Sept. 16, 1969 R. M. SMITH 3,466,764

HOLDDOWN FORCE CONTROL FOR A SCRAPER ELEVATOR

Filed Dec. 9, 1966 2 Sheets-Sheet 1

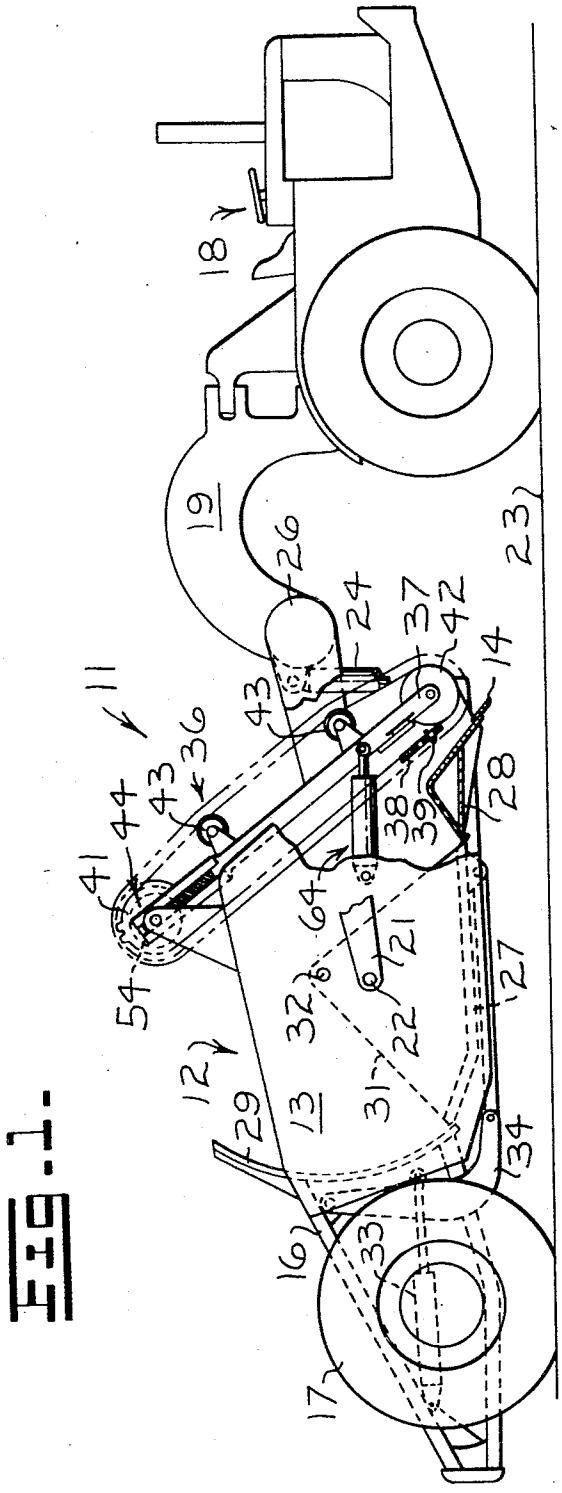


Fig. 1

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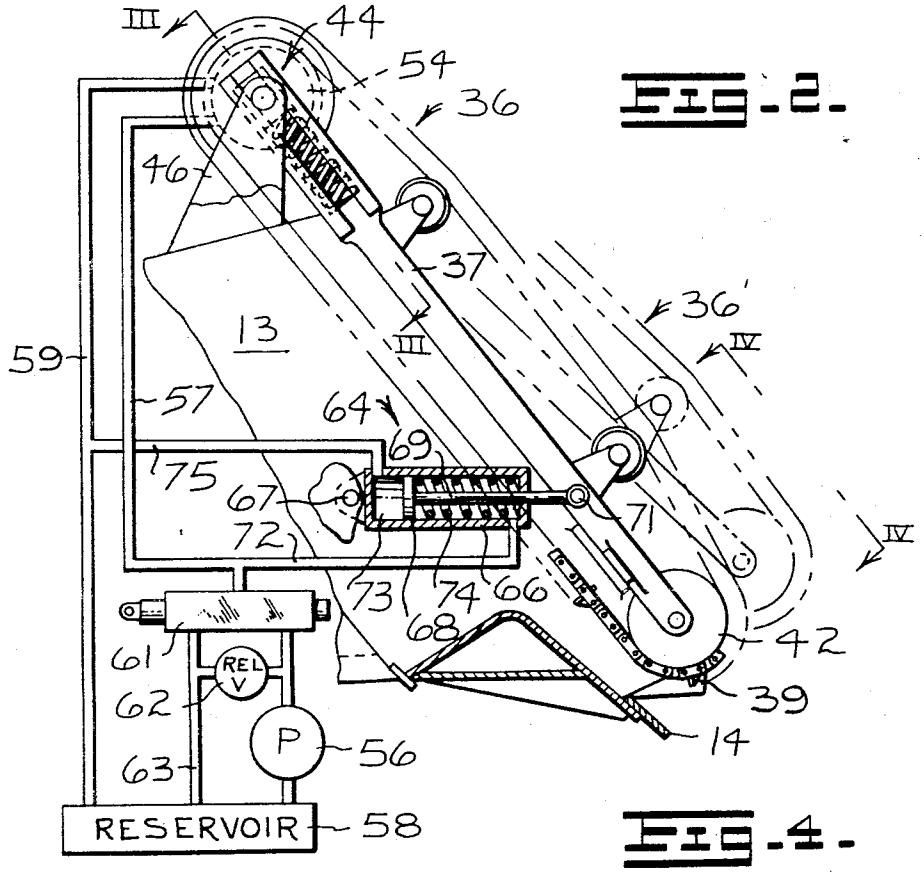


FIG-2-

FIG-4-

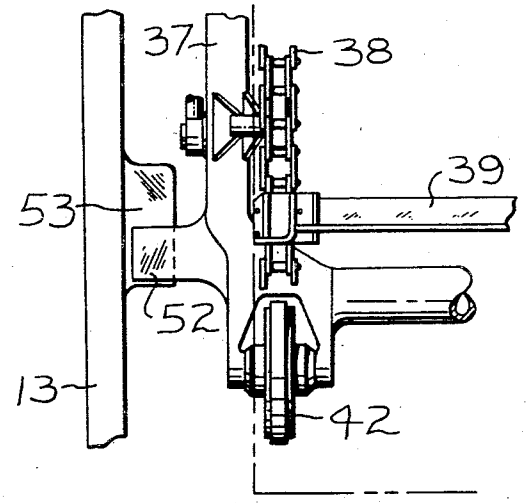
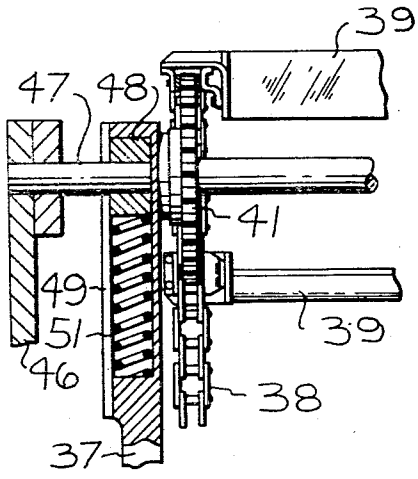


FIG-3-



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HOLDDOWN FORCE CONTROL FOR A SCRAPER ELEVATOR

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U.S. Cl. 37—8 5 Claims

ABSTRACT OF THE DISCLOSURE

A fluid motor powered elevator of a self-loading scraper is pivoted to the bowl thereof whereby it may swing upward and forward from the cutting edge to adjust to varying depths of cut. Elevator holddown force, supplementary to gravity, is provided by a fluid operated cylinder and piston assembly connected between the elevator and the bowl and communicated with the driving fluid input to the elevator motor. The holddown force is thereby varied in accordance with the forces tending to lift the elevator inasmuch as an increase in elevator loading causes a pressure rise at the elevator motor fluid intake which in turn increases the downward force exerted on the elevator by the holddown cylinder.

