Fig. 1

Fig. 2

Fig. 3

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This invention relates to road building machines and more particularly to an improved leveling control system which provides a three-point suspension of the tool-carrying main frame of a road building machine with respect to its ground traction units.

Road building machines are utilized to a great extent for such operations as scraping road beds and laying sub-base, base, black top and concrete for surfacing the scraped roadway. Essentially, road building machines comprise (1) a main frame for carrying appropriate road building tools such as strike-off blades, conveyors, screw and scrapers, (2) traction units for propelling the main frame forward or backward, and (3) frame supports for connecting the four corners of the main frame to the traction units. Since the traction units are in direct contact with the ground where grade, cross grade and general surface conditions are usually different from the road surface level to be constructed, and since the road building tools are firmly fixed to the main frame, vertically adjustable supports are utilized to maintain the position of the main frame and thereby the road building tool at an accurate and predetermined level reflecting a desired grade and cross grade irrespective of the grade, cross grade and irregularities of the ground engaged by the traction unit. Of course, if the irregularities of the ground are very great, the demands made upon the adjustable supports may be somewhat reduced by utilizing angle blades mounted to the front of the main frame and maintained at the level of the working tool to cut a path over which the ground traction units may move.

The vertically adjustable main frame supports of the prior art include vertically positioned hydraulically operated rams connecting each corner of the main frame to a traction unit. Herefore, each hydraulic ram was controlled independently of the other hydraulic rams either manually by an operator or automatically by a level guide such as grade wires or grade surfaces or a combination thereof disposed along the sides of the road bed to be constructed. In this manner, each of the four corners of the main frame was kept at a fixed height with respect to the level guide which controlled the degree of extension of the hydraulic rams associated with that corner.

Prior art road building machines, because of their four corner control, have certain inherent limitations with respect to their stability, versatility and efficiency. For example, it is always necessary to provide for two guide levels, one along each side of the road, to control the grade and cross grade of the tool-carrying main frame. Furthermore, four independently servo actuated corner supports attached to the four corners of a rigid frame provide what may be termed a four point suspension system. Since only three of the four corner supports can operate at any one time to determine the plane of the main frame, one support is generally not supporting its corner. Of course, that corner of the main frame will be at the proper height due to the action of the other three supports, but its support will not carry its portion of the weight of the frame when the ground is uneven and drops away since there can be no servo action as long as the main frame is in its required plane. Consequently the full load of one side of the frame is then carried by the single active support causing a doubling of the working pressure. This extra weight thrust upon the active support causes a variation of compaction under the traction unit to which it is connected and extra movement of the main frame which must be corrected to bring the main frame back to its proper plane. Since the support of the main frame shifts continually to a different set of three rams, there is extra duty put upon the control system which detracts from the accuracy at which the main frame can be maintained in the desired plane.

It is therefore one of the objects of this invention to provide a road building machine in which the grade and height of one side of the main frame is controlled by a level guide such as a grade wire or grade surface and in which the cross grade of the main frame (and thereby the tool) is controlled either by a pendulum operated servo valve or by second level guide.

It is another object of this invention to provide a road building machine having its tool-carrying main frame supported in a more equal manner than heretofore possible by utilizing a three-point instead of a conventional four-point suspension system.

It is still another object of this invention to provide a road building machine which includes a more practical and more reliable automatic leveling mechanism which maintains the main frame, during its advance, at a predetermined and accurately held level regardless of any variations in the level of the supporting traction unit and which provides for an equal weight distribution of the main frame upon four vertically adjustable supports.

In accordance with a preferred embodiment of the road building machine of this invention, the vertically adjustable frame supports associated with the front and back of one side of the main frame are conventionally controlled, that is, each hydraulic ram has its own control valve whose valve actuating member may be controlled either directly or indirectly through micro switches of solenoids by a control lever which engages the guide such as a grade wire or a preformed slab placed along the road. The vertically adjustable frame supports associated with the front and back of the other side of the frame, however, have their hydraulic rams tied to a single control whose valve actuating member may either be in engagement with a second level guide placed on the other side of the road or with a gravity operated pendulum for setting the average height of this side of the main frame to a desired cross grade. As a result of tying the two hydraulic rams together, vertical height control along one side of the main frame is no longer imposed separately on the front and back supports of that side, but rather on the mid-point of that side allowing the front and back supports to pivot about the mid-point in accordance with the desired grade and resulting in a sharing of the load.

