United States Patent [19]

Hatcher et al.

[11] **3,724,900**

[45] **Apr. 3, 1973**

[54] **CONCRETE PAVEMENT CUTTING MACHINE**

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[73] Assignee: **Pavement Grooving Ideas, Ltd.**, Pasadena, Calif.

[22] Filed: **Dec. 17, 1971**

[21] Appl. No.: **209,118**

[52] **U.S. Cl.**.....**299/39**, 51/176

[51] **Int. Cl.**.....**E01c 23/09**

[58] **Field of Search**.....299/39–41; 51/176

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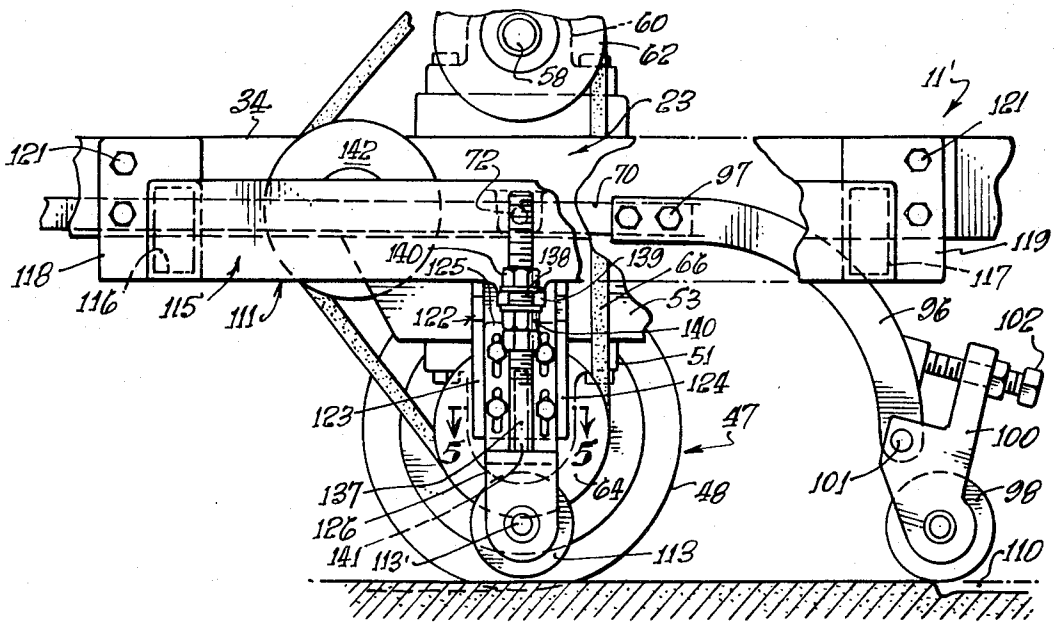
Primary Examiner—Ernest R. Purser

Attorney—William E. Beatty

[57] **ABSTRACT**

Pavement cutting machine with a carriage frame having a cutter for cutting grooves in a pavement. The carriage frame has front wheels in front of the cutter and rear wheels at the rear of the cutter, an auxiliary wheel being provided with a support which retains the bottom of its periphery above and out of contact with the pavement in the absence of an abrupt drop in the level of the pavement. The auxiliary wheel contacts the pavement to limit the depth of cut of the cutter when the wheel in front of the cutter encounters an abrupt drop in the level of the pavement.

7 Claims, 17 Drawing Figures



PATENTED APR 3 1973

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SHEET 1 OF 7

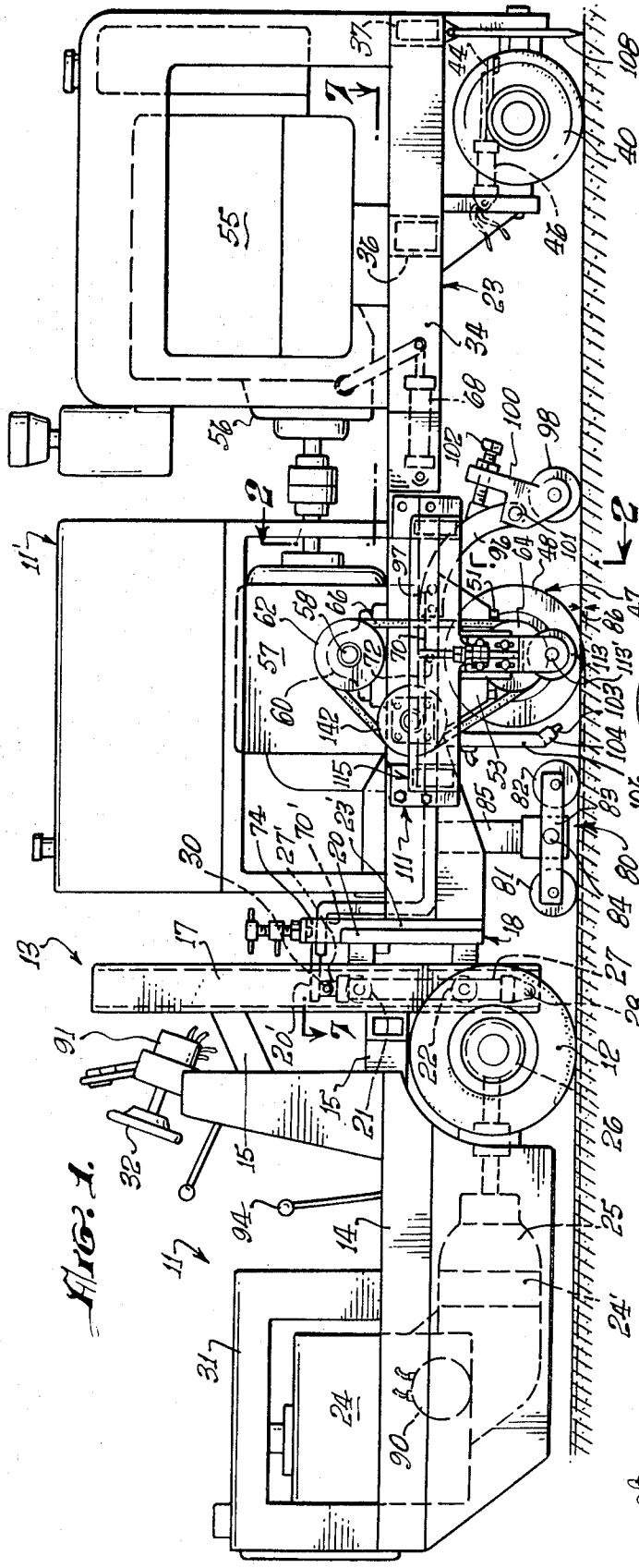


Fig. 1.

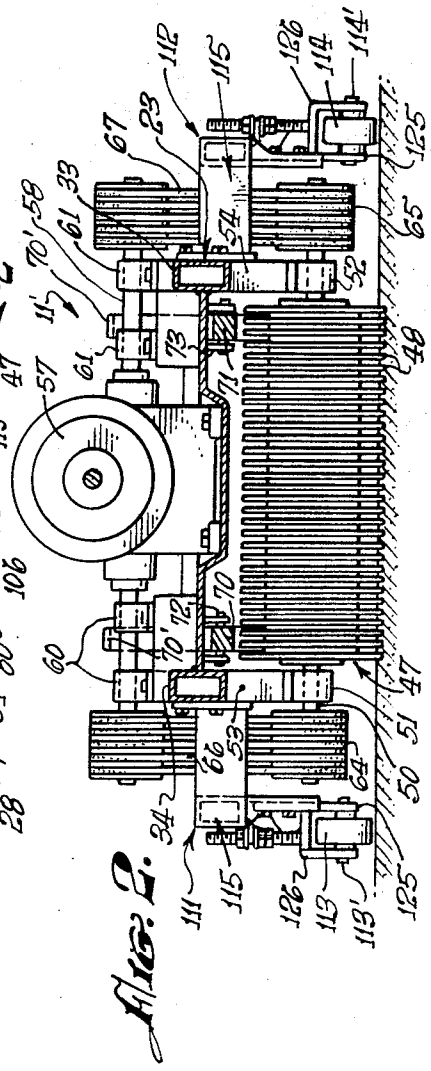


Fig. 2.

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FIG. 3.

