

March 18, 1952

H. R. HORNING

2,589,256

ROAD-PAVING MACHINE

Filed July 1, 1948

6 Sheets-Sheet 1

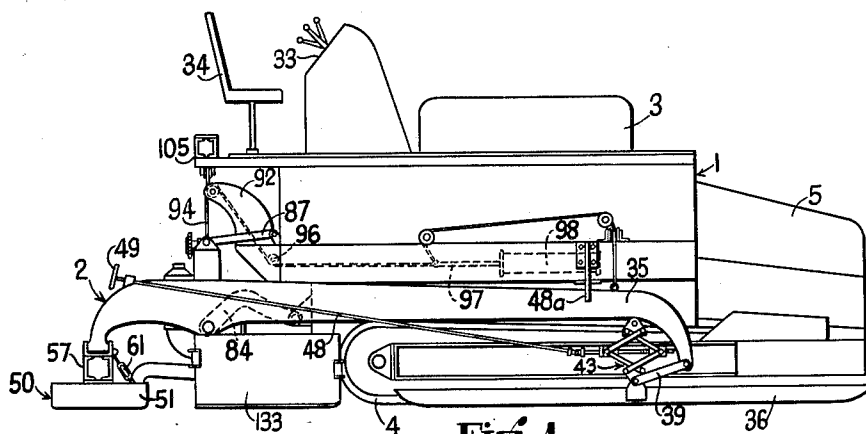


Fig. 1

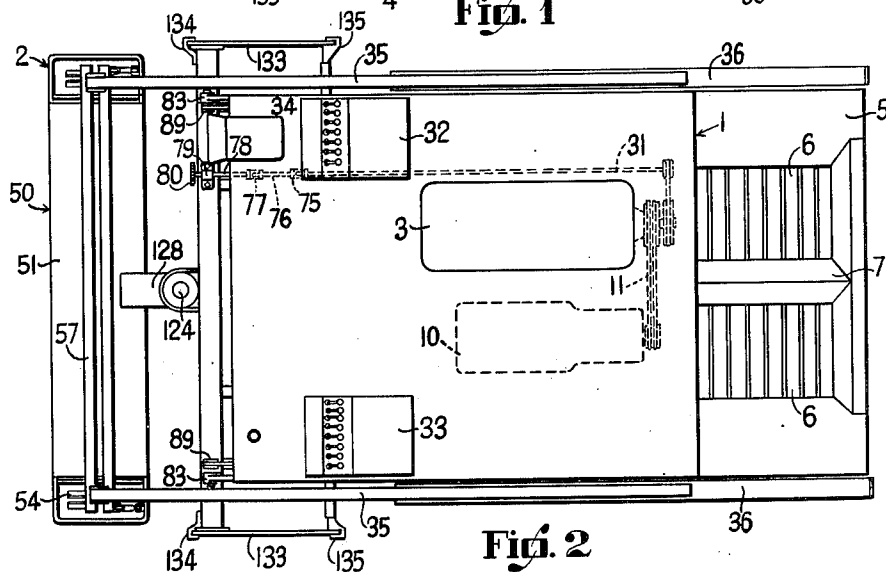


Fig. 2

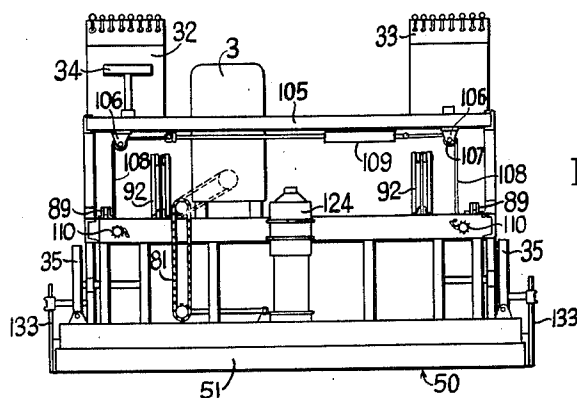


Fig. 3

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6 Sheets-Sheet 3

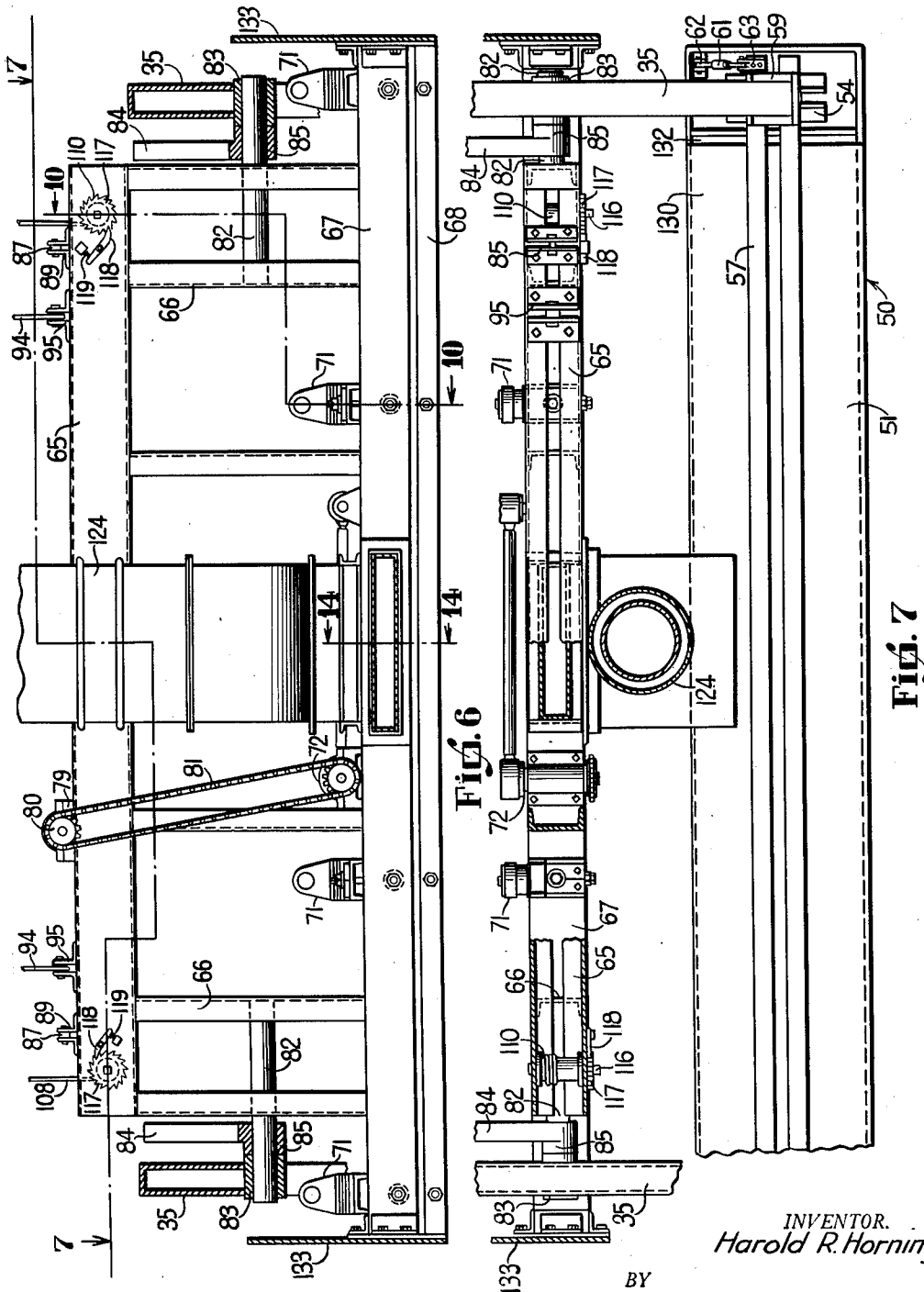


