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Hyler

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[54] **AUTOMATIC ADJUSTMENT OF SCRAPER ELEVATOR USING CONTROL LINK COUPLED TO DRAFT FRAME**

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[52] **U.S. Cl.** **37/8**

[51] **Int. Cl.** **B60P 1/36**

[58] **Field of Search** 37/8

[56] **References Cited**

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Attorney, Agent, or Firm—Wolfe, Hubbard, Leydig, Voit & Osann, Ltd.

[57] **ABSTRACT**

An elevating type scraper for earth moving purposes having an open-fronted bowl with rear supporting wheels and with a scraper blade at the front of the bowl. The bowl is pivotally supported on a pair of draft members forming a part of a tractor supported draft frame. A bowl supporting actuator is interposed between the draft frame and the front end of the bowl to determine the degree of tilt of the bowl and hence the depth of the cut of the blade. An elevator of the endless conveyor type is positioned at the front end of the bowl with its lower end in proximity to the blade and inclined upwardly and rearwardly so that the earth loosened by the blade is conveyed into the bowl, the elevator being mounted for upward and downward swinging movement with respect to the ground. To maintain the elevator at a predetermined height above the ground, a linkage is provided which includes a control link of reference length secured at its upper end to the tractor draft frame and which carries a lever of the first class fulcrumed on its lower end. The first end of the lever is coupled to the lower end of the bowl supporting actuator while the second end of the lever is coupled to the elevator so that when the blade is at a reference cutting level the elevator is in a predetermined sweeping relation with the ground. When the actuator is contracted to raise the cutting level of the blade from its reference level, the elevator is lowered with respect to the bowl. Conversely, when the bowl-supporting actuator is elongated to lower the cutting level of the blade, the elevator is raised with respect to the bowl thereby to maintain the elevator in sweeping relation with the ground at all levels of cut.

21 Claims, 12 Drawing Figures

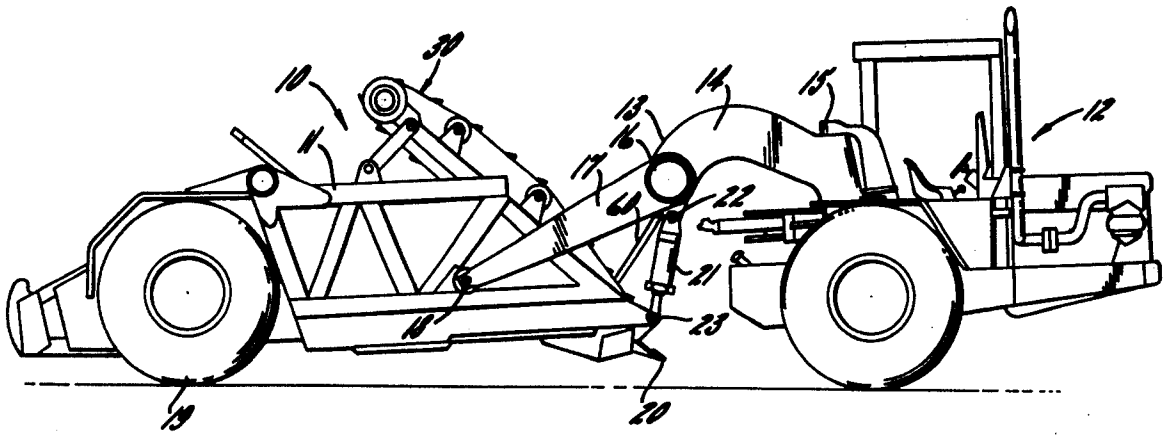

Fig. 1.

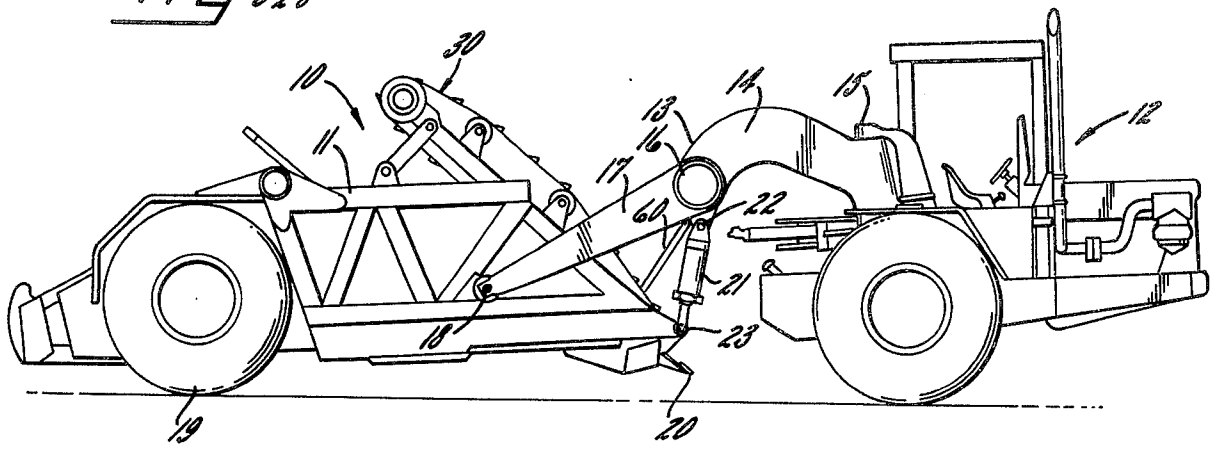
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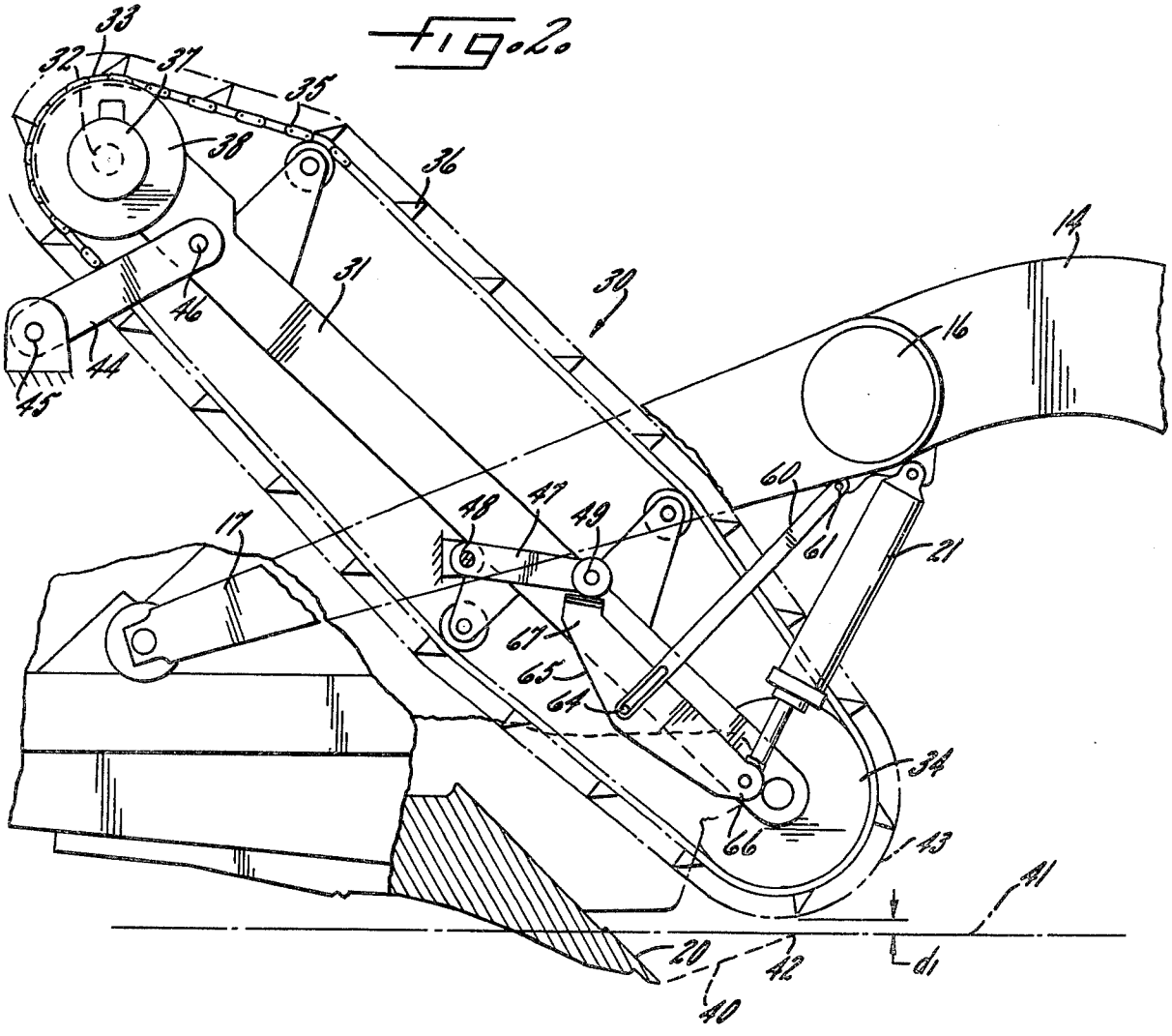
Fig. 2.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64
34
66
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41
20
42
40
d1