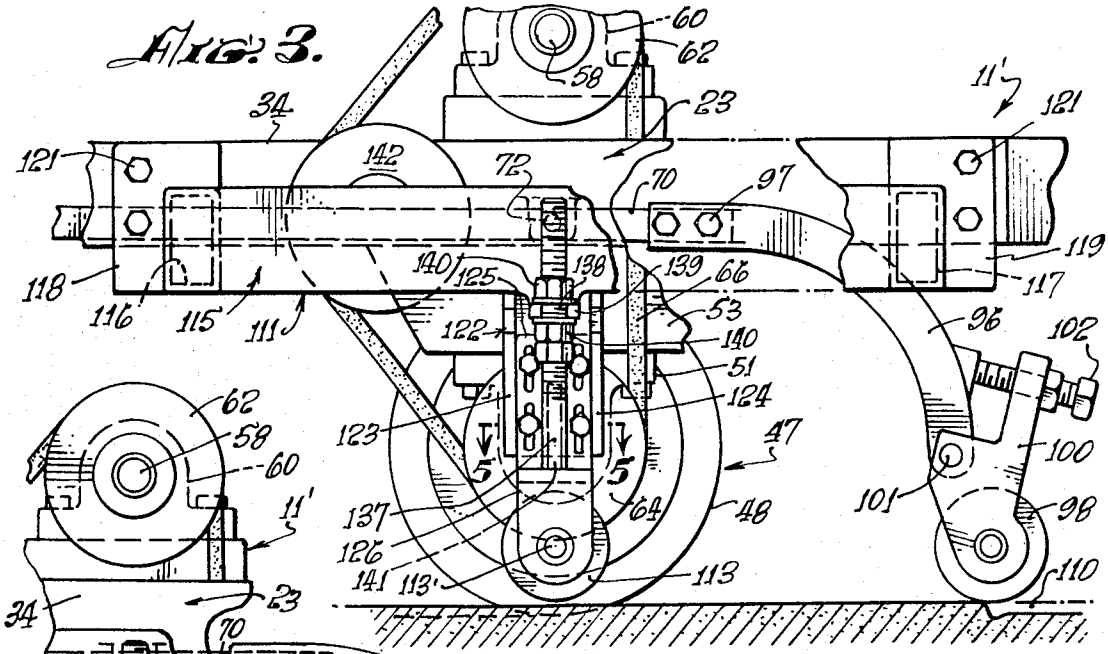


FIG. 4.

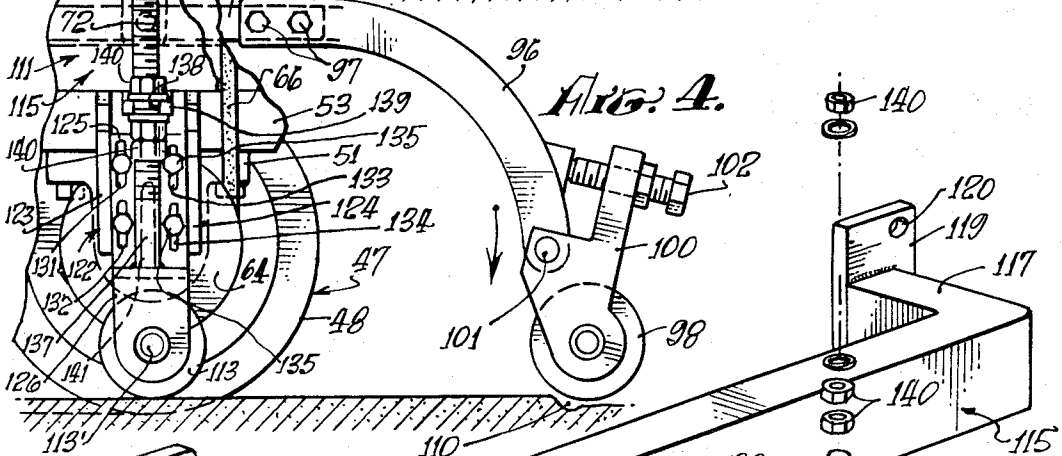


FIG. 5.

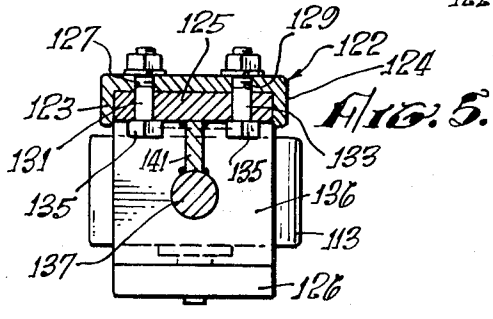
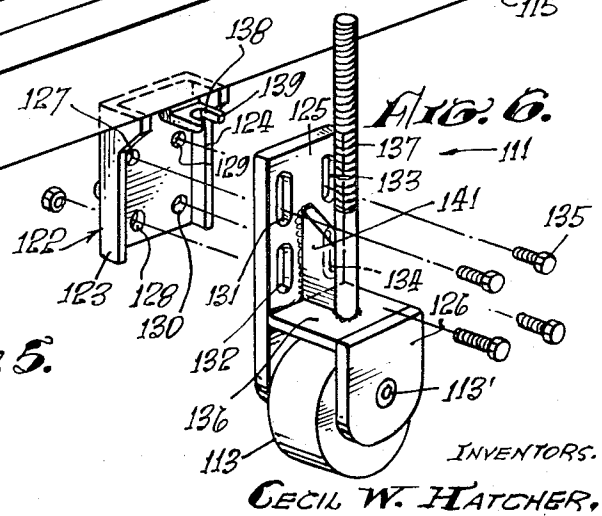


FIG. 6.



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Fig. 7.

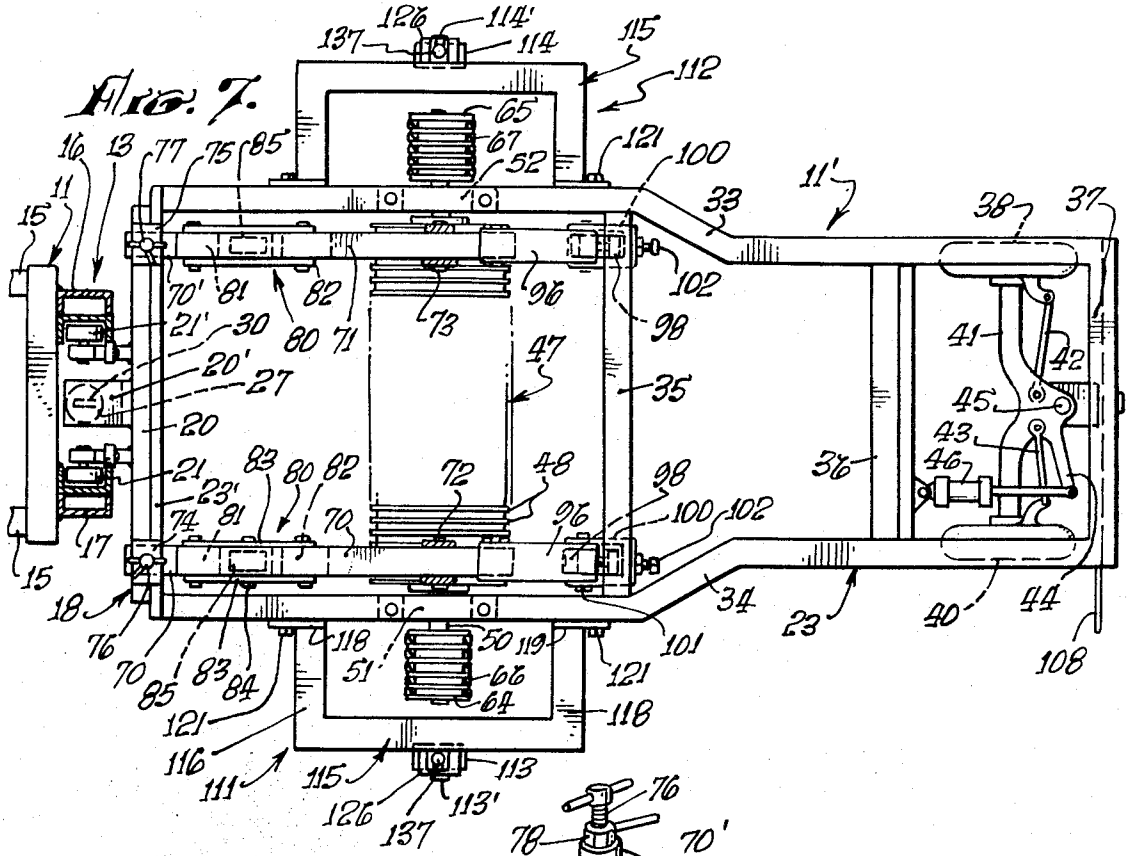


Fig. 8.

