Jan. 9, 1940. R. D. BAKER 2,186,059

FINE-GRADING MACHINE

Filed July 5, 1938 8 Sheets-Sheet 1

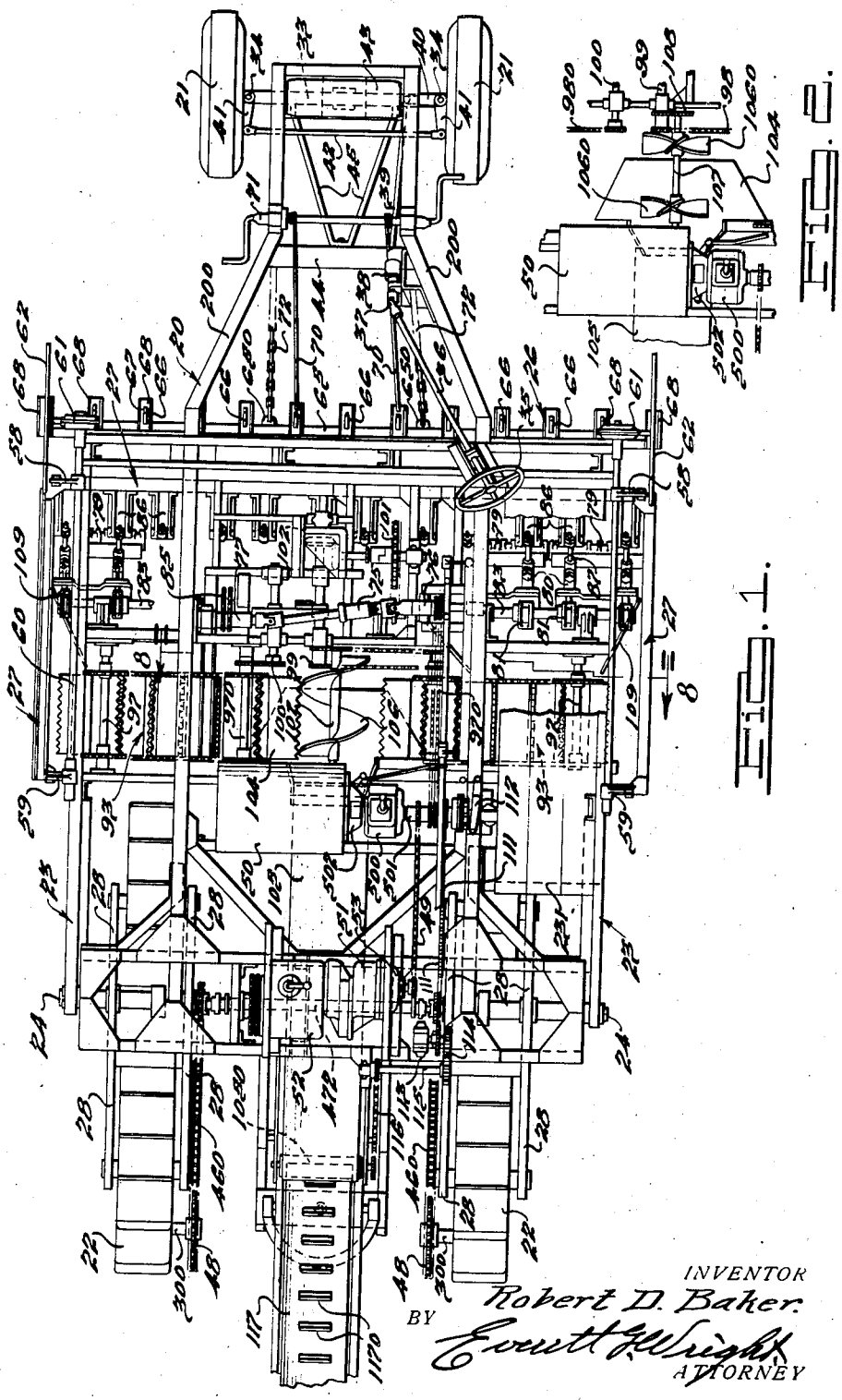

Fig. 1.

Fig. 2.

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FINE-GRADING MACHINE

Filed July 5, 1938 8 Sheets-Sheet 2

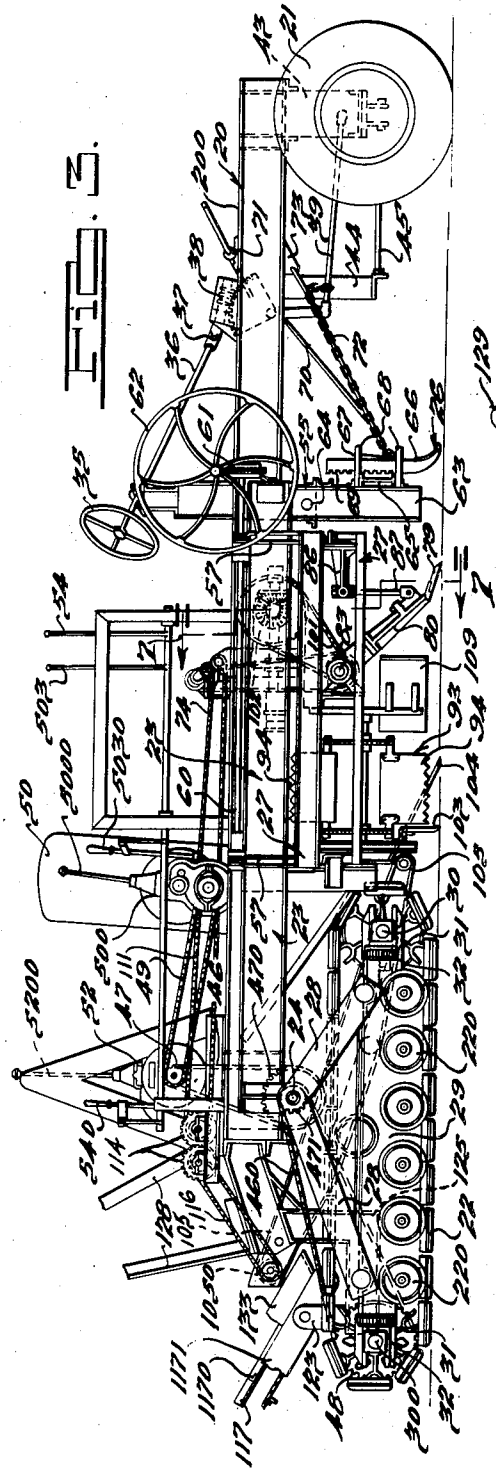

Fig. 3.

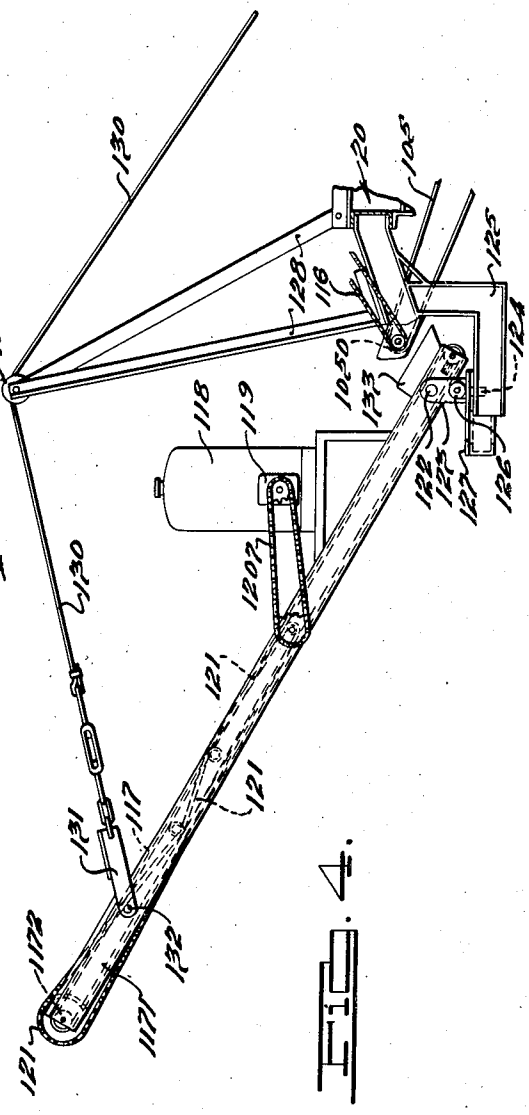

Fig. 4.