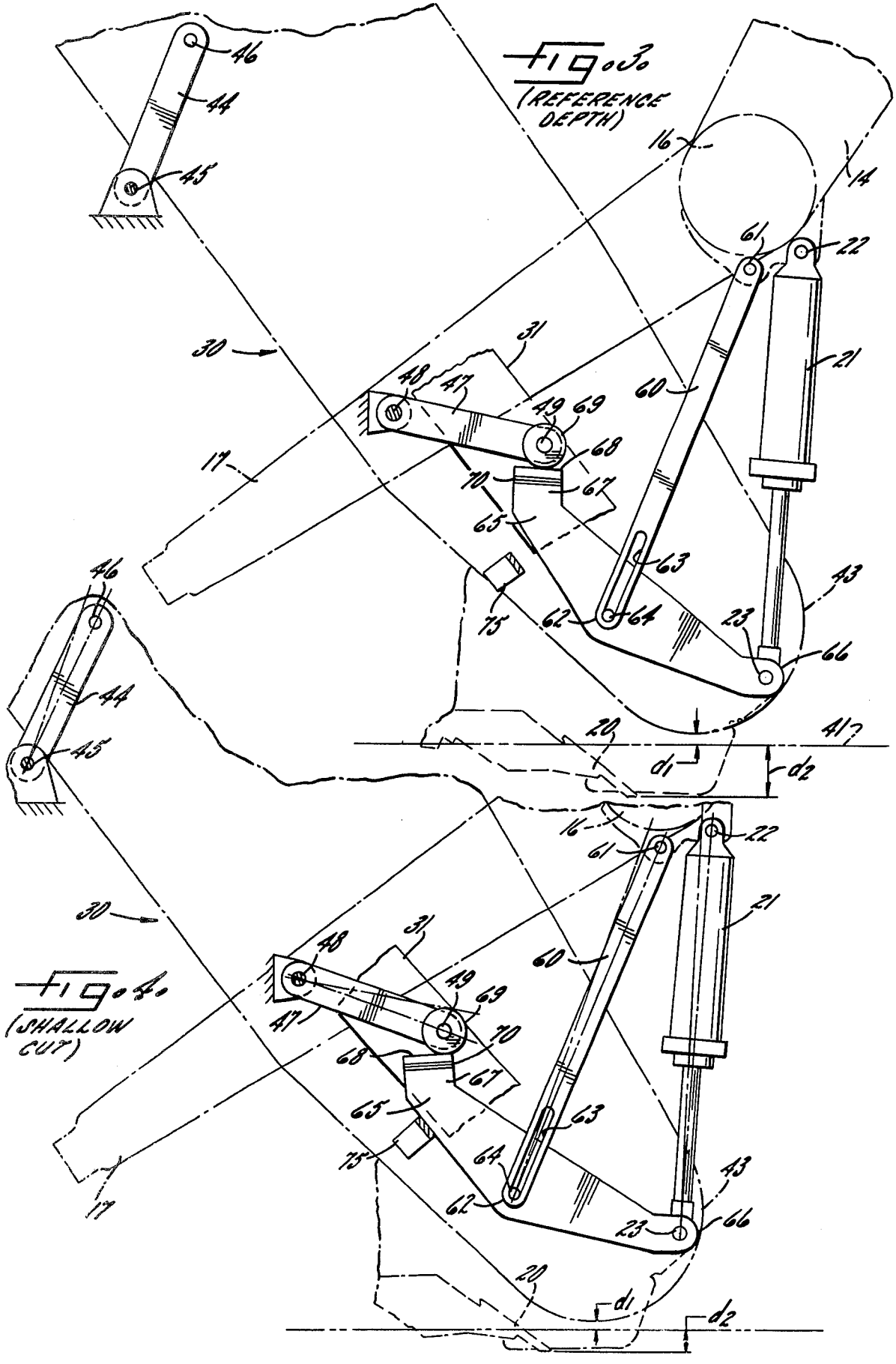


Fig. 3
(REFERENCE DEPTH)
Fig. 4
(SHALLOW CUT)
46
44
45
30
31
48
47
49
69
68
70
67
65
75
16
14
61
22
21
60
63
64
62
23
66
43
17
20
d1
d2