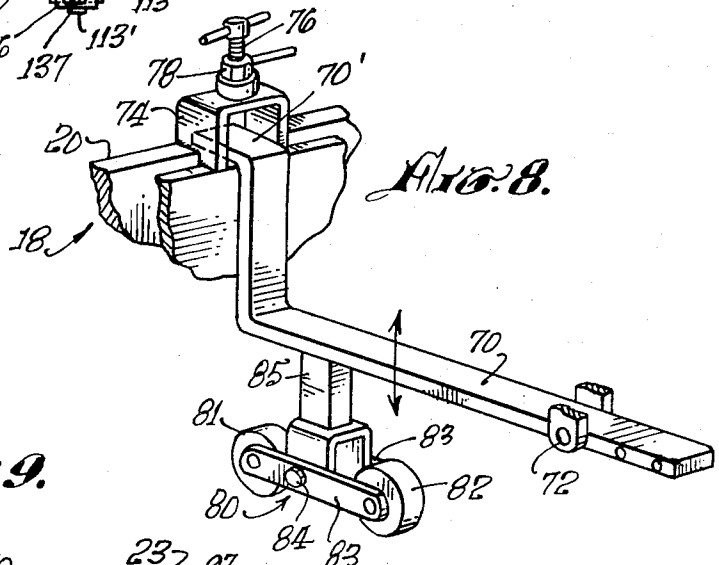
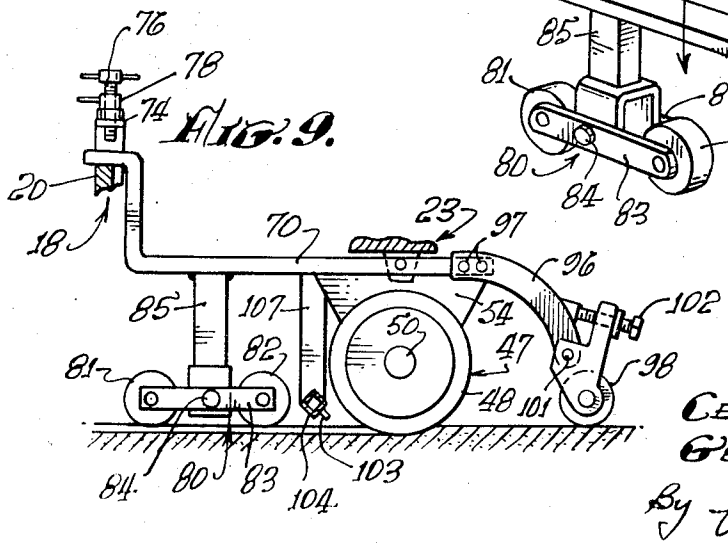


Fig. 9.



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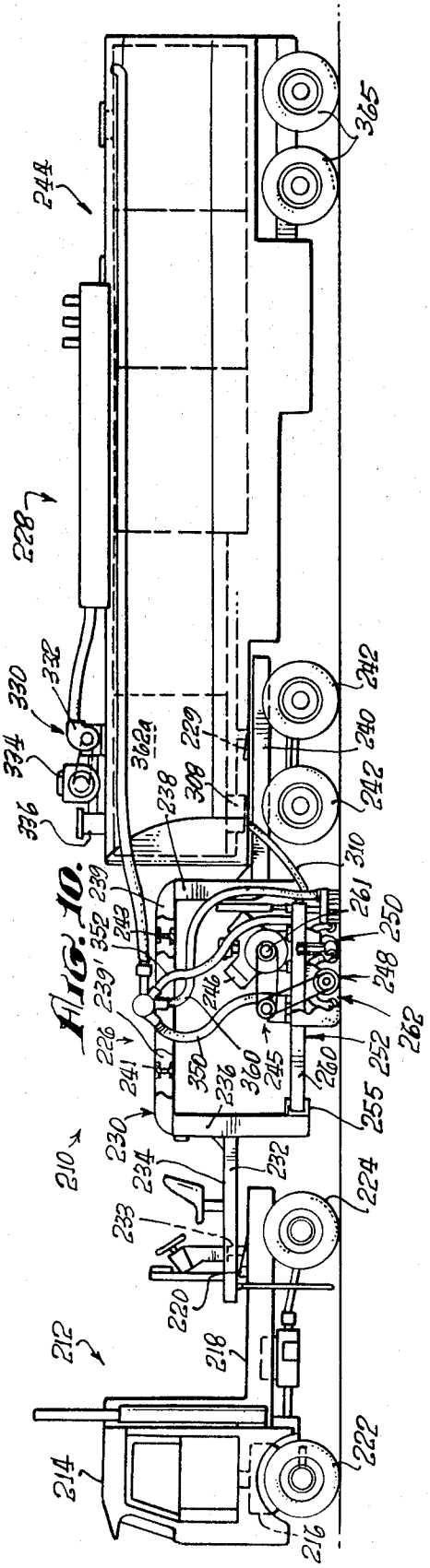


Fig. 10.

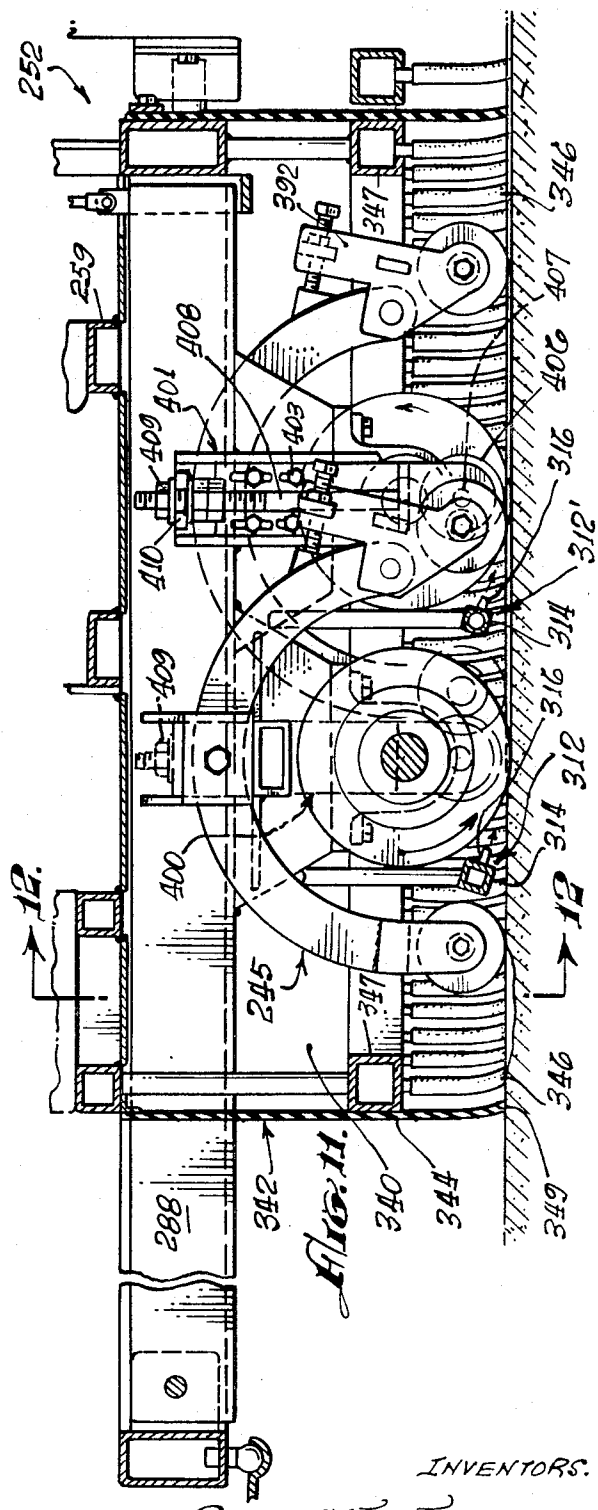


Fig. 11.

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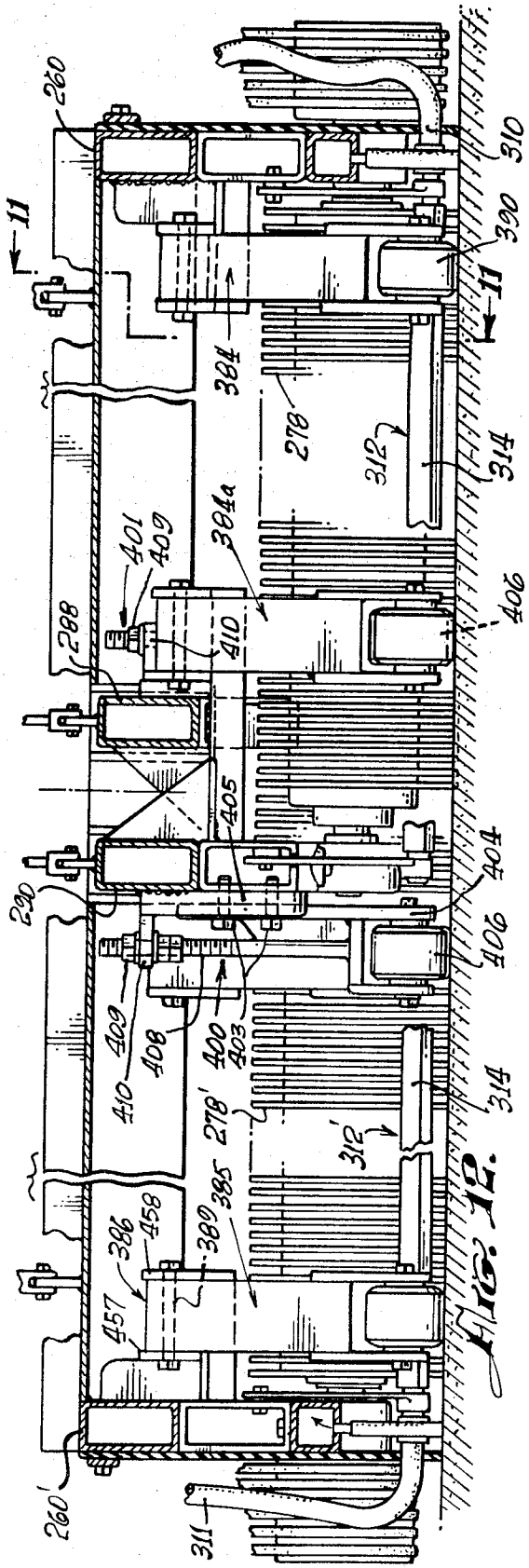


Fig. 12.

