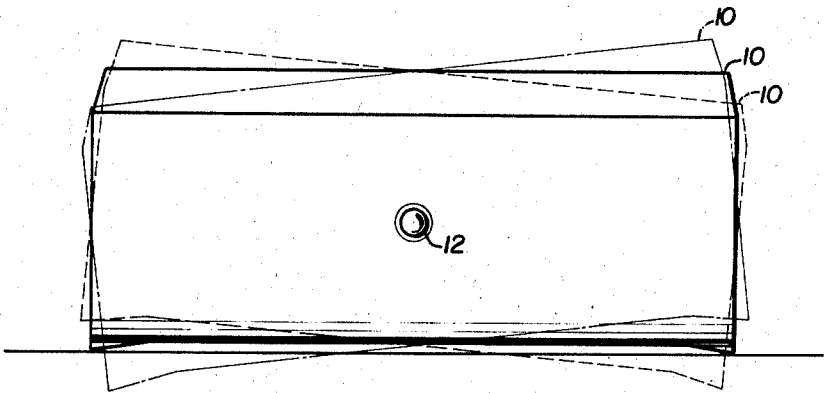
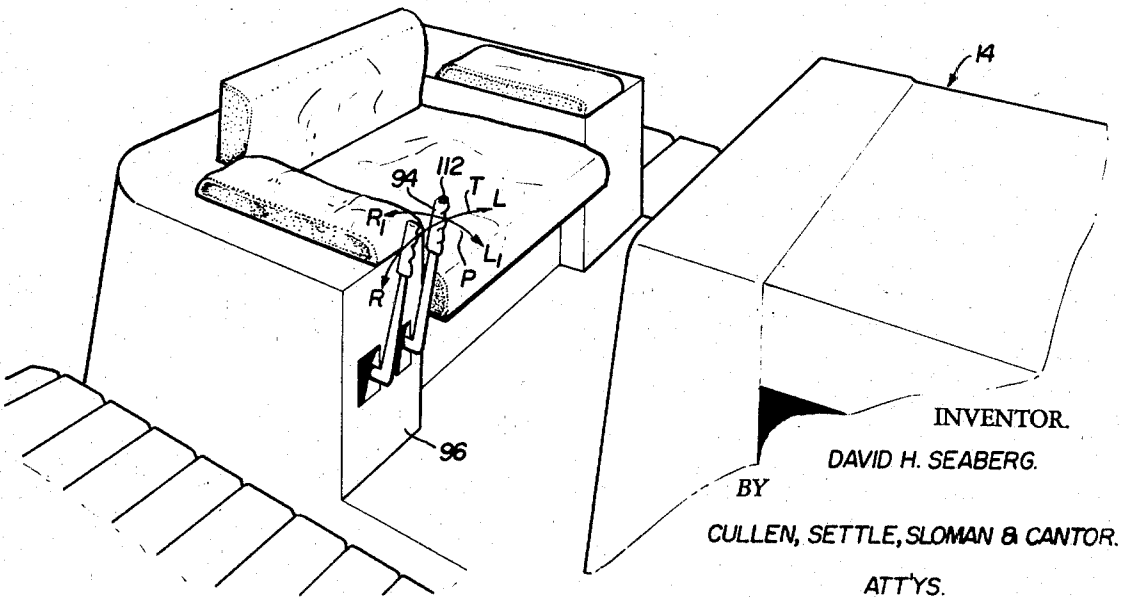


FIG. 4



HYDRAULIC TILT AND PITCH CONTROL FOR DOZER BLADE

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates in general to fluid pressure operated load handling mechanisms and more in particular to earth moving equipments such as dozers or the like and to an improved fluid control for the load handling blade of a dozer.

In earth moving equipments such as scrapers, dozers and the like, it is known to position and pivotally mount a load handling blade forwardly of the tractive vehicle and to provide means to selectively vary the pitch position of the blade relative to a longitudinal axis of the equipment and further to selectively vertically position the blade around a rotary axis disposed in a plane containing the longitudinal axis of the earth moving equipment.

It is well known that earth moving equipments of this character are subject to considerable shock loads during operation and therefore must be of extremely rugged construction. Thus, when the blade is set at a desired pitch or tilt position, such as in forming a ditch or leveling a road, the blade must be capable of maintaining the position regardless of the hardness or composition of the material being moved and regardless of the heavy thrust loads which the load handling blade delivers back to the equipment.

