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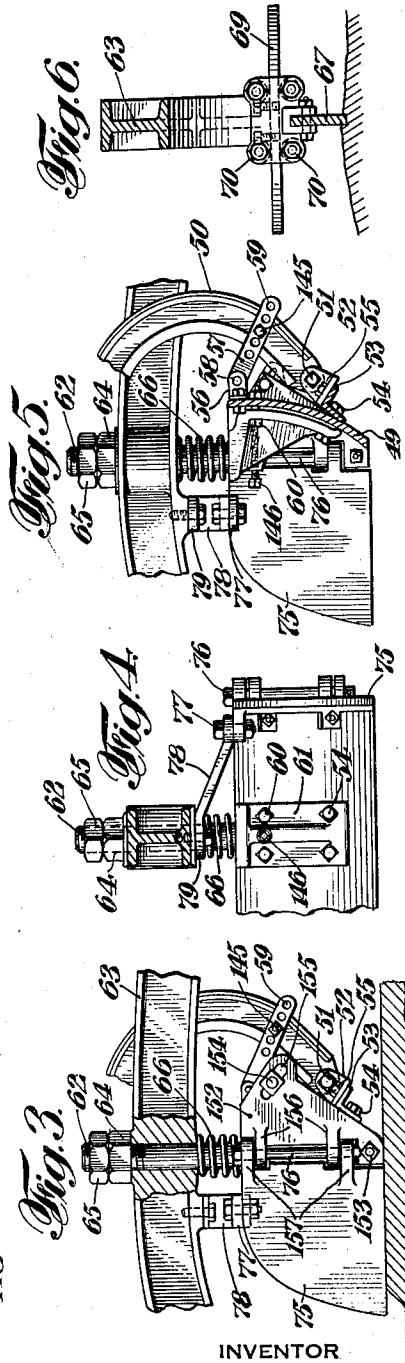
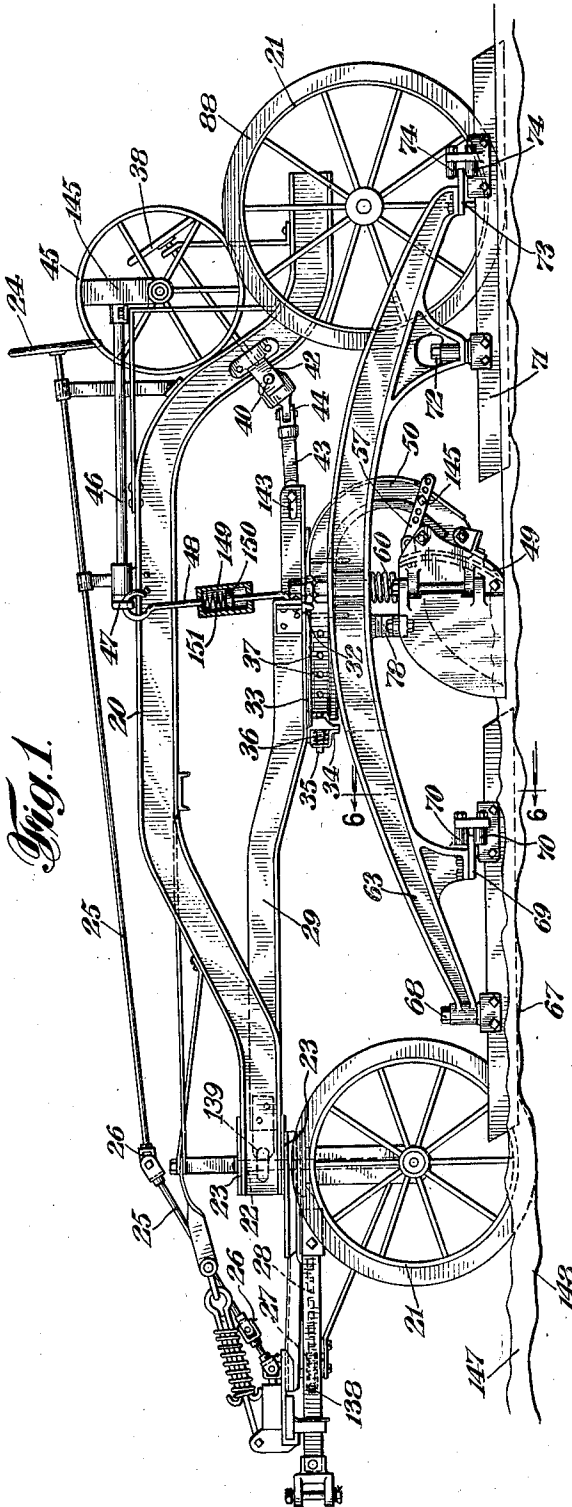
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2,006,384

GRADING APPARATUS

Filed June 3, 1931

5 Sheets-Sheet 1



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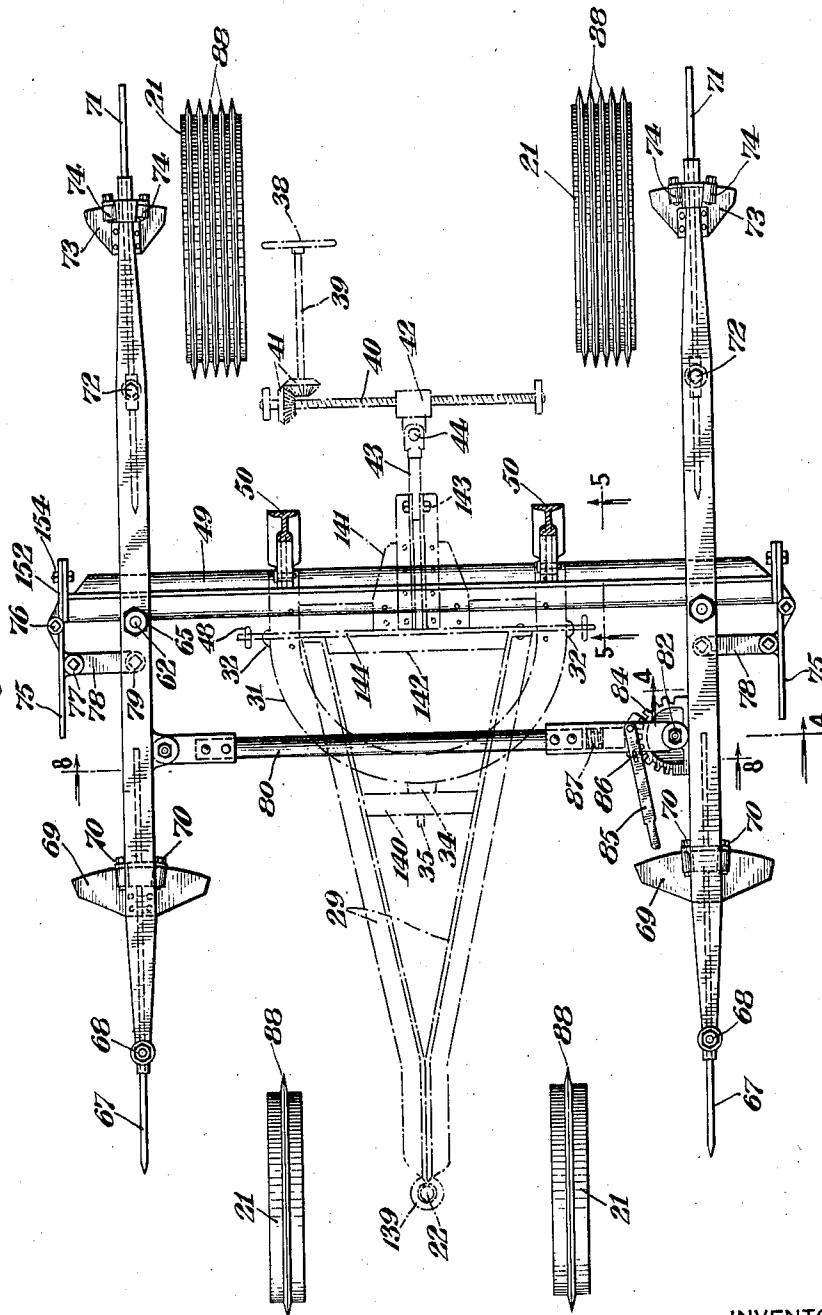
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Fig. 2.