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FINE-GRADING MACHINE

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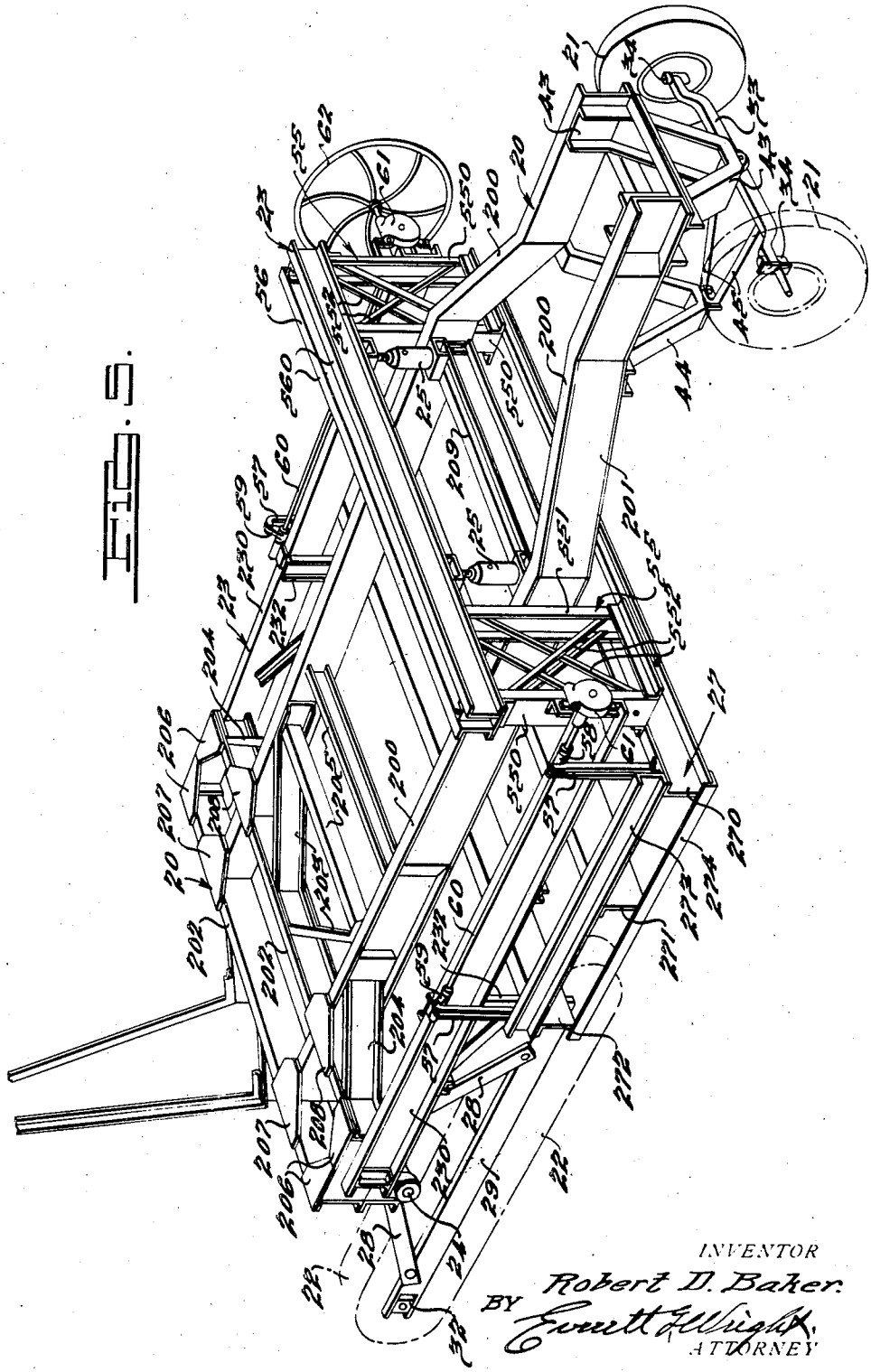

Fig. 5.

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FINE-GRADING MACHINE

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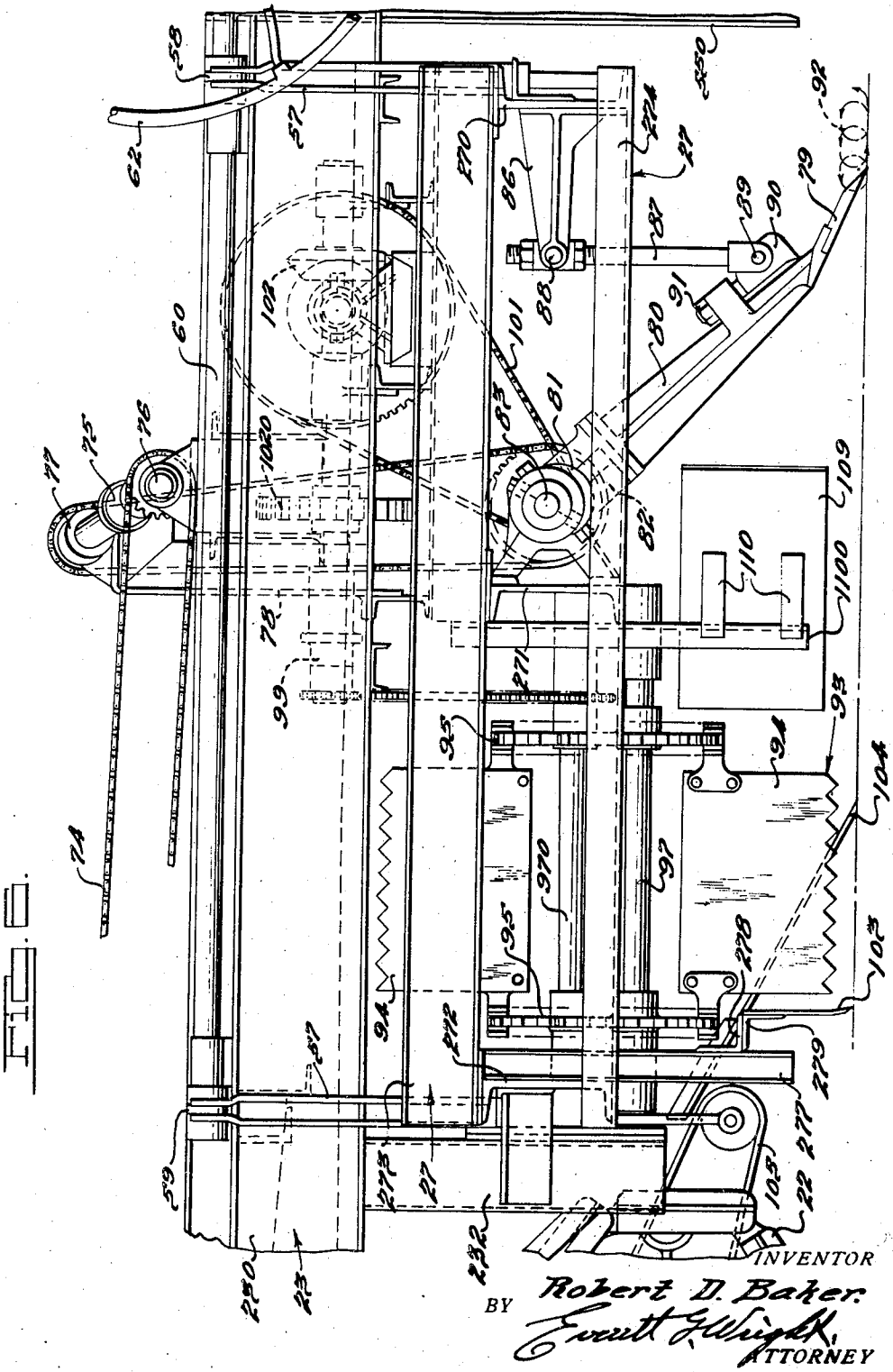

Fig. 6.

