May 9, 1967 H. D. DURSTON ETAL 3,318,208

PAVING MACHINE

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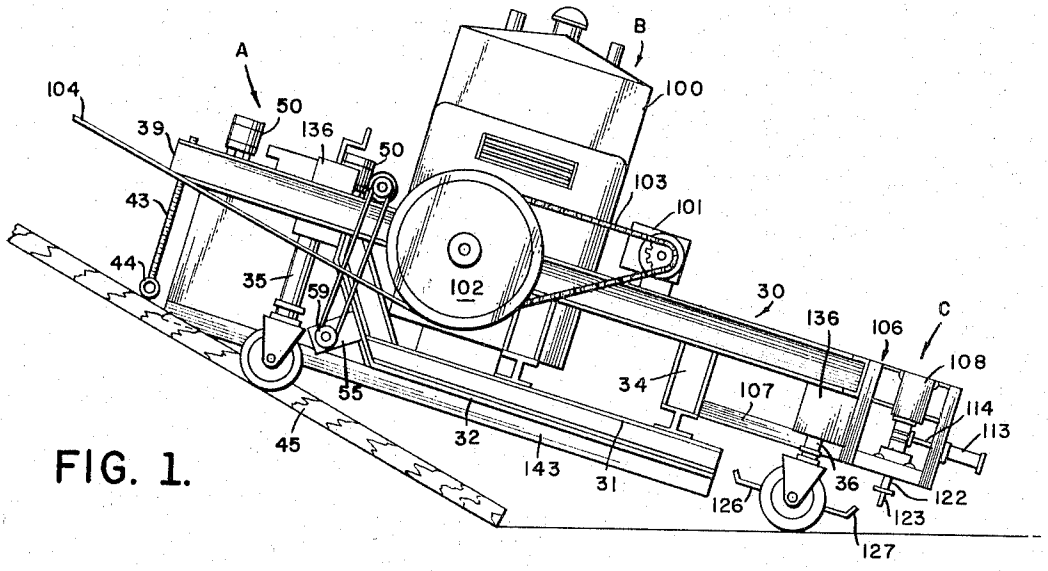


FIG. 1.

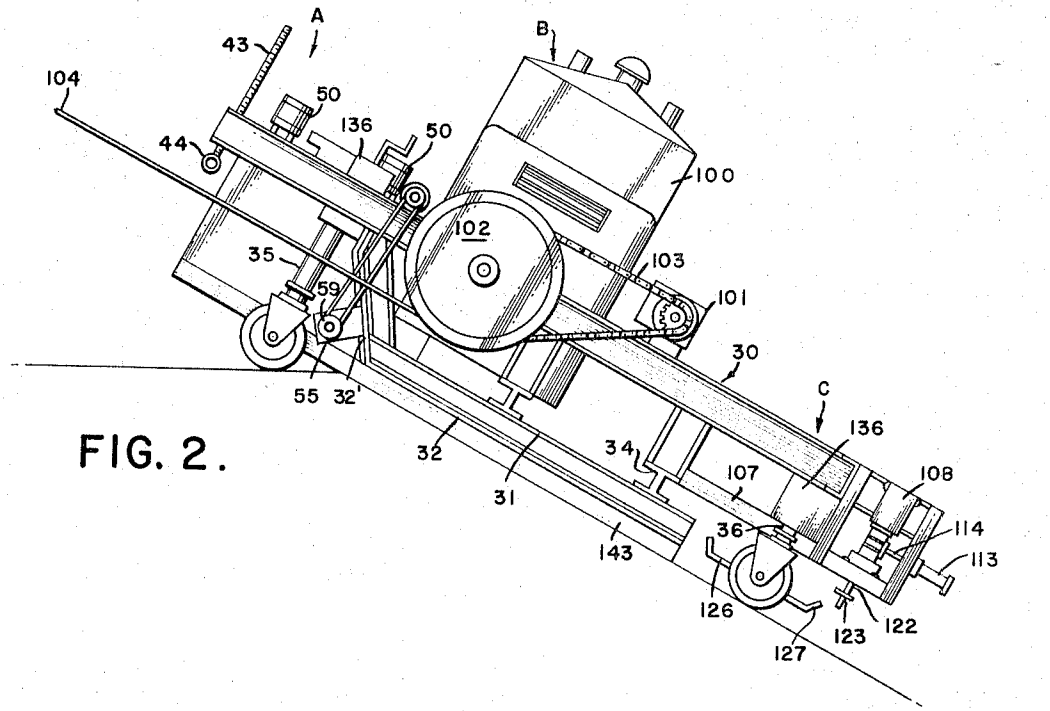


FIG. 2.

INVENTORS

HARRY D. DURSTON
ALFRED PERRY

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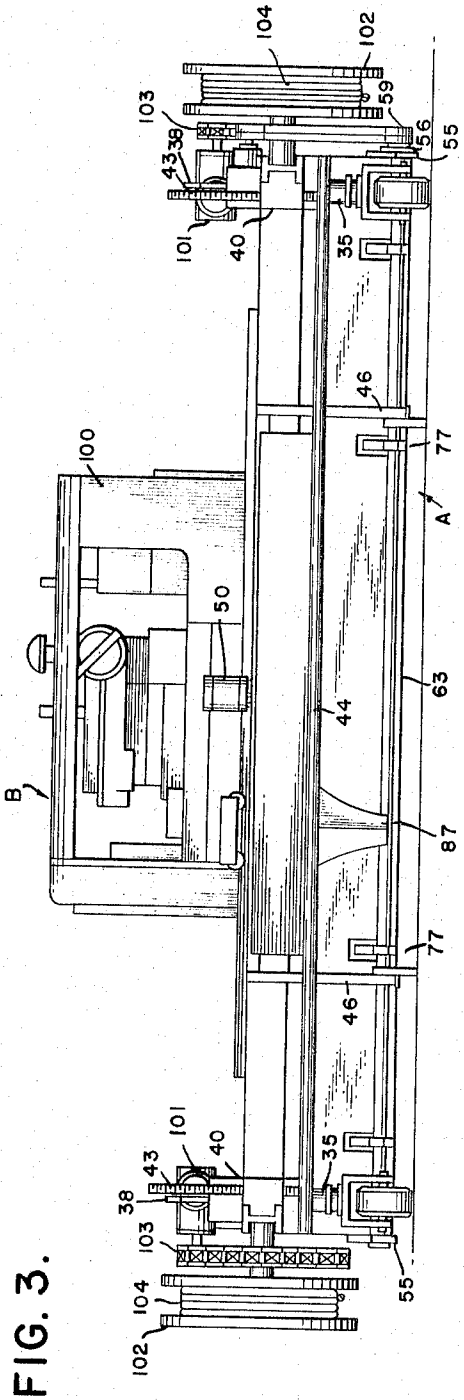


FIG. 3.

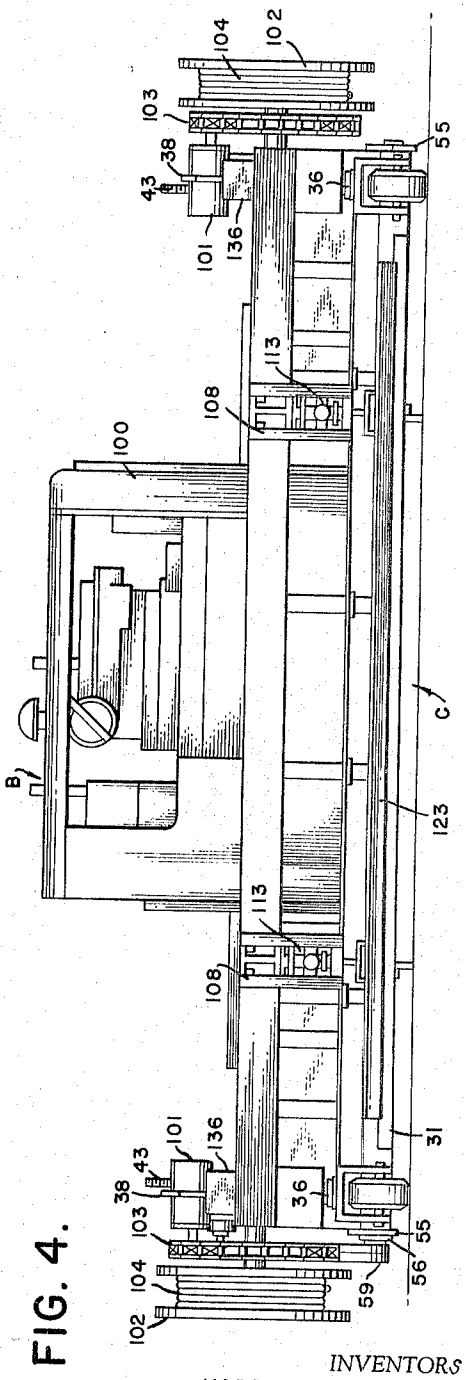


FIG. 4.

INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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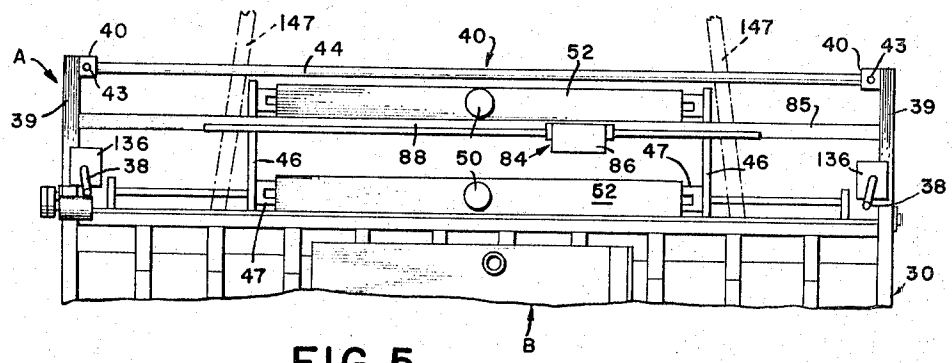


FIG. 5.