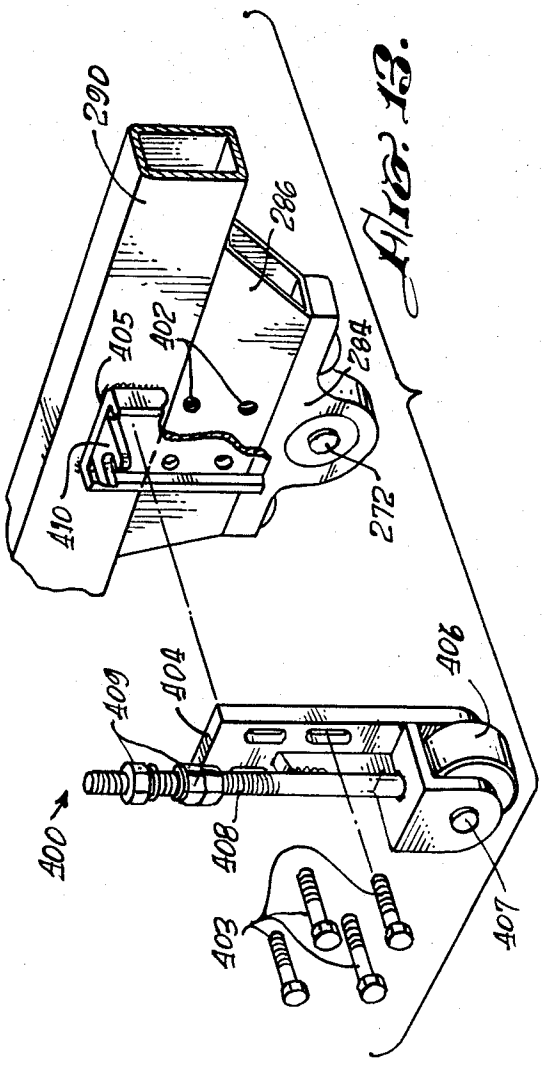


Fig. 13.

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FIG. 14.

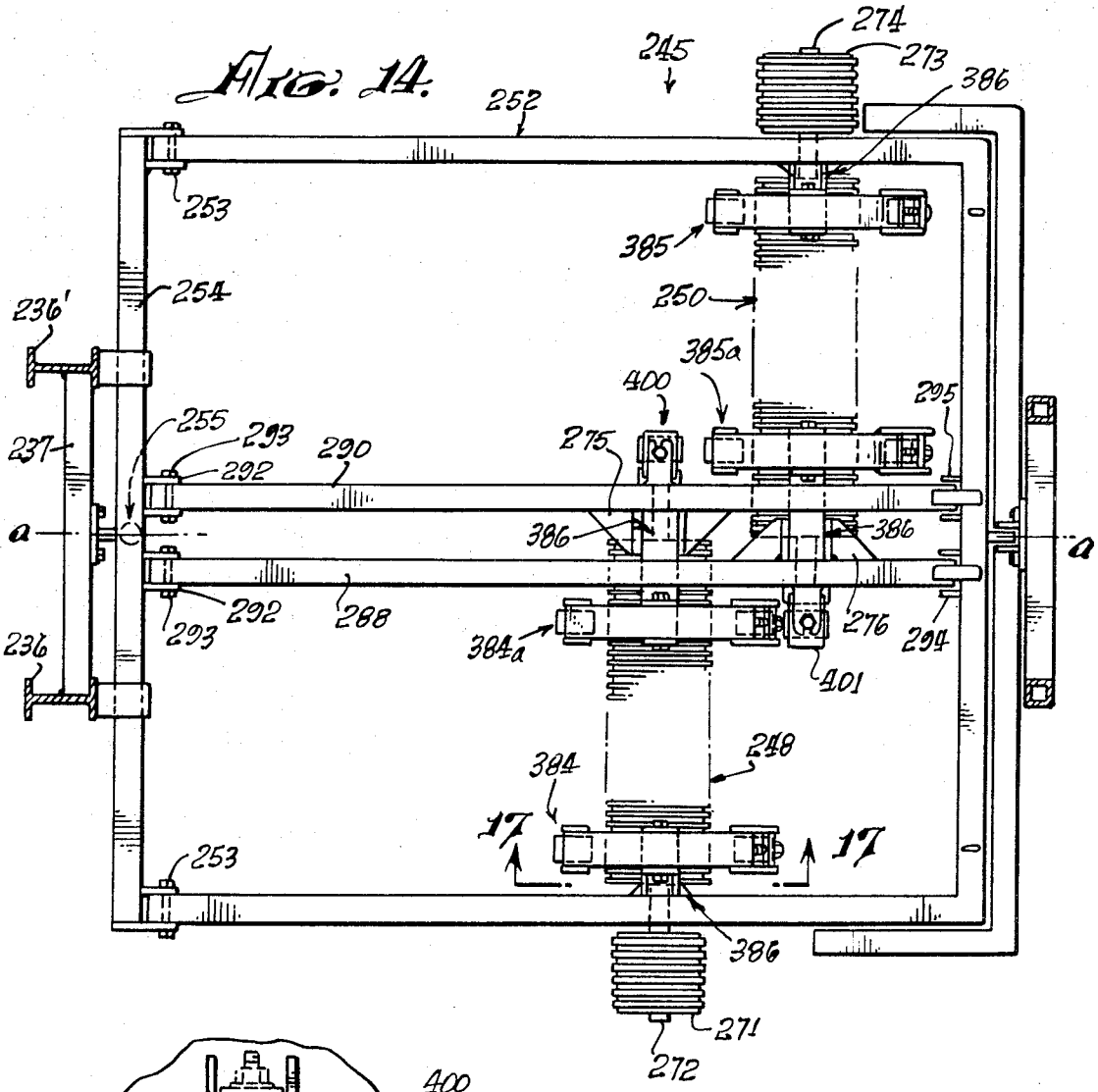
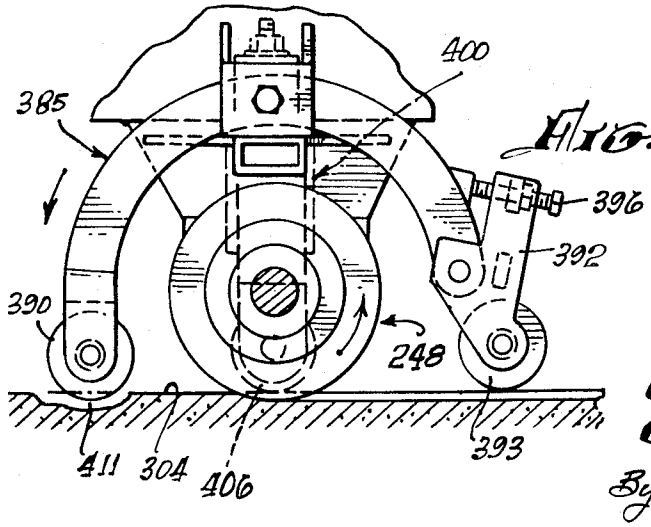


FIG. 15.



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FIG. 16.