Conventionally, the load handling blade is mounted on the earth moving equipment by means of a central swivel joint, one part of which is attached the rear of the blade and the companion part is attached to the pusher frame of the earth moving equipment to permit angular positioning of the blade around a vertical and horizontal axis.

Normally, a pair of fluid cylinders are attached to the rear of the blade and at both ends thereof having their other end attached to the frame of the earth moving equipment, which, when selectively actuated, vary the pitch angle of the blade by pivoting the blade around a horizontal axis of the swivel joint relative to the longitudinal axis of the equipment. Normally, to vary the vertical position of the blade edgewise (tilting) a separate fluid motor has been provided heretofore in addition to the fluid motors for pitching of the blade, which has a separate control means for selective actuation by the operator of the equipment.

This conventional arrangement requires multiple hydraulic control means and multiple fluid power tubing carried by the earth moving equipment increasing the difficulties in installation of hydraulic power equipment and further increasing the maintenance of the fluid power equipment and complicating the operation of the controls.

In accordance with the present invention, an improved hydraulic control system for a load handling or earth moving blade, such as a dozer blade, has been provided, which effectively eliminates the above difficulties of the prior art by combining the hydraulic control for tilting and pitching of the blade into a single integrated hydraulic circuit operable by means of a single control lever at the operator's control console.

Accordingly, a pair of hydraulic cylinders are provided connected by conduits to a selector valve and from there to separate sections of a main control valve.

The two valve sections in the main control valve are operated in synchronization by a linkage hooked up to the single operator control lever. Synchronization of the two valve sections is a function of spool position only and is affected only slightly by pressure changes. Thus, when spool movements in the two valve sections are synchronized the fluid flow delivery from these two sections will be the same.

The selector valve has an actuator which is electrically connected to a switch button on the single operating lever from the blade pitching and tilting control. In the tilt position of the control lever, the electrical switch for actuation of the selector valve is open and fluid pressure, provided from the main control valve, flows through the selector valve in a series circuit connection, supplying fluid to diagonally opposite ends of the pair of cylinders and exhausting fluid from diagonally opposite ends of the pair of cylinders to thereby rotatably tilt the blade (either left or right) around the swivel joint.

When it is desired to change the pitch angle of the blade, the switch button on the single control lever is depressed which closes the electrical circuit to thereby energize the valve actuator of the selector valve, shifting the selector valve. This action changes the previous hydraulic series circuit to a parallel circuit in which fluid pressure is applied to directly opposite ends of the double acting cylinders to thereby pitch the upper edge of the blade around an axis transverse to the longitudinal axis of the machine or equipment.

The fluid conduits of each of the pair of cylinders are connected to pilot operated check valves operable in both directions of fluid flow. The pilot operated check valves are used to provide locking of the cylinders in place when the main control valve is not supplying fluid and also prevents the cylinders from pulling away from the pump when negative loads are encountered. This action is accomplished by the check valves not allowing return flow from the cylinders to the tank unless a positive pressure is applied at the other end of the cylinders.

Both of the pairs of cylinders used for tilting and pitching of the load handling blade, are identical having one end attached to the rear of the blade and the other end secured to a part of the equipment.

With the present arrangement pitching can be done after tilting of the blade (or vice-versa), provided that one or the other cylinder has not bottomed out to make further cylinder movement impossible. Thus, if tilting of the blade is done first to the maximum position in either direction, further operation of the hydraulic cylinder for pitch positioning of the blade, will cause either an advance of the other cylinder, which will change the tilt setting or retract both cylinders and pitch back if the control is reversed. Thus, pitching of the blade, after previous tilting of the blade, is best done when the cylinders are between stops in either position so that additional pitch adjustment will not influence the tilt setting of the blade.

The present improved integrated hydraulic system to obtain both, pitch angle tilt setting of the blade by means of the same pair of hydraulic cylinders, considerably facilitates installation requirements and maintenance of the hydraulic system of the equipment by means of actuation of both pitch and tilt settings of the

blade by a single control lever. By this, a combination operation is provided in which the operator of the equipment does not have to move his hand from the control lever or to use another hand or foot for operation of a separate control lever, as in previous arrangements and thus, equipping the operator with more freedom in the operation of the equipment which, as is known, requires several hand or foot movements by the operator to manipulate the many controls of the equipment.