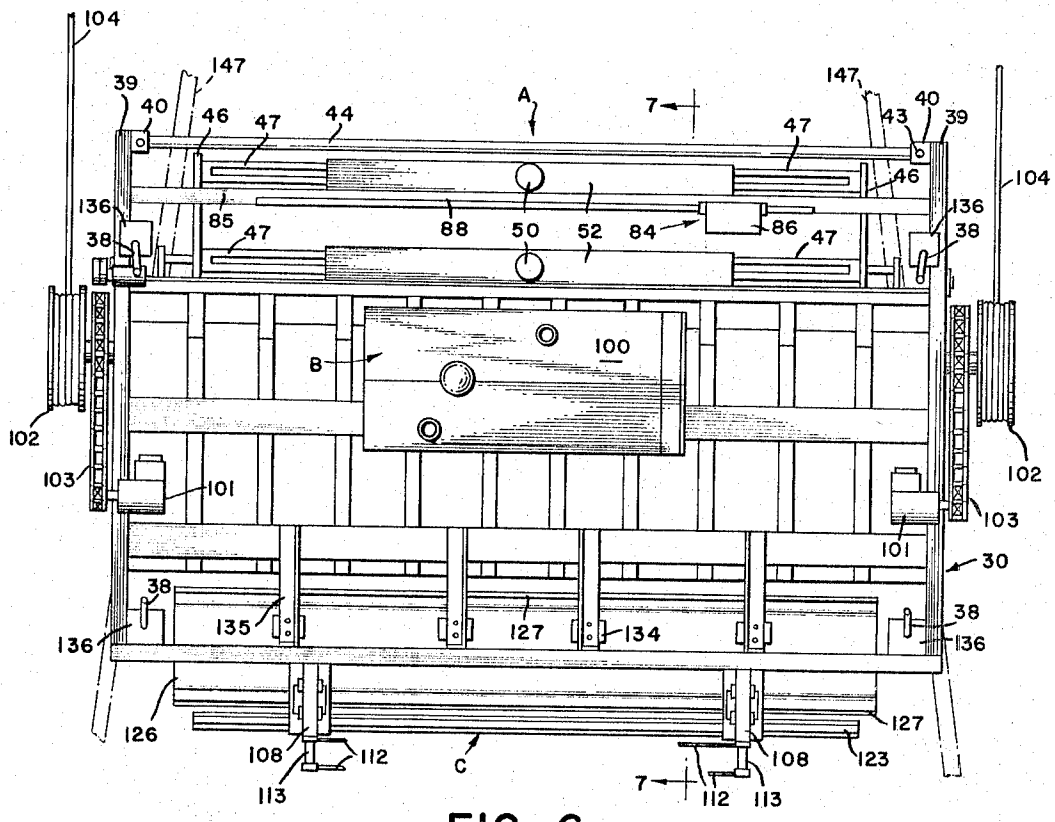


FIG. 6.

INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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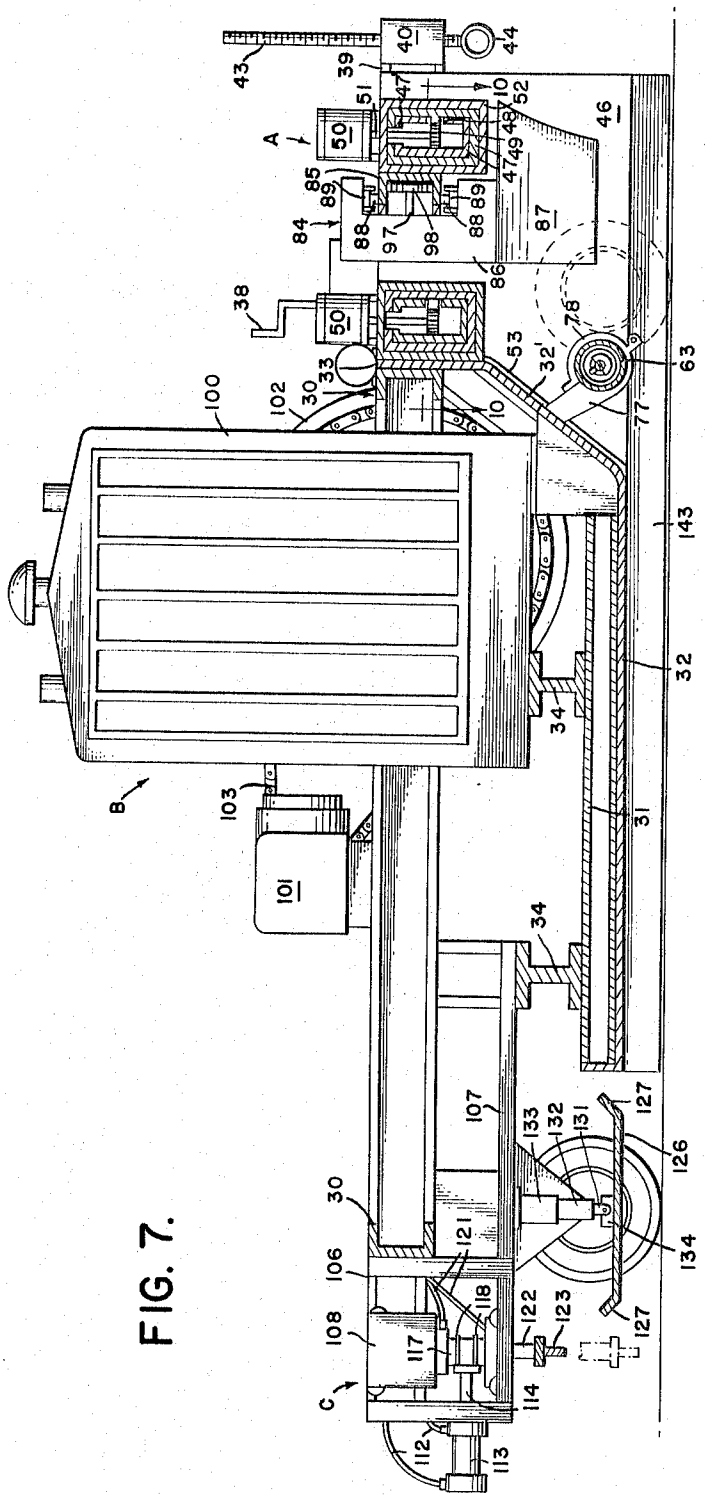


FIG. 7.

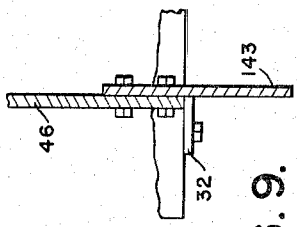


FIG. 9.

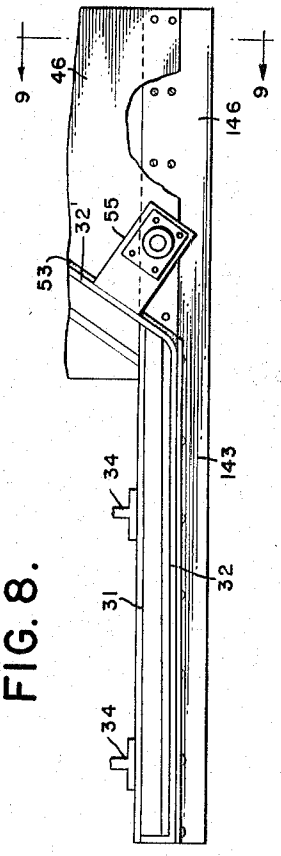


FIG. 8.

INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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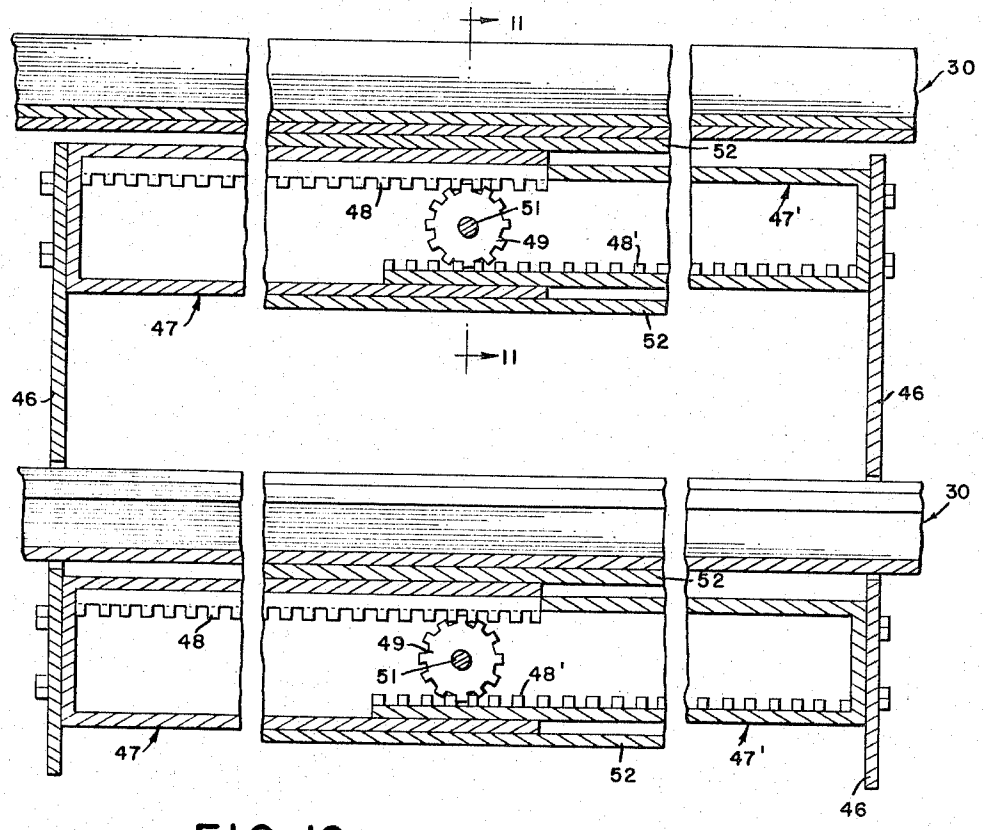


FIG. 10.

