

May 3, 1966

J. CURLETT ET AL
CONSTRUCTION MACHINES

3,249,026

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3 Sheets-Sheet 1

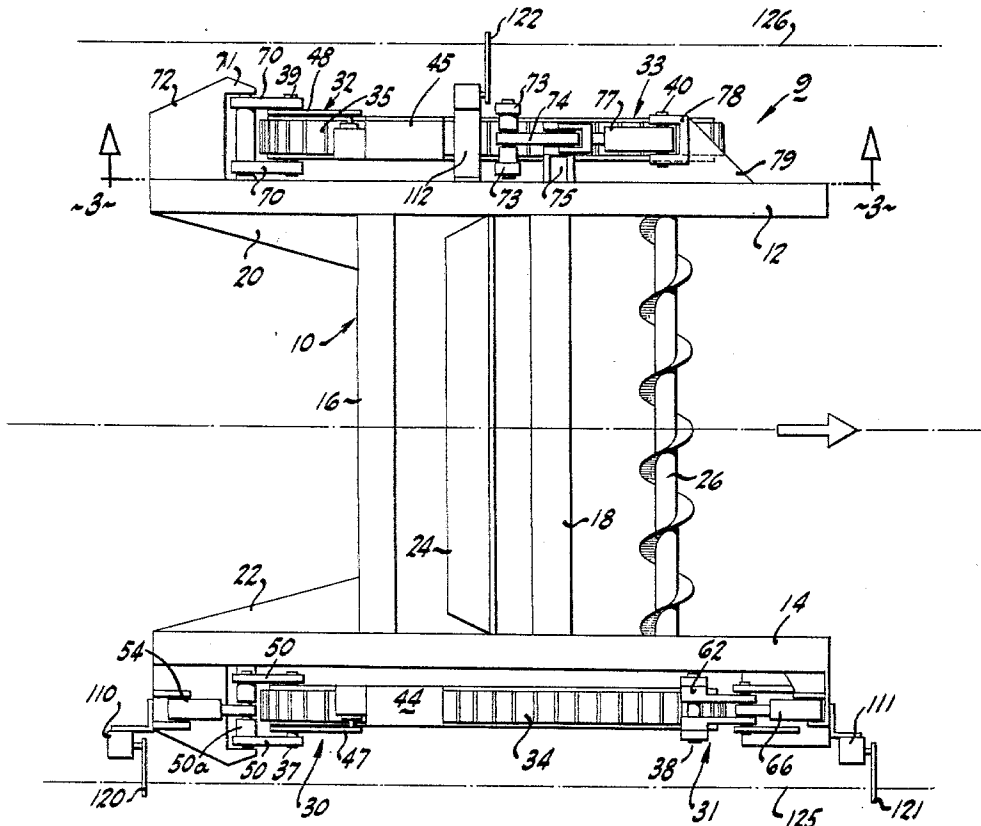


FIG-1

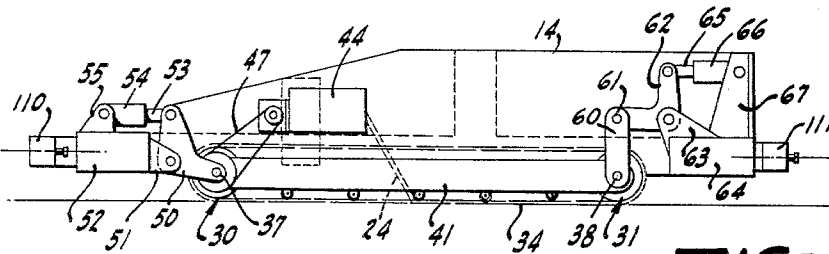


FIG-2

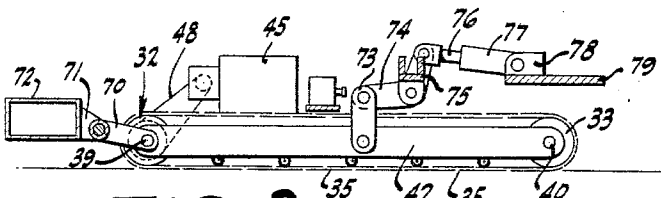


FIG-3

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FIG-4

