Dec. 24, 1957 H. A. MULLIN 2,817,168

BULLDOZER

Filed March 29, 1954 3 Sheets-Sheet 1

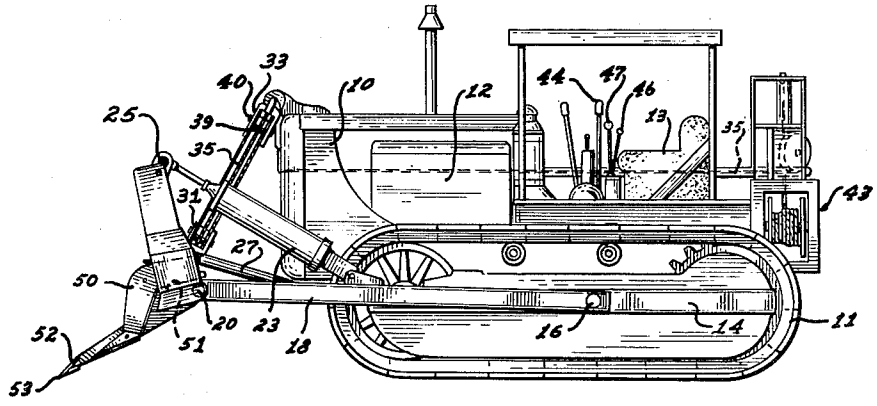


Fig. 1

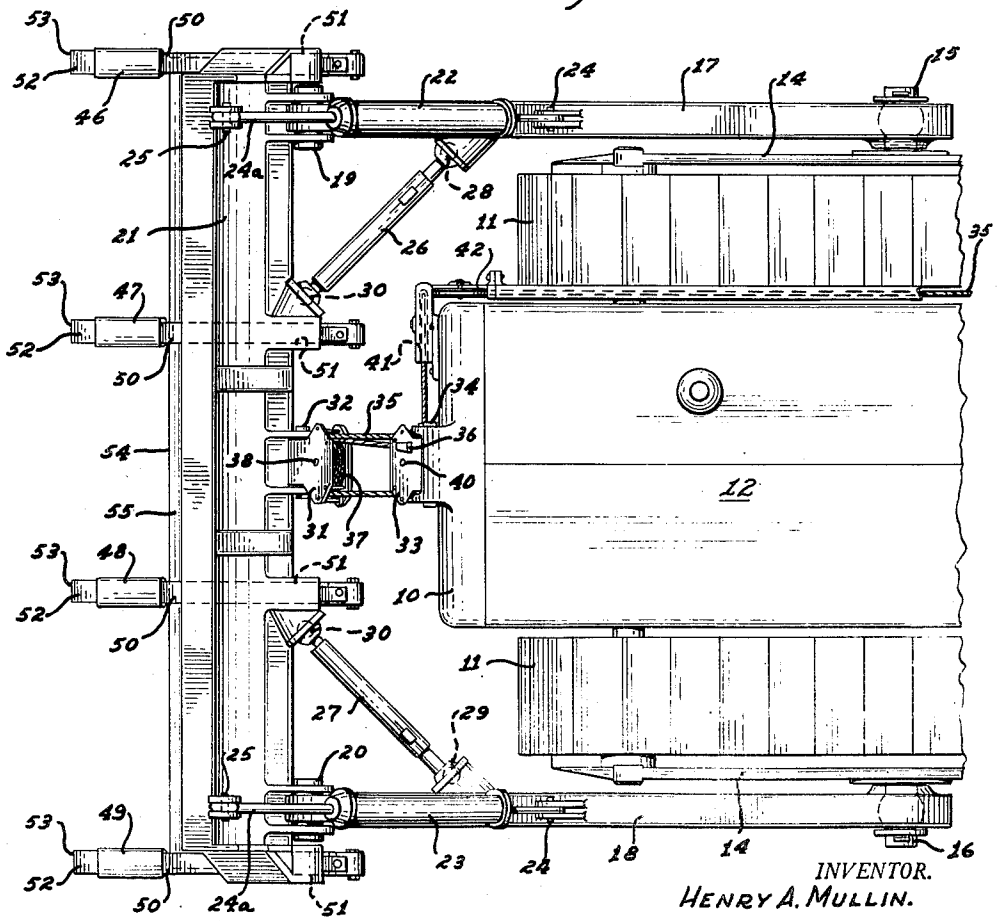


Fig. 2

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