FIG. 11.

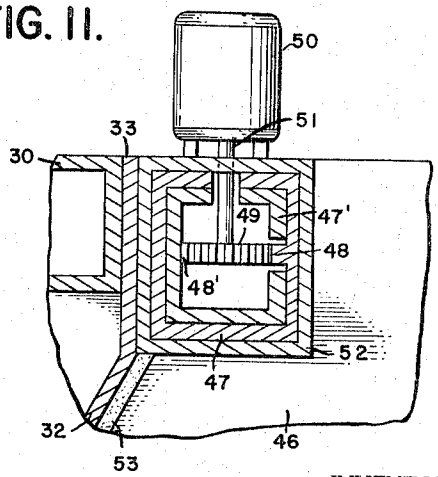
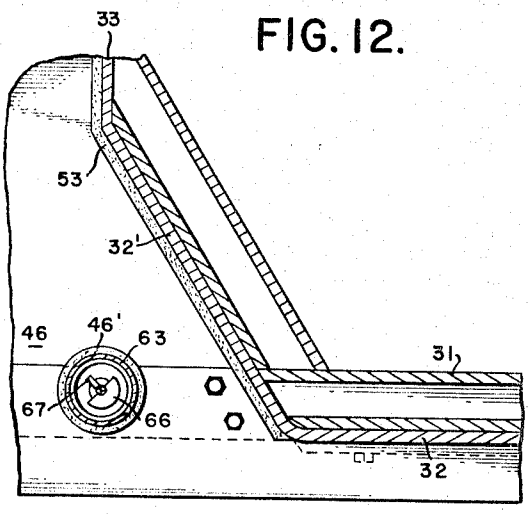


FIG. 12.



INVENTORS

HARRY D. DURSTON

ALFRED PERRY

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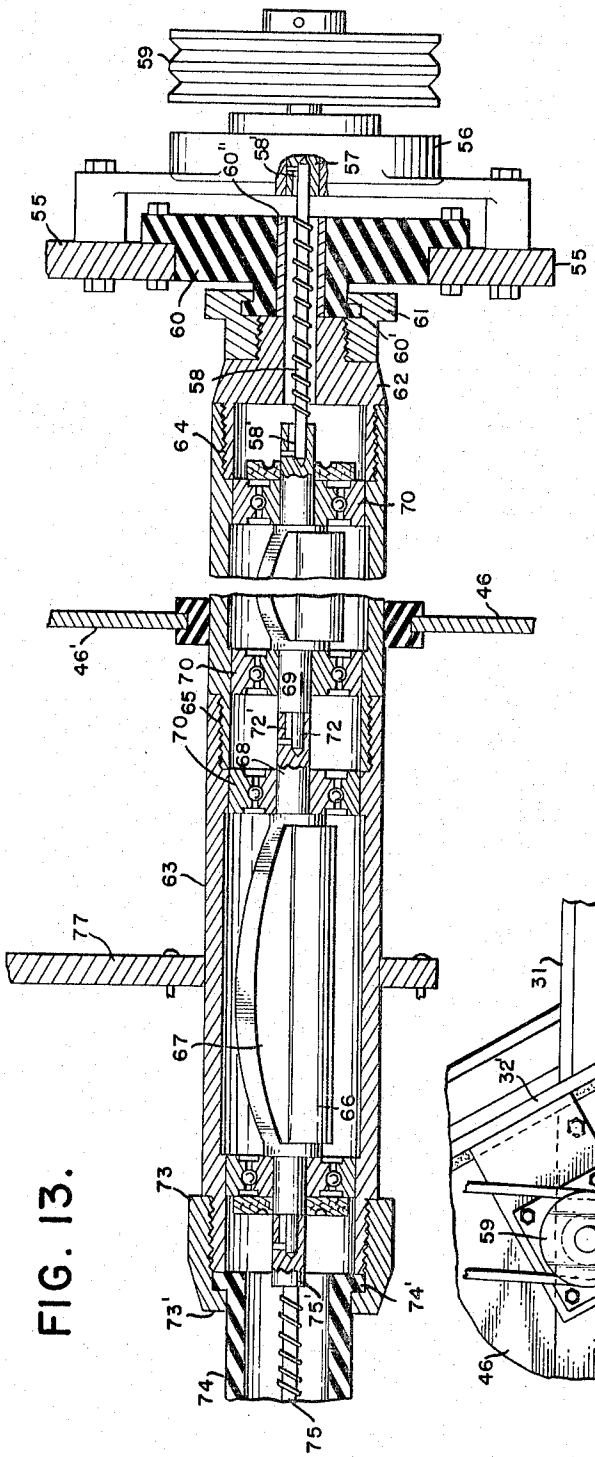


FIG. 13.

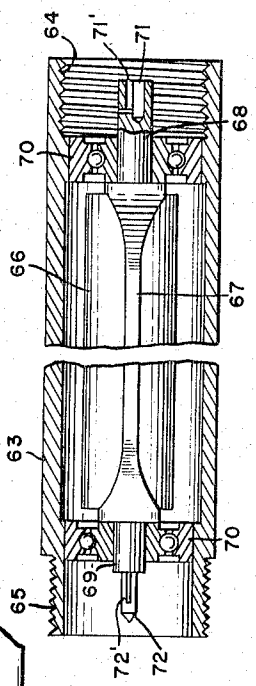


FIG. 14.

FIG. 13a.

INVENTORS

HARRY D. DURSTON
ALFRED PERRY

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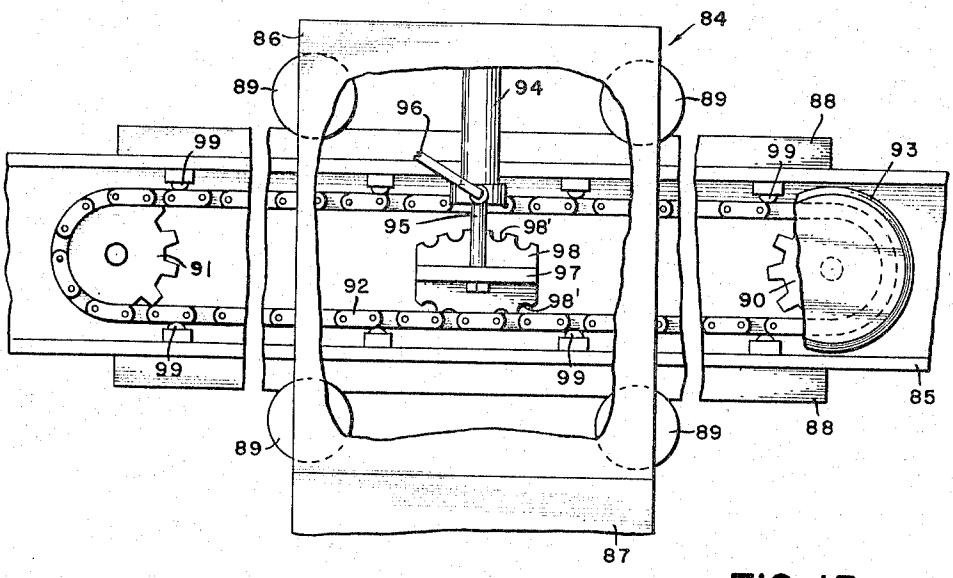


FIG. 15.

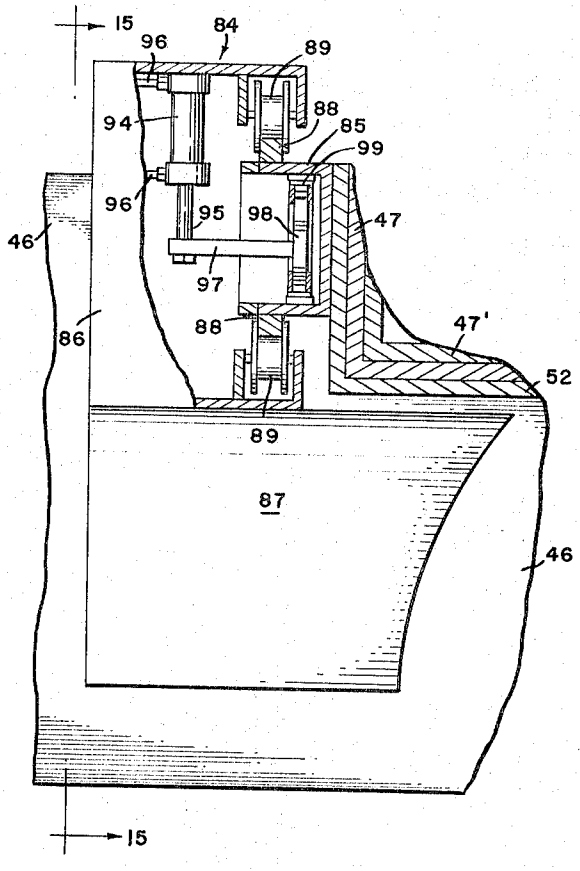


FIG. 16.

