Oct. 30, 1923.

1,472,562

E. S. KNIGHT

GRADING AND EXCAVATING MACHINE

Filed July 26, 1922 4 Sheets-Sheet 1

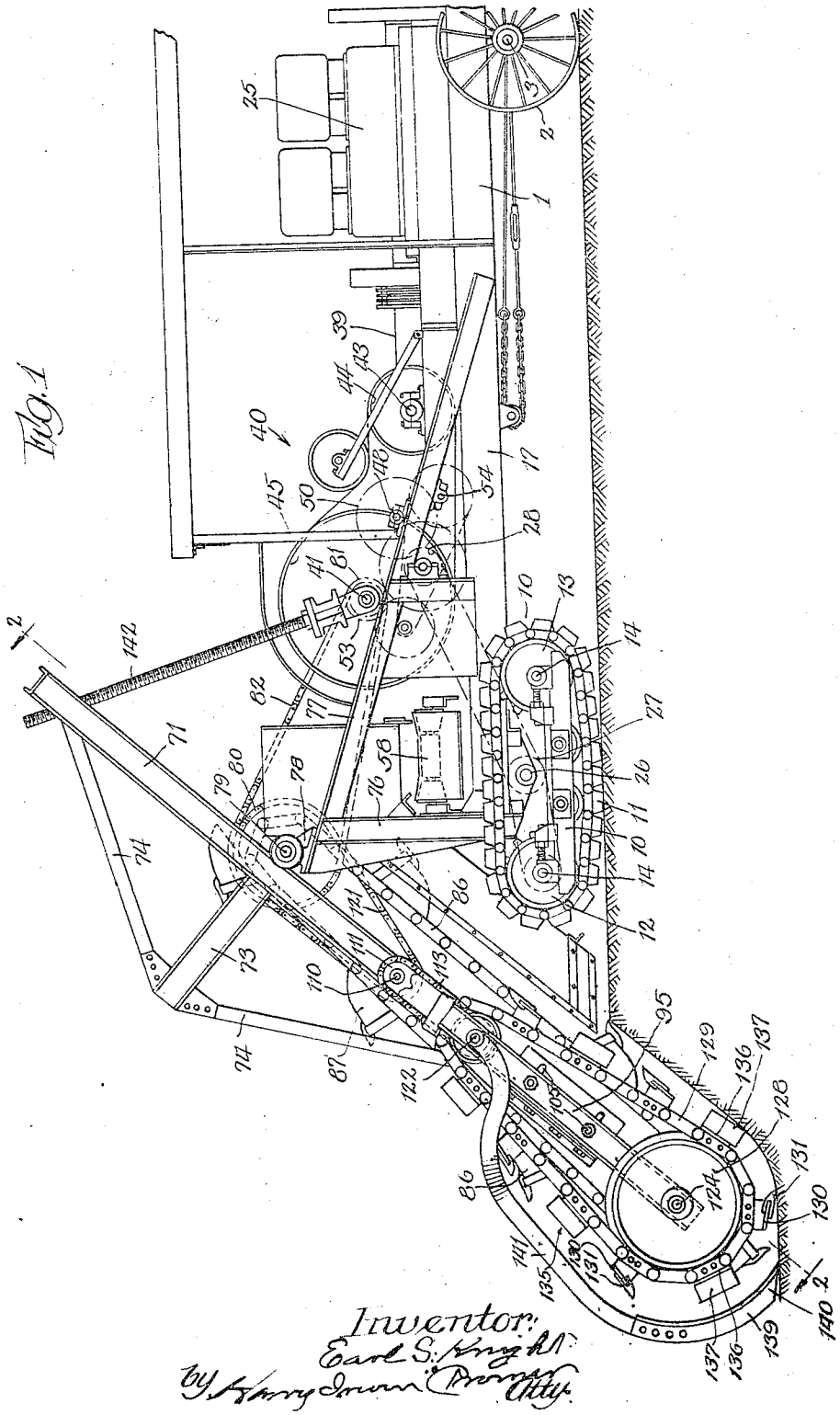


Fig. 1

Inventor:
Earl S. Knight
By Harry Irwin Prior Atty.

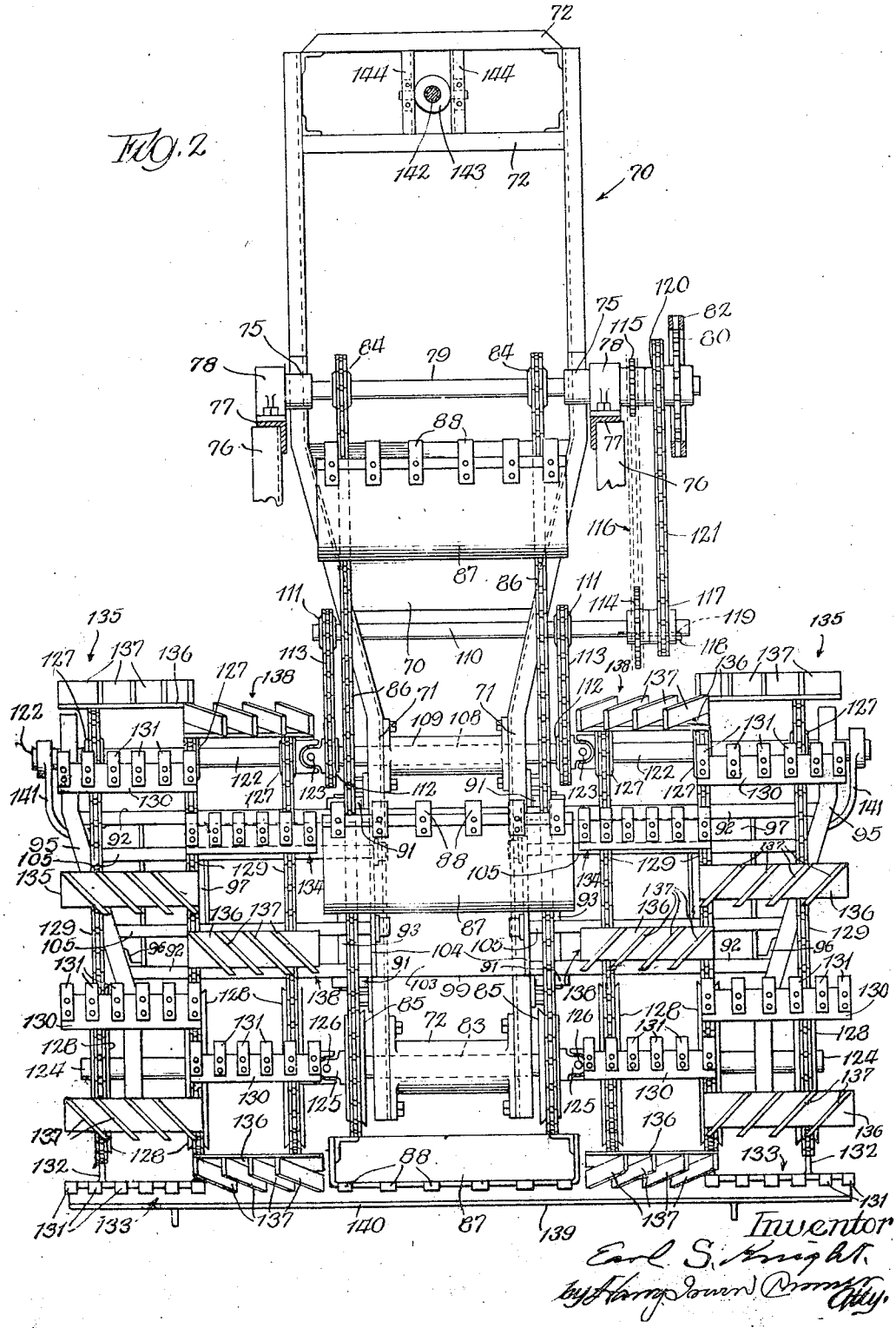
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GRADING AND EXCAVATING MACHINE

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Fig. 2.