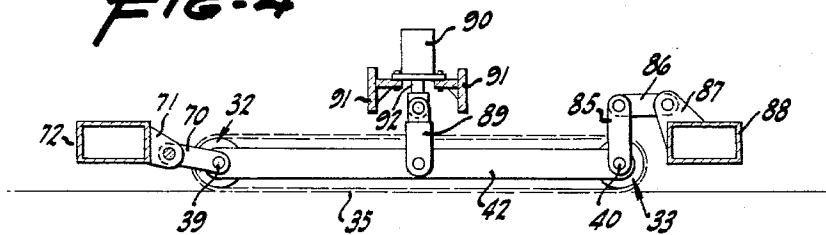


FIG-5

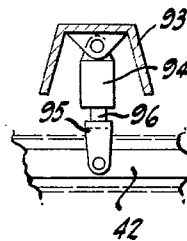
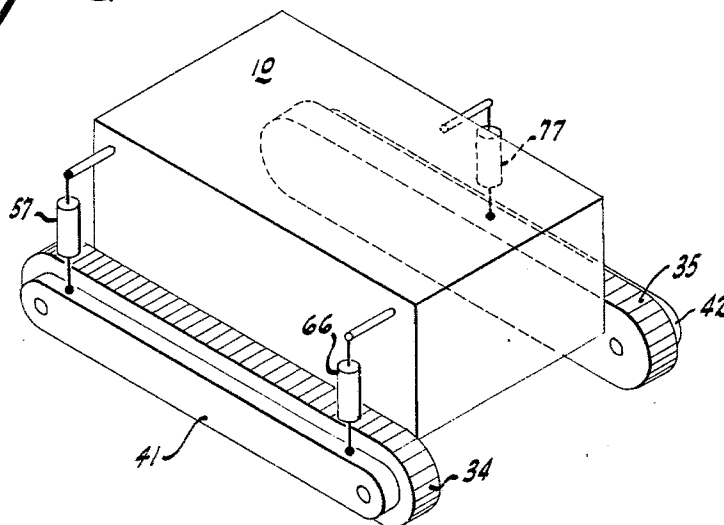


FIG-7



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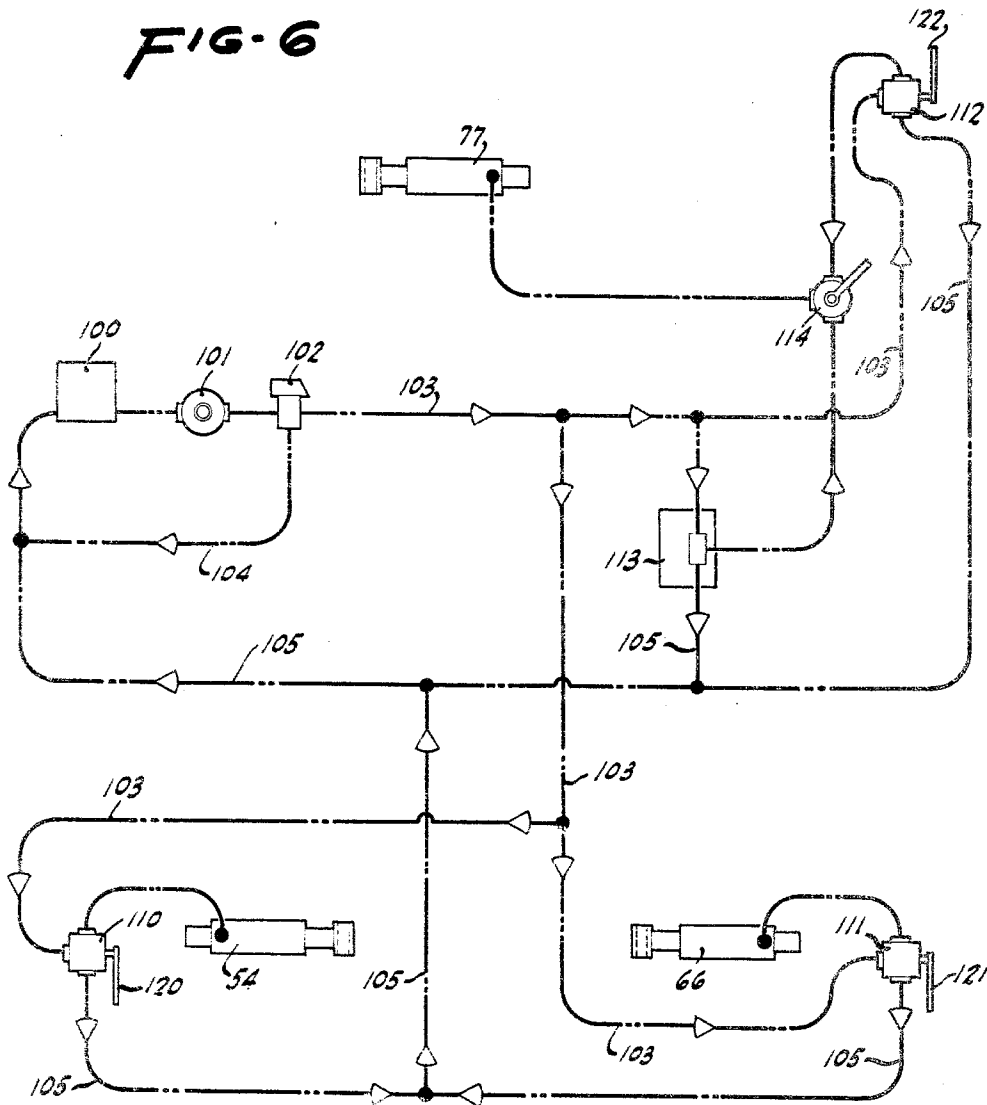
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3,249,026