Fig. 2

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6 Sheets-Sheet 4

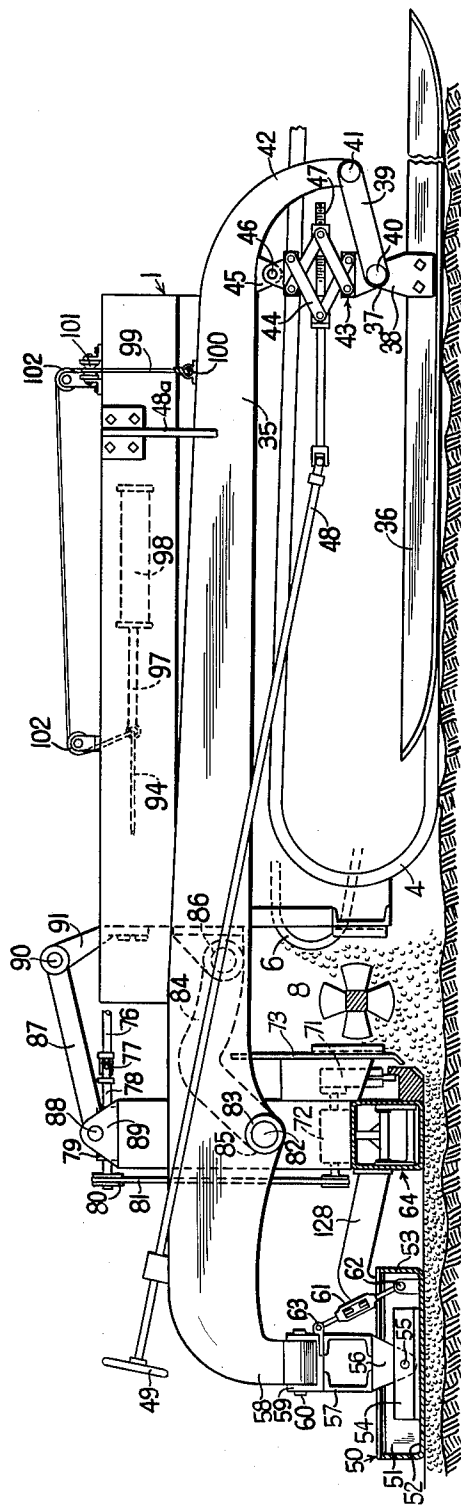


Fig. 8

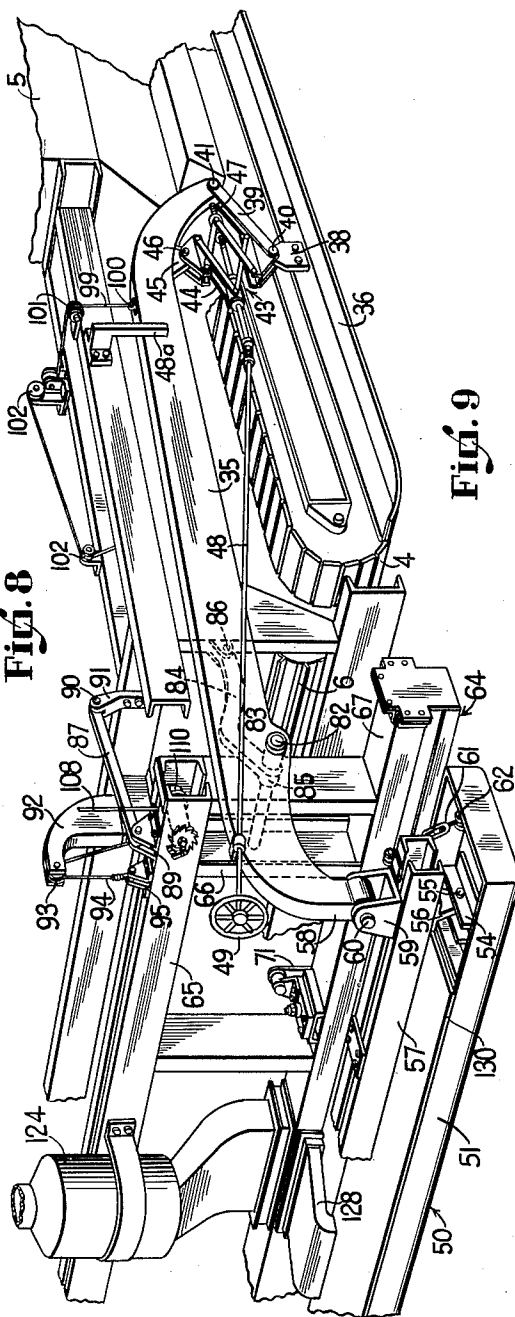


Fig. 9

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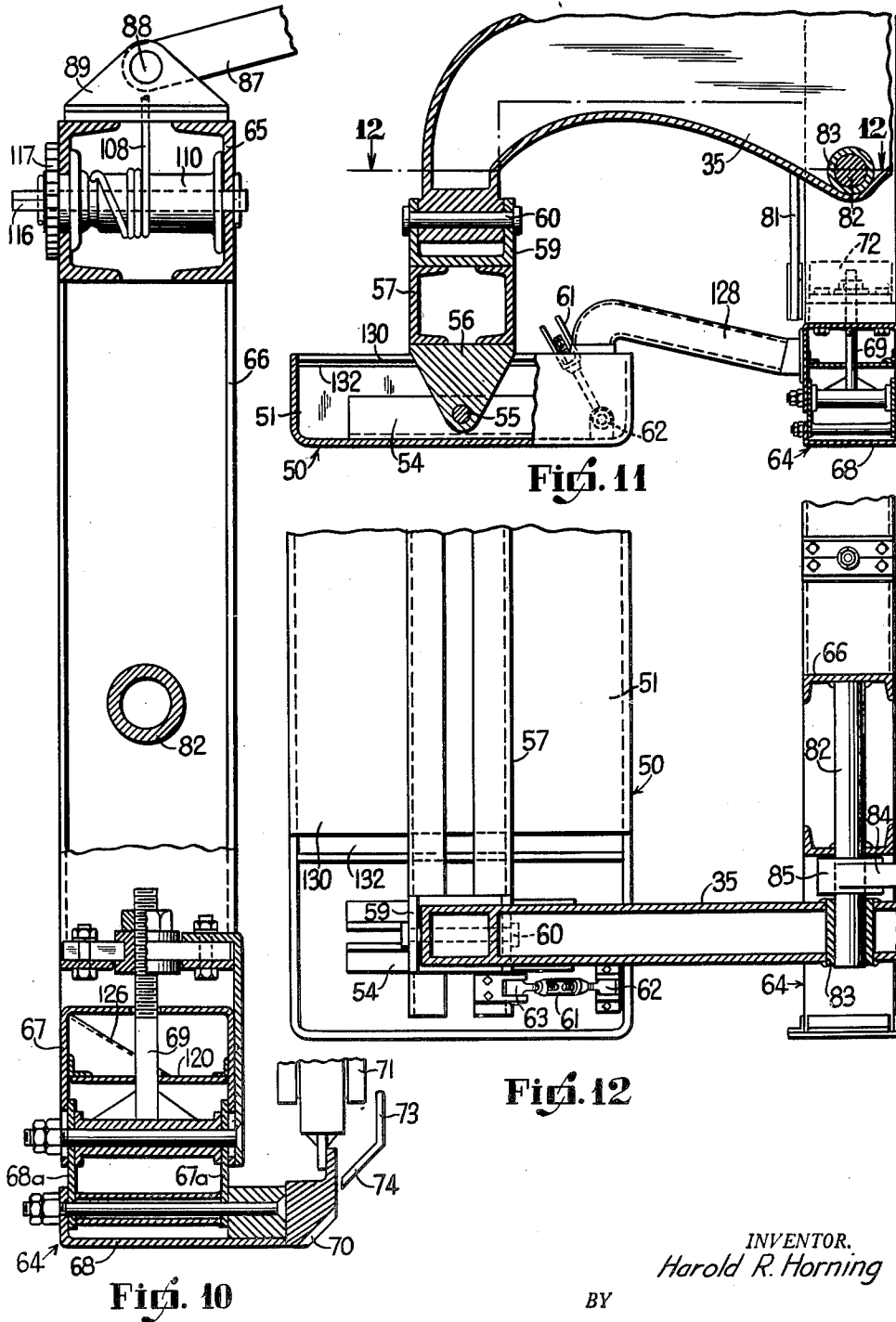
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6 Sheets-Sheet 6