This invention relates to powered earthmoving equipment and more particularly to mechanism for varying the holddown force on the elevator of a self loading scraper to optimize elevator action.

In the operation of tractor drawn scrapers of the class having a load carrying bowl with a cutting edge at the forward face, the contents of the partially filled bowl tend to resist the entrance of additional material. Consequently it has become a common practice to equip such scrapers with an elevator at the forward portion of the bowl to assist the movement of earth across the cutting edge and up into the bowl. Such scrapers are self loading under most conditions and thus do not require supplementary motive power, in the form of a pusher tractor or the like, which may otherwise be needed to insure complete loading.

The volume of earth or other material which passes over the cutting edge and into the bowl will vary during operation and relatively thick solid objects such as rocks or the like may present. To accommodate to these variables, the elevator must be capable of a limited amount of movement with respect to the cutting edge. This is generally provided for through the mounting structure which attaches the elevator to the scarper bowl. In most such structures the elevator is carried on pivots which allow the lower end of the elevator to swing upward and forward from the cutting edge when it is necessary that the opening therebetween increase.

The elevator flights react against the material being loaded in such a manner as to create a turning moment which tends to pivot the elevator upward from the cutting edge to a greater extent than is desirable. Accordingly provision must be made for exerting a counter-balancing holddown force on the elevator. In some prior constructions this has been provided solely by the weight of the elevator itself and in other instances springs have been employed to produce supplementary holddown force. In either case, the magnitude of the holddown force has been almost constant or has varied solely as a function of the angular position of the elevator. Thus prior techniques do not relate the holddown force, in any optimum way, to the turning moment exerted against the elevator by the material being loaded.

The prior constructions have not realized the most efficient elevator action inasmuch as, in operation, the optimum amount of holddown force varies substantially under different conditions. More specifically, the turning moment which tends to lift the elevator varies in accordance with the reaction against the elevator flights by the material being loaded and the holddown force should be varied accordingly.

If, for example, a very strong cohesive material or an unusually heavy material is being loaded a larger than normal loading of the elevator occurs. This causes the elevator to tend to withdraw from the cutting edge to an excessive extent and in an extreme case the elevator may more or less override the material which is being loaded. To avoid this effect, holddown force should be increased as the loading of the elevator increases. Under the opposite conditions, where the loading of the elevator decreases, the holddown force should be reduced as the elevator tends to move too close to the cutting edge and the height of the passage into the bowl is excessively restricted.

The present invention avoids these inefficiencies by varying the holddown force in accordance with variations in the forces tending to lift the elevator.

The torque exerted on the elevator drive by the elevator motor is proportional to the lifting forces inasmuch as it is changes in the loading of the elevator which produce the changes in the lifting force. Accordingly, in the common case where the elevator is operated by a hydraulic motor, the variable controlled holddown force can conveniently be derived from a hydraulic cylinder having a port communicated with the driving fluid input to the motor. As pressure at the motor input increases when the torque output of the motor increases, the holddown force is automatically varied in the optimum manner.

Accordingly it is an object of this invention to provide for more efficient elevator action in a self loading scraper.

It is another object of this invention to vary the holddown force on the elevator of a self loading scraper in accordance with the counterforces thereon.

It is another object of this invention to provide means for varying the holddown force on the elevator of a self loading scraper in an optimum manner while providing for maximum freedom of movement of the elevator.

It is still another object of this invention to improve the operation of self loading scrapers where materials having differing characteristics are to be loaded.

The invention, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in conjunction with the accompanying drawing of which:

FIGURE 1 is a side elevation view of a self loading scraper with portions of the bowl sidewall and associated elements broken out to better illustrate the elevator and mounting structure therefor;

FIGURE 2 is a side elevation view of the elevator region of the scraper of FIGURE 1 showing one form of positional change which the elevator may undergo in response to variable loading conditions and showing certain of the hydraulic circuit elements in schematic form;

FIGURE 3 is a partial section view taken along line III—III of FIGURE 2 showing further details of mounting structure at the top of the elevator; and

FIGURE 4 is a view taken along line IV—IV of FIGURE 2 and illustrating motion limiting structure at the lower end of the elevator.

