Oct. 21, 1958 E. C. BROWN ET AL 2,856,705

TRAILER TYPE OF ELEVATING GRADER ATTACHMENT

Filed Aug. 20, 1954 5 Sheets-Sheet 1

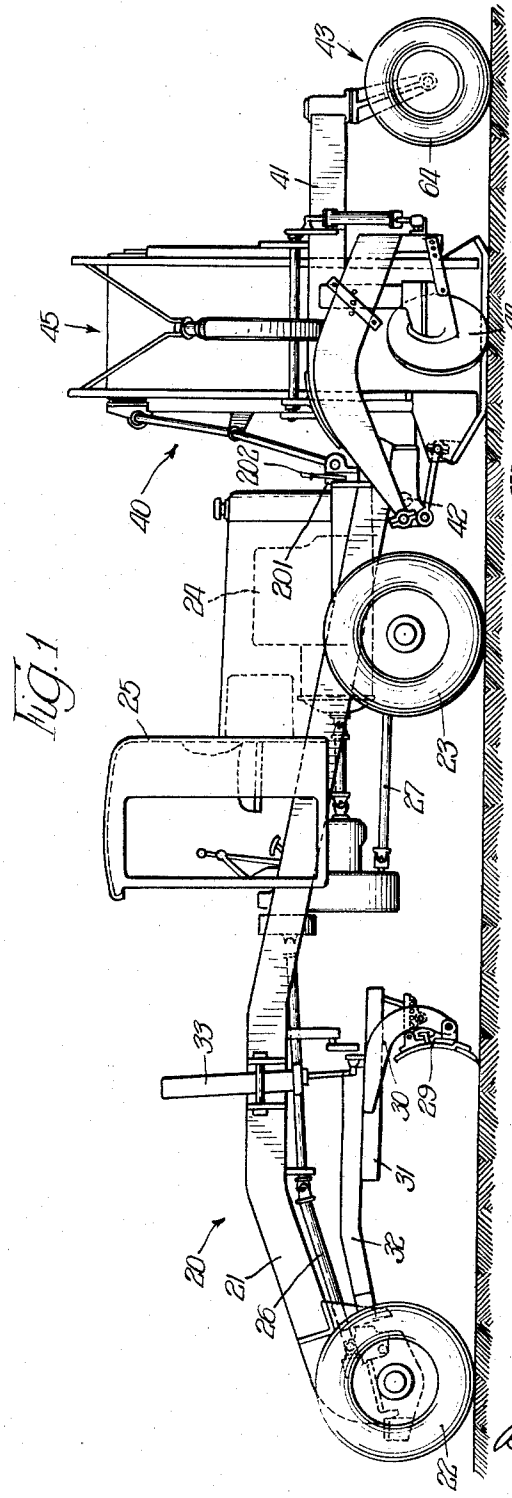


Fig. 1

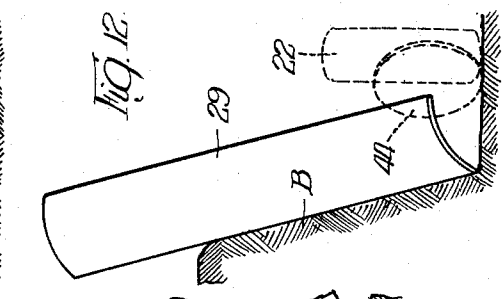


Fig. 12

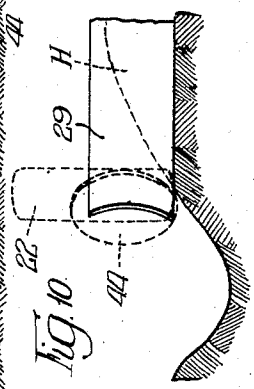


Fig. 10

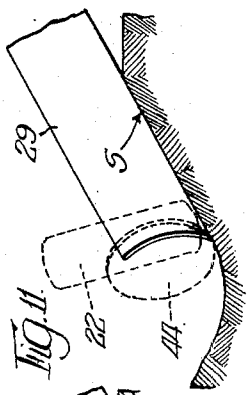


Fig. 11

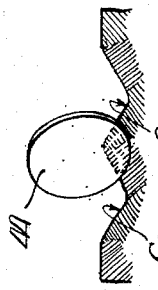


Fig. 8A

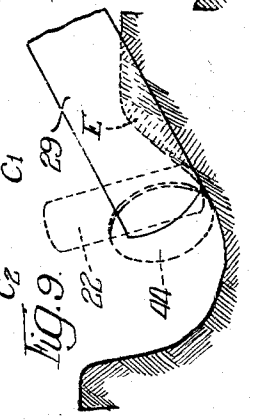


Fig. 9

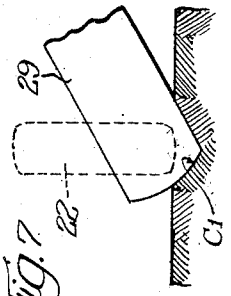


Fig. 7

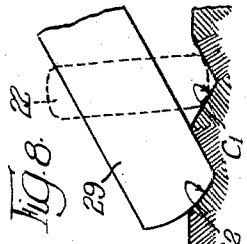


Fig. 8

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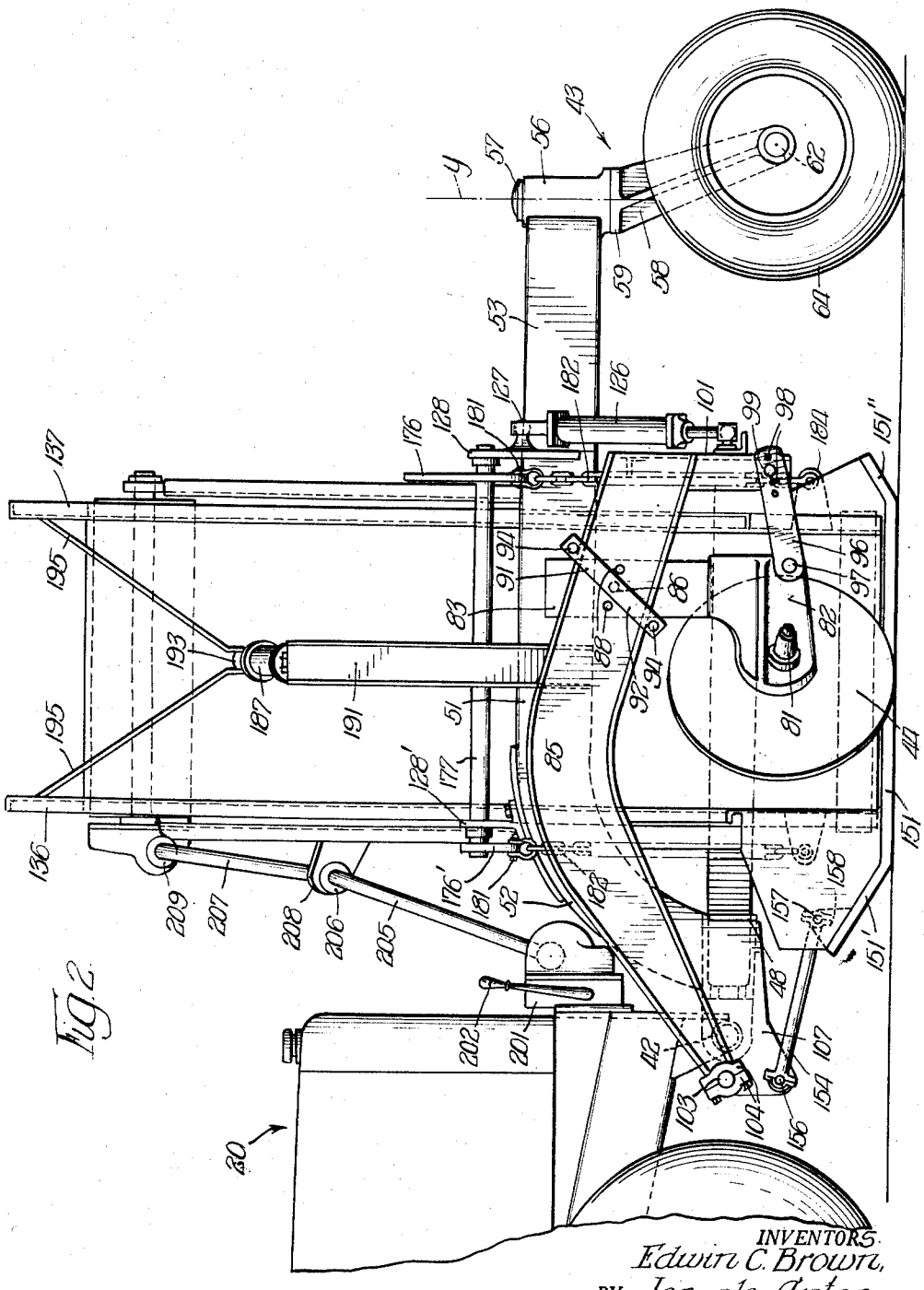