CONSTRUCTION MACHINES

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Filed July 3, 1962, Ser. No. 207,207
8 Claims. (Cl. 94-46)

This invention relates to construction machines particularly useful in connection with the construction of roads, canals, trenches and the like. More particularly, the invention relates to an improved and simplified automatic control system for maintaining the desired slope and grade of the construction tools as the machine proceeds along a selected path regardless of the existing grade and slope of the path. This application is a continuation-in-part of our application Serial No. 110,087 filed May 15, 1961.

Construction machines of the type to be described are utilized to a great extent for such operations as preparing road beds by scraping, laying one or more sub-bases and bases thereon and finally surfacing the road with black top and concrete.

Reduced to basic essentials, such construction machines comprise: a main frame for carrying one or more appropriate road building tools such as strike-off blades, conveyor screws, scrapers, hoppers, levelers; ground engagement or traction means such as wheels or endless tracks; and adjustable support means for supporting the main frame upon the traction means.

Since the traction means are in direct contact with the ground where the grade, slope and general surface conditions are usually different from the road surface level to be constructed and are irregular, and since the road building tools are carried by the main frame, adjustable frame support means are utilized to maintain the plane of the main frame and thereby the road building tool accurately at a predetermined plane reflecting a desired grade and slope irrespective of the grade, slope and irregularities of the ground engaged by the traction means. Of course, if the irregularities of the ground are very great, the demands made upon the adjustable frame 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 precut a path over which the ground traction units may move.

The term "grade" as used herein refers to the elevation of the path traversed by the construction machine in the direction of travel, i.e., along the road. The term "slope," also known as "cross-grade," as used herein refers to the inclination of the path traversed by the construction machine in a direction perpendicular to the path of travel, i.e., across the road.

A typical adjustable main frame support means of prior art construction machines comprise four hydraulically operated rams connected to, respectively, the four corners of the main frame and to the traction means. Each of the hydraulic rams is controlled independently of the other hydraulic rams either manually by an operator or automatically by reference means such as two grade wires, two grade surfaces or a combination thereof disposed along and outside the road bed to be constructed. In this manner, each of the four corners of the main frame is maintained at a selected height with respect to the respective reference means.

These prior construction machines, because of their four corner control, have certain inherent operational limitations with respect to their stability, versatility and efficiency. As fully explained in the above referred to copending application, it is necessary to provide two guide levels, one along each side of the road, to control the

grade and slope of the tool-carrying main frame. Furthermore, four independently servo operated corner supports provide what may be termed a four point suspension system. Since only three of the four frame supports can operate at any one time to determine the plane of the main frame, one support is generally not supporting its associated corner. Of course, such an unsupported 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 a single active support means designed to carry only one-half of the load. Further, this extra weight thrust upon the active support causes a variation of compaction under the traction means to which it is connected and this extra downward movement of the main frame requires correction 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.