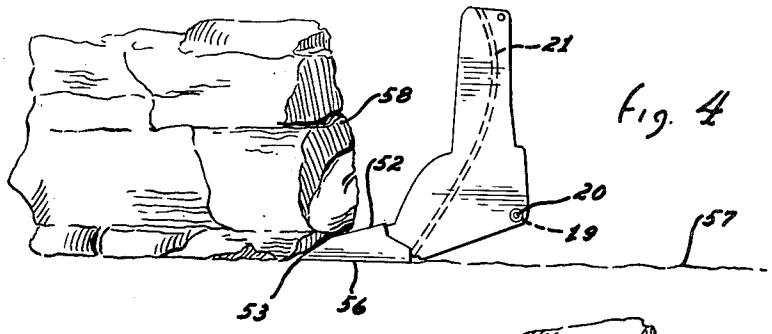


Fig. 4

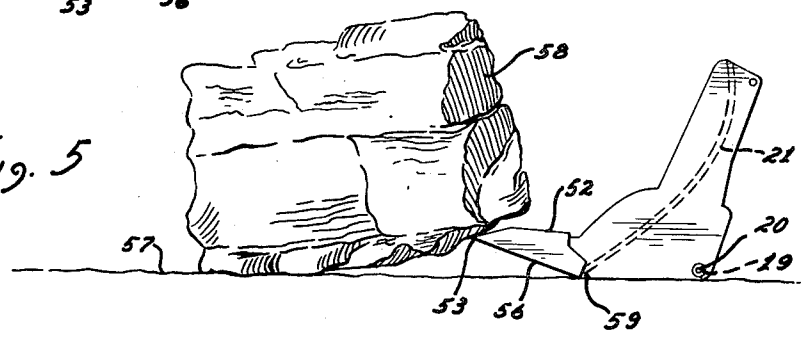


Fig. 5

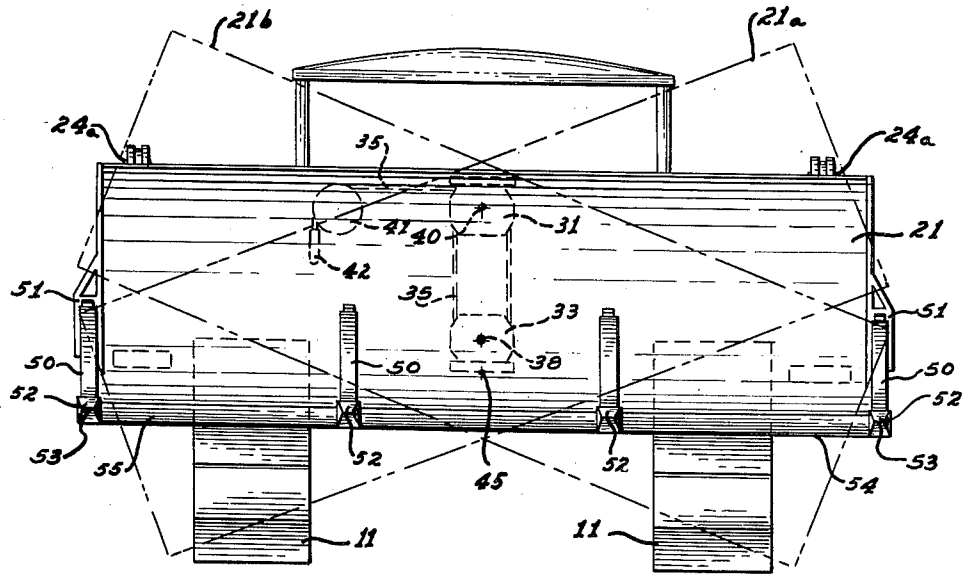


Fig. 3

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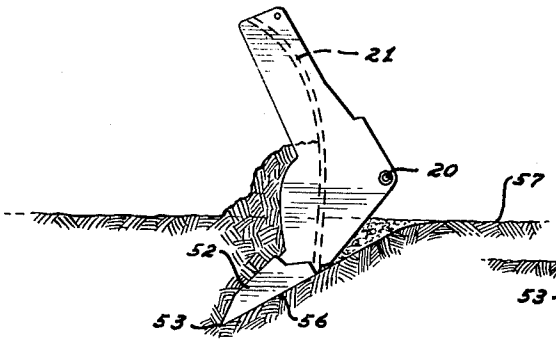