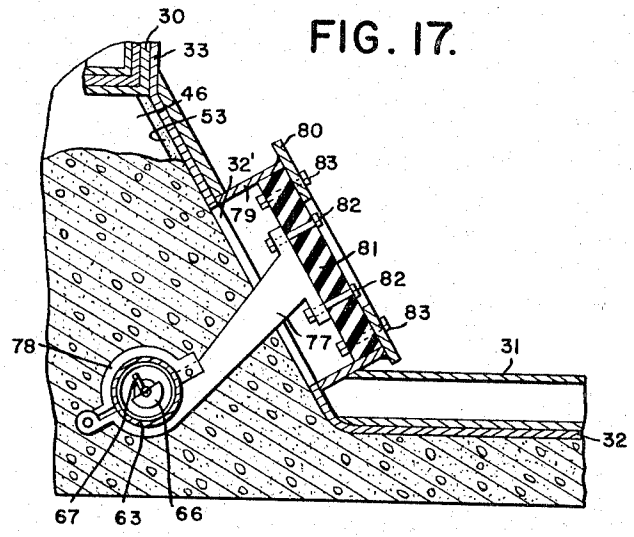
INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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PAVING MACHINE

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FIG. 17.



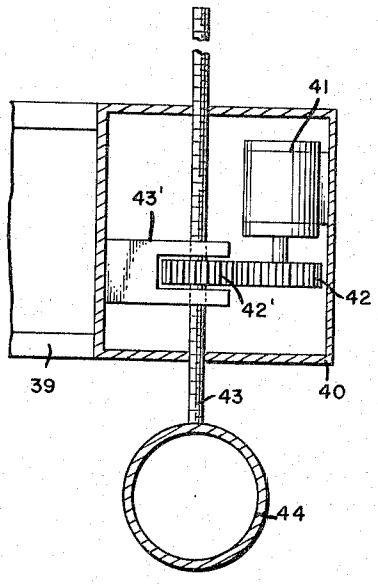


FIG. 18.

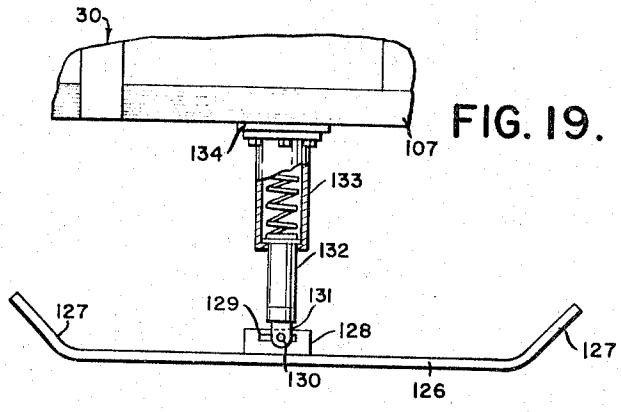
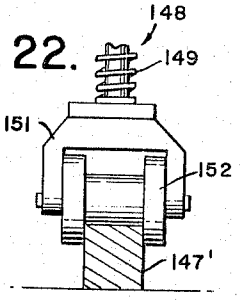


FIG. 19.

FIG. 22.



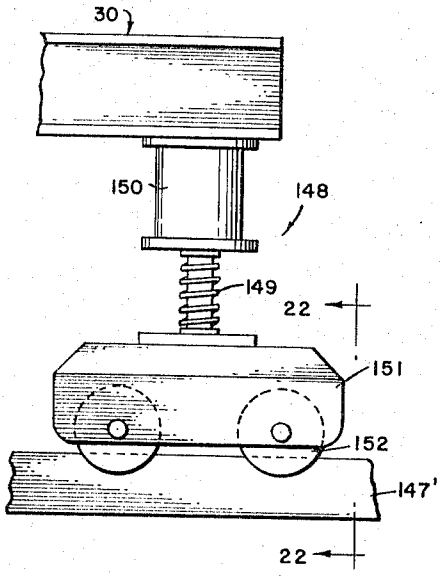


FIG. 21.

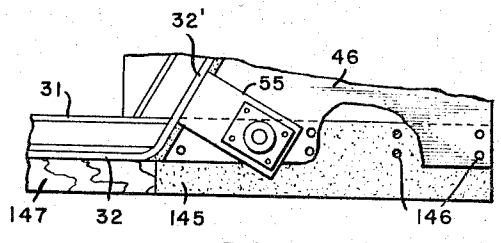


FIG. 20.

INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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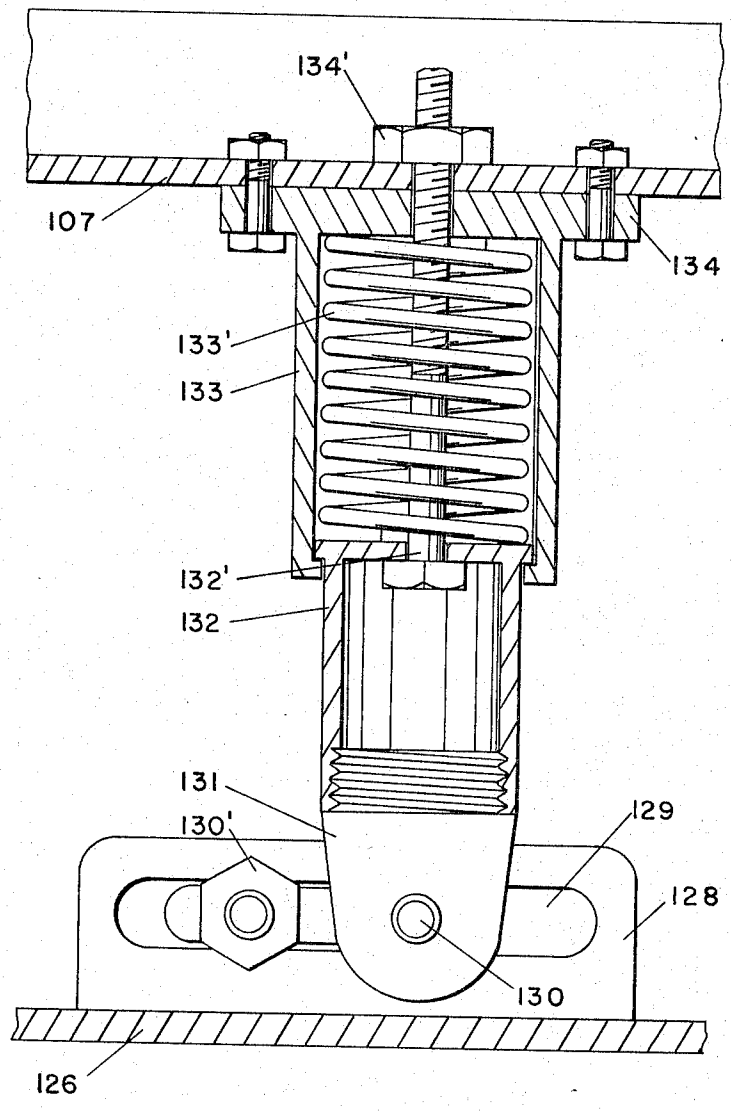


FIG. 19A

INVENTORS
HARRY D. DURSTON
ALFRED PERRY

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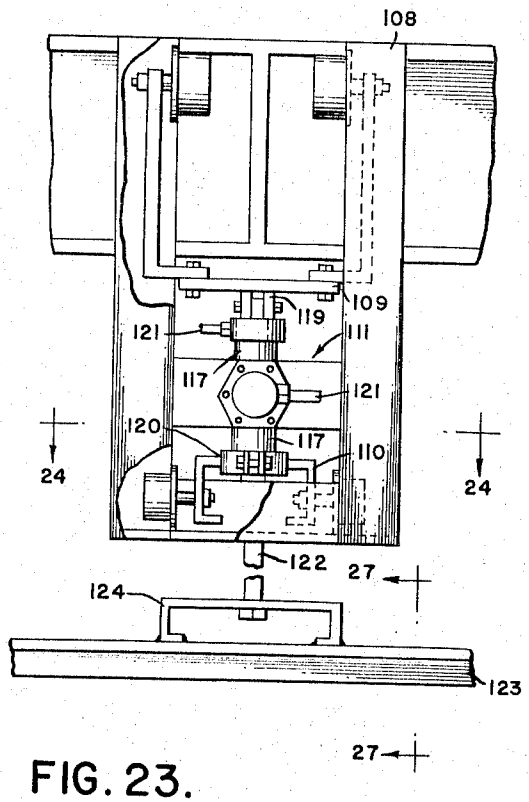


FIG. 23.

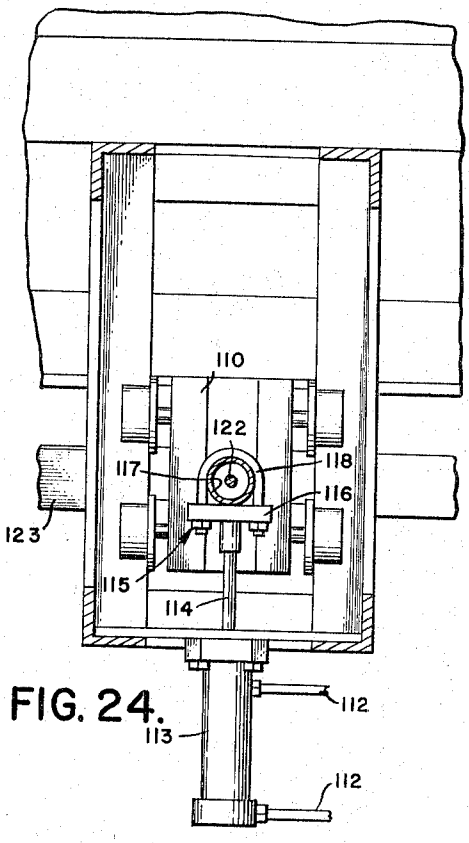
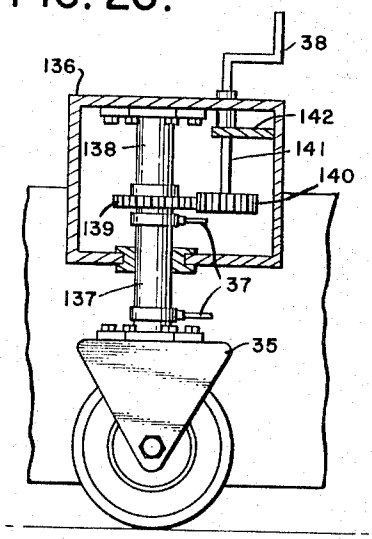


FIG. 24.

