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MEANS FOR LAYING PAVING MATERIAL

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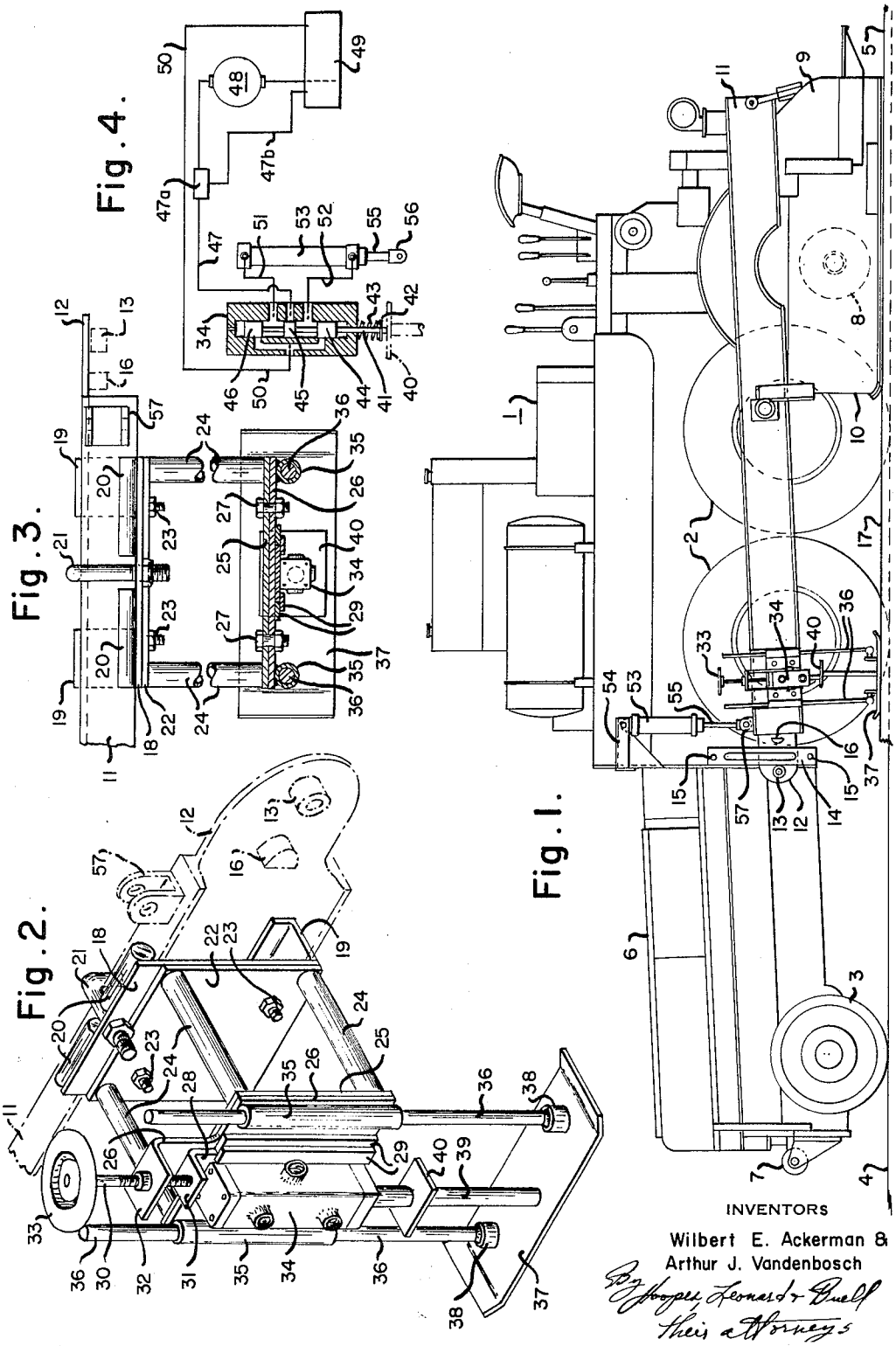


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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MEANS FOR LAYING PAVING MATERIAL

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This invention relates to means for paving wherein the paving material is placed and then is smoothed and leveled by means drawn forwardly along the deposited paving material.