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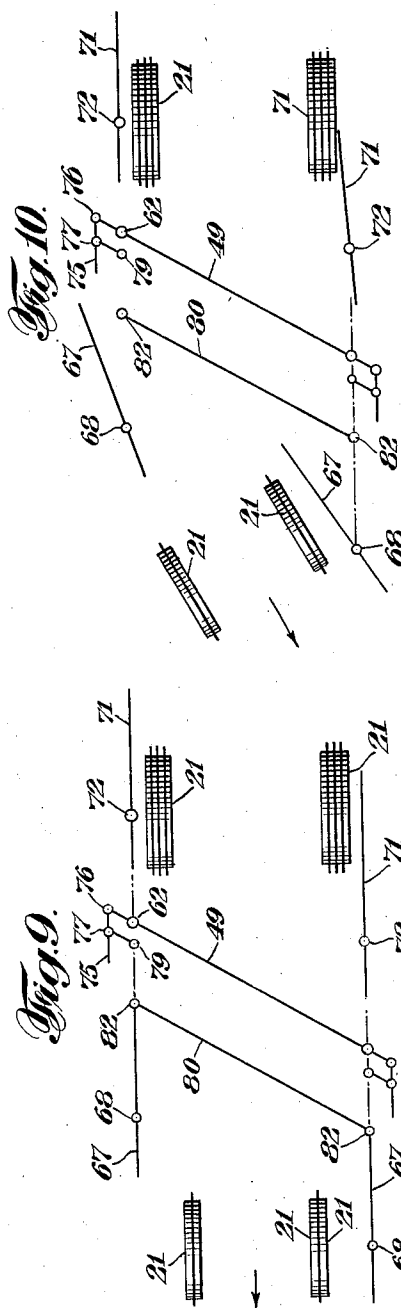
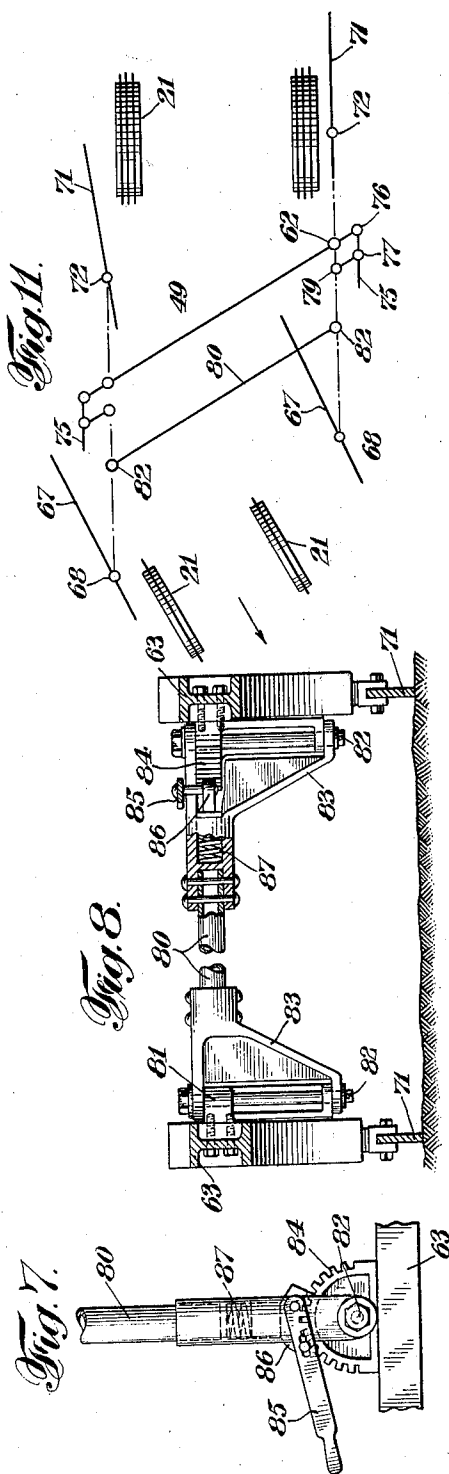
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GRADING APPARATUS

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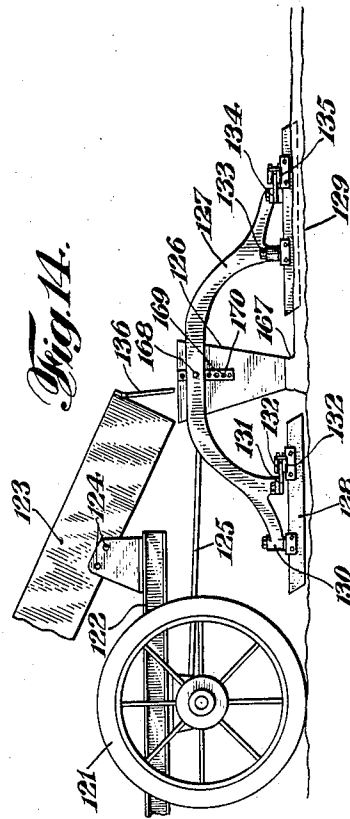
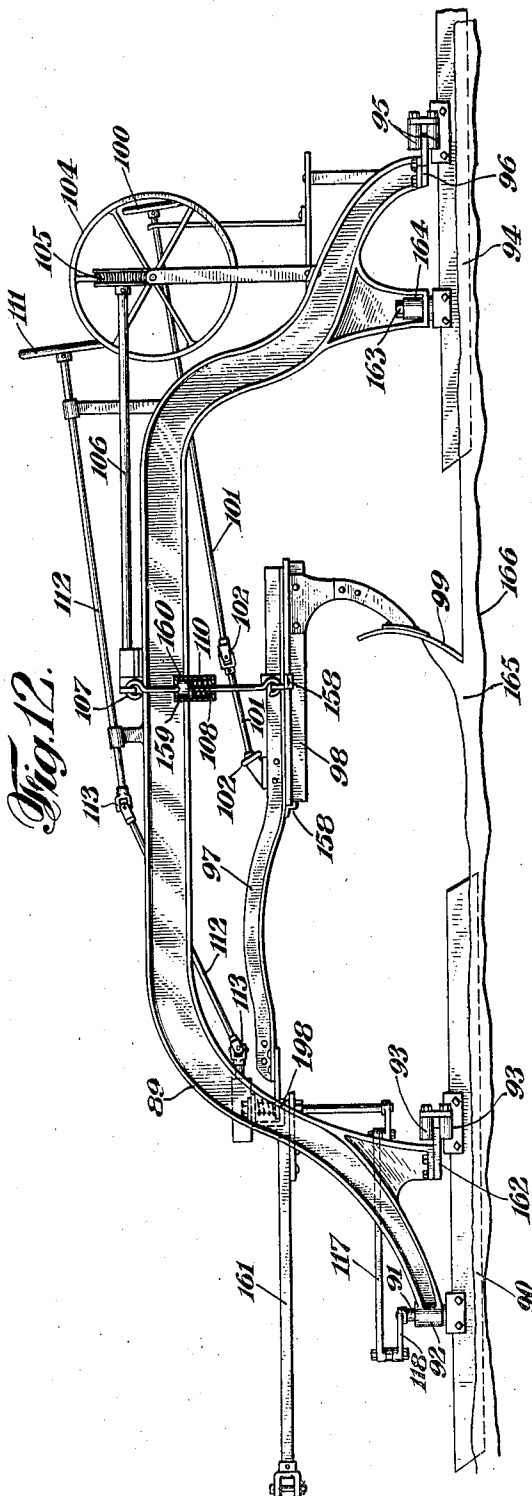
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GRADING APPARATUS

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July 2, 1935.