The above referred to copending application describes a construction machine which overcomes many of the limitations of the prior art by effectively providing a three-point main frame support utilizing four hydraulic rams. Three point suspension is obtained by operating two hydraulic rams along one side of the main frame in parallel by a single control valve which may be actuated either by a level guide along that side of the machine or by a pendulum operated servo valve. The side of the machine having its two hydraulic rams operated in parallel controls the slope of the main frame as fully explained in the copending application.

The present invention involves a further simplification of the invention described in the copending application by providing a three point suspension system for the main frame upon a four cornered traction means by utilizing three hydraulic rams, one of which is constructed to bear a double load. Each hydraulic ram is provided with its own control for automatically maintaining the plane of the main frame to reflect desired height, grade and slope.

By "four cornered traction means" is meant traction means which supports the frame at four points as in a four wheeled vehicle, but it is intended to include, also, endless track and skid-type traction means.

It is an object of this invention to provide a simple and stable support system for supporting the main frame (or the tool if supported independently of the main frame) of a construction machine upon its traction means.

It is a further object of this invention to provide a construction machine for building roads, canals, ditches or the like in which the height and grade of the moving tools is automatically controlled by a grade level maintained along to one side of the path to be traversed by the machine and in which the slope is controlled either by a gravity operated sensor or by a second grade level.

It is another object of this invention to provide a simplified road building machine having greatly improved stability and versatility, which is more economical to operate than those known heretofore and which distributes the weight of the main frame so that each support means carries a constant predetermined portion of the

It is still another object of this invention to provide a road building machine which includes a more simplified automatic leveling mechanism for supporting the main

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frame, during its advance, at a predetermined and accurately held plane and height regardless of variations in the grade, slope or height of the ground traversed.

In accordance with a preferred embodiment of the road building machine of this invention, the adjustable main frame support means associated with the front and back of one side of the main frame each include a hydraulic ram constructed to support about one-quarter of the load. The rams are conventionally controlled, that is, each of these two hydraulic rams has its own control valve with its own valve actuating member which is actuated either directly, or indirectly as through micro switches of solenoids, by engagement with a level guide placed along one side of the road to be traversed. The other side of the main frame is connected to an adjustable main frame support means which includes but a single hydraulic ram constructed to support about one-half of the load. The double-duty ram is controlled by a control valve whose actuating member is actuated to provide slope control either by directly or indirectly engaging a second level means or a gravity sensor such as a pendulum.

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

FIG. 1 is a top view of the construction machine of this invention, certain conventional parts of the superstructure having been omitted for greater simplicity;

FIG. 2 is a side elevational view of the right side (looking forward) of the construction machine of FIG. 1;

FIG. 3 is a view taken along line 3—3 of FIG. 1 and shows the left side (looking forward) of the construction machine.

FIGS. 4 and 5 are views similar to that of FIG. 3, showing further embodiments of the left side of the construction machine of this invention.

FIG. 6 is a schematic hydraulic flow diagram of the control system of this invention; and

FIG. 7 is a perspective view of a schematic control system useful in explaining the operation of this invention.

Referring now to the drawings, in which like reference characters designate like parts, there is shown a construction machine 9 which incorporates the present invention. Machine 9 comprises a main frame 10 having 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 for additional rigidity of main frame 10.

Suspended between and carried by side frame members 12 and 14 (either directly or indirectly) are road building tools such as striker blade 24 and conveyor screw 26. During operation of machine 9, these tools or at least one of them are in contact with the ground and build the road or dig the channel or lay the base or sub-base or perform some other operation. 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 operation to be performed. In some instances, many different tools are mounted in vertically adjustable mounts to be selectively lowered for ground engagement to perform certain well-known operations. In the case of laying base, asphalt or concrete, appropriate hoppers are carried by main frame 10 carrying the desired material to be deposited upon the road bed.