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FINE-GRADING MACHINE

Filed July 5, 1938 8 Sheets-Sheet 5

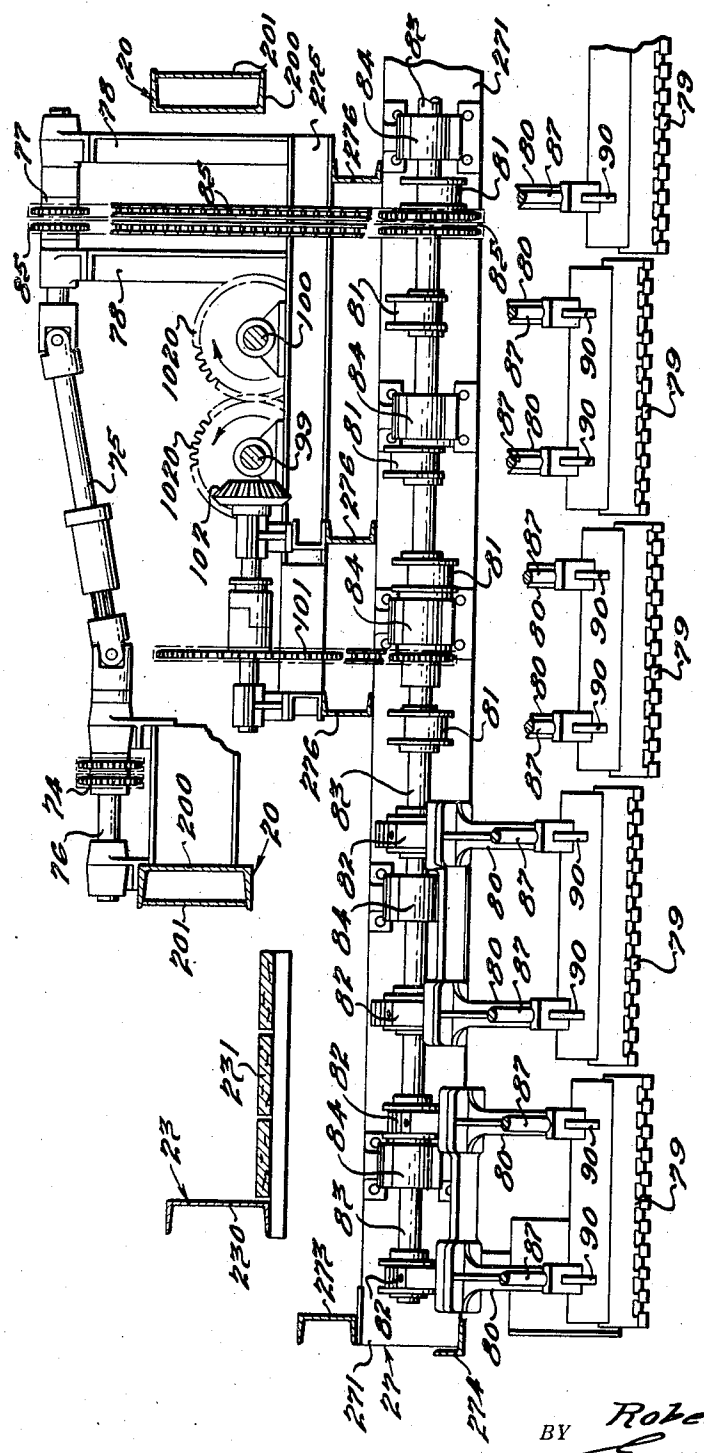

Fig. 7.

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FINE-GRADING MACHINE

Filed July 5, 1938 8 Sheets-Sheet 6

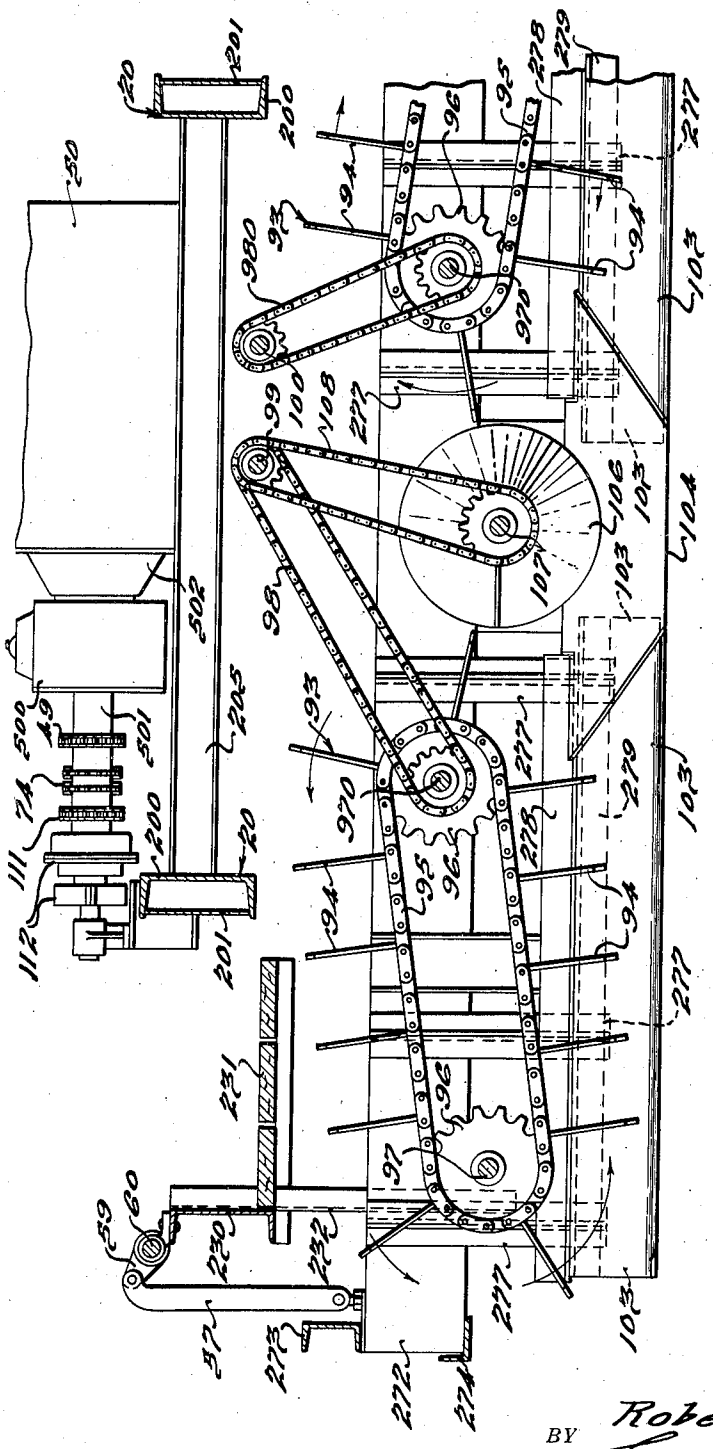

FIG. 6.

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FINE-GRADING MACHINE

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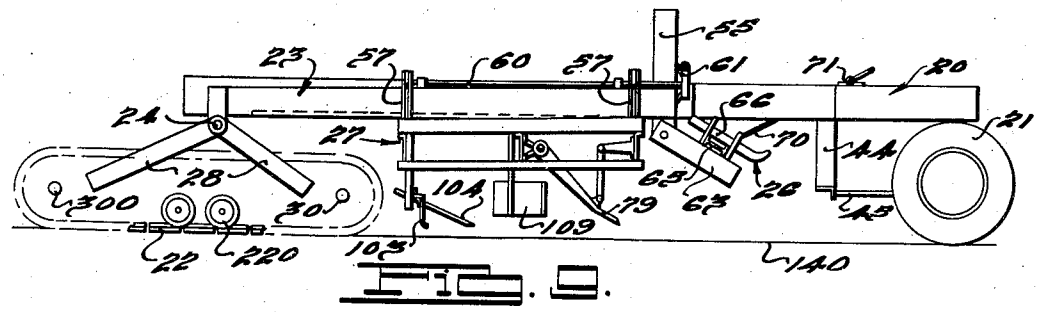

FIG. 9.

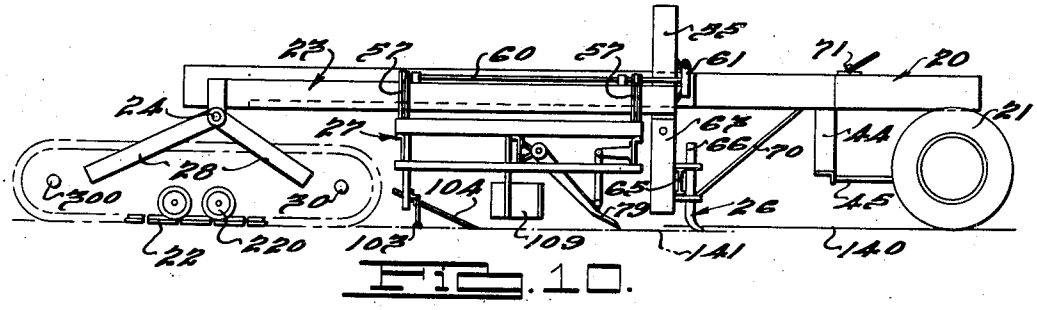

FIG. 10.