FIG 2

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Oct. 21, 1958 E. C. BROWN ET AL 2,856,705

TRAILER TYPE OF ELEVATING GRADER ATTACHMENT

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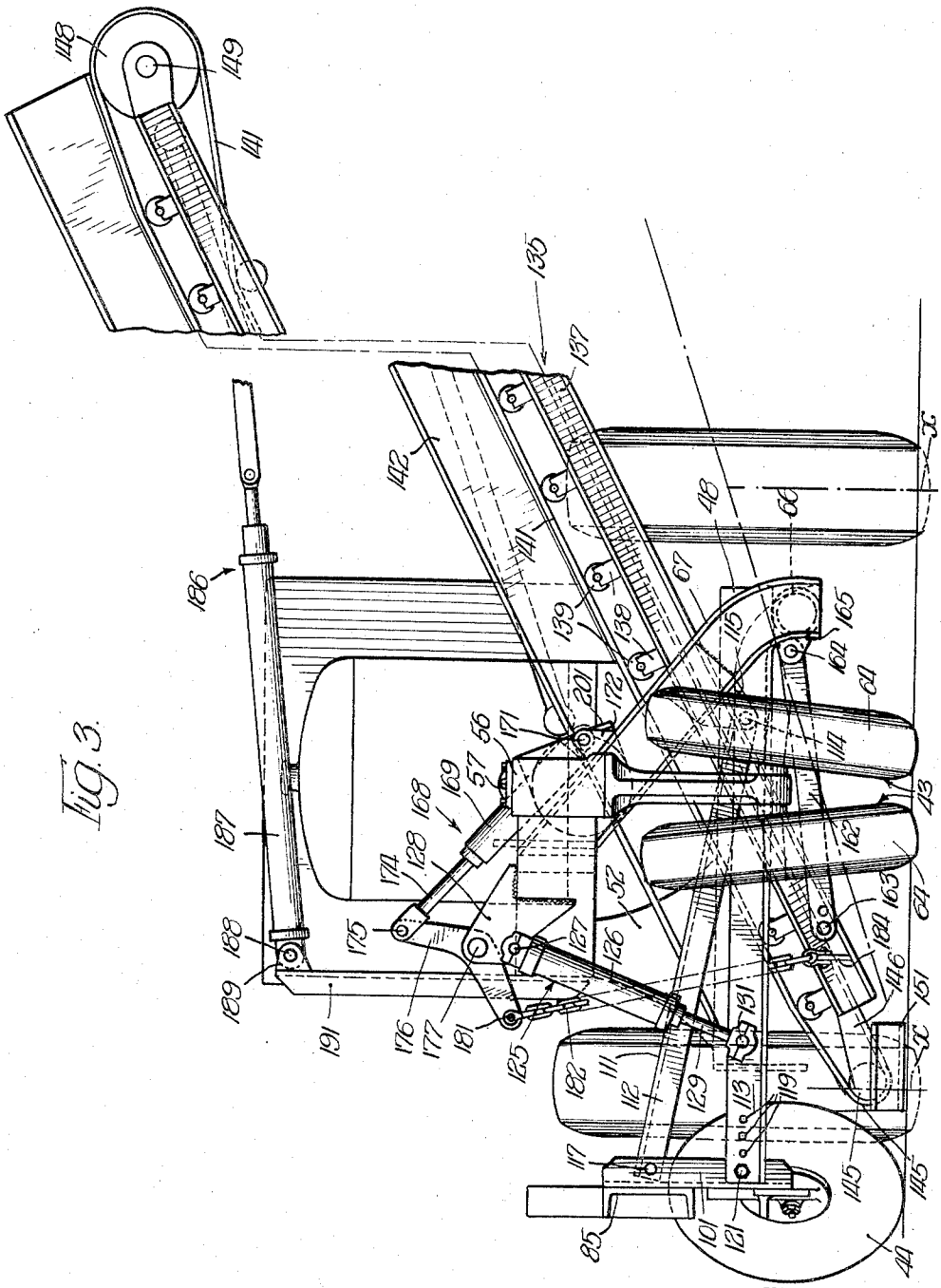


Fig. 3.

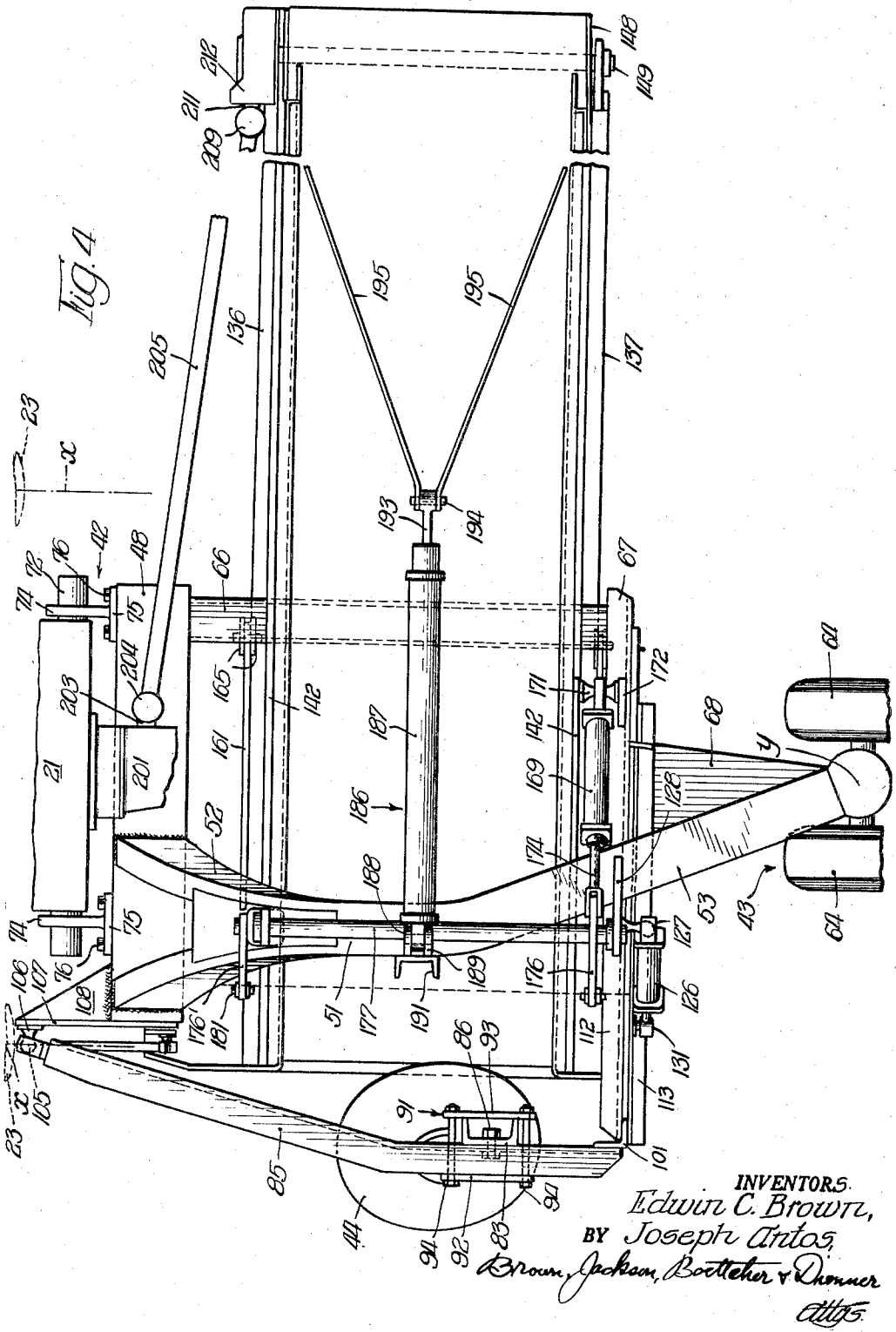
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TRAILER TYPE OF ELEVATING GRADER ATTACHMENT