In other words, two valves individually control the front and rear height of one side of the main frame and a further valve controls the height of the mid-point between the front and rear of the other side of the main frame. The respective heights of the front and rear of the single valve controlled side depending on the grade of the double valve controlled side of the frame. In this manner, a stable or three-point suspension is realized, the three points being the front and rear on one side of the main frame and the mid-point between the front and rear on the other side of the main frame. Since the height of one side is determined solely by the vertical height of its mid-point, the cross slope is now easily controlled by either a single conventional pendulum operated servo valve or by a second level guide. Although control of
the mid-point is preferred, it is apparent that since, geometrically, three points determine a plane, any point on the other side of the main frame may be used as a control point to establish the desired planar disposition of the main frame.

Other objects and a fuller understanding of the invention may be had by reference to the following description of the construction, taken in conjunction with the accompanying drawings in which:

FIGURE 1 shows a top view of the road building machine of this invention, certain conventional parts of the superstructure having been omitted for the sake of clarity.

FIGURE 2 shows a side elevational view of the road building machine of FIGURE 1.

FIGURE 3 shows a side elevational view of a further embodiment of the road building machine of this invention.

FIGURE 4 shows a schematic hydraulic flow diagram of the three-point suspension control system employed in the machine of this invention; and

FIGURE 5 shows an illustrative diagram of the effective height of the side of the main frame controlled by a single control valve.

Referring now to the drawings, in which like characters designate like parts, there is shown a main frame generally indicated as 10, having two vertically extending side frame members 12 and 14, two vertically extending cross frame members 16 and 18 for connecting side frame members 12 and 14 to one another, and two horizontally extending webs or ribs 20 and 22 for strengthening the connection between cross frame member 16 and side frame members 12 and 14 and for providing additional rigidity to main frame 10.

Suspended between and mounted to side frame members 12 and 14 are road building tools such as striker blade 24 and the conveyor screw 26. During operation of the road building machine of this invention these tools are in contact with the ground and build the road. Of course, a large number of different road building tools may be substituted for or added to blade 24 and screw 26, depending on the particular work to be done. In some instances, many different tools are mounted in vertically adjustable mounts to be selectively lowered for ground engagement. In the case of laying base, asphalt or concrete, appropriate hoppers are suspended on the main frame, carrying the desired material to be deposited upon the road bed.

Four ground traction units 30, 31, 32 and 33 are associated, respectively with the front and rear of each side of main frame 10, serve to support and to propel main frame 10 over the ground. The ground traction units may comprise spoke wheels 30' and 31' engaging an endless track 35 (FIG. 2) or individual wheels 36 and 37 (FIG. 3) having coarsely treaded tires mounted thereon. Each ground traction unit is rotatably mounted upon a short axle respectively designated as 30', 31', 32' and 33'. A track frame 27 supports axles 30' and 31' in spaced horizontal relationship to one another.

Shaft 39 is supported by a rocker bracket 40 which pivots about a shaft 41 carried by a support bracket 42 mounted on a bolster 43 bolted or otherwise affixed to frame 10. The other end of rocker bracket 40 is rotatably connected to plunger 44 of a horizontally extending hydraulic ram 54 connected by a bracket 46 to bolster 52. The cross-symmetrically arranged hydraulic rams are disposed in the same manner as the ones described hereinabove.

The operation of the linkage mechanism including the hydraulic rams will now be explained. As hydraulic ram 45 gets a command and expels plunger 44, rocker bracket 40 starts turning clockwise about axle 39' (which cannot move vertically) and raises end 45 of the same about base 41 by frame 10. Likewise, as plunger 53 comes out of ram 54, rocker arm 49 turns about shaft 48 and lifts bolster 52. Retraction of the plungers will cause a lowering of this side of main frame 10.