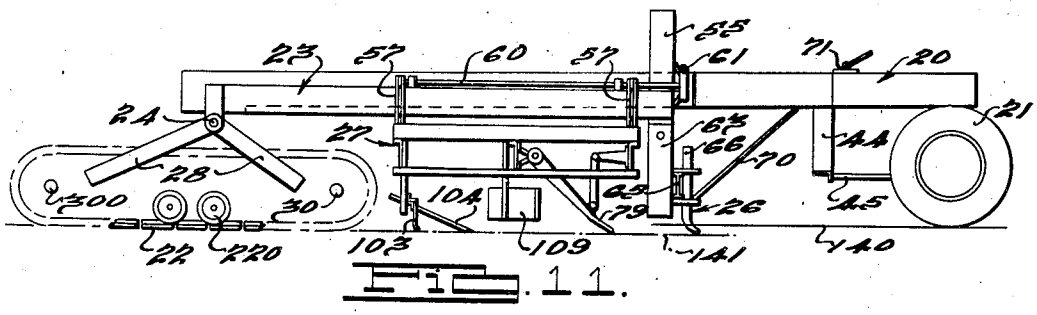

FIG. 11.

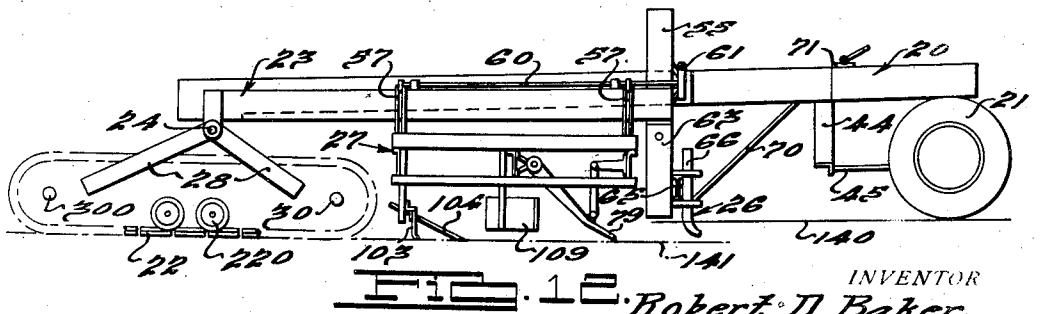

FIG. 12.

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FINE-GRADING MACHINE

Filed July 5, 1938 8 Sheets-Sheet 8

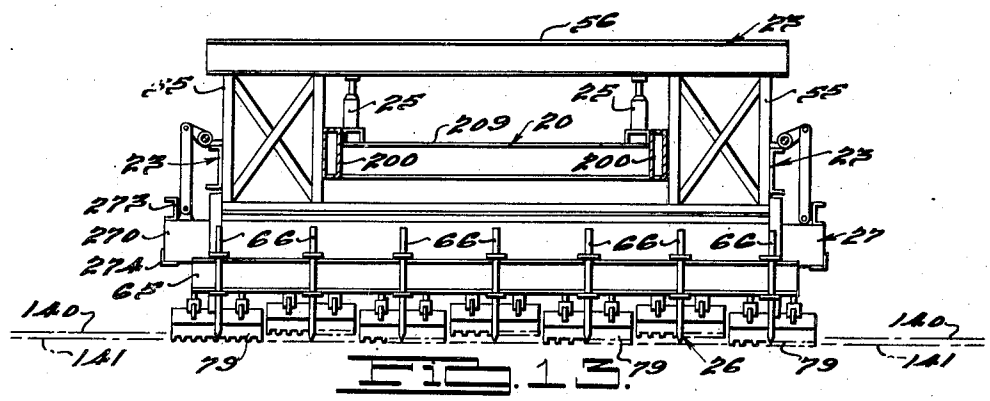

FIG. 13.

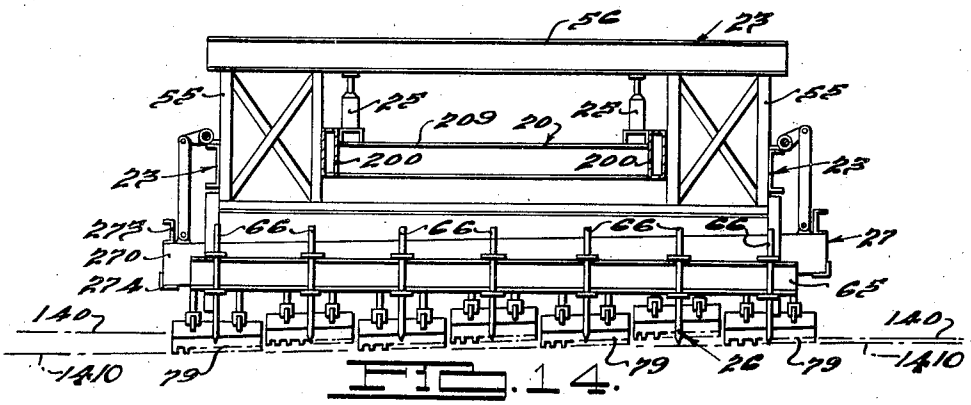

FIG. 14.

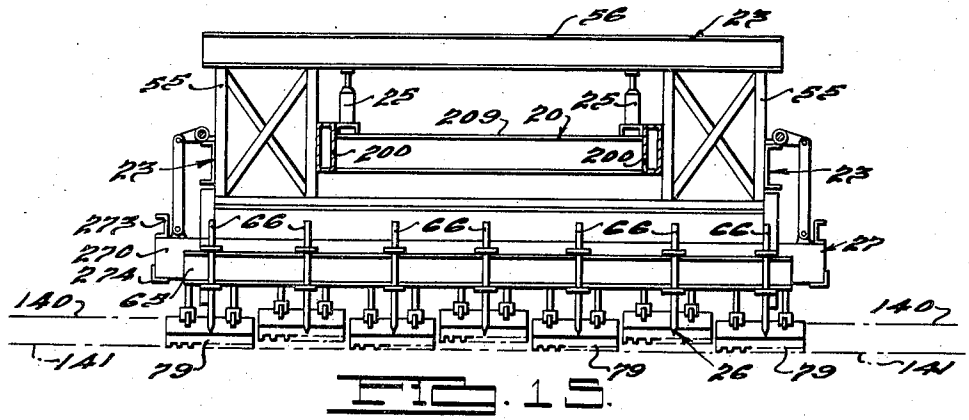

FIG. 15.

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Patented Jan. 9, 1940 2,186,059

UNITED STATES PATENT OFFICE

2,186,059

FINE-GRADING MACHINE

Robert D. Baker, Birmingham, Mich.

Application July 5, 1938, Serial No. 217,418

20 Claims. (Cl. 37—108)

This invention relates to fine-grading machines and in particular to machines for preparing an accurate subgrade over which a pavement of concrete or other material is placed.

This invention is an improvement upon the fine-grading machine inventions disclosed and claimed in Patent Nos. 1,939,289; 1,990,362 and 1,995,629 previously issued to Robert D. Baker.

Most fine-grading machines are adapted to travel on road forms erected alongside a strip to be graded and paved after all necessary rough-grading is done by means of plows, harrows, bulldozers, scrapers or other earth moving equipment. Some fine-grading machines have been mounted on caterpillar endless chain type tractors with the earth cutting mechanism thereof cantilevered thereahead.

The use of road forms as means upon which a fine-grader travels is extremely expensive inasmuch as the said forms must be placed prior to the fine-grading of a road which requires a great amount of hand ditching and grading to place the said road forms accurately before the fine-grading operation. The use of a fine-grader mounted on caterpillar endless chain type tractors having the earth cutting mechanism cantilevered thereahead is not susceptible to accurate adjustment during operation to assure accurate results and to admit of accurate changes of the gradients of the subgrade being prepared thereby.