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GRADING AND EXCAVATING MACHINE

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Fig. 3

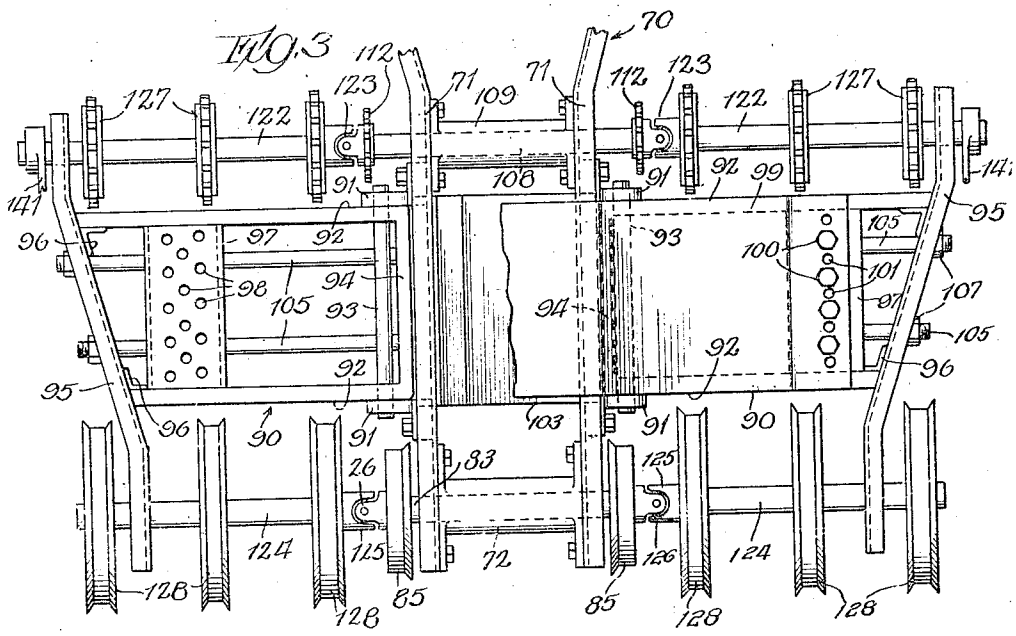


Fig. 4

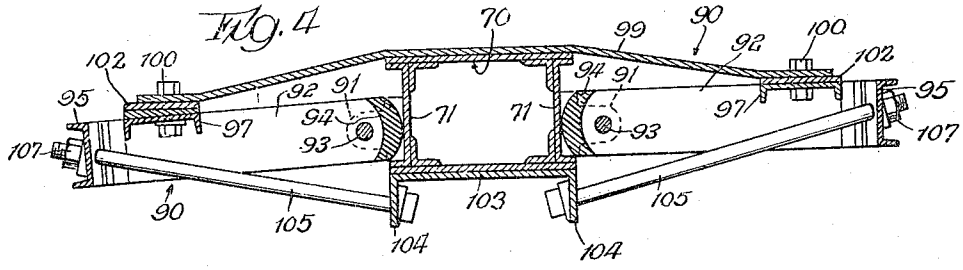
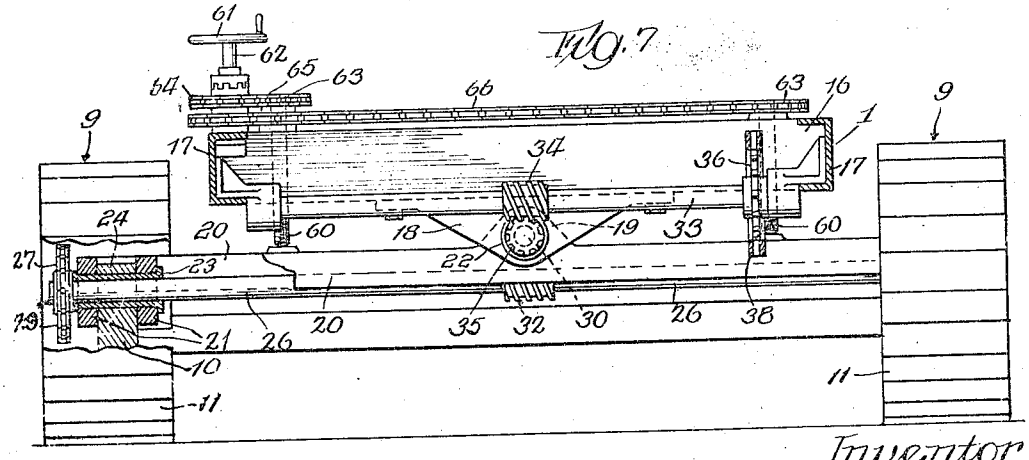


Fig. 7



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GRADING AND EXCAVATING MACHINE