The present invention will be best understood by reference to the following detailed description of a preferred embodiment thereof, described in connection with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings schematically illustrate a preferred embodiment of the invention in which:

FIG. 1 is a schematic illustration of the hydraulic system of the present invention with associated hydraulic components being indicated in dot and dash lines and shown in position for tilting;

FIG. 1a shows the hydraulic system of FIG. 1 in position for pitching of the blade;

FIG. 2 is a schematic side view of the blade of the equipment being operated by the system of FIG. 1 with various pitch positions of the blade being indicated in dot and dash lines;

FIG. 3 is a schematic front elevation of the blade of the equipment in which the various tilt positions of the blade are indicated in dot and dash lines; and

FIG. 4 is a schematic illustration of a representative control arrangement at the operators control console of the equipment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With continuing reference to the attached drawings, the earth moving blade 10 is centrally attached by means of an universal swivel joint indicated at 12, to the front end of a tractive earth moving or load handling machine, such as schematically indicated at 14 in FIG. 4.

The universal swivel joint 12 is preferably of the ball and socket type so as to permit universal movement of the blade 10 at least around two intersecting axis and in both directions of rotation.

Generally, the blade 10 is conventionally connected to a pair of opposite lift cylinders 16 and 18 respectively, for raising or lowering of the blade relative to the ground surface and both of which are connected by conduits to a valve section 20 of a main control valve 22 which is in fluid communication with a pump 24 and a source of fluid under pressure indicated at 26. The blade 10 additionally may be connected in conventional manner to a pair of opposite angling cylinders 28 and 30 respectively for angling of the blade relative to the longitudinal axis of the machine, as is commonly known. Both angling cylinders 28 and 30 are likewise connected by conduits to another valve section 32 of the same main control valve 22 of the machine.

These arrangements are conventional, as for instance disclosed in U.S. Pat. No. 2,943,407 to E.B. Long, and do not form a part of the present invention.

In accordance with the present invention, the rear of the dozer blade 10 is pivotally attached to one end of a pair of combined tilt and pitch cylinders 34 and 36 respectively, at pivot points 38 and 40 near the opposite upper and outer edges of the blade 10. The opposite ends of the pitch and tilt cylinders 34 and 36, which define reciprocating piston rods 42 and 44 respectively, are each pivotally connected at opposite universal and transversely aligned pivot points 46 and 48 to a stationary part of the machine, indicated at 14. Both pair of pivot points 38 and 40 and 46 and 48 are each transversely aligned on parallel horizontal axis normal to the longitudinal axis "X" of the machine, which extends through the center of the swivel joint 12 of the blade, for equalized force distribution at either end of the blade during pitch or tilt actuation of the cylinders 34 and 36.

The cylinder 34 has a front end chamber 50 which is connected by a fluid conduit 52 via a one-way check valve 54 to a selector valve 56. The rear chamber 58 of the cylinder 34 is connected by means of fluid conduit 60 via a one-way check valve 62 likewise to the selector valve 56. The selector valve 56 is connected by a first pair of fluid conduits 64 and 66 respectively to a separate valve section 68 of the main control valve 22. The pair of one-way check valves 54 and 62 and fluid conduits 52 and 60, respectively, are connected by pilot lines 58 and 61, respectively, to the respective opposite conduit for a purpose to be explained hereafter.

The opposite fluid cylinder 36 is likewise provided with a front end chamber 70 which is in communication by means of a fluid conduit 72 via one-way check valve 74 with another end of the selector valve 56.

The rear chamber 76 of the fluid cylinder 36 is similarly connected by a fluid conduit 78 via a similar check valve 80 to the selector valve 56. The pair of check valves 74 and 80 are similarly interconnected by pilot lines 75 and 81 respectively to be pilot operated for a purpose to be described hereafter.

The section of the selector valve 56 connected by conduits 72 and 78 to the fluid cylinder 36 is connected by a pair of conduits 82 and 84 respectively to another separate section 86 of the main control valve 22 for operation independent of the valve section 68.