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Fig. 4



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TRAILER TYPE OF ELEVATING GRADER ATTACHMENT

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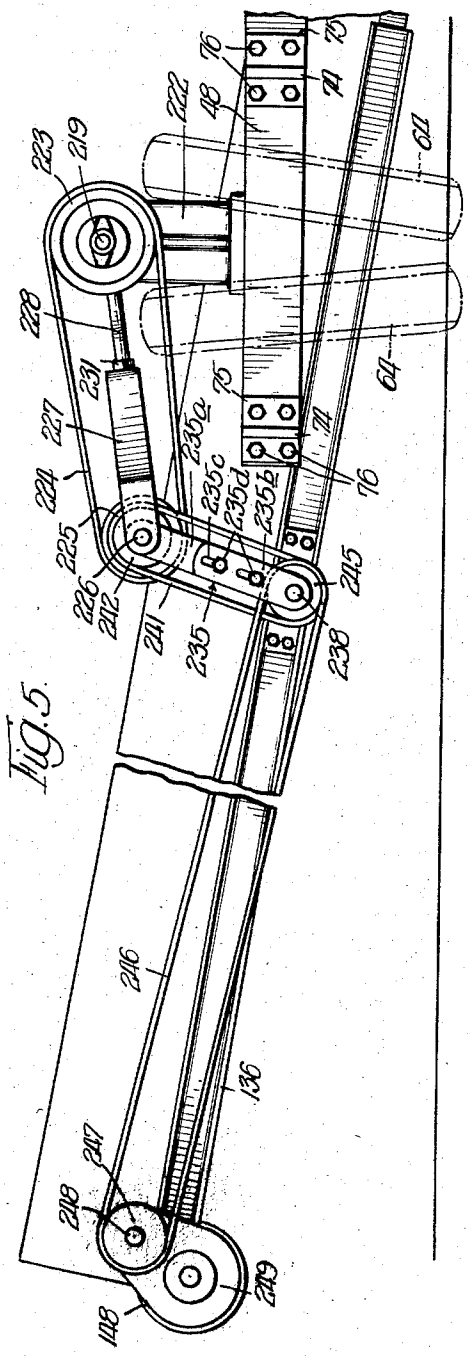


Fig. 5.

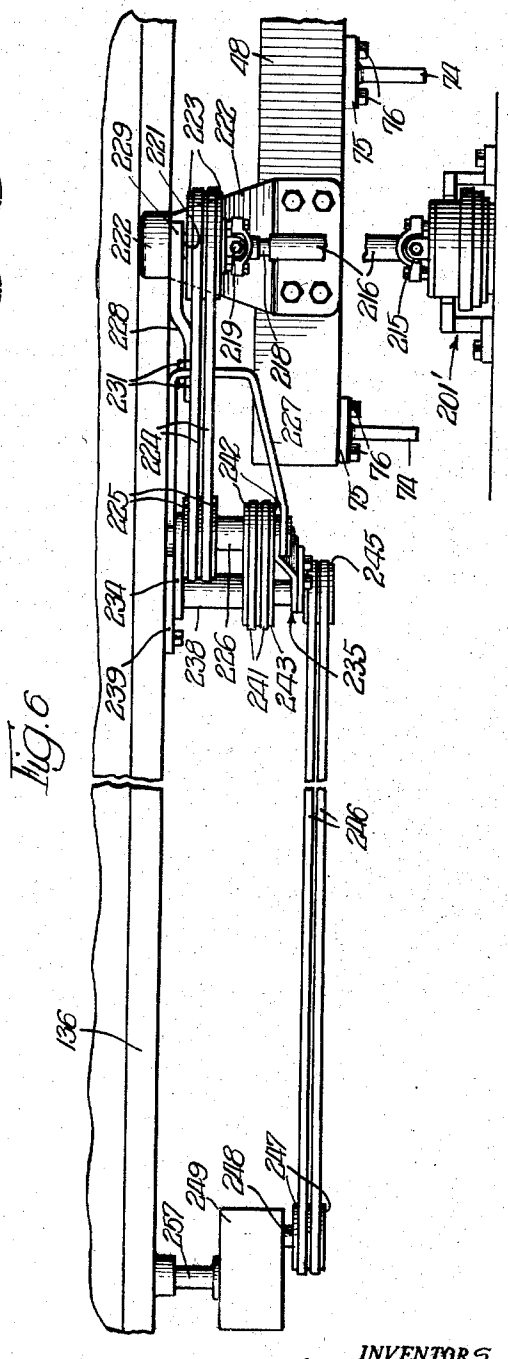


Fig. 6.

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United States Patent Office 2,856,705 Patented Oct. 21, 1958

2,856,705

TRAILER TYPE OF ELEVATING GRADER ATTACHMENT

Edwin C. Brown and Joseph Antos, Aurora, Ill., assignors, by mesne assignments, to Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application August 20, 1954, Serial No. 451,246

9 Claims. (Cl. 37—110)

The present invention relates generally to elevating grader attachments adapted for attachment to motor-driven road graders and the like, in the field of earth moving equipment. When attached or coupled to the motor-driven road grader, the attachment picks up earth from the strip being cut and conveys it outwardly on a laterally extending conveyor which forms part of the attachment unit. This laterally extending conveyor either dumps the earth into a truck travelling alongside the grader, or casts the earth upon the ground along a line spaced outwardly a substantial distance from the line of grading or cut.

One prior type of elevating grader attachment which has heretofore been used on motor graders in the "center-mounted" type, which is adapted to have detachable mounting on the frame of the motor grader at a point between the front and rear wheels, i. e. substantially at the center of the motor grader in the space normally occupied by the transverse scraper blade. There are at least three very serious objections to this center-mounted type of elevating grader attachment: (1) it requires hours of labor to mount the attachment on the frame of the grader and to dismount it therefrom; (2) the long overhanging span of the conveyor reaching out to one side of the grader imposes very heavy twisting or torsional stresses on the grader frame, particularly when the conveyor is heavily loaded; and (3) the necessity of removing the transverse cutting blade before the elevating grader attachment can be mounted on the grader thereafter limits the utility of the machine, because there are important operations which the grader cannot perform as well or cannot perform at all without the cutting blade, such as the operation of "striking out" the zone or line of cut, etc. These objections are avoided by constructing the elevating grader in the form of a trailer type of attachment adapted to be coupled to the rear end of the motor grader in the relation of a wheel-supported trailer.

The general object of the present invention is to provide an improved trailer type of elevating grader attachment. One of the more specific objects of the invention is to provide an improved trailer type of hitch between the trailer attachment and the motor grader, together with an improved caster wheel mounting of the trailer attachment. The trailer hitch connection is of the vertically hinging type which permits free vertical rise and fall of the trailer attachment relatively to the motor grader in passing over uneven ground, etc. However, this trailer hitch connection is laterally stiff in the sense that it prevents any lateral swinging of the attachment from side-to-side relatively to the motor grader. Hence, on turning movements of the motor grader the trailer attachment functions as a laterally rigid extension of the motor grader; also on any backing movements of the motor grader there is no danger of any jackknifing between the motor grader and the trailer attachment. The caster wheel mounting of the trailer attachment is preferably confiined to a single castering axis which is located in relatively close proximity to the transverse center of gravity of the trailer attachment. The mounting of the trailer attachment on a single castering axis insures that the entire trailer attachment will rise and fall as a unit about the vertically hinging hitch connection, whereby the overhanging discharge end of the conveyor is prevented from rocking upwardly or downwardly in passing over uneven ground, so that this end of the conveyor maintains a substantially constant height above the ground. Moreover, the mounting on the single castering axis affords a wide range of adjustment of the overhanging discharge end of the conveyor. For example, it enables this outer end of the conveyor to be lowered almost horizontally, which is particularly desirable when "casting" the conveyor material directly upon the ground, i. e. when the conveyor material is not being loaded into trucks.

Another object of the invention is to provide an improved adjustable mounting of the plow on the trailer attachment, which plow displaces the soil laterally onto the lower end of the elevating conveyor.

Another object of the invention is to provide an improved adjustable mounting of the elevating conveyor on the trailer attachment.

Another object of the invention is to provide an improved construction and arrangement of drive mechanism for driving the conveyor belt of the elevating conveyor.