Referring now to the drawing and more particularly to FIGURE 1 thereof, a scraper **11** of the type to which the invention is applicable will typically have a load carrying bowl **12** with sidewalls **13** and a cutting edge **14** carried at the lower edge of the open forward face thereof. To support the bowl **12** at the back end, frame members **16** extend rearwardly and connect with rear wheels **17**.

The scraper is drawn by a tractor **18** which is coupled to the bowl **12** through a gooseneck **19** and a pair of draft arms **21** which extend along opposite bowl sidewalls **13** and connect to centrally located points thereon through pivots **22**. To control the elevation of the cutting edge **14** relative to the ground surface **23**, a pair of hydraulic jacks **24** are connected between the forward portion of the bowl **12** and the spreader arm **26** which couples draft arms **21** to the gooseneck **19**. Thus extension of the jacks **24** pivots the entire bowl **12** including the cutting edge **14**, downwardly about the axis of rear wheels **17** so that the edge may be caused to bite into the ground surface **23** and guide a superficial layer of soil upwardly into the bowl. Contraction of the jacks **24** pivots the bowl **12** and cutting edge **14** upwardly away from the ground surface to the load carrying position.

To discharge the load from bowl **12**, ejection mechanism is provided which in this example is comprised of a rectractable floor section **27**. Floor section **27**, in the closed position, extends from the cutting edge support **28** to the arcuate rear wall **29** of bowl **12** and is supported by triangular side members **31** extend upward and attach to the bowl sidewalls **13** at pivots **32**. A pair of hydraulic jacks **33** are connected between the rear frame members **16** and linkage **34** which connects to the underside of the floor section **27** so that contraction of the jacks swings the floor section rearwardly and upward to release material from the bottom of bowl **12**.

In self loading scrapers of this general type, the movement of earth across the cutting edge **14** and up over support **28** into bowl **12** is assisted by a chain and flight elevator **36** disposed at the forward portion of the bowl. The elevator **36**, which also functions to retain material at the open front face of the bowl **12**, is mounted with the lower end above and slightly forward from the cutting edge **14** and extends upward and rearwardly therefrom. Salient elements of the elevator **36** include a rectangular frame with side members **37** and endless chains **38** carrying transverse flights **39** and carried on drive sprockets **41** at the top of the elevator and idlers **42** at the base thereof. Rollers **43** are spaced along the forward faces of the frame side members **37** to aid in supporting the chains **38**.

The elevator **36** cannot be rigidly fixed relative to the bowl **12** inasmuch as the lower end of the elevator must be free to move upward from the cutting edge **14** to adjust to varying depths of cut and to override obstacles such as rocks and the like which might otherwise jam or damage the elevator. Referring now to FIGURE 2, this motion is provided for by coupling the upper end of the elevator **36** to the bowl **12** by means of a pivot connection **44** to arms **46** which project upward from the bowl sidewalls **13**. Thus the lower end of the elevator **36** may swing upward and forward from cutting edge **14** when necessary to a position such as that illustrated by dashed lines **36'**.

Most prior self loading scrapers have employed an elevator mounting which limits the movement of the lower end of the elevator to a fixed arcuate path in the manner described above. This curvilinear forward and upward motion of the lower end of the elevator provides for a maximum change in the distance between the elevator and the cutting edge **14** with a minimum of elevator motion. However in many instances the forces which act on the elevator may be more or less in direct alignment with the plane of the elevator frame and the inability of the elevator to move along that plane increases the likelihood of damage. Accordingly in the present invention the coupling between the upper end of the elevator **36** and bowl sidewall arms **46** is arranged to provide for longitudinal upward movement of the elevator in addition to the pivoting motion described above.