Fig. 7

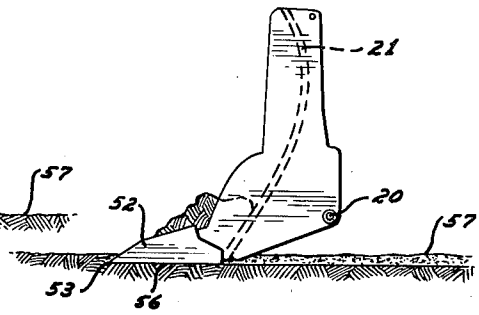


Fig. 6

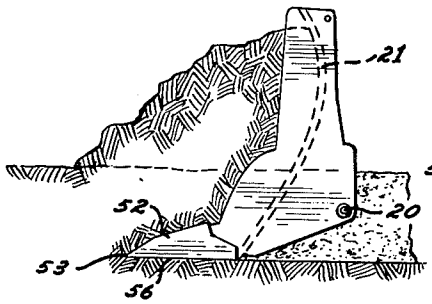


Fig. 8

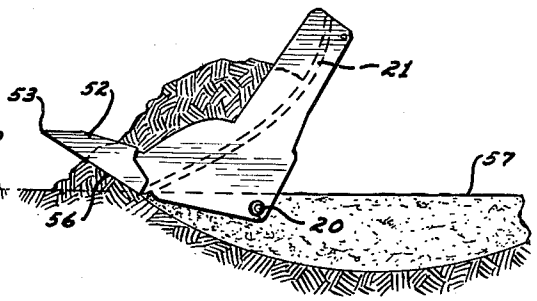


Fig. 9

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BULLDOZER

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Application March 29, 1954, Serial No. 419,345

2 Claims. (Cl. 37—145)

A non-exclusive, irrevocable, royalty-free license in the invention herein described, for all governmental purposes, throughout the world, with the power to grant sublicenses for such purposes, is hereby granted to the Government of the United States of America.

This invention pertains to improvements in bulldozers and is particularly directed to improvements in a hydraulic power controlled tilt bulldozer equipped with a plurality of digging teeth mounted in a fixed position and removably installed through the moldboard of the bulldozer. More particularly, the bulldozer incorporates a series of teeth mounted above the bulldozer moldboard cutting edge and in which all of the moldboard adjustments are made from the operator's position by control levers which energize hydraulic cylinders and power means for universally controlling the positioning and functioning of the moldboard and digging teeth of the bulldozer.

Heretofore the handling or digging rocky or hardpacked formations has always been an inefficient operation for a conventional bulldozer. Even the use of angle type bulldozers with one bulldozer end bit being lowered for the working operation by itself was not effective under severe operating conditions. The only effective method heretofore for getting the earth and rock moved was to resort to using rippers. Rippers are necessarily limited in flexibility. They are used to loosen the earth and to surface large rocks to facilitate large earth movers in picking up the load and to assist bulldozers in loading. Even though this is done, rippers encounter difficulty in placing large rocks above the ground level so they can be picked up by a carryall or so that they can be contacted by a bulldozer for efficient handling.

Large rock, when handled by any flat cutting edge, has a tendency to be caught about midway of its mean diameter and scooted ahead of the cutting edge, thereby increasing the power required to move the load. Due to their load behind the tractor, rippers cannot be effectively used on pioneering work and because of the location of the teeth with reference to the wheels and frame they cannot be used in close places as against a sloping or vertical cut.

The prior conventional bulldozers encounter difficulty in clearing land of brush and small trees, the straight cutting edge of the bulldozer being limited in this work as it must shear off everything it contacts or skip over it. In clearing road right-of-way of timber and brush the long, flat blade cannot surface the roots and rocks efficiently as they are encountered but must move all the earth it contacts even though it would be desirable to leave behind the finer earth for use on the road. In many cases this limitation is costly in building low-standard roads, for example, logging roads. Clearing brush and other debris with conventional bulldozers adds to the cost of burning, since dirt and fuel are mixed and will not burn effectively.