It is one of the objects of this invention to provide a fine-grading machine which operates without the use of road forms or other trackage particularly adapted to cut and remove earth to an accurate grade.

Another object of the invention is to provide a fine-grading machine in which the earth cutting and removing mechanism may be raised, lowered and tilted during the operation of the said machine at a multiplicity of positions with respect to the main frame of the said machine.

Another object of the invention is to provide a fine-grading machine having scarifiers positioned ahead of the earth cutting and removing mechanism thereof in which the said earth cutting and removing mechanism may be raised, lowered and tilted independently of the scarifier means during the operation of the said machine whereby to admit of complete flexibility in the operation of the said machine over rough terrain to produce an accurately finished gradient.

In addition to the improved means for applying earth cutting mechanism to the terrain being fine-graded, it is a further object of the instant invention to provide a complete and improved fine-grader including means for disposing of earth removed by the earth cutting mechanism of the improved fine-grader either to the rear or to the side of the said machine and including novel means for positively feeding earth removed by the earth cutting mechanism of the said improved fine-grading machine to the said earth disposed means carried thereby.

Other objects of the invention and improvements upon fine-grading machines will become apparent by reference to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a fragmentary plan view of a fine-grading machine embodying the invention.

Fig. 2 is a fragmentary plan view of a portion of the fine-grading machine shown in Fig. 1 disclosing an alternate means for positively feeding earth to the earth disposal means carried by the said fine-grader.

Figs. 3 and 4 combined show a complete side elevational view of the novel fine-grader shown in Fig. 1.

Fig. 5 is a skeletonized view in perspective showing the framework of the novel fine-grader.

Fig. 6 is an enlarged fragmentary side elevational view showing the earth digging mechanism employed in the illustrative embodiment of the fine-grader disclosed and a portion of the earth disposal means.

Fig. 7 is an enlarged fragmentary cross sectional view taken on the line 7—7 of Fig. 3 showing the earth digging mechanism employed.

Fig. 8 is an enlarged fragmentary cross sectional view taken on the line 8—8 of Fig. 1 showing a portion of the earth disposal means employed.

Fig. 9 is a more or less skeletonized diagrammatic side elevational view of the fine-grading machine disclosed in Figs. 1 to 8 inclusive showing the first and second sub-frame thereof raised with respect to the main frame thereof to a transport position, and the scarifiers thereof carried by the first sub-frame also raised to a transport position.

Fig. 10 is a skeletonized side elevational view similar to Fig. 9 showing the first sub-frame and the scarifiers carried thereby lowered from a transport to a working position and the second sub-frame carrying the earth cutting mechanism lowered to a working position.

Fig. 11 is a skeletonized side elevational view similar to Fig. 10 showing the second sub-frame carrying the earth cutting mechanism lowered

to a deeper cutting position with respect to the first sub-frame and scarifiers carried thereby.

Fig. 12 is a skeletonized side elevational view similar to Fig. 11 showing the first sub-frame and the scarifiers carried thereby lowered to a deeper working position and the second sub-frame carrying the earth cutting mechanism lowered to a still deeper cutting position with respect to the said first sub-frame and the scarifiers carried thereby.

Fig. 13 is a more or less skeletonized diagrammatic cross sectional view of the fine-grading machine disclosed in Figs. 1 to 8 inclusive showing the first sub-frame thereof and the scarifiers carried thereby in the working position illustrated in Fig. 10 and the second sub-frame carrying the earth cutting mechanism lowered to the working position illustrated in Fig. 10.

Fig. 14 is a skeletonized diagrammatic cross sectional view similar to Fig. 13 showing one side of the second sub-frame carrying the earth cutting mechanism lowered on one side only to a deeper cutting position with respect to the first sub-frame and the scarifiers carried thereby than shown in Fig. 13.

Fig. 15 is a skeletonized diagrammatic cross sectional view similar to Fig. 13 showing the entire second sub-frame carrying the earth cutting mechanism lowered to a deeper cutting position with respect to the first sub-frame and the scarifiers carried thereby than shown in Fig. 13.

Referring now to the drawings wherein like numerals refer to like and corresponding parts throughout the several views, the illustrative embodiment of the invention disclosed therein comprises, in general, a fine-grading machine having a main frame 20 mounted for mobility on front wheels 21 and rear caterpillar type endless treads 22, a first sub-frame 23 pivotally supported at its rearward end from caterpillar tread axles 24 which also pivotally supports the rear end of the said main frame 20, means such as screw or hydraulic jacks 25 supported on the main frame 20 adapted to support the said first sub-frame 23 at the forward end thereof and pivotally raise and lower the said first sub-frame 23 around its rear pivotal axis 24, scarifiers 26 secured from said first sub-frame, a second sub-frame 27 suspended from the said first sub-frame 23 in a laterally and longitudinally tiltable and vertically adjustable relationship therefrom, earth cutting and removal mechanism as hereinafter described in detail carried by said second sub-frame, and means for driving the various movable elements of the said fine-grading machine.

The said main frame 20 is composed of a pair of main longitudinally disposed channel members 200 reinforced into a box shaped section by suitable plates 201 welded to the outwardly disposed flanges of the said channels 200 and spaced transverse rear members 202, all braced together by suitable bracing members 203, 204, 205 and gussets 206, 207 and 208. A transverse strut 209 disposed between the main longitudinally disposed channel members of the said main frame 20 located in vertical alignment with the forward end of the first sub-frame 23 serves as a means for supporting the said jacks 25 upon which the forward end of the said first sub-frame 23 is adjustably supported.

The said main frame 20 is suitably pivotally mounted at its rear end to the caterpillar tread axles 24 which in turn are mounted on the apex of the A-struts 28 extending upwardly from the side rails 29 of the endless caterpillar treads 22 through which front and rear caterpillar tread sprocket shafts 30 and 300 respectively carrying caterpillar tread sprockets 31 are journaled on the usual take-up type bearings 32. The said side rails 29 are provided with a plurality of caterpillar tread idlers 220 against which the said treads 22 travel between the said caterpillar tread sprockets 31.

The said main frame 20 is supported at its front end on suitably tired front wheels 21 journaled on a front axle 33 in the usual manner on suitable spindles 34 to admit of steering the fine-grading machine by turning the said front wheels 21 by such means as a conveniently located steering wheel 35 mounted on a steering column 36, a universal joint 37, and a worm and sector mechanism 38 adapted to impart reciprocating motion to a steering rod 39 connected to a steering arm 40. A parallelogram composed of a pair of arms 41, the front axle 33 and a laterally disposed strut rod 42 causes both front wheels to turn together under control of the steering wheel 35 and the aforementioned steering mechanism. The front end of the said main frame 20 is suitably mounted on and supported above the front axle 33 on a suitable vertically disposed V-strut 43. A like vertically disposed V-strut 44 spaced rearwardly from the said V-strut 43 serves as an anchorage for the horizontally disposed wishbone strut 45 which maintains the front axle 33 in proper alignment.

The caterpillar traction treads 22 are each driven by means of endless chains 46 and 460 running between slow speed drive sprockets 47, intermediate reducing sprockets 470 and 471 on the countershaft 472 and the rear driven sprockets 48 keyed on the inwardly extended end of each rear caterpillar tread rear sprocket shaft 300. A chain drive 49 driven from the main motor 50 through the main transmission 500 and main power sprocket shaft 501 under the control of a main clutch 502 engaged and disengaged by a main clutch hand lever 503 conveniently located near the steering wheel 35 is connected to a speed reducer 51 coupled to the traction transmission 52 which is adapted to rotate the slow speed drive sprockets 47 and apply power to the traction treads 22 under control of a traction clutch 53 engaged and disengaged by means of a traction clutch hand lever 54 also conveniently located near the steering wheel 35. Transmission shift levers 5000 and 5200 are provided to select the desired speed gearing in the main transmission 500 and the traction transmission 52 respectively. An auxiliary main clutch hand lever 5030 and an auxiliary traction clutch hand lever 540 is provided toward the rear of the fine-grader for convenience.