Referring now to FIGURE 3 in conjunction with FIGURE 2, the elevator **36** is capable of linear movement in its own plane inasmuch as the pivot pins **47** which couple the elevator to the bowl sidewall arms **46** extend into

blocks **48** which are slidable within longitudinal tracks **49** formed in the elevator frame sidemembers **37**. A compression spring **51** is disposed within each track **49** to urge the elevator frame member **37** downwardly relative to block **48**. Thus if a force is imposed on the lower end of the elevator **36** in a direction parallel to the plane of the elevator frame, the entire elevator assembly may move upwardly against the action of springs **51**. Should the elevator experience a combination of forces which tend both to move it linearly in its own plane and also to pivot it upwardly and forwardly, it is free to undergo any combination of such motions.

Downward motion of the elevator **36** in its own plane is limited by abutment of the top of tracks **49** against the blocks **48**. Referring now to FIGURE 4 in combination with FIGURE 2, pivoting of the elevator **36** towards the cutting edge **14** is limited by abutment of a lateral projection **52** at the lower end of each elevator frame sidemember **37** against a stop **53** which projects a small distance inwardly from each bowl sidewall **13**. Thus the flights **39** of the elevator **36** are kept from contact with the cutting edge **14**.

While the elevator **36** should be free to move away from the cutting edge **14** as described above, it is also necessary that means be provided to yieldably resist such motion so that the lower end of the elevator is held in engagement with the material to be loaded. Some of this holddown force is inherent in the structure inasmuch as the pivot connection **44** at the upper end of the elevator is above and behind the lower end thereof so that the weight of the elevator tends to produce the desired result. In many prior constructions this effect is relied upon to provide all of the holddown force while some other prior scrapers also use springs connected between the elevator and the bowl to supplement the gravity force. In either instance the magnitude of the holddown force is a function solely of the angular position of the elevator relative to its upper pivot and is not meaningfully related to the instantaneous loading of the elevator.

As a practical matter the optimum holddown force for most efficient elevator operation varies considerably at different times. Such factors as changes in the characteristics of the material being loaded and changes in the amount of material in the bowl have a pronounced effect on the loading of the elevator and if the holddown force does not vary accordingly the flights **39** may bite too deeply into the material being loaded and restrict the passage into the bowl or may lift and tend to override the material. To overcome this effect, the present invention provides for varying the holddown force in response to changes in elevator loading.

This is most efficiently done by making use of the fact that the driving fluid pressure at the input to the hydraulic motor **54** which operates the elevator varies in proportion to the loading thereon. The hydraulic motor **54** is generally situated at the top of the elevator and is operated by a high pressure fluid such as oil supplied from a pump **56** through an intake conduit **57**. Pump **56** draws oil from a reservoir **58** and a return conduit **59** extends from the motor outlet to the reservoir.

Operation of the elevator **36** is controlled by a spool valve **61** disposed between the pump **56** and motor intake conduit **57**. Valve **61** has a first position at which high pressure fluid from pump **56** is delivered to motor **54** through conduit **57** and has a second position at which the fluid flow from the pump is returned directly to the reservoir **58** thereby bypassing the motor and stopping the elevator. To protect the hydraulic circuit against overpressures, a relief valve **62** is connected between the outlet of pump **56** and the conduit **63** which returns the fluid from valve **61** directly to the reservoir at the second position of the valve.

To generate a holddown force on the elevator **36** which is proportional to the fluid pressure between motor **54** and pump **56**, one of a pair of hydraulic cylinder as-

semblies **64** is connected between each bowl sidewall **13** and the lower portion of the corresponding elevator frame sidemember **37**. In a preferred form, each such assembly **64** has a cylinder member **66** with one end coupled to the bowl sidewall **13** by a pivot **67**. A slidable piston **68** within cylinder **66** has a rod **69** coupled thereto which extends along the axis of the cylinder and projects therefrom to connect to the elevator frame sidemember **37** at a pivot coupling **71**. A conduit **72** connects the motor intake conduit **57** with the end of cylinder **66** which is remote from pivot **67** and a vent and leakage oil return line **75** extends from the opposite end of the cylinder to reservoir **58**.