Another object of the invention is to provide an improved relationship of motor grader and elevating grader attachment wherein the adjustable scraper blade of the motor grader and the plow and conveyor of the trailer attachment uniquely cooperate with each other in the performance of different grading or earth-moving operations. The motor grader is of the type having a universally adjustable scraper blade that can be raised and lowered relatively to the vehicle; that can be inclined or tilted at different vertical angles relatively to the vehicle; that can be inclined at different fore and aft angles relatively to the vehicle; that can be shifted endwise of itself for different transverse adjustments relatively to the vehicle, etc. These adjustments enable certain cooperating relationships to be established between the scraper blade of the motor grader, and the plow and conveyor of the trailer attachment, so as to simplify certain grading, ditching and other earth moving operations.

Other objects, features and advantages of the invention will appear from the following detailed description of certain preferred embodiments of our invention. In the accompanying drawings illustrating such embodiments:

Figure 1 is a side elevational view showing our improved trailer type of elevating grader attachment connected to the above described type of motor grader having a universally adjustable scraper blade;

Figure 2 is a fragmentary side elevational view on a larger scale showing only the elevating grader attachment and its connection to the motor grader;

Figure 3 is a fragmentary rear elevational view of the elevating grader attachment;

Figure 4 is a fragmentary plan view of the same;

Figure 5 is a fragmentary elevational view illustrating a modified form of drive mechanism for driving the conveyor belt of the elevating grader attachment;

Figure 6 is a fragmentary plan view of this same mechanism; and

Figures 7 to 12 inclusive are schematic diagrams illustrating different earth moving operations in which the scraper blade of the motor grader and the plow of the

elevating conveyor coact in the performance of successive operations in the same trip or pass of the machine.

In Figure 1 the motor grader is designated **20** in its entirety, and the trailer type of elevating grader attachment is designated **40** in its entirety. The motor grader **20** comprises a main frame **21** supported by front and rear pairs of wheels **22** and **23**. In the preferred type of motor grader illustrated, the front wheels **22** and the rear wheels **23** are all power driven from a power plant **24** preferably located directly in rear of the operator's cab **25**. The power drive to the front wheels is indicated by the line of shafting **26**, and the power drive to the rear wheels is indicated by the line of shafting **27**. For greater tractive power, there may be tandem pairs of rear wheels **23** at each side of the vehicle. Preferably, the rear wheels **23** are capable of steering movement, as well as the front wheels **22**.

The scraper blade or moldboard **29** is mounted under the upwardly arched front portion of the frame **21**, directly in front of the operator's cab **25**, where the operations of the scraper blade can be easily observed by the operator. The scraper blade is mounted for rotative adjustment on a circle **31** which has a draft connection with the forward portion of the main frame through a tiltable or rockable gooseneck or A-frame **32**. Hydraulic cylinders **33** are operatively connected between the main frame **21** and the circle **31** or A-frame **32** in such manner as to enable the scraper blade to be raised or lowered to different cutting depths, and also to be inclined laterally to one side or the other for performing striking-out operations, side slope grading operations, ditching operations, etc. Hydraulically operated power means are also provided for rotating the blade **29** around the axis of the circle **31**, and hydraulically operated power means are also provided for effecting endwise shifting movement of the blade **29** relatively to the supporting arms **30** extending down from the circle **31**.

The above described motor grader, and the hydraulically operated adjusting controls of the scraper blade **29** are well known in the art, being typically illustrated in Wilson and Burns, Patent No. 2,195,607, issued April 2, 1940, and also in copending application of Edwin C. Brown and James D. Benbow, Serial No. 164,636, filed May 27, 1950, now Patent No. 2,748,509.

Referring now to the elevating grader attachment **40**, this comprises a main frame **41** having a readily detachable hitch connection **42** at its front end with the motor grader, and having its rear end supported by a caster wheel assembly **43**. Mounted at the left hand side of this trailer attachment unit **40** is an adjustable plow **44**, preferably of the disk type, and extending transversely from this plow toward the right hand side of the unit is the elevating conveyor **45** which is preferably power driven from a power take-off on the motor grader **20**.

Referring particularly to the construction of the frame **41**, it will be seen from Figures 3 and 4 that it comprises a relatively heavy transverse front frame member **48**, preferably of channel or angle cross-section. The vertically hinging hitch **42** is established between this front frame member **48** and the rear end of the motor grader, as will be later described. Welded to the top surface of the frame member **48**, preferably adjacent to its left hand end, is a rearwardly extending frame member **51** which extends rearwardly to the caster wheel assembly **43**. As shown in Figure 2, this rearwardly extending frame member **51** has its front end formed with a downwardly curved goose-neck formation **52** for welded attachment to the transverse frame member **48**, this goose-neck curvature permitting the adjacent end of the elevating conveyor frame to pass in under the frame member **51**. As viewed in plan in Figure 4, this frame member **51** has its rear end portion **53** deflected or inclined laterally toward the right so as to dispose the caster wheel assembly **43** at a point approximately midway of the tread lines of the rear wheels **23** of the motor grader. The tread lines

or tread span of these rear wheels **23** are diagrammatically indicated by the dash-dot lines *x*—*x* in Figure 4. It will be seen that the castering axis *y* (Figure 2) of the caster wheel assembly **43** is disposed substantially midway of these tread lines *x*—*x*. The swivel socket of the caster wheel assembly comprises a substantially vertical bearing sleeve **56** welded to the rear end of the inclined frame arm **53**, and receiving the rotative spindle **57** of a wheel supporting arm **58**. The latter is provided with an annular bearing shoulder **59** having bearing engagement aginst the lower end of the tubular bearing mount **56**. The wheel supporting arm **58** is sloped rearwardly to provide the desired degree of castering action, and the lower end of this arm carries a wheel supporting spindle or axle **62**. Mounted on this axle are the two closely disposed castering wheels **64**, **64** which are preferably cambered or sloped inwardly towards each other at their lower peripheries (Figure 3), so as to have the tread lines of these two caster wheels close together for greater freedom of castering movement. The employment of two castering wheels **64**, **64** is advantageous from the standpoint of providing a greater load-bearing area between the wheels and the ground, but, if desired, the wheel supporting arm **58** may be in the form of a U-shaped fork embracing a single caster wheel. These caster wheels have pneumatic tires, the same as the wheels **22** and **23** of the motor grader.

The trailer frame **41** also comprises a rearwardly extending tubular frame bar **66** which has its front end welded to the right hand end of the transverse front frame bar **48** and which has its rear end welded to a rear frame bar **67**. As shown in Figure 3, this rear frame bar **67** slopes upwardly toward the left, and has its upper end welded to the adjacent side of the goose-neck frame member **53**. A triangular reinforcing plate **68** (Figure 4) is welded between the rear frame bar **67** and the main frame member **53**, in the manner of a reinforcing gusset plate.

The above described frame elements **48**, **51**, **66**, **67** and **68** constitute the principal elements of main frame **41** of the trailer attachment, which main frame is supported at its front end on the vertically articulating hitch **42** and is supported at its rear end on the caster wheel assembly **43**. Referring again to the hitch connection **42**, it will be seen from Figure 4 that this comprises a substantially horizontal draw bar **72** in the form of a round bar or pipe extending transversely of the rear end of the motor grader frame **21**, with the ends of this draw bar projecting from each side of the grader frame. Pivotally mounted on this transverse draw bar **72** are two laterally spaced draw bar ears **74**, **74**, having pivot apertures therein adapted to have free rotative movement on the cylindrical draw bar **72**. The rear ends of these draw bar ears **74**, **74** are provided with attachment bases **75** adapted to be releasably secured by bolts **76** to the front face of the front frame member **48**. The unfastening of the bolts or screws **76** permits the ready attachment and detachment between the motor grader and the trailer unit. It will be obvious that this pivoted draw bar connection permits rising and falling movement of the trailer unit corresponding to the travel of the caster wheel assembly **43**, but compels the trailer unit to swing with the motor grader as a laterally rigid extension of the grader, which insures that the disk plow **44** will remain in any desired position of fore and aft alignment with respect to the scraper blade **29**, and which also insures that there will be no jackknifing between the motor grader and the trailer attachment in backing movements of the motor grader. In these backing movements, the caster wheels **64** merely swivel around to reversed castering positions.