The said first sub-frame 23 is composed of a pair of laterally spaced longitudinally disposed channel members 230 pivotally journaled and supported at their rearwardly disposed ends on the transverse caterpillar tread axles 24 which also have the rear end of the said main frame 20 journaled thereto and supported therefrom. A braced tower 55 composed of spaced vertical channels 550 and 551 and suitable cross bracing 552 is secured to the back of each of the said longitudinally disposed channel members 230 of the first sub-frame 23 at the forward end of the said channel members 230, the back of each of the said vertical channels 551 of each tower 55 being located laterally adjacent the outer side

of each of the main frame members 200 whereby to serve as a lateral guide for the said sub-frame 23. The said braced towers 55 having the forward end of the longitudinal channels 230 of the said first sub-frame 23 secured thereto are hung in depending relationship from a bridge 56 composed of a pair of transversely disposed channels 560 positioned above the said jacks 25 supported on the said transverse strut 209 of the said main frame 20. The said first sub-frame 23 is thusly adapted to be pivotally raised and lowered at its forward end with the said transversely disposed caterpillar tread axles 24 as its pivot point. An operating platform 231 preferably supported from the said first sub-frame 23 provides access to the various controls of the fine-grader.

The said second sub-frame 27 is composed of three laterally disposed channel members 270, 271 and 272 secured in spaced relationship to each other by upper longitudinally disposed spacer channels 273 and lower longitudinally disposed spacer angles 274 secured to the top and bottom of the said laterally disposed channel member 270, 271 and 272 substantially at the ends thereof. The said second sub-frame 27 is slightly wider than the first sub-frame 23 and is suspended therefrom by suitable hangers 57 pivotally connected to front and rear eccentric hoist arms 58 and 59 respectively projecting from and turnable with a hoist shaft 60 mounted on and parallel to each of the said longitudinal channel members 230 of the said first sub-frame 23, the said hangers 57 being pivotally connected to the corners of the said second sub-frame 27 near the ends of the laterally disposed channel members 270 and 272 thereof. Worm and pinion gearing 61 and a hand wheel 62 mounted on the forward end of each channel 230 of the first sub-frame 23 rotates each of the said hoist shafts 60 thereby raising or lowering the second sub-frame 27 with respect to the first sub-frame 23.

It will be particularly noted that the front eccentric hoist arms 58 are longer than the rear eccentric hoist arms 59 which causes the said second sub-frame 27 to be lowered with respect to the said first sub-frame 23 a greater distance at the front thereof than at the rear thereof whereby the angle at which the earth cutting mechanism carried by the said second sub-frame 27 is caused to work may be varied with respect to the terrain. Also, the earth cutting mechanism carried by the said second sub-frame 27 may be adjusted and tilted to various digging angles by manipulation of the said second sub-frame 27 with respect to the first sub-frame 23 both with and without the pivoting of the said first sub-frame 23 around its pivotal axis 24 to various vertical angles with respect to the said main frame 20 whereby to admit of complete control of the earth cutting mechanism and the finished grade at which the fine-grader works regardless of the elevation at which its front wheels 21 may be positioned on rough terrain with respect to the position of the caterpillar treads 22 on the finished graded surface prepared by the said fine-grader.

Inasmuch as the hoist shafts 60 carrying the eccentric hoist arms 58 and 59 may be operated independently of each other, the said second sub-frame 27 may be tilted laterally and longitudinally simultaneously whereby to permit the fine-grader to grade a strip to substantially one-half of a crowned roadway or to grade a strip substantially to the bank of a curve.

The said first sub-frame 23 is provided with a plurality of depending arms 63 preferably pivoted from the vertical channels 550 and 551 of the braced towers 55 thereof around suitable pivot pins 64, the said depending arms 63 carrying a transversely disposed scarifier beam 65 onto which a plurality of scarifier blades 66 are wedged by wedges 67 driven into suitable apertures formed in the wedge plates 68. The rear edge of each scarifier blade 66 is provided with a plurality of suitably spaced notches 69 which register with the flanges of the said scarifier beam 65 when the rear of the said scarifier blades 66 are wedged thereagainst. The said notching 69 of the rear of the scarifier blades 66 provides means for accurately and adjustably mounting the said scarifier blades 66 in any desired position on the said scarifier beam 65. The said scarifier beam 65 is pivotally raised and lowered by means of cables 70 connected to a scarifier hoist 71 mounted on the top of the forward portion of the longitudinal main frame members 200 of the main frame 20. Chains 72 anchored to brackets 73 on the bottom of the forward portion of each of the said main frame members 200 of the main frame 20 suitably secured to the swingable scarifier beam 65 at chain anchor plates 650 thereon causes the scarifier blades 66 to be towed by the main frame 20 of the fine-grader whereupon stresses from the scarifiers are directly transferred to the main frame 20 of the fine-grader whereby to avoid over-stressing the comparatively light first sub-frame 23 thereof.

The earth cutting or digging mechanism and the loading mechanism for loading earth cut or dug by the said earth cutting mechanism onto earth disposal means supported on the main frame 20 are carried by the second sub-frame 27 and are driven by the main motor 50 by means of a suitable preferably double chain drive 74 from the main power sprocket shaft 501 through a universal splined shaft 75, one end of which is connected to a sprocket shaft 76 journaled on the main frame 20 and the other end of which is connected to a sprocket shaft 77 journaled on the supports 78 on the said second sub-frame 27.

As best shown in Figs. 6 and 7, the said digging mechanism comprises a plurality of cutting blades 79, each mounted on a pair of reciprocating arms 80 connected to eccentrics 81 by suitable eccentric straps 82 rigidly fixed to the said reciprocating arms 80, the said eccentrics 81 being mounted on an eccentric shaft 83 suitably journaled on the central laterally disposed second sub-frame member 271 by suitable bearings 84. The said eccentric shaft 83 is driven from the said sprocket shaft 77 journaled on the supports 78 on the second sub-frame 27 by a suitable double chain drive 85. The forward portion of each of the reciprocating arms 80 are pivoted from suitable brackets 86 mounted on the rear of the forward laterally disposed second sub-frame member 270 by means of pivot arms 87 pivotally depending from the said brackets 86 on pivot pins 88, the said pivot arms 87 being pivotally connected to the said reciprocating arms 80 by pivot pins 89 extending through the lower end of each pivot arm 87 and a bracket 90 preferably secured by such means as a nut 91 to the said forward portion of each of the said reciprocating arms 80. The arrows on the dotted lines 92 in Fig. 6 indicate the path taken by the said cutting blades 79 when the eccentric shaft 83 rotates in a clockwise direction when looking at the end of the eccentric shaft as in Fig. 6. The eccentrics 81 are preferably mounted on the eccentric shaft 83 in pairs

in circumferential staggered relationship to other pairs of eccentrics 81 to admit of only a fraction of the cutting blades 79 to be on their cutting stroke at any time during any single revolution of the eccentric shaft 83.

A pair of laterally spaced oppositely running flight conveyors 93 as best shown in Figs. 1, 3, 6 and 8 are disposed between the central and rear laterally disposed sub-frame members 271 and 272 respectively of the second sub-frame 27, each flight conveyor comprising a plurality of saw tooth flights 94 secured to and cantilevered from a pair of endless conveyor chains 95 disposed over conveyor sprockets 96 keyed to conveyor sprocket shafts 97 and 970 which are suitably journaled between the said laterally disposed second sub-frame members 271 and 272. The said flight conveyors 93 are driven by flight conveyor chain drives 98 and 980 which rotate conveyor sprocket shafts 970 in opposite directions from a pair of oppositely rotating idler shafts 99 and 100 driven from the eccentric shaft 83 by means of a reduction chain drive take-off 101, right angle bevel gearing 102 and pinion gearing 1020. The said idler shafts 99 and 100, the slow speed end of the reduction chain drive take-off 101, the said bevel gearing 102 and the pinion gearing 1020 are all mounted on a platform 275 supported on channels 276 disposed on top of the laterally disposed channel members 270 and 271 of the said second sub-frame 27.

Final smoother blades 103 located to the rear of each flight conveyor 93 and the scoop 104 disposed therebetween carried by the rear transverse member 272 of the second sub-frame 27 on vertically disposed depending hangers 277 and horizontally disposed angles 278 and 279 urge all loose earth or other material cut or dug by the earth cutting blades 79 thereahead as the fine-grader travels forward, the said smoother blades 103 scrape the said loose earth or other material in the path of the laterally spaced flight conveyors 93 which drag or scrape the said loose earth or other material cut or dug by the said earth cutting blades 79 to the longitudinal center of the fine-grader in front of the said scoop 104.