In operation, the pressure of the motor driving fluid reacts against the piston **68** in each cylinder **66** to produce a holddown force which is transmitted to the elevator **36** through rods **69** and pivots **71**. Further, such holddown force varies automatically with variations in the loading of the elevators **36**. Thus an increase in the forces resisting motion of the elevator flights **39** produces a compensating pressure rise in the motor intake conduit **57**. The increased pressure is transmitted to cylinder **66** by conduit **72** and reacts against the piston **68** to increase the holddown force. A reversed effect occurs if the elevator flights **39** encounter a decreased resistance inasmuch as the resulting pressure drop within the motor intake conduit **57** is similarly transmitted to the cylinder **66**. Thus the cylinder assemblies **64** vary the holddown force automatically and in an optimum manner.

The holddown force generating cylinder assembly **64** may be made fully compatible with the maximized freedom of movement of the elevator **36** as hereinbefore described. The elevator **36** may pivot forwardly and upward from cutting edge **14** about the upper pivot connection **44** as hereinbefore described inasmuch as the piston **68** can travel forwardly within cylinders **66** against the fluid pressure therein. Movement of the elevator **36** upwardly and backwardly within its own plane as hereinbefore described would be prevented if the piston **68** within cylinder **66** were allowed to bottom out against the end of the cylinder at the start of such movement. To avoid this effect, the cylinder **66** is proportioned to provide ample clearance space **73** to allow movement of the piston **68** in the direction of pivot **67** as needed to effect the longitudinal movement of the elevator. If desired, a compression spring **74** may be disposed in the cylinder **66** to urge piston **68** in the direction of pivot **67**. Such a spring **74** will tend to reduce unwanted pivoting of the elevator **36** from miscellaneous pressure fluctuations which may occur in the hydraulic circuit.

While a specific embodiment of the invention has been described herein, it will be apparent that many variations and modifications are possible within the scope of the invention and it is not intended to limit the invention except as defined in the following claims.

I claim:

1. In a scraper of the class having a bowl with a cutting edge and a movable elevator above said cutting edge, said elevator being driven by a fluid motor having a driving fluid intake, mechanism for providing a holddown force on said elevator comprising fluid operated force generating element coupled between said elevator and said bowl to urge said elevator toward said cutting edge, said force generating element having a fluid input communicated with said driving fluid intake of said elevator motor whereby said holddown force varies in accordance with changes in loading of said elevator.

2. In a scraper of the class having a bowl with a cutting edge and a movable elevator above said cutting edge wherein said elevator is operated by a fluid powered motor mechanism for providing a holddown force on said elevator comprising a controllable force generating element coupled between said elevator and said bowl to urge said elevator toward said cutting edge wherein said controllable force generating element comprises a cylinder having an end communicating with the driving fluid intake of said motor, a slidable piston therein, and a rod extending into said cylinder and coupled with said piston therein, said element being pivotably coupled to said elevator and pivotably coupled to said bowl, said communication of said cylinder end with said fluid intake of said motor being a control means which varies the holddown force produced by said element in accordance with changes in the loading of said elevator.

3. The combination defined in claim **2** and further comprising a resilient element coupled between said elevator and said bowl to resist movement of said elevator away from said cutting edge.

4. The combination defined in claim **2** and further comprising a spring disposed within said cylinder and acting against said piston therein to resist movement of said elevator away from said cutting edge.

5. The combination defined in claim **2** wherein said elevator is pivoted to said bowl at the top of said elevator and stops are secured to said bowl to limit downward pivoting movement of said elevator toward said cutting edge and wherein said elevator is movable longitudinally within a plane containing the pivot axis of said elevator, said controllable force generating element having a first end pivoted to said elevator and having the opposite end pivoted to said bowl rearwardly from said elevator and being contractible to a greater extent than required to contact said elevator with said stops when said elevator is at its lowermost position with respect to said longitudinal movement thereof whereby said elevator may lift longitudinally without also being forced away from said stops.

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