Four traction means 30, 31, 32 and 33 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 to be worked. In the embodiment shown in FIG. 1, traction means 30, 31, 32 and 33 may comprise spoke wheels engaging endless tracks 34 and 35. Wheels 30, 31, 32 and 33 are mounted upon short axles 37, 38, 39 and 40. Axles 37 and 38 are rotatably journaled in

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bearings mounted in the end portions of a right side track frame 41, as best seen in FIG. 2. Similarly, axles 39 and 40 are rotatably journaled in bearings mounted in the end portions of a left side track frame 42, as best seen in FIG. 3.

It is within the contemplation of this invention to utilize other traction means, such as coarsely treaded tires mounted on wheels such as wheels 31, 32, 33 and 34; flanged wheels running on rails; or skids. Drive units for propelling construction machine 9 over the ground may be provided in the form of individual engines 44 and 45 mounted respectively upon track frames 41 and 42. The drive shafts of engines 44 and 45 may be connected by means of appropriate chain gears 47 and 48 respectively to suitable sprockets rigidly mounted upon shafts 30 and 32 respectively. Of course, other means of propulsion may be utilized such as, for example, a tractor pulling the machine 9. Since various forms of frame construction, traction means and drive unit may be employed, no further particulars thereof are deemed necessary.

Referring now particularly to FIGS. 1 and 2, there is shown the right hand side adjustable main frame support means for connecting support axles 37 and 38 respectively to the front and rear of the right side of construction machine 9. Axle 37 engages, at each of its ends, one arm of a pair of rocker brackets 50 which are pivotally mounted, by means of a bracket 51, to a bolster 52 bolted or otherwise affixed to main frame 10. The other arms of rocker bracket 50 are connected by a cross member 50a which is pivotally mounted to a plunger 53 of a hydraulic ram 54 also mounted to bolster 52 by means of a bracket 55. Similarly, axle 38 is rotatably supported, at opposite ends, by a pair of links 60 the other end of which are connected to a cross member 61. Cross member 61 pivotally engages one arm of a pair of rocker brackets 62, which are pivotally supported in a bracket 63 extending upwardly and rearwardly from a bolster 64 rigidly mounted on main frame 10. The other end of rocker brackets 62 are pivotally connected to a plunger 65 of a hydraulic ram 66 which is pivotally mounted on a bracket 67 extending upwardly from bolster 64.

The combination of each hydraulic ram and its associated linkages is referred to as adjustable main frame support means. It is immediately apparent from FIG. 2 that as hydraulic ram 54 extends the rear right corner of main frame 10 is raised due to rotation of rockers 50. Likewise, a contraction of hydraulic ram 66 causes the right front corner of main frame 10 to be lowered due to clock-wise rotation of rocker arms 62. In general, extension of each of the rams 54, 66 will cause movement of the frame in one vertical direction and retraction will cause vertical movement in the opposite direction, thereby raising or lowering the respective corner of the frame.

Referring now to FIGS. 1 and 3, there is shown the adjustable main frame support means for connecting the left side of main frame 10 to traction means 32 and 33. Left rear axle 39 is pivotally connected by means of a pair of links 70 and bracket 71 to a bolster 72 rigidly mounted to side plate 12 of main frame 10. The center of track frame 42 is straddled by and pivotally connected to one end of a pair of links 73, the other end of which pivotally engage a rocker arm 74 pivotally mounted in a bracket 75 rigidly affixed to side plate 12. The other arm of rocker arm 74 is pivotally connected to a plunger 76 of double duty hydraulic ram 77. The main body of ram 77 is pivotally connected to a bracket 78 mounted upon bolster 79 rigidly affixed to said plate 12.

As is immediately apparent by inspection, links 70 pull main frame 10 as track frame 42 is propelled forward by traction means 39. Also, the relative height between the left side of main frame 10 and track frame 42 is determined by the angular position of rocker arm 74. If straddle links 73, connecting rocker arm 74 to track frame 42, are supported and secured to take side loads (loads perpendicular to side plate 12) then the front end of track frame

42 may be left unsupported as shown. In case no side loads can be taken by links 73 or in case additional supports against side loads are desired, a further pair of links may be utilized to secure the front of track frame 42 to side plate 12 in the manner shown and as described hereinafter in connection with FIG. 4.