Pioneering with conventional bulldozer equipment is limited to the ability of the bulldozer to dig the material to be moved. Ordinary bulldozers are limited to the work

that can be done with the conventional straight or angle blade. End bits are the only means of penetration. Numerous types have been made and all types are costly to maintain because they dull quickly and are costly to build up and/or replace. When digging hard-packed material the entire power of the tractor is concentrated on the point of the end bit which has a limited cutting surface area. Furthermore, the position of the cutting surface in relation to its base offers only a shearing action. This, compared to the uniquely positioned digging points and method of manipulating the same in applicant's device, is inefficient. In applicant's device the digging point is mounted far ahead of the bulldozer end bit and is supported by a boot and tooth shank which actually penetrates the hard material at a relatively great distance preceeding the bulldozer, wedging it apart with a minimum of scraping action. The conventional bulldozer must depend on shearing force and is therefore subject to terrific shock when conditions exist where the end bit can get a bite but cannot push the end bit through the material. The alternative under these conditions is for the end bit to slide over the material.

The limitations of prior conventional tractor bulldozer outfits may therefore be summed up as follows:

(1) The prior devices lack penetration ability, thus subjecting the tractor to numerous shock loadings that increase in proportion to the severity of the various soil types which results in a higher overall cost of machine maintenance as well as reduced earth-moving production.

(2) Prior devices result in costly end bit maintenance and replacement.

(3) The limited versatility of prior bulldozers requires additional costly equipment such as root and rock rakes and ripping devices.

(4) The bulldozer moldboard design will not accommodate auxiliary equipment thereby limiting its primary usefulness to moving earth.

(5) In some operations such as clearing and moving rocky formations unnecessary amount of earth and soil movement must also be undertaken.

(6) Although the prior tractor and bulldozer equipment represent a substantial investment it is seriously limited in usefulness. The usual conception of a bulldozer is a large flat tool pushed by a powerful tractor designed to push things around by brute force. Auxiliary equipment to ease digging conditions is seldom used until the dozer has done its best, which usually results in severe strain and damage to the entire tractor mechanism. This has resulted in prior devices and increased cost of doing the work that only a tractor bulldozer outfit is maneuverable and flexible enough to do.

Therefore, one of the objects of the present invention is to provide an improved bulldozer which eliminates the above subject disadvantages of prior bulldozer devices.

Still another object of this invention is to provide an improved bulldozer having a tooth design and the location of teeth in relation to the bulldozer moldboard and the cutting edge on the bottom of the moldboard in such a manner as to provide effective penetration characteristics which relieve the shock load imposed on the tractor.

Still another object of this invention is to provide an improved bulldozer having a moldboard which is capable of being bodily raised and lowered, capable of being tilted forward and back, and further, is capable of being tilted from one side to the other, all of such movements being controlled by the operator of the tractor during the digging operation either simultaneously or any one or more movements being independently controllable during the movement and maneuvering of the bulldozer.

Still another object of this invention is to provide in a bulldozer, a moldboard manipulating structure comprising support arms at each side of the tractor capable

of bodily raising and lowering the moldboard together with means for tilting the moldboard forward and back for changing the angle of approach of cutting teeth on the front of the moldboard and in addition means for tilting the moldboard to one side or the other for angular or sloping cuts to maintain a level moldboard when the tractor is working on a side hill.

Still another object of this invention is to provide means under the control of the operator of the tractor for horizontally inserting the digging teeth under a rock formation or the like to be dislodged and then to apply power to swing the moldboard top portion rearwardly to raise the cutting teeth in a prying and heeling action to dislodge said rock formations or the like.

Still another object of this invention is to provide an improved bulldozer moldboard manipulating mechanism including means for pivotally mounting the central portion of the moldboard on the tractor structure and to provide further means for bodily raising and lowering the moldboard, tilting the moldboard to one side or the other, and in addition provide means for rocking the moldboard forwardly and rearwardly of the tractor all under the simultaneous or independent control of the operator of the tractor during its digging operations.