A pair of suitably braced push arms 232 fixed to and depending from the said longitudinally disposed channels 230 of the first sub-frame 23 receive and resist the reaction of the cutting blades 79 and the final smoother blades 103 carried by the second sub-frame 27.

Means for positively feeding earth or other material conveyed by the flight conveyors 93 to the scoop 104 up the said scoop onto a disposal conveyor 105 is positively accomplished by a screw 106 as shown in Figs. 1 and 8 or by propeller blades 1060 as shown in Fig. 2 keyed on a shaft 107 suitably journaled between the sub-frame members 271 and 272 at the longitudinal center of the fine-grader a proper distance above the said scoop 104, the said shaft 107 and screw 106 or propeller blades 1060 keyed thereto is preferably rotated by means of a chain drive 108 connected to the idler shaft 99.

Deflector plates 109 supported in depending relationship from the central laterally disposed sub-frame member 271 at the sides of the second sub-frame 27 on brackets 110 and the depending hanger 1100 serve to guide loose earth and other material cut by the outer cutting blades 79 into the path of the flight conveyors 93.

The said disposal conveyor 105 is preferably of the usual troughing belt type and is supported on and from the main frame 20. The said disposal conveyor slopes upwardly from below the top of the scoop 104 to a position sufficiently high to transfer earth or other material carried thereby to a boom conveyor 117. However, although not shown, it is obvious that the said disposal conveyor 105 may be of any suitable length and its discharge end may be made sufficiently high to discharge earth or other material carried thereby directly to trucks or the like brought up to the rear of the fine-grader.

The said disposal conveyor 105 is preferably driven by a suitable chain drive 111 from the main power sprocket shaft 501 under control of a clutch 112 and through a speed reducer 113, pinion gearing 114, a countershaft 115 and a chain drive 116 connected to a suitable sprocket keyed to the laterally extending shaft of the top conveyor power roller 1050.

The boom conveyor 117 is also of the usual troughing belt type and is preferably provided with a plurality of spaced cleats 1170 disposed at the base of the trough of the belt thereof to overcome any tendency for earth or other material carried thereby to pile up at the lower end thereof when the said boom conveyor 117 is elevated to an extremely high angle. The said boom conveyor 117 is preferably mounted on a suitable spaced channel boom 1171 and may be driven by an independent engine 118 connected to a speed reducer 119, a chain drive 120 and a boom chain drive and take-up 121 which is connected to a suitable sprocket keyed to the laterally extending shaft of the top conveyor power roll 1172.

The said boom 1171 is preferably pivotally connected by the horizontally disposed pivot pin 122 to a U-shaped bracket 123 pivotally connected by a vertical king pin 124 to a frame 125 supported by suitable means from the main frame 20. Rollers 126 journaled to the sides of the said U-shaped bracket 123 travel on an arcuate track 127 to permit the said boom 1171 to swing easily. A tower 128 also suitably supported from the said main frame 20 carries a sheave 129 at the top thereof over which a hoist rope 130 runs, the said hoist rope 130 being secured to the spaced channel boom 1171 by means of a suitable U-shaped bridle 131 pivotally connected to the said boom 1171 by the pivot pins 132. A hand hoist, not shown, conveniently located on the fine-grader is provided to raise and lower the said boom. Suitable means, not shown but preferably located on the U-shaped bracket 123, may be provided to fix the boom 1171 in any position to which it may be swung. A chute 133 at the foot of the said boom 1171 directs loose earth or other material from the disposal conveyor 105 onto the boom conveyor 1170.

The complete flexibility of operation of the novel fine-grader disclosed herein is best shown in Figs. 9 to 15 inclusive, which figures are more or less skeletonized diagrammatic views showing the novel fine-grader with the earth scarifying and digging mechanism thereof in a transport and various dig positions.

Fig. 9 shows the fine-grader in its transport position with the first sub-frame 23 and the second sub-frame 27 thereof raised materially above the general grade line 140, and with the scarifiers 66 thereof hoisted well up out of their operating position.

Figs. 10 and 13 show the fine-grader in a working position taking a light cut with its front wheels 21 running on the general grade 140, and with the scarifiers 26, earth cutting blades 79, final smoothing blades 103 and scoop 104 all

lowered to a shallow cut position on the finished grade line 141; the tractor treads 22 running on the finished grade 141.

Fig. 11 shows the fine-grader in another working position taking a medium heavy cut with its front wheels 21 running on the general grade 140, with the scarifiers 26 taking a light cut, and with the earth cutting blades 79, final smoothing blades 103, scoop 104 all lowered to a medium cut position on the finished grade line 141; the tractor treads 22 running on the finished grade 141.

Figs. 12 and 15 shows the fine-grader in another working position taking a heavy cut with the front wheels 21 running on the general grade 140, with the scarifiers 26 taking a medium heavy cut, and with the earth cutting blades 79, final smoothing blades 103, and scoop 104 all lowered to a heavy cut position on the finished grade line 141; the tractor treads 22 running on the finished grade 141.

Fig. 14 shows the fine-grader with the second sub-frame 27 carrying the earth cutting blades 79 tilted by mechanism hereinbefore described in detail to accomplish a laterally sloping cut such as the bank of a curve, the scarifiers 26 being illustrated in the position shown in Fig. 10 while the earth cutting blades 79 have been tilted to accomplish a medium cut on one side of the fine-grader and a deep cut on the other as best indicated by the finished grade line 1410.

It is obvious that any desired relationship between the work to be done by the scarifiers 26 and the work to be done by the earth cutting blades 79 may be easily and readily varied by manipulating the elevation of the first sub-frame 23 and the second sub-frame 27 as hereinbefore described. Also, by hoisting the scarifiers 26 out of a working position, the scarifying operation may be dispensed with. Obviously, in addition to accomplishing a sloping cut as shown in Fig. 14, a level cut may be accomplished when the main frame 20 of the fine-grader is tilted as one of the front wheels 21 becomes elevated on high spots in the terrain being graded by tilting the second sub-frame 27 carrying the earth cutting blades 79 in an opposite direction to the tilt of the said main frame 20.

As hereinbefore pointed out, the cutting blades 79 carried by the second sub-frame 27 are tilted longitudinally forward as the said second sub-frame 27 is lowered by virtue of use of longer hoist arms at the front of the mechanism used to raise and lower the sub-frame 27 than at the rear of the mechanism used to raise and lower the said sub-frame 27. This makes it possible for the operator of the fine-grader to "dig in" faster at the start of a cut or when changing the gradient of a finished surface being prepared by the novel fine-grader.

The various drive means disclosed and described herein are not a part of this invention, it being understood that the means for applying power to and driving the various movable elements of the novel fine-grader disclosed herein may be altered and arranged in any manner desired without departing from the scope of the invention.

Although but one embodiment of the invention and one modification thereof has been shown and described herein, it is obvious that many changes and other modifications may be made in the size, shape, arrangement and details of the various elements of the invention without departing from the spirit thereof and it is not intended to limit the scope of the invention other than by the terms of the appended claims.

I claim:

1. In a fine-grading machine, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, and means for raising and lowering the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and lowering of the same.

2. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, scarifier means pivotally depending from the said first sub-frame along the front thereof, means connected to said scarifier means below the pivots thereof for towing said scarifiers from said main frame, a second sub-frame supported in depending relationship from the said first sub-frame rearwardly of said scarifier means, earth cutting mechanism carried by said second sub-frame, and means for raising and lowering the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame, first sub-frame and the scarifiers carried thereby, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and lowering of the same.

3. In a machine of the class described, a main frame, mobile means supporting the said main frame at the front and rear thereof, the said front mobile means traveling on terrain to be graded, a first sub-frame pivotally mounted at said rear mobile supporting means, means on the said main frame for pivotally raising and lowering said first sub-frame longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the forward end of said first sub-frame, earth cutting means operably mounted on said second sub-frame, and means for raising and lowering said second sub-frame at longitudinal and transverse angles with respect to said first sub-frame whereby to admit of directing the said cutting mechanism to accurate finished grade regardless of the position which the said main and first sub-frame may assume with respect to the terrain being graded during the forward movement of the machine, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and lowering of the same.