In operation, extension of hydraulic ram 77 causes counterclockwise rotation of rocker arm 74 which raises the entire left side of main frame 10 and more particularly side plate 12 with respect to track frame 42. Likewise, upon retraction of hydraulic ram 77, rocker arm 74 rotates clockwise causing lowering of side plate 12 with respect to track frame 42.

Also mounted upon main frame 10 are three valves 110, 111 and 112, as will be fully explained in connection with FIG. 6. Valve 110 has a control lever 120 which is mounted to the rear right side of main frame 10 to control ram 54. Valve 111 has a control lever 121 which is mounted to the front right side of main frame 10 to control ram 66. Valve 112, which has a control lever 122, is mounted centrally along the left side of main frame 10 to control ram 77.

FIG. 4 shows a further embodiment of an adjustable main frame support means for supporting the left side of main frame 10 (or more specifically, side plate 12) upon traction means 32 and 33. Rear axle 39 is connected to bolster 72 by means of links 70 in the same manner shown and described in connection with FIG. 3 so that links 70 pull main frame 10 forward. Front axle 40 is pivotally connected by means of a first pair of links 85 which in turn are pivotally connected to the ends of a second pair of links 86. The other ends of links 86 are pivotally mounted on bracket 87 fixedly attached to side plate 12 by way of a bolster 88. The function of links 85 and 86 is to take side loads and to keep track frame 42 parallel to side plate 12.

A link 89, which straddles track frame 42 and is pivotally connected thereto, has its other end pivotally connected to a plunger 92 of a double duty hydraulic ram 90. Ram 90 is rigidly affixed to side plate 12 by means of brackets 91 which extend outwardly from side plate 12. As ram 90 extends, it raises bracket 91 and thereby side body plate 12 with respect to track frame 42.

FIG. 5 shows still another embodiment of an adjustable main frame support means for supporting the left side of main frame 10 with respect to track frame 42. In this embodiment, a bracket 93, rigid with side plate 12, is provided for pivotally mounting thereto a double duty ram 94. The plunger 96 of ram 94 is provided with a link 95 which straddles track frame 42 and is pivotally connected thereto. Rear axle 39 (see FIG. 4) may be fastened to pull main frame 10 in the same manner as shown in FIGS. 3 and 4.

FIG. 6 shows the hydraulic flow diagram in which the three hydraulic rams 54, 66 and 77 are placed to correspond with the placement of the rams in the top plan view of FIG. 1. The hydraulic fluid system for operating the three hydraulic rams includes a tank 100 for holding hydraulic fluid, a pump 101 connected thereto to develop hydraulic pressure, and a conventional regulator and bypass valve 102 connected across tank 100 and pump 101. Tank 100, pump 101 and valve 102 define a constant hydraulic fluid pressure system which supplies hydraulic fluid at a predetermined constant pressure to a hydraulic pressure line 103.

Hydraulic pressure line 103 is connected to the input port of hydraulic control valves 110, 111 and 112 and pendulum 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; i.e., 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 from the center port

to the low pressure output port when the plunger is in the other of its two positions. Since the particular valve may be of conventional design, no further description thereof is deemed necessary.

As previously 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 54 and 66. The hydraulic rams are extended by the introduction 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 100.

The center ports of control valve 112 and 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 hydraulic ram 77. In this manner, selector valve 114 controls whether the center port of control valve 112 or of pendulum valve 113 communicates with hydraulic ram 77. 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 (directly or indirectly) with grade wires 125 and 126 as shown in FIG. 1 (or with grade surfaces such as pre-fabricated slabs) which are accurately set to a predetermined relation to the grade on each side of the road. Wires would be supported at intervals at a predetermined level by stakes or brackets (not shown) in a manner well known in the art. As machine 9 advances with control levers 120, 121 and 122 engaging, for example, grade wires 125 and 126 any change in the level of main frame 10 with respect to wires 125 and 126 causes the control levers to actuate their respective valves to return main frame 10 to its proper level in relation to wires 125 and 126.

The height of the side associated with hydraulic ram 77 is controlled by lever 122 of control valve 112. If control lever 122 is in engagement with a lever control means such as grade wire 126, it will cause the center of that side of the main frame to correspond to the height of grade wire 126.