A still further object of this invention is to provide an improved bulldozer having a moldboard with cutting teeth extending through and at an extended distance in front of said moldboard and at a predetermined position relative to the cutting blade thereof in which the moldboard may be initially tilted forward to effect efficient and rapid penetration of the cutting teeth and cutting blade into the ground surface to be worked, and then to provide further means for tilting back the moldboard to a position where the cutting teeth then moves substantially horizontally in the direction of movement of the tractor to effect a wedging action to break up the soil ahead of the scraper blade of the moldboard. It is then a further object to provide means for tilting the moldboard still further backwardly so that the cutting teeth no longer effect a digging operation but that the cutting blade of the moldboard then performs its normal scraping bulldozing action after the soil materials have been loosened by the aforementioned operation of the digging teeth.

Further features and advantages of this invention will appear from a detailed description of the drawings in which:

Fig. 1 is a left hand side elevation of a bulldozer incorporating the features of this invention.

Fig. 2 is an enlarged fragmentary plan view of the bulldozer shown in Fig. 1.

Fig. 3 is a front elevation of the bulldozer shown in Figs. 1 and 2.

Fig. 4 is an enlarged diagrammatic view of the left hand side of the moldboard and digging teeth shown approaching a rock formation to be pried loose.

Fig. 5 is a view similar to Fig. 4 but showing the moldboard in rocked back position after prying the rock formation loose.

Fig. 6 is a view similar to Fig. 4 but showing the moldboard positioned for normal light scraping and dressing operations on a ground surface.

Fig. 7 is a view similar to Fig. 4 but showing the moldboard tilted forward for rapid penetration of the digging teeth to a depth in a ground surface.

Fig. 8 shows a view similar to Fig. 4 but with the moldboard positioned below the ground surface to digging depth and traveling horizontally to effect the combined ripping and scraping action for the bulldozer.

Fig. 9 is a view similar to Fig. 4 showing the moldboard rocked back and being elevated to conclude a depth of cut back up to the original ground surface.

As exemplary of one embodiment of this invention there is shown a bulldozer comprising the usual tractor consisting of the frame **10**, the ground contacting treads **11** with the main drive engine **12** and the driver's seat **13**. On the side frames **14**, located one each side of the ground contacting treads **11**, are fixed trunnions **15** and **16** upon which are pivotally mounted the respective side arms **17** and **18**. In the outer ends of the side arms **17** and **18** are carried pins **19** and **20** upon which is pivotally mounted the moldboard **21**. A pair of actuating cylinders **22** and **23** are pivotally connected by pins **24** at an intermediate point of the side arms **17** and **18** and have their piston rods **24***a* connected pivotally through the pins **25** at each end of the top portion of the moldboard **21**. Suitable tie bars **26** and **27** are connected by ball joints **28** and **29** respectively with the side arms **17** and **18** and through the ball joints **30** with the moldboard **21** to give added rigidity and to prevent side sway and motion of the moldboard **21** and side arms **17** and **18** during the operation of the device.

Interconnected between the frame **10** of the tractor and the middle portion of the moldboard **21** is an extensible and retractable connection which may take the form of a block and tackle arrangement as shown comprising a lower block member **31** pivotally mounted on a pin **32** at the rear central portion of the moldboard **21** and the upper block member **33** pivotally mounted on a pin **34** carried in the frame **10** of the tractor. A cable **35** having one end fixed at **36** to the block **33** passes over a series of sheaves **37** journaled on the pin **38** in the block **31** and over suitable sheaves **39** journaled on the pin **40** in the block **33** and then passes over suitable guide sheaves **41** and **42** journaled suitably on the tractor frame rearwardly to the regular winch mechanism **43** of the tractor. The winch mechanism **43** may be operated in the usual manner by mechanism (not shown) controlled by a lever **44** for taking in or paying out the cable **35** for contracting or releasing the block and tackle mechanism **31—33** for bodily raising and lowering the moldboard and side arms **17** and **18** and connected apparatus described from the mid point of the moldboard indicated generally at **45**. Further, each of the fluid pressure cylinders **22** and **23** may be respectively controlled by the levers **46** and **47** through suitable fluid pressure supply lines (not shown) from the fluid pressure pump system of the tractor in a well known manner so that their respective piston rods **24***a* may be extended or retracted as desired by the operator in the seat position **13** of the tractor.