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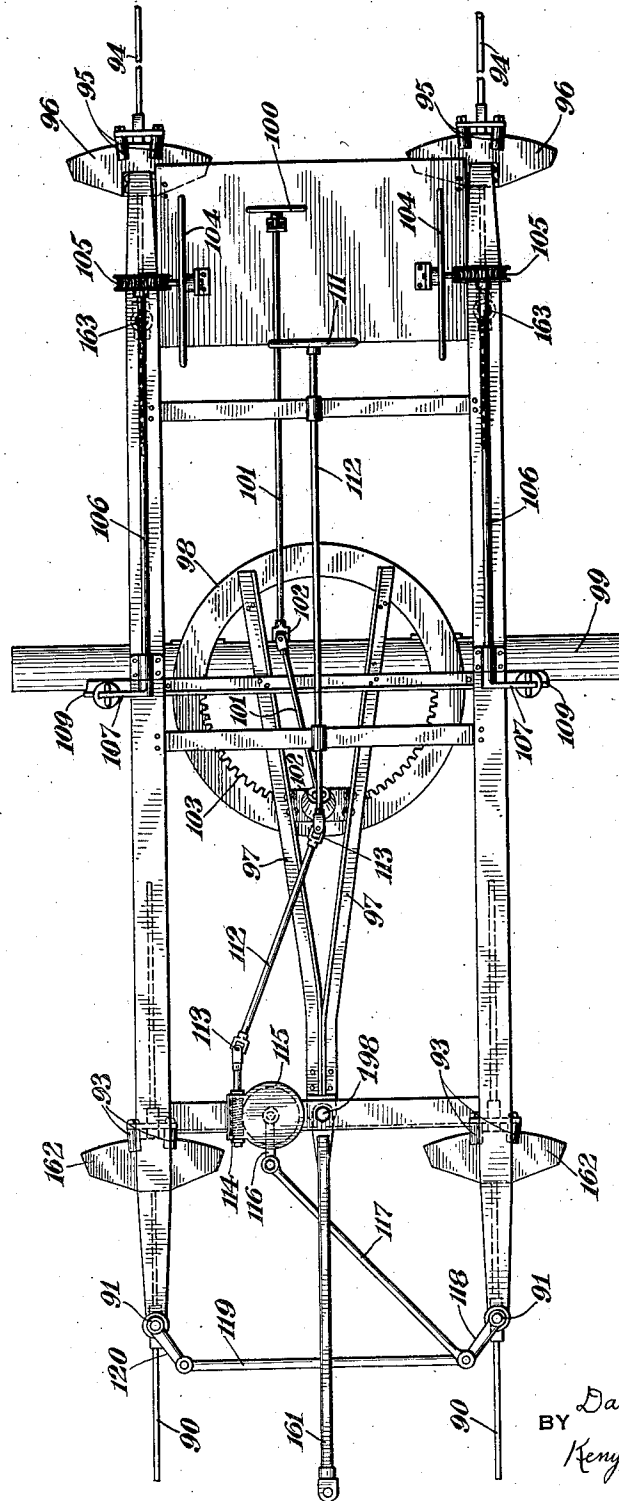
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GRADING APPARATUS

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Fig. 13.



UNITED STATES PATENT OFFICE

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GRADING APPARATUS

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23 Claims. (Cl. 37—156)

This invention relates to grading apparatus and particularly to road grading apparatus designed to spread materials uniformly and smoothly on roads.

5 It is a purpose of this invention to afford grading apparatus capable of grading with superior smoothness, uniformity and precision and at the same time with increased effectiveness and efficiency. It is a further purpose of this invention to afford grading apparatus which is capable of giving excellent results even when employed by unskilled operators.

10 Graders heretofore have been constructed having a suitable frame mounted on wheels and having a grading blade depending from the frame transverse to the direction of travel of the apparatus. Means have also been provided for raising and lowering the blade and adjusting its vertical and horizontal angular position. Separately
15 propelled and power-driven graders have been used. It has been an objectionable feature of such road graders, however, that the apparatus necessarily passes over uneven parts of the material to be graded such as holes, bumps, depressions and the like which are followed by the wheels of the grader as they pass over them and give a very irregular and uneven motion to the frame of the grader and the grader blade. As a result, the grader blade is constantly elevated
20 and lowered as it passes along the road and does not produce an even surface but quite the reverse. Moreover, in means heretofore used for raising and lowering the grader blade there is considerable play, increasing with the number of movable joints in the lifting mechanism, between the frame of the grader and the edge of the blade. This loose play interferes greatly with proper control of the blade by the operator since the blade tends to rise somewhat upon striking hard places
25 in the surface being graded and tends to sag appreciably where less resistance is encountered. The loose play is, of course, particularly objectionable in exact work such as grading a smooth riding surface according to the high standard of present day requirements or in evenly spreading expensive materials. While these difficulties can be counteracted to a certain extent by skillful manipulation of the grader blade by the operator, they cannot be entirely compensated for even
30 with the exercise of most extraordinary skill and in any event skilled and therefore expensive labor is necessary in using such a grader.

35 In addition to the above, drags have also been used heretofore for grading. Such drags merely slide along the surface of the material to be

spread. Many different transverse means have been used for smoothing over material while the apparatus is dragged. Such drags, however, are objectionable for many reasons, among them being that they also follow the irregularities of the material being spread and are not effective in producing an even and uniform surface.

Heretofore, also, roads of satisfactory smoothness have been made by carefully laying stationary straight edges along the sides of a road, placing material between the edges and then moving a bar along the upper sides of the straight edges, thus smoothing the material between them. While this method gives very good results, it is exceedingly costly, due to the excessive amount of labor required for placing the stationary straight edges in position, moving the smoothing bar along them and repeating the operation again and again. This method is also objectionable, as it is very slow and cumbersome.

20 It is a feature of this invention that road grading apparatus comprising this invention has straight edges which, instead of being stationary, are moved continuously along the foundation upon which the road is being laid, and has a grader blade which, instead of being moved along stationary straight edges, is moved with them. It has been found that by this novel means it is possible to secure the superior results attainable with stationary straight edges without the high labor cost and slowness of operation incidental thereto.

25 It is a further feature of apparatus embodying this invention that straight edges which are adapted to remain in contact with the surface travelled may be mounted on a suitable frame adapted to move them longitudinally along the surface together with a transverse blade whose vertical movements are controlled by said straight edges. Where loose material has been placed upon a road foundation or other surface travelled by the apparatus prior to passage of the grader thereover, the straight edges can be positioned and constructed so that they will cut longitudinally through such material and rest directly on the foundation so as to be unaffected by differences in thickness, mounds, etc., of such material. To this end, it is a feature of this invention that straight edges may be used which are high enough so that when the bottom edges thereof rest on a road foundation, for example, the top edges will protrude somewhat above the loosely-laid material after it has been spread by the grader blade.

It is an advantage of this invention that, where straight edges of considerable length are moved along in contact with a road foundation, for example, they do not follow the numerous abrupt inequalities, bumps, hollows and the like in the foundation, but describe a relatively uniform course. As a result, a grader blade mounted transversely thereon follows a very even course and smooths material upon the road foundation with precision and uniformity and irrespective of bumps and minor irregularities in the material itself or in the foundation. Moreover, where longer rises and hollows are encountered, the straight edges upon which the grader blade is mounted tend to bridge the hollows somewhat making the coating of material thicker in the hollows. On the other hand, the tops of the rises receive a thin coating particularly when the straight edges are divided in the middle by a space. By thus making the surfacing material relatively thicker in the hollows and relatively thinner on the tops of rises, the hollows are made less deep and the rises less high and the road made much more even.

It is a further advantage of this invention that it can be readily adapted for use in connection with road graders of standard types. For example, a standard road grader which may be either power driven or propelled by separate means, instead of being equipped with a grader blade which follows the irregular vertical motion imparted to the frame by the wheels thereof going over bumps and hollows in the road, may be provided with a grader blade that is guided by straight edges which remain in contact with the road foundation and thus control the path of the grader blade and guide it uniformly and smoothly irrespective of the irregular motion of the frame or loose play in the blade elevating mechanism. In such case, it is an added advantage that part of the weight of the grader can be borne by the wheels of the grader, thus reducing the friction between the straight edges and the road. Moreover, means can also be provided according to this invention for regulating the pressure with which the straight edges are maintained in contact with the road foundation. In the usual case, the weight of the blade and straight edges will be sufficient to cause the blade to cut through material loosely laid on a road foundation, for example, and to keep them in contact with the foundation. If, however, additional pressure is desirable, means may be provided for exerting additional pressure. For example, a spring may be interposed between the grader frame and the straight edges, which is adapted to maintain constant pressure on the straight edges and keep them in contact with the foundation. Means may also be provided for controlling the degree of pressure exerted by the spring. While it is even possible to lift the wheels of the apparatus off the ground and to bring the entire weight of the grader upon the straight edges, this ordinarily is not desirable.