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Fig. 5

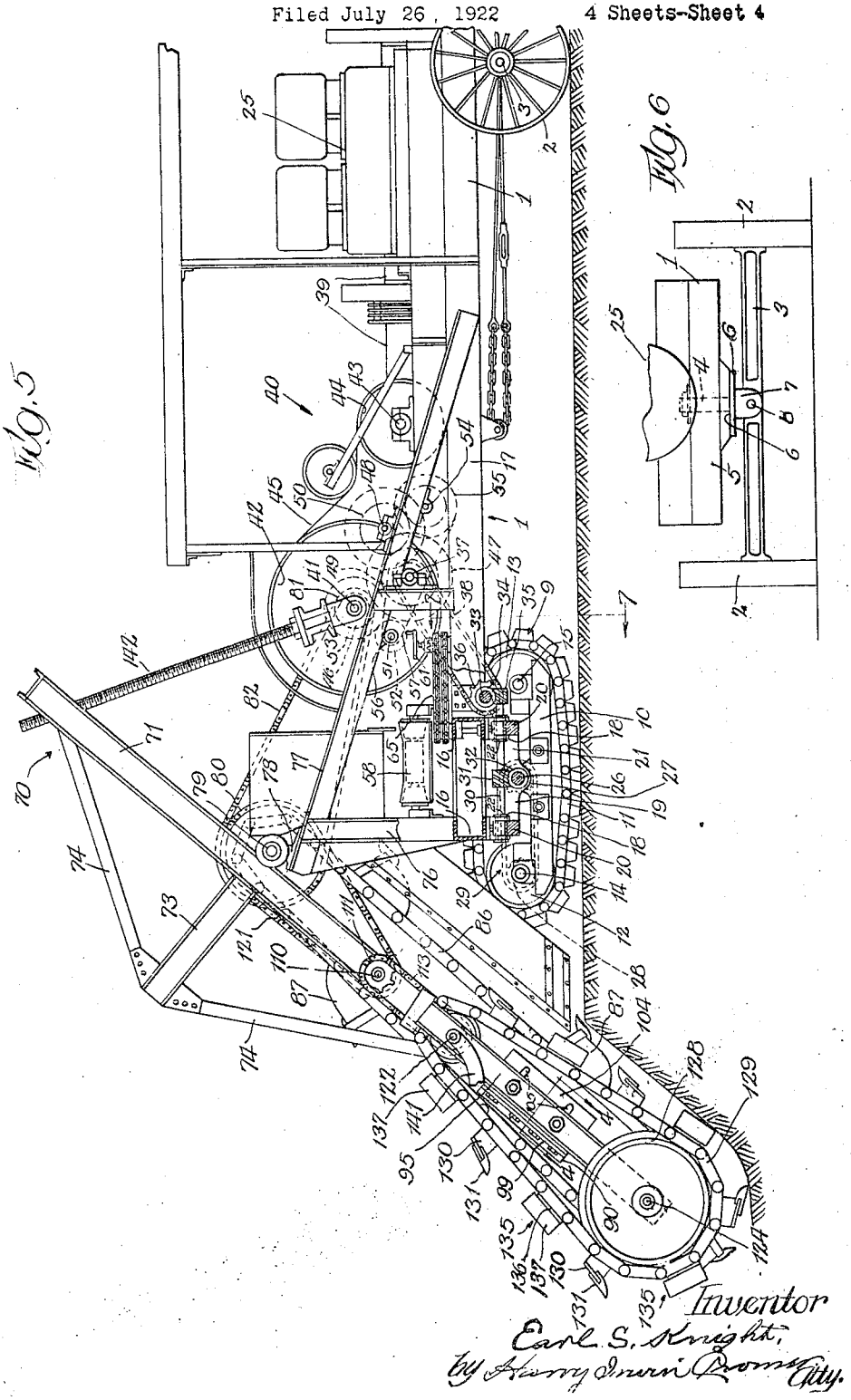


Fig. 6

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Patented Oct. 30, 1923. 1,472,562

UNITED STATES PATENT OFFICE.

EARL S. KNIGHT, OF WATERLOO, IOWA.

GRADING AND EXCAVATING MACHINE.

Application filed July 26, 1922. Serial No. 577,531.

To all whom it may concern:

Be it known that I, EARL S. KNIGHT, a citizen of the United States, residing at Waterloo, in the county of Blackhawk and State of Iowa, have invented certain new and useful Improvements in Grading and Excavating Machines, of which the following is a specification.

This invention relates to that class of grading and excavating machines having an endless conveyor provided with a series of receptacles and cutters, and having cutter and scraper mechanisms located on opposite sides of such endless conveyor and adapted to dig and deposit material in position to be raised or carried away by the endless conveyor mechanism.

The principal object of the invention is to provide a simple, economical and efficient road grading and excavating machine.

A further object of the invention is to provide an efficient road grading machine adapted to cut or dig into the earth to a suitable depth and form a suitable predetermined grade, or graded surface, of the desired width and shape or conformation, with facility and with a minimum expenditure of time and power.

A further object of the invention is to provide an efficient road grading and excavating machine of simple and economical construction, which is adapted to cut or excavate to the desired depth and form an uniform grade of the desired width, pitch, and conformation notwithstanding the irregularities of the surface of the ground or area to be graded or operated upon.

Other and further objects of the invention will appear from the following description and claims, and from an inspection of the accompanying drawings, which are made a part hereof.

The invention consists in the features, combinations, details of construction, and arrangement of parts herein described and claimed.

In the accompanying drawings:

Figure 1 is a view in side elevation of an ordinary excavating machine frame provided with improved grading and excavating mechanism constructed in accordance with my invention;

Fig. 2 is a bottom plan view looking upward, taken on line 2—2 of Fig. 1, showing the bottom of the main digging beam or boom and digging buckets and main digging bucket-supporting chains, and the side digging and deflector scraper mechanism;

Fig. 3 is a top plan view in detail showing the rear portion of the digging beam or boom and the laterally projecting side frame arms connected therewith, and showing the side shafts and side digging chain supports;

Fig. 4 is a view in transverse section taken on line 4—4 of Fig. 3, showing the rear portion of the main digging beam and the adjustable side frame members thereon;

Fig. 5 is a view in side elevation, showing my improved laterally tiltable main frame and grading mechanism supported upon the tractor mechanism of an ordinary and well known form of excavating machine;

Fig. 6 is a detail end view in front elevation, showing the manner of pivotally connecting the front portion of the main frame with the front axle; and

Fig. 7 is a view in transverse vertical section taken on line 7—7 of Fig. 5 showing the manner of mounting the rear portion of the main frame upon the tractor mechanism, and the means for operatively connecting the tractor mechanism with the engine or source of power.

In constructing a road grading machine, or grading and excavating machine, in accordance with my invention and improvements, I provide a main frame 1, which is mounted upon suitable front supporting wheels 2, having an axle 3 extending transversely of and operatively connected in supporting engagement with the main frame 1 by suitable connecting means which, by preference, comprises an upright bolt or king bolt 4 rotatively mounted in a suitable vertical opening in a transverse forward frame member 5 of the main frame 1 and having a depending head 6 having side flanges 7 which are spaced apart and extend downward on opposite sides of the axle 3. A transverse bolt 8 extends through the depending flanges 7 of the bolt head 6, and through a suitable horizontal opening in the axle 3, or in a suitable connecting member or clip connected with or forming a part of said axle.

The rear portion of the main frame 1 is, by preference, supported by means of suitable tractor mechanism 9, which may be of any desired well known or suitable form, and comprises a rear supporting frame 10 of

an ordinary caterpillar mechanism, having the usual endless traveling chains or flexible elements 11 located on opposite sides of the main frame 1 and operatively connected with suitable sprockets or supporting wheels 12, 13 mounted on axles 14 and 15, respectively, said axles being mounted in turn upon the main rear supporting frame or caterpillar frame 10 in the usual manner.

In order to enable the main frame, with the boom and other mechanism supported thereby, to be tilted with respect to the caterpillar mechanism or tractor mechanism and supporting wheels, the rear portion of the main frame is, by preference, connected with and supported by the caterpillar mechanism or tractor mechanism 9, as follows: A pair of rear transverse frame members 16 is provided, each of said transverse members having its opposite ends fixed to the longitudinal side frame members 17 of the main frame 1, and forming a part of said frame. These transverse frame members 16 are spaced apart, and each provided with a pair of depending side flanges 18. And an intermediate transverse pivoted frame or axle 19 is interposed between the caterpillar frames or tractor side frames 10 and the main frame 1. The transverse frame or axle 19 comprises in its construction a pair of transverse frame members 20, the opposite ends of which are connected by means of side frame members 21 located on opposite sides of the main frame. Each of the transverse members 20 extends between a pair of the flanges 18, 18, of a corresponding transverse bottom frame member 16. And a hollow cylindrical sleeve or thimble 22 extends through a suitable perforation, or horizontal opening in each transverse axle or frame member 20, and has its opposite ends anchored in the flanges 18 of a corresponding transverse member 16, so as to pivotally connect each of the axle members 20 with a corresponding transverse flanged frame member 16, and form a pivoted connection between the main frame 1 and said intermediates transverse frame or axle 19. The transverse frame or axle 19 is pivotally connected at its opposite ends with a corresponding tractor frame member 10 by suitable means which may be in the form of a hollow sleeve or pivot 23 mounted in each end of the axle 19, each of said hollow sleeves or pivots having its opposite ends anchored in a pair of end frame members 21, which are spaced apart to receive an upwardly projecting bearing member or yoke portion 24 of a corresponding tractor frame member 10, through which extends one of said hollow sleeves or pivots 23. The axle or intermediate transverse frame 19 is thus pivotally connected with the tractor frames 10 by means of the hollow pivots 23, which extend transversely of the main frame in a horizontal plane, and with the main frame 1 by means of the flanged transverse frame members 16, and horizontal hollow pivots or thimbles 22, already described.