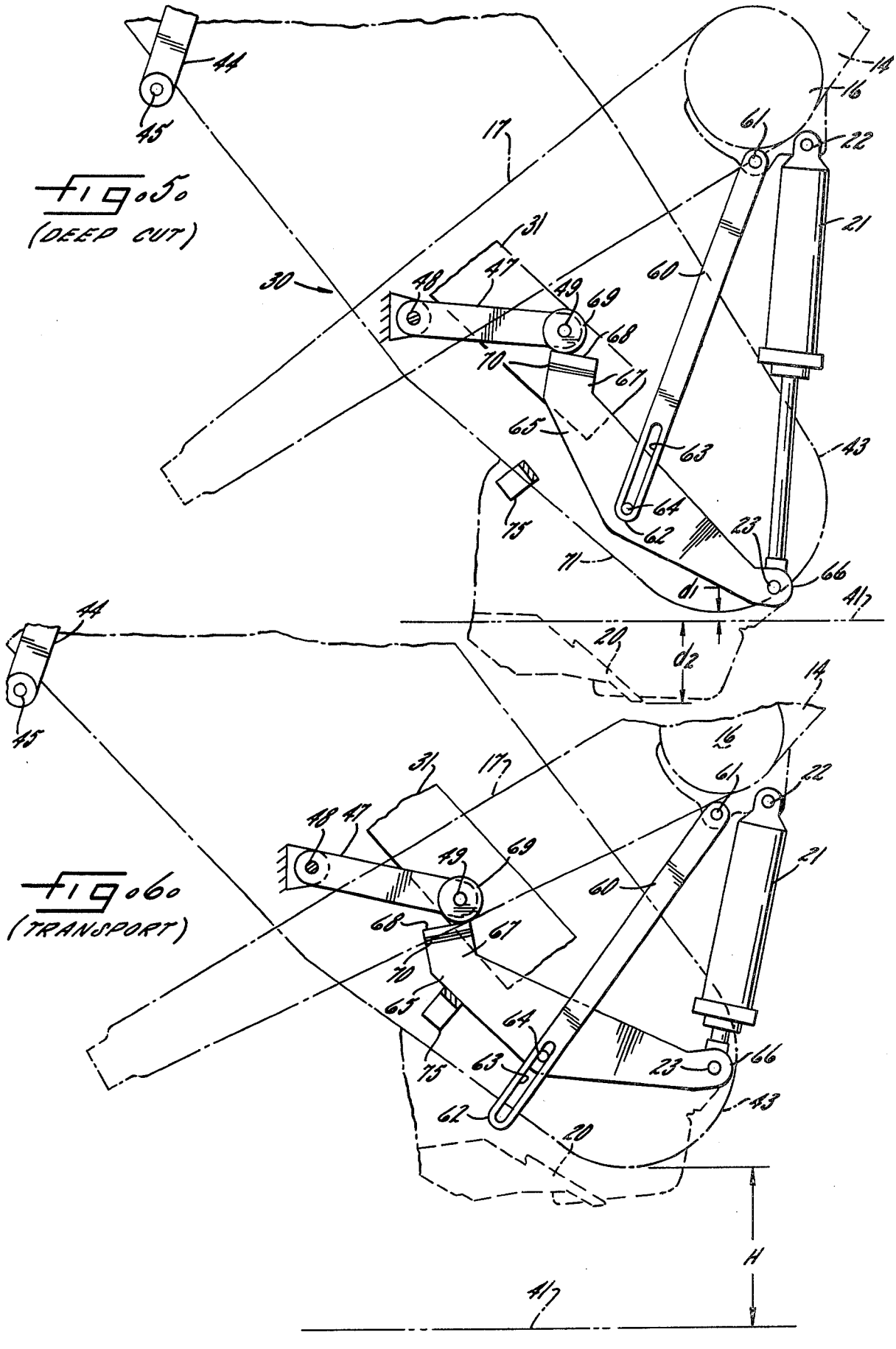


FIG. 5
(DEEP CUT)

FIG. 6
(TRANSPORT)

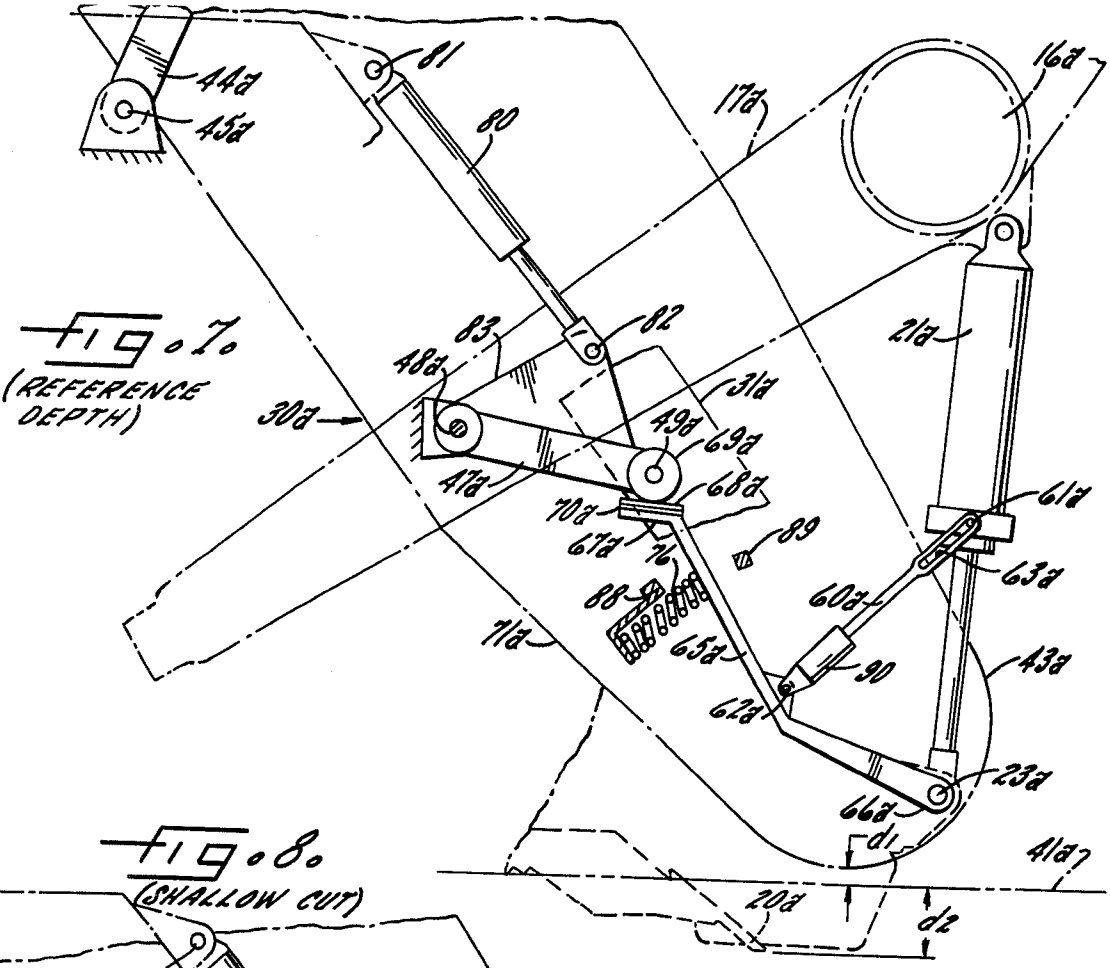
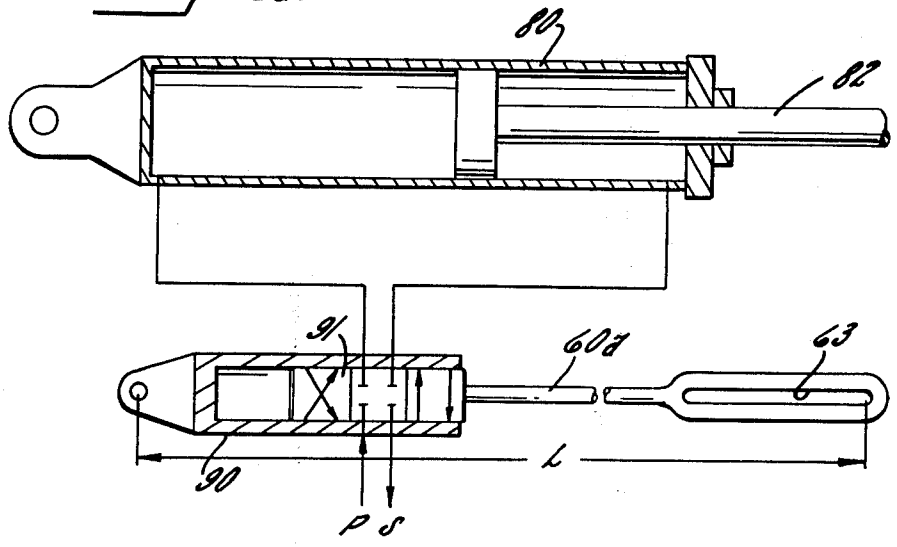


FIG. 7
(REFERENCE DEPTH)

FIG. 8
(SHALLOW CUT)