The drive unit, for propelling main frame 10 in either a forward or reverse direction, may be provided by mounting a pair of engines 60 and 60' on brackets above the track frames such as track frame 27 shown in FIG. 2 and connecting engine 60 by means of a chain drive 61 to an appropriate chain gear 62 mounted on hubs fastened to shafts 39' and 33'. Alternatively, the self-propelled traction units 30, 31, 32, 33 can be replaced by simple wheels or other ground engagement means with no power applied directly thereto. Since neither this traction unit nor the frame construction per se constitute any part of this invention and are well known to those skilled in the art of road building machines, no further particulars thereof are deemed necessary.

The road building machine shown in FIG. 3 differs from the one of FIG. 2 in that the horizontally extending hydraulic rams 65 and 66 are located between the front and rear ground traction units. Rams 65 and 66 are attached to bolsters 67 and 68, respectively, which are bolted to traction frame 69 which supports the short axles 70 and 71 in spaced horizontal relationship. Axles 70 and 71 respectively support wheels 36 and 37 and serve as pivots for a pair of rocker brackets 72 and 73. Rocker bracket 72 has one end connected to a bracket 74 mounted to a bolster 75 fixed to main frame 76 and has the other end connected to a plunger 77 of hydraulic ram 65. Rocker bracket 73 has one end connected, via a pair of links 78, to a bracket 79 mounted upon bolster 80 fixed to main frame 76 and the other end is connected to plunger 81 of hydraulic ram 66. The other side of the machine of FIG. 3 is supported in the same manner as the one of FIG. 2 is supported.

The operation of the frame support means of FIG. 3 will now be explained. As hydraulic ram 65 receives a command to expand, rocker bracket 72 rotates about shaft 70 and lowers support bracket 74 and thereby frame 76. The same command applied to hydraulic ram 66 will likewise cause clockwise rotation of rocker bracket 73 about shaft 71 and lower bolster 80. Upon a command to retract, plungers 77 and 81 will cause a raising of frame 76. When hydraulic ram 65 is actuated, frame 76 has a horizontal component of motion with respect to traction frame 69 because rocker bracket 72 moves bolster 75 along an arcuate path about shaft 70. To allow for such horizontal motion, an articulate connection comprising link 78 is provided for support of the other end of spacer bar 69 through rocker bracket 73.

FIG. 4 shows four hydraulic rams in spaced relation to correspond with the top plan view of FIG. 1, which are respectively designated by reference characters 90, 91, 92 and 93. The hydraulic fluid system for operating the four hydraulic rams include an oil tank 100 for holding hydraulic fluid, a pump 101 connected thereto to develop hydraulic pressure, and a conventional regulator valve 102 connected across tank 100 and pump 101. Tank 100, pump 101 and bypass valve 102 develop a constant hydraulic fluid pressure system which supplies hydraulic fluid under constant pressure to a hydraulic line 103. If the pressure developed by pump 101 exceeds a predetermined pressure, regulator valve 102 opens a bypass port permitting fluid to circulate back to tank 100 through bypass line 104 and 105.

Hydraulic pressure line 103 is connected to the input port of hydraulic control valves 110, 111, 112 and pen-
dulum valve 113. Valves 110, 111, 112 and 113 may be of the three-way closed-center type in which a central plunger communicates the center port either with the high pressure input port or with the low pressure output port. The center port therefore permits flow in either direction, high pressure from the high pressure input port to the center port when the plunger is in one of its two positions, and low pressure flows from the center port to the low pressure output port for the plunger in the other of its two positions. Since the particular valve does not form any part of this invention and is of a conventional design, no further description thereof is deemed necessary.