The placing of paving material has long been carried on employing various forms of mechanical paving equipment. Such paving machines have often embodied a tractor-like apparatus which places or distributes paving material and is followed by apparatus which serves to level and smooth the deposited paving material. The leveling and smoothing apparatus is commonly known as a screed but may variously include paving material compactors, fixed or moving strike-off bars, and the like. In some forms of prior art pavers, the screed rests upon the deposited paving material and is pulled forwardly therealong by extended arms reaching forwardly from the screed. Such a paver long known to the art is shown, for example, in British Patent 397,882 to Waldvogel.

The pavers previously known to the art often placed a course of paving material to form a pavement with the surface at an improper elevation. For example, when such pavers are used to place several parallel courses of paving material, the second course was not infrequently at a different final grade than the earlier course immediately beside it. In like manner, where a single course was being placed, it was sometimes at the wrong elevation when completed. While the error in case of a single course is not nearly as critical as where parallel abutting courses are being laid with a continuous longitudinal joint, the lack of control and adjustment has caused some problems. The problem is accentuated by the fact that the base over which the paving machine operates is normally irregular and such irregularities are reflected in the finished grade if careful control is not maintained.

We provide means for depositing paving material on a base, leveling and smoothing means resting upon the deposited paving material and drawn therealong, and means to vary the angle of the leveling and smoothing means relative to a reference plane. We provide means to maintain a predetermined distance between the leveling and smoothing means and the reference plane, and to correct for variations in said predetermined distance. We preferably provide tractor means adapted to move along an irregular base and deposit paving material thereon, leveling and smoothing means extending transversely across the deposited paving material rearwardly of the tractor means, and pull means extending forwardly therefrom to the tractor means. We further preferably provide means to selectively adjust the forwardly portion of said pull means vertically relative to the tractor means and provide means to measure the vertical distance between the pull means and a reference plane. We further preferably provide control means in operative connection with the measuring means and controlling the means for adjustment of the pull means. We preferably arrange the control means and adjusting means in operative connection for operation of the adjusting means responsive to the control means to maintain a fixed measured distance from a point on the forward end of the pull means to the reference plane and preferably provide means to vary the operative connection between the control means and adjusting means.

Other details, objects and advantages of our invention will become more apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings, we have illustrated a present preferred embodiment of our invention in which

FIGURE 1 is a side view of a paving machine embodying the invention but with certain conventional elements omitted;

FIGURE 2 is a perspective view of a portion of the apparatus shown in FIGURE 1, but illustrated on the opposite side of the paving machine and having portions omitted for clarity;

FIGURE 3 is a plan view of the apparatus shown in FIGURE 2; and

FIGURE 4 is a schematic view of the hydraulic control circuit.