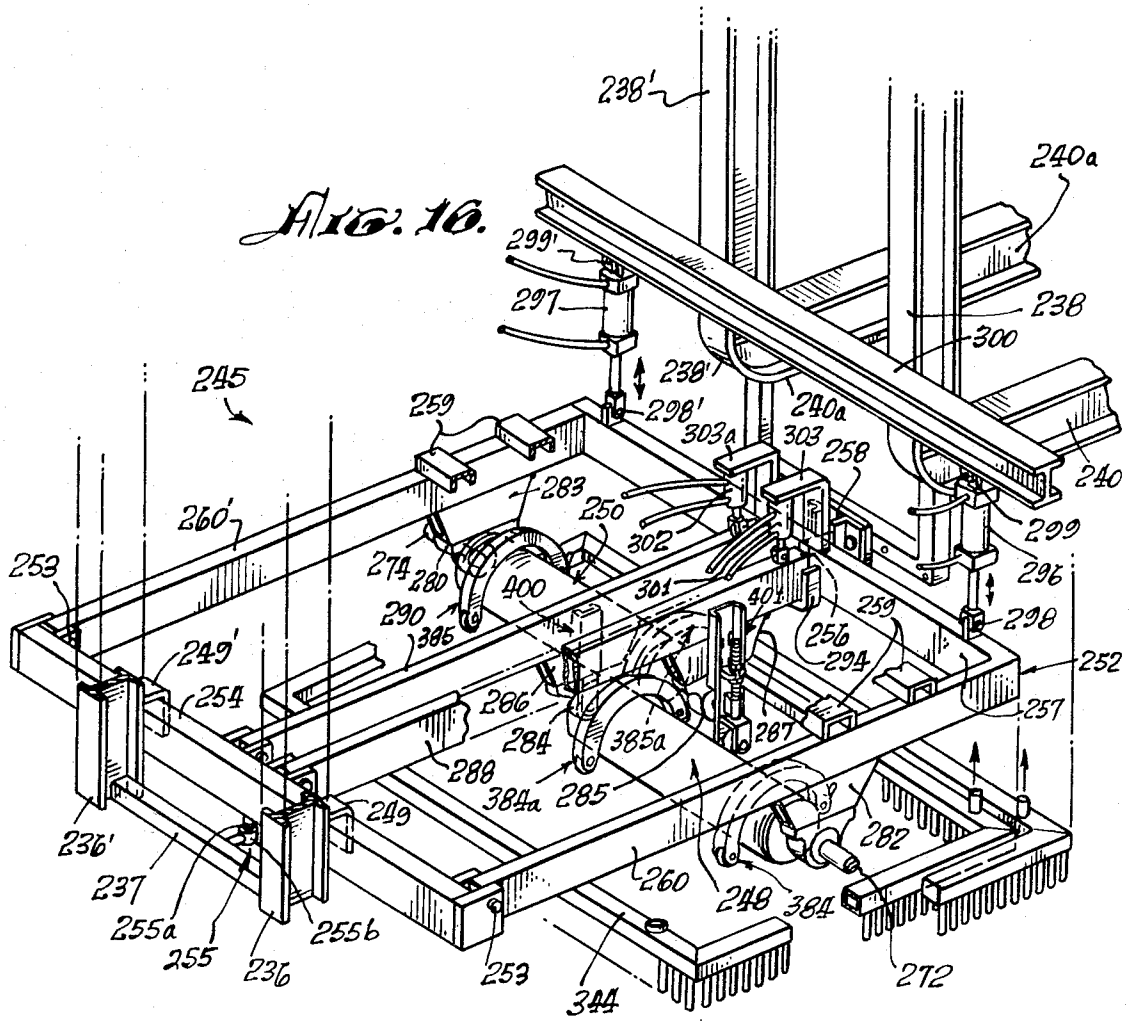
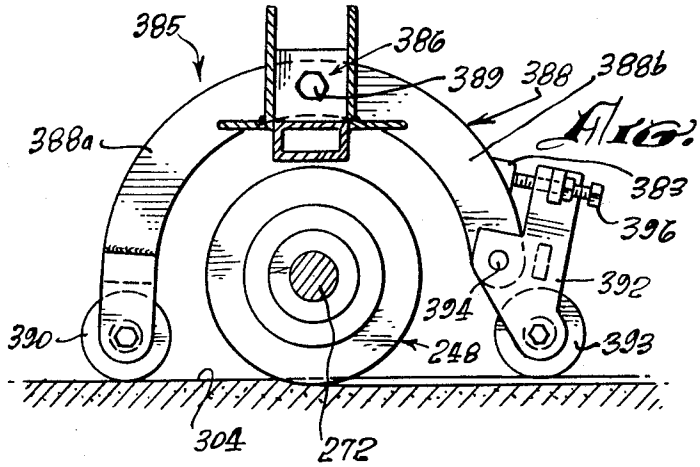


FIG. 17.



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CONCRETE PAVEMENT CUTTING MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

PAVEMENT CUTTING MACHINE, Ser. No. 119,476, filed Mar. 1, 1971 by Cecil W. Hatcher et al. and now U.S. Pat. No. 3,703,316; and CONCRETE PAVEMENT CUTTING MACHINE, Ser. No. 118,909, filed Feb. 25, 1971 by Cecil W. Hatcher et al. and now U.S. Pat. No. 3,697,135.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to concrete pavement cutting machines and has particular reference to machines having axially spaced, rotatable, abrasive disks engageable with the pavement to cut anti-skid grooves therein.

2. Description of the Prior Art

Concrete cutting machines have been employed heretofore to cut closely spaced grooves in the pavement to reduce skidding tendencies of vehicles traveling thereon. Certain types of such machines have a carriage wheel in front of the cutter. If the pavement has an abrupt drop as sometimes occurs at a joint in the pavement, the cutter drops correspondingly to cut deeper grooves than required. This produces undesirable wear on the cutter blades and also produces grooves which are too deep to meet the required specification.

SUMMARY OF THE INVENTION

A principal object of the present invention is to limit the depth of cut of the cutter when a wheel in front of the cutter encounters an abrupt drop in the level of the pavement.

The invention provides an auxiliary wheel rotatable on an axis below and substantially parallel to the axis of the cutter shaft, with means supporting the auxiliary wheel with the bottom of its periphery above and out of contact with the pavement in the absence of an abrupt drop in the level of the pavement. The machine includes a front wheel means in front of the cutter, the auxiliary wheel limiting the depth of cut of the cutter when the front wheel means encounters an abrupt drop in the level of the pavement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of the machine described and claimed in U. S. Ser. No. 118,909 provided with the auxiliary wheel of the present invention.

FIG. **2** is a sectional view on line **2—2** of FIG. **1**, looking in the direction of the arrows.

FIG. **3** is an enlarged side elevational view, with parts broken away, of the frame, bracket and adjustable auxiliary wheel as seen on one side of the machine, a similar bracket and auxiliary wheel, not appearing in this figure, being provided on the other side of the machine. This view shows the auxiliary wheel in elevated position.

FIG. **4** is a side elevational view, with parts broken away, of the parts shown in FIG. **3**, with the front wheel encountering a drop in the pavement and with the auxiliary wheel in contact with the pavement.

FIG. **5** is a sectional view on line **5—5** of FIG. **3**, looking in the direction of the arrows.

FIG. **6** is an exploded perspective view of the auxiliary wheel and its bracket support.

FIG. **7** is a sectional plan view taken substantially along line **7—7** of FIG. **1**.

FIG. **8** is a fragmentary perspective view of one of the cutting depth control arms.

FIG. **9** is a fragmentary sectional side view showing one of the control arms in depth-limiting position, with an adjustable wheel in front of the cutter as used in cutting anti-skid grooves.

FIG. **10** is a side elevational view of the machine shown in U. S. Ser. No. 119,476 provided with the auxiliary wheel of the present invention.

FIG. **11** is a sectional view on line **11—11** of FIG. **12**, looking in the direction of the arrows and showing the auxiliary wheels above the level of the pavement, these wheels appearing only at the inner end of each cutter.

FIG. **12** is a sectional view on line **12—12** of FIG. **11**, looking in the direction of the arrows.

FIG. **13** is an enlarged, exploded perspective view of the auxiliary wheel assembly, with parts broken away.

FIG. **14** is a plan view of the assembly of FIG. **16**.

FIG. **15** is a vertical sectional view showing a portion of FIG. **11** and illustrating the auxiliary wheel in contact with the pavement.

FIG. **16** is a partial perspective view of the grooving trailer assembly with the auxiliary wheels at the inner end of each cutter.

FIG. **17** is a vertical sectional view on line **17—17** of FIG. **14**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Machine of FIGS. **1** through **9**

Referring to the drawings, the machine comprises, in general, a truck **11** coupled to a cutter vehicle **11'**. The truck **11** is supported by a single set of coaxial drive wheels, one of which is shown at **12**. An upright mast assembly **13** is attached to the truck frame **14** by brackets **15** and comprises inwardly facing U-channel members **16** and **17**, FIG. **7**, along which a carriage **18** is movable. The carriage comprises a vertical plate **20** carrying two vertically spaced rollers **21** and **22** which move along the channel member **17**, and two similar rollers which move along the channel member **16**, upper roller **21'** appearing in FIG. **7**. The plate **20** is welded or otherwise attached to the rear cross member **23'** of a cutter supporting frame **23**. When the vehicle **11'** is being pushed by truck **11**, side sway of vehicle **11'** is prevented as the slide couplings including channel members **16** and **17** are laterally spaced apart on opposite sides of the longitudinal axis of the truck **11** and vehicle **11'**.

An engine **24** is carried by the truck **11** and is connected to the drive wheels **12** through a drive train comprising a fluid coupling **24'**, a multi-speed transmission **25**, and a differential **26**.

As shown in FIG. **1**, a hydraulic cylinder **27** is secured at **28** to the lower end of the mast assembly **13**, and its piston rod **27'** is connected at **30** to a bracket **20'** fixed to the carriage plate **20**, whereby extension of the piston will raise the rear end of the frame **23** which tilts about the horizontal axis of the front wheels **38, 40**.