Referring now to the plow **44** and its mounting, this is preferably a rolling disk type of plow, although a stationary disk or a mould board type might be employed if desired. The disk **44** has rotative mounting about an axial spindle **81** mounted in a bracket **82** which is secured

to the lower end of an upwardly extending standard 83. As shown in Figure 4, this standard is preferably in the form of a heavy channel extending upwardly on the inner side of a forwardly extending plow beam 85, which is also in the form of a heavy channel. A bolt 86 is adapted to pass through a central aperture in the web of the channel 83 and through any one of a series of holes 88 in the web of the plow beam channel 85. The shifting of the bolt 86 to different apertures 88 in the plow beam channel enables the plow to be adjusted forwardly or rearwardly with respect to the plow beam and with respect to the adjacent end of the elevating conveyor. Further attachment of the plow standard 83 to the plow beam 85 is effected by a clamp 91 comprising outer and inner diagonally extending clamping bars 92 and 93 which are drawn into clamping engagement with the channel flanges by bolts 94. A bracing link 96 is pivotally connected at its front end to a pivot 97 carried by the plow mounting bracket 82 as a point approximately in rear of the spindle axis 81. The rear end of this bracing link 96 has a plurality of spaced holes 98 for selectively receiving a pivot bolt 99 projecting outwardly from an angle bar bracket 101 which is welded to the rear end of the plow beam 85 and extends vertically downwardly therefrom. The selective positioning of different holes 98 over the bolt 99 accommodates different fore and aft adjustments of the plow beam standard 83 when the bolt 86 is located in different holes 88, and also accommodates different angular settings of the plow standard 83 around the axis of the bolt 86.

As shown in Figure 2, the plow beam 85 is formed with a substantial gooseneck curvature intermediate its ends to provide ample clearance space for different adjusted positions of the plow and also to provide clearance for the lower end of the bedframe of the elevating conveyor. The front end of the plow beam 85 has draft connection with the attachment frame 41 through a ball and socket joint 103 which accommodates the vertical adjusting movements of the plow beam, and which also accommodates transverse tilting or angular adjustments of the plow beam, which will be later described. The ball and socket joint 103 is shown as comprising two split socket halves 104 secured to the plow beam and engaging over the ball end 105 of a laterally projecting arm or stud 106. The latter is secured to a draft transmitting bracket plate 107 which is welded to the left hand end of the front frame member 48, the attachment thereto being reinforced by the welded gusset plate 108 (Figure 4).

Referring now to Figure 3, it will be seen that the transverse adjustment or cutting position of the plow 44 is determined by a pivoted frame 111 comprising an upper angle bar 112 and a lower angle bar 113. The right hand ends of these two angle bars have pivotal mounting on a common pivot axis afforded by a bolt or pin 114 projecting forwardly and rearwardly from opposite sides of a bracket 115, which is welded to the frame member 67 to extend downwardly therefrom. The upper angle bar 112 has its stiffening flange extending forwardly, and the vertical flange of this angle bar is abutted against the front face of the bracket 115 for receiving the pivot pin 114. The lower angle bar 113 has its stiffening flange projecting rearwardly, and the vertically extending flange of this angle bar is abutted against the rear face of the bracket 115 for receiving the pivot pin 114. The outer end of the upper angle bar 112 is secured by a bolt 117 to the front side of the longitudinal flange of angle bar bracket 101. The lower angle bar 113 is provided with a series of holes 119 adapted to have selective positioning over a bolt or pin 121 projecting rearwardly from the longitudinal flange of angle bar bracket 101. The selective positioning in different holes 119 by means of the attaching bolt 121 enables the angle bar bracket 101 to be inclined at different angles around the axis of the bolt 117, this causing corresponding inward tilting of the plow beam 85, plow beam standard 83 and the disk plow 44 for different working adjustments of the plow. Such transverse tilting adjustment of the entire plow beam and plow assembly are accommodated by the ball and socket draft connection 103 at the front end of the plow beam.

The plow 44 can be raised to an elevated non-plowing position out of the contact with the ground, or it can be forced down into the ground under a relatively heavy pressure, through the action of a hydraulic ram 125 which, as shown in Figure 3, is pivotally connected between the trailer frame 41 and the lower angle bar 113. This ram comprises a hydraulic cylinder 126 pivotally connected at its upper end to pivot pin 127 extending from a bracket 128 which is welded to the frame member 53. The pivot 127 may be a ball and socket joint. Extending from the lower end of cylinder 126 is the piston rod 129 which is pivotally connected at 131 to the angle bar 113, which latter pivotal connection 131 may also be a ball and socket joint if desired. The ram 125 is of the double acting type whereby fluid pressure on the under side of the piston is operative to lift the pivoted plow frame for holding the plow out of contact with the ground; or whereby fluid may be applied to the upper side of the cylinder for exerting a relatively large downward force through the plow frame to the plow disk for securing better penetration in hard ground. In the absence of any fluid pressure acting on either side of the piston, the plow will remain in contact with the ground under its own weight and the weight of the plow beam 85 and frame members 112, 113, etc. In the ram operated lifting and lowering movements of the plow assembly, the tilting motion occurs about a diagonal axis extending from the ball and socket joint 105 at the front to the pivot pin mounting 114 at the rear, there being sufficient play in these joints to accommodate the tilting movement about this diagonal axis, or the pivot pin 114 being aligned with the joint 105.

Referring now to the elevating conveyor 45, this comprises a laterally extending bed frame 135 comprising spaced front and rear channels 136 and 137 suitably cross-braced at intervals to form a rigid frame. Extending upwardly from each side frame channel 136 and 137 are closely spaced bearing brackets 138 (Figure 3) in which are journaled the transversely extending belt supporting rollers 139. The conveyor belt 141 has its upper run travelling over these supporting rollers 139, and has its lower run or span returning between the frame channels 136 and 137. Sideboards 142 extend upwardly from the frame channels 136 and 137 at the sides of the conveyor belt so as to confine the dirt being elevated by the conveyor and prevent it from spilling off the sides of the belt. The lower end of the belt passes around an idler drum 145 which is journaled in brackets 146 extending downwardly from the lower ends of the frame channels 136, 137. The upper end of the conveyor belt passes around a driving drum 148 mounted on a transverse shaft 149 which is journaled in the side frame channels 136, 137. The drive to this upper driving drum will be later described.

Referring now to the mounting of the elevating conveyor and to the manner of adjusting it into its different positions, it will be seen from Figures 2 and 3 that the lower end of the conveyor carries a bed frame shoe 151 which is adapted to slide on the ground directly inside of the plow 44. This shoe has upwardly sloping front and rear ends 151' and 151'' to insure that the shoe will be deflected upwardly when striking irregularities in the ground surface. The shoe may be secured to the bedframe 135 of the conveyor through the brackets 146, or by the provision of other separate brackets suitable for supporting the shoe. It will be seen from Figure 3 that the lower end of the conveyor belt 145 is disposed in close proximity to the bottom part of the shoe, where the conveyor belt is protected by the upturned front and rear ends of the shoe, but in which position the conveyor belt can readily receive the dirt being deflected inwardly by the plow 44. The drag

of the shoe 151 in its forward travel over the ground is borne by a drag link 154 which has its front end pivotally connected on a draft stud 156 projecting laterally from the draft transmitting bracket plate 107. The rear end of the draft link 154 is pivotally connected to a horizontal draft pin 157 mounted in a bracket 158 welded to the front end of the shoe 151. This pivoted draft link 154 accommodates free rising and falling movement of the shoe 151 during either forward or backward travel of the elevating trailer attachment, and confines movement of the elevator bedframe 135 in a direction fore and aft of the vehicle in all working and transport positions of the elevator bedframe.

Referring to Figure 3, it will be seen that rising and falling movement of the lower end of the bedframe and of the shoe 151 is confined in the transverse direction by a pair of pivoted links 161 and 162 disposed at the front and rear sides of the bedframe. The rear link 162 has its left hand end pivotally connected at 163 to the lower portion of the bedframe channel 137, and has its right hand end pivotally connected at 164 to a lug or pair of pivot ears 165 welded to the longitudinally extending frame tube 66. The front link 161 (shown in Figure 4) has like pivotal attachment 163 to the elevator bedframe and like pivotal attachment 164 to the lug or pair of ears 165 extending downwardly from the fore and aft torque tube 66. This torque tube 66 is disposed at a low level to permit the outer end of the elevator bedframe 135 to be adjusted to a relatively low level before the frame bars 136—137 engage the torque tube 66.