It is to be understood that in place of the block and tackle mechanism **31–33** any suitable device such as a fluid pressure cylinder and piston or a nut and screw mechanism could be provided for effecting the bodily raising and lowering of the moldboard as described.

The moldboard is provided with a series of digging teeth **46**, **47**, **48** and **49** preferably of a type shown in my co-pending patent application Serial No. 171,482, filed June 30, 1950, now Patent No. 2,716,823, entitled Dozer Moldboard Auxiliary Device. These digging teeth comprise the main shank portions **50** which extend through socket means **51** formed in the moldboard **21**. Suitable boots or shoes **52** are fitted and secured to the ends of the digger teeth **46**, **47**, **48** and **49** so as to provide cutting edges **53** positioned far in advance of the cutting edge **54** on the moldboard blade **55**. These teeth have their bottom ground contacting surfaces located on or above the cutting edge of the blade when the blade is positioned in normal scraping position as shown in Figs. 6 and 8.

It is to be noted that by manipulating the control lever **44** for energizing the winch **43** the block and tackle **31—33** is adapted to bodily raise and lower the bulldozer moldboard **21** at any time under any operative condition. Further, by simultaneously manipulating the control levers **46** and **47** for the cylinders **22** and **23** so as to simultaneously extend the piston rods **24***a* the moldboard may be

tilted forwardly and by manipulating the levers 46—47 to cause the simultaneous withdrawal inwardly of the piston rods 24*a* in cylinders 22 and 23 the moldboard may be rocked rearwardly at its upper portion on the pins 19 and 20 on the side arms 17 and 18. It is further to be noted that by oppositely energizing the cylinders 22 and 23 such as retracting piston rod 24*a* and cylinder 22 and extending piston rod 24*a* and cylinder 23 the moldboard may be tilted so that its right hand end is lowered while its left hand end is raised as shown at 21*a* in Fig. 3. Similarly, by oppositely energizing the cylinders 22 and 23 so that the piston rod 24*a* of cylinder 22 is extended while piston rod 24*a* of cylinder 23 is retracted the dozer moldboard may be rocked to the opposite position 21*b* as shown in Fig. 3. It is to be also kept in mind that any variation of simultaneous or independent or group operation of the cylinders 22 and 23 and the block and tackle mechanism 31–33 may be entertained by the operator in the driver's seat 13 by any judicious or desired selection of the manipulation of the control levers 44, 46 and 47.

By way of a specific example of a structure incorporating the features of this invention from a dimensional stand-point, and it is to be understood that applicant is in no wise limited to the specific dimensions recited, applicant wishes to point out that a highly satisfactory bulldozer of excellent performance has been constructed having the side arms 17 and 18 (sometimes called push arms) pivotally mounted at 15 and 16 on the side frames 14 of the tractor and pivotally mounted by the pins 19 and 20 at their outer ends on the moldboard 21 approximately 12 inches above the cutting edge 54 of the moldboard blade. When both cylinders 22 and 23 are energized to extend their piston rods 24*a* the top portion of the moldboard is pushed forward so that the digging points 46, 47, 48 and 49 move with the moldboard and swing downwardly and are lowered equally so that they are then positioned with the cutting edges 53 approximately 8 inches below the cutting edge 54 of the moldboard blade 55. This is accomplished because the digging points 46, 47, 48 and 49 and their respective cutting edges 53 protrude well in front of the cutting edge 54 by some 20 inches. This feature permits the operator to adjust the digging angle of the digging teeth 46, 47, 48 and 49 from approximately a 15 degree angle of attack if the moldboard is fully retracted at its top portion such as shown in Fig. 9 to a maximum tooth angle of approximately 45 degree such as shown in Fig. 7. If one of the cylinders 22 is held stationary and the other expanded to full stroke of the piston rod, the digging tooth and the moldboard will raise on this side and thus lowering the opposite tooth placing it in a digging position of approximately 3½ feet below the raised tooth. Many years of experience have convinced the applicant that the bulldozer efficiency will be increased if a tooth could be designed that would assist in pulling the moldboard into the ground and while at the same time breaking up the material ahead of the cutting edge 54 and thereby eliminating much of the energy required to push along relatively flat surface through hard-packed materials. Some means was also required to allow the bulldozer to pry out and lift large rock and to efficiently handle shot rock as mentioned above.