The aforementioned truck **11** preferably comprises a conventional forklift truck from which a second set of

wheels and the usual fork attached to the carriage have been removed. A seat 31 is provided for the operator, and various controls, including a steering wheel 32, are mounted on an upright part of the truck frame within easy reach of the operator.

The frame 23 comprises spaced side frame members 33 and 34, FIG. 7, and integral cross members 23', 35, 36 and 37. The frame 23 is supported at its forward end by spaced, steerable wheels 38 and 40, which support an axle 41 suitably attached to the frame 23. A power-operated steering linkage is provided, comprising cross links 42 and 43 connected between the bearing supports of the wheels and a crank 44 pivoted at 45 and operable by the piston of a hydraulic cylinder 46 mounted on the cross member 36.

A rotatable concrete cutter, generally indicated at 47, is provided, comprising a plurality of abrasive cutting disks 48 secured on a cutter shaft 50. The latter is rotatably mounted in bearings 51 and 52 suitably secured to pillow blocks 53 and 54 integral with the side frame members 34 and 33, respectively.

An engine 55 is mounted on the forward part of the frame 23 and drives the cutter through a drive train including a clutch 56 and a differential unit 57, output shaft 58 of which is journaled in bearings 60 and 61 supported by the frame 23. Pulleys 62 and 63 are secured to the outer ends of the shaft 58 and drive pulleys 64 and 65 secured to the cutter shaft 50 through sets of drive belts 66 and 67, respectively. In order to adjust the tension in belt 66 and take up the slack, a longitudinally adjustable idler pulley 142 is carried by the frame 23.

The cutter 47 is selectively driven by engaging the clutch 56; and for this purpose, the clutch is controlled by a hydraulic clutch engaging cylinder 68 under control of the truck operator.

Means exclusive of the lift cylinder 27 are provided to accurately limit the depth of cut and to provide an accurate adjustment which may be preset according to the depth of cut desired. For this purpose, a pair of arms 70 and 71, FIGS. 1, 7, 8 and 9, are pivoted on a horizontal axis at 72 and 73, respectively, on the side frame members 33 and 34, vertically above the axis of shaft 50.

The arms 70 and 71 are guided at their upper horizontal end portions like 70' in inverted U-shaped members 74 and 75 welded to the carriage plate 20 and to cross member 23'. Adjustable limit screws 76 and 77 are threaded in the members 74 and 75 to engage end portions like 70' and limit the vertical movement of the arms. Lock nuts, like nut 78, are provided to lock the screws 76 and 77 in different adjusted positions. When the frame 23 is raised to its transporting position with cutter 47 and wheels 81, 82 in elevated position, arms 70 and 71 engage the top of the plate 20 and are thus raised, with their wheeled supports, like 80, with the frame. A wheeled support, like support 80, is mounted on each of the arms 70 and 71, and each comprises a pair of wheels 81 and 82 rotatably mounted at opposite ends of a wheel truck 83 pivotally attached at its center at 84 to a column 85 integral with and depending from the respective arm.

By adjusting limit screws 76 and 77 relative to each other, the frame 23, and hence the cutter 47, may be tilted slightly or not in a transverse direction relative to the level of the pavement.

From the above, it will be seen that, when the rear end of the frame 23 is lowered by the hydraulic cylinder 27, the cutting disks 48 will engage the surface of the pavement. At substantially this time, the wheels 81 and 82 also engage the pavement, rocking the arms 70 and 71 upward on pivots 72, 73 until arrested by the limit screws 76 and 77. The screws 76 and 77 are preferably preadjusted so that the cutting disks 48 will cut to a predetermined depth, as indicated at 86, FIG. 1. Therefore, a fine and accurate control of the lift cylinder 27 is not required.

When hydraulic pressure is applied below the piston of the cylinder 27, to extend piston rod 27', the carriage 18 will be driven up along the mast assembly. The truck frame 14 will remain parallel to the frame 23, due to the upright sliding connection between them provided by the mast assembly 13.

Hydraulic power for enabling remote control of the steering cylinder 46, clutch control cylinder 68 and lift cylinder 27 is derived from a hydraulic pump 90 driven by the truck motor 24. For this purpose, the steering wheel at 32 controls a valve 91 connected in a fluid circuit between the pump 90 and the opposite ends of the steering cylinder 46, as well known. A lift cylinder control valve, not shown, within reach of the operator, is connected in circuit between the pump 90 and opposite ends of the lift cylinder 27. Likewise, a clutch control valve, not shown, also within reach of the operator, is connected in circuit between the pump 90 and opposite ends of the clutch control cylinder 68.

The truck transmission 25 is controlled by a gear shift lever 94, FIG. 1, whereby the machine may be selectively driven at a slow rate of speed, as when cutting, or a fast rate when transporting from one place to another.

To cut anti-skid grooves in a pavement, the cutter 47 has abrasive disks spaced apart, i.e., with a spacing on the order of .375 inch between adjacent disks. In this case, see FIG. 9, a downwardly curved bracket, like bracket 96, is secured to each of the arms 70 and 71 by bolts like 97. A wheeled support comprising a wheel 98 is rotatably mounted on an arm 100 pivoted at 101 to each bracket 96, and extends directly in front of the cutter 47. An adjustment screw 102 is threaded through the arm 100 and engages the bracket 96 to swing the arm 100 relative to its bracket whereby to provide a height adjustment for the rear of the associated arm 70 or 71 independently of the stop screws 76 and 77, which, in this case, are preferably backed off.

FIG. 9 shows the screw 102 at one extreme of its adjustment wherein the extension 70' of arm 70 rests on the top of the carriage plate 20.

As the cutter frame 23 is lowered, the wheel 81, 82 and 98 engage the pavement of opposite sides of the cutter, and by adjusting the screw 102, the depth of cut of the groove-cutting disks can be accurately adjusted without requiring close attention by the operator.

The abrasive disks are cooled by a spray of water forced through orifices of 103 spaced along a pipe 104 supported from the side frame members 33 and 34 by brackets 106 and 107. An indicator rod 108 is suspended from the front end of the frame 23 to aid the operator in steering the machine along a line or previous cut or grooved section of the pavement.

Auxiliary Wheels of Machine of FIGS. 1 through 9

Auxiliary wheels are provided to limit the depth of cut if the wheels like **98** which are in front of the cutter **47** advance to a position where the pavement drops as indicated at **110** in FIGS. **3** and **4**. An auxiliary wheel assembly is provided at each end of the cutter **47** as indicated at **111** and **112** in FIG. **2**, the assembly **111** appearing in FIG. **1**. Assembly **111** has a wheel **113** rotatable on axle **113'**, and assembly **112** has a wheel **114** rotatable on axle **114'**. Both of these wheels are in elevated position with a clearance such as one thirty-second to one-sixteenth inch above the pavement under normal conditions, in the absence of a drop-off in the pavement. Assembly **111** is mounted on and carried by the side frame member **34**, and the assembly **112** is mounted on and carried by the side frame member **33**, these members forming sides of the frame **23**. As both of the assemblies **111** and **112** are the same, only one of them will be described.

The assembly **111** is shown in perspective exploded view in FIG. **6** and comprises a horizontally extending U-shaped bracket or frame **115**, the legs **116** and **117** thereof terminating in vertical plates **118** and **119**, respectively. Each plate has bolt holes like **120** to receive bolts like **121** in FIG. **3** for fastening the plate to the side frame member **34**. Welded to the underside of the center of bracket **115** in a base plate **122**. Plate **122** has vertical sides **123** and **124** spaced apart to slidably receive the adjustable plate **125**. The space between the sides **123** and **124** is substantially the same as the width of the plate **125**. Plate **125** is mounted on and forms a part of the support **126** for the auxiliary wheel **113**. The base plate **122** has bolt holes **127** and **128** in vertical alignment at one side of the plate and bolt holes **129** and **130** in vertical alignment at the other side of the plate. The holes **127** and **128** match the slots **131** and **132** in plate **125**, and the holes **129** and **130** match the slots **133** and **134** at the other side of plate **125**. A bolt like **135** is provided for each of the four sets of holes in the plates **122** and **125**, the slots **131** to **134** permitting vertical adjustment of the auxiliary wheel **113** to a desired height. For all positions of adjustment, the axis or axle **113'** of the wheel **113** is below and in a vertical plane containing the axis of cutter shaft **50**; and a similar relation applies to the adjustment of wheel **114**.

In order to further support the wheel **113** and hold it in adjusted position, the top **136** of the wheel support **126** has arising therefrom a vertical bolt **137** which fits in the notch **138** in a bracket **139** extending horizontally from and welded to the underside of the center of bracket **115**. Suitable nuts and washers indicated at **140** are provided to engage the upper and lower sides of the bracket **139** and hold the bolt **137** in adjusted position. A brace **141** fills the space between the base of bolt **137** and the plate **125** and is welded thereto and to the top **136** of the wheel support **126**.