Where straight edges are designed according to this invention to rest upon a road foundation, for example, and to cut through rather than pass over material loosely laid upon the foundation, the straight edges can be made relatively narrow, thus not only facilitating the cutting of the straight edges through the material but also leaving only very narrow cuts behind them in the smoothed material. Such narrow cuts largely disappear where loose material is used and in any event are readily and entirely eliminated

by consolidating the material as by a roller. Where such straight edges are used in connection with a grader having wheels in addition to the straight edges, the straight edges may be combined according to this invention with the use of wheels having narrow flanges on the periphery thereof. By so doing, the wheels can also be made to rest on the foundation and to cut through loosely laid material thereon. In such case, the wheels do not leave a relatively wide track of compressed material, as would be the case were wheels used as heretofore with wide tires, but leave very narrow cuts which can be readily eliminated from the smoothed material as above described. Where apparatus embodying this invention is to be towed by a tractor, the wheels of the tractor may be provided with narrow flanges.

It is a feature of this invention that straight edges may be provided which can be moved around curves without substantially displacing loose material through which the edges pass. If long straight edges were employed in single pieces or in several pieces secured rigidly to a frame, the edges, in being moved in a curve along the road foundation, would displace a relatively wide path through loose surface material due to the swinging of the ends of the edges in being moved in a curve and would leave undesirable open spots in the material. Straight edges are employed according to this invention which, instead of being rigid or rigidly fixed to a frame, are made in two or more parts which are readily capable of horizontal angulation but which are maintained securely against vertical angulation. In this manner, straight edges are provided which are composed of independent elements which are capable of angulation only in a plane substantially parallel to the surface travelled and which are adapted to adopt that direction which least displaces material on the road when the apparatus is moved in a curve. At the same time, effective straight edges are afforded corresponding to linear disposition of the separate elements thereof.

It is a further feature of this invention that means are provided for mounting a grader blade between straight edges so that the continuity of the straight edges will be interrupted in the least possible degree by the grader blade, notwithstanding that means may be provided for adjusting the blade for grading in right-hand position or left-hand position. For example, a grader blade may be mounted between two straight edges and each of the straight edges may be divided as at about the midpoint for the ends of the grader blade to extend therethrough.

It is preferable that the space between the divisions of the straight edges be the minimum required when the blade is adjusted to any particular angular position. According to this invention, this minimum can be preserved, and horizontal angulation of the grader blade with respect to the straight edges afforded, by moving the straight edges with the ends of the blade when the angular position of the blade is changed. By this means the ends of the blade remain in substantially the same longitudinal relation with respect to each of the straight edges and the straight edges can be maintained in position for longitudinal movement along surface traveled by the apparatus. Superior operating results are obtained by thus minimizing the break in the continuity of the straight edges. Moreover superior operating results are obtained

by maintaining the longitudinal position of the ends of the grader blade relatively constant with respect to the straight edges. For example, it is preferable to have the ends of the grader blade at about midposition with respect to the straight edges regardless of the horizontal angle at which the blade is turned.

In addition to a grader blade and straight edges, guide plates may be attached to one or both of the ends of a grader blade so as to prevent excessive amounts of surfacing material from being pushed to one side by the grader blade and to give a uniform edge to the smoothed surface. The guiding plates should preferably travel parallel to the direction of travel of the apparatus along the road. According to this invention, novel means are provided whereby such guide plates are afforded and whereby they may be maintained parallel to the direction of travel of the apparatus, irrespective of the direction of angulation of the grader blade.

There are also many other advantageous and novel features of grading apparatus embodying this invention. Some of these, while they will be described more in detail in connection with the accompanying drawings, may be briefly mentioned. For example, novel means are provided for mounting the grader blade on the straight edges and permitting the adjustment and the locking of the vertical angle of the grader blade with respect to the straight edges. Novel means are also provided for permitting the relative horizontal angular positions of the straight edges, the grader blade, the guide plates if used, and the like to be adjusted and to be locked in position.

Features of this invention may be employed in many different types of road grading apparatus. While features and advantages of this invention may be employed in connection with road graders having wheels in addition to straight edges, they may also be embodied in apparatus wherein wheels are not used. Moreover, a grading box suitable for attachment to a truck may be mounted on straight edges according to this invention, thus affording means for uniformly and accurately smoothing material discharged as from a truck into the smoothing box.

This invention comprises numerous features which when considered separately are separate parts of this invention and which when considered conjointly are cooperating features adapted to secure the advantages and purposes resulting from their cooperative relation.

Other purposes, features and advantages of this invention will become apparent from the following description of this invention in connection with the accompanying drawings wherein

Fig. 1 is a side view in elevation of a preferred form of apparatus embodying this invention.

Fig. 2 is a plan view of the apparatus shown in Fig. 1 with some of the parts removed.

Fig. 3 is a detail view of an end of the grading blade and a guiding plate and mounting assembly for same.

Fig. 4 is a front detail view of the assembly shown in Fig. 3 taken on the line 4—4 of Fig. 2.

Fig. 5 is a detail view of the grader blade and a guide plate and mounting assembly for same taken on the line 5—5 of Fig. 2.

Fig. 6 is a detail sectional view of one of the straight edges and a part of the frame mounted thereon taken on the line 6—6 of Fig. 1.

Fig. 7 is a detail plan view of the locking quadrant assembly for maintaining the horizontal

angular position of the grader blade and straight edges.

Fig. 8 is a detail view partly in section on the line 8—8 of Fig. 2.

Fig. 9 is a diagrammatic view of the relative position of wheels, straight edges, guide plates and grader blade of apparatus shown in Fig. 1 when the grader blade is adjusted to the right and the apparatus in position to move straight forward.

Fig. 10 is a diagrammatic view corresponding to Fig. 9 showing the relative position of the parts when the grader blade is adjusted to right and the apparatus in position to move in a curve to the left.

Fig. 11 is a diagrammatic view corresponding to Fig. 9 showing the relative position of the parts when the grader blade is adjusted to the left and the apparatus is in position to move in a curve to the left.

Fig. 12 is a side elevation of a modified form of apparatus embodying this invention.

Fig. 13 is a plan view of the apparatus shown in Fig. 12.

Fig. 14 is a side elevation of a further modification of this invention particularly adapted for use in connection with dumping trucks and the like.

Referring to Figs. 1 to 11, the apparatus shown may be mounted on any suitable frame 20 mounted on wheels 21. The front wheels of the apparatus may be pivoted by rod 22 in bushing 23 of frame 20 to permit turning of the front wheels. The steering of the front wheels may be controlled from hand wheel 24 and through rods 25 containing universal joints 26. Cog reel 27 turned thereby meshes with chains 28 leading to any suitable arms from pivot rod 22.

The apparatus here shown is provided with a tongue 138 whereby the apparatus may be towed by connecting the tongue to any suitable towing means such as a tractor. While apparatus embodying this invention may be thus propelled by separate power, it is to be understood that apparatus embodying this invention may be used in connection with power driven grading apparatus of well known types and is particularly advantageous when so used. For example in the apparatus shown the wheels 21 on the rear of frame 20 could be driven by any suitable motive power such as a gasoline engine thus affording a power driven grader.

Draft bars 29 in the shape of a wishbone are attached at their forward ends to pivot rod 22 by pivot ring 139 affording them horizontal angulation. Pivot ring 139 by virtue of fitting loosely about pivot rod 22 also affords them vertical angulation and permits the rearward ends of the draft bars 29 to be elevated and lowered irrespective of frame 20. A quadrant 31 is revolvably attached adjacent the rear ends of the draft bars 29 by any suitable guides 32 which are on cross bar 144 attached to the rear ends of bars 29 and which are adapted to co-operate with flanges 33 on quadrant 31. The quadrant 31 is thus adjustable angularly with respect to draft bars 29 and frame 20. A locking device for maintaining the angular position of quadrant 31 may consist of a small rod 35 which is actuated by spring 36 in lug 34 attached to bar 140 and which is adapted to be inserted in a plurality of holes 37 in quadrant 31 locking its position. Lug 34 also assists in maintaining the position of quadrant 31.

The angular position of quadrant 31 may be adjusted from hand wheel 38 in the following

manner. Hand wheel 38 through rod 39 is adapted to rotate threaded rod 40 through beveled gears 41. A block 42 having threads on the interior thereof is adapted to co-operate with the threads on rod 40 and to be moved along rod 40 in one direction or the other depending upon the direction of rotation of the hand wheel 38. A connecting link 43 is pivotally attached to block 42 at pivot 44. The other end of link 43 is attached to plate 141 mounted on cross-bar 142 of quadrant 31 by a slidable connection 143 which gives the link 43 a certain amount of play and permits the angular position of quadrant 31 to be changed by moving block 42 along threaded rod 40.