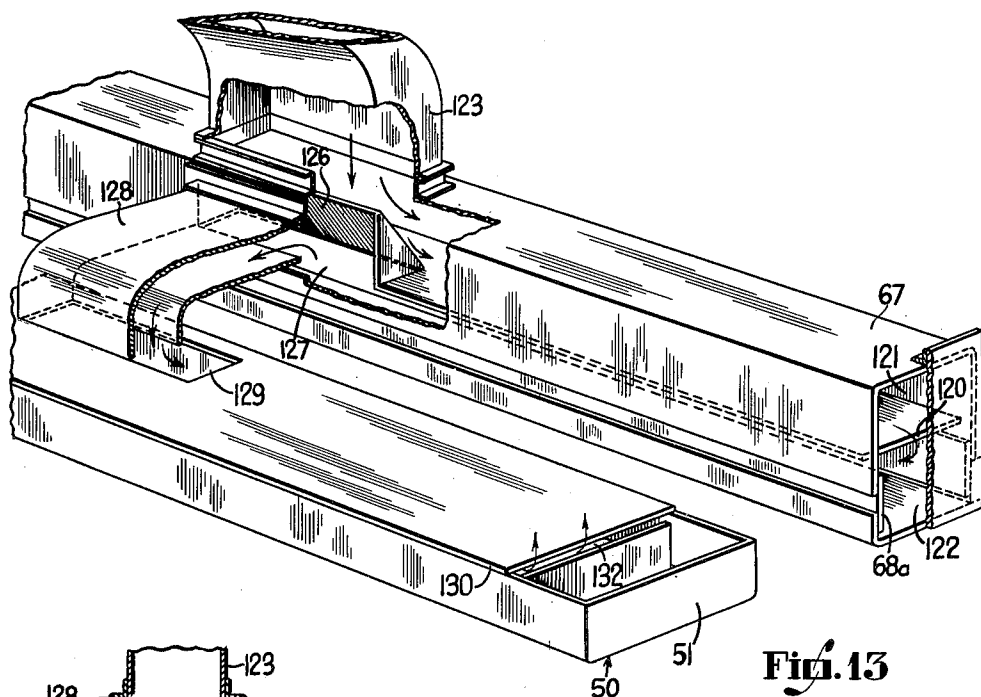


Fig. 13

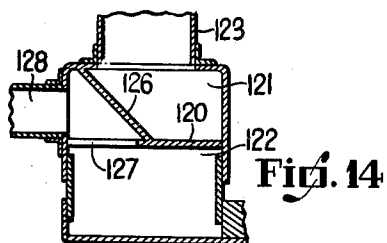


Fig. 14

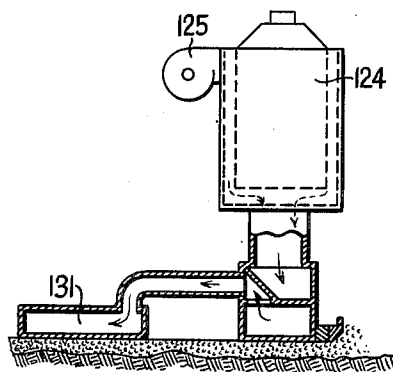
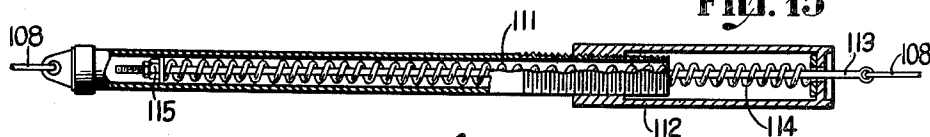


Fig. 15



UNITED STATES PATENT OFFICE

2,589,256

ROAD-PAVING MACHINE

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Application July 1, 1948, Serial No. 36,463

18 Claims. (Cl. 94-46)

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My invention relates to a road-paving machine. It has to do, more particularly, with a machine for applying a layer or mat of material to a relatively rough surface, such as a concrete base, an old road surface or a rough graded surface, and producing thereon a smooth surface of proper predetermined contour in both a longitudinal and a transverse direction. My machine is particularly useful with bituminous mixes but is also capable of use with concrete or other aggregate road-building materials.

More specifically, my invention relates to that type of road paver which comprises generally a material-receiving and spreading unit for receiving material and depositing it on the surface to be covered and a material finishing and leveling unit disposed in trailing relationship to the first unit and adapted to act upon the material deposited thereby.

This application is related to my co-pending application directed to Road-Finishing Machine, Serial No. 36,464, filed July 1, 1948.

The main object of my invention is to provide a road-paving machine of the type indicated composed of a material-receiving and spreading unit and a trailing finishing and leveling unit which are so constructed and arranged relative to each other that they will cooperate in producing a finished smooth surface of proper contour in both a transverse and a longitudinal direction, such surface being free of the irregularities of the relatively rough surface being covered which irregularities are averaged out in the final surface by the machine during the application of the material to the rough surface and the formation of the final surface on such material.

Another object of my invention is to provide a road-paving machine of the type indicated wherein the material-receiving and spreading unit is of the self-propelled tractor type which is so designed that it will receive the road-building material, distribute it and spread it across the surface to be covered so that the trailing finishing and surfacing unit can act effectively thereon.

Another object of my invention is to provide a machine of the type indicated wherein the leveling and finishing unit is disposed substantially in trailing relationship to the tractor unit and is pulled along thereby by such tractor unit which is designed to travel on the relatively rough surface to be covered, the two units being connected together to permit relative vertical movement so that vertical movement of the tractor unit will have substantially no effect on the leveling and finishing unit and to permit the leveling action of the latter unit.

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Another object of my invention is to provide a machine of the type indicated wherein the leveling action of the trailing unit is accomplished by having such unit supported by forwardly disposed elongated members which operate along the sides of the relatively rough surface to be covered and bridge the irregularities thereof, and by a rearwardly disposed supporting pan which acts on the surface of the layer of material produced by the machine, so that the irregularities in the relatively rough surface being covered are averaged out between the two points of support by means of a transversely extending screed structure carried by said leveling and finishing unit intermediate such points of support.

Another object of my invention is to provide a machine of the type indicated above wherein the leveling and finishing unit has its rear portion suspended in working position from the rear portion of the tractor unit by flexible cushioning means which is adjustable readily to vary the amount of weight applied by the screed structure and the supporting pan to the material upon which they are acting to prevent undue compaction of the material.

Another object of my invention is to provide a machine of the type indicated in the preceding paragraph wherein additional means is provided for suspending the leveling and finishing unit completely from the tractor unit so that it can be quickly raised for transportation while supported by the tractor unit or can be lowered quickly into working position.

Another object of my invention is to provide a machine of the type indicated above wherein the leveling and finishing unit can be adjusted quickly and easily during operation of the machine to vary the thickness of the layer of material produced by the machine by changing the height of the intermediately supported screed, it being possible to make this adjustment in such a manner that the change in thickness will be gradual and not abrupt so as to avoid producing sharp bumps or depressions in the final surface.

Still another object of my invention is to provide a machine of the type indicated above wherein the intermediately supported screed of the leveling and finishing unit has means associated therewith, including drag means for connecting the leveling and finishing unit to the tractor unit for relative vertical movement, for preventing tilting thereof about its own axis regardless of the vertical position of the leveling and finishing unit relative to the tractor unit.

A further object of my invention is to provide means in association with the supporting pan of

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the leveling and finishing unit for adjustably tilting it so that its forward edge will not dig into the newly laid material.

An additional object of my invention is to provide a heating system carried by the leveling and finishing unit of the machine for heating both the intermediately disposed screed structure and the rearwardly disposed supporting pan, such system including a flexible duct arrangement which permits relative adjustment of such members.

Another object of my invention is to provide a machine of the type indicated wherein the tractor unit is provided with material-conveying means for receiving the road surfacing material and conveying it into association with a transversely disposed spreading member for spreading it across the surface to be covered in front of the trailing screed of the leveling and finishing unit, means being provided for effectively controlling the drive of the conveying means and the drive of the spreading member from a convenient point at either side of the tractor unit to give the operator complete unobstructed visibility at the one side of the machine, for example, at the side where the one strip of material being laid is caused to merge with a previously laid strip.

A further object of my invention is to provide a machine of the type indicated in the preceding paragraph wherein the leveling and finishing unit preferably has an oscillating cutter bar associated with the screed thereof which is provided with driving means driven from the power unit of the tractor unit by a flexible drive which does not interfere with the required movement of the leveling and finishing unit relative to the tractor unit, such driving means being also controlled by the operator from either side of the machine along with the other driving means controls.

Various other objects will be apparent.