Fig. 7d


80
82
91
60d
63
90
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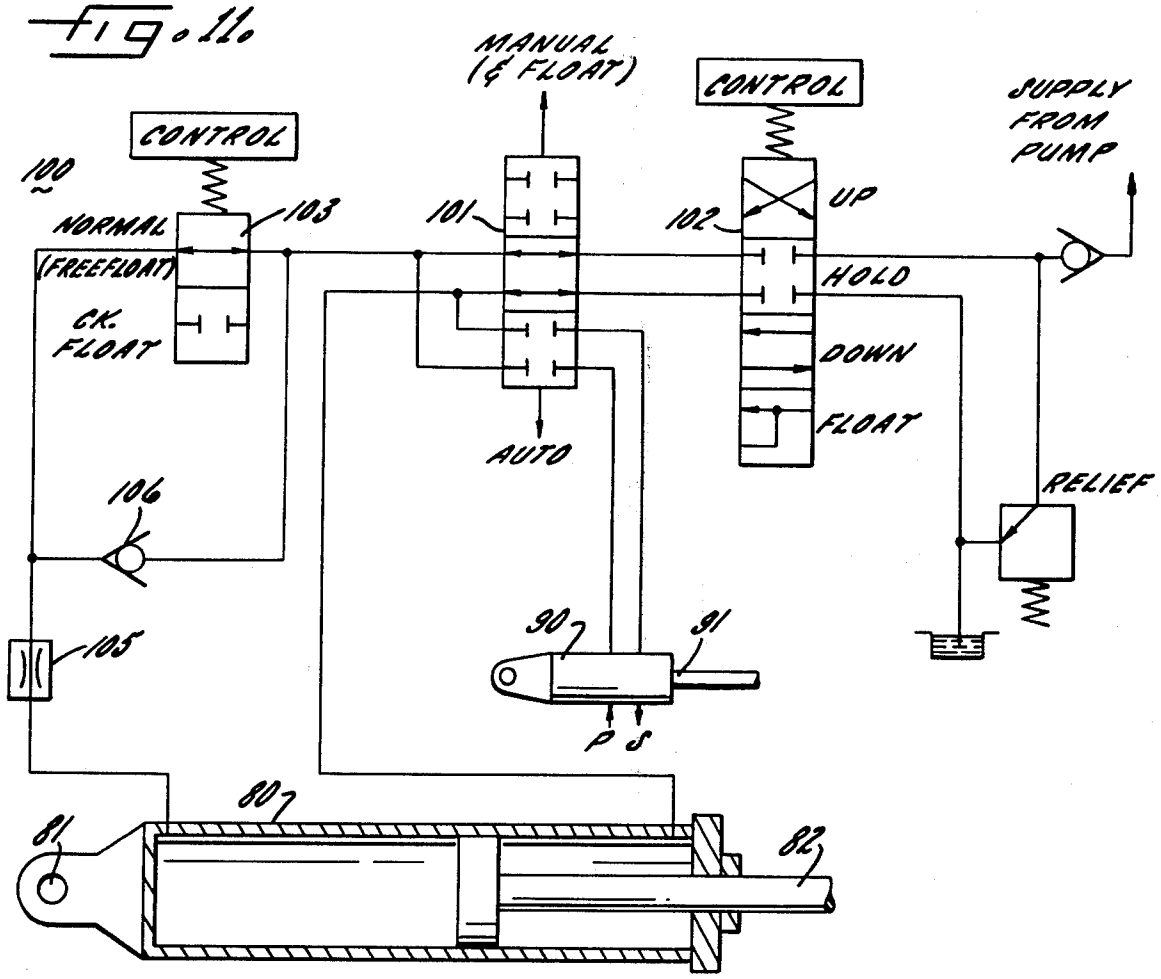
P
S

Fig. 11


MANUAL (& FLOAT)
CONTROL
CONTROL
SUPPLY FROM PUMP
100
NORMAL (FREEFLOAT)
103
101
102
UP
HOLD
DOWN
FLOAT
CK. FLOAT
AUTO
106
RELIEF
105
90
91
P
S
80
81
82

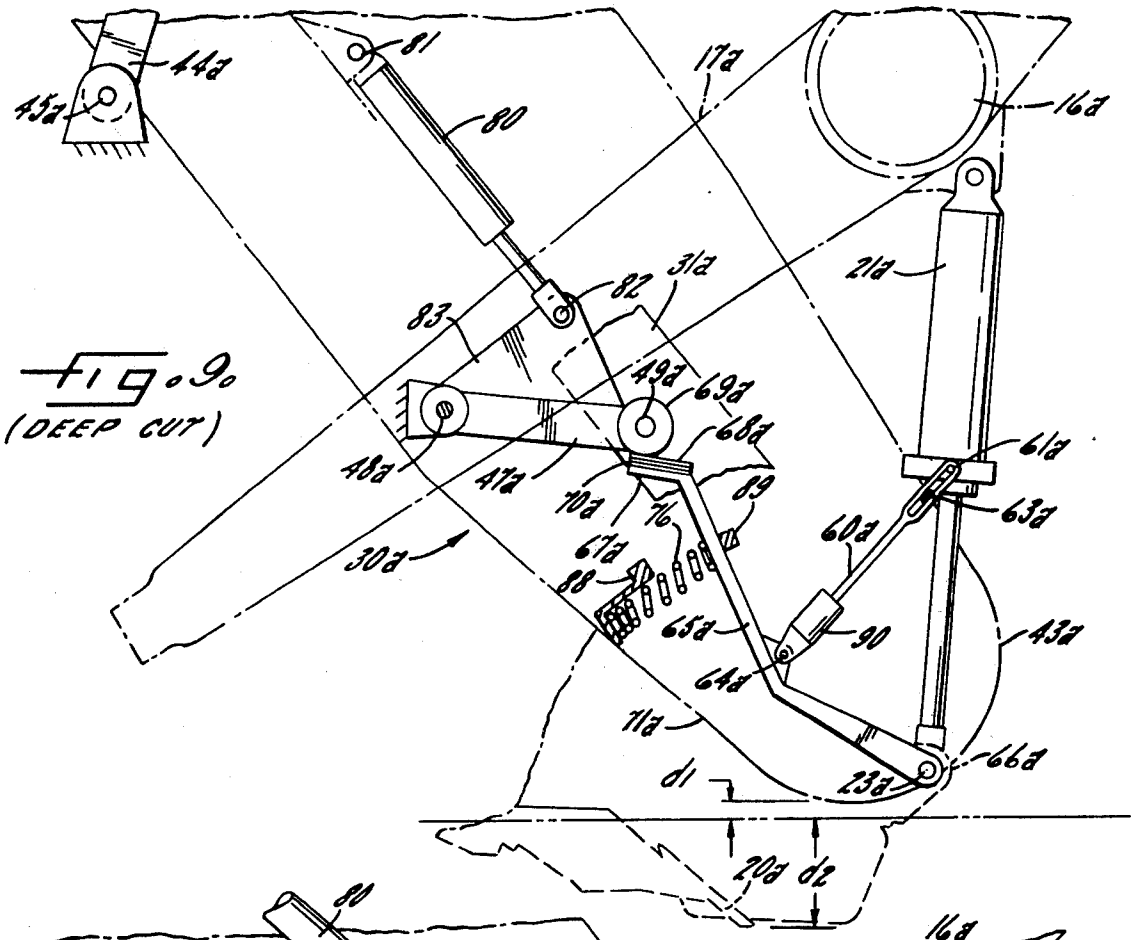


Fig. 9a
(DEEP CUT)