The elevation of either side of the quadrant may be controlled from hand wheels 45 which through suitable worm gears 145 are adapted to rotate rods 46 and cranks 47 attached to the ends of said rods. Links 48 are attached at their upper ends to the ends of cranks 47 and at their lower ends to the ends of the bar 144. It is apparent that by turning either of hand wheels 45 either side of quadrant 31 can be raised or lowered.

Mechanisms thus far described in connection with the drawings have been heretofore used in connection with a grader blade secured directly to the quadrant 31. In such apparatus, however, it is apparent that when the wheels of the apparatus go over irregular bumps, depressions and the like in the road, or other surface travelled, the frame 20 is thereby bumped along in an irregular course and transmits its irregular motion to the grader blade producing an irregular and non-uniform graded surface having undesirable bumps, depressions and the like. Moreover, as heretofore pointed out there has been considerable loose play in the mechanism heretofore used for elevating quadrant 31 which loose play results in irregular motion of the grader blade and uneven graded surface. While skilled operators can control the position of the grader blade to a certain extent, it has been found practically impossible even for highly skilled operators to manipulate the grader blade so as to anticipate the sudden jolting of the frame of the apparatus and the loose play in the blade elevating mechanism so as to compensate therefor and produce smooth and uniform grading. Means whereby the grader blade can according to this invention be made to follow a uniform and regular course even in the hands of an unskilled operator irrespective of the jolting and vertical movements of the frame and loose play so as to produce a smoother surface than has been possible heretofore will be now described.

Curved members 50 leading from opposite sides of quadrant 31 support grader blade 49. Blade 49 is secured to curved members 50 by bolts 51 which pivotally secure L-members 52 to curved members 50. L-members 52 are attached to L-members 53 by bolts 55 and L-members 53 are in turn attached to grader blade 49 by bolts 54. At the top of the grader blade L-members 56 are pivotally secured to links 57 by bolts 58. Links 57 are provided with a plurality of holes 59. Bolts 145 may pass through any of holes 59 and through corresponding holes in curved members 50 and are thus adapted to maintain the grader blade 49 at any desired vertical angle.

Brackets 61 are securely attached to blade 49 and means are provided whereby pivot bolts 62 mounted thereon may be maintained substan-

tially vertically regardless of the vertical angle at which blade 49 is set. To this end threaded setting screws 146 are threaded in the upper parts of brackets 61 so that by turning screws 146 the distance between the upper part of bracket 61 and grader blade 49 can be adjusted. Having adjusted the setting screws 146 to proper position, the upper part of brackets 61 may be tightened against the grader blade by means of bolts 60. The lower ends of brackets 61 may be tightened against blade 49 by bolts 54 which extend through said bracket.

A pair of arches or frame members 63 are adapted to fit over bolts 62 and thus be pivoted thereon. Nuts 64 and lock nuts 65 are adapted to secure frame members 63 in position on bolts 62. In order to permit blade 49 to be adjusted vertically with respect to frame members 63 powerful springs 66 are interposed between the brackets 61 and frame members 63. By tightening bolts 64 and 65 against springs 66 the blade 49 can be raised with respect to frame members 63. By reversing the procedure the blade can be lowered.

Adjacent the front end of frame members 63 straight edges 67 may be pivoted as by pivot bolts 68. In order to prevent vertical angulation of the straight edges 67 substantially horizontal plates 69 may be attached to frame members 63 and guides such as rotatable rollers 70 may be secured to straight edges 67 so as to cooperate with the upper and lower surfaces of plates 69. Adjacent the rear ends of frame members 63 corresponding straight edges 71 may be pivoted as by pivot bolts 72. Also in order to prevent vertical angulation of straight edges 71 a substantially horizontal plate 73 may be fixed to frame members 63 and guides such as rotatable rollers 74 may be secured to straight edges 71 so as to cooperate with the upper and lower surfaces of plates 73. In addition to the above, other means for preventing the vertical angulation of straight edges with respect to the frame may be employed according to this invention. For example, plates may be secured to the straight edges and guiding means cooperating with the plates attached to the frame.

By the above arrangement, straight edges 67 and corresponding straight edges 71 may be adjusted in the same horizontal plane and cooperate with each other to produce an effective straight edge effect corresponding to the total length from the front of straight edges 67 to the rear of straight edges 71. Thus straight edges 67 and corresponding straight edges 71 may be regarded in effect as divided portions of single straight edges extending from the front of straight edges 67 to the rear of straight edges 71. The individual portions are however capable of individual horizontal angulation.

It is important in connection with this invention that straight edges 67 and 71 may be constructed so that they will cut longitudinally through loosely laid material 147 on surface 148 which is traveled by the apparatus and so that they will move along in contact with surface 148. To this end they are preferably in the form of narrow strips of metal, e. g., $\frac{1}{4}$ " in thickness. Moreover, they should preferably be of such height that the distance between the bottom edge and the means whereby they are secured to frame members 63 will be greater than the depth of loosely laid material after it has been spread by the grader blade 49 upon the surface traveled by the apparatus so that the securing means will

clear the smoothed surface and not displace the smoothed material.

Front straight edges 67 and rear straight edges 71 are preferably arranged so that when the apparatus is moved straight forward, edges 71 will follow in the track made by edges 67. As the straight edges 67 and 71 are capable of angulation only in a plane which is substantially parallel to the plane of the surface traveled by the apparatus, they are capable of swinging horizontally when the apparatus is moved in a curve and all of the straight edges individually adopt that position which least displaces loosely laid material through which the straight edges pass. This is highly advantageous in connection with this invention for it is apparent that if the straight edges were made in one long piece or were attached to a frame so as to be incapable of horizontal angulation, they would cause relatively large and objectionable displacements or holes in the loose material when the apparatus is moved in a curve.

As the grader blade 49 is secured to the frame members 63 upon which the straight edges 67 and 71 are mounted, the vertical motion of the grader blade is necessarily controlled by the straight edges as they pass along the surface travelled by the apparatus.

Thus substantially the same effect can be secured according to this invention as if the straight edges were placed in stationary position on the ground and the grader blade were moved along the upper edges of the straight edges. Roads of superior smoothness and uniformity can be made with apparatus embodying this invention even though the apparatus is operated by a relatively unskilled workman.

The total effective length from the front of straight edges 67 to the rear of straight edges 71 may be subject to wide variation. Where, however, the total distance is from 8 to 12 feet excellent results are obtainable.

As the grader blade 49 is adjustable by turning nuts 64 and lock nuts 65, the blade can be adjusted to smoothly spread material on the surface travelled to any desired depth. Moreover, by adjusting the blade so that it is in approximately the same plane as the bottom of straight edges 67 and 71, the apparatus can be utilized as a scraper, for example, to plane off the tops of bumps and fill in little hollows, etc., thus trueing the surface travelled by the apparatus.

In order that the straight edges 67 and 71 may pass along the surface travelled by the apparatus and control the vertical movements of blade 49 irrespective of vertical movements of frame 20 caused by wheels 21 passing over bumps and irregularities in the surface travelled, a certain amount of play is preferably allowed in link 48. For example, a frame box 149 may be inserted in link 48 and attached to the upper portion thereof which is adapted to permit a plate 150 attached to the lower part of link 48 to have a certain amount of play therein. By turning cranks 47 until plates 150 strike the bottom of frame boxes 149, the straight edges can be raised from the ground as for example in transporting the apparatus to a point of use. When the apparatus is to be used according to this invention, the cranks 47 may be lowered permitting straight edges 67 and 71 to come in contact with the surface traveled by the apparatus. The play provided by frame boxes 149 prevent irregular vertical motions of frame 20 from being transmitted to the grader blade and straight edges.

Ordinarily the weight of the grader blade 49, straight edges 67 and 71, frame members 63, quadrant 31, and other parts of this assembly will be sufficient cause for edges 67 and 71 to follow along the surface traveled by the apparatus and cut through material loosely laid on the surface. In order to provide for any increased pressure that may be desirable in pressing the straight edges 67 and 71 against the surface traveled, springs 151 may be positioned between the top of frame boxes 149 and plates 150. By lowering cranks 47 it is apparent that springs 151 can be compressed, thus exerting added pressure in maintaining straight edges 67 and 71 in contact with surface 148. By regulating the position of cranks 47 the amount of pressure exerted by springs 151 can be controlled. For example, if surface 148 were relatively soft, the pressure on the straight edges could be made relatively light. Or if material 149 on surface 148 were dense, the pressure on the straight edges could be appropriately increased.