FIG. 7 is an illustration of the particular control provided by rams 54, 66 and 77. Rams 54 and 66 respectively support the rear and front of the right side of main frame 10 upon track frame 41 which is provided with a driving endless track 34. Ram 77 supports the center of the left side of main frame 10 upon track frame 42 which is provided with a driving endless track 35. The level of main frame 10 is determined solely by the rams 57 and 66. More particularly, as main frame 10 passes over uneven ground the desired level is maintained by keeping main frame 10 at a predetermined height in relation to the right hand grade wire with the aid of rams 57 and 66.

The cross slope, that is the angular inclination of main frame 10 transverse to the direction of motion, is maintained solely by ram 77. More particularly, ram 77 is continually adjusted by a slope control means to provide main frame 10 with the desired slope.

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 the pendulum valve 113 or by the lateral template controlled valve 112. Pendulum valves are valves actuated by a pendulum which always assumes a vertical position because of gravity forces acting thereon. Valve 113 is set in such a way that the pendulum closes the valve for a predeter-

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mined angular position of the valve body (slope) and opens the valve when the valve body angle differs from the predetermined angular position. Depending upon the direction of deviation hydraulic fluid is introduced into or is removed from the ram 77. Such a pendulum valve is fully described and claimed 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. The right side of the main frame is controlled by valves actuated by a lever, or the like, which is operated by a grade wire along the side of the road or by a gauge wheel running on a preformed slab laid along the side of the road. In case of multiple lane roads, grade wires are strung first to provide for the proper level of the first lane. Thereafter, the first lane may be used to provide the grade level guide and the valve actuating mechanism actuated by a gauge wheel engaging the first lane surface. Suitable grade wire-operated and gauge wheel-operated mechanisms are well known in the art and are shown in our copending application Serial No. 198,392, filed May 11, 1962, entitled "Automatic Level Control System For Construction Machines."

The other side of the tool carrying main frame, with its single ram, provides slope control. Slope control may be obtained in any of several ways. For example, the actuating lever 122 of valve 112 is in engagement with a grade wire strung along the other side of the road. Alternatively the valve 112 is operated by a gauge wheel running on a preformed slab. A third way comprises the use of the gravity operated pendulum valve 113, as explained hereinabove.

Any method of controlling the height of one side may be combined with any method of 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.

There has been described a novel road building machine in which the tool carrying main frame is provided with a three-point suspension with the aid of two standard and one double duty hydraulic rams for greater stability and versatility of operation. Two suspension points are the front and back of one side of the main frame and the third suspension point is substantially at the midpoint of the other side of the main frame.

In the description hereinabove frequent reference is made to "road building" and to "road building machines." It will be understood that the invention has wider application. For example it can be applied to earth working and/or paving machines used for such purposes as airport construction, slab construction, agricultural purposes, canal lining, etc.

What is claimed is:

1. A construction machine comprising: a main frame; at least one working tool carried by said main frame for ground engagement; a pair of ground engagement means disposed on opposite sides of said main frame, each engaging the ground at positions spaced in the direction of travel; a pair of main frame support means connecting opposite sides of said main frame to respective ground engagement means adjustably supporting said main frame thereon, one of said main frame support means including two fluid pressure operated rams connected to said frame at spaced points and the other of said main frame support means including one fluid pressure operated ram pivotally joined to one of said ground engagement means substantially centrally thereof relative to its direction of travel; a fluid pressure and return system connected to said rams; and normally closed valves disposed between

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said system and each of said rams and carried by said main frame, each valve including a valve actuating means disposed and formed for engagement with a level control means disposed along and outside opposite sides of the path of said construction machine.

2. A construction machine comprising: a main frame; at least one working tool carried by said main frame for ground engagement; a pair of ground engagement means disposed on opposite sides of said main frame, one of said ground engagement means being adapted to engage the ground at positions spaced in the direction of travel; a pair of main frame support means connecting opposite sides of said main frame to respective ground engagement means for adjustably supporting said main frame thereon, one of said main frame support means including a pair of independent linkage means for respectively connecting the front and rear of one side of said main frame to the front and rear respectively of the associated ground engagement means, the other of said main frame support means including a further linkage means pivotally connecting the mid portion of the other side of said main frame to the mid portion of the associated ground engagement means; fluid pressure operated rams included in each linkage means; a fluid pressure and return system connected to said rams; normally closed valves disposed between said system and each of said rams and carried by said main frame, each valve including a valve actuating means disposed and formed for engagement with a level control means disposed along the side of the path nearest to the side of said main frame whose height it controls; a gravity operated valve carried by said main frame and connected between said system and the ram in said other main frame support means; and a three-way selector valve connected between the valves operating the last-mentioned ram for selecting one of last-mentioned valves for communication with the last-mentioned ram.