An engine or motor 25, which may be of any suitable ordinary and well known form, is mounted upon the main frame member, and operatively connected with the tractor mechanism or caterpillar mechanism, above described, by suitable connecting and driving means. In the form of the device shown in the drawings, a transverse tractor shaft 26 is rotatively mounted in the intermediate axle or pivoted frame 19, and, by preference, has its opposite extremities journaled in the hollow sleeves or pivots 23, said shaft being provided with suitable means for operatively connecting it with the driving sprockets 12 of the caterpillar mechanism, and with suitable shaft and gear mechanism, or connecting and driving mechanism for operatively connecting said tractor shaft 26 with the engine or source of power. For this purpose toothed sprocket wheels 27 are fixed to the opposite ends of the shaft 26, and each operatively connected with a corresponding sprocket wheel 28 on and in fixed relation to an axle 14 of a tractor chain driving wheel 12 by means of the sprocket chain 29.

A horizontal shaft 30 is journaled in the hollow pivots or sleeves 22, in the flanged transverse frame members 16, which form suitable journal bearings for said shaft. This shaft extends longitudinally of the main frame, and is located in a horizontal plane at or below the level of the longitudinal center of the main frame. A worm or gear wheel 31, fixed to the shaft 30, is in toothed engagement with a suitable worm or gear wheel 32 fixed to the shaft 26. And a shaft 33, journaled in the main frame 1 is operatively connected with the horizontal longitudinal shaft 30 by suitable connecting gear mechanism, which may be of any desired ordinary and well known form. For example, a toothed gear or worm wheel 34 is fixed to the shaft 33 and in toothed engagement with a worm or gear wheel 35 fixed to the shaft 30. The shaft 33 is also provided with a toothed sprocket wheel 36 fixed thereto. And said sprocket wheel 36 is operatively connected with a transverse traction shaft 37, on the main frame 1 by means of the sprocket chain 38, said traction shaft 37 being operatively connected with the engine shaft 39, by means of a suitable train of gears, which may be of any desired ordinary and well known form. The train of gears and shaft mechanism, by means of which the traction shaft 37 is operatively connected with the engine shaft 39, or source of power, are well known and

in common use and familiar to those skilled in the art, and are particularly well known and in common use upon ditch digging machines, or what is commonly known as trenching machines. It is therefore deemed unnecessary to describe said gear mechanism and shaft mechanism herein, or to illustrate the same in detail, or otherwise than as shown in the drawings.

The traction shaft 37 is operatively connected with the engine 25 or other source of power by connected shafts and a train of gears 40 of the usual ordinary and well known form which is in common use on ordinary excavating machines, and therefore need not be described or shown in detail herein. A main driving shaft 41 of an ordinary and well known form of trench digging or excavating machines is mounted on the main frame 1 and operatively connected with the engine shaft 39 of the engine 25 in the usual manner. And shafts 41, 43, 39, 37, 48, 51, 54, conveyor 58 and tilting screw 142 are operatively connected in the usual ordinary and well known manner by gear and clutch mechanism,—not shown—but which is common and well known in the art. A belt wheel 42 is fixed to the main driving shaft 41 and operatively connected with a reversing shaft 43 by means of a belt pulley 44 fixed to said reversing shaft, and a belt 45. The reversing shaft 43 is operatively connected with the engine shaft 39 in the usual and ordinary manner, by means of suitable reversing gear and clutch mechanism,—not shown. The main drive shaft 41 is operatively connected with the traction shaft 37 by means of a spur gear wheel 46 fixed to said main drive shaft and a spur gear wheel 47 fixed to the traction shaft 37. The traction shaft 37 is operatively connected with the intermediate shaft 48 by means of a spur gear wheel 49 fixed to the shaft 37 and in toothed engagement with a spur gear wheel 50 which is fixed to the intermediate shaft 48.

The main drive shaft 41 is operatively connected with a shaft 51 commonly known as the first feed shaft by means of a spur gear wheel 52 fixed to said first feed shaft 51 and in toothed engagement with a spur gear wheel 53 which is fixed to the main drive shaft. And said first feed shaft 51 is operatively connected with a second feed shaft 54 by means of a belt pulley wheel 55 fixed to said second feed shaft 54 and a belt pulley wheel 56 fixed to the shaft 51, and a belt 57 mounted on and operatively connecting said pulleys 55 and 56.

The first feed shaft 51 is also operatively connected with a transverse endless conveyor 58, which may be of any ordinary well known or desired form, by means of suitable connecting gear mechanism not shown.

In order to provide means for conveniently tilting the main frame 1, so as to enable the frame and mechanisms supported thereby to be maintained in upright position, or in any desired inclined position, and enable a uniform grade to be made notwithstanding the irregularities of the ground over which the machine is required to travel during the operation of grading, I mount a pair of tilting screws 60, 60, in upright position in the frame 1, by preference, in position to extend through and in threaded engagement with a suitable screw-threaded support, such as the transverse frame member 16. Each of the tilting screws 60 thus mounted on opposite sides of the main frame 1 has its bottom end in position to engage and abut against a suitable support upon or forming part of the intermediate frame or axle 19. For example, the bottom end of each screw 60 may be in abutting engagement with the upper surface of a transverse bar or axle member 20. The screws 60 are provided with suitable operating means, which may consist of a hand wheel 61 fixed to an upright rotative shaft 62 mounted in suitable bearings in the main frame 1 in convenient position to be reached by the operator. And the upright operating shaft 62 is operatively connected with the tilting screws 60 by suitable means, which may be in the form of sprocket wheel and chain mechanism or equivalent connecting and operating means. For example, each tilting screw 60 has a sprocket wheel 63 fixed thereto; and the upright operating shaft 62 has one or more sprocket wheels 64 fixed to said shaft. And a sprocket chain 65 is mounted upon and connects one of the sprocket wheels 64 with the sprocket wheel 63 of one of the tilting screws 60; while a sprocket chain 66 connects the sprocket wheel 63 of the other tilting screw with a corresponding sprocket wheel 64 on said operating shaft 62.

By providing one of said tilting screws 60 with right hand screw threads, and the other with left hand screw threads, both screws may be operated simultaneously in the proper direction to tilt the frame in either direction as desired, or to bring it to upright position as circumstances may require. It is obvious that each of the screws 60 may be operated independently of the other, when desired, by means of a crank or other similar or ordinary operating means.

In constructing digging and grading mechanism, comprising a pivoted supporting frame or boom, and endless chains, buckets, scarifiers or cutter tools, and scrapers or deflectors, in accordance with my invention and improvements, I provide a main pivoted frame or boom 70, which may be of any usual ordinary and well known or suitable form, such as are in common use in

trenching machines or excavating machines, but which, by preference, is in the form of a trussed beam comprising longitudinal side members or beams 71, which may be in the form of channel irons, and are connected by suitable transverse braces 72 in the usual manner. Suitable compression members 73 and tension members 74, fixed to the main trussed beam 71 in the usual manner, serve, in connection with the beam 71, to make a strong portable frame or boom adapted to sustain the stresses and strains to which it is subjected in use. This boom is provided with a bearing 75 fixed to the beam 71, and is pivotally mounted upon upright trusses or side frame members 76 and 77 which are fixed to the rear extremity of and form a part of the main frame 1.

The boom 70 is pivotally connected with the main frame in the usual ordinary and well known manner of connecting the booms with the main frames of ordinary and well known forms of excavating or trenching machines. And it should be noted that the boom 70, with the digging mechanism, including the endless digging chains and buckets, scarifiers or cutters, and scrapers or deflectors, and the shaft and gear or sprocket mechanism and transverse frame members forming the digging and grading mechanism proper, are adapted to be used upon and in connection with the ordinary and well known forms of trench-digging and excavating machines. And the boom 70 is adapted to be pivotally connected with the main frame of an ordinary trench-digging or excavating machine, such as is in common use and familiar and well known in the art to which this invention relates. In the form of grading machine, or grading and excavating machine herein shown and described, the boom is provided with a transverse upper main bucket-chain supporting and driving shaft 79 which is journaled in suitable bearings and extends through the bearings or hinge members 75 fixed to said boom or tilting digging beam 70, and through the bearings or hinge members 78 fixed to the upper rear frame members 76, 77 of the main frame 1. The shaft 79 thus serves to pivotally connect the boom or tilting digging beam 70 with the main frame.

