

[54] CONTROL SYSTEM FOR A VEHICLE
ENGINE

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[58] Field of Search 214/762, 138, 763,
214/764

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[57] ABSTRACT

A vehicle having a tiltable load engaging bucket and elevatable booms connecting the bucket to the vehicle is provided with a control system having a pressure sensitive switch connected to sense the fluid pressure required to raise or tilt the bucket. The switch is adapted to actuate when the fluid pressure exceeds a level indicating that the bucket has encountered an obstruction in its work, and upon the switch's actuation a governor is activated to reduce the speed of the vehicle's engine so that the vehicle moves forward more slowly and the lifting bucket has an opportunity to lift past the obstruction.

12 Claims, 4 Drawing Figures

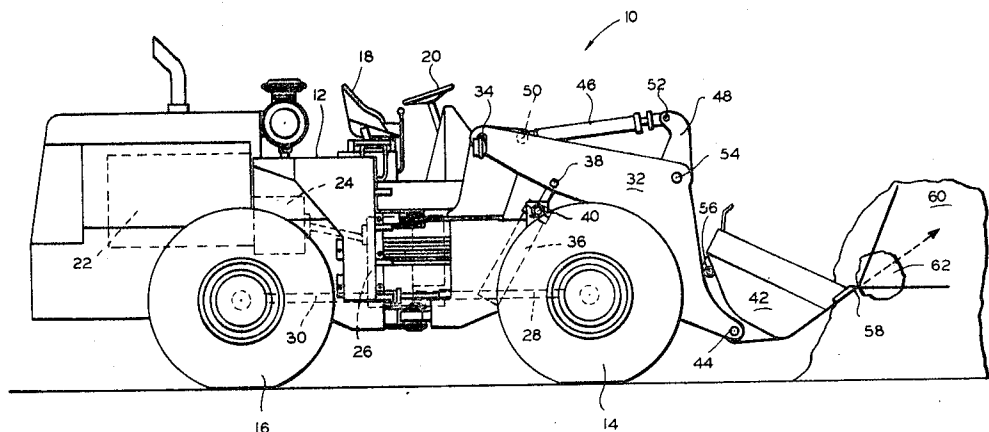
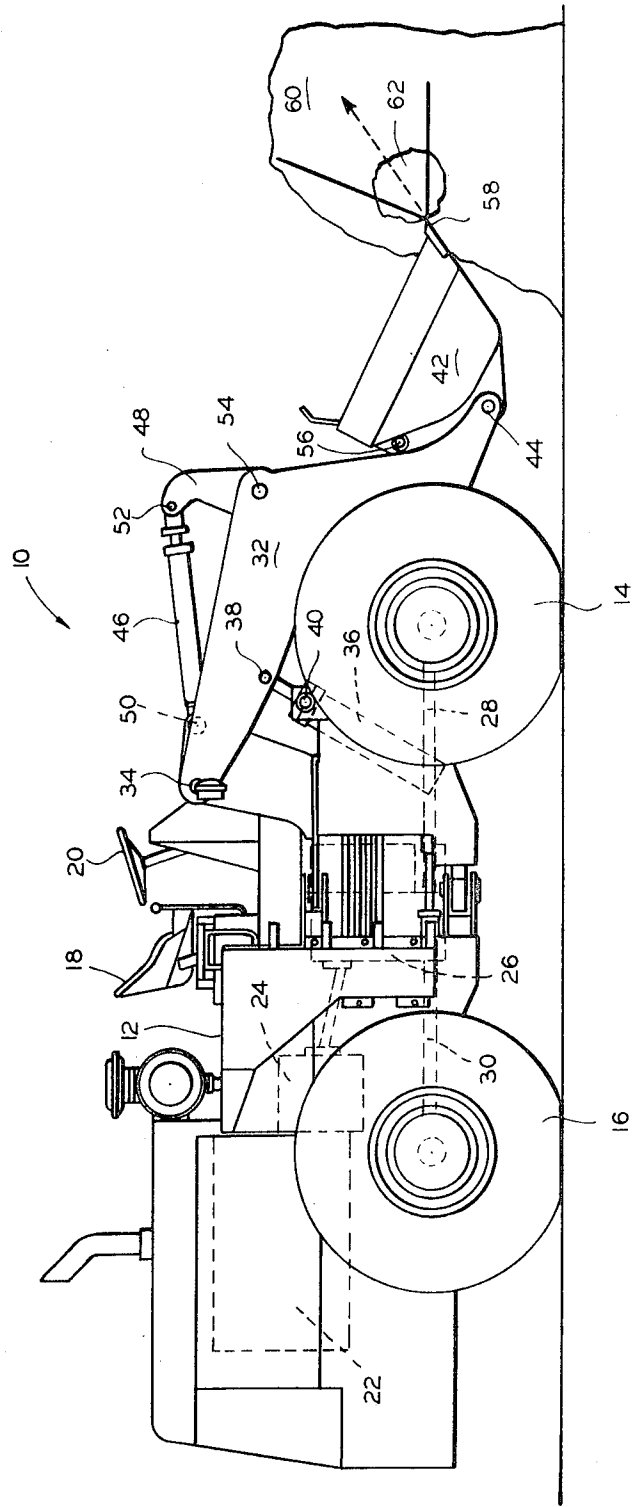
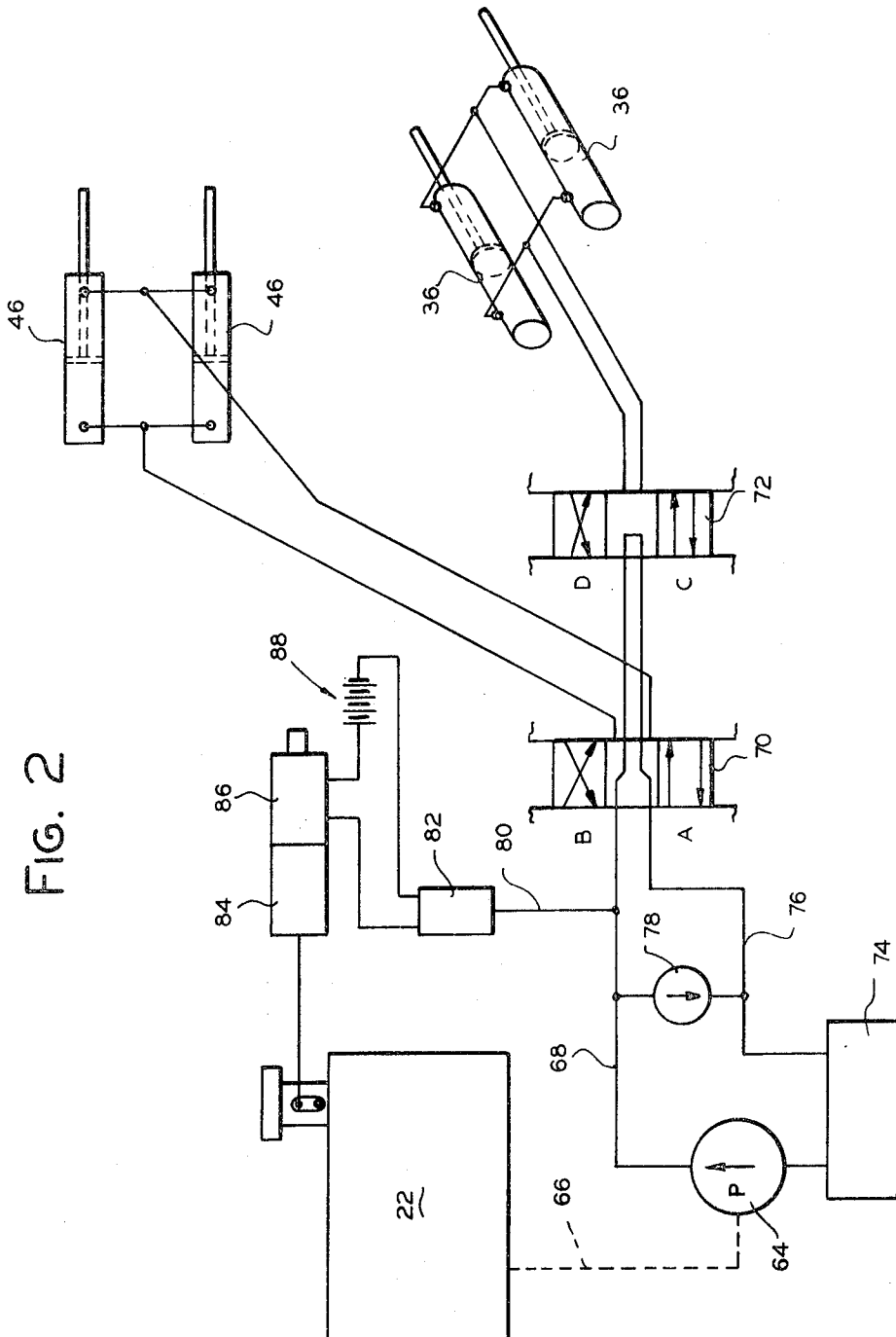