The tractor unit of my machine is self-propelled and is supported by a pair of elongated crawlers which operate on the relatively rough surface to be covered, the crawlers bridging irregularities thereof and minimizing vertical movement of the tractor unit. This tractor unit is preferably provided with a material-receiving portion or hopper at its forward end which is designed to receive material from a dump truck moving ahead and along with the tractor unit. A pair of conveyers are provided in association with the hopper and are arranged at each side of the tractor for conveying the material rearwardly of the tractor where it is discharged onto the surface in front of a transversely extending spreading member or agitator which is composed of two opposed sections that feed the material transversely in opposite directions across the surface. In order to obtain completely controlled distribution of the material across the surface, each of the two conveyers and each of the two spreader sections is provided with an independently controllable drive which is driven from the power unit of the tractor unit. Also, to facilitate steering of the tractor unit, each of the crawlers is provided with an independently controllable drive from such power unit. In addition, I provide an additional independently controllable drive from such power unit for driving the cutter bar of the screed structure to be referred to later. These drives are preferably under the control of a bank of control levers located at each side of the tractor so that the operator can operate the machine from either side of the machine where he will have good visibility at such side.

The finishing and leveling unit is disposed in

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trailing relationship to the tractor unit and is connected thereto by draught means in such a manner that it is dragged along thereby, but free relative vertical movement of the two units is permitted. Thus, if the tractor unit is moved vertically by its passage over irregularities of the relatively rough surface to be covered, such vertical movement will not be transmitted to the finishing and leveling unit. Furthermore, the latter unit can function to perform its leveling action without interfering with the tractor unit.

The trailing finishing and leveling unit comprises a pair of longitudinally extending substantially horizontally disposed screed supporting arms which extend forwardly along opposite sides of the tractor unit to points adjacent the front end thereof. The forward end of each of these arms is pivotally connected for relative vertical swinging movement to an elongated runner which slides along the side of the relatively rough surface to be covered and bridges irregularities thereof. The arms are connected to the runners at points midway between the ends thereof to minimize vertical movement of the arms upon any vertical movement of the runners. The connections of the forward ends of the arms to the runners includes jacks by means of which the height of the arms relative to the runners can be varied for a purpose which will be apparent later. The rear ends of the arms are connected to and are supported by a pan structure which extends transversely and has a flat lower surface that rests upon and slides along the surface of the layer of material laid by the machine. This pan structure is connected to the arms by pivot structures which permit transverse tilting of the pan relative to the arms but which prevent tilting of the pan in the direction in which the arms extend, that is, longitudinally of the layer of material. However, adjustable means is associated with the pan for tilting its forward edge upwardly and holding it in such position so that such edge will not dig into the newly laid material.

The arms, intermediate their connection to the runners and their connection to the pan, carry a transversely extending strike-off or screed structure. This screed structure will engage the material spread in front of it, will compact it and cut it off to the desired level and contour. It preferably includes an oscillating cutter bar disposed ahead of the final surfacing member of the screed. The ends of the screed structure are pivotally connected by transverse horizontal pivots, arranged intermediate the height of the screed structure, to the arms, and to these pivots are also connected drag links which are connected to the tractor unit for pulling the finishing and leveling unit along therewith. Thus, the tractor unit can move vertically without transmitting this movement to the finishing and leveling unit and the arms can pivot during their vertical movement, about their pivots to the runners, relative to the screed structure. This makes it possible to keep the screed structure in a substantially vertical plane at all times and to prevent tilting of the screed structure forwardly or rearwardly, additional links are pivotally connected to the upper portion of the screed structure and the tractor unit. The drag links provide a connection between the two units but still permit the necessary relative vertical movement. Side edging plates are supported for free vertical movement at the ends of the screed structure for forming straight edges on the layer of material. The leveling and finishing unit car-

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ries a heating system for the screed and the pan, the heater being carried by the screed structure and being connected to the pan by a flexible duct to permit limited relative movement of the screed structure and pan.

The leveling and finishing unit of my machine is suspended from the tractor unit by a cable arrangement which permits the entire unit to be lowered quickly into operative position relative to the surface to be covered or to be raised to inoperative position for transportation. When in operative position, the leveling and finishing unit is suspended at both sides by a cable and pulley arrangement connected to the screed structure and which has a cushioning unit incorporated therein that will provide for yieldable suspension of such unit from the tractor unit. This cable and pulley arrangement is provided with adjustable ratchet units at each end of the screed structure whereby the resistance of such cushioning unit can be varied so that more or less of the weight of the leveling and finishing unit and especially the screed structure and supporting pan will be supported from the tractor unit and, therefore, the amount of weight acting on the material being finished can be varied. This is important when the machine is working on slow-curing materials which must not be unduly compacted.

The preferred embodiment of my invention is illustrated in the accompanying drawings wherein similar characters of reference designate corresponding parts and wherein:

Figure 1 is a side elevational view of my machine.

Figure 2 is a plan view of the machine.

Figure 3 is a rear elevational view of the machine.

Figure 4 is a plan view of one side of the machine with covering plates of the tractor unit removed to show details of such unit.

Figure 5 is a side elevational view of the machine, partly cut away, to illustrate details of the drive provided on the tractor.

Figure 6 is a vertical transverse sectional view, taken substantially along line 6—6 of Figure 5, and showing the screed structure.

Figure 7 is a horizontal sectional view taken along line 7—7 of Figure 6.

Figure 8 is a diagrammatic view in side elevation illustrating the action of the finishing and leveling unit.

Figure 9 is a perspective view of the rear portion of the machine illustrating mainly the leveling and finishing unit.

Figure 10 is a vertical sectional view taken along line 10—10 of Figure 6 through the screed structure.

Figure 11 is a vertical sectional view taken along line 11—11 of Figure 4.

Figure 12 is a horizontal sectional view taken along line 12—12 of Figure 11.

Figure 13 is a perspective view, partly cut away, of part of the screed structure and associated pan structure, showing the heating arrangement therefor.

Figure 14 is a transverse section along line 14—14 of Figure 6 through the screed showing the connection to the heating duct which leads to the pan.

Figure 15 is a diagrammatic view of the heating system.

Figure 16 is a sectional view through the cushioning unit used in suspending the leveling and finishing unit from the tractor unit.

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With reference to the drawings, in Figures 1 to 3, inclusive, I have illustrated generally a road paving machine constructed according to my invention. The machine comprises the tractor unit 1 and the trailing leveling and finishing unit 2. The tractor unit 1 preferably is of such type that it will receive material at its forward end from a dump truck along with which it will move, carry it rearwardly and deposit it on the surface to be covered in position to be acted on by the unit 2. The unit 1 will travel on the relatively rough surface to be covered while the unit 2 will engage the surfacing material and produce the desired finished surface thereon at the proper level.

The tractor unit 1 is self-propelled by means of an engine 3 preferably of the internal combustion type. The unit is supported by a pair of elongated crawlers 4 which operate on the relatively rough surface to be covered and which because of their length will bridge irregularities thereof and minimize vertical movement of the tractor unit. The forward end of this tractor unit is provided with a material-receiving portion or hopper 5 which is designed to receive material from a dump truck properly associated with the machine. A pair of endless belt conveyors 6 are provided in the bottom of the hopper and are arranged at each side thereof being separated by a peaked plate 7 which extends longitudinally of the hopper. These conveyors extend from the forward end of unit 1 substantially to the rear end thereof and are provided for the purpose of conveying the material rearwardly of the tractor where it is discharged onto the surface to be covered. The material discharged on the surface will be engaged by a transversely extending spreading member or agitator 8 which is shown best in Figures 4 and 5. This agitator is rotatably carried by the tractor unit 1 at the rear side of the frame thereof and is disposed at a level slightly above the surface on which the material is deposited. This spreading member 8 is composed of two opposed sections 9 that feed the material in opposite directions across the surface due to the arrangement of the helically disposed blades thereof. Thus, the sections 9 will spread the material, discharged on the surface by the conveyors 6, cross the surface before it is engaged by the leveling and finishing unit 2.

As shown best in Figures 4 and 5, driving means is preferably provided on unit 1 for driving the crawlers 4 independently, for driving the conveyors 6 independently and for driving the sections 9 of the spreader member independently. The independent drive of the crawlers 4 permits steering of the tractor unit. The independent drive of the conveyors 6 and spreader sections 9 permits complete control of the distribution of the material across the surface. The driving mechanism includes the transmission 10 which is driven from the engine 3 by a belt drive 11. The unit 10 drives a transverse shaft 12 of a chain drive 13 and also drives a sleeve 14, rotatably mounted on shaft 12, by means of a chain drive 15. The sleeve 14 (Figure 5) drives one of the crawlers 4 through the medium of a sprocket 16 carried thereby which drives a chain 17 that extends downwardly around the sprocket 18 of the crawler. The shaft 12 drives the other crawler 4 through a similar chain drive arrangement. Clutches 19 are associated with the sprockets which drive the crawlers and may be independently actuated to render either of the crawler drives operative or inoperative.