This link mounted lower end of the bedframe is adapted to be lifted by a bedframe lift ram 168 comprising a cylinder 169 having its lower end pivotally connected on a pivot pin 171 carried by a bracket 172 (shown in Fig. 4) suitably secured to the frame bar 67 of the attachment frame 41. Extending from the upper end of the hydraulic cylinder 169 is a piston rod 174 which is pivotally connected at 175 to the upper arm of a bell crank lever 176. This lever is secured fast to a shaft 177 which extends across the entire width of the elevating conveyor and is journaled at its rear end in bracket 128, and at its front end in a companion bracket 128' which is welded to the gooseneck frame member 51. The bell crank lever 176 comprises an outwardly extending arm which is pivotally connected at 181 to a lifting chain 182 having connection at its lower end through a clevis pivoted to a lifting bracket 184 extending outwardly from the bedframe channel 137. Referring to Figure 4, it will be seen that the front end of the rock shaft 177 carries an arm 176' which has like pivotal connection 181 with a lifting chain 182 which extends down on the forward side of the conveyor for attachment to a similar lifting lug 184 projecting forwardly from the front channel 136 of the bedframe. Thus, it will be seen that by energizing the hydraulic cyclinder 169 to draw the piston rod 174 into the cylinder, the two levers 176 and 176' will be swung in a clockwise direction around the axis of the rock shaft 177 for lifting the lower end of the elevator frame, together with the bedframe shoe 151, into transport position clear of the ground, when the elevating conveyor is not functioning during forward travel of the implement. Such upward lifting movement of the elevator frame into the transport position occurs around the pivot centers of the front and rear mounting links 161 and 162. The plow 44 is also raised to an elevated position clear of the ground when the implement is in transport.

The outer discharging end of the elevating conveyor is adapted to be held at different heights of adjustment through an elevator lift ram 186 which is disposed above the conveyor, extending outwardly toward the outer end thereof. This ram comprises a cylinder 187 having its rear end pivotally connected at 188 to a pivot lug 189 on the upper end of a channel-shaped upright 191. The lower end of the channel-shaped upright 191 is welded to the left hand side of the gooseneck main frame member 51. The piston rod 193 extending from the outer end of the hydraulic cylinder 187 has a transverse pivot 194 which is connected by bridle links 195 with the outer end of the conveyor bed frame, these links being pivotally connected with the bed frame at any desired point. By appropriately energizing the hydraulic cylinder 187, the outer end of the elevating conveyor may be placed in any one of the following positions of vertical adjustment: (1) at a relatively low level when spreading or casting the conveyed dirt directly onto the ground in windrow form, or along a bank, road surface, etc.; (2) at a higher level when the elevating conveyor is discharging the dirt into trucks or other vehicles travelling with the elevating conveyor, and; (3) at a relatively high or maximum height for reducing the transverse width of the trailer attachment to enable it to pass through narrow gates, narrow underpasses and other narrow spaces when travelling in transport. The mounting of the trailer attachment on the single caster wheel assembly 43 accommodates this wide range of vertical adjustment at the outer end of the elevating conveyor, and the single line of support between this single caster wheel assembly and the ground minimizes jolting and transverse rocking of the trailer attachment in passing over uneven ground.

The hydraulic cylinders 126, 169 and 187 of the three lifting or position controlling rams 125, 168 and 186 respectively, are of the double acting type having flexible conduits leading from opposite ends of each cylinder and adapted for connection through quick detachable couplings with a hydraulic pressure system on the motor grader 20, or other traction unit pulling the trailer attachment. The controls for controlling the supply of hydraulic fluid under pressure to either end of each cylinder are arranged for convenient operation by the operator in the cab 25 of the motor grader 20, or other traction vehicle.

Referring now to the mechanism for driving the belt 141 of the elevating conveyor, we have illustrated one embodiment thereof in Figures 1, 2 and 3 comprising a line of jointed shafting extending from a power take-off mechanism on the motor grader up to the driving roll 148 of the elevating conveyor. The power take-off mechanism 201 is mounted on the rear end of the grader frame 20 and includes a control lever 202 (Figures 1 and 2) for engaging and releasing a clutch in the take-off unit. A shaft 203 projecting laterally from the housing of the power take-off mechanism is connected through a universal joint 204 with a first shaft 205 having its upper end connecting through a universal joint 206 with a second shaft 207. This second shaft has its lower end journaled in a bearing bracket 208 projecting forwardly from the bed frame of the conveyor, and has its upper end connected through a universal joint 209 with a stub shaft 211 entering the bevel gear housing 212, the latter being fixedly mounted on the forward side of the bed frame at the outer end thereof. Bevelled gearing within this housing 212 transmits a drive from the stub shaft 211 to the shaft 149 of the driving roller 148. Included in one or both of the universal joints 204, 206, or in the length of the first shaft 205, may be a splined slip joint for accommodating any change of effective length of the shaft 205 as the elevating conveyor is adjusted from its lowermost casting position to its uppermost truck loading position or to its higher transport position.

In Figures 5 and 6 we have illustrated a modified form of driving mechanism for driving the belt conveyor, this driving mechanism being of the V-belt type. In this embodiment, the power take-off mechanism 201' has connection through a universal joint 215 with a rearwardly extending slip joint or telescopic shaft connection 216 comprising outer and inner splined shaft sections slidable relatively to each other, the inner splined section 218 being operatively connected through a universal joint 219 with a stub shaft 221 journaled in a bearing bracket 222. This bearing bracket 222 has its base bolted to the transverse front frame member 48 of the trailer unit, and has

its journal portion set rearwardly a sufficient distance to accommodate the universal joints 215, 219 and telescopic shaft 216 between the shafts 201' and 221. These joints and telescopic shaft connections accommodate the rising and falling movement of the trailer attachment relatively to the motor grader. Secured to the stub shaft 221 is a pair of side-by-side V-belt pulleys 223 over which are trained a pair of V-belts 224 extending outwardly to another pair of pulleys 225 mounted on a transverse shaft 226. The latter shaft 226 has a floating mounting to accommodate the lifting and lowering and tilting movements of the conveyor bedframe 135 relatively to the trailer frame 41. The horizontal position of this floating mounting is determined by a U-shaped clevis 227 having spaced bearings in which the shaft 226 is journaled. This clevis has a spacer adjustment from the axis of the stub shaft 221 through a bolt or link connection 228 having pivotal connection at its right hand end on or adjacent to the stub shaft 221, and having threaded adjustment 231 at its left hand end with the cross bar of the clevis 227, whereby the spacing of the shaft 226 from the stub shaft 221 can be adjusted for maintaining the belts 224 at the proper driving tension. The vertical support or position of floating shaft 226 is established by inner and outer parallel links 234 and 235 which have bearing engagement at their upper ends over the shaft 226 and which have fixed axis mounting at their lower ends on an idler shaft 238 supported in a bearing bracket or pedestal 239 bolted to the adjacent channel of the conveyor bedframe. As shown in Figure 5, the link 235 comprises upper and lower sections 235*a*, 235*b* which are connected together for extensible and contractible adjustment, such being provided for by forming slots 235*c* in one of the link sections and having bolts 235*d* pass through these slots for fixedly clamping the two link sections together in different adjustments of extensibility. This same construction also applies to the rear link 234. By adjusting the effective lengths of these inner and outer supporting and spacing links 234, 235 the proper tension can be maintained on a second pair of V-belts 241 which transmit the power take-off drive from the shaft 226 down to the fixed axis shaft 238. The latter belts 241 travel over pulleys or sheaves 242 mounted on the upper shaft 226, and pass around sheaves 243 mounted on the lower shaft 238. The lower shaft 238 also carries another pair of pulleys 245 over which are trained relatively long V-belts 246 extending outwardly to a pair of pulleys 247 on the input shaft 248 of a speed reducing mechanism 249 which is mounted at the outer end of the conveyor bedframe, adjacent to the driving drum 148. This speed reducing mechanism 249 is preferably of the enclosed gear type, and transmits its speed reduced output through an output shaft 257 which connects with the driving drum 148 at the outer end of the conveyor frame. The provision of the speed reducing unit 249 located at the driving drum 148 enables the V-belts 224, 241 and 246 to be operated under high speed, low torque conditions which are most conducive to efficient operation of this type of drive.

Our improved trailer type of elevating grader attachment can be coupled to a tractor or other prime mover, if desired, but for most road grading, ditching, or like earth moving operations it is preferably coupled to a motor grader, such as is indicated at 20 in Figure 1, having a universally adjustable scraper blade, such as is indicated at 29. This results in a compound earth moving vehicle having two cutting or scraping elements, viz., the blade 29 and the plow 44, which can be employed cooperatively in various two-stage earth moving operations—with the blade 29 performing the first stage of the operation and the plow 44 performing the second stage of the operation. This can best be explained by the following description of certain typical operations in road work and the like, taken in connection with the schematic diagrams of Figures 7 to 12 inclusive.