FIG. 26.



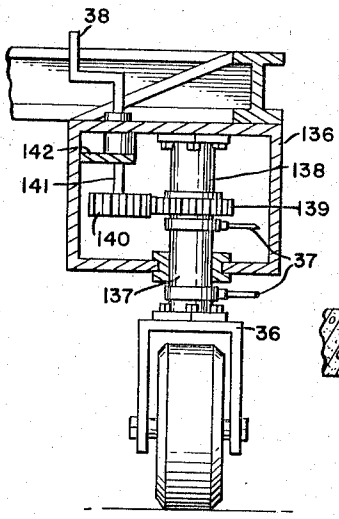
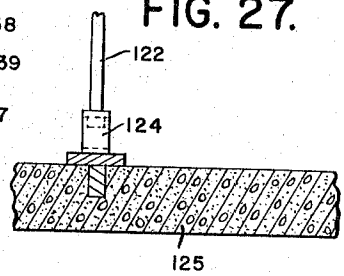


FIG. 25.

FIG. 27.



INVENTORS
HARRY D. DURSTON
ALFRED PERRY

United States Patent Office 3,318,208
Patented May 9, 1967

3,318,208

PAVING MACHINE

Harry D. Durston, Kennewick, and Alfred Perry, Moses Lake, Wash., assignors to J. A. Terteling & Sons, Inc., Boise, Idaho

Filed July 8, 1965, Ser. No. 486,581
30 Claims. (Cl. 94—44)

This application is a continuation-in-part of our application Ser. No. 341,694, filed January 31, 1964, now abandoned.

This invention relates to a paving machine, and more particularly, to a paving machine operable to lay a blanket of selected material on any surface, including a sloping foundation.

In the construction of roads, channels, levees, canals and the like, it is most frequently desirable to lay an impervious plastic or semi-plastic material over sloping foundation surfaces, to prevent erosion of such surfaces. In the case of water conduits, such as channels, canals, and the like, such an impervious material tends to prevent the intrusion of water and contaminants, carried thereby, into adjacent areas. Equipment known in the art for paving sloping surfaces are inherently very large, rigid structures, the machines requiring substantial frameworks and transport vehicles at the bottom and top of the slope, thereby necessitating high overhead clearances, and the absence of obstructions in the path of the transport vehicles at the top of the slope. Thus, such equipment is not adapted for paving sloping surfaces which are under low clearance bridges, transmission lines, and the like. Additionally, equipment known in the art cannot be used in transition sections where the slope angle and slope distance changes. Such equipment is described in United States Letters Patent 2,827,771, issued to Josef Baer on March 25, 1958, and owned by the assignee of the present invention.

It is an object of this invention to provide an apparatus for paving sloping foundations, in sections, laid transversely of the slope, to effect ready and expeditious paving of the slope without interference to the paving operation, caused by obstructions in the path of movement of paving equipment used in the past.

Other objects of the present invention are to provide an improved paving machine for accurately spreading, compacting and finishing sections of paving material such as concrete, asphalt and the like, poured in advance of the machine, these operations being effected in a continuous operation by a single pass of the machine from the bottom to the top of the slope, to provide a machine of stable construction, which obviates the tendency of the machine to float up on the paving material mass and has a low profile to permit usage thereof in areas having low overhead clearance; and to provide a machine of the character described, adapted for adjustment to changing slope angle and slope distances in transition areas of the slope.

Further objects are to provide a machine for paving sloping foundations, while the machine is ascending the slope, which includes strike-off means at one end of the machine, operable in conjunction with temporary screed forms; and means for spreading, densifying, i.e., compacting and consolidating, floating and trowelling, surface-finishing and forming contraction joints in the paving material, in successive steps.

While emphasis is placed herein on use of the paving machines of the invention to lay plastic or semi-plastic paving material (such as asphalt and concrete) on slopes, the machine has a number of features particularly desirable for such as highway paving (whether or not on a slope) and for laying non-plastic paving material such as riprap, sand or gravel on any surface. Accordingly, it is a further object of the invention to provide an improved paving machine for single-pass laying of paving material on highways and the like.

In one of the embodiments of the present invention, a strike-off float body is mounted on wheeled support means, each of the latter comprising a support assembly such as a hydraulically or pneumatically operated piston, an electrically operated jack shaft or the like, having a housing with a wheel assembly mounted therein, permitting movement of the machine on the slope foundation, or on a previously laid paved area adjacent the section to be paved. By operating the support assembly of the wheeled support means, the strike-off float body may be raised and lowered to the desired height, above the work surface. Associated with the support assembly are turning means which will steer the wheels so that the paving machine may be moved easily from work section to work section.

The strike-off float body of the invention includes a float panel having a flat under surface operable to smooth paving material therebeneath and which is slightly inclined with respect to the frame so as to have its rear end lower than the front end thereof. The float body also includes a strike-off nose portion inclined forwardly and upwardly from the forward end of the float panel at an angle determined by the slope of the surface being paved and the angle of repose of the paving material on that slope. Also, the float body has a further dozer blade-like portion extending substantially vertically upwardly from the nose portion upon which a diverter member is preferably mounted to push excess paving material downward as it rises up from the nose portion in order to mix the material and prevent it from rising up over the top of the float body and onto the frame.

Another particularly advantageous feature of the invention is a frontless hopper formed by the nose portion of the float body and a pair of forwardly-extending side walls, with the front wall omitted to avoid the upward forces on the machine attendant the confinement of the paving material in the forward direction, and which tend to cause the machine to ride upwardly over the paving material rather than push it forward.

A further feature of the invention is particularly desirable with plastic or semi-plastic paving material. That feature is a trowelling float pan positioned to the rear of the strike-off means, such pan being resiliently urged downwardly against the paving material at an adjustable tilting attitude. With such a trowelling pan, the usual hand finishing operations can be eliminated, or at least considerably reduced.

The invention also includes a novel tubular vibrator which is mounted slightly in advance of the strike-off member and is operable to cause compaction of the paving material as it is laid.

In another embodiment of the invention, each of the wheeled support means upon which the strike-off float body is mounted comprises a support assembly, similar to that above described, having a wheeled truck assembly mounted thereon, wherein the trucks are provided with flanged wheels that ride upon screed forms previously laid at each side of a work section. When riding upon previously laid screed forms, the flanged wheels are designed so that one edge of the wheel will extend below the form and thereby press a finished edge, into the material being laid, as the paving machine is moved up or down the slope, as herein later described.

A further embodiment of the present invention provides a novel slip form shoe which obviates the need for screed forms at each side of the work surface and thus, the use and need for the flanged wheel trucks and screed

forms above described. The slip form shoe may be a rigid strip of metal which is perpendicularly juxtapositioned to the work face, at the side limits thereof, and extends from the forward bottom portion of a paving-material-directing assembly, to the rearward extremity of the strike-off float body and is attached thereto. On some paving work, the slip form shoe may be removed, and the strike-off float body thereby permitted to ride on previously laid screed forms. A flexible wiper blade is provided to replace the slip form shoe on the directing assembly, to confine the paving material within such work areas.

It shall be emphasized that the various features of the invention referred to hereinabove are of utility apart from each other. Nevertheless, they are particularly useful in combination and will now be more fully described in conjunction with drawings showing an entire machine embodying all such features.

In the drawings:

FIGURE 1 is a side elevational view of a machine constructed in accordance with the present invention, illustrating its position after the ascent on the slope has been started;

FIGURE 2 is a similar view of the machine, showing its position when the summit of the slope has been reached by the front part of the machine;

FIGURE 3 is a front elevational view of the machine;

FIGURE 4 is a rear elevational view of the same;

FIGURE 5 is a fragmentary top plan view of the forepart of the machine, showing the side walls, for confining the paving material, in retracted position;

FIGURE 6 is a top plan view of the entire machine showing the confining side walls in extended position, and showing to advantage the surface-finishing pan depending from the back of the machine, in front of the contraction joint forming assembly;

FIGURE 7 is a longitudinal sectional view taken along the lines **7—7** of FIGURE 6, looking in the direction of the arrows, and showing details of the fore and aft components A and C respectively;

FIGURE 8 is a fragmentary side elevational view of the sledge-like float body assembly, showing to advantage the manner of connecting one of the screed shoes to the bottom of the body and to one of the confining walls;

FIGURE 9 is a sectional view taken along the lines **9—9** of FIGURE 8, looking in the direction of the arrows;

FIGURE 10 is an enlarged detail fragmentary transverse sectional view of the confining walls and their complemental housings, with their inter-engaging rack bars and pinions by which the walls are adjusted for varying the width of the paving material on a foundation;

FIGURE 11 is a sectional view taken along the lines **11—11** of FIGURE 10, looking in the direction of the arrows, and showing to advantage the manner in which one pair of the housings are inter-engaged and operatively connected to a power shaft;