FIG. 1



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FIG. 3

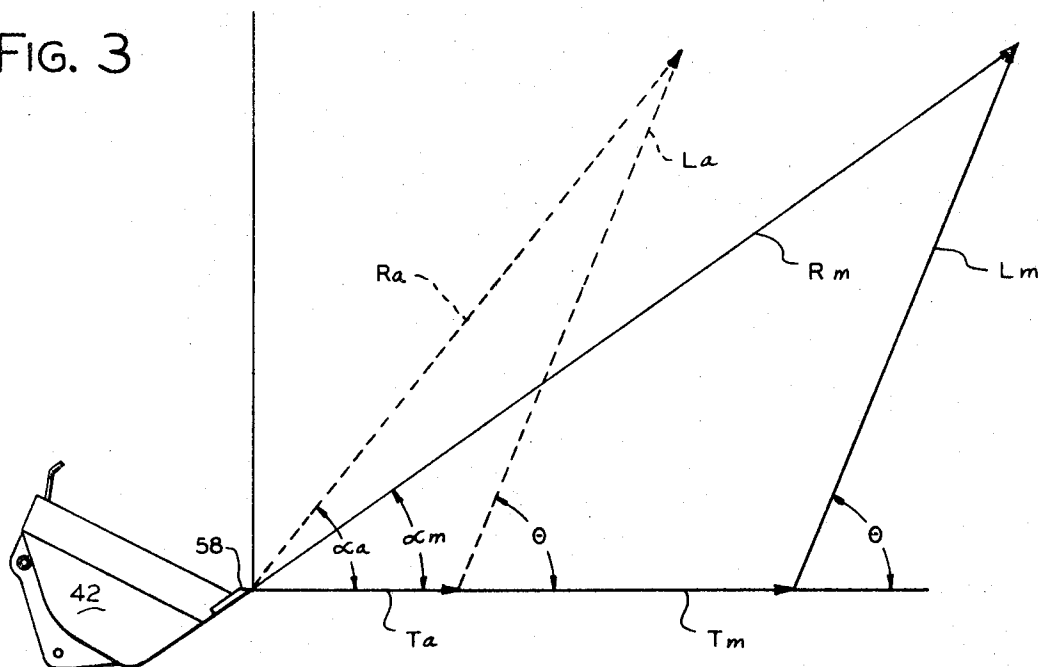
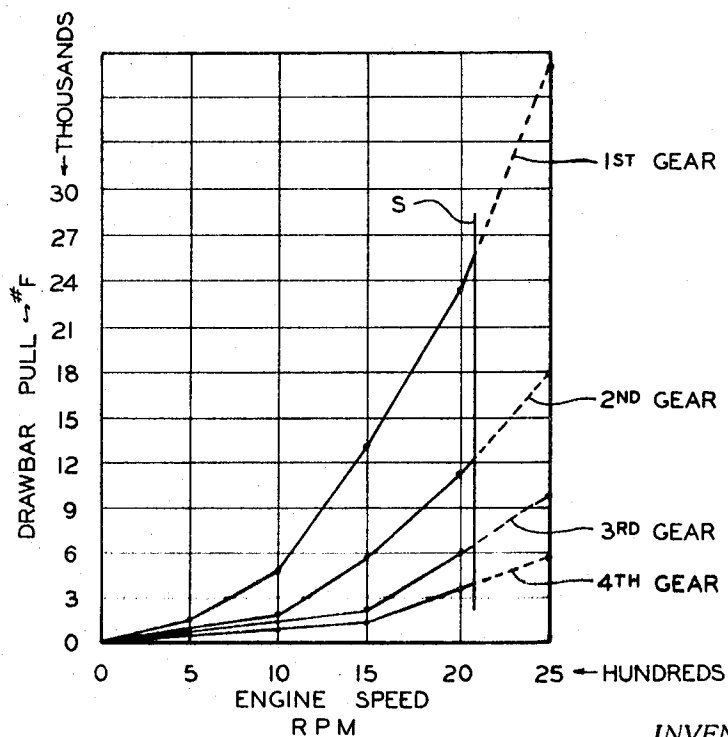