A paving machine which may be of well-known design is shown in FIGURE 1. It comprises a self-propelled tractor **1** mounted upon pneumatic tires **2** and rubber wheels **3** for forward motion. The paver operates upon a base **4** upon which paving material is to be placed to form a pavement **5**. Base **4** may sometimes be an earlier layer of paving material which is to be resurfaced, or it may be material which has been graded prior to placing the paving material for new construction. In such circumstances, the base will ordinarily be formed of broken stone or the like. Paving material is ordinarily dumped from a truck into a hopper **6** positioned at the forward end of the paver. Rollers **7** are provided on each side of the paver at its forward end for pushing the trucks while they are delivering paving material. Paving material is then conveyed rearwardly within the tractor and is deposited behind wheels **2** in advance of a distributing screw **8** which extends transversely across the rear of the tractor and distributes paving material across the base in excess quantity. A screed indicated at **9** extends tranversely across the pavement behind the distributing screw. Various forms of screeds are well-known in the art and need not be described in detail here. A screed may, for example, comprise a strike-off which will contact paving material which has been deposited and spread by the paver and push the excess material ahead, bringing the balance of the material to a level approximating the final grade. Compactors may optionally be employed to consolidate the paving material to the extent desired as it is laid. The screed embodies a large sole plate which acts in the nature of a large flatiron to smooth the surface which has been leveled by the strike-off or tampers. An edge plate **10** is mounted on either end of the screed to prevent paving material from being carried beyond the end of the screed by the distributing screw. The screed itself is rigidly affixed to a pair of pull arms **11** which extend forwardly, one on either side of the tractor, at the forward end of which a roller bearing **13** is mounted on the outer side of a plate section **12** at the forward end of each pull arm, the inner race of the bearing being bolted to the pull arm and the outer race being free to rotate. The pull arms propel the screed forwardly with the tractor. A vertically positioned anchor bar **14** is bolted to the tractor frame by bolts **15**. Spacers are provided to hold the anchor bar spaced outwardly from the frame and to form a narrow slot therebetween. Forward movement of the tractor brings anchor bar **14** against roller bearing **13** and thus transmits forward pull to the pull arms. The screed arm is prevented from moving forwardly by a stop **16** which is welded to the forward portion **12** of each pull arm and which will strike the rear side of anchor bar **14** in the event the pull arms move forwardly relative to the tractor.

A fragment of a previously laid course of pavement is

indicated at 17 with the paver laying a new course abutting the course at 17.

A bracket 18 is clamped to the forward end of one or both of the pull arms. Two flanges 19 extend beneath and behind the lower part of one of the pull arms 11, and stops 20 welded to bracket 18 rest on the upper surface of the pull arm. An angle bolt 21 passes above and behind the upper surface of the pull arm and, when tightened up, holds bracket 18 securely fastened in position. A plate 22 is bolted to bracket 18 by bolts 23. Extension members 24 extending from plate 22 terminate in a plate 25 welded to their opposite ends. Bracket 26 is then bolted to plate 25 by bolts 27. Assemblies of plates 22 and 25 having intermediate extension members 24 of various lengths may be provided for the purpose of selectively fixing the distance the measuring means are supported from the pull arm. A sliding valve mounting 28 is slidably clamped to bracket 26 by an assembly of bars 29 welded to bracket 26 which form a flange under which bracket 28 is slidably movable. A screw 30 has its lower end fixed for rotation in flange 31 of valve mounting 28. It is threaded in a corresponding flange 32 of bracket 26. A handwheel 33 is fixed to the upper end of screw 30 for easy rotation of the handwheel. A hydraulic valve 34 is fixed to valve mounting 28.

Two tubes 35 are welded to bracket 26 and receive rods 36 which are slidable vertically within tubes 35. A feeler shoe 37 is mounted on the lower ends of rods 36 by ball and socket joints 38. The ends of the shoe are turned upwardly to assist it in riding over the surface upon which it rests as the paver moves forwardly. An upwardly extending rod 39 is welded to the upper surface of shoe 37 and terminates in a pad 40.

Valve 34 is a spool valve having a central rod 41 which rests against pad 40. A washer 42 is fixed to the lower end of the rod and a spring 43 is compressed between washer 42 and the body of valve 34, urging the rod downwardly. Three spools 44, 45 and 46 are formed on rod 41 within the valve. Hydraulic fluid is supplied to the valve through a line 47 from hydraulic pump 48 which draws the fluid from a sump 49. A relief valve 47*a* is placed in line 47 and permits oil to be returned to sump 49 through line 47*b* when excess pressure is developed in line 47. A fluid return line 50 is provided from valve 34 to return fluid to sump 49. Two hydraulic lines 51 and 52 extend to opposite ends of a double-acting hydraulic cylinder 53. A bracket 54 is welded to each side of the tractor above the front end of the pull arms. Cylinder 53 may optionally be placed on either side of the tractor. The upper end of the cylinder is attached to bracket 54 by a removable pin which may be withdrawn to permit cylinder 53 to be conveniently moved from one side of the tractor to the other. Piston rod 55 extending from cylinder 53 terminates in a flat portion 56 which is mounted in a clevis 57 welded to the upper surface of each pull arm adjacent its forward end. The hydraulic lines are shown diagrammatically in FIGURE 4 but have been omitted from the other figures for purposes of clarity. Extensions of the lines 51 and 52 are provided to both sides of the tractor for convenient connection of cylinder 53 thereto, and valves are provided to close off the inactive extensions.