The main bucket-chain supporting and driving shaft 79 is operatively connected with the engine or source of power, which may be of any ordinary and well known or desired form, by means of a sprocket wheel 80 fixed to the shaft 79, a sprocket wheel 81 fixed to the main driving shaft 41 already described, and a sprocket chain 82 mounted upon and connecting said sprocket wheels and shafts.

A rear bottom bucket-chain supporting shaft 83 is rotatively mounted in suitable bearings on the lower rear extremity of the tilting digging beam or boom 70, and extends transversely of and, by preference, through the lower rear extremity of the boom, and in parallel relation to the upper main bucket-chain supporting and driving shaft 79.

Fixed to the upper bucket-chain supporting and driving shaft 79 is a pair of toothed sprocket wheels 84, 84. Fixed to the lower transverse bucket-chain supporting and grading shaft 83 is a pair of toothed sprocket wheels 85. And mounted upon and connecting the sprocket wheels 84 and 85, and supported by said sprocket wheels and their supporting shafts, is a pair of main endless digging-bucket supporting and conveyor chains 86, 86, which are mounted in parallel relation and extend longitudinally of the boom 70, the upper downwardly and rearwardly moving laps of said chains being above the boom, and the lower upwardly moving lap of said pair of chains being below the boom. These chains are thus supported by the transverse shafts 79 and 83. And it is obvious that the sprocket wheels 85 on shaft 83 may be either fixed to said shaft and rotate therewith and in toothed engagement with the chains 86, so as to drive or tend to drive said chains, or be driven by the same, or may be losely mounted on said shaft 83 and act as idlers.

Mounted upon the endless chains 86, 86 is an endless series of digging and conveyor buckets 87, each having its opposite ends attached to the sprocket chains 86, 86, in the usual ordinary and well known manner, and each having on its outer upwardly and forwardly moving and forwardly facing margin a series of sharp edged cutters or scarifiers, or scarifier teeth 88, which are of the usual ordinary and well known form. But the toothed edge of each of the digging buckets 87 is, by preference, straight; and the end walls of the buckets are also, by preference, substantially flat. But the buckets are open at the back and bottom inner side or toward the shafts around which they revolve, so as to readily dump material into a transverse conveyor 58, which is of the usual ordinary and well known form, operated in the usual and ordinary manner and driven by any ordinary and well known driving means. The endless conveyor 58 is mounted on the main frame in position to extend beneath the upper extremity of the endless bucket-chains 86 and endless series of buckets so as to receive and convey away material dumped from said buckets at the upper extremity of their path of movement.

The tilting boom or digging beam 70 is provided at or near its lower extremity with a pair of transverse laterally projecting frame arms 90, mounted on and projecting

laterally from opposite sides of said boom or tilting beam.

These transverse frame arms 90 may be attached to the boom in various ways. For example, they may be, and in this instance, are flexibly or adjustably connected with the main beam 70, by means of hinge members 91 fixed to the beam 70, on opposite sides of said beam, corresponding mating hinge members 92 fixed to the inner end of each frame arm 90, and pivot rods or pintles 93 each mounted in the perforated hinge members 92 of a corresponding one of said frame arms 90, and extending through the openings in the adjacent hinge members or lugs 91 on the boom 70, and forming a pivotal connection between each of said transverse frame arms, respectively, and the boom.

In the form of the device shown in the drawings, each of the transverse laterally projecting frame arms 90 comprises in its construction laterally projecting frame arm members 92, 92, which may form the hinge members through which the pivot rod 93 extends, as already described. These frame members 92 are connected at their inner ends by means of an inner frame member 94, which may be in the form of a channel iron having its opposite ends fixed to the corresponding inner ends of said frame members or hinge members 92, which may also be formed of channel iron. The outer extremities of the frame members 92, 92, are rigidly connected by means of an outer frame member 95 fixed thereto by gusset plates 96, or other suitable securing means. This frame member 95 may also be formed of channel iron.

Each of the transverse frame arms 90 is, by preference, of open work construction strongly braced by means of braces which may be of any desired suitable form. For example, the heavy brace beam or plate 97, of channel iron construction, and provided with perforations 98 arranged in a plurality of series of perforations and in staggered relation to each other, is fixed at its opposite ends to the lateral frame members 92; and a heavy metallic top plate 99 extends transversely across the top of the main beam 71 of the boom or digging beam 70, and has its opposite ends adjustably connected with the outer extremities of each of the pivoted lateral frame arms 90 in such a manner as to enable said frame arms 90 to be adjusted with respect to each other and with respect to the boom so as to control and determine the grade, not only as to depths, but also the pitch and conformation or shape of the grade, and particularly, to enable the grade to be made lower on one side of the boom than on the other, or lower on both sides of the boom than it is directly beneath the boom, as desired. The top transverse plate or frame member 99 is therefore, by preference, adjustably secured at its outer extremities to the adjacent outer extremities of the pivoted transverse arms 90, respectively. For this purpose headed bolts 100 are mounted in perforations 101 in the outer extremities of the top plate 99 and extend through corresponding perforations 98 in the perforated channel iron frame member 97 directly beneath the perforations 101. Filler plates or wedges 102 are interposed between the perforated channel iron frame members 97 and the corresponding perforated ends of the top plate 99. And it is obvious that by removing a filler plate from either end of the top plate 99 and connecting the top plate directly with the corresponding pivoted arm 90, the outer extremity of the latter can be conveniently raised to a desired suitable elevation with respect to the pivoted arm 90 on the other side of the boom. By inserting both filler plates or wedges 102, the outer extremities of both pivoted arms 90 may be readily lowered, so that each of said arms extends downward and outward at an incline from the boom, or downward and outward below the normal level of said arms. And by removing a filler plate 102 from one end of the top plate 99 and inserting it, along with the other filler plate 102 beneath the opposite end of the top plate 99, the corresponding adjacent arm 90 will be lowered, and by securing the end of the top plate 99 from which the filler plate has been removed, directly in contact with the adjacent pivoted arm 90, the latter will be raised above its normal level and higher than the arm over which the plurality of filler plates 102 are located.

A heavy channel iron member 103 having depending side flanges 104 is fixed to the bottom side of the main beam 71, or boom 70; and headed rods or tension members 105 are mounted with their inner headed ends extending through suitable perforations in the flanges 104, there being a pair of said rods 105 for each pivoted arm 90. The outer channel iron member 95 of each pivoted frame arm 90 is provided with suitable perforations 106 through which extend the outer ends of the corresponding pair of upwardly and outwardly inclined rods or bolts 105. And nuts 107 mounted on and in threaded engagement with the outer threaded ends of the threaded rods 105 and on the outside of the outer channel iron member 95 of such pivoted frame arm 90 serve to rigidly connect the frame arm with its pair of rods 105, and to permit the latter to be adjusted with respect to such pivoted frame arm 90, in whatever position the latter may be required to be supported. A strong trussed transverse frame, comprising the transverse pivoted arms 90, top plate 99, and rods 105 extending upward and outward at

an incline from the bottom side of the boom to the outer extremities of said pivoted arms 90, is thus provided. It is obvious that tapered filler plates in the form of wedges may be mounted between the outer ends of the top plate 99 and the corresponding arms 90, with the points of the wedges extending inward, and adjustable endwise toward and from the boom, to permit the raising and lowering or adjustment of the outer end of each arm 90, and the securing of the same rigidly in any desired adjusted position with respect to the boom.