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The transmission 10 also drives a short shaft 20 which drives a forwardly extending sprocket drive 21 that, in turn, drives a transversely extending shaft which extends transversely of the unit 1 at the rear end thereof. This shaft carries a sprocket 23 adjacent each end and a pair of sprockets 24 substantially midway between its ends. Each of the sprockets 24 drives a chain 25 (Figure 5) which extends downwardly around a sprocket 26 which is keyed on one of the sections 9 of the spreader member. Associated with each of the sprockets 24 on the shaft 22 is a clutch 27 (Figure 4) by means of which the drive for each section 9 can be independently controlled. Each of the sprockets 23 drives a chain 28 (Figure 5) which extends downwardly around the driving sprocket 29 of one of the conveyers 6. The sprockets 23 have the clutches 30 associated therewith which can be independently controlled to drive either of the conveyers, 6. The engine 3 (Figure 2) also drives a rearwardly extending shaft 31 at one side of the unit 1 which is provided for a purpose to be described later. All of the clutches are preferably controlled from a bank of control levers 32 (Figures 2 and 3) which is provided at one side of the machine or from a bank of control levers 33 which is provided at the other side of the machine. An operator's seat 34 is preferably removably supported at the rear of the unit 1 so that it may be positioned adjacent either the controls 32 or the controls 33 to obtain good visibility at either side of the machine.

The finishing and leveling unit 2 is disposed in trailing relationship to the tractor unit 1 and is connected thereto in such a manner that it is dragged along thereby but free relative movement of the two units is permitted. Thus, when the tractor unit 1 is caused to move vertically by passing over irregularities of the relatively rough surface on which the crawlers 4 operate, such vertical movement will not be transmitted to the finishing and leveling unit 2. Furthermore, the latter unit can function in the manner described below to perform its leveling action without interfering with the tractor unit 1 because of this type of connection.

The unit 2 comprises a pair of screed-supporting arms 35 which are shown best in Figures 1 to 5, 8 and 9. These arms 35 extend longitudinally along opposite sides of the unit 1 and are substantially horizontally disposed. They are of considerable length and extend forwardly along the unit 1 to points adjacent the forward end of such unit where they are pivotally connected for relatively vertical swinging movement to elongated runners 36. The runners 36, which are relatively long, are disposed at opposite sides of the unit 1 and slide along the relatively rough surface but will serve to bridge irregularities thereof. The forward ends of the arms 35 are pivoted to the runners at points 37 substantially midway between the ends of the runners so as to minimize vertical movement of the arms upon any vertical movement of the runners. The pivot structure for connecting the arms to the runners includes upstanding brackets 38 (Figures 1, 5, 8 and 9) to which one end of a link 39 is pivoted, as at 40. The opposite end of this link 39 is pivoted, as at 41, to the downturned forward end 42 of the arm 35. To vary the height of the arm 35 relative to the runner 36, each of the pivot connections of the arms to the runners is provided with a jack 43 in the form of a toggle frame 44 which has its upper

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end pivoted to a depending bracket 45 on the arm 35, as at 46. The lower end of the frame 44 is pivoted to bracket 38 carried by the runner at the pivot 40. The frame 44 is extended or collapsed by means of a rotatable screw 47. This screw may be operated by a rearwardly extending rod 48 which has a handwheel 49 keyed at its rear end which is disposed at the rear end of the unit 2. It will be apparent that by operating the handwheel 49, the jack 43 will be actuated to vary the distance between the arm 35 and the runner 36, or in other words, to change the level of the forward end of the arm 36. Normally, the arms and runners will pivot relative to each other about the pivot 40. The links 39 serve as drag links for dragging runners 36 along with the arms 35. Lateral movement of the forward ends of the arms 35 is limited by depending guide brackets 43a which are fastened to the frame of the unit 1 at each side thereof. These brackets are of inverted L-form and will not interfere with the necessary vertical movement of the arms 35.

The rear ends of the arms 35 are connected to and are supported by a pan structure 50 which is shown best in Figures 1 to 5, 8, 9, 11 and 12. This pan structure extends transversely from one arm to the other and includes a pan member 51 with a flat lower plate 52 which rests upon and slides along the surface of the layer of material laid by the machine, as shown best in Figure 8. The pan 51 is provided with an upstanding peripheral flange 53 and adjacent its ends is provided with pivot brackets 54 attached to the top surface of plate 52. The brackets 54 are pivoted by transverse pins 55 to depending brackets 56 which depend from the frame 57 of the pan structure. The frame 57 has its ends pivoted to the depending portions 58 on the rear ends of the arms 35. The lower ends of these portions 58 of the arms are disposed in U-shaped brackets 59 which are secured to the frame 57 in upstanding position thereon. Pivot pins 60 pivot the portions 58 to the brackets 59 and it will be noted that these pins 60 are disposed at right angles to the pins 55. The entire pan structure 50 will be permitted to pivot relative to the arms 35 about the pivot pins 60 so that the pan structure can tilt transversely of the machine and the surface being covered. Ordinarily, the pan structure will be prevented from tilting forwardly or rearwardly relative to the arms 35. However, in order to prevent the forward edge of the pan 51 from digging into the material, means is provided for tilting its forward edge upwardly. This means comprises the turnbuckles 61, the lower ends of which are connected to the forward edge of the pan 51, as at 62, and the upper ends of which are connected to the pan structure frame 57, as at 63. Adjustment of the turnbuckles 61 will tilt the pan forwardly or rearwardly about the pivots 55.

The arms 35 intermediate their forward and rear ends carry a transversely extending screed structure 64. This screed structure will be located directly behind the spreader member 8 and slightly forwardly of the pan structure 50, as illustrated best in Figure 8. The details of this screed structure are described and claimed in my said co-pending application and do not form a part of this invention. Therefore, only those details necessary to understand how the screed structure co-operates with the other elements of the machine will be described herein. This screed structure will engage the material spread

in front of it by the member 8, will compact it and cut it off to the desired level and contour.

The screed structure 64 comprises a frame formed of the transversely extending upper beams 65 provided with the depending supports 66 at spaced intervals. The lower ends of these supports 66 (Figure 10) are welded or otherwise suitably secured to the top surface of a transversely extending inverted channel member 67. This member 67 serves to adjustably support the surfacing plate 68 of the screed structure as shown best in Figure 10. The plate 68 is flat and horizontally disposed and can be bowed to the proper crown by means of the vertically disposed thrust rods 69 which suspend it, as described, in my co-pending application. Thus, the screed plate 68 may be adjusted to any desired crown. The screed preferably includes a head of the plate 68, a transversely oscillatable cutter bar 70 (Figures 8 and 10). This cutter bar is suspended from the main part of the screed by means of the pendulum links 71 which swing transversely. The cutter bar is oscillated by means of an eccentric drive 72. This cutter bar preferably has a serrated edge, as described in my co-pending application, which is directed rearwardly and downwardly for compacting material and directing it under the plate 68. A baffle plate 73 is provided at the front of the screed structure for engaging the material into which the screed is advanced so as to protect the cutter bar oscillating mechanism. This plate is vertically disposed but has a rearwardly and downwardly directed lower edge portion 74 which is substantially flush with the face of the cutter bar 70. This portion will serve to direct the material downwardly and rearwardly to the cutter bar. The eccentric drive 72 is driven from the engine 3 of the tractor unit 1 by the shaft 31 carried by such unit and previously referred to, this shaft being connected to the eccentric drive by a flexible shaft connection which permits relative vertical movement of the units 1 and 2. This connection comprises a universal connection 75 (Figure 2) at the rear end of shaft 31 which is connected to a short shaft section 76 that, in turn, is connected by a universal connection 77 to a stub shaft 78 which is rotatably carried in a bearing 79 secured on the cross beams 65 of the screed structure. The rear end of this shaft 78 carries the sprocket 80 which drives the chain 81 that, in turn, drives the eccentric drive 72.