4. In a machine of the class described, in combination, a main frame, mobile means supporting the said main frame at the front and rear thereof, the said front mobile means traveling on terrain to be graded, a first sub-frame pivotally mounted at said rear mobile supporting means, means on the said main frame for pivotally raising and lowering said first sub-frame longitudinally with respect to the said main

frame, scarifier means carried by said first sub-frame, a second sub-frame supported in depending relationship from the said first sub-frame rearward of said scarifier means, earth cutting means mounted on said second sub-frame, and means for raising and lowering said second sub-frame at longitudinal and transverse angles with respect to said first sub-frame whereby to admit of directing the said cutting mechanism to accurate finished grade regardless of the position which the said main frame and scarifiers may assume with respect to the terrain being graded during the forward movement of the machine, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and lowering of the same.

5. In a fine-grading machine, a main frame, mobile means supporting the said main frame at the front and rear thereof, a first sub-frame pivotally supported at the rear of the said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame, digging mechanism carried by the said second sub-frame, and means for suspending said second sub-frame from said first sub-frame adapted to raise and lower the said second sub-frame and digging mechanism carried thereby simultaneously with forwardly tilting the same upward and downward with respect to the said first sub-frame.

6. In a fine-grading machine, a main frame, mobile means supporting the said main frame at the front and rear thereof, a first sub-frame pivotally supported at the rear of the said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame, digging mechanism carried by the said second sub-frame, means for suspending said second sub-frame from said first sub-frame adapted to raise and lower the said second sub-frame and digging mechanism carried thereby simultaneously with forwardly tilting the same upward and downward with respect to the said first sub-frame, and means depending from the said first sub-frame adapted to receive and transfer the rearward reaction from the said digging mechanism carried by the said second sub-frame during the operation thereof from the said second sub-frame to the said rear mobile means.

7. In a fine-grading machine, a main frame, mobile means supporting the said main frame at the front and rear thereof, a first sub-frame pivotally supported at the rear of the said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a hoist shaft mounted on and parallel to each side of the said first sub-frame, a pair of eccentric arms keyed to each hoist shaft in spaced relationship to each other, the forward eccentric arm on each hoist shaft being longer than the rear eccentric arm thereon, hangers pivoted on each eccentric arm, a second sub-frame suspended from the said first sub-frame on said hangers, earth digging mechanism carried by said second sub-frame, and means for rotating said hoist shafts whereby the said second sub-frame and digging mechanism carried thereby may be tilted longitudinally of the said main and first sub-frames simultaneously with raising and lowering the said second sub-frame and digging mechanism with respect thereto.

8. In a fine-grading machine, a main frame, mobile means supporting the said main frame at the front and rear thereof, a first sub-frame pivotally supported at the rear of the said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a hoist shaft mounted on and parallel to each side of the said first sub-frame, a pair of eccentric arms keyed to each hoist shaft in spaced relationship to each other, the forward eccentric arm on each hoist shaft being longer than the rear eccentric arm thereon, hangers pivoted on each eccentric arm, a second sub-frame suspended from the said first sub-frame on said hangers, earth digging mechanism carried by said second sub-frame, and means for rotating said hoist shafts independently of each other whereby the said second sub-frame and digging mechanism carried thereby may be tilted longitudinally and transversely of the said main and first sub-frames simultaneously with raising and lowering the said second sub-frame and digging mechanism with respect thereto.

9. In a fine-grading machine, main framework carried by mobile means at the front and rear thereof, digging mechanism, sub-framework carrying said digging mechanism suspended from said main framework, and means for tilting said sub-framework both longitudinally and transversely with respect to said main framework simultaneously with raising and lowering the same with respect to said main framework whereby to apply said digging mechanism to the desired finished grade while the front mobile means travels on terrain to be graded.

10. In a fine-grading machine, in combination, main framework carried by mobile means at the front and rear thereof, scarifiers pivotally suspended from and towed by said framework adapted to be raised and lowered with respect to said framework, digging mechanism, sub-framework carrying said digging mechanism suspended from said main framework, and means for tilting said sub-framework both longitudinally and transversely with respect to said main framework simultaneously with raising and lowering the same independently of and with respect to said scarifiers and said main framework whereby to apply said digging mechanism to the desired finished grade while the front mobile means travels on terrain to be graded.

11. In a fine-grading machine, main framework carried by mobile means at the front and rear thereof, digging mechanism, sub-framework carrying said digging mechanism suspended from said main framework, means for tilting said sub-framework and digging mechanism carried thereby both longitudinally and transversely with respect to said main framework simultaneously with raising and lowering the same with respect to a finished grade line, final smoothing means carried by said sub-framework movable with said digging mechanism to the said finished grade line, and means for disposing of surplus material removed by said digging mechanism.

12. In a fine-grading machine, main framework carried by mobile means at the front and rear thereof, scarifiers pivotally suspended from and towed by said framework adapted to be raised and lowered with respect to said framework to or above a finished grade line, digging mechanism, sub-framework carrying said digging mechanism suspended from said main framework, means for tilting said sub-framework and digging mechanism carried thereby both longitudinally and transversely with respect to said framework simultaneously with raising and lowering the same independently of and with re-

spect to said scarifiers and said main framework to the said finished grade line, final smoothing means carried by said sub-framework movable with said digging mechanism to the said finished grade line, and means for disposing of surplus material removed by said digging mechanism.

13. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame adapted to scrape surplus material from in front of said smoother blades to said scoop, and a disposal conveyor positioned to receive material from said scoop.

14. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame between said earth cutting mechanism and said smoother blades adapted to scrape surplus material from in front of said smoother blades to said scoop, a disposal conveyor positioned to receive material from said scoop, and means disposed in spaced relationship above said scoop adapted to feed material deposited on said scoop by the said flight conveyors up said scoop and onto said disposal conveyor.

15. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame between said earth cutting mechanism and said smoother blades adapted to scrape surplus material from in front of said smoother blades to said scoop, a disposal conveyor positioned to receive material from said scoop, and a screw disposed in spaced relationship above said scoop adapted to throw material deposited on said scoop by the said flight conveyors up said scoop and onto said disposal conveyor.

16. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame between said earth cutting mechanism and said smoother blades adapted to scrape surplus material from in front of said smoother blades to said scoop, a disposal conveyor positioned to receive material from said scoop, and propeller blades disposed in spaced relationship above said scoop adapted to throw material deposited on said scoop by the said flight conveyors up said scoop and onto said disposal conveyor.

17. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame between said earth cutting mechanism and said smoother blades adapted to scrape surplus material from in front of said smoother blades to said scoop, a disposal conveyor positioned to receive material from said scoop, and a boom conveyer adapted to receive material from said disposal conveyor and discharge the same to the rear or sides of the said grading machine.

18. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising, lowering and tilting the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main

frame and first sub-frame, a central earth scoop and laterally adjacent final smoother blades carried by the rear of the said second sub-frame, flight conveyors mounted on said second sub-frame between said earth cutting mechanism and said smoother blades adapted to scrape surplus material from in front of said smoother blades to said scoop, a disposal conveyor positioned to receive material from said scoop, means disposed in spaced relationship above said scoop adapted to feed material deposited on said scoop by the said flight conveyors up said scoop and onto said disposal conveyor, and a boom conveyor adapted to receive material from said disposal conveyor and discharge the same to the rear or sides of the said grading machine.

19. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, a second sub-frame supported in depending relationship from the said first sub-frame, earth cutting mechanism carried by said second sub-frame, means for raising and lowering the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame and first sub-frame to a finished grade line, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and the lowering of the same, final smoothing means carried by said second sub-frame movable therewith to the said finished grade line, and means for disposing of surplus material accumulating ahead of said final smoothing means.

20. In a fine-grading machine, in combination, a main frame, mobile means supporting said main frame at the front and rear thereof, a first sub-frame shorter than the said main frame pivoted at the rear of said main frame adapted to be pivotally raised and lowered longitudinally with respect to the said main frame, scarifier means pivotally depending from the said first sub-frame along the front thereof, means connected to said scarifier means below the pivots thereof for towing said scarifiers from said main frame, a second sub-frame supported in depending relationship from the said first sub-frame rearwardly of said scarifier means, earth cutting mechanism carried by said second sub-frame, means for raising and lowering the said second sub-frame and earth cutting mechanism carried thereby both longitudinally and transversely independently of and with respect to the said main frame, first sub-frame and the scarifiers carried thereby, to a finished grade line, the said raising and lowering means being adapted to tilt the said second sub-frame simultaneously with the raising and the lowering of the same, final smoother means carried by said second sub-frame movable therewith to the said finished grade line, and means for disposing of surplus material accumulating ahead of said final smoother means.

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