FIGURE 12 is an enlarged fragmentary vertical sectional view of the sledge-like float body, illustrating the manner of sealing the vibrator tube and the movable side wall panels to confine the fluent materials;

FIGURE 13 is an enlarged fragmentary longitudinal sectional view taken through sections of the vibrator, illustrating the manner of mounting the same;

FIGURE 13*a* is an enlarged fragmentary side elevational view showing to advantage one of the end mountings for the vibrator;

FIGURE 14 is an enlarged fragmentary longitudinal sectional view taken through one of the vibrator sections illustrated in FIGURE 13;

FIGURE 15 is a vertical sectional view taken along the lines **15—15** of FIGURE 16, looking in the direction of the arrows, showing details of the spreader plate for the paving material, portions thereof being broken away to disclose details of construction;

FIGURE 16 is a fragmentary sectional view taken transversely through the sprocket and gearing support which effects oscillation of the spreader plate mounted between the confining side walls of the machine;

FIGURE 17 is a fragmentary sectional view taken through the inclined panel portion of the float body and illustrating to advantage, the manner of intermediate support of the vibrator, portions of the latter being shown in cross section;

FIGURE 18 is a fragmentary vertical sectional view taken through one of the strike-off bar casings mounted on the front of the machine;

FIGURE 19 is an end elevational view of the surface-finishing pan, a portion thereof being broken away to illustrate the manner in which it is yieldably supported on the machine subframe;

FIGURE 19*a* is a fragmentary sectional view, to a larger scale, of the mounting means for the finishing pan of FIGURE 19;

FIGURE 20 is a fragmentary elevational view of a modified form of machine embodying a flexible shoe secured to one of the confining side walls;

FIGURE 21 is a side elevational view of another modified form of the invention, showing a wheeled truck resiliently carried by the frame, the wheels being flanged for engagement with a complemental screed shoe;

FIGURE 22 is a fragmentary vertical sectional view taken along the lines **22—22** of FIGURE 21, looking in the direction of the arrows;

FIGURE 23 is a fragmentary elevational view of the mechanism used for forming expansion joints in the paving material, portions thereof being broken away to disclose details of construction;

FIGURE 24 is a cross sectional view taken along the lines **24—24** of FIGURE 23, looking in the direction of the arrows, showing to advantage the means employed for returning the contraction joint blade to its starting position;

FIGURE 25 is an elevational view of a wheel used in one form of the invention, illustrating the manner of mounting the same in a housing supported by the frame, with manual means extending from the housing for turning the wheel assembly at the option of the operator, the housing being shown in section to disclose internal parts thereof;

FIGURE 26 is a view similar to FIGURE 25, but showing the wheel and its mounting in said elevation; and

FIGURE 27 is a sectional view taken along the lines **27—27** of FIGURE 23, illustrating a contraction joint forming blade engaged with the paving material, the latter being shown fragmentarily.

The machine and method of this invention is the result of years of experiments with apparatus and processes for efficiently paving sloping foundations, of considerable length, width and depth, particularly where bridges and the like, spanning the canal being paved, are of low clearance. This is an all-purpose slope paving machine which effects directing of the poured paving material to a preselected area on the slope, followed by the other necessary steps for paving said area in a single pass of the machine over the area.

A preferred embodiment of this invention, as herein shown and described, comprises a combination of components, all carried by a main frame, with an underslung sledge-like member, which serves as a strike-off float body and movable as a unit over a slope foundation to be paved. These components are designated A fore, B intermediate, and C aft. Each component is made up of appurtenances for selectively performing certain operations, incident to paving sloping foundations, from top to bottom, or vice versa, as the machine moves over the foundation. For instance, component A, inter alia, intercepts and spreads the material, as it is delivered from a suitable source in the path of the inclined front end of the seldge body. The front end of the sledge body carries a vibrator for

compacting and consolidating the material. The interceptor includes laterally adjustable hopper-forming sides, for varying the width, when desired, of the paved surface, even while the machine is in motion. Component B is a power plant, in operative engagement with motors, strategically positioned on and in the frame, for activating the appurtenances of said components, as well as adjuncts hereinafter described, at the option of the machine operator. The power plant, supported centrally on the main frame, is of sufficient size and weight to act as ballast, to help to prevent so-called "floating" of the machine on the soft paving material, while the machine is in motion. Component C, inter alia, includes a trowelling float pan to smooth over and finish the surface of the material, in advance of a blade assembly which forms contraction joints, at preselected intervals, in the material. The fore and aft components are also equipped with vertically adjustable wheel assemblies for increasing or decreasing the thickness of the material being laid, as well as adjusting for changes in the paving material and inclination of the slope. In this preferred embodiment, the adjuncts include power operated cable drums, one on each side of the machine, which provide the motive power for operating the machine. Each drum is rotated by a motor which is operatively connected to power plant, component B. One end of a cable is secured to a drum, the free end of each cable being adapted for anchorage to an object or objects remote from the machine.

The machine comprises a main frame **30** with a pendently supported, sledge-like assembly **31** which simulates, in part, the shoe **48** in said Baer Patent Number 2,827,-771. This assembly provides the strike-off float body of the machine. Assembly **31** extends from the front of the frame rearwardly to a point short of the aft end of the frame, and is of a width substantially co-extensive with the width of the frame. The bottom of the sledge body is a smooth, flat float panel **32** which is inclined slightly downwardly from front to rear so that the rear end is depressed below the front end thereof. As will be more fully explained hereinafter, it has been found that such depression is extremely important to satisfactory operation of the machine, particularly on slopes, though also on level surfaces. Moreover, when fluid paving materials are being laid, the depression of the float panel helps to hold the machine on the slope.

The forward end of the float body extends upwardly at an angle, to provide a sloping front wall or nose **32'**. Nose **32'** engages the paving material placed in its path and pushes the surplus material ahead of it, thereby acting as a strike-off while bottom panel **32**, in a trowelling-like motion, smooths the material to grade and similarly pushes excess material forward.

The float assembly further includes a vertical anchoring flange portion **33** secured to the frame **30**, as shown in FIGURE 7. This further portion acts like a dozer blade in pushing excess paving material forwardly. The top of the assembly is rigidly secured to the transverse frame parts **34**, and is supported by the latter in an elevated position above the surface of the foundation to be paved.

The float panel depression may be achieved by positioning a shim strip, of appropriate thickness, between the rear transverse frame part **34** and the upper surface of float body **31**. The thickness of such shim strip has been found to be most desirably, about ½ inch. With a float panel **32** of three feet in length (best results are obtained when the panel is between three and five feet long in the direction of travel of the machine), the angle of depression of the float panel **32** is about 48 minutes of arc. Such angle of depression has been found to be the most desirable, particularly from the standpoint of adhesive force tending to hold the machine on a fluid paving material, such as concrete. The tests by which this fact was determined will now be described.

A float body of one quarter design width (four feet) was constructed, with a float panel three feet in length parallel to the direction of travel, exclusive of the nose portion of the float body. The forward end of the float body was pivotally suported from a frame, while the rear end was suspended from the frame by a bolt and nut suspension which permitted adjustment of the rearward end of the float panel upward and downward with respect to the forward end, thereby permitting variation in the angle of depression of the panel. A form of substantially the same width as the float body was constructed for the paving strip, and a pair of rails were suspended above that form in such fashion that the frame rode along such rails on wheels at a height such that the float panel was four inches above ground elevation. The float body was pulled along the rails by a winch assembly into contact with two or three feet deep piles of concrete placed at random intervals in the form. A five bag mix of concrete was used, having both three inch and five inch slump, but no differences were observed with the two types of concrete. Also, the form covered both sloped and level ground, but no differences were observed in test results therebetween.

Three different kinds of tests were performed, using both consolidated and unconsolidated concrete, consolidation being effected by vibrating the material mass. The first test was of the adhesive force of the concrete on the float body and was performed by measuring the force required to lift the float body away from the laid concrete by a mobile crane having a hook connected to the frame by a strain gauge. While this test was performed by separately lifting at the front and rear of the float body, no apparently significant differences were noted in the results, so that the measurements from lifting adjacent the front only will be given. The plus indication for depression indicates that the front end of the panel was above the rear end, while minus indicates the apposite.

Pan Depression (in inches)	Adhesive Force (in pounds)	
	Unconsolidated	Consolidated
+1½	127	821
+1	297	1,218
+¾	909	1,719
+½	1,228	2,183
0	52	93
−½	1,009	619
−¾	619	229
−1	83	117

The second kind of test was of the tendency of the float body to "float" or ride up on the concrete as it was pulled along. This test was performed with a strain gauge connected between the float body frame and a trolley-like yoke which rode along the under side of the flange of a rail placed on the ground. The results were as follows:

Pan Depression (in inches)	Adhesive Force (in pounds)	
	Unconsolidated	Consolidated
+1½	86	78
+1	43	34
+¾	27	13
+½	4	0
0	120	127
−½	12	37
−¾	73	142
−1	118	171

It will be noted that the adhesive force on the float panel is extremely low when there is no depression, but sharply increases as the panel is depressed more and more, until a maximum is reached, whereupon, with further depression, the adhesive force sharply decreases. The maximum adhesion at +½ inch depression, though a lower maximum occurs at −½ inch. (The extreme effect of consolidation is also evident.) Similarly, the tendency to ride upward is minimal at the plus and minus

½ inch points, is quite high when the panel is level, and increases more gradually as the degree of depression increasingly exceeds ½ inch.

Though the adhesion effect is obviously stronger when the rearward end of the float panel is the lower, as the tendency to "float" is less, these two tests indicate the desirability of either sense of depression. A further test however indicates the superiority of "plus" depression. That test concerned the characteristics of the laid slab, itself, and was performed by measurements of the variation in thickness of material laid from the four inch norm and of the thickness of glaze, or of encrusting fines, on the surface of that slab.