Machine of FIGS. **10** through **17**

There is shown in FIG. **10** a tractor-trailer vehicle, generally indicated at **210**, comprising a tractor, indicated generally at **212**, which is provided with a typical cab **214** and a Diesel or similar engine **216** mounted at the front end of the tractor frame **218**. The frame **218** is provided with a swivel bed or hitch **220** for an operable connection between the tractor and a tandem trailer. Tractor **212** is movably supported by a set of front wheels **222** for steering the vehicle **210** and a back set of drive wheels **224**.

However, there is included means for disengaging the engine power from the rear drive or traction wheels **224** to engage a hydraulic drive system when required. This forms no part of the present invention and its details are disclosed and claimed in U. S. Ser. No. 119,476.

There is operably connected to the swivel bed or hitch **220** of the tractor **212** a first tandem trailer unit **226** and a second tandem trailer unit **228** which is operably connected to said first trailer unit **226** by a swivel bed or hitch **229**, supported on the rear of said first trailer unit. The first trailer unit **226** includes a grooving machine having a rotary cutter assembly **245**, having a hitch **225** with the frame structure **230** which in turn has a hitch **220** with the tractor **212**.

The trailer unit **226** comprises a carriage or frame structure **230** having a somewhat Z-shaped configuration which includes a horizontal box framework **232** having a mating member **233** for the swivel bed **220** and a platform **234**. Positioned rearwardly of the platform **234** and attached to frame **232** are a pair of parallel vertical beams **236, 236'** spaced apart sufficiently to receive a transverse support bar **237**, as seen in FIGS. **14** and **16**. The beams **236, 236'** are secured to the box frame **232** intermediate their ends. Rearwardly disposed from the beams **236, 236'** is a second pair of matching beams **238, 238'**, the beams **236** and **238** being interconnected by overhead horizontal girder member **239**, and beams **236'** and **238'** being similarly interconnected by an overhead horizontal girder member **239'**. The girders **239, 239'** have suitable transverse supports shown as I-beams **241** and **243**, see FIG. **10**, welded at their ends into the girders **239, 239'**. Attached to the lower portion of the rear vertical beams **238, 238'** is a set of parallel frame members like **240** having a platform to support the second swivel bed or hitch member **229** (FIG. **10**). To carry the rear portion of the frame structure **230**, there is provided a set of tandem wheels **242** positioned directly under the swivel bed member **229** whereby the front end of the second trailer **228** is operably connected thereto. The trailer **228** has rear wheels **365**.

Referring to FIGS. **10, 14** and **16**, there is provided a rotary cutter assembly **245** operably mounted within the frame structure **230** of the carriage, said cutter assembly **245** comprising an independent drive engine **246** for operating a pair of rotary cutter units, indicated generally at **248** and **250**, respectively. There is also provided means for supporting one of said cutting units in advance of the other, with the inner ends of said cutter units in substantial alignment. The supporting means comprises a U-shaped frame structure **252**, as seen in FIGS. **14** and **16**, hingedly connected, as indicated at **253**, at its forward open end to a header **254** having a hitch **255** which includes an upper ball member **255*a*** secured to the header **254** and a cooperating lower mating socket member **255*b*** horizontally projecting from and secured to the transverse support bar **237**. Oppositely and rearwardly disposed from the header **254** is the bight portion **257** of the U-shaped frame **252**, said bight **257** being a rear transverse member having mounted thereon a slide **256** in the form of a cylindrical pin which is rotatably

received in and guided for vertical and pivotal movement by vertical spaced angle irons providing slot means **258** carried by bracket **240'** depending from frame members **240**, **240***a*, see FIGS. **10** and **16**. The slot means **258** prevents lateral movement of frame **252** with respect to the frame structure **230**, while permitting rocking movement about a horizontal axis.

The beams **236**, **236'**, see FIG. **16**, have an angle bracket **249**, **249'**, respectively, extending over the header **254** at opposite sides of its longitudinal axis to limit pivotal movement of header **254** about that axis, particularly when acted on by hydraulic cylinders **296** and **297**, described later.

Due to the ball and socket hitch **255** at one end of the frame **252** and the slide **256** rotatably received in slot **258**, the frame and cutter assembly **245** together are capable of being angularly adjustable about a horizontal axis *a—a*, seen in FIG. **14**, said hitch and said slide permitting the cutter units to be readily adapted to an inclined surface, when required.

An independent engine **246** is used to operate the cutter units **248** and **250**, said engine being mounted to the floating U-shaped frame **252** adjacent the bight portion **257** of the U by transverse channel members **259** secured at their ends to the side members **260**, **260'** of the frame **252**. The power output shaft **261** of the engine **246** is provide at one end with a pulley and belt arrangement **262** appearing in FIG. **10** to drive the pulley **271** of cutter **248**, see FIG. **14**. The engine also drives a similar pulley and belt arrangement, not shown, to drive the pulley **273** of cutter **250**, FIG. **14**.

As mentioned above, the cutter units **248** and **250** are so arranged that one assembly is positioned forwardly of the other cutter assembly with the endmost disks of their inner ends **275** and **276** spaced apart the same distance as the spacing between adjacent disks (FIG. **14**). Each cutter unit **248** and **250** comprises a plurality of evenly-spaced-apart cutter disks having identical diameters and secured on the shafts **272** and **274** for rotation therewith. The disks are generally provided with diamond bits for cutting hard materials, such as cement and concrete.

The shafts **272** and **274** are journaled at their outer ends by universal bearings **279** and **280**, respectively, said bearings being supported within dual pillow blocks **282** and **283** along the rearward section of the side members **260**, **260'** of the frame **252**. However, the inner ends **275** and **276** of cutter units **248** and **250**, respectively, have their shafts **272** and **274** journaled in bearings **284** and **285**, respectively, supported within dual blocks **286** and **287**, respectively.

As shown in FIGS. **14** and **16**, a pair of parallel floating beams **288** and **290** are provided along the inner longitudinal length of the frame **252** for supporting the inner ends of each cutter unit. Each floating beam **288** and **290** is independently hinged to the header **254** by brackets **292** and bolts **293**, acting as hinge pins, at the forward end thereof. The opposite or rear free end of each beam **288** and **290** is movably received within the U-shaped brackets **294** and **295**, respectively. Said brackets are secured to the rear bight portion **257** of the frame member **252**. It should be particularly noted that each beam is capable of being actuated individually with respect to each other, as well as with respect to the floating frame **252**.

As shown in FIG. **16**, the inner support block **286** for the inner end of shaft **272** is mounted on beam **290**, whereas the block **287** for the inner end of shaft **274** is carried by beam **288**, with the inner ends of those shafts in overlapping relation as also shown in FIGS. **14** and **16**. This construction makes it possible to preserve between the endmost disk of the cutter assembly **248** and the adjacent endmost disk of the cutter assembly **250**, at the inner ends of those cutters, for groove cutting purposes, a spacing which is substantially the same as the spacing between the adjacent disks on each cutter assembly.

As shown in FIG. **16**, the frame **252** and the rotary cutting assembly **245** are lifted or lowered by means of a pair of hydraulic cylinders **296** and **297** which are hingedly connected at their lower ends **298** and **298'** to the rear end of frame **252**, and their upper ends **299** and **299'** are hingedly connected to the underside of a transversely-extending beam **300** which is secured to the rear vertical beams **238**, **238'** of the frame structure **230**. The bight or rear end **257** of frame **252** with the cutter assemblies **248** and **250** pivots about a horizontal axis passing through the hinge **253** and the hinge pins **293** of the beams **288** and **290**. Since the tank trailer **228** is loaded with a dead weight of a large quantity of water, the frame structure **230** and the upper ends of cylinders **296** and **297** are held down from any vertical movement thereof when the cylinders **296** and **297** are activated, when the cutter assemblies **248** and **250** are in working engagement with the pavement. The force of the cylinders **296**, **297** butt against the over-all weight of the tank which becomes an effective opposing force against the lifting effort of the cylinders **296** and **297**. Not only can the frame **252** be adjusted vertically, but it can also be tilted at an angle through the longitudinal axis *a—a* (FIG. **14**) by adjusting the hydraulic cylinders **296**, **297**.

There is hingedly connected at the free or rear ends of beams **288**, **290** hydraulic cylinders **301** and **302**, respectively, for operating the rear end of each floating beam in different or similar vertical displacements. The hydraulic cylinders **301** and **302** are hingedly supported above the adjacent floating beams **288** and **290**, respectively, by upside-down L-shaped brackets **303** and **303***a* which are fixedly secured to the rear **257** of the floating frame **252**. The inner ends of the cutter units **248** and **250** can be positioned at a greater elevation than their outer ends to fit a convex road surface. The inner ends can also be adjusted lower than the outer ends to fit a concave road surface. Therefore, by adjusting the floating beams **288** and **290**, the inner ends of the cutters may be raised or lowered with respect to their outer ends to substantially fit either a convexity or a concavity in the pavement.