The main control valve 22 is a directional flow compensating valve such, that the flow rate of any spool in the separate sections provide a rigidly fixed quantity completely independent of flow changes. The valve is generally of conventional construction and may be of the type of directional control valve such as manufactured by the Warner-Motive Division of Borg-Warner Corporation, Auburn, Ind. or Hydraulic Industries, Hartland, Wisconsin, to provide equalized flow to the two cylinders 34 and 36 during pitching operation. Controlled fluid flow from the two valve sections, operating from one pump, will be synchronized when the total flow requirement is less than pump output.

Each of the valve sections 68 and 86 is provided with a reciprocable actuator stem 88 and 90, respectively, which are synchronized for operation by connection to a common pivot lever 92 which in turn is connected to the control lever 94 of the machine positioned at the operator's control console 96, as shown in FIG. 4.

With continued additional reference to FIG. 4, when the control lever 94 is rocked within a plane defined by

the arrow "T" and in a direction towards the letter "R", the tilt adjustment of the blade 10 is initiated to cause edgewise rotation of the blade around the swivel joint 12 in a manner as schematically illustrated in FIG. 3. By rocking the control lever 94 towards the direction "R", fluid pressure is introduced through valve section 86 into fluid line 84, through the selector valve 56, into fluid conduit 78, and through one-way check valve 80 into the rear chamber 76 of the cylinder 36, as indicated by the arrows in FIG. 1. Fluid pressure build-up in the rear chamber 76 of the cylinder 36 causes relative cylinder-piston movement and, since the cylinder is secured to the blade 10 at point 40 and the piston rod to the machine 14 at point 48, the blade 10 is caused to rotate edgewise around the swivel joint 12 in a manner illustrated in FIG. 3.

Relative cylinder-piston movement of cylinder 36 reduces the volume of the respective front end chamber 70, causing fluid to be displaced therefrom through conduit 72, check valve 74 and into the selector valve 56, as indicated by the direction of the arrows. Fluid, displaced from the chamber 70, passes longitudinally through the valve 56 into the opposite conduit 52 and through check valve 54 into the front end chamber 50 of the opposite cylinder assembly 74 at the opposite end of the blade 10. Thus, relative pressure build-up in the front end chamber 50 of cylinder 34 due to the reduced fluid volume in the front end chamber 70 of the opposite cylinder 36 at a directly proportional magnitude thereto, causes similar piston-cylinder movement of cylinder 34 in an opposite direction to that of cylinder 36 in correspondence with the direction of rotation of the blade 10 around the swivel joint 12. Relative piston-cylinder movement of the cylinder assembly 34 due to an increase in fluid pressure in the front end chamber 50 causes the fluid volume to be reduced in the rear end chamber 58 forcing fluid out through the conduit 60 and through the check valve 62 into the selector valve 56, as likewise indicated by the direction of the arrows. The return flow of fluid from the lower chamber 58 of the cylinder assembly 34 passes through the selector valve 56 in linear direction and through the conduit 82 back into the main control valve section 86 for return flow through the conduit 25 back into the reservoir 26.

If the control lever 94 is rocked in the opposite direction along the arrow "T" towards the letter "L", the main valve section 86 will be actuated to supply fluid pressure to line 82 and exhaust line 84. This reverses the direction of actuation of cylinder assemblies 34 and 36 to cause rotational pivoting of the blade 10 around the swivel joint 12 in the opposite direction.

Thus, it will be understood that, when one cylinder assembly is extended the other cylinder assembly is contracted a similar amount, due to direct fluid pressure connection between opposite chambers of the two cylinders, which cause proportional fluid pressure being applied to opposite sides of the respective pistons of the cylinders.

Each pair of pilot operated check valves 62, 54 and 74, 80, upon actuation of either cylinder 34 or 36, is operational to lock both cylinders in their respective adjusted position after further supply of fluid pressure from the main control valve 22 is interrupted. The pilot operated check valves also function in inoperative posi-

tion of the cylinders 34 and 36, to prevent return flow from the cylinders to the reservoir unless a positive pressure is applied at the other end of the cylinders.

The pilot operated check valves 62, 54 and 74, 80 are commercially available items and may be of the type as those manufactured by the Parker Hydraulics Division, Parker-Hannifin Corporation, Cleveland, Ohio, under their model no. VCPD10.