The two upstanding supports 66 adjacent the ends of the screed structure are disposed close to each other and carry a trunnion or pivot pin 82 as shown best in Figures 6 and 9. Each of these pins extends outwardly beyond the outermost member 66 and into a bearing 83 provided in the arm 35. Thus, each end of the screed structure 64 is pivoted to an arm 35. For pulling the unit 2 along with the unit 1, drag links 84 are provided in association with each of the pins 82 between the end of the screed structure 64 and the arm 35. Each of these drag links has its rear end pivotally mounted, as at 85, on the pin 82 and has its forward end pivotally connected, as at 86, to the rear end of the frame of the unit 1. Thus, the unit 2 will be pulled along by the unit 1 and free relative vertical movement between such units will be permitted. To keep the screed structure 64 in a vertical plane, that is, to prevent it from tilting forwardly or rearwardly, additional links 87 are provided adjacent the top of the screed structure and are pivotally connected, as at 88, to brackets 89 upstanding from

the beams 65 at the ends thereof. The forward ends of these links 87 are pivotally connected, as at 89, to upstanding brackets 91 secured to the rear end of the frame of the tractor unit 1 at the upper side thereof. Thus, the two sets of links serve to provide a parallelogram structure which keeps the screed 64 vertical. This link connection between the unit 2 and the unit 1 permits relative vertical movement between such units whether it is caused when unit 1 passes over irregularities and moves vertically or when the runners 36 are moved vertically by irregularities over which they pass and which results in vertical movement of the arms 35 about the pivots 82. At all times during these movements the screed 64 is maintained substantially perpendicular to the surface being covered.

The leveling and finishing unit 2 of my machine is suspended from the tractor unit 1 by a cable arrangement which permits the entire unit to be lowered quickly into operative position relative to the surface to be covered or to be raised to inoperative position for transportation. This cable arrangement is illustrated best in Figures 1, 3, 5 and 6. It will be noted from Figure 5 that the frame of the unit 1 is provided with upwardly and rearwardly extending supporting arms 92 at each side of the frame. Each of the arms 92 carries a pulley 93 on its outer end about which a cable 94 is passed. The lower ends of cables 94 are connected at 95 to the upper transverse beams 65 of the screed structure 64, as shown best in Figure 6. The cables pass downwardly and forwardly around additional pulleys 96 carried by the frame of unit 1 at a lower level and their forward ends are connected to the rear ends of piston rods 97 of pistons 98 carried by the frame of unit 1. Thus, cables 94 will serve to lift the rear end of the unit 2. The forward end of this unit will be lifted by means of cables 99 connected at 100 to the forward ends of arms 35. These cables pass upwardly and rearwardly around guide pulleys 101 supported by the frame of unit 1, and then downwardly and forwardly around guide pulleys 102 carried by the frame of unit 1. The forward ends of the cables 100 are also connected to the outer ends of piston rods 97. The pistons 98 are preferably controlled by suitable valves connected thereto and disposed at the control points 32 and 33 on the unit 1. It will be apparent that movement of the piston rods 97 within the cylinders 98 will result in lifting of the entire unit 2 and completely supporting it on the unit 1. This raises pan 50, screed 64 and runners 36. The brackets 43a will limit upward movement of the forward ends of the arms 35 but the permitted movement will be sufficient to space the runners 36 above the surface. If desired, the jacks 43 may be operated to shorten the distance between pivot points 40 and 46 before raising the unit 2 to insure that the runners 36 will be raised sufficiently.

An additional cable and pulley arrangement is provided for yieldably suspending the unit 2 from the unit 1 to permit the unit 2 to perform its function of leveling and finishing the material. This arrangement is illustrated best in Figures 1, 3, 5, 6 and 10. With reference to Figures 1 and 5, it will be noted that the upper part of the frame of the unit 1 is extended slightly beyond the rear ends of the arms 92 and supports a transverse beam 105 which is shown best in Figure 3. Suspended from each end of this beam by a bracket 106 is a pulley 107 and around each of these pulleys passes a cable 108. The upper ends of these cables are directed inwardly towards each

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other and are connected to an adjustable cushioning unit 109. The lower end of each of these cables is anchored to a drum 110 (Figures 3, 6, 9 and 10) rotatably carried between the upper transverse beams 65 of the screed structure adjacent the ends thereof.

The unit 109 is transversely disposed beneath the beam 105 of unit 1, as shown in Figure 3, and the details of this unit are illustrated in Figure 16. It includes a housing composed of telescoping tubular sections 111 and 112, the section 111 threading into the section 112. The outer end of the section 111 is connected to the inner end of the left-hand cable 108 (Figure 3) while the right-hand cable 108 has its inner end connected to the outer end of a rod 113 extending outwardly from the section 112. The rod 113 is slidably mounted in the end of the section 112, as shown in Figure 16 and extends into the section 111, having a compression spring 114 surrounding it. At one end this spring bears against the head of section 112 and at its other end it bears against a stop nut 115 provided on the rod 113. This spring 114 may be compressed to the desired extent initially by threading section 111 into or out of the section 112.

As illustrated best in Figures 6 and 10, the drums 110 are rotatably carried by the beams 65 and may be rotated by cranks applied to the projecting ends 116 of the supporting shaft thereof. These shafts carry ratchet gears 117 (Figures 6 and 7) which are engaged by pawls 118 normally held in engagement therewith by springs 119. Thus, normally the drums 110 are prevented from rotating. However, they may be rotated when the pawls 118 are released. Rotation of the drums 110 will either further compress the spring 114 or permit it to expand, depending upon the direction of rotation of the drums. Either drum may be rotated independently. Thus, the resistance of the spring 114 may be varied readily. The drums should be so adjusted that a portion of the weight of the rear end of the unit 2 will be supported from the unit 1 by the cables 108. However, part of the weight of the unit 2 will be supported on the layer of leveled material by the supporting pan 51 and sufficient weight will be applied to the screed structure 64 so that it will exert the proper compacting and leveling action.

I also provide a heating arrangement for heating the screed structure 64 and the pan structure 50. This arrangement is illustrated best in Figures 13, 14 and 15 and makes the machine suitable for operating satisfactorily on hot mix black top material. It will be noted from Figures 10 and 13 that the inverted channel 67 and the surfacing plate 68 of the screed structure, along with the associated forward and rear plates 67a and 68a, produce a hollow chamber within the screed structure which extends the full length thereof. A baffle plate 120 is secured to the flanges of channel 67 and divides the hollow screed into an upper passageway 121 and a lower passageway 122. The plate 120 extends almost the full length of the channel 67 but its ends are spaced slightly from the ends of the hollow screed which are closed by the plates 123 illustrated best in Figure 9. When heating medium is passed through the lower passageway 122, the heat is conducted into surfacing plate 68 and from this plate into the cutter bar 70. Heat is supplied to the upper passageway 121 by means of a vertical duct 123 which extends downwardly from a heating unit 124 which is shown in Figure 9

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as being attached to the upper beam 65 of the screed structure. This unit 124 may be of any suitable type and the duct 123 leading downwardly therefrom is connected to a passageway 121 through an opening provided in the top of channel 67 intermediate the ends thereof as shown best in Figure 13. As illustrated in Figure 15, the heating unit 124 preferably includes a blower 125. Directly below the duct 123, the plate 120 carries a forwardly and downwardly inclined baffle plate 126 which is disposed over a slot 127 in the plate 120. The heating medium will leave the passageway 122 through the opening or slot 127, being deflected rearwardly by the plate 126 into a duct 128 which is connected to an opening in the rear flange of the channel 67. The duct 128 leads rearwardly to the pan 51 and has a downturned portion connected to a slot 129 formed intermediate the ends of a cover plate 130 provided for the pan. The cover plate in cooperation with the pan forms a heating chamber or passageway 131 extending substantially the full length of the pan. An outlet slot 132 is provided adjacent each end of the pan for escape of the heating medium. The duct 128 is flexible to permit the limited relative movement of the pan and screed occurring during operation of the machine and upon vertical movement of the arms 35. This flexibility also permits the necessary adjustment of the pan 51 by the turn-buckle 61.

With this heating arrangement, the heat developed by the unit 124 passes downwardly, or is forced downwardly, through the duct 123 into passageway 121 of the screed and flows transversely in both directions around the ends of the plate 120 and down into the passageway 122. The heating medium then flows inwardly in both directions until it passes through the slot 127. During passage through the passageway 122, the screed surfacing plate 68 and associated cutter bar 70 are heated. Heating medium emerging through the slot 127 passes through the duct 128 and down through opening 129 into the chamber 131 in the pan and flows outwardly in both directions through this chamber, venting through the slots 132. This will result in heating of the plate 52 of the pan which is in contact with the surface of the layer of material laid by the machine.