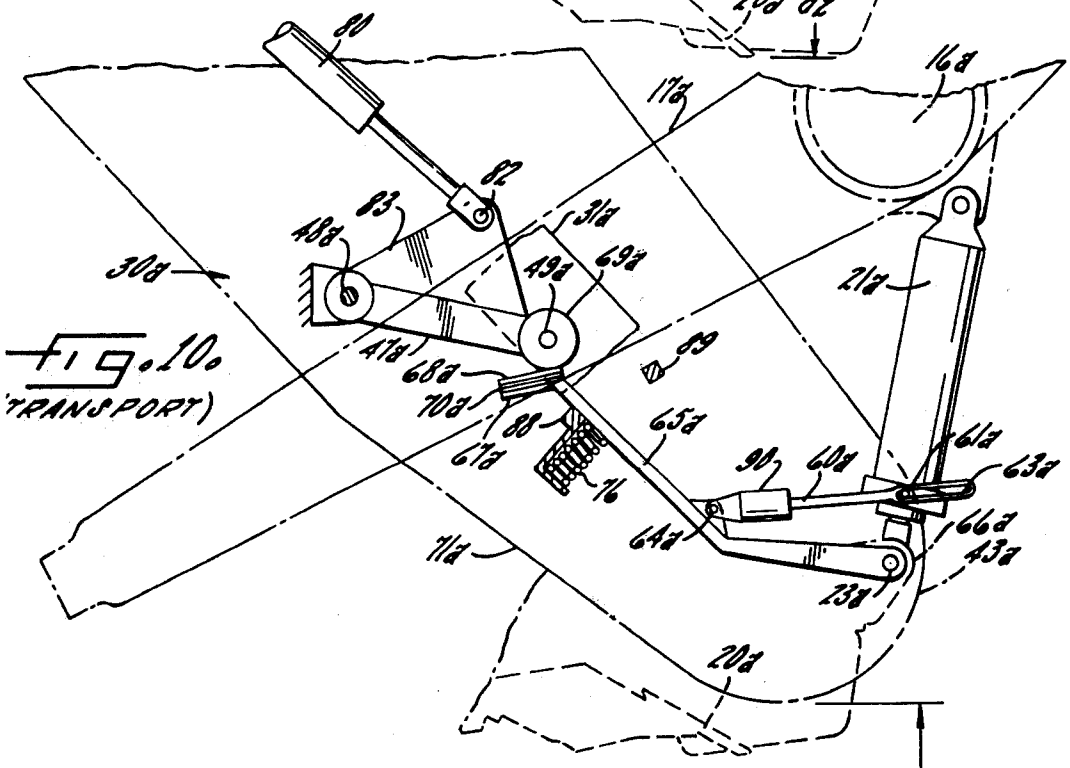


Fig. 10a
(TRANSPORT)

AUTOMATIC ADJUSTMENT OF SCRAPER ELEVATOR USING CONTROL LINK COUPLED TO DRAFT FRAME

In a first embodiment the control link bears the weight of the elevator. In a second embodiment the control link does not bear the weight of the elevator but serves as the control element for a servo system which includes an elevator-supporting power actuator which strives to maintain the control link constantly at its reference length thereby to keep the elevator in sweeping relation to the ground for all depths of cut.

Hydraulic circuitry is provided for enabling the elevator supporting actuator to perform additional functions both automatically and under manual control. For example, in "checked float" mode the elevator is permitted to climb upon a windrow to a higher level, and the elevator is thereafter held automatically at such level until released by the operator.

BACKGROUND OF THE INVENTION

The invention relates generally to an earth moving device in the form of a tractor-drawn scraper having a blade for loosening the soil and an elevator for conveying the loosened soil into the scraper bowl, and which has improved means for maintaining the elevator in predetermined sweeping relation with respect to the ground regardless of the depth of cut.

In conventional elevating type scrapers the elevator is swingably mounted on the scraper bowl, with the normal running position being determined by a set of stops. The stops are adjustable so as to provide the proper relationship between the conveyor and the undisturbed ground ahead of the blade for an assumed average depth of cut. However, the problem is that the depth of cut, which is under the control of the machine operator, can be varied over rather wide limits. When the blade is lowered to obtain a deeper cut, the elevator is correspondingly lowered so that the elevator flights, instead of sweeping over the surface of the undisturbed ground, strike the surface more or less flatly and with considerable impact. Conversely, when the blade is adjusted to a higher cutting level the elevator tends to be lifted clear of the ground thereby reducing the loading efficiency.

Where the elevator rides too low, the shocks to the elevator structure and its driving system, particularly where the ground is hard, may be so severe as to be of destructive effect. As each flight strikes the ground the elevator, in effect, tries to "climb up" upon the flight resulting in high peak loading, loss of power, and vibration which affects not only the elevator itself but the whole scraper assembly, with annoyance and fatigue to the operator.

This condition has been so consistently encountered in the past that compromises have been incorporated into the design and operation of the elevator such as driving the elevator at reduced speed and the use of additional, more closely spaced flights, all of which have meant a sacrifice in loading efficiency. Moreover, when the elevator rides too high or too low, and does not load efficiently, the loosened soil, which piles up ahead of the blade, must be pushed by the blade requiring greater tractive effort and higher horsepower.

In an effort to overcome these problems, adjustable stops have been provided to establish an elevator height which is suited to the depth of cut, but changing

the stops is burdensome and time consuming and requires temporary shutdown of the machine. Consequently where the operator must change cutting height frequently he usually finds it more practical to tolerate the vibration and other effects than to make frequent stop adjustments.

Moreover, the conventional means for adjusting elevator height is not designed to cope with extraordinary conditions such as the encountering of a windrow, boulders or other obstructions, and the driver tends to rely upon the self-elevation protective qualities which are built into a moder elevator even at the cost of possible damage.

SUMMARY OF THE INVENTION

It is, accordingly, an object of the present invention to provide an elevator height control arrangement for a scraper in which the elevator is automatically maintained in a predetermined sweeping relationship with the undisturbed ground regardless of variations in the tilt of the bowl and depth of cut of the blade. In using the invention the elevator is adjusted to clear the undisturbed ground with a predetermined clearance to establish a sweeping height on the order of an inch or two, with the blade at an average, or reference, depth of cut. Subsequently when the driver raises the blade level to take a shallower cut, the elevator automatically moves downwardly with respect to the bowl to preserve the same ground clearance. Conversely where the driver tilts the bowl to secure a deeper cut, adjustment is automatically and simultaneously imparted to the elevator so that it is raised relatively to the bowl, again maintaining the ground-sweeping relation.

It is, accordingly, an object to provide an automatic height adjusting means for an elevator which compensatingly responds to the change of blade height to avoid riding too high with its attendant loss in loading efficiency or riding too low with its destructive effects and loss of driving energy.

In carrying out the present invention elevator supporting means are provided which include a control ink of constant effective length interposed between the draft frame and the lower end of the elevator for supporting the elevator in predetermined sweeping relationship with the ground when the blade is at a reference cutting level. The link has compensating means in the form of a lever of the first class coupled to the lower end of the bowl-supporting actuator for increasing the effective length of the control link so that the elevator is lowered with respect to the bowl when the blade is raised above its reference level by the operator to take a shallower cut. The compensation means conversely acts to decrease the effective length of the control link to raise the elevator with respect to the bowl when the blade is lowered to take a thicker cut, with the result that the elevator is maintained in its desired sweeping relationship with the undisturbed ground level at all levels of cut without any thought or attention on the part of the operator.

In a first, purely mechanical embodiment of the present invention a control link, suspended from the tractor draft frame, carries a lever of the first class fulcrumed at its lower end. The first end of the lever is connected to the lower end of the bowl-supporting actuator while the second end of the lever supportingly engages the elevator. Means are provided for adjusting the linkage so that when the cutter blade is at a reference depth the

desired ground-sweeping relationship is established. However when the operator elongates the actuator to take a deeper cut a proportioned movement in the opposite direction raises the elevator with respect to the bowl, i.e., prevents the elevator from moving more closely to the ground, maintaining it, instead, at the desired operating level. The converse takes place when the blade is adjusted to a shallower cutting level, that is to say, the blade moves up, but the elevator is lowered with respect to the blade so that the elevator maintains the same ground clearance. In this embodiment the control link, in addition to its control function, supports the weight of the elevator.

In a modified embodiment of the invention a control link is provided but the support function is performed by an elevator supporting actuator, and means including a valve interposed in the control link serves to control the actuator with servo action, with the servo constantly striving to maintain the effective length of the control link constant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general elevational view showing a scraper embodying the present invention secured to a tractor.

FIG. 2 is a fragmentary elevation showing the elevator and its supporting and adjusting means.

FIG. 3 is a diagram showing the elevator supported in reference spacing above the ground.

FIGS. 4 and 5 are similar to FIG. 3 but show the blade set for a shallow and deep cut respectively.