In the above described tilt operation of the present improved hydraulic system, the selector valve 56 remains in an inactive position, such as to provide unobstructive fluid flow through the valve in the manner indicated by the direction of the arrow along the respective fluid lines in FIG. 1.

With further reference now to FIG. 1a and 2 in the drawings, these FIGS. schematically illustrate the position of the improved hydraulic system for varying the pitch angle of the blade 10 around the universal swivel joint 12 in a direction of rotation, as indicated in FIG. 2, around an axis of the universal swivel joint which intersects the tilt axis of the swivel joint at a 90° angle.

With additional reference to FIG. 4, the selector valve 56 is provided with actuator 100 which may be a solenoid suitably connected by conduit 102 to ground and by conduit 104 to a source of current 106, which may be the battery of the machine in which the present improved system is embodied. Conduit 104 includes switch 108 normally retained in open position and having switch arm 110 suitably connected for actuation to push button 112 conveniently disposed within or on control lever 94 (FIG. 4) for selective manual actuation of switch 108.

In order to change the pitch angle of the blade as schematically shown in FIG. 2, the operator depresses switch button 112 on control lever 94 which energizes the solenoid circuit to close switch 108 and actuate solenoid 100 to shift selector valve 56 to the alternate position shown in FIG. 1a. Movement of control lever 94 in the "T" plane, that is, the same plane which controls tilt when button 112 has not been actuated, will selectively raise or lower the edge of blade 10 relative to the ground, as indicated in FIG. 2. Thus, movement of control lever 94 in the direction towards the letter "R" will supply fluid pressure from main control valve 22 simultaneously to both valve sections 68 and 86 at a synchronized fluid flow, as previously explained in the description of the main control valve. Thus, fluid flow at an even pressure is transmitted through opposite fluid conduits 64 and 84 into selector valve 56, which is in the new position shown in FIG. 1a. From the selector valve 56, fluid pressure is delivered through conduits 60 and 78 and through the respective pilot operated check valves 62 and 80, into rear chambers 58 and 76 of cylinders 34 and 36. The equalized fluid pressure in rear chambers 58 and 76 causes simultaneous relative cylinder-piston movement at both cylinders in a direction to draw the upper edge of blade 10 rearwardly around swivel joint 12 to angularly reposition the lower cutting edge of the blade, as shown in FIG. 2. Simultaneous relative cylinder-piston movement causes a decrease in fluid volume in front end chambers 50 and 70 of respective cylinders 34 and 36, forcing fluid out through conduits 52 and 72 and through check valves 54 and 74, respectively, and selector valve 56 and from there back into main control valve 22

through conduits 66 and 82, respectively, for return to fluid reservoir 26.

The two pairs of pilot operated check valves 54, 62 and 74, 80, in this mode of operation, similarly function to lock the cylinders in place when main control valve 22 stops supplying fluid pressure to the cylinders, thereby positively retaining the blade 10 in the adjusted pitch position.

To pitch blade 10 in the forward direction, control lever 94 is moved along the arrow line "T" in the opposite direction, towards the letter "L" with switch button 112 depressed, reversing the fluid flow through the conduits to apply positive fluid pressure to front ends 50 and 70 of respective cylinders 34 and 36.

In order to obtain controlled pitch angle positioning of the blade 10, it is necessary that fluid pressure is supplied to both cylinders simultaneously and at the same magnitude to prevent twisting of the blade around swivel joint 12, which is herein provided for by synchronized actuation of both valve sections 68 and 86 of main control valve 22.

The present invention thus provides both pitching and tilting of the blade by the same pair of cylinders, this being controlled by movement of control lever 94 in only a single plane, the "T" plane. The "P" plane is reserved for lifting and lowering of the blade by cylinders 16 and 18. Both pitching and tilting of the blade can be accomplished so that pitching can be done after tilt movement of the blade, or vice-versa, providing that neither of cylinders 34 or 36 has bottomed out in the previous pitch or tilt operation. Thus, pitch adjustments after tilting or tilt adjustments after pitching, when the cylinders are between stops, will not affect the previous tilt or pitch angle setting of the blade. If one of the cylinder has previously reached a stop, subsequent adjustment in the other mode of movement will change the setting of the first mode, or, if main control valve 22 is reversed, will eliminate non-neutral positioning in the first mode.