Pan Depression (in inches)	Variation in Thickness (in inches)		Glaze Thickness (in inches)	
	Unconsolidated	Consolidated	Unconsolidated	Consolidated
+1½	−¾	−½	½	½
+1	−¼	0	½	¾
+¾	0	+¼	⅜	½
+½	0	0	⅛	¼
0	+½	+¼	0	⅛
−½	0	0	0	½
−¾	+½	+½	0	⅛
−1	+1	+1¼	0	⅛

While not so startling in contrast as the adhesion tests, these measurements do indicate the superiority of plus depression for thickness of glaze (particularly if the concrete is not consolidated) and variation in blanket thickness. While adhesion of the float body to the paving material is of most importance to paving a fluid material, such as asphalt or concrete, on a slope, variation in blanket thickness is of importance both on the slope and the level. This variation is significantly lower with a depressed float panel, indicating the great importance of the expressing or extrusion-like operation obtained with such a panel. Indeed it was observed during the tests described above, that the concrete rose up by a significant amount as the float body passed, indicating that the lower level thereof was impressed into the subjoining foundation. Such an effect is most desirable with any kind of paving material, particularly on a slope, because the material is bonded to the foundation thereby.

The tests described so far indicate that a +½ inch depression of a three foot float panel is optimum, such depression in angular measurement being about 48 minutes of arc. However, these tests and other observations indicate that such angle between the surface being paved and the float panel should be between about 20 minutes and 1 degree 40 minutes.

In addition to the degree and sense of the float panel depression, it has also been found that the angle of inclination of the nose portion 32′ is extremely important, particularly for paving on a slope. Extensive experience, including many tests, have shown that there is a different optimum angle of inclination of that nose portion to the surface being paved for each different paving material (including different concretes) and each different angle of slope of such surface. Indeed, such experience has shown that such optimum angle may be determined arithmetically by subtracting the slope angle from the known angle of attack which would be used to lay the involved paving material at the desired depth upon a horizontal surface and push ahead surplus paving material, and adding thereto the angle of repose of that material on the particular slope, corrected for fracture.

The slope angle of course is readily determined, as is the optimum angle of attack on the horizontal (the handbooks and bulldozer operating manuals indicate, for instance, that a dozer blade should be set at 60° to the horizontal to lay a four inch deep blanket of material of consistency similar to concrete and push excess material forwardly). The corrected angle of repose of the particular paving material on the slope may be found by subtracting the slope angle from the angle of repose of the material on the horizontal and adding thereto the angle of fracture of such material on such slope. By such determinations and calculations, the optimum angle of attack for various slopes and materials have been calculated. The materials are 1:2:4 concrete, having a three inch slump; ¾ inch minus gravel, uniformly mixed; three inch minus riprap, uniformly mixed; ¼ inch minus sand, with 5% passing a 50 mesh sieve; and RC 3 hot mix asphaltic membrance asphat. The results were as follows:

Paving Material	Optimum Angle of Attack on Various Surfaces				
	Horizontal	2:1 Slope	1.5:1 Slope	1.25:1 Slope	1:1 Slope
Concrete	60°	69°5′	57°50′	49°25′	39°.
Gravel	45°	49°5′	42°50′	39°25′	34°.
Riprap	45°	44°5′	37°50′	34°25′	29°.
Sand	50°	56°50′	47°50′	42°40′	35°.
Asphalt	50°	51°50′	43°20′	37°40′	30°.

The results for a 1:1 slope have been rounded off.

By examination of these results, it can be seen that changes in slope require substantial changes in angle of attack, the values for concrete dropping from 69° to 39° as the slope increases from 26°35′ (2:1 slope) to 45° (1:1 slope). Moreover, changes in material also require significant changes in angle of attack, the values for a 2:1 slope dropping from 69° to 44° as the material changes from concrete to gravel.

These angles of attack of course are optimal. However, it will be evident that it would not be practical to provide a sufficient number of paving machines so that one would be available for each different condition. Further, the cost of infinite adjustment of nose portion angle would discourage such alternative. However, it has been found that a few basic float bodies of different nose angles can suffice, provided that the float body may be raised or lowered at its forward end (as by raising and lowering the frame with respect to the wheel, which will be described hereinafter). A table of such designs, including float panel length and range of articulation required follows, the panel length being the middle figure in each case.

Paving Material	2:1 Slope	1.5:1 Slope	1.25:1 Slope	1:1 Slope
Concrete	60°–3′–1′	60°–3′–1′	45°–3′–1′	30°–3′–1′.
Gravel	45°–4′–2′	45°–4′–2′	30°–5′–1′	30°–5′–1′.
Riprap	45°–4′–1′	30°–5′–1′	30°–5′–1′	30°–5′–1′.
Sand	45°–4′–1′	50°–4′–1′	45°–4′–1′	30°–4′–1′.
Asphalt	45°–4′–1′	45°–3′–2′	30°–4′–1′	30°–4′–1′.

It will be realized that substantial changes in the angle of attack by vertical adjustment of the front end of the float body will cause substantial changes in the angle of depression of the float panel, thereby losing a portion of the adhesion effect. Consequently, adjustment to the optimum angle of attack of the nose portion may not be desirable and some sacrifice in effectiveness of the machine may be required, particularly where a steep slope is being paved. Nevertheless it has been found possible to pave cohesive materials at angles of up to 135° from the horizontal without riding up of the machine. With non-cohesive materials, such as sand, gravel and riprap, a somewhat lower limit of 105° has been determined, because of the lack of adhesive effect therewith.

In practice, it has been found that the significantly improved results obtained with the paving machine of the invention can be achieved with a float panel length of 3 to 5 feet, a depression of the float panel of about ½ inch at lowermost position of the forward end thereof, a range of adjustment upwardly of the forward end of up to 2 feet, and a basic nose angle of 30 to 60 degrees.

Returning now to description of portions of the machine

other than the float body, reference will first be made to the travel-providing means therefor. In one embodiment of the invention, wheel assemblies are used, as shown to advantage in FIGURES 1 and 2. Here a pair of front and rear wheel assemblies 35 and 36 respectively, are employed, which include movable parts, hydraulically or pneumatically operated, as indicated at 37 in FIGURES 25 and 26. Furthermore, these wheel assemblies are dirigible and may be individually operated by manual means 38, after the fashion shown in FIGURES 25 and 26, and hereinafter described in detail. It is desirable that each of the wheel assemblies be operable independently, synchronously and in cooperation with any or all of the other wheel assemblies to orient the sledge to an intended work face as herein described. In this manner, variation in the thickness, from top to bottom of the slope, of the blanket being laid, may be achieved.

Component A also includes arms 39 which are provided by the forwardly-extending portions of the side beams of frame 30. The arms support a starter strike-off entity illustrated in FIGURES 7 and 18. This entity comprises twin casings 40, one on the free end of each arm (see FIGURES 5 and 6). Each casing 40 houses an actuating mechanism which includes a reversible motor 41 which drives mating gears 42 and 42'. Gear 42' is provided with an internally threaded axial bore for operative engagement with a vertical threaded shaft 43, the lower ends of which independently support a horizontal strike-off bar 44. Starting strike-off bar 44 is preferably cylindrical and of sufficient size to push surplus material ahead of it, and to provide an adequate angle of attack to smooth the fluent material to proper grade, so that it may be later acted upon by float body 31. The diameter of strike-off bar 44 may be varied for different operating conditions. Gear 42' is disposed between the furcations of a stationary bifurcated bearing 43', through which furcations threaded shaft 43 passes, which bearing permits rotational movement only of gear 42'. The motors of the casings are synchronously operated to cause threaded shafts, carrying bar 44, to be lowered. As also shown in FIGURES 5 and 6, the bar 44 spans the distance between the arms 39, so that when lowered into engagement with starter screed forms 45, disposed in parallel spaced relation at the bottom of the slope, it functions as a strike-off means to limit the thickness of the paving material to the height of the starter screed forms during the period the machine is moving from the flat bottom of the canal onto the slope thereof. The forward wheels of course will be caused to raise and then lower the frame at this time in a manner hereinafter explained.

Starter screed forms 45 are approximately the same length as the machine of the present invention illustrated in FIGURES 1 and 2, for reasons more fully hereinafter set out. After bar 44 clears starter screed forms 45, and the machine is entirely on the slope, the strike-off entity is then elevated to the inoperative or rest position shown in FIGURES 2, 7 and 18, by reversing motors 41. In operation, strike-off bar 44 is adjustably positioned on previously laid screed forms as above stated. As the device and structure here disclosed advances toward and up the slope, bar 44 is maintained at a relative elevation on the forms. The wheel assemblies may be continuously and synchronously adjusted with the bar 44 until the main strike-off float body is properly juxtapositioned to the work face. At that point, bar 44 may be elevated as above described.