A transverse shaft 108 is rotatively mounted on the boom 70 in suitable journal bearings 109, and is located between the lower shaft 83 and the top main boom shaft 79, which support the endless bucket chains 86. This shaft 108 is in parallel relation to the shaft 83, and is provided with suitable driving mechanism, which may be of any desired ordinary and well known form. For example, an intermediate shaft 110 is mounted in the boom, and between the shaft 108 and shaft 79. A toothed sprocket wheel 111 is fixed to the shaft 110; and a toothed sprocket wheel 112 is fixed to the shaft 108; and a sprocket chain 113 is mounted upon and connects said sprockets 111 and 112. A toothed sprocket wheel 114 is fixed to or detachably connected with the shaft 110, and a sprocket wheel 115 is mounted upon and adapted to rotate with the shaft 79; and a sprocket chain 116 is mounted upon and operatively connects said sprockets 114 and 115. Suitable speed changing mechanism is, by preference, provided for enabling the speed of rotation of the shafts 108 and 110, or either desired one of said shafts to be changed or varied with respect to the speed of rotation of the shaft 79 and main driving shaft 41, or other driving means or source of power by means of which the shafts 108 and 83 and 79, and the digging and grading or excavating mechanism operatively connected therewith, are to be driven. For example, a toothed sprocket wheel 117 is mounted upon the shaft 110 and a key or spline 118 is mounted in a suitable peripheral longitudinal slot or groove 119, and movable longitudinally of the shaft 110. By moving the spline or key 118 in one direction longitudinally of the shaft, it will hold the sprocket 114 in fixed relation to the shaft; and by moving it in a direction away from the sprocket 114 and toward the sprocket 117 it will release the sprocket 114 and secure the sprocket 117 in fixed relation to the shaft 110. A sprocket wheel 120 is fixed to the shaft 79, and is of a different diameter from the sprocket 115. In this instance, it is shown as of larger diameter; and a sprocket chain 121 is mounted upon and operatively connects the sprocket wheels 117 and 120. By this means, or any other suitable ordinary and well known or desired speed changing mechanism, the speed of rotation of the shaft 108 and shaft 110 may be changed with respect to the rotation of the shaft 79.

The shaft 108 projects laterally on opposite sides of the boom; and its projecting end portions or extensions 122, 122, although they may be formed in one integral piece with the central or main body portion of the shaft, are, by preference, flexibly connected with said central main body portion by means of universal joints 123, 123, which may be of any desired well known or suitable form. And I also, by preference, provide the shaft 83 with suitably projecting end portions or extensions 124, 124, which project laterally on opposite sides of the boom, and in parallel relation to the extensions 122 on the shaft 108. The laterally projecting shafts 124, however, may be entirely separate from the shaft 83 which supports the lower extremity of the pair of endless bucket chains 86. And said transverse extensions or separate shafts 124, 124, may, if desired, be non-rotatively mounted, each in a corresponding one of the pivoted or adjustable frame arms 90. But even when the shafts or extensions 124 are non-rotatively mounted, they may be connected with or form an integral part of the shaft 83, by being connected with the latter by means of ordinary universal joints 125, or merely by means of suitable pivot pins or hinges 126 of sufficient strength to withstand the stresses and strains to which the mechanism is subjected in use.

Each of the laterally projecting transverse shafts 122 is provided with a series of toothed sprocket wheels 127 fixed thereto. In this instance, three of such sprockets are shown upon each laterally projecting shaft member 122. Three idler wheels 128 are mounted upon each of the transverse laterally projecting shaft members or supporting rods 124. And each sprocket wheel 127 is operatively connected with a corresponding idler or sprocket wheel 128 by means of a sprocket chain 129. These sprocket chains 129 are in the form of heavy digging chains and are driven, by preference, by means of the shaft 108, which is operatively connected with the engine or source of power, in the manner already described, or by similar suitable connecting and driving means.

Mounted on each series of endless side digging chains 129 is a series of cutters or scarifiers, each of which is, by preference, in the form of a heavy transverse bar 130, having its opposite ends flexibly connected with a pair or plurality of the endless digging chains 129. And a series of sharp edged cutters or scarifier teeth 131 is mounted upon by each of said bars 130.

The rear shaft 83 and its extensions 124,

whether separate or connected, may be non-rotatively mounted in their supports. And the sprocket wheels or idlers may be made without sprocket teeth, and of any suitable ordinary form.

An outer series 133 of scarifiers 132 is thus located between the outermost chain 129 and the next adjacent inner chain 129; and an intermediate series 134 of scarifiers is thus located between and supported by the innermost endless chain 129 and the adjacent chain 129. Any desired number of endless series 133, 134 of scarifiers may thus be mounted side by side on opposite sides of the boom 70, and driven at any desired predetermined speed with respect to the speed of movement of the main central endless bucket supporting chains 86. And the speed of movement of the outermost and intermediate scarifiers and their supporting chains 129 may be varied with respect to the speed of movement of the main central digging buckets and their supporting chains, as desired. And, I prefer, in most instances, to drive the side digging chains, scarifiers and deflector scrapers at a speed which is faster than the speed of movement of the main digging and conveyor buckets and their supporting chains mounted on the boom.

An outer series of oblique scrapers or deflectors 135 is provided, comprising an endless series of transverse deflector supporting bars 136, each connected at its opposite ends with a pair of digging chains 129, and having fixed thereto one or more oblique scrapers or deflector blades 137. A similar intermediate series of oblique deflectors, comprising a series of supporting bars 136 and one or more oblique scrapers or deflector blades 137, is mounted upon endless chains 129 and between the outer series 135 of deflectors and the central digging buckets 87, already described. The deflector blades of the outer series 135 are inclined or disposed at an oblique angle so as to extend forward and outward at an oblique angle with relation to the forward upward movement of said blades, there being one or more of said deflector blades back of and immediately following each scarifier 132 of the corresponding series of scarifiers. The deflector blades of the intermediate series 138 of oblique deflectors or scrapers, likewise extend forward and outward at an oblique angle with respect to the forward upward movement of said deflectors, of which there is one or more behind and following each scarifier of the intermediate series 134 of scarifiers or cutters. The outer series of deflectors or scrapers thus act to deflect or move the material loosened by the outer series of scarifiers inward toward and into position to be engaged and operated upon by the next adjacent inner or intermediate series of deflectors, and the intermediate series 138 of deflectors serves to receive the material dug up or loosened by the outer series 133 of scarifiers and moved inward or deflected toward and into the path of movement of the intermediate deflectors, and delivers the material in position to be carried forward and upward by the endless series of digging buckets 87, which are adapted to convey and deliver all of the material dug up by the buckets 87 and scarifiers and deflectors or scrapers, on to the transverse conveyor 89, already described.

A rear scraper 139 is mounted back of the rear extremity of the boom 70, and back of the digging buckets, scarifiers, and deflectors or oblique scrapers, above described, and extends transversely of the machine entirely from one side to the other thereof, and in position to scrape up and gather any and all particles of material which may have been accidentally permitted to remain upon the ground or grade operated upon or passed over and graded by the grading, or grading and excavating machine.