FIG. 4



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CONTROL SYSTEM FOR A VEHICLE ENGINE

BACKGROUND OF THE INVENTION

In the excavation of earth and the handling of bulk materials it is common to use vehicles known as "tractor shovels", which include material handling buckets as a portion of the vehicle. Such buckets are often mounted at the front of the vehicle on boom arms which provide for the raising and lowering of the bucket between a digging or loading position and a dumping position. Means are usually provided for curling or tilting the bucket itself about its pivotal connection to the outer end of the booms so that the bucket may be tilted back to a horizontal carrying position as it is being scooped full of material. Operators of tractor shovels accomplish their work by lowering the boom to its loading position, tilting the bucket forward to its digging position, and then moving the vehicle forward into the material to be loaded. As the vehicle moves forward the bottom is intermittently raised to scoop material and the bucket is tilted back to capture the material scooped so that the bucket lifts out of the material pile in its horizontal carrying position. The vehicle operator may control the arcuate path which the bucket's cutting edge follows within the material pile by varying the amount or rate of bucket tilt, the vertical speed with which the boom is raised, and the horizontal speed with which the vehicle is driven into the material pile. Occasionally an obstruction, such as a buried rock or log, is encountered by the bucket cutting edge as the bucket scoops a load and the normal reaction of an inexperienced operator upon such an encounter is to increase the driving power of the vehicle in an effort to overcome the obstruction, but increasing vehicle power increases only the horizontal vehicle driving force exerted upon the buried obstruction and the usual result of such power increase is to merely drive the obstruction deeper into the pile. On the other hand, experienced operators have learned that if they can reduce the vehicle driving power quickly enough upon encountering a buried obstruction the lifting bucket will have an opportunity to do its work and the obstruction will either be lifted free, or overridden altogether.

Systems which completely disengage the vehicle drive train when an obstruction is encountered and automatically reengage the drive when the obstruction is overcome are known, but such systems subject the vehicle's working components to undue shock loadings and provide such jerky vehicle operation that they have not generally been acceptable. An object of the present invention is to provide a system which will smoothly and quickly reduce vehicle driving power when an obstruction is encountered during bucket loading without disengaging the vehicle drive train so that the improper reaction of an inexperienced operator is avoided and the reaction time of an experienced operator is no longer a factor in efficient tractor shovel operation, and further so that the vehicle's components are not unduly worn due to shock loading.

SUMMARY OF THE INVENTION

In carrying out my invention in one preferred form thereof, I provide a control system for controlling the engine speed of a vehicle having tiltable load engaging means and elevatable boom means connecting the load engaging means to the vehicle. The control system senses the value of the lifting force exerted to elevate

the load engaging means and when the value of such lifting force exceeds a preselected value the control system actuates to decrease the speed of the vehicle engine.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side view of a vehicle embodying this invention,

FIG. 2 is a schematical representation of a portion of the hydraulic system utilized to control the operation of the vehicle shown in FIG. 1,

FIG. 3 illustrates, vectorially, the forces which may be exerted by the load engaging bucket of the vehicle shown in FIG. 1, and