When it is desired to move to a different location and travel at comparatively high speed with the cutter assemblies **248** and **250** in elevated position, the cylinders **296** and **297** are operated to raise the rear end **257** or frame **252**, and in so doing, the outer ends of the cutter assemblies are raised, their inner ends and the floating beams **288** and **290** being raised by reason of the brackets **294**, **295**. The brackets **294**, **295** are carried by the frame member **257** and underhang the beams **288** and **290** to lift them when the rear end **257** of the frame is lifted. Brackets **294** and **295** are open at

their tops to permit the upward movement of the beams **288** and **290** under working conditions, the brackets **294** and **295** then being in a lowered position free from supporting relation with the beams **288** and **290** which are then floated. The operator can adjust the pressure on the cylinders **301** and **302** to adjust the beams **288** and **290** and the inner ends of the cutter assemblies so as to suit working conditions and obtain a uniform depth of groove with resulting maximum length of life of the cutter disks.

As shown in FIGS. **10** to **12**, the rotary cutter assembly **245** is provided with a continuous flow of liquid coolant which consists, generally, of water supplied from cell **362***a* of tank **244** of the end trailer **228**. This water coolant is pumped by a pumping means **308** which is located at the front end of the tank **244** and is provided with a pair of flexible conduits, or hoses, **310** and **311** (FIG. **12**) interconnected to separate spray nozzle means, indicated generally at **312** and **312'**. The hoses **310** and **311** are attached to the lower portion of side members **260**, **260'**, respectively, of the frame **252**. The hoses are operably connected to individual spray nozzle means **312** and **312'**. The nozzle means **312** and **312'** are identical and both comprise a tubular conduit or manifold **314** having a plurality of spray nozzles **316**, see FIG. **11**, spaced along the side of the conduit facing the cutting edge of the blades **278**, **278'** as they contact the pavement during cutting thereof, thereby spraying water for coating the blades or disks of the cutting units **248** and **250**, respectively. Details of the liquid coolant system form no part of the present invention and are disclosed and claimed in U. S. Ser. No. 119,476.

In order to supply a continuous, uninterrupted flow of water to the blades **278**, **278'**, there is provided a vacuum system, generally indicated at **330** in FIG. **10**. This system is used to return the water, along with the sludge material created by the cutting of the pavement, to the tank **244**. The vacuum system comprises a vacuum pump **332** mounted to the end tank trailer **228**. This pump is operated by motor **334**. A vacuum is pulled from within the tank **244** through an outlet passage **336** located in the front upper wall of the tank cell **262***a*. As the pressure within the tank **244** is reduced by the vacuum system **330**, a flow of water and sludge is created between the cutting assembly **245** and tank **244**. This flow is accomplished by establishing a vacuum chamber **340** which is defined by a flexible and elastic shroud, indicated generally at **342**, having a somewhat rectangular wall or curtain **344** secured to and depending from frame **252**. Said chamber also includes an upper shield partition **345** to seal or close the top of the vacuum chamber **340**. The lower edges **349** of the side walls **344** of the vacuum chamber **340** form a sealing contact with the pavement around the cutting units and the spray nozzles. Included within the vacuum chamber **340** is a plurality of suction nozzles **346** which are operably connected to a rectangular manifold **347** connected to conduits like **350**, **352** and **360** in FIG. **10** which lead to tank **244** for returning the water and sludge to said tank. Details of the vacuum system form no part of the present invention and are disclosed and claimed in U.S. Ser. No. 119,476.

For groove cutting purposes, each end of each cutter **248** and **250** is provided with a depth control device. For this purpose, as indicated in FIG. **14**, cutter unit **248** has at its opposite ends the depth control devices **384** and **384***a*. Cutter unit **250** at its opposite ends has a depth control device **385**, **385***a*. Each depth control device is carried by a support bracket like **386** welded to the frame **252** for the outer ends of the cutters and welded to the floating beams **288** and **290** for the inner ends of the cutters.

All four of these depth control devices for groove cutting are alike; and one of them, namely **385** at the outer end of cutter **248**, is shown in elevation in FIG. **17** wherein the frame member **260** has a bracket **386**, the bolt **389** acting as a pivot support for the top of an inverted U-shaped rocker arm **388** having depending arms **388***a* and **388***b*. Arm **388***a* is at the front of the cutter **248** and terminates in a roller or wheel **390** which rides on the pavement ahead of the cutter. Arm **388***b* extends behind the cutter and has a pivotal support at **394** for an adjusting arm **392** which terminates at its lower end in a roller or wheel support **393** which rides on the pavement behind the cutter. The angular position of arm **392**, and hence the depth that the cutter can cut into the pavement, is controlled by operating the adjusting screw **396** mounted in the arm **392** and bearing against an abutment **383** on arm **388***b*.

As shown in FIG. **12**, bracket **386** is welded to frame member **260'** and includes upright plates **457** and **458** spaced apart to receive the top of the rocker arm **388** which is held in position by bolt **389** as described above.

The depth control shown in FIG. **17** makes it possible to keep a very close tolerance on the depth of the kerf being cut, even when the surface of the pavement **304** raises or lowers during a cutting pass. Since the center of the cutting unit is intermediate that of the two rollers **390**, **393**, any raising or lowering of a roller with respect to the other roller will cause only a slight rise to the cutting area of the blade **278**. That is, if the rollers **393** on the rearward side of the blades are thus one inch above the level pavement, then the cutter axis is raised only one-half the amount because of the arms involved. It should be noted, at this time, that the above description is with respect to the grooving operation of the machine.

As disclosed and claimed in U.S. Ser. No. 119,476, there is provided a separate means for laterally adjusting the position of frame **252** by repositioning hitch **255** and the slot means **258**, which allows the shifting of the outer ends of the cutter units to be positioned closely adjacent to a curb.

Auxiliary Wheels of Machine of FIGS. **10** through **17**

As shown in FIG. **14**, cutter **248** has an auxiliary wheel device similar to that described in connection with FIGS. **1** to **9** and as appearing in FIG. **15**, as indicated at **400** at the inner end only of this cutter. Similarly, cutter **250** has an auxiliary wheel device **401** at the inner end only of this cutter. As shown in FIG. **13**, the so-called pillow block **286** is in the form of a hollow rectangular tube of structural steel, open at both ends and having four tapped holes as indicated at **402** each to receive one of the four bolts indicated at **403** to clamp the slidable plate **404** in adjusted position on the base plate **405**. As shown in FIG. **13**, the outer end of cutter shaft **272** terminates behind the plate **404**, which makes it possible to support the plates **404** and **405** on the floating beam **290** which carries the bearing

284 for the shaft 272. Plate 404 has an auxiliary wheel 406, and the axis of its axle 407 is in the same vertical plane with the axis of cutter shaft 272. The auxiliary wheel device 400 has a bolt 408 and nuts 409 for a bracket 410, similar to the corresponding items previously described in connection with FIGS. 1 to 9. The auxiliary wheel device 401 is similar to the device 400 and is carried by the floating beam 288, as shown in FIG. 14.

The operation of the auxiliary wheel devices 400 and 401 in the case of FIGS. 10 to 17 is similar to that described in connection with FIGS. 1 to 9, the auxiliary wheel like 406, see FIG. 15, contacting the pavement to limit the depth of cut in the case where the depth control wheel like 390 drops in a hole or depression in the pavement as indicated at 411. Otherwise, the bottom of the periphery of the auxiliary wheel is out of contact with the pavement.

The invention as its attendant advantages will be understood from the foregoing description; and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangements hereinbefore described being merely by way of example, without restriction to the specific forms shown or uses mentioned, except as defined in the accompanying claims.

We claim:

1. A pavement cutting machine comprising a carriage having a longitudinal axis, a frame member associated with said carriage, said frame member having a cutter having a shaft extending transversely of said axis, said carriage having front wheel means in front of said cutter and rear wheel means at the rear of said cutter, auxiliary wheel means including an auxiliary wheel rotatable on an axis below and substantially parallel to the axis of said cutter shaft, and means for supporting said auxiliary wheel with the bottom of its periphery above and out of contact with the pavement, in position to contact the pavement and limit the depth of cut of said cutter when said front wheel means encounters an abrupt drop in the level of the pavement.

2. Machine according to claim 1, said supporting means for said auxiliary wheel means comprising means for adjusting the vertical position of said auxiliary wheel means to a position slightly above a plane tangent to the bottom of said front and rear wheel means.

3. Machine according to claim 1, said supporting means for said auxiliary wheel means comprising bracket means carried by said frame member for supporting said auxiliary wheel beyond the outer end of said cutter shaft.

4. Machine according to claim 1, said auxiliary wheel means being provided at each end of said cutter shaft.

5. Machine according to claim 1, said supporting means comprising a fixed member and a relatively movable member, said fixed member being carried by said frame member, said auxiliary wheel being carried by said relatively movable member, and means for securing said relatively movable member to said fixed member in adjusted position.

6. Machine according to claim 5, said fixed member comprising a bracket carried by said frame member for supporting said fixed and relatively movable members and said auxiliary wheel beyond the outer end of said cutter shaft.

7. Machine according to claim 5, said cutter shaft having a bearing support, and means for securing said fixed member to said bearing support.

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