The scraper 139, when constructed as herein shown, is in the form of an inclined blade, having a sharp bottom edge 140, which is located in position to engage the surface of the grade or bed immediately back of the rear extremity of the boom and digging and grading mechanism above described, and from outside to outside of the cut or bed, or graded surface over which the grading, or grading and excavating machine has passed. The opposite ends of the scraper 139 are connected with a suitable support by means of side arms 141, the rear extremities of which are secured to the corresponding ends of the scraper, and the forward extremities of which are connected with, and, by preference, in flexible or pivotal relation to the frame of the machine by any suitable securing means. For example, the side arms 141 of the scraper may be connected with a projecting end portion of a convenient transverse shaft, such as the shaft 122, or with any desired convenient outer side extremity of a corresponding frame arm 90. The scraper 139 is sufficiently heavy so that its weight will hold it in the desired operative position.

I claim:

1. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a portable frame upon which said digging and conveyor mechanism is mounted, side digging chain mechanism located on opposite sides of the main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main central digging and conveyor mechanism and supported b said side digging chain mechanism, and deflector scrapers mounted between said scarifiers and adapted

to deflect the material loosened by the scarifiers toward and into the path of movement of said main central digging and conveyor mechanism.

2. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a portable frame upon which said digging and conveyor mechanism is mounted, side digging chains located on opposite sides of the main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main central digging and conveyor mechanism and operated by said side digging chains, deflector scrapers mounted between said side scarifiers and adapted to deflect material loosened by the scarifiers toward and into the path of movement of said main central digging and conveyor mechanism, and means for operating said main central digging and conveyor mechanism and said side digging chains.

3. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a portable frame upon which said digging and conveyor mechanism is mounted, side digging chains located on opposite sides of the main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main central digging and conveyor mechanism and operated by said side digging chains, deflector scrapers mounted between said side scarifiers and adapted to deflect material loosened by the scarifiers toward and into the path of movement of said main central digging and conveyor mechanism, means for driving the main central digging and conveyor mechanism, and means for driving said side digging chains and scarifier and deflector mechanism independently of the main central digging and conveyor mechanism.

4. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a portable frame upon which said digging and conveyor mechanism is mounted, side digging chains located on opposite sides of the main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main central digging and conveyor mechanism and operated by said side digging chains, deflector scrapers mounted between said side scarifiers and adapted to deflect material loosened by the scarifiers toward and into the path of movement of said central digging and conveyor mechanism, means for operating said main digging and conveyor mechanism and said side digging chains, and means for changing the speed of movement of said side digging chains and scarifier and deflector scraper mechanism with respect to the speed of movement of the main central digging and conveyor mechanism.

5. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a portable frame upon which said digging and conveyor mechanism is mounted, side digging chains located on opposite sides of the main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main central digging and conveyor mechanism and operated by said side digging chains, deflector scrapers mounted between said side scarifiers and adapted to deflect material loosened by the scarifiers toward and into the path of movement of said central main digging and conveyor mechanism, means for driving the main central digging and conveyor mechanism and said side digging chains and means for supporting the side digging and scraper mechanism in adjustable relation to the main central digging and conveyor mechanism.

6. In a machine of the class described, the combination of a main central digging and conveyor mechanism comprising a series of digging buckets, and digging chains upon which said buckets are mounted, a main digging beam, transverse shafts journaled in said beam and provided with sprocket wheel mechanism on said shafts in supporting engagement with said chains, a portable frame upon which said digging beam is mounted, side digging chains located on opposite sides of the main digging beam, edged scarifiers and deflector scraper mechanism mounted on said side digging chains and adapted to loosen and move material toward and into the path of movement of the central digging buckets, sprocket wheels in supporting engagement with said side digging chains, transverse rotative shaft mechanism in supporting engagement with said last mentoned sprocket wheels and flexibly connected with the transverse shaft mechanism journaled in the main digging beam, and means for driving said main central digging and conveyor mechanism and said side digging chains.

7. In a machine of the class described, the combination of a portable main frame, a main central digging beam mounted on said main frame, transverse shafts journaled in said beam in parallel relation to each other, a pair of sprocket wheels mounted upon each of said shafts, endless digging chains mounted upon said sprocket wheels, a series of digging buckets mounted upon said chains, means for driving one of said shafts to operate said chains and digging buckets, laterally extending transverse side shafts located on opposite sides of said digging beam and having their inner ends

flexibly connected, sprocket wheels fixed to said laterally extending flexibly connected transverse shafts on opposite sides of said main digging beam, endless side digging chains located on opposite sides of the main digging beam and having their forward extremities supported by said sprocket wheels on said laterally extending flexibly connected shafts on opposite sides of said beam, means for supporting the rear extremities of said side digging chains, a series of cutters mounted on said side digging chains, and means for driving said flexibly connected laterally extending side shafts.

8. In a machine of the class described, the combination of a portable main frame, a main central digging beam mounted on said frame, main central digging and conveyor mechanism mounted on said digging beam and comprising a pair of transverse shafts journaled in said digging beam, sprocket wheels on said shafts and a series of digging buckets and digging bucket supporting chains mounted on said shaft and sprocket mechanism, means for driving one of said shafts to operate said main central digging and conveyor mechanism, an intermediate driven shaft journaled on said digging beam, laterally extending transverse shafts located on opposite sides of said digging beam and having their inner ends flexibly connected with the ends of said last mentioned driven shaft on said beam, sprocket wheels fixed to said laterally extending flexibly connected shafts on opposite sides of said digging beam, endless side digging chains located on opposite sides of said digging beam and supported upon said sprocket wheels on the laterally extending shafts, a series of scarifiers located on each side of said digging beam and supported by said side digging chains, and a series of deflector scrapers mounted on the side digging chains on opposite sides of the main digging beam and adapted to move material loosened by the scarifiers inward toward and into the path of movement of the digging buckets of the main central digging and conveyor mechanism.

9. In a machine of the class described, the combination of a portable main frame, a main central digging beam movably mounted on said frame, main central digging and conveyor mechanism mounted on said digging beam and comprising a pair of transverse shafts journaled on said beam, sprocket wheels on said shafts and a series of digging buckets and digging bucket supporting chains mounted on said shaft and sprocket mechanism, means for driving one of said shafts to operate said main central digging and conveyor mechanism, laterally projecting transverse shafts located on opposite sides of said digging beam and connected with the ends of said driven shaft on said beam, the outer ends of said laterally projecting shafts being adjustable upward and downward with respect to the digging beam, sprocket wheels fixed to said laterally projecting shafts on opposite sides of the digging beam, endless side digging chains located on opposite sides of said digging beam and having their forward extremities supported upon said sprocket wheels on said laterally projecting shafts, means for supporting the rear extremities of said digging chains, and scarifier and scraper mechanism mounted on the side digging chains on opposite sides of the digging beam and adapted to dig and deliver material to the main central digging and conveyor mechanism.

10. In a machine of the class described, the combination of a main central digging and conveyor mechanism, a main digging beam in supporting engagement with said main central digging and conveyor mechanism, shaft and gear mechanism mounted on said beam and in supporting engagement with said chains, a portable frame upon which said digging and conveyor mechanism is mounted, endless side digging chains located on opposite sides of the main central digging and conveyor mechanism, scarifiers located on opposite sides of said main central digging and conveyor mechanism and adapted to be operated by said digging chains, deflecting scrapers located between and extending obliquely with respect to the path of movement of said scarifiers and adapted to deflect material loosened by the scarifiers toward said main central digging and conveyor mechanism and said side digging chains, and transverse frame members mounted on said main digging beam adapted to support said side digging chains and said scarifiers and deflecting scrapers in adjustable relation to the first mentioned main central digging and conveyor mechanism.