FIG. 4 illustrates the pertinent performance information for a representative engine and drive train which may be used in the vehicle shown in FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring to FIG. 1 of the drawing, reference numeral 10 generally indicates a type of mobile vehicle known as a tractor shovel which embodies this invention. Vehicle 10 includes an articulated body 12 supported by a pair of front driving wheels 14 and a pair of rear driving wheels 16, only one of each being shown. An operator's station is provided with an operator's seat 18 located for easy access to the hand steering wheel 20 and various other control levers and pedals necessary for the operator's control of the vehicle. A suitable prime mover, preferably an internal combustion engine 22, provides power to driving wheels 14 and 16 through the usual drive train including a torque converter 24, a transmission 26, and drive shafts 28 and 30. Engine 22 also provides power to the various working components of the vehicle as hereinafter explained.

A pair of forwardly extending boom arms 32 (only one of which appears in the drawing) are pivotally connected to body 12 on each side thereof at 34 and may be controllably elevated by means of the elevating force exerted by two double acting fluid motors 36 whose rod ends are pivotally connected to each boom arm at 38 and whose head ends are connected to body 12 through the trunnion mounting at 40. A load engaging means or bucket 42 is carried at the forward end of boom arms 32 and is adapted to be controllably curled or tilted about its connection 44 to the outer ends of the booms through the selective actuation of a bucket tilt assembly which includes a second pair of double acting fluid motors 46 and associated tilt levers 48. Each tilt motor 46 is pivotally connected at one end thereof to the vehicle body at 50 and the other end thereof to its respective tilt lever at 52 so that the pressurization of these tilt motors provides a tilting force causing the tilt levers to swing about their fulcrum 54 fixed to the boom arms and apply force through their pivotal connection 56 to bucket 42, thereby urging the bucket to tilt about its connection 44 to the boom arms.

The cutting edge 58 of bucket 42 may be lifted to capture material within the bucket by the actuation of either tilt motors 46 or of elevating motors 36, and through the proper manipulation of vehicle 10 the bucket may be an effective tool in excavating the material generally indicated at 60. Occasionally cutting edge 58 may encounter an obstruction 62 in its loading pass through the material which would hinder the bucket's progress. Vehicle 10 is adapted, as hereinafter ex-

plained, to sense the encounter of such an obstruction and to automatically take remedial action.

Referring now to FIG. 2, the hydraulic system utilized in vehicle 10 to effect the elevation of boom arms 32 and the tilting of bucket 42 is shown schematically. A positive displacement pump 64 is driven by engine 22 through the power "take-off" indicated at 66 and is connected by pump discharge line 68 to supply pressurized fluid to bucket tilt control valve 70 and there-through to boom elevating control valve 72. Tilt valve 70 is manually operable by the vehicle operator and may be of any type adapted to receive pressurized fluid from pump 64 and selectively direct such fluid to either end of tilt motors 46 while at the same time connecting reservoir 74 through return line 76 to the respective opposite ends of the tilt motors. Tilt valve 70 is of the "open center" type and may be positioned as shown in FIG. 2 to pass pressurized fluid directly to the elevating valve 72 which may be of any type adapted to direct such fluid to either end of elevating motors 36 and connect the respective opposite ends with reservoir 74. Valves 70 and 72 may be positioned as shown in FIG. 2 at their neutral position in which fluid is routed directly back to reservoir 74 so that when the valves are in these positions motors 36 and 46 are hydraulically locked. Tilt valve 70 may, however, be moved upward to the position A for the tilting of bucket 42 backward, or this valve may be moved downward to the position B for the tilting of bucket 42 forward. When tilt valve 70 is in either position A or B flow is restricted to elevating valve 72 and elevating motors 36 are hydraulically locked no matter what position the elevating valve may be in. When tilt valve 70 is moved to the neutral position shown, elevating valve 72 may direct pressurized fluid to the head ends of elevating motors 36 for the elevation of booms 32 if valve 72 is in the position C, or elevating valve 72 may direct fluid to lower booms 32 if the valve is in the position D. A pressure relief valve 78 is connected between pump discharge line 68 and return line 76 and is set to open for the bypass of fluid back to reservoir 74 when the pressure in discharge line 68 has reached an extreme level, so that pump 64 may be protected from damage due to excessive back pressures. The fluid pressure in line 68 at any given time is a prime indicator of the work being performed at that time by pump 64 and, since the pump work is consumed by elevating motors 36 or tilt motors 46, such pressure is also an indicator of the lifting force being exerted by bucket cutting edge 58. For example, if valves 70 and 72 are in the neutral positions shown in FIG. 2, the pressure in line 68 would be relatively low since pump 64 is merely recycling fluid back to reservoir 74; but if tilt valve 70 is in the working position A the pressure in line 68 will rise to produce whatever lifting force is required by the bucket cutting edge to tilt bucket 42 back, or if tilt valve 70 is in the neutral position and elevating valve 72 is in the boom elevating position C then the pressure in line 68 will rise to produce whatever elevating force is required to overcome the resisting force exerted upon cutting edge 58 and hence exerted upon the rods of elevating motors 36 as they attempt to lift booms 32 upward. A pressure "tap" or line 80 connects pump discharge line 68 with a pressure sensitive switch 82 that is adapted to actuate when the pressure in the discharge line has exceeded a level selected to indicate that bucket cutting edge 58 has encountered an obstruction in its work, such as the buried