When valve rod 41 is moved upwardly from the position shown in FIGURE 4, upward movement of the spools will uncover the port connected to supply line 47, connecting it to supply line 52. The same upward movement will cause spool 46 to open hydraulic line 51 to fluid return line 50. In similar manner, when valve rod 41 moves downwardly from the position shown in FIGURE 4, movement of spool 45 will connect supply line 47 to line 51 and movement of spool 44 will open hydraulic line 52 to return line 50.

The forward ends of pull arms 11 may be conventionally operated up and down by a vertically positioned screw member which threadedly engages a nut attached to the forward end of each pull arm. The screw members and operating means are well understood and have, therefore, been omitted from the drawings to clarify the points of novelty herein. When cylinder 53 is to be placed in operative connection between one of the brackets 54, the associated screw member is unscrewed from the nut and is temporarily removed.

In operation, tractor 1 is propelled forwardly along the base 4. Paving material is supplied to hopper 6 and is deposited on the base where it is distributed by screw 8 ahead of the screed. As the tractor moves forward, pull arms 11 will pull the screed forwardly. It is free to pivot about roller bearing 13 and receives only a horizontal or pulling force from the tractor. As the paver advances, the screed will adopt an angle in which the sole plate will slide forwardly along the deposited paving material in the plane of its motion. The forces on the paving material beneath the screed will ordinarily be composed of a normal force entirely due to the weight of the screed and a force in the plane of the pavement surface caused by the screed sliding along it. Any other angle of the screed relative to the paving material will place the sole plate at an angle to its direction of motion and will produce a component of upward or downward force on the screed. The screed will then tend to move responsive to that component of force as it advances forwardly until the component of upward or downward force disappears and the screed is again moving with the sole plate in the plane of movement of the screed. The result is to increase or decrease the relative elevation of the screed and strike-off thereby having a greater or lesser thickness of paving material placed beneath the screed.

The screed will tend to assume the same position regardless of the vertical relationship between the pull arms 11 and tractor 1. In consequence, the thickness of the paving material which is placed—and the thickness of the pavement—may be varied by shifting the position of the forward end of the screed pull arms. If the forward ends of the pull arms are lifted, the screed and sole plate will gradually rise to a higher level as the paver moves forwardly and will increase the thickness of the material being placed. In like manner, if the front ends of the pull arms are lowered, the screed will gradually descend to a lower elevation and will strike off more of the paving material leaving a thinner layer.

The screed is sufficiently flexible that it may be warped or twisted by raising or lowering one of the pull arms independently of the other. Ordinarily, the two pull arms will be independently controlled—ordinarily one by manual control and one by automatic control as set forth herein. The screed will warp to conform to the positions of the two pull arms and establish a smooth paving surface between its two sides, each side acting in conformity to its associated pull arm.

Frequently, the base upon which paving material is to be laid is somewhat roughened and irregular, with the result that the tractor moves vertically due to roughness and irregularities as it proceeds forwardly along the base. This consequently changes the absolute level of the front ends of the pull arms. The irregularities then tend to be reflected in the surface of the paving material 5 which is being leveled and smoothed by the screed. The construction of the machine and the gradual change of elevation of the screed following change of elevation of the front end of pull arms 11 tends to minimize minor irregularities, but they will be reflected to some extent in the finished grade of the pavement.