As stated, high pressure line 103 is connected to the high pressure input ports of control valves 110, 111 and 112 and also to the high pressure input port of a pendulum valve 113. The center ports of control valves 110 and 111 are connected respectively to hydraulic rams 90 and 91. Since the hydraulic rams are extended by the insertion of hydraulic fluid under high pressure and are retracted by the removal of hydraulic fluid under low pressure, a low pressure return line 105 is connected between the low pressure output ports of control valves 110 and 111 and hydraulic fluid tank 106.

The output ports of control valve 112 and of pendulum valve 113 are connected to the two input ports of a conventional three-way selector valve 114 which has a single output port and which may be manually operated. The output port of selector valve 114 is connected to both hydraulic rams 92 and 93. In this manner, selector valve 114 controls whether the center port of control valve 112 or of pendulum valve 113 communicates with hydraulic rams 92 and 93. Return line 105 is also connected to the low pressure output port of valves 112 and 113.

Valves 110, 111, and 112 are actuated by control levers 120, 121 and 122, respectively, which are connected either directly or indirectly to the center plungers of the valves in a manner well known to those skilled in the art. By way of example, control levers 120, 121 and 122 may be in engagement with grade wires 125 and 126 (or grade surfaces such as prefabricated slabs) accurately set to a predetermined relation to the grade on each side of the road and supported at intervals from the ground by stakes or braces (see FIG. 1). As the machine advances and the grade wire or grade surface along the side of the road rises with respect to the main frame and therefore with respect to the road building tool, the levers are raised, controlling the motion of the center port of control valve 112 to move the center plunger to the other side of the center port of control valve 112 and thereby raising the frame 10 and with it the blade 24 or screw 26.

The height of the side associated with hydraulic rams 92 and 93 is controlled by single control valve 112, by means of lever 122. If control lever 122 is in engagement with a lever control means such as grade wire 126, it will cause the average height of side of the main frame to correspond to the height of grade wire 126. FIG. 5 is an illustration of the result obtained by tying hydraulic rams 92 and 93 to single control valve 112. The points of suspension of a main frame 129 are designated as 130 and 131 and correspond respectively to shafts 41 and 50 of FIG. 2. Consequently, the frame 132 is effectively suspended at its midpoint on the side of points 130 and 131. Since these points 130 and 131 are maintained longitudinally at the same level because of the operation of the hydraulic rams on the midpoint when the control levers are operating, the suspension points 130 and 131 at this same level indicated at 132. If now the traction means move upwardly or downwardly as indicated at 133 and 134 in FIG. 5, a pressure differential will exist between the supporting hydraulic rams 92 and 93 which will automatically be balanced by flow of hydraulic fluid from one ram to the other and no change in the elevation of the midpoint 132 will be experienced. However, if a sensing unit such as wire 126 or the pendulum valve senses that the point 132 moves either above or below the desired level, the ram may be actuated to return the midpoint 132 to the desired level. Together with the height and grade control of the front and rear of the other side of frame 129, the plane of the main frame and thereby the tool is positively controlled.

An important advantage realized with the control system of this invention, in addition to increased stability, is that the cross grade may be set by either a single point pendulum or template surface operated valve. Pendulum valves are valves actuated by a pendulum which always assumes a vertical position because of gravity forces acting thereon. The valve is set in such a way that the pendulum closes the valve for a predetermined angular position of the valve body (the cross grade) and opens the valve when the valve body angle differs from that predetermined angular position by either causing the injection of hydraulic fluid at high pressure to the center port, or by permitting return of hydraulic pressure to the low pressure output port. Such a pendulum valve is fully described in U.S. Patent No. 2,934,078 entitled "Pendulum Controlled Valve."

By way of summary, the road building machine of this invention may have the height of its tool carrying main frame adjusted in a number of ways which will now be stated. The side of the main frame whose front and back are individually controlled by valves may have their valves actuated either by a lever connected to the valve actuating mechanism in engagement with the horizontally strung grade wire along the side of the road or by a gauge wheel connected to the valve actuating mechanisms and running on a preformed slab laid along the side of the road. In case of multiple lane roads, a grade wire is strung first to provide for the proper level of the first lane. Thereafter, the first lane provides the grade level means and the valve actuating mechanism is actuated by a gauge wheel engaging the first lane surface.