In order to form straight edges on the layer of material laid by the machine, the vertically disposed longitudinally extending side edging plates 133 are provided. It will be noted best from Figures 4 and 5 that each of these plates has its rear edge mounted for vertical sliding movement in a bracket 134 which is mounted on the end of the lower hollow part of the screed structure and has its forward edge mounted for vertical sliding movement in a guide bracket 135 attached to the rear portion of the frame of unit 1 at the lower side thereof. These plates have flanges 136 on their lower edges which serve as runners for sliding along the surface. Thus, the plates are free to float vertically relative to the screed and will always be in contact with the surface. The plates will be spaced slightly from the ends of the cutter bar to permit oscillation thereof. Stop pins 137 are provided at the upper forward and rearward corners of the plate to prevent it from dropping from the brackets 134 and 135 when the unit 2 is lifted. The plates 133 are so connected to units 1 and 2 as not to interfere with the relative movement thereof.

In the operation of this machine, material is dumped from a dump truck which preferably is moving along with the machine and directly ahead of it. This material is received by the forward end of the hopper portion 5 of unit 1 and is carried rearwardly by the conveyers 6 which deposit the material on the surface being covered in front of the sections 9 of the spreader 8. The spreader sections serve to feed the material transversely in both directions. As previously indicated, the conveyers 6 and the spreader sections 9 may be independently controlled to obtain selected distribution of the material across the surface in front of the unit 2.

The material deposited by the unit 1 in front of the unit 2 will now be acted upon by the unit 2. Initially, the screed structure 64 is set at a proper height to produce the thickness of laid material desired by adjustment of the jacks 43 which adjust the height of the arms 35 relative to the runners 36 at the forward ends of the arms. In starting the paving operation with the machine, it is customary to use a block under each end of the screed 64 to support it at the proper height until the machine has moved forwardly sufficiently to lay enough of the layer of material for the pan 50 to rest on the surface of such material and prevent dropping of the rear end of the unit 2. As the machine moves forward, the material is cut off by the cutter bar and compacted slightly by the screed 64 and the pan 50 then rides upon such material and further smooths it. With the pan 50 riding on the newly laid material, further adjustment of the jack 43 may be necessary to obtain the correct thickness and this can be accomplished from the rear of the machine, where the newly laid material can be seen, by operating the handwheels 49. No further adjustment for thickness is necessary unless it is desired to change the thickness of the mat or layer. During movement of the machine along the surface to be covered, the operator can efficiently control all the units thereof from the control point 32 or the control point 33 depending upon which side visibility is desired.

The leveling action is accomplished by the runners 36 riding on the relatively rough surface and the pan structure 50 riding on the newly laid material. The screed 64 is suspended between these two points and cuts off and consolidates the material at the level determined by the combined relative positions of runners 36 and pan 50. If the pan 50, which rests upon the newly laid material, is considered as the fulcrum point of the screed arms 35, it can be readily seen that any irregularities in the relatively rough surface which is encountered by runners 36 will influence the height of screed 64 in a lesser amount determined by the ratio between the pan 50, screed 64 and jacks 43 and the position of the runners 36 relative to the irregularity. As an example, assume that the one runner 36 encounters a high spot in the old pavement, the leading end of the runner will rise on this high spot, thus raising the lever arm 35 gradually until the high spot is directly under the pivot point 40 at which time, the lever arm 35 will be at its highest point. As the machine proceeds, the arm 35 will be lowered gradually until the trailing end of the runner passes off of the obstruction. In the meantime, the material which passes under the screed 64 will be laid at various levels, corresponding to the movement of the screed arm 35, and as the pan 50 contacts these changes in level of the

laid material, this pan also influences the level at which the screed 64 is working in that it eventually rides on the material which was cut off by screed 64 under the influence of the runners 36. Since the screed 64 and pan 50 are at a considerable distance behind the leading ends of the runners, and since the relative movement between the runners and the screed 64 takes place gradually, it is possible to average out discrepancies in the level of the old surface and produce a smooth riding new surface. As an illustration, assume the machine encounters a bump. The action of the runners 36, the screed 64 and the pan 50 will tend to deposit more material as the machine approaches the bump, and as the runners start to pass over the bump, a lesser amount of material will be deposited, thus obtaining more material for filling the low spot and less material over the high spot, and as the screed 64 and pan 50 pass over the high spot, the machine will again deposit more material until such time as it reaches a stable condition on the far side of the bump. This process of building up gradually when approaching the high spot, laying a comparatively small amount of material directly over the high spot, and building up again when leaving the high spot, is the general principle by which leveling is accomplished. If a short low spot is encountered, it will be bridged by the runners 36, thus permitting the machine to continue laying material in the same plane. If a low spot long enough to allow the runners to enter is encountered, an operation just the reverse of the one described for the high spot takes place. In laying over rolling sections of road where there are no sharp bumps or low spots, the machine through its average capacity, will lay a uniform thickness of material. This also applies to level sections of highway.

If it is desirable to change the thickness of the laid material while the machine is in operation, this can be accomplished readily by raising or lowering the arms 35 by operation of the handwheels 49. Any movement of this nature will take place gradually due to the distance between screed 64 and pan 50. In actual practice, changes in thickness should be made in small increments while the machine is moving forward so as not to cause the machine to deviate radically from its level at any one point. The screed 64 and the pan 50 may be tilted transversely to obtain lateral tilt in the finished surface by raising one arm 35 higher than the other. Furthermore, the screed may be adjusted to obtain the desired crown on the surface. The suspending means for the unit 2, including cushioning unit 109, can be adjusted so that only the proper amount of weight of the unit 2 is applied by the pan 50 to the newly laid surface.

When moving the machine to another job, the unit 2 may be raised by operation of the hydraulic cylinders 98 for transportation by the unit 1.

It will be apparent from the above description that I have provided a machine having a number of desirable features. Most of these features have been discussed but others will be apparent. Having thus described my invention, what I claim is:

1. Apparatus for leveling material and forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit moved along by said vehicle, said leveling unit including supporting means adapted to ride along said surface for

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supporting the front end of said unit, and supporting means adapted to ride on the newly leveled material for supporting the rear end of said unit, a vertically yieldable connection between said unit and said vehicle to cause them to move along said surface together and to permit relative vertical movement therebetween in response to vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by its front supporting means operating over irregularities in said surface and by vertical movement of the rear supporting means as it moves over the newly leveled material, said leveling unit also including a transversely extending screed structure pivotally carried thereby for movement about a transverse axis intermediate of and spaced from said front and rear supporting means, and parallelogram linkage between said vehicle and said screed of said unit for controlling pivoting of the screed about said transverse pivot axis to maintain said screed substantially vertical regardless of the vertical movement of either end of said unit caused by said supporting means operating over irregularities.

2. Apparatus for leveling material and forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit moved along by said vehicle, said leveling unit including supporting means adapted to ride along said surface for supporting the front end of said unit, and supporting means adapted to ride on the newly leveled material for supporting the rear end of said unit, a vertically yieldable connection between said unit and said vehicle to cause them to move along said surface together and to permit relative vertical movement therebetween in response to vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by its front supporting means operating over irregularities in said surface and by vertical movement of the rear supporting means as it moves over the newly leveled material, said leveling unit also including a transversely extending screed structure pivotally carried thereby for movement about a transverse axis intermediate of and spaced from said front and rear supporting means and intermediate the height of said screed structure, and a connection between said vehicle and said screed of said unit for controlling pivoting of the screed about said transverse pivot axis to maintain said screed substantially vertical regardless of the vertical movement of either end of said unit caused by said supporting means operating over irregularities, said first-named connection comprising drag links pivotally connected to said vehicle and to said unit at said transverse pivot axis and said second-named connection comprising links of equal length to said drag links and parallel thereto which are pivoted to said vehicle and to said screed structure at a level above said transverse pivot axis and which cooperate with the drag links to produce a parallelogram linkage arrangement.

3. Apparatus for leveling material and forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit in trailing relationship with and pulled along by said vehicle, said unit in-

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cluding leveling arms extending along the sides of said vehicle and projecting rearwardly therefrom, elongated runners disposed along the sides of said vehicle and adapted to ride on said surface, means for pivotally connecting the forward ends of said arms to said runners for support thereby, a supporting structure disposed behind said vehicle and adapted to ride on the newly leveled material, said supporting structure including a transversely extending pan which will slide along on the newly leveled material, means for connecting the rear ends of said arms to said supporting structure, a vertically yieldable draught connection connecting said unit to said vehicle to cause them to move along said surface together and to permit relative vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by said runners operating over irregularities in said surface and by vertical movement of said pan of said rearward supporting structure as it moves over the newly leveled material, said draught connection including drag links having their forward ends pivotally connected to the rear side of said vehicle and having their rear ends pivotally connected to said arms, said leveling unit including a transversely extending strike-off member supported by said arms intermediate of and spaced from their points of connection to said runners and to said rearward supporting structure, said strike-off member comprising an upstanding screed structure disposed between said arms and having its ends pivotally connected to said arms intermediate the height of said screed structure, and means for maintaining said screed structure substantially vertical regardless of the vertical positions of said arms, said means including links having their rear ends pivotally connected to said screed structure at a level spaced from said arms and having their forward ends pivotally connected to the rear side of said vehicle.