Although the selector valve actuator means has been described herein as a solenoid and electrical circuit operable by a manual switch means, it will be appreciated that any other known conventional, mechanical or fluid operated valve actuating mechanism may be employed to the same advantage, although the present solenoid actuated embodiment is preferred for convenience and quick acting response.

It will be obvious from the foregoing description in conjunction with appended drawings, that the present invention provides an improved hydraulic control system for a load handling implement and particularly for repositioning the blade of a dozer in directions around two intersecting axes.

The present improved system employs only a pair of identical cylinders for combined pitch and tilt angle positioning of the blade, utilizing the same hydraulic circuit in both operations by incorporation of a selectively repositionable selector valve disposed between the main control valve and the pair of cylinders. This improved arrangement greatly facilitates installation requirements and maintenance of the fluid power equipment of the dozer and at the same time greatly facilitates the handling of the equipment by the operator of the machine by the provision of only a single control lever utilized for both pitching and tilting of the blade.

The selected angular position of the blade is positively locked in place by provision of pilot operated check valves in the hydraulic circuit between the selector valve and the pair of cylinders, to prevent return flow of fluid from one end of the cylinders if no positive pressure is present at the other end of the cylinders. The function of the check valves at the same time reduce blade drift and prevent the cylinders from pulling away from the pump when negative loads are encountered.

Although the present invention has been described for illustrating purpose by means of a schematically illustrated embodiment, it will be obvious that various changes in structure, arrangement and details may be made without departing from the spirit and essential characteristic of the invention as defined by the scope of the appended claims.

I claim:

1. In a fluid control system for an earth moving blade pivotally supported on a vehicle for selectively varying the pitch and tilt position of said blade relative to a ground surface, said blade being pivoted around intersecting axes and said vehicle having a control console, the improvement comprising:
 - first and second fluid cylinders, each having a piston and piston rod and each having one end connected to opposite upper ends of said blade and the other end to said vehicle;
 - a main control valve means connected to a source of fluid under pressure and having first and second sections separate from each other;
 - a selector valve movable by selector valve control means between a pitch control and a tilt control position;
 - first and second conduits interconnecting the rear and front ends, respectively, of said first cylinder with said selector valve, and third and fourth conduits interconnecting the rear and front ends, respectively, of said second cylinder with said selector valve;
 - first and second pairs of conduits interconnecting said first and second sections, respectively, of said main control valve means with said selector valve, each of said pairs including a supply and an exhaust conduit, and said main control valve having reversing means for simultaneously reversing the supply-exhaust functions of said conduits within each conduit pair;
 - said selector valve, in its tilt position, providing communication between said second and fourth conduits, between said first conduit and the exhaust conduit of said second pair of conduits, and between the supply conduit of said second pair of conduits and said third conduit, all when said main control valve is in a first position, to tilt the blade in a first direction, and the reversing of the supply-exhaust functions of said second pair of conduits by said main control valve reversing means causing the blade to tilt in the opposite direction;
 - said selector valve, in its pitch position, providing communication between said first and third conduits and the respective supply conduits of said first and second pair of conduits, and further providing communication between said second and fourth conduits and the respective exhaust conduits of said first and second pair of conduits,

all when said main control valve is in a first position, to pitch the blade in a first direction, and the reversing of the supply-exhaust functions of said first and second pairs of conduits by said main control valve reversing means causing the blade to pitch in the opposite direction.

2. The control system of claim 1 wherein said main control valve reversing means comprises a control lever connected to said first and second sections of said main control valve, said control lever being pivotally mounted on the control console for pivotal movement in two intersecting planes, movement of said control lever in a first of said planes controlling direction of blade tilt adjustment when said selector valve is in its tilt position, and movement of said control lever in said first plane controlling direction of blade pitch adjust-

ment when said selector valve is in its pitch position.

3. The control system of claim 2 wherein said selector valve control means comprises an independently controllable actuating switch on said control lever operatively connected to said selector valve to selectively shift it between its pitch and tilt positions.

4. The control system of claim 1 wherein pilot-operated check valves are provided in each of said first, second, third and fourth conduits, each of said check valves functioning to prevent return flow from the associated end of the respective fluid cylinder towards said selector valve unless a positive fluid pressure is applied from the selector valve to the opposite end of said respective fluid cylinder associated with such check valve.

* * * * *

20

25

30

35

40

45

50

55

60

65