The other side of the tool carrying main frame, with its single valve which determines the height of the midpoint of that side, provides cross grade control. Cross grade control may be obtained in three ways: one way comprising the valve actuating lever to be in engagement with the wire strung along the other side of the road, a second way comprising the utilization of a gauge wheel connected to the valve actuating mechanism in engagement with the preformed slab along that side of the road, and the third way comprising the use of a gravity operated pendulum valve as explained hereinabove.

Any method of controlling the height of one side may be combined with any method for control of the other side of the main frame with equally good results. For example, one side may be controlled by means of gauge wheels engaging a preformed slab while the other side may be controlled by a lever engaging a grade wire, or the height of the main frame may be controlled with grade wires running along both sides of the road, these grade wires being in engagement with levers for controlling the valves.

Of course, the position of the lever engaging the wire or the gauge wheel engaging the preformed slab determines the height adjustment provided by the particular hydraulic ram with which the valve actuating mechanism is associated. For example, in FIG. 4, lever 122 actuating valve 112 is positioned a considerable distance away from the midpoint between the main frame...
its location. Placing the actuating lever, such as lever 122 of FIG. 4, ahead of the road building machine may be used in certain instances to overcome a lack of res- olation. But ordinarily the lack of response is so short that such a lead time will not be necessary. Actuating lever 122, as shown in FIG. 1, is placed in the middle of the road building machine, a position better suited than the position indicated in FIG. 4.

There has been described a novel road building ma-

achine in which the tool carrier main frame is provided with a three point suspension for greater stability and versatility of operation and in which the weight of the main frame is equally distributed on four frame supports. Two suspension points are the front and back of one side of the main frame and the third suspension point is the midpoint between the physical suspension points of the other side of the main frame. Such a support system makes it possible to control the plane of the main frame with a single level means and a single pendulum valve.

What is claimed is:

1. A road building machine comprising: a rectangular main frame; at least one working tool for road engage-

ment supported by said frame; front and rear ground traction means on opposite sides of said main frame; frame support means connecting each of said ground traction means to said main frame; said frame support means including hydraulically-operated rams for provid-

ing vertical adjustment of said main frame with respect to each of said ground traction means; three normally closed hydraulic ram actuating means, two of said actuating means independently operating the rams associated with the front and rear traction units on one side of said main frame and the remaining actuating means collect-

ively operating the rams associated with the front and rear traction units of the other side of said main frame; the hydraulic rams on the other side of said frame being inter-connected by a common conduit; level control means on said machine operating each of said actuating means, the level control means for said two actuating means on said one side of the main frame being spaced longitudi-

nally to engage common grade means, and the level con-

trol for the remaining actuating means being adapted to engage separate grade means, said grade means and separate grade means being disposed along the road on opposite sides of said machine.

2. A road building machine comprising: a rectangular main frame; at least one working tool for road engage-

ment supported by said frame; four ground traction means for propelling said road building machine; four frame support means connecting said ground traction means to front and rear of opposite sides of said main frame; said frame support means including hydraulic rams for pro-

viding vertical adjustment of the four corners of said main frame with respect to said ground traction means; separate valves connected to each of the hydraulic rams associated with the front and rear of one side of said main frame; a common conduit interconnecting the hy-

draulic rams associated with the front and rear of the oth-

er side of said main frame; a valve connected to said common conduit to control fluid pressure therethrough to said rams; longitudinally-spaced level control means on said machine adapted to engage grade means along one side of said road building machine, said level control means engaging and operating said separate valves; and a gravity operated means engaging and operating said common valve.