4. Apparatus for leveling material for forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit in trailing relationship with and pulled along by said vehicle, said unit including leveling arms extending along the sides of said vehicle and projecting rearwardly therefrom, elongated supports disposed along the sides of said vehicle and adapted to ride on said surface, means for connecting the forward ends of said arms to said supports for support thereby, a supporting structure disposed behind said vehicle and adapted to ride on the newly leveled material, and means for connecting the rear ends of said arms to said supporting structure, a vertically yieldable draught connection connecting said unit to said vehicle to cause them to move along said surface together and to permit relative vertical movement therebetween in response to vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by said elongated front supports operating over irregularities in said surface and by vertical movement of said rear supporting structure as it moves over the newly leveled material, said leveling unit including a transversely extending strike-off member supported by said arms intermediate of and spaced from their points of connection to said forward elongated supports and to said rearward support-

ing structure, a suspending connection between the rear end of said leveling unit and said vehicle for supporting part of the weight of said unit, and a cable arrangement for suspending both the front and rear ends of said leveling unit from said vehicle, said cable arrangement including hydraulic actuating cylinders supported by the vehicle, cable guides on said vehicle and cables carried by said guides and connected to said cylinders and to said unit.

5. Apparatus according to claim 4 wherein said suspending connection includes means adjustable to vary the weight of the unit supported by the vehicle.

6. Apparatus for leveling material and forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit in trailing relationship with and pulled along by said vehicle, said unit including leveling arms extending along the sides of said vehicle and projecting rearwardly therefrom, elongated runners disposed along the sides of said vehicle and adapted to ride on said surface, links pivotally connecting the forward ends of said arms to said runners, jacks connected between the forward end portions of said arms and said runners and being vertically adjustable to vary the height of the arms relative to said runners, a supporting structure disposed behind said vehicle and adapted to ride on the newly leveled material, said supporting structure including a transversely extending pan which will slide along on the newly leveled material, and means for connecting the rear ends of said arms to said supporting structure, a vertically yieldable draught connection connecting said unit to said vehicle to cause them to move along said surface together and to permit relative vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by said runners operating over irregularities in said surface and by vertical movement of said pan of said rearward supporting structure as it moves over the newly leveled material, said leveling unit including a transversely extending strike-off member supported by said arms intermediate of and spaced from their points of connection to said runner members and said rearward supporting structure.

7. Apparatus according to claim 6 including adjusting members connected to said jacks and extending to points adjacent the rear end of said leveling unit.

8. Apparatus for leveling material and forming a desired surface thereon comprising a vehicle having supporting means for operating on the surface to which said material is to be applied, a leveling unit in trailing relationship with and pulled along by said vehicle, said unit including leveling arms extending along the sides of said vehicle and projecting rearwardly therefrom, elongated supports disposed along the sides of said vehicle and adapted to ride on said surface, means for connecting the forward ends of said arms to said supports for support thereby, a supporting structure disposed behind said vehicle and adapted to ride on the newly leveled material, means for connecting the rear ends of said arms to said supporting structure, a vertically yieldable draught connection connecting said unit to said vehicle to cause them to move along said surface together and to permit relative vertical movement therebetween in response

to vertical movement of the vehicle caused by its supporting means operating over irregularities in said surface and in response to vertical movement of said unit caused by said elongated front supports operating over irregularities in said surface and by vertical movement of said rear supporting structure as it moves over the newly leveled material, said leveling unit including a transversely extending strike-off member supported by said arms intermediate of and spaced from their points of connection to said forward elongated supports and said rearward supporting structure, a suspending connection between the rear end of said leveling unit and said vehicle for supporting part of the weight of said unit and being adjustable to vary the amount of weight supported thereby, such suspending connection including a pair of cables each of which has one end connected to said leveling unit and the other end passing over a guide supported by said vehicle, a cushioning unit, said cushioning unit including relative movable elements having a cushioning member therebetween, said elements being respectively connected to the other ends of said cables, one of said elements being adjustable relative to the other to vary the effect of said cushioning member.

9. Apparatus according to claim 8 including an additional cable arrangement for suspending both the front and rear ends of said leveling unit from said vehicle, said cable arrangement including hydraulic actuating cylinders supported by the vehicle, cable guides on said vehicle, and cables carried by said guides and connected to said cylinders and to said unit.

10. In combination with a vehicle, a leveling unit connected to said vehicle for movement therewith and for producing a predetermined surface on road material or similar material deposited on the surface to be covered, comprising a frame having forward supporting means adapted to operate along the relatively rough surface to be covered and rear supporting means adapted to operate on the newly laid material, a transversely extending screed structure pivotally carried by said frame for movement about a transverse axis intermediate of and spaced from said forward and rearward supporting means, parallelogram linkage for maintaining said screed structure substantially vertical regardless of the vertical movement of either end of said frame caused by said supporting means operating over irregularities, said linkage including drag links pivotally connected to said vehicle and pivotally connected to said frame at said transverse screed pivot axis and links pivoted to said vehicle and pivoted to said screed structure at a level above said transverse axis.

11. The combination of claim 10 wherein said frame includes longitudinally extending leveling arms, said front supporting means includes elongated runners that slide along the relatively rough surface and to which the forward ends of said arms are pivotally connected, said rear supporting means includes a transversely extending pan which operates on the newly leveled material and to which the rear ends of said arms are connected, and said screed structure is pivoted to said arms intermediate the length thereof.

12. The combination of claim 11 wherein said pivotal connections includes links pivoted to said arms and to said runners and jacks connected between the forward end portions of said arms and said runners and being vertically ad-

justable to vary the height of the arms relative to said runners.

13. The combination of claim 12 wherein connecting means is provided between the rear ends of said arms and said pan and includes transverse pivots for pivotally supporting said pan on said arms for tilting movement forwardly or rearwardly, and adjustable rods pivotally connected to said pan and to said arms for tilting said pan relative to said arms and for holding it in adjusted position.

14. The combination of claim 13 wherein said connecting means also includes longitudinal pivots provided between the rear ends of said arms and said pan at right angles to said transverse pivots for transverse tilting of the pan.

15. In combination with a vehicle, a leveling unit connected to said vehicle for movement therewith and for producing a predetermined surface on road material or similar material deposited on the surface to be covered, comprising a frame having forward supporting means adapted to operate along the relatively rough surface to be covered and rear supporting means adapted to operate on the newly laid material, said frame including longitudinally extending leveling arms, said front supporting means including elongated runners that slide along the relatively rough surface and to which the forward ends of said arms are pivoted, a transversely extending screed structure pivoted to said arms intermediate the length thereof for movement about a transverse axis, said rear supporting means including a transversely extending pan which operates on the newly leveled material and to which the rear ends of said arms are connected by connecting means between the rear ends of said arms and said pan including transverse pivots, means between said pan and said arms which normally prevent tilting of said pan forwardly or rearwardly about said pivots, and pivots between said arms and said pan disposed at right angles to said transverse pivots which permit transverse tilting of the pan relative to said arms, and parallelogram linkage for maintaining said screed structure substantially vertical regardless of the vertical movement of either end

of said frame caused by said supporting means operating over irregularities, said linkage including drag links pivotally connected to said vehicle and pivotally connected to said frame at said transverse screed pivot axis and links pivoted between said screed structure and vehicle at a level above said transverse pivot axis and pivoted to said vehicle.

16. The combination of claim 15 wherein said means between said pan and said arms comprises adjustable rods having their ends pivotally connected to said pan and to said arms and being adjustable to tilt said pan forwardly or rearwardly about said transverse pivots relative to said arms.

17. The combination of claim 15 wherein said pan and screed structure are hollow, a heating unit carried by said screed structure, a duct connecting said unit to said hollow screed structure, and a flexible duct connecting said hollow screed structure and said pan to permit relative movement.

18. The combination of claim 15 including side edging plates vertically disposed at each end of said strike-off member; and means for mounting said plates on said frame and said vehicle for free vertical movement relative to said strike-off member.

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