11. In a machine of the class described, the combination of a main central digging and conveyor mechanism comprising an endless series of digging buckets, endless chains upon which said digging buckets are supported, a main digging beam in supporting engagement with said main central digging and conveyor mechanism, shaft and gear mechanism mounted on said beam in supporting engagement with said chains, a portable frame upon which said digging and conveyor mechanism is mounted, endless side digging chains located on opposite sides of the main central digging and conveyor mechanism, scarifiers located on opposite sides of said main central digging and conveyor mechanism and adapted to be operated by said side digging chains, deflecting scrapers located between and extending obliquely with respect to the path of movement of said

scarifiers and adapted to deflect material loosened by the scarifiers toward said main central digging and conveyor mechanism, means for operating said main central digging and conveyor mechanism and said endless side digging chains, and supporting means on opposite sides of and supported by said main digging beam and adapted to operatively support said side digging chains and said side scarifiers and deflecting scrapers in adjustable relation to the first mentioned main central digging and conveyor mechanism.

12. In a machine of the class described, the combination of a main central digging and conveyor mechanism comprising an endless series of digging buckets, endless chains upon which said digging buckets are supported, a main digging beam mounted upon a suitable portable supporting frame, said digging beam being tiltable longitudinally in a vertical plane to permit the raising and lowering of the rear end of said beam, shaft and gear mechanism mounted on said tiltable digging beam and in operative engagement with said endless chains, tractor mechanism in supporting engagement with said portable frame, endless side digging chains located on opposite sides of the said main central digging and conveyor mechanism, edged scarifiers located on opposite sides of said main digging beam, deflecting scrapers operatively connected with said side digging chains and located on opposite sides of said main digging beam and adapted to deflect material lossened by said side scarifiers toward said main central digging and conveyor mechanism, means for operating said central digging and conveyor mechanism, and said endless side digging chains, and transverse side frame arms mounted on and extending laterally on opposite sides of said tiltable digging beam and acting to support said side digging chains and said side scarifiers and deflecting scrapers in different adjusted positions.

13. In a grading machine, the combination of a main central digging and conveyor mechanism, a portable main frame upon which said main central digging and conveyor mechanism is mounted, tractor mechanism on which said portable main frame is mounted, supplementary side digging mechanism located on opposite sides of the main central digging and conveyor mechanism, said supplementary side digging mechanism comprising a series of scarifiers located on each side of the main central digging and conveyor mechanism, and deflecting scrapers located between said scarifiers and on opposite sides of the main central digging and conveyor mechanism and adapted to loosen and deflect material toward and into the path of movement of said main central digging and conveyor mechanism, and means for tilting said main central digging and conveyor mechanism laterally to different angles with respect to the tractor mechanism.

14. In a grading machine, the combination of a main central digging and conveyor mechanism, a portable main frame upon which said main central digging and conveyor mechanism is mounted, tractor mechanism on which said portable main frame is mounted, supplementary side digging mechanism located on opposite sides of the main central digging and conveyor mechanism, said supplementary side digging mechanism comprising an endless series of scarifiers located on each side of the main central digging and conveyor mechanism, and deflecting scrapers located between said scarifiers and on opposite sides of the main central digging and conveyor mechanism and adapted to deflect material toward and into position to be operated upon by said main central digging and conveyor mechanism, and means for tilting said main central digging and conveyor mechanism and said supplementary digging mechanism laterally to different angles with respect to the tractor mechanism.

15. In a grading machine, the combination of a main central digging and conveyor mechanism, a portable main frame upon which said main central digging and conveyor mechanism is mounted, tractor mechanism on which said portable main frame is mounted, supplementary side digging mechanism located on opposite sides of the main central digging and conveyor mechanism, said supplementary side digging mechanism comprising a series of scarifiers located on each side of the main central digging and conveyor mechanism, and deflecting scrapers located between said scarifiers and on opposite sides of and adapted to loosen and deflect material toward said main central digging and conveyor mechanism, means for tilting said main central digging and conveyor mechanism on a transverse axis, to raise and lower the back extremity thereof, and means for adjusting the main central digging and conveyor mechanism to different laterally inclined positions with respect to the varying inclined positions of the tractor mechanism.

16. In a grading machine, the combination of a main central digging and conveyor mechanism, a portable main frame upon which said main central digging and conveyor mechanism is mounted, tractor mechanism upon which said portable main frame is mounted, supplementary side digging mechanism located on opposite sides of said main central digging and conveyor mechanism, and comprising scarifiers and deflecting scrapers adapted to loosen and deflect material toward and into position to be op-

erated upon by said main central digging and conveyor mechanism, means for tilting said main central digging and conveyor mechanism on a transverse axis, and means for permitting the tilting of the tractor mechanism to different laterally inclined positions with respect to the main central digging and conveyor mechanism.

17. In a grading machine, the combination of a main central digging and conveyor mechanism, a portable main frame upon which said main central digging and conveyor mechanism is mounted, tractor mechanism in supporting engagement with said portable main frame, supplementary side digging mechanism located on opposite sides of said main central digging and conveyor mechanism, and comprising scarifiers and deflecting scrapers adapted to loosen and scrape material toward and into position to be operated upon by said main central digging and conveyor mechanism, means for securing said main central digging and conveyor mechanism in different tilted positions with respect to the portable main frame, and means for permitting the tilting of the main central digging and conveyor mechanism and tractor mechanism to different laterally inclined positions with respect to each other.

18. In a grading machine, the combination of a main central digging and conveyor mechanism comprising a digging beam having digging and conveyor mechanism movably mounted thereon, means for pivotally connecting said beam with said portable main frame and adapted to permit the beam to be tilted on a transverse axis with respect to said portable frame, tractor mechanism for supporting the portable main frame, supplementary side digging mechanism located on opposite sides of said main central digging and conveyor mechanism and digging beam, and comprising endless side digging chains provided with scarifiers and deflecting scrapers adapted to loosen and scrape material toward and into position to be operated upon by the main central digging and conveyor mechanism, means for permitting the tilting of the main central and supplementary side digging mechanism with respect to the tractor mechanism, an engine on the portable main frame, means for operatively connecting the engine with the main central digging and conveyor mechanism and supplementary side digging and scraper mechanism, and means for operatively connecting the tractor mechanism with the engine.

19. In a machine of the class described, the combination of a portable main frame, a tilting digging beam mounted on said main frame, main central digging and conveyor mechanism mounted on said digging beam and comprising a series of digging buckets mounted upon a pair of main digging chains, a pair of transverse shafts journaled in said beam and provided with sprocket wheels fixed to said shafts and in supporting engagement with said chains, means for driving one of said shafts to operate said main central digging and conveyor mechanism, transverse frame arms located on opposite sides of said tilting digging beam and each pivotally connected with and projecting laterally from said beam, means for securing said transverse frame arms in different adjusted positions in rigid relation to said tilting digging beam, a pair of laterally projecting transverse side shafts rotatively mounted upon each of said pivoted transverse frame arms, respectively, a plurality of endless side digging chains located on opposite sides of the tilting digging beam, sprockets on said transverse side shafts in supporting engagement with said side digging chains, scarifiers mounted on said side digging chains, deflecting scrapers located between and extending obliquely with respect to the path of movement of said scarifiers and adapted to deflect material loosened by the scarifiers toward said main central digging and conveyor mechanism, a shaft rotatively mounted in suitable bearings on the tilting beam and having its opposite ends flexibly connected with the inner ends of a plurality of said transverse side shafts, means for driving said last mentioned shaft on the tilting beam, to operate said transverse side shafts and side scarifier and deflecting scraper mechanism, tractor mechanism upon which said portable main frame is mounted, means for tilting the portable main frame laterally with respect to the tractor mechanism, and means for tilting said main tilting beam upon its transverse axis with respect to said portable main frame.

Signed at Chicago, in the county of Cook and State of Illinois, this 19th day of July, 1922.

EARL S. KNIGHT.