While the provision for play in links 48 and for pressing straight edges 67 and 71 against surface 148 is preferable according to this invention, it is possible to employ links 48 of continuous construction. In such case the advantages of this invention can be partially realized by the operator constantly maintaining, by means of hand wheels 45 and crank 47, a downward pressure on the straight edge assembly. In such case, however, it is difficult to prevent bumps encountered by the wheels of the apparatus from lifting the straight edges off the ground from time to time and to prevent depressions encountered by the wheels from placing the entire weight of the grader on the straight edges from time to time.

In order to permit horizontal angular adjustment of blade 49 with respect to frame members 63 and in order to lock the parts in position after suitable adjustment has been made, a bar 80 may be extended between frame members 63 and in position substantially parallel to blade 49 and pivoted at either end to each of said frame members. Brackets 81 may be secured to frame members 63 which maintain the bolts 82 therein in a vertical position. Adapted to receive bolts 82 are hinge members 83 which are secured to bar 80, said brackets and hinge members forming hinges permitting horizontal angulation between said bar and said frame members. One of the brackets 81 may be provided with a notched locking quadrant 84 and at the corresponding end of bar 80 a lever 85 may be positioned having a lug 86 thereon adapted to cooperate with the notches in quadrant 84. By spring 87 the lever 85 may be maintained resiliently in locking position so that lug 86 will normally be engaged with notches in quadrant 84. The lever 85 can however be moved against the pressure of spring 87 so as to move lug 86 out of engagement with notches on the quadrant 84 and permit angular adjustment of frame members 63 with respect to grader blade 49.

By this arrangement bar 80, blade 49, and parallel portions of frame members 63 form a parallelogram, the angles of which may be adjusted in any desired position and locked, thus providing means for adjusting the grader blade to any desired angular position and locking it in that position. While the arrangement of a parallelogram affords advantageous means for accomplishing the purpose stated, it is apparent any other means for accomplishing a similar purpose may be used according to this invention.

By having the ends of grader blade 49 pivoted to frame members 63 as described, the ends of the blade 49 are always maintained in substantially the same longitudinal position with respect to the straight edges which control the vertical movements of the grader blade. For example, where grader blade 49 is mounted at about the mid point, as is preferable, between the front ends of straight edges 67 and the rear ends of edges 71, the blade 49 will remain in the same relative longitudinal position with respect to those blades regardless of the angle at which the blade is positioned transversely of the straight edges. This is of great advantage as both ends of the blade may be thereby guided uniformly. Moreover with such construction only a minimum space need be left between the rear ends of edges 67 and the front ends of edges 71. If the straight edges were not moved in changing the angle of the grader blade considerable space would have to be allowed between the front and rear straight edges in order to permit such angular adjustment. Where, however, the straight edges move together with the ends of the grading blade according to this invention, this space need only be wide enough, for example, to permit material pushed to one side by the grading blade to pass therethrough and at the same time means are afforded for adjusting the horizontal angle of the grading blade.

If it is desired, guide plates 75 may be attached to the one or both ends of blade 49 in such manner as to be maintained parallel to the direction of travel of the apparatus. To this end, plates 152 may be secured to ends of blade 49 by bolts 153 and 154. Elongated openings 155 in plates 152 may be provided so that bolts 154 will have a certain amount of play therein permitting the vertical angle of blade 49 to be changed while maintaining hinge bolts 76 in substantially vertical position in hinge members 156 of said end plates 152. Guide plates 75 may be hinged to hinge bolts 76 by hinge members 157. Links 78 pivoted to frame members 63 at pivots 79 and to guide plates 75 at pivots 77 may be positioned parallel to blade 49 forming parallelograms consisting of blade 49, links 78, guide plates 75 and a portion of frame members 63. While the angles of the parallelogram can be changed as desired, the guide plates 75 will be maintained in proper direction. The above described means of maintaining guide plates 75 in proper direction is illustrative merely and it is to be understood that this invention comprises other means of so doing.

In addition to having straight edges 67 and 71 of such construction that they can cut through loosely laid material on surface traveled by the apparatus and maintain contact with the surface, wheels 21 may also be provided according to this invention with flanges 88 which are of sufficient height to permit them to cut through the loosely laid material and rest on the surface on which the loose material is spread. For this purpose one or more of such flanges may be used in each wheel and may be of any suitable thickness such as one-quarter inch. Where wheels are used having flanges thereon as described, the narrow flanges leave very narrow cuts in the spread material. Both the cuts made by the flanges on the wheel and by the straight edges are so narrow that they disappear entirely upon rolling the material.

In Figs. 9, 10 and 11 the relative position of

the straight edges, guide plates, bar, links and wheels is indicated diagrammatically. In Fig. 9 the apparatus is being moved straight forward and the grader blade is placed in right hand adjustment. It is to be noted that the ends of the grader blade 49 are midway with respect to the straight edges on each side of the apparatus. Moreover the guide plates 75 are parallel to the direction of the motion of the grader.

In Fig. 10 the motion of the apparatus is in a curve to the left. The grader blade is here shown in right hand adjustment. It is to be noted that the front pair of straight edges 67 have adopted that position which permits them to cut through loosely laid material on the road while displacing the material a minimum amount in being passed therethrough. They are permitted to come into this position by virtue of the pivots 68 and are maintained in proper vertical relation by plates 69 and rollers 70. Similarly the rear pair of straight edges 71 adopt a position appropriate to their passage through the loosely laid material.

In Fig. 11 the apparatus is being moved in a curve to the left and the grader blade is shown in left hand adjustment. It is to be noted here that both the front and rear straight edges have again adopted that position which best permits them to pass through loosely laid material on the traveled surface.

Figs. 12 and 13 show a modified form of apparatus embodying this invention which is preferably of relatively light construction permitting it to be dragged along by any suitable means such as a tractor without excessive friction by means of tongue 161.

The apparatus is illustrative among other things of apparatus embodying this invention wherein straight edges are not moved when the horizontal angular position of the grader blade is changed.

The apparatus may comprise a suitable frame 89 and adjacent the front end thereof may be pivoted straight edges 90 by pivot bolts 91 operating in bushings 92. Mounted on straight edges 90 are rollers 93 which are adapted to co-operate with the upper and lower surfaces of substantially horizontal plates 162 attached to frame 89 thereby affording straight edges 90 angulation only in a plane substantially parallel to surface traveled by this apparatus. Adjacent the rear end of frame 89 are straight edges 94 which are pivoted to frame 89 by pivot bolts 163 operating in bushings 164. Mounted on straight edges 94 are rollers 95 which co-operate with the upper and lower surfaces of substantially horizontal plates 96 attached to frame 89 and which afford straight edges 94 angulations only in a plane substantially parallel to the surface traveled by the apparatus.

Draw bars 97 in the form of a wishbone are pivoted at their front ends to frame 89 by pivot 198 which permits the rear ends of draw bars 97 to be elevated and lowered in respect to frame 89. In slidable and rotatable relation to draw bars 97 by virtue of guides 158 is ring 98 from which is suspended grader blade 99. The horizontal angular position of grader blade 99 can be changed from hand wheel 100 through rods 101 and universal joints 102 and through a suitable toothed gear not shown adapted to co-operate with teeth 103 on the inside of ring 98. By turning wheel 100 the ring 98 is rotated as desired and the horizontal angular position of

grader blade 99 adjusted. The elevation of the ends of grader blade 99 can be adjusted from hand wheels 104 through worm gears 105, rods 106, cranks 107 and links 108 which links are attached to ring 98 by means of bar 109. Links 108 may be provided with frame box 159 attached to an upper portion of links 108 and a plate 160 attached to the lower portions of said links, so as to afford play therein in case the grader blade should be violently thrust upward by obstructions in the road. A spring 110 may be interposed between the lower end of frame boxes 159 and plates 160 to assist in supporting the blade 99, ring 98 and other parts of the assembly. It is to be noted that notwithstanding springs 110 the grader blade 99 is maintained in a relatively fixed position with respect to the frame 89.

In order that the device may be steered along the road surface, suitable steering mechanism may be provided operable from any suitable hand wheel 111. The steering may be accomplished from wheel 111 through rods 112 and universal joints 113 and through worm 114, worm wheel 115, and crank 116 affixed to worm wheel 115. Link 117 attached at one end to crank 116 is attached at the other end to crank 118 that is fixed to pivot bolt 91 mounted on one of straight edges 90. Cross link 119 leads from crank 118 to crank 120 which is affixed to pivot bolt 91 of the other straight edge of the front pair of straight edges 91. The relative angular positions of cranks 116, 118 and 120 and the lengths of links 117 and 119 may be adjusted so that each of the straight edges 90 will be turned to that degree which permits them to pass through loosely laid material on the surface traveled with minimum displacement of the material when the apparatus is moved in a curve.