When parallel courses are being laid, it is desirable to place the second course at precisely the same elevation as the first course. Failure to do so results in a rough longitudinal joint due to the sudden change of elevation between the adjoining courses. An assembly of plates 22 and 25 is selected having extension members 24 of proper length for feeler shoe 37 to rest upon the adjoining course 17. If the paver is employed to lay a course between two

existing courses, independent automatic control means may be employed on each side. As the tractor proceeds forwardly along the base, the weight of feeler shoe **37** and of rods **36** will cause shoe **37** to follow the previously laid pavement surface. In the event of upward movement of the tractor relative to the previously laid pavement, shoe **37** and rods **36** will drop in tubes **35** permitting spring **43** to move valve rod **41** downwardly. This will cause hydraulic fluid to be supplied from pump **48** to the upper end of cylinder **53**. This will cause piston rod **55** to extend, thereby moving the forward ends of the associated pull arm **11** downwardly. When it has moved downwardly a distance to compensate for the relative upward movement of the tractor, the lower end of valve rod **41** will contact pad **40** and return the valve to the position shown in FIGURE 4. In like manner, should the tractor move downwardly relative to pavement course **17**, valve rod **41** will be moved upwardly resulting in upward movement of the associated pull arm until it has compensated for relative movement of the tractor and returned the pull arm to a fixed distance above pavement course **17**. Thus, the forward end of one pull arm **11** will continuously be maintained a fixed distance from pavement course **17**. Accordingly, one side of the screed will follow a reference plane established by the earlier laid pavement course **17**. Even though the tractor is subject to irregular movement because of travel over the base **4**, the screed will maintain a relatively stable position while moving forwardly with the tractor. The other side will ordinarily be under manual control in the conventional manner, and the screed will warp as necessary, forming a smooth pavement surface between the two sides. In this manner, the new course adjoining the previously laid course will be perfectly matched without any vertical displacement at the joint. The other side of the new course will be leveled and a grade established as heretofore, the flexibility of the screed permitting it to warp sufficiently to accommodate any variances between the two sides.

Thus, the screed will tend to stay a fixed distance from the reference plane, providing a smooth and even joint between adjoining courses. Minor variations will automatically be corrected, restoring the screed to its predetermined elevation and maintaining it there.

In the initial start-up it may be found that the adjoining courses are laid at different elevations. Rotation of handwheel **33** will move valve **34** up or down changing the relationship between the fixed valve and the movable feeler. In this manner, the forward ends of pull arms **11** may be adjusted until the screed is stabilized to lay course **5** coplanar with course **17**. It is to be noted that asphaltic paving material is ordinarily rolled following passage of the paver and that the rolling further compacts the paving material. In such a case, handwheel **33** is adjusted to lay course **5** at an elevation above course **17** to compensate for compaction upon rolling.

Feeler shoe **37** need not necessarily operate or rest upon a previously laid course of pavement. A measurement may be obtained from any other convenient reference plane. The reference plane may be set, for example, by survey and the placing of a surface indicative of the plane. Other forms of guides may also be used to indicate or define a reference plane. While it is convenient to employ the previously laid course of pavement as a reference plane where parallel courses are being laid, it is apparent that a plane otherwise determined may be desirable or necessary where an original course is being laid. The shoe may, for example, engage a previously laid curb and gutter structure.

While we have illustrated and described a present preferred embodiment of our invention, it is to be understood that the invention is not limited thereto and may be otherwise variously practiced within the scope of the following claims.

We claim:

1. In a paving machine, tractor means adapted to move along a base and deposit paving material thereon, screed means resting upon the deposited paving material, screed arm means extending forwardly from the screed means and connected to the tractor means by a vertically shiftable connection, means to vertically adjust the point of connection of the screed arm means relative to the tractor means, means to measure the vertical distance between the screed arm means at a point forward of the screed and a reference plane extending generally in the direction of movement of the tractor means, and control means in operative connection therewith and with the screed arm adjusting means whereby said measuring means actuates said control means in response to change in distance between said point and said reference plane to operate said arm adjusting means and maintain said point at a fixed position.