In starting an operation on new ground, it is preferable to perform the first cut or "striking out" operation by the scraper blade 29, with the left-hand end of the blade cutting a straight line trench, usually of shallow depth. This is illustrated in Figures 7, in which the initial cut is indicated at C1, the operation being comparable to staking out the "building lines," so as to insure a straight line start. Without a trailer type of elevating grader, another motor grader would be required to strike out the lines.

In the next pass of the machine along this "striking-out" cut C1, the left front wheel 22 of the motor grader rides in this cut C1, and thus guides the machine along the straight line of the cut, as shown in Figure 8. When working in hard ground, the motor grader blade 29 is preferably adjusted to make another or break-through cut C2 (Figure 8) to assist the disk plow 44 in getting started (Figure 8A). At this time, the blade 29 and plow 44 function cooperatively in a simultaneous two stage operation, the blade 29 making the second cut and the plow 44 cutting away the intervening ridge or leveling off the ground between the two-blade cuts C1 and C2 (Figure 8A).

As the cut is progressively increased and deepened, the dirt receiving end of the elevating conveyor 45 is progressively carried down to lower and lower points in the cut, until in many instances a condition is arrived at where the elevating conveyor has such a steep slope leading up to its discharge end that the dirt will not be conveyed up by the conveyor belt. Attempts to obviate this by lowering the outer end of the elevating conveyor very often result in the lower edge of the conveyor bed frame 135 striking the right hand shoulder of the cut. However, in our compound type of vehicle, the grader blade 29 is brought into operation, as shown in Figure 9, for cutting off this right hand edge or shoulder E, and flattening the slope at this side of the cut to permit the elevating conveyor to be operated at a lower angle of slope.

In Figure 10 we have illustrated another situation in which both the scraper blade 29 and conveyor plow 44 coact in a two-stage operation in the same pass or run of the machine. In this situation, the scraper blade 29 knocks off the earth humps H or levels the fill, and simultaneously therewith the plow 44 picks up the earth discharged from the grader blade 29 for loading into trucks at the outer end of the conveyor 45 or for casting upon the ground or into a windrow at the outer end of the conveyor.

Figure 11 illustrates a similar two-stage situation in which the grader blade 29 is performing the operation commonly known as making the "in-slope" (designated S). The dirt discharged from the scraper blade is simultaneously picked up by the plow 44 for truck loading or for casting from the outer end of the conveyor 45.

Figure 12 illustrates one of the last operations to be performed in building roads passing through cuts, etc.; such consisting of sloping the outer banks by setting the scraper blade 29 at a high angle or high lift at one side of the motor grader for shaping or sloping the adjacent bank B. The dirt removed from the bank B has to be brought out, either by being discharged up on the roadway or by being carried away. In the case of the conventional motor grader alone, this would require another trip for the grader, or a clean-up pass by a conventional elevating grader alone. However, with our combined implement, the plow 44 and elevator 45 pick up the dirt as a second stage function, so that the entire operation can be performed in one trip.

In the performance of these two-stage functions, the fact that the hitch 42 is laterally rigid is important because this prevents side-wise weaving or shifting of the trailer unit relatively to the motor grader, thus insuring that the plow 44 will continue to track in its predeter-

mined transverse position with regard to the setting of the scraper blade **29**.

In this same regard, the fact that the hitch connection is laterally rigid compels the trailer unit to take the same lateral slope as the motor grader in working along side-long slopes, which is advantageous for maintaining the plow **44** at the same working depth or same relative position of vertical adjustment when working along slopes as when working on level surfaces. The laterally rigid hitch also compels the trailer unit to take on the same transverse rocking movement that the grader unit goes through in passing over uneven ground. Because of the trailer unit having to assume the same side slope angle and the same transverse rocking movement of the motor grader, it is advantageous to locate the single point of caster wheel support of the trailer unit intermediate the tread lines of the motor grader wheels **23**. The location of caster wheel axes outwardly of the median line of the grader increases the severity of the twisting or torsional stresses that the laterally rigid hitch connection transmits to the trailer unit in passing over bumps or uneven ground particularly when grading along the side slope of a road, ditch or the like. These torsional stresses are minimized by having the single point of castor wheel support located between the tread lines *x*—*x* of the rear grader wheels **23**, preferably midway of these tread lines, as shown in Figure 4.

Numerous additional features and improvements may be embodied in the trailer unit to facilitate its use. One such feature of further improvement is the provision of support stands which support the trailer unit when it is disconnected from the motor grader for storage or repairs. For example, a front support stand is provided to extend downwardly from the front frame bar **48** of the trailer unit to engage the ground. Two additional support stands also extend downwardly from each conveyor bed frame channel near the outer end of the conveyor for holding the conveyor bed frame just above the ground. These support stands and the castor wheels **64** serve to support the trailer unit when disconnected from the motor grader. The support stands may be hinged to the trailer unit for swinging into and out of operative position, or may be mounted in sockets on the trailer unit.

Another improvement is the use of quick detachable hitch connections of the hinged clasp type instead of the hitch members **74**.

Another feature is the provision of a hydraulic control valve system on the trailer unit, according to which only two hydraulic lines would extend from the grader to the trailer unit, requiring connection and disconnection when the trailer is connected and disconnected. Three valves contained in a multiple valve body on the trailer unit control the flow through the six hose lines to the opposite ends of the three hydraulic rams **126**, **169** and **187**. These three valves are controlled by readily connectable push-pull links extending to controls in the operator's cab on the motor grader.

Another improvement is a so-called "camel-backing" type of hinge in the conveyor bed frame **135** just beyond the point where the bed frame contacts the longitudinal tubular frame bar **66**. This camel-back hinge comprises aligned hinge pins mounted in hinge fittings interposed in each side channel of the conveyor bed frame **135**, whereby this bed frame is divided into a relatively short inner section adapted to engage the tubular frame bar **66**, and a relatively long outer section which can be lowered to bring its outer end much below the frame bar **66**, or practically into contact with the ground. This outer section can also be swung up to a relatively steep angle, approaching the vertical, when it is desired to move the trailer unit through a gate or other narrow space.

While we have illustrated and described what we regard to be the preferred embodiments of our invention, nevertheless it will be understood that such are merely exemplary and that numerous modifications and rearrangements may be made therein without departing from the essence of the invention.

We claim:

1. In a trailer type of elevating grader attachment for connection to a motor grader provided with an adjustable scraper blade the combination of a trailer frame including a rearwardly extending main support beam, draft hitch means at the front of said trailer frame for establishing a vertically articulated, laterally rigid hitch connection with the rear portion of said motor grader which will permit rise and fall of the trailer frame relatively to said motor grader, but which will compel lateral swinging of the trailer frame with the motor grader substantially as a laterally rigid extension thereof, a caster wheel assembly supporting the rear portion of said trailer frame, a plow mounted at one side of said trailer frame main support beam and positioned to engage the earth in the path of the scraper blade, and a transverse elevating conveyor carried by said trailer frame under said main support beam adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, said caster wheel assembly defining a single point of wheel support for the trailer unit located on a line intermediate the tread lines of the motor grader wheels.

2. In a trailer type of elevating grader attachment adapted for connection to a motor grader having a universally adjustable earth moving scraper blade disposed between the front and rear wheels of the motor grader, the combination of a trailer frame, draft hitch means at the front of said trailer frame for establishing a vertically articulated, laterally rigid hitch connection with the rear portion of said motor grader which will permit rise and fall of the trailer frame relatively to the motor grader, but which will compel lateral swinging of the trailer frame with the motor grader substantially as a laterally rigid extension thereof, a single caster wheel assembly supporting the rear portion of said trailer frame, a plow mounted at one side of said trailer frame and positioned in the earth moving path of the scraper blade, an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, means for driving said elevating conveyor, means for adjusting said plow relatively to said trailer frame, and means for adjusting said elevating conveyor relatively to said trailer frame, said caster wheel assembly defining a single point of caster wheel support for said plow and for said elevating conveyor, which single point of caster wheel support is disposed in a fore and aft plane lying substantially medially of the tread lines of the motor grader wheels whereby the dual functioning of the scraper blade and of said trailer plow in the same earth moving operation will not be materially disturbed because of the laterally rigid hitch connection compelling the plow and elevating conveyor to rock transversely with the motor grader.