The above apparatus provides simple means embodying features of this invention which may be used advantageously for example in smoothing loosely laid material 165 on a road foundation 166. The straight edges 90 and 94 are preferably of sufficient height to permit them to cut through the loosely laid material 165 and to follow along the foundation in contact therewith. As straight edges 90 and 94 are maintained in the same plane an effective straight edge effect is afforded corresponding to the distance from the front end of edges 90 to the rear end of edges 94. As the apparatus is moved along an irregular road foundation the vertical movement of blade 99 is controlled by the straight edges which contact with the road foundation and which due to their length do not follow the irregularities in the foundation but assume an average position which is substantially unaffected by such irregularities. The result is that a very uniform and smooth layer is distributed on the foundation. Moreover, as the individual straight edges are capable of horizontal angulation they assume when the apparatus is guided in a curve that position which least displaces the loosely laid material through which the straight edges cut.

The apparatus shown in Fig. 14 is particularly adapted for use in smoothing material discharged from a dumping truck. The rear end of a truck has been shown diagrammatically. Wheels 121 support the truck chassis 122 upon which a body portion 123 is pivoted at 124. A smoothing box or hopper 126 carried by frame 127 supported by a front pair of straight edges 128 and a rear pair of straight edges 129 may be pulled by the truck through any suitable draft bar 125. The front straight edges 128 are pivoted at pivots 130 and

by means of plates 131 attached to frame 127 and rollers 132 attached to straight edges 128 straight edges 128 are afforded angulation only in a plane substantially parallel to surface traveled by the apparatus. The rear straight edges 129 are similarly pivoted at pivots 133 and plates 134 attached to frame 127 and rollers 135 attached to straight edges 129 also afford straight edges 129 angulation only in a plane substantially parallel to surface traveled by the apparatus. As the truck containing the surfacing material is moved forward, the body 123 can be inclined permitting the material contained therein to fall out through door 136 into box 126. The straight edges 128 and 129 extend a substantial distance in front and in back of box 126 so as to be adapted to follow the foundation of the road and guide the bottom of box 126 and so that material discharged from the bottom of box 126 will be smoothed by a smoothing edge 167 on the bottom of said box and lay the material in a uniform and smooth layer on the road foundation. Straight edges 128 and 129 are preferably positioned with respect to box 126 and smoothing edge 167 so that they will follow a path inside the outer edge of the spread material so as to permit spreading of material without disturbing adjacent spread material. The box 126 may be raised and lowered if desired by means of pins 168 adapted to fit in any of the vertically disposed holes 169 in bars 170 affixed to the ends of box 126.

Apparatus embodying this invention is adapted to a wide variety of uses. It is particularly adapted, for example, to spreading loosely laid material such as mineral aggregate coated with a bituminous binder upon prepared or old foundations, so as to produce a uniform layer of the material which can be rolled and consolidated to make a road of superior smoothness. For example, great difficulties have heretofore been encountered in successfully placing smooth thin surface coatings on old pieces of rough macadam or concrete as such coats are extremely difficult to spread evenly. With the above apparatus the above difficulties can be overcome and a relatively unskilled laborer is enabled to lay very great amounts of well smoothed surfacing material in relatively short periods of time. Moreover due to the precision of apparatus embodying this invention thinner surface coatings may be applied than have been possible heretofore with consequent great saving of surface material.

While this invention has been described specifically in connection with specific embodiments of this invention it is apparent that this has been done for purposes of illustration merely and that numerous modifications of the apparatus shown may be made without departing from the scope of this invention.

While in the above description of embodiments of this invention, the straight edges have been shown in their preferable form, namely, as composed of single pieces of metal having substantially straight lower edges, these straight edges may also comprise according to this invention, discontinuous members mounted so as to have the lower edges thereof in a substantially straight line. Moreover the straight edges may also comprise a plurality of small wheels or disks rotatably mounted so as to have the lowermost portion of the peripheries thereof maintained in a substantially straight line. Any such or similar construction will be understood to be included in the term "straight edge" as employed in the

specification and claims. Moreover, while the straight edges shown in the drawings are adapted to cut through material loosely laid in the surface traveled by the grading apparatus and rest upon such surface, advantages of this invention may also be realized wherein a part only of the straight edges or a limited number thereof are of such character. For example, the straight edges in front of the grading blade may be of thin construction adapted to cut through loosely laid material while the straight edges in back of the grading blade may comprise wide shoes or skis adapted to slide over the smoothed material or may comprise a plurality of small wheels with wide tires adapted to operate on top of the smoothed surface and in such case the rear straight edges are preferably raised with respect to the front edges in an amount corresponding to the thickness of the material being spread. Furthermore, numerous features of this invention are of novel and useful character both when used in connection with straight edges which cut through loosely laid material and when used in connection with straight edges which merely contact with surface traveled by the apparatus without cutting through loosely laid material. In either case the straight edge will be understood to contact with surface traveled by the apparatus. It is also possible in embodiments of this invention wherein this invention is used in connection with a machine mounted on wheels, whether power driven or otherwise, to employ for example rear wheels having wide treads which operate on the surface of the graded material.

In connection with the above drawings a grading blade comprising a single straight piece of metal is shown and described. Other shaped grading blades may also be employed according to this invention without departing from the scope thereof. For example, a grading blade in the shape of a V may be employed wherein the apex of the V points in the direction of travel of the apparatus. Any such modification will be understood to be included in the terms "blade" or "grading blade" and to be mounted transversely to the straight edges.

I claim:

1. Apparatus of the character described which comprises a blade, straight edges in front of said blade and corresponding straight edges in back of said blade, said straight edges being adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and to maintain contact with said surface, frame members having means for maintaining corresponding front and back straight edges in the same substantially horizontal plane, means connecting said straight edges and frame members for permitting each of said corresponding front and back straight edges to swing horizontally independently with respect to each of the others so as to adopt that position which least displaces said loosely laid material on said surface upon said straight edges cutting through said material when said apparatus is moved in a curve, and means co-operating with said frame members for causing said blade to follow substantially the vertical motion of said straight edges when said straight edges are moved along said surface.

2. Apparatus of the character described which comprises a frame, a pair of straight edges on the front of said frame adapted to cut through material laid upon a road foundation and to maintain contact with said foundation, a pair of

corresponding straight edges on the rear of said frame, a blade mounted on said frame transversely of said straight edges and controlled as to vertical position thereby, means co-operating with said frame for maintaining said straight edges in the same substantially horizontal plane, and means connecting said straight edges and frame for permitting each of said straight edges to swing horizontally independently with respect to each of the others so as to adopt that position which least displaces material on said foundation when said apparatus is moved in a curve.

3. Apparatus of the character described which comprises a frame, a pair of straight edges pivoted to said frame and means for maintaining said straight edges in substantially the same horizontal plane while permitting said straight edges to swing horizontally independently of each other, said means including substantially plane plate guiding means affixed to said frame and guiding means affixed to each of said straight edges co-operating with said plate guiding means whereby each of said straight edges is movable independently of the other and guided with respect to said frame in a single plane.

4. Apparatus of the character described which comprises a frame member, a straight edge pivoted to said frame member, a substantially horizontal plate affixed to said frame member, rotatable guiding means affixed to said straight edge contacting with the upper and lower surfaces of said plate, thereby guiding the angulation of said straight edge with respect to said frame member in a substantially horizontal plane.

5. Apparatus of the character described which comprises a frame, straight edges on the front and rear of said frame adapted to move longitudinally in contact with surface traveled by said apparatus, a blade mounted on said frame transversely of said straight edges and controlled as to vertical position thereby, means affording said front and rear straight edges angulation only in a plane substantially parallel to said traveled surface, and means for changing the horizontal angle of said blade with respect to said frame without changing the longitudinal position of the ends of said blade with respect to said straight edges.

6. Apparatus of the character described which comprises a frame, straight edges on the front and rear of said frame adapted to move longitudinally in contact with surface traveled by said apparatus, a blade mounted on said frame transversely of said straight edges and controlled as to vertical position thereby, means affording said front and rear straight edges angulation only in a plane substantially parallel to said traveled surface, means for changing the horizontal angle of said blade with respect to said frame without changing the longitudinal position of the ends of said blade with respect to said straight edges, and locking means for locking said blade in fixed angular position with respect to said frame.