rock or log 62 shown in FIG. 1. A governor 84 of common type provides means for varying the speed of engine 22 in response to the actuation of switch 82, and is activated by means of a solenoid 86 energized by the electrical current source 88 when switch 82 is actuated to complete the circuit.

The operation of vehicle 10 is best understood with reference to FIGS. 3 and 4 of the drawing. FIG. 4 illustrates the pertinent performance information for a representative engine 22 and associated drive train which may be used in vehicle 10. The abscissa of FIG. 4 represents the speed of engine 22 and the ordinate thereof represents the drawbar pull or tractive force which may be exerted by the vehicle in the various gear ratios of its drive train. Referring now to FIG. 3, the overall resultant force R which may be exerted by bucket cutting edge 58 at various operating conditions is represented vectorially and results from the vector addition of the vehicle tractive force vector T acting horizontally and the bucket cutting edge lifting force vector L (produced by either tilt motors 46 or elevating motors 36) acting angularly upward. The magnitude or length of the tractive force vector T is a function of the speed of engine 22 as illustrated by FIG. 4 and the direction of the vector T coincides with the direction of movement of vehicle 10. The magnitude of lifting force vector L will vary during the tilting of bucket 42 or the elevation of booms 32 as required to overcome the resistance to the lifting of bucket cutting edge 58 since pump 64 is of the constant displacement type and will therefore supply such pressure as is necessary. The direction of vector L is tangent to the arc of bucket cutting edge 58 as it is tilted or elevated so that at a given time vector L acts at a set angle θ to the direction of vehicle travel. During normal working operation of vehicle 10, engine 22 may be controlled in the normal manner by the vehicle operator to supply tractive force T up to the converter stall condition (as indicated by the stall line S shown on FIG. 4) and pump 64 will supply pressurized fluid up to converter stall in producing whatever lifting force L is necessary to overcome resistance to the movement of cutting edge 58 in its work. At the maximum operating levels the vectors T_m and L_m shown on FIG. 3 combine to produce the maximum resultant force R_m which cutting edge 58 may exert, and the magnitudes of these force components require that such resultant force R_m act at an angle α_m to the direction of vehicle travel. Pressure sensitive switch 82 is connected to sense the magnitude of lifting force L as previously explained and is adapted to actuate when such force L exceeds a preselected level indicating that cutting edge 58 has encountered an obstruction in its work. Preferably, switch 82 is set to actuate at a point indicating the impending stall of converter 24 but a lower pressure may be selected if desired. Upon the actuation of switch 82, governor 84 automatically operates to reduce the speed of engine 22 to a predetermined level and to therefore reduce the tractive force (illustrated by FIG. 4) to a selected magnitude as represented by the vector T_a shown on FIG. 3. The magnitude of lifting force L is not, however, affected by the actuation of switch 82 since such force remains equal but opposite to the resisting force encountered. Consequently as shown on FIG. 3, cutting edge 58 exerts a new overall resulting force R_a acting at a new angle α_a more nearly vertical than the angle α_m at which the cutting edge previously exerted its force and therefore the

bucket is more likely to either lift the obstruction clear or to override it altogether.