Attention is directed to Figs. 4 and 5 showing the latter capabilities of this device. In Fig. 4 is shown the moldboard positioned in an intermediate rocked position with both cylinders 22 and 23 with piston rods 24*a* partially extended so that the bottom surface 56 of the digger teeth 46, 47, 48 and 49 extend substantially parallel to the ground surface 57 and having its angular upper surfaces 52 and 53 arranged to be pushed in wedging action under a rock formation 58 to be pried up and dislodged. Under these conditions the angle 52—53 is a relatively slim angle so that it has a high degree of penetration lifting and prying power, usually under these circumstances, several times the drawbar force exerted by the tractor in its forward movement. Thus, a tremendous upward prying force is effected to lift and break loose the rock formation 58 from its original plane of contact with the ground surface 57. Further, noting Fig. 5, as the teeth 46–49 are thus entered into and under the rock formation 58 the operator may then retract the piston rods 24*a* and cylinders 22 and 23 to cause a healing action at the point 59 which is substantially at the point of the cutting edge 54 of the moldboard blade 55 so that a tremendous prying or crowbar action results in extreme force being applicable to raising and lifting the rock formation 58 and breaking it loose from its adjacent structure.

In Fig. 6 is shown the use of the device in its intermediate tilted position of the moldboard for finished scraping or beginning to start a lower depth of cut in a ground surface 57 to be worked. During the forward movement of the tractor the operator may energize both cylinders 22 and 23 to tip the moldboard forward as shown Fig. 7 so as to greatly increase the angle of attack of the digging teeth to cause rapid and efficient penetration inwardly and downwardly of the teeth into the ground surface 57. When the desired depth is reached with continued forward motion of the tractor the operator may again straighten up the moldboard by partial retraction of the piston rods 24*a* and the cylinders 22 and 23 to then position the moldboard for forward digging action to depth as shown in Fig. 8. And finally, as it is desired to run out of the digging cut the operator then retracts the moldboard to fully withdrawn position of the piston rods 24*a* and the cylinders 22 and 23 as shown in Fig. 9 and may raise bodily the moldboard by energizing the block and tackle mechanism 31–33 to bring the entire load up to ground level for disposal at a new location. It is also to be noted that any of the aforementioned operations shown in Figs. 4 through 9 inclusive may be undertaken while at the same time the moldboard is in any sidewise tipped position such as shown in Fig. 3. Thus, the device is fully universally actuable for performing all sorts of complex grading operations with a high degree of efficiency, with rapidity of penetration of the work surface, and with capabilities of dislodging solid rocks and other obstructions with ease and instant control on the part of the operator during the manipulation and movement of the bulldozer by the tractor mechanism.

While the apparatus herein disclosed and described constitutes a preferred form of the invention, it is also to be understood that the apparatus is capable of mechanical alteration without departing from the spirit of the invention and that such mechanical arrangement and commercial adaptation as fall within the scope of the appendant claims are intended to be included herein. Having thus fully set forth and described this invention what is desired to be obtained by United States Letters Patent is:

1. In an earth moving apparatus having, a frame, a moldboard pivotally mounted for tilting about a horizontal transverse axis on said frame, and means interconnected between said frame and said moldboard actuable to tilt said moldboard, the combination of a scraper blade fixed along the lower portion of said moldboard having a cutting edge thereon, a plurality of digger teeth fixed to the front concave surface of said moldboard having bottom ground contacting surfaces lying in a common plane passing through the cutting edge of said blade, said surfaces extending forwardly of said cutting edge of said blade parallel to the direction of travel of said moldboard when in normally tilted scraping position, and terminating at the outer cutting points of said teeth, so that said outer cutting points of said teeth may be raised and lowered relative to the plane of scraping action of said blade by tilting said moldboard on said frame to either side of its normally tilted scraping position.

2. In an earth moving apparatus as set forth in claim 1 wherein additional actuating means may be provided be-

tween said frame and said moldboard for bodily vertically moving said moldboard when in any tilted position.

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