FIG. 6 shows the elevator supporting means disabled during transport.

FIGS. 7–10 correspond to FIGS. 3–6 but with the weight of the elevator supported by a servo system.

FIG. 7*a* shows the elements of a simplified hydraulic servo system for use in the embodiment shown in FIGS. 7–10.

FIG. 11 is a more complete hydraulic control diagram permitting a number of additional modes of operation.

While the invention has been described in connection with certain preferred embodiments, it will be understood that there is no intention to limit the invention to such embodiments and that it is intended, on the contrary, to cover various alternative and eqivalent constructions included within the spirit and scope of the appended claims.

DETAILED DESCRIPTION OF THE FIRST EMBODIMENT

Referring now to the drawings, there is disclosed a scraper assembly made up of a bowl **10** having a frame **11** and a tractor **12** having a draft frame **13.** The draft frame includes a so-called gooseneck **14** which is of rigid construction pivoted to the tractor at **15** for horizontal swinging movement and carrying a transversely extending torque tube **16** to which draft members **17** are secured. The latter extend rearwardly and downwardly and are pivoted at **18** to the respective sides of the bowl. The rear end of the bowl is supported upon a pair of wheels **19.**

Mounted along the front edge of the bowl is a blade **20** which digs into the ground to a depth determined by the angle of tilt of the bowl about the draft axis **18.** For determining this angle, and the cutting depth, a bowl supporting actuator **21** is provided at each side of the bowl, the actuator shown in FIG. **1** having an upper point of anchoring **22** to the tractor draft frame and having a lower connection **23** to the front portion of the bowl structure conveniently one of the bowl side plates. For the purpose of conveying the soil loosened by the blade to the back of the bowl, an elevator **30** is provided (FIG. **2**) having a lower end which rides above and slightly ahead of the blade **20** and which extends rearwardly and upwardly enclosing the front end of the bowl. The elevator includes a pair of longitudinal frame members **31** journalling a cross shaft **32** at its upper end driving a pair of sprocket wheels **33.** At the lower end of the elevator, in alined positions, are idler wheels **34.** Trained about the sprockets and idlers are conveyor chains **35** having transversely extending flights **36.** The cross shaft **32** is driven by a motor **37** through a gear box **38.**

The blade moving through the ground tends to break the soil along a shear plane indicated at **40.** The elevator is mounted so that its low point, with respect to the undisturbed ground surface **41,** approximately coincides with the end **42** of the shear plane. The elevator should be sufficiently elevated above the ground under running conditions so as to provide a slight amount of grazing or sweeping clearance d1 which may, for example, be on the order of a fraction of an inch, with respect to the flight envelope **43.**

For the purpose of mounting the elevator for upward and foward swinging movement thereby to change the running position of the elevator with respect to the ground, and also permitting the elevator to yield upon encountering boulders or other obstructions, the frame of the elevator is swingably supported upon a pair of upper links **44** having pivot connections **45, 46** and a pair of lower links **47** having pivot connections **48, 49,** made to the bowl and elevator frame, respectively.

In conventional constructions, to determine the height at which the elevator rides for a given depth of cut, limit stops are used, for example, limit stops which may be mounted upon the bowl structure in the downward path of swing of the lower links **47,** with shims being adjustably interposed. However, in accordance with the present invention, a control link of reference length is coupled to the draft frame, with a lever of the first class fulcrumed at the bottom of the control link, the first end of the lever being coupled to the lower end of the bowl supporting actuator, that is, to the bowl and blade and the second end of the lever being coupled to the elevator. Because of the reversal of direction which is brought about by the teeter-totter action of a lever of the first class, the direction of movement of the elevator is caused to be just the opposite of that of the cutting blade. That is to say, when the bowl supporting actuator is contracted to raise the cutting level of the blade, the elevator is lowered with respect to the bowl, and when the bowl supporting actuator is elongated to cause the blade to dig deeper, the elevator is relatively raised. As a result the elevator maintains a constant height above the ground, with maximum conveying efficiency, at all blade levels without care or attention on the part of the operator. The lever may also be thought of as a means for effectively changing the length of the control link, that is, as a means for compensatingly varying the distance between the draft frame and the elevator in accordance with the cutting level of the blade.

Thus, turning to FIG. **3** of the drawings, there is provided a control link **60** which is pinned at its upper end

61 to the torque tube 16 of the tractor draft frame. At its lower end 62 the link has a slot 63, slidably containing a pivot pin 64, which serves to fulcum a lever 65 of the first class having a first end 66 and a second end 67. The end 66 is connected to the lower end 23 of the bowl supporting actuator 21 so that the lever 65 is rocked upwardly and downwardly as the actuator changes in length. At the second or lefthand end 67 the lever provides a supporting surface 68 which provides a supporting surface for a roller 69 mounted on the elevator. Shims 70 are interposed between the lever and its supporting surface, the shims being adjusted so that when the blade is at the reference depth d2 the flights of the elevator, moving within envelope 43, sweep the ground at a small clearance distance d1.

When the operator desires to take a more shallow cut, the actuator 21 is contracted bringing the mechanism into the condition shown in FIG. 4. Contraction of the actuator rotates the lever 65 counterclockwise, relatively dropping the elevator with respect to the bowl so that the same clearance distance d1 is preserved even through the blade is at a more shallow depth. Conversely when the operator decides to take a deeper cut he does so by elongating the actuator 21 which rotates the lever 65 clockwise into the condition shown in FIG. 5 which results in the raising of the elevator with respect to the bowl, thereby preserving the elevator height at the same sweeping clearance above ground.

Referring back to FIG. 4 which shows the minimum depth condition, it is apparent that as the blade is moved to the shallower level, approaching the undisturbed surface of the ground, the blade and elevator flights will approach one another ever more closely. To insure that there will always be a safe clearance distance between the flights and the blade and its associated structure, a stop 75 mounted upon the bowl structure is provided in the path of movement of the second or lefthand end of the lever 65.

It will be apparent to one skilled in the art that while the control link 60 has a constant and reference length, the effect of the lever 65, which is interposed between the link 60 and the elevator, is to change the effective spacing between the elevator and tractor draft frame by introducing compensation via the centrally pivoted lever. The central pivoting responds to the degree of expansion or contraction of the actuator 21 which determines blade depth but reverses the direction so that the elevator moves oppositely, that is, compensatingly, with respect to the blade, the amount of movement being a matter of proportioning the lever arms and matter of determining where, on the elevator structure, the lever displacement is to be applied.

For convenience the righthand end 66 of the lever is connected to the same center as the lower or movable end 23 of the actuator, but it will be apparent that it is not essential to employ this center in practicing the invention as long as the end of the lever is secured to a point which is responsive to actuator, or bowl, movement.

While it is preferred to use shims at the second or lefthand end of the lever to achieve the condition of initial adjustment, it will be apparent to one skilled in the art that it is a matter of convenience and that the initial condition may be adjusted by providing adjustable displacment at any of the three points of connection to the lever. Once the initial adjustment has been made, operation of the machine is greatly simplified since the operator need only concern himself with blade depth and need not make any compensatory change in elevator height which, in the usual case, requires stopping the machine to change shims.

It is one of the features of the present invention that, in addition to providing a stop 75 for limiting the approach of the elevator to the blade, one-way lost motion connections are provided between the elevator and the second end of the lever as well as at the fulcrum. Lost motion at the fulcrum is secured by the slot 63. The fulcrum normally seats at the bottom of the slot for all normal control functions, the bottoming force being reliably high because of the weight of the elevator. However when the bowl is drawn upwardly by the actuator 21 out of the normal control range, as required, for example, by high lever transport, the lost motion is utilized, disabling the control function as set forth in FIG. 6, with the elevator being carried at a height H above the ground.