When the resisting force exerted upon the cutting edge 58 again returns to its normal operating level the fluid pressure in pump discharge line 68 reduces to a value less than the pressure selected to actuate switch 82 and therefore solenoid 86 is deenergized to deactivate governor 84 so that engine 22 accelerates to the speed desired by the vehicle operator. Thereafter, the operation of vehicle 10 is completely within the control of the vehicle operator until an obstruction is again encountered.

While I have described and illustrated herein a preferred embodiment of my invention, it will be apparent to those skilled in the art that other embodiments and modifications of the invention may be made. It should be understood, therefore, that I intend to cover by the appended claims all modifications and variations which fall within the true spirit and scope of my invention.

I claim:

1. A control system for use with a vehicle having elevatable boom means connecting a tiltable load engaging means to the vehicle, and an engine and torque converter connected to drive the vehicle, comprising:

means for lifting the load engaging means by exerting a lifting force upon the load engaging means, means for varying the speed of the vehicle engine, and

sensing means responsive to the value of said lifting force for activating said varying means to decrease the speed of the vehicle engine when the value of said lifting force exceeds a preselected value.

2. A control system as set forth in claim 1 wherein said lifting means includes a first fluid motor connected between the vehicle and the elevatable boom means, and wherein said responsive means is connected to sense the pressure in said first motor to thereby sense the value of said lifting force.

3. A control system as set forth in claim 1 wherein said lifting means includes a tilt assembly connected between the vehicle and the load engaging means to tilt said load engaging means and having a second fluid motor, and wherein said responsive means is connected to sense the pressure in said second motor to thereby sense the value of said lifting force.

4. A control system as set forth in claim 1 and including pump means, said lifting means including a first fluid motor connected between the vehicle and the elevatable boom means and a tilt assembly connected between the vehicle and the load engaging means having a second fluid motor, said pump means being connectable to supply pressurized fluid to either said first or said second motors and said responsive means connected to sense the discharge pressure of said pump means to thereby sense the value of said lifting force.

5. A control system as set forth in claim 4 wherein

said responsive means includes a pressure sensitive switch, said switch actuating when the discharge pressure of said pump means exceeds a preselected value to thereby activate said varying means.

6. A control system as set forth in claim 1 and including means for connecting the vehicle engine to provide said lifting force, said preselected value of said lifting force being selected to be the force required to stall the torque converter.

7. A control system as set forth in claim 4 wherein the vehicle engine is connected to drive said pump means, said preselected value of said lifting force being selected to be the force required to produce a back pressure upon said pump sufficient to stall the torque converter.

8. A control system as set forth in claim 7 wherein said responsive means includes a pressure sensitive switch, said switch actuating when the discharge pressure of said pump exceeds said preselected value to thereby activate said varying means.

9. A vehicle comprising a vehicle body, ground engaging means supporting said body, an engine, a drive train including a torque converter drivingly connecting said engine to said drive means, load engaging bucket means having a liftable cutting edge, boom means connecting said bucket means to said body, elevating means for elevating said boom means to lift said cutting edge, tilt means for tilting said bucket means to lift said cutting edge, power transmitting means for connecting said engine to power said elevating means and said tilt means to lift said cutting edge, means for varying the power produced by said engine, and sensing means responsive to the power required by said elevating means and said tilt means to decrease the power output of said engine when said power required exceeds a preselected value.

10. A vehicle as set forth in claim 9 wherein said preselected value is selected to be the power necessary to stall said converter.

11. A vehicle as set forth in claim 9 wherein said elevating means includes a first fluid motor connected between said body and said boom means and wherein said tilt means includes a tilt assembly connected between said body and said bucket means and having a second fluid motor, said power transmitting means being a fluid pump drivingly connected to said engine and connectable to supply pressurized fluid to said first and second motors and said responsive means being a pressure sensitive switch connected to sense the discharge pressure of said pump to thereby sense said power required by said elevating means and said tilt means to lift said bucket cutting edge.

12. A vehicle as set forth in claim 11 wherein said preselected value is selected to be the power necessary to stall said converter.

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