3. A road building machine comprising: a main frame; at least one working tool for road engagement supported by said frame; front and rear ground traction means on the opposite sides of said frame; frame support means connecting said main frame to each of said ground traction means said frame support means including hydraulically operated rams for vertically adjusting said main frame with respect to each of said ground traction means; three

values, two of said valves being connected to independ-

ently operate the hydraulic rams associated with the two ground traction means on one side of said main frame, the third valve being connected to the other side of said frame being directly connected through a common conduit, and the remaining valve being connected through said common conduit to collectively operate the hydraulic rams asso-

ciated with the other side of said main frame; a hy-

draulic fluid system connected to said three valves; and longitudinally-spaced level control means on one side of said main frame for actuating said two valves to operate said rams and thereby change the height of one side of said main frame upon deviation of the road surface traversed from a predetermined grade, and level control means on the other side of the main frame for actuating said remaining valve thereby to change the height of the side of said main frame upon deviation of the road surface traversed from a predetermined cross-grade.

4. A road building machine comprising: a rectangular main frame; at least one working tool for road engage-

ment supported by said frame; four ground traction means; four frame support means connecting said ground traction means to the front and rear of both sides of said main frame, said frame support means including hydraulically-operated rams for providing vertical adjustment of the four corners of said main frame with respect to said ground traction means; three normally closed valves, two of said valves being connected to independently operate the hydraulic rams associated with the front and back frame support means along one side of said main frame, the hydraulic rams on the other side of said frame being connected through a common conduit, and the remaining valve being connected through said common conduit to collectively operate the hydraulic rams associated with the support means along the other side of said main frame; a hydraulic fluid pressure system connected to said three valves; and grade and cross grade level control means operated associated with said two valves and said remaining valve, respectively to operate said rams upon deviation of the road surface traversed from a pre-

determined grade and cross grade of said main frame.

5. Support and level control mechanism for a road building machine which includes a tool holding rectangular main frame and ground traction units in front and rear of each side of said main frame; said main frame including a level control mechanism comprising: vertically adjust-

able frame supports including hydraulic rams connecting said main frame to said ground traction units; first, sec-

ond and third normally closed control valves; a hydraulic fluid pressure and return system connected to said control valves, said first and second control valves being re-

spectively connected to the hydraulic rams associated with the front and the rear of one side of said main frame, the hydraulic rams on the other side of said frame being interconnected by a common conduit, said third control valve being connected through said common con-

duit to both hydraulic rams associated with the other side of said main frame; a three-way selector valve interposed between said third control valve and the rams associated therewith; a pendulum-controlled valve mounted to said main frame and connected between said pressure and return system and said selector valve selectively com-

municating said third and said pendulum valve with its associated hydraulic rams, said pendulum-controlled valve being gravity operated to raise and lower said other side of said main frame upon deviation of the road traversed by said road building machine from a prede-

terminated cross grade; and a pair of spaced level control means on one side of said main frame for engaging a com-

mon grade indicator disposed along the road traversed by the machine for actuating said first and second valves for level adjustment of said main frame in accordance with the level of said grade indicator.
6. A road building machine in accordance with claim 5 in which the frame supports include a rocker bracket pivotally mounted to said main frame and in which the hydraulic ram is horizontally disposed and connected at opposite ends to said main frame and to one end of said rocker bracket, the other end of said rocker bracket being coupled to the ground traction means.

7. A road building machine comprising a frame, a working tool carried thereby, a pair of ground engagement means disposed adjacent opposite sides of said frame, first and second frame support means connecting opposite sides of said frame to respective ground engagement means for adjustably supporting said frame thereon in a desired plane, said first frame support means including two vertically adjustable supports connected to said frame at spaced positions so as to define two points of support, actuating means for said first frame support means and adapted for operative engagement with an exterior grade control reference disposed along the path to be traversed by said road building machine, said second frame support means including two hydraulic rams connected to said frame at longitudinally-spaced positions and hydraulically interconnected by a common conduit, a valve connected through said conduit to both of said rams for controlling the supply of hydraulic fluid thereto wherefoe identical hydraulic pressure exists in said rams; and means operative in response to a variation in elevation of the side of said frame supported by said second frame support means for simultaneously actuating said hydraulic rams.

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