It is to be particularly noted that while the tractor draft frame is used for reference pusposes to bring about a corrective change in elevator position, the draft frame itself does not remain at a reference height but changes in height as changes are made in cutting depth. In is one of the features of the present device that it automatically takes into account, and indeed untilizes, this height variation.

DETAILED DESCRIPTION OF SECOND EMBODIMENT

In the preceding embodiment the weight of the elevator is borne by the constant length control link 60. In accordance with my teachings it is possible to utilize the invention while relieving the control link of its weight-supporting function as set forth in FIG. 7 where the mechanism is illustrated in a reference condition as in FIG. 3. Similar elements have been assigned similar reference numerals with addition of subscript *a*. That is, a bowl supporting actuator 21*a* is pivoted at its upper end to the transverse draft frame member 16*a* and, at its lower end 23*a*, to the bowl. The elevator, generally indicated at 30*a*, is supported upon links 44*a*, 47*a*. The control link 60*a* of constant length is connected at its upper end 61*a*, as a matter of convenience, to the body of the actuator 21*a* and at its lower end 62*a* to the center of a lever of the first class 65*a*. The first, or righthand, end 66*a* of the lever is coupled to the lower end of the actuator 21*a* while the second, or lefthand, end 67*a* of the lever presents a supporting surface 68*a* which engages a roller 69*a* which is mounted upon the elevator, and the supported level of which is determined by shims 70*a*. The stack of shims is adjusted so thaat the envelope 71*a* of the flights has a clearance spacing *d*1 with respect to the undisturbed ground when the blade 20*a* cuts at a reference depth *d* 2.

For the purpose of supporting the weight of the elevator, while achieving automatic elevator level control, and for obtaining additional benefits as will be discussed, a servo actuator 80 is provided which is connected at its upper end 81 to the frame of the bowl and coupled at its lower end 82 to the elevator. Conveniently the lower end of the actuator is connected to a bracket 83 which is secured to the lower elevator supporting link 47*a*. For the purpose of controlling the servo actuator a valve 90 having a plunger 91 is pro-

vided in the constant length control link **60***a* as set forth in FIG. 7*a*. Thus the control link, instead of actually bearing the load, performs a servo control function to instruct the servo actuator **80** as to what level the load shall be borne by the actuator in order to maintain the link **60***a* at its constant reference length.

The corrective action of the servo may be verified as follows: Suppose that the elevator happens to be positioned slightly "low". Under such circumstances the roller **69***a* will bear upon the lever **65***a* rocking the lever slightly counterclockwise and tending to increase the length of the control link **60***a*. Under such circumstances the valve plunger **91** of the valve will be drawn outwardly causing the lower, or righthand, end of the actuator **80** to be pressurized. This causes the actuator to contract slightly, raising the elevator and tending to cause the roller **69***a* on the elevator to retreat from the lefthand end of the lever **65***a*. The spring **76** performs a follow-up function, maintaining the lever seated upon the roller, thereby rotating the lever clockwise which tends to shorten the control link **60***a*, that is, restore it to its reference length. This shuts off further flow of fluid to the actuator and no further movement takes place. The converse occurs in the event that the elevator is positioned, by the actuator **80**, a little on the "high" side. This results in a shortening of the control link **60***a* which operates the valve **90** to pressurize the upper or lefthand end of the actuator **80**, lowering the elevator to a position in which the reference length condition is established and the valve turns off.

The same mode of elevator height correction takes place when the blade level is intentionally changed by the operator. For example, if the bowl supporting cylinder **21***a* is contracted so as to take a shallower depth of cut, which is the condition illustrated in FIG. **8**, this results in immediate momentary shortening of the control link **60***a*. As previously noted, this results in the feeding of fluid to the upper or lefthand end of the servo actuator **80**, lowering the elevator with respect to the bowl upon which it is supported, such lowering continuing, accompanied by elongation of the control link until restoration of the control link to its reference length causes the flow of fluid to be turned off. This will occur when the elevator is at a sweeping clearance spacing d1 from the undisturbed ground level. In the event that the elevator should, for any reason, to tend to rise or fall, the servo system will act automatically to restore the original clearance condition.

In the event that the operator calls for a deeper cut by elongating the bowl supporting actuator **21***a*, just the reverse occurs. The effect of elongation is to cause the control link to elonage, pressuring the lower or righthand end of the servo actuator **80** causing such actuator to contract and raising the elevator with respect to the bowl so that, instead of being lowered with the bowl and blade, the elevator remains at its desired clearance distance (FIG. **9**) with respect to the ground. Thus the clearance remains constant in spite of changes in blade cutting level and with the running clearance being subject to adjustment by changing the thickness of the shims **70***a*.

Just as in the earlier embodiment, one-way lost motion connections are provided at the lefthand end of the lever and also at the fulcrum. Thus there is provided in the contol link **60***a* an elongated slot **63***a*, with lost motion being taken up in the slot out of the control range and during transport conditions as illustrated in FIG. **9**.

To limit movement of the lever **65***a* to a normal control range, limit stops are provided on each side of the lever as indicated at **88, 89,** respectively.

In accordance with one of the aspects of the present invention, the servo actuator **80,** in addition to its servo function, is used for manual raising and lowering of the elevator and to establish conditions referred to as "free float" and "checked float". To achieve this versatility I prefer to use an hydraulic circuit as set forth at **100** in FIG. **11** including an auto-manual selector valve **101** and a manual-float selector valve **102.** The auto-manual valve **101** is shown in its manual position. The circuit includes, in addition, a checked float and free float selector valve **103,** this being shown in its normal or free float condition.

In the free float condition the actuator **80** is effectively by-passed by a fluid loop so that it does not have any control upon elevation and the elevator operates as a conventional elevator without the present invention. Preferably the fluid loop includes a damping orifice **105** so that the actuator serves, in this mode, as a shock absorber. To achieve the checked float mode the actuator, instead of being simply by-passed, is shunted by a check valve **106** so that, upon striking a windrow or other obstruction, causing the elevtor to rise by its well-known climbing action, the actuator **80** will be free to accommodate the rising elevator movement but, because of the action of the check valve **106,** will hold the elevator in its upraised position until such time as the elevator may be released. Thus where the scraper encounters a windrow, the elevator, after climbing on its flights, to windrow height, will remain at such height until the operator by operating the valves takes over control or restores the elevator to automatic control. Thus the operator, after shifting the valve **103** to the normal (free float) position may either resume automatic level control by movement of valve **101** to its auto position or may manually control the elevator or obtain free float by manipulation of valve **102.**

To review the functions attainable in the hydraulic circuit, it will be assumed, first of all, tht the valve **101** is in its "auto" position and that valve **103** is in its normal (illustrated) position. Automatic elevator clearance will then be achieved as discussed in connection with FIGS. **7, 8** and **9.**

For raising and lower the elevator manually, the valve **101** is shifted to manual position and valve **102** is shifted to its up or down position.

To establish a floating condition the valve **102** is shifted to float, which provides a short circuit connection between the ends of the actuator **80** so that the actuator has no effect upon the elevator. During free float the movement is, however, not completely free but is damped by the damping orifice **105.**

Upon shifting the valve **103** to its checked float position, the short circuit connection is blocked so that any fluid flow must take place through the check valve **106.** Fluid flow takes place readily through the check valve when the elevator rises in response to climbing up upon an obstruction, the elevator being held at the new height because of the checking action. Where it is desired to subsequently lower the elevator the valve **103** is moved to its normal position and the valve **102** is moved either to its down or float position. In all of the various operating conditions the motion is slowed and movement is cushioned by the damping orifice **105.**

It will be apparent to one skilled in the art that the centrally pivoted lever 65, coupled to the central link 60, serves as one form of motion-reversing linkage. The latter term as used herewith will be understood to refer generally to force transmitting means having two portions which are constrained to move in opposite directions so that when the front end of the bowl is lowered by the bowl actuator to lower the blade the elevator is raised and vice versa. The term "control link" as used herein is a general term to cover any member interposed, for control purposes, between the draft frame and the motion-reversing linkage.