7. Apparatus of the character described described which comprises frame members having substantially parallel portions thereof, straight edges affixed adjacent the front and rear of said frame members, a blade transverse said frame members and pivotally affixed to each of said members, and a bar parallel to said blade and pivotally affixed to each of said frame members

to complete a parallelogram consisting of said frame members, blade and bar.

8. Apparatus of the character described which comprises frame members having substantially parallel portions thereof, straight edges affixed adjacent the front and rear of said frame members, a blade transverse said frame members and pivotally affixed to each of said members, a bar parallel to said blade and pivotally affixed to each of said frame members to complete a parallelogram consisting of said frame members, blade and bar, a guide plate pivoted at the end of said blade, and a link parallel to said blade and pivoted to said plate and to one of said frame members to form a parallelogram consisting of said frame member, said plate, said blade and said link.

9. Apparatus of the character described which comprises frame members, straight edges affixed adjacent the front and rear of said frame members, a blade transverse said frame members and pivotally affixed to each of said frame members, and locking means for locking said frame members and blade in fixed angular position with respect to each other.

10. Apparatus of the character described which comprises frame members, straight edges affixed adjacent the front and rear of said frame members, said straight edges being adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and to maintain contact with said surface, means affording said straight edges angulation only in a plane substantially parallel to said traveled surface, a blade transverse said frame members and pivotally affixed to said frame members about midway between the front ends of said front straight edges and the rear end of said rear straight edges, and locking means for locking said frame members and blade in fixed horizontal angular position with respect to each other.

11. Apparatus of the character described which comprises a blade, a vertical pivot bolt affixed to said blade, a frame member pivotally affixed to said bolt, straight edges attached to said frame member adjacent the front and rear of said frame member adapted to move longitudinally in contact with the surface traveled by said apparatus, and means for adjusting the vertical angle of said blade with respect to said vertical pivot bolt.

12. Apparatus of the character described which comprises a blade, a vertical pivot bolt affixed to said blade, a frame member affixed pivotally to said pivot bolt, a guide plate parallel to said frame member pivotally affixed to said blade adjacent the end of said blade, a link parallel to said blade and pivoted to said plate and said frame member, and means for adjusting the vertical angle of said blade with respect to said pivot bolt and guide plate.

13. In apparatus of the character described the combination comprising a blade, straight edges mounted on said blade adapted to move longitudinally along a surface traveled by said apparatus, a frame, wheels for carrying said frame, means connecting said straight edges and frame for permitting said blade controlled by said straight edges mounted thereon to follow the surface traveled by said apparatus irrespective of movements of said frame caused by wheels of said apparatus passing over irregularities in said surface a member mounted on said frame and means between said member and said blade whereby the horizontal angle of said blade with

respect to said straight edges may be changed by movement of said member.

14. Apparatus of the character described which comprises a frame mounted on wheels, straight edges drawn by said frame adapted to move longitudinally in relation to surface traveled by said apparatus, means connecting said straight edges and frame for permitting said straight edges to remain in contact with the traveled surface irrespective of vertical movements of said frame caused by said apparatus moving over irregularities in said surface, a blade secured transversely to said straight edges means affording the changing of the horizontal angle of said blade with respect to said straight edges without changing the longitudinal position of the ends of said blade with respect to said straight edges, a member on said frame, and means between said member and said blade operative to change the horizontal angle of said blade with respect to said straight edges by movement of said member.

15. Apparatus of the character described which comprises a frame carried by wheels, straight edges adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus, means connecting said straight edges and frame for permitting said straight edges to remain in contact with the surface traveled by said apparatus irrespective of vertical movements of said frame of said apparatus caused by wheels of said apparatus moving over irregularities in said surface, a blade carried transversely by said straight edges, first and second members on said frame, and means between said first and second members respectively and said blade for elevating and lowering one end of the blade independently of the other upon appropriate movement of one of said first and second members.

16. Apparatus of the character described which comprises a frame mounted on wheels, a blade, means for drawing said blade transversely to the line of travel of said apparatus, members carried by said blade, straight edges adjacent the forward ends of said members in front of said blade, straight edges adjacent the rear ends of said members behind said blade, means affording said straight edges angulation only in a plane substantially parallel to surface traveled by the apparatus, and means permitting said blade to follow the vertical movements of said straight edges in passing longitudinally along surface traveled by said apparatus irrespective of vertical movements of said frame.

17. Apparatus of the character described which comprises a frame mounted on wheels, a blade, means for drawing said blade transversely to the line of travel of said apparatus, members carried by said blade, straight edges adjacent the forward ends of said members in front of said blade, straight edges adjacent the rear ends of said members behind said blade, means affording said straight edges angulation only in a plane substantially parallel to surface traveled by the apparatus, means between said frame and said straight edges for permitting said blade to follow the vertical movements of said straight edges in passing longitudinally along surface traveled by said apparatus irrespective of vertical movements of said frame for resiliently pressing said straight edges against surface traveled by said apparatus.

18. Apparatus of the character described which comprises a frame mounted on wheels, flanges on said wheels adapted to cut through loosely laid

material on surface traveled by said apparatus, straight edges adapted to cut longitudinally through said loosely laid material and maintain contact with said surface, a blade secured transversely of said straight edges, means affording angulation of said straight edges only in a plane substantially parallel to surface traveled by said apparatus, and means for propelling said blade and straight edges and for permitting said blade to follow vertical movements of said straight edges in passing over surface traveled by said apparatus irrespective of vertical movements of said frame caused by wheels of said apparatus passing over irregularities in the surface traveled.

19. Apparatus of the character described which comprises a plurality of straight edges adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and means affording each of said straight edges different degrees of angulation with respect to each other and with respect to said apparatus but only in a plane substantially parallel to said traveled surface.

20. Apparatus of the character described which comprises a frame supported by straight edges which are adapted to cut through loosely laid material on surface traveled by said apparatus, each of said straight edges being capable of different degrees of angulation with respect to each of the others and to said frame, but only in a plane substantially parallel to surface traveled by said apparatus and a vertically adjustable blade secured to said frame transverse to the intended line of travel of said apparatus.

21. Apparatus of the character described which comprises a grader blade, a frame, means for maintaining said blade in desired position with respect to said frame, straight edges mounted on said frame in front and in back of said blade, said straight edges being adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and to maintain contact with said surface, and said blade being adapted to follow the motion of said straight edges as they are moved along said surface and to smooth said loosely laid material on said surface, and pivot means for each of said straight edges whereby each of said straight edges is pivotally mounted with respect to said frame so as to permit angular movement of each of said straight edges independently of each of the other

straight edges in a plane substantially parallel with the surface traveled by said apparatus.

22. Apparatus of the character described which comprises a grader blade, a frame, means for maintaining said blade in desired position with respect to said frame, straight edges mounted on said frame in front and in back of said blade, said straight edges being adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and to maintain contact with said surface, and said blade being adapted to follow the motion of said straight edges as they are moved along said surface and to smooth said loosely laid material on said surface, pivot means for each of said straight edges whereby each of said straight edges is pivotally mounted with respect to said frame so as to permit angular movement of each of said straight edges independently of each of the other straight edges in a plane substantially parallel with the surface traveled by said apparatus, and means co-operating between each of said straight edges and said frame for controlling the angular movement of all of said straight edges with respect to said frame to movement substantially in a single plane substantially parallel with the surface traveled by said apparatus.

23. Apparatus of the character described which comprises a grader blade, a frame, means for maintaining said blade in desired position with respect to said frame, straight edges mounted on said frame in front and in back of said blade, said straight edges being adapted to cut longitudinally through loosely laid material on surface traveled by said apparatus and to maintain contact with said surface, and said blade being adapted to follow the motion of said straight edges as they are moved along said surface and to smooth said loosely laid material on said surface, pivot means for each of said straight edges whereby each of said straight edges is pivotally mounted with respect to said frame so as to permit angular movement of each of said straight edges independently of each of the other straight edges in a plane substantially parallel with the surface traveled by said apparatus, and means co-operating with said frame and said straight edges and spaced substantially from said pivot means for controlling the angular movement of said straight edges with respect to said frame to movement in a plane substantially parallel with the surface traveled by said apparatus.

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