3. In combination, a motor grader comprising a grader frame supported on front and rear sets of wheels, a scraper blade carried by said grader frame between said front and rear sets of wheels, means on said grader frame for adjusting said scraper blade vertically and horizontally, and a power take-off on said motor grader, a trailer type of elevating grader attachment adapted for coupling to the rear of said grader frame and including a trailer frame, draft hitch means establishing a vertically articulated, laterally rigid hitch connection between said grader frame and said trailer frame which will permit rise and fall of the trailer frame relatively to the grader frame but which will compel lateral swinging of the trailer frame with the rear end of the grader frame substantially as a laterally rigid extension thereof, a single caster wheel assembly supporting the rear portion of said trailer frame, a plow mounted at one side of said trailer frame,

an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, means for driving said elevating conveyor from said power take-off on the motor grader, means on said trailer frame for adjusting said plow relatively to said trailer frame, and means on said trailer frame for adjusting said elevating conveyor relatively to said trailer frame, said caster wheel assembly defining the sole point of wheeled support for said trailer frame, which sole point of wheeled support is disposed in a fore and aft plane lying substantially medially of the tread lines of the motor grader wheels whereby the dual functioning of the scraper blade and of said trailer plow in the same earth moving operation will not be materially disturbed because of the laterally rigid hitch connection compelling the plow and elevating conveyor to rock transversely with the motor grader.

4. In a trailer type of elevating grader attachment adapted for connection to a motor grader having a universally adjustable scraper blade disposed between the front and rear wheels of the motor grader, the combination of a trailer frame, draft hitch means at the front of said trailer frame for establishing a vertically articulated, laterally rigid hitch connection with the rear portion of said motor grader which will permit rise and fall of the trailer frame relatively to the motor grader, but which will compel lateral swinging of the trailer frame with the motor grader substantially as a laterally rigid extension thereof, a plow mounted at one side of said trailer frame, an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, means for adjusting said elevating conveyor relatively to said trailer frame, and a single caster wheel assembly supporting the rear portion of the trailer frame and serving to define a single point of wheel support for the plow and elevating conveyor, such single point of wheel support being disposed in a fore-and-aft plane lying substantially medially of the tread lines of the motor grader wheels, whereby the laterally rigid hitch connection, compelling the plow and elevating conveyor to rock transversely with the motor grader, is substantially prevented from disturbing the dual functioning of the scraper blade and the trailer plow in the same earth-moving operation.

5. In a trailer type of elevating grader attachment adapted for connection to a motor grader having an adjustable scraper blade disposed between the front and rear wheels of the grader and having a transversely extending cylindrical draw bar at its rear end, the combination of a trailer frame comprising a transversely extending front frame channel with the web of said channel facing forwardly, two laterally spaced draw bar ears secured to the web of said channel and adapted to have free rotative movement in a vertical plane on the ends of said cylindrical draw bar whereby to establish a vertically articulated, laterally rigid hitch connection with the rear portion of said motor grader which will permit rise and fall of the trailer frame relatively to the motor grader but which will compel lateral swinging of the trailer frame with the motor grader substantially as a laterally rigid extension thereof, a main generally longitudinal frame member of box-like section welded to the top of said front frame channel near one end thereof and curving upwardly and rearwardly from said channel, said main longitudinal frame member having a rear portion which is deflected laterally toward the center of the trailer frame, a second longitudinal frame member having its front end welded to said front frame channel and extending rearwardly therefrom, and a transversely extending rear frame bar welded at one end to the rear end of said second longitudinal frame member and having its other end extending diagonally upwardly and laterally and being welded to the laterally deflected portion of said main longitudinal frame member, a single caster wheel assembly mounted at the rear end of the laterally deflected portion of said main longitudinal frame member, a plow mounted at one side of said trailer frame, and an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, said caster wheel assembly defining the sole point of wheel support for said trailer frame, which sole point of wheel support is disposed in a fore-and-aft plane lying substantially medially of the tread lines of the motor grader wheels, whereby the dual functioning of the scraper blade and of said trailer plow in the same earth moving operation will not be materially disturbed because of the laterally rigid hitch connection compelling the plow and elevating conveyor to rock transversely with the motor grader.

6. In a trailer type of elevating grader attachment, the combination of a trailer frame, draft hitch means at the front of said trailer frame for establishing a vertically articulated, laterally rigid hitch connection with the rear portion of a towing vehicle which will permit rise and fall of the trailer frame relatively to the towing vehicle, but which will compel lateral swinging of the trailer frame with the towing vehicle substantially as a rigid extension thereof, a caster wheel assembly supporting the rear portion of said trailer frame, a plow mounted at one side of said trailer frame, an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, and mechanism for adjustably mounting said plow comprising a plow beam, a ball and socket joint establishing a universally pivoting draft connection between the front end of said plow beam and said trailer frame, a plow mounting bracket having an upwardly extending standard, means for adjustably securing said standard to said plow beam, upper and lower transverse bars pivotally connected between said trailer frame and the rear portion of the said plow beam, said transverse bars being connected with said plow beam at vertically spaced points, adjusting holes in one of said transverse bars enabling the plow beam and plow to be tilted transversely to different angles relatively to the lower end of said elevating conveyor, a bracing link having its front end pivotally connected with said plow mounting bracket and having its rear end pivotally connected with the rear portion of said plow beam, and plow lifting and lowering mechanism comprising a two-way hydraulic ram connected between said trailer frame and said plow beam operable to raise the plow out of contact with the ground and also being operable to exert a hydraulically energized downward pressure against the plow for forcing it into the ground.

7. In a two-stage grading combination with a motor grader of the type having a grader frame supported on front and rear sets of wheels, a scraper blade carried by said grader frame between said front and rear sets of wheels, means on said grader frame for adjusting said scraper blade vertically and horizontally, a trailer type of elevating grader attachment adapted for coupling to the rear of said grader frame and including a trailer frame, draft hitch means establishing a vertically articulated, laterally rigid hitch connection between said grader frame and said trailer frame which will permit rise and fall of the trailer frame relatively to the grader frame but which will compel lateral swinging of the trailer frame with the rear end of the grader frame substantially as a laterally rigid extension thereof, a single caster wheel assembly supporting the rear portion of said trailer frame, said caster wheel assembly engaging the ground intermediate the tread lines of the motor grader wheels as the sole ground support of the trailer frame, a plow mounted at one side of said trailer frame, means for adjusting the plow position relative to the adjustable

scraper blade position to provide a predetermined working relationship therewith, and an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, said laterally rigid hitch connection compelling said plow to maintain said predetermined working relationship to said scraper blade.

8. A two-stage grader combination comprising a motor vehicle having a main frame supported by front and rear sets of wheels, a scraper blade carried by the frame between the front and rear wheel sets for defining a selected earth-moving path, a trailer frame pivotally connected at laterally spaced points to the main frame for establishing a vertically hinged, laterally rigid hitch thereto, said trailer frame having a rearwardly extending main support beam terminating in a fore-and-aft plane lying substantially medially of the tread lines of said wheels, a caster wheel assembly carried at the trailing end of said support beam defining the sole wheeled support for the trailer frame, a plow beam pivoted to the trailer frame and extending to one side of said main support beam, a plow carried by said beam in a fore-and-aft plane lying in the earth moving path of the scraper blade, and a transverse elevating conveyor supported from the conveyor frame having its lower end passing under said main beam and positioned adjacent the plow for removing earth moved by said blade and plow, said laterally rigid hitch compelling said plow and said lower end of said conveyor to follow in predetermined working relationship to said scraper blade.

9. In a trailer type of elevating grader attachment adapted for connection to a motor grader having an adjustable scraper blade disposed between the front and rear wheels of the grader, the combination of a trailer frame comprising a transversely extending front frame beam, means pivotally connecting the front frame beam at transversely spaced points to the rear of the grader to establish a vertically articulated, laterally rigid hitch, a

main generally longitudinal frame beam welded to the top of said front frame channel near one end thereof and curving upwardly and rearwardly from said channel, said main longitudinal frame member having a rear portion which is deflected laterally toward the center of the trailer frame, a single caster wheel assembly mounted at the rear end of the laterally deflected portion of said main longitudinal frame beam, a plow mounted at one side of said trailer frame, and an elevating conveyor carried by said trailer frame adapted to receive dirt from said plow at one side of the trailer frame for discharge at the opposite side of the trailer frame, said caster wheel assembly defining the sole wheel support for said trailer frame, which sole wheel support is disposed in a fore-and-aft plane lying substantially medially of the tread lines of the motor grader wheels, whereby the dual functioning of the scraper blade and of said trailer plow in the same earth moving operation will not be materially disturbed because of the laterally rigid hitch connection compelling the plow and elevating conveyor to rock transversely with the motor grader.

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