What is claimed is:

1. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured at their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, elevator support means including a control link of reference length coupled to the draft frame, a lever of the first class fulcrumed on the control link, the first end of the lever being coupled to the lower end of the bowl-supporting actuator, the second end of the lever being coupled to the elevator so that when the blade is at a reference cutting level the elevator is in sweeping relation with the ground, so that when the bowl-supporting actuator is contracted to raise the cutting level of the blade the elevator is lowered with respect to the bowl and so that when the bowl-supporting actuator is elongated to lower the cutting level of the blade the elevator is raised with respect to the bowl, thereby to maintain the elevator in sweeping relation with the ground at all levels of cut.

2. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured at their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, a control link of reference length coupled to the draft frame, a lever of the first class fulcrumed on the control link, the first end of the lever being coupled to the lower end of the bowl-supporting actuator, the second end of the lever being connected to the elevator for supporting the same so that when the actuator is contracted to raise the cutting level of the blade from its reference level the elevator is lowered with respect to the bowl and so that when the bowl-supporting actuator is elongated to lower the cutting level of the blade the elevator is raised with respect to the bowl, thereby to maintain the elevator in sweeping relation with the ground at all levels of cut.

3. The combination as claimed in claim 1 in which a limit stop is interposed between the elevator and the frame of the bowl to limit the approach of the elevator to the blade when the bowl is moved upwardly beyond its normal blade-controlling range for transport and a one-way lost motion connection at the fulcrum of the lever for accommodating such upward movement of the bowl.

4. The combination as claimed in claim 3 in which the control link has pins at its respective ends and in which the lost motion connection is in the form of a longitudinal slot formed in at least one end of the link providing relative sliding movement for the associated pin.

5. The combination as claimed in claim 1 in which means are provided for adjusting at least one of the lever connections with respect to the lever thereby to vary the reference amount of sweeping clearance of the elevator with respect to the ground.

6. The combination as claimed in claim 1 in which shims are interposably provided at one end of the lever thereby to vary the reference amount of sweeping clearance of the elevator with respect to the ground.

7. The combination as claimed in claim 1 in which shims are provided at the second end of the lever and interposed between the lever and the elevator.

8. The combination as claimed in claim 2 in which a stop is provided on the frame of the bowl in the path of downward movement of the second end of the lever for limiting the lowering movement of an elevator with respect to the blade.

9. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured at their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, a control link of reference length coupled to the draft frame, a lever of the first class fulcrumed on the control link, the first end of the lever being coupled to the lower end of the actuator, the second end of the lever being coupled to the elevator, and

a servo actuator system including a (1) servo valve interposed in the control link and (2) an elevator supporting servo actuator interposingly coupled between the bowl frame and the elevator for correctively positioning the elevator in response to any change in effective length of the control link so that when the bowl-supporting actuator is contracted to raise the cutting level of the blade from its reference level the elevator is relatively lowered and when such actuator is elongated to lower the cutting level of the blade the elevator is raised, thereby to maintain the elevator in sweeping relation to the ground at all depths of cut.

10. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured a their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, a control linkage coupled to the draft frame and including a lever, one end of the lever being coupled to the lower end of the actuator, the other end of the lever being coupled to the elevator, and a servo actuator system including (1) a servo valve interposed in the control linkage and (2) a servo actuator supportingly connected to the elevator for correctively positioning the elevator in response to departure of the linkage from a reference condition, the lever serving by its teeter-totter action to reverse the movement so that when the bowl-supporting actuator is contracted to raise the cutting level of the blade the elevator is relatively lowered and when such actuator is elongated to lower the cutting level of the blade the elevator is raised, thereby to maintain the elevator in relation to the ground at all depths of cut.

11. The combination as claimed in claim **9** in which a manual control valve is provided for the servo actuator and in which a selector valve is provided connected to the servo valve and manual control valve for causing the actuator to act in the normal servo mode to achieve desired automatic control of elevator position relative to ground surface during loading operations, or alternatively in the manual mode for positioning of the elevator as desired.

12. The combination as claimed in claim **9** in which the elevator is connected to the frame of the bowl by upper and lower pairs of links, the elevator supporting servo actuator being connected between one of the links and the frame of the bowl, and control means for causing the actuator to act in a normal servo mode to achieve desired automatic control of elevator position relative to ground surface during loading operations, or alternatively in the manual mode for positioning of the elevator as desired.

13. The combination as claimed in claim **9** in which a limit stop is provided on the frame of the bowl to limit the movement of the lever when the elevator is upraised to its idle carry position for transport.

14. The combination as claimed in claim **9** in which one-way lost motion connections are provided at the fulcum and at the second end of the lever to accommodate upward swinging movement of the elevator into an idle carry position for transport.

15. The combination as claimed in claim **14** in which a spring is provided for taking up the lost motion at the second end of the lever.

16. The combination as claimed in claim **9** in which the elevator supporting actuator is provided with an hydraulic circuit capable of permitting the elevator to rise in response to climbing action of the elevator flights upon a windrow or the like to an elevated position with respect to the frame of the bowl, and selectively operable means for automatically retaining the elevator in such elevated position until intentionally released therefrom.

17. The combination as claimed in claim **16** in which the elevator supporting actuator has a check valve effectively bypassing the same and oriented in a direction to permit the elevator freely to rise upon engagement with a windrow.

18. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured at their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, elevator support means including a control link of reference length interposed between the draft frame and the lower end of the elevator for supporting the elevator in sweeping relation with the ground when the blade is at reference cutting level, the link having level compensation means coupled to the lower end of the actuator for increasing the effective length of the control link to lower the elevator with respect to the bowl when the blade is raised from its reference level and for decreasing the effective length of the control link to raise the elevator with respect to the bowl when the blade is lowered from its reference level so that the elevator is maintained in predetermined relation with the ground at all levels of cut.

19. In an elevating type scraper for earthmoving purposes, the combination comprising an open-fronted bowl having a frame, ground wheels at the rear of the frame for supporting the bowl, a scraper blade at the front of the bowl, a tractor supported draft frame, a pair of draft members pivotally secured at their rear ends to the sides of the bowl and extending forwardly and upwardly having rigid connections at their front

ends to the draft frame, means including a bowl-supporting actuator interposed between the draft frame and the front end of the bowl and having control means for determining the degree of tilt of the bowl about its supporting wheels and hence the depth of cut of the blade, a driven endless elevator positioned at the front end of the bowl having its lower end in proximity to the blade and inclined upwardly and rearwardly for conveying loosened soil from the blade into the bowl, the elevator being mounted on the frame of the bowl for upward and downward swinging movement with respect to the ground, elevator support means including a control link coupled to the draft frame and a motion-reversing linkage coupled to the control link, the linkage having first and second portions which move in opposite directions, the first portion of the motion-reversing linkage being coupled to the lower end of the bowl-supporting actuator, the second portion of the motion-reversing linkage being coupled to the elevator so that when the bowl-supporting actuator is contracted to raise the cutting level of the blade the elevator is lowered with respect to the bowl and so that when the bowl-supporting actuator is elongated to lower the cutting level of the blade the elevator is raised with respect to the bowl, thereby to maintain the elevator in substantially the same sweeping relation with the ground at all levels of cut.

20. The combination as claimed in claim **19** in which a limit stop is interposed between the elevator and the frame of the bowl to limit the approach of the elevator to the blade when the bowl is moved upwardly beyond its normal blade-controlling range for transport, the control link having a one-way lost motion connection for accommodating such upward movement of the bowl.

21. The combination as claimed in claim **19** in which means are provided for adjusting at least one of the connections to the motion-reversing linkage thereby to vary the maintained sweeping clearance of the elevator with respect to the ground.

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