2. In a paving machine, tractor means adapted to move along an irregular base and deposit paving material thereon, pavement leveling and smoothing means extending transversely across the rear end of the tractor means, pull means connected to the leveling and smoothing means and extending forwardly, means mounted on the tractor means and restraining the forward end of the pull means from horizontal movement relative thereto, power means operable to selectively move the forward end of the pull means vertically relative to the tractor means, feeler means extending downwardly from said pull means adjacent the forward end thereof to a reference plane and mounted for vertical movement relative to the pull means, control means in operative connection with the feeler means and the power means and operable to cause the power means to move the forward end of the pull means vertically relative to the tractor means following movement of the feeler means relative to the pull arms thereby maintaining the forward end of the pull arms a fixed distance from the reference plane.

3. In a paving machine, tractor means adapted to move along an irregular base and deposit paving material thereon, pavement leveling and smoothing means extending transversely across the rear end of the tractor means, pull means connected to the leveling and smoothing means and extending forwardly, means mounted on the tractor means and restraining the forward end of the pull means from horizontal movement relative thereto, power means operable to selectively move the forward end of the pull means vertically relative to the tractor means, reference plane feeler means extending downwardly from said pull means adjacent the forward end thereof to a reference plane and mounted for vertical movement relative to the pull means, control means in operative connection with the feeler means and the power means and actuated by relative vertical movement of the feeler means to cause the power means to move the forward end of the pull means vertically relative to the tractor means following movement of the feeler means thereby maintaining the forward end of the pull arms a fixed distance from the reference plane, and means to vary said operative connection between the control means and the feeler means.

4. In a paving machine, tractor means adapted to move along an irregular base and deposit paving material thereon, said tractor means being subject to irregular motion as it proceeds forwardly along said base, pavement leveling and smoothing means extending transversely across the rear of the tractor means, pull means connected to the leveling and smoothing means and extending forwardly, means mounted on the tractor means restraining the forward end of the pull means from horizontal movement relative thereto, means interconnected between the tractor means and pull means and operative to cause vertical movement of the front end of the pull means relative to the tractor means, distance measuring means placed to measure the vertical distance between the pull means adjacent the front end thereof and a reference plane, control means in operative connection with the distance measuring means and responsive

thereto and controlling operation of the means for vertical movement, said control means and measuring means being arranged to cause operation thereof and thereby produce relative vertical movement of the front end of the pull means upon a change in the measured distance between the pull means and the reference plane whereby the measured distance between the pull means and the reference plane is maintained constant.

5. In a paving machine, tractor means adapted to move along a base and deposit paving material thereon, pavement leveling and smoothing means extending transversely across the rear of the tractor means, pull means connected to the leveling and smoothing means and extending forwardly, means mounted on the tractor means restraining the forward end of the pull means from horizontal movement relative thereto, hydraulic means interconnected between the tractor means and pull means and operative to cause vertical movement of the front end of the pull means relative to the tractor means, distance measuring means mounted on the pull means and placed to measure the vertical distance between the pull means adjacent the front end thereof and a reference plane, control means in operative connection with the distance measuring means and responsive thereto and controlling operation of the hydraulic means, said control means and measuring means being arranged to cause operation of the hydraulic means and resulting relative vertical movement of the front end of the pull means upon a change in the measured distance between the pull means and the reference plane whereby the measured distance between the pull means and the reference plane is maintained constant, and means to vary said operative connection between the control means and the measuring means.

6. In a paving machine, tractor means for depositing paving material upon a base, screed means resting upon said deposited paving material and drawn along by the tractor means, means measuring the vertical distance between a point on a forwardly extending extension of the screed and a reference plane extending generally in the direction of movement of the tractor means, screed angle adjusting means carried by the tractor means and operatively connected to the forwardly extending extension of the screed, control means responsive to said measuring means and in controlling relationship to said screed angle adjusting means whereby said measuring means actuates said control means in response to a change in said vertical distance to operate said screed angle adjusting means and maintain a desired vertical distance between said point and said reference plane.

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