3. A construction machine comprising: a main frame; at least one working tool carried by said main frame for road engagement; a track frame on each side of said main frame; an endless track mounted upon each track frame and extending longitudinally thereof in the direction of travel; propulsion means engaging each of said endless tracks for moving said machine; main frame support means connecting each side of said main frame to one of said frame tracks, one of said support means including a pair of hydraulically operated rams including linkage means for respectively providing vertical adjustment means for the front and rear of one side of said main frame, the other of said support means including a single hydraulically operated ram and linkage means for pivotally connecting the other support means between a mid portion of said track frame and said main frame for providing vertical adjustment means for the other side of said main frame; a hydraulic pressure and return system connected to said rams; valve means disposed between said system and each of said rams and carried by said main frame; valve actuating means included in each of said valves, the valve actuating means associated with said pair of rams being disposed for engagement with a grade control means disposed along one side of the path to be traversed by said construction machine and the valve actuating means associated with said single ram being disposed for engagement with a slope control means.

4. A construction machine in accordance with claim 3 in which said slope control means comprises a level means disposed along the other side of said path.

5. A construction machine in accordance with claim 3 in which said slope control means comprises a pendulum means carried by said main frame and movable in a plane transverse to said path.

6. A construction machine comprising: a main frame; a working tool for road engagement carried by said main frame; traction means extending longitudinally in the direction of travel on either side of said main frame; first and second main frame support means connecting the

front and rear of one side of said main frame to one of said traction means, third main frame support means pivotally connecting the other side of said main frame to the other of said traction means, each of said main frame support means including a hydraulically operated ram for changing its effective vertical length; first, second and third normally closed control valves mounted to said main frame and associated respectively with the rams of said first, second and third support means; a pendulum operated valve responsive to changes of the slope of the said main frame from a preselected slope mounted to said main frame; a three-way selector valve; a hydraulic fluid pressure and return system connected to said control valves and said pendulum valve, said valves including valve actuating means; said third valve and said pendulum valve both being connected to said selector valve and said selector valve being connected to operate the hydraulic ram of said third support means in response to said third control valve and said pendulum valve in accordance with the position of said selector valve, said first and said second control valve being connected to independently operate the hydraulic rams associated with said first and second support means, the actuating means associated with said first and second control valves being formed and arranged for engagement with a grade control means disposed along the associated side of the path traversed by said construction machine, the actuating means associated with said third control valve being formed and arranged for engagement with a slope control means disposed on the other side of the path traversed when said selector valve is communicating with ram associated with said third support means with said third control valve.

7. A construction machine in accordance with claim 6 in which said third main frame support means comprises: a cam lever pivotally journaled to said main frame, one end of said cam lever being pivotally connected to one end of the associated ram, the other end of the associated ram being pivotally connected to said main frame; link

means pivotally connecting the other end of said cam lever to the associated traction means; and at least one further link means pivotally connecting one end of said traction means to said main frame.

8. A construction machine comprising a frame, a working tool carried thereby, a pair of ground engagement means disposed adjacent opposite sides of said frame for accommodating transportation thereof, a pair of frame support means connecting opposite sides of said frame to respective ground engagement means adjustably supporting said frame thereon, one of said frame support means including a pair of extensible members connected to said frame at spaced points, the other frame support means being pivotally connected to one of said ground support means substantially centrally thereof and including a single extensible member, actuating means operatively connected to said pair of extensible members including a control lever adapted for operative engagement with an exterior grade control reference disposed along a path to be traversed by said construction machine, and actuating means for said single extensible member operative to control the transverse slope of said frame relative to said path.

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JACOB L. NACKENOFF, *Examiner*.

N. C. BYERS, *Assistant Examiner*.