Also included in the component A is an intercepting entity or hopper for the paving material, poured from a source such as a conventional controlled-bottom-discharge bucket. The entity comprises adjustable side walls 46, the rear edges of which complement and are contiguous with, inclined nose portion 32' of float body 31. As shown in FIGURES 10 and 11, the side walls 46 are connected at the upper fore and aft edges thereof by front and rear adjustment assemblies. Each assembly includes an elongated outer housing 47, substantially square in cross section, and an inner telescoping elongated housing 47' of similar, but smaller, cross sectional shape. The inner face of one side of outer housing 47 is provided with a longitudinal pinion rack 48 which extends through a wall of housing 47'. A similar pinion rack 48' is fixed to an inner wall of housing 47' in opposed relationship to rack 48. A power pinion 49 engages racks 48, 48' for effecting simultaneous, equi-distant movement of housings 47, 47' in opposite directions, to vary the distance between side walls 46. Adjustment of the side walls may be effected during movement of the machine. Pinion 49 is actuated by a conventional reversible motor 50 and drive shaft 51, the motor being reversible to effect bi-directional adjustment of the side walls in an obvious manner. Motors 50 of each assembly are synchronously operated to maintain side walls 46 in parallel relationship at all times. Each adjustment assembly is partially housed in an elongated box-like enclosure 52, which is fixed to a transverse portion of frame 30. Housings 47 and 47' extend laterally through the ends of enclosures 52 to adjust the position of side walls 46, as illustrated to advantage in FIGURES 5 and 6. Shaft 51 pends through an opening in enclosure 52 and through corresponding slots 51' in housings 47 and 47', as advantageously shown in FIGURE 11. Seal means 53, made of rubber or other suitable material, are affixed to the inclined rear edges of sides 46 (FIGURES 7, 12 and 17) to prevent the fluent paving material 54 from passing between sides 46 and nose 32' of sledge assembly 31.

The progressive operation of the intercepting entity on transition sections is advantageously shown in FIGURES 5 and 6. It is intended that side walls 46 forwardly advance inside previously laid screed forms which must be laid the full distance, from top to bottom, of the work face when the present machine is used for laying such sections.

It will be evident that the hopper formed by nose portion 32' of the float body and the adjustable side walls 46 has no front wall. As indicated earlier, this construction is one of the significant features of the present invention. It is used because it has been found that one important reason why prior paving machines ride up on paving material (this trouble is evident in existing road pavers, which frequently must stop, reverse and then make another pass, by reason of the ride-up phenomenon) is that the forward end of the paving material hopper confines the material and causes it to exert a reactive upward force on the machine. The omission of the front wall of the hopper eliminates this reason for the ride-up action. Since the paving material may readily be deposited in front of the float body 31 and between the hopper-forming side walls 46, the front wall is not necessary.

The telescoping housings 47 and 47' and outer enclosure 52 of the side wall-adjusting apparatus perform another very important function—that of forcing back downwardly excess material pushed upwardly by the inclined nose portion 32' and mixing such material to prevent segregation thereof. For such diverter member purpose, the lower surfaces of the housings and enclosure extend generally horizontally forwardly (that is, parallel to the slope) from the vertical flange surface 33 of the float body.

The importance of the consolidation of the paving material has been indicated earlier. A particularly advantageous construction of a tubular vibrator operable to perform the consolidation function will now be described.

The vibrator extends transversely of the present machine, forward of sloping wall 32' and is resiliently mounted between end hangers 55 located at each side of front nose portion 32' and secured in any suitable manner to the sledge body. The hangers are so mounted that the vibrator is disposed downwardly into the paving material to a point uniplanar with strike-off flat panel 32.

Salient features of the present vibrator are the unique

mounting means, coupling means, power transmission means, and the unitizing and sectionalizing arrangement of vibrator components, illustrated in FIGURES 13, 14 and 17.

As shown to advantage in FIGURES 13 and 13*a*, end mounting assemblies extend through hangers **55**. Each end mounting assembly comprises a conventional flange-mounted drive bearing **56** which is bolted to hanger **55**. Drive bearing **56** is provided with a shaft **57** which is bored and includes an internal keyway adapted to receive a flexible shaft **58**. Shaft member **57** is driven by a sheave **59**. Each end mounting assembly includes an interconnected moulded resilient mounting block **60**, an end coupling **61** and an end adaptor **62** secured to drive bearing **56**. As shown in FIGURE 13, each mounting block **60** extends through an opening in hanger **55** and is provided with a retaining projector **60'** adapted to be received in a complemental groove of end coupling **61**. Adaptor **62** is externally threaded at both ends for engagement at one end with threaded end coupling **61**, and at the other end with a terminal vibrator tube to be hereinafter more fully described. Bored shaft **57** is adapted to receive flexible shaft **58**. A sleeve **60''** is cast into block **60** to reinforce the latter through which sleeve flexible shaft **58** passes. Shaft **58** is provided with a pair of male shaft ends fixed to the terminals of the flexible wire shaft. The shaft ends are provided with keys **58'**. By means of flexible shaft **58**, vibrations generated by the vibrator are not transmitted to the driving means. Also, resilient block **60** dampens the vibration of hangers **55**, and thus that vibration which would be otherwise transmitted to sledge body **31**.

As shown in FIGURES 13 and 14, a preferred embodiment of the vibrator comprises a plurality of cylindrical units **63**, detachably engaged in axial alignment. One terminal of each unit **63** is internally threaded at **64**, and the other terminal is externally threaded at **65**. Each of the units carries an eccentric power shaft including a weighted body portion **66** and a shaft reinforcing strut portion **67**. As shown in FIGURE 14, the end portions of the eccentric shaft are reduced, to form shaft extensions or terminal ends **68** and **69** respectively, which are rotatably mounted in dust-sealed bearings **70**. One terminal of shaft extension **68** is centrally bored to provide a recess **71** having a longitudinal keyway **71'**. The opposite shaft extension is reduced and provided with a shaft **72** having a longitudinal key **72'**, which complements the recess and keyway of the opposite extension. The eccentric shafts are operatively inter-engaged by insertion of key **72** of one unit into keyway **71'** of an adjacent unit, as shown in FIGURE 12. Units **63** are actuated by virtue of the connection of the terminal eccentric power shaft with flexible wire shaft **58**.

In actual operation of the apparatus of the invention, it has been found that the vibrator units **63** should be no longer than about two feet in length and that no more than about 10 of such units should be connected together to form vibrator sections. However, a plurality of such sections may be employed, providing they are isolated from each other. For this purpose, an intermediate drive coupling assembly is provided so that two or more unit sections may be driven from the same source at the same intensity. By this means, the inherent centrifugal motion at the end of one section is not transmitted to the next section. The drive coupling assembly comprises an end coupling **73** which is threadedly engaged with externally threaded portion **65** of adjacent cylindrical unit **63**. Coupling **73** is provided at one end with an internal annular member **73'** adapted for retaining engagement with a flange **74'** of a resilient tubular sleeve **74**. Operative connection with adjacent cylindrical unit **63** is effected by a flexible wire shaft **75**, similar in operation and construction to wire shaft **58**, with the exception that shaft **75** is provided with both a female and male end, the former being indicated at **75'**. It will be noted from FIGURE 13 that female end **75'** includes a recess provided with a keyway for the reception of keyed shaft **72** of adjacent unit **63** for transmitting rotary motion to shaft **75**. An end cap (not shown) is engaged with the free end of the terminal unit **63**, the end cap being similar in structure and manner of engagement to coupling **73**. Shaft seals for the vibrator are indicated at **76**.

It should be here noted that a drive bearing, such as indicated at **57**, may be used to terminate a section or a series of sections, if it is desired to drive the vibrator from both ends.

In order to restrain and reduce the effect of centrifugal motion of the vibrator, it is within the contemplation of the present invention to provide one or more intermediate support brackets **77**, which extend through an opening in inclined front panel **32'** of sledge member **31**, shown to advantage in FIGURE 17. The lower terminal of bracket **77** is adapted for supporting engagement with a cylindrical unit **63**, which portion of the bracket is provided with a hinged cover **78** normally in retained engagement with unit **63** in any suitable fashion, but adapted to be opened in order to permit access to the unit. The upper terminal of bracket **77** extends through front panel **32'** into a housing bracket comprising a cylindrical body portion **79**, one terminal of which is welded or secured in any other suitable manner to the rear face of front nose portion **32'**. An annular cap **80** is fixedly secured to the opposite terminal of cylindrical body portion **79**. Dampening of the vibrations is effected by the interpositioning of a heavy resilient member **81** which is preferably a solid rubber discal body which fits snugly within cylindrical body portion **79** between bracket **77** and annular cap **80**. Bracket **77** is secured to resilient member **81** by suitable means **82**, the resilient member being secured to annular cap **80** as indicated at **83**.

As shown in FIGURE 13, the vibrator passes through an opening in adjustable side wall **46** and, in order to dampen vibrations to that member, a grommet seal **46'** is interposed between the vibrator and wall.

It has been found in practice that by providing a series of short cylindrical units **63**, each having an eccentric shaft as above described, an economy may be achieved in replacing only a few small worn parts, rather than the complete vibrator assembly. Additionally, the length of the vibrator may be readily and economically extended or shortened within the modular limits of unit **63** to suit the particular job requirements, by merely adding or removing units. This arrangement of parts further provides the salient advantage of closely controlling the mechanical efficiency and operating characteristics of the vibrator by virtue of the fact that the intensity of the vibrations at various unit lengths along the length thereof may be controlled. In the event that it is desired to decrease the vibrations of the vibrator assembly, it is only necessary that the eccentric shaft of a selected unit or units be removed and replaced by flexible wire shafts such as indicated at **58**, or that units so equipped be substituted for eccentric units. Inherently, the rotation of a long eccentric or a long series of eccentrics rotating together, will set up a centrifugal motion causing a harmonic bending moment proportional to the length of vibrator, thereby placing a strain on the drive means of the vibrator. With the present invention, the number of cylindrical units to be employed may be varied, to provide a vibrator of predetermined length. Additionally, the present vibrator provides an effective consolidator and compactor which dampens out vibratory impulses before they reach the sledge body, to further prevent or reduce to a minimum, floating of the latter. Further, the desirability of reduced vibration intensity progressing away from the center of the paved panel is readily satisfied by the unitized construction of the invention, since, for instance, alternate units adja-

cent the outer edges may be of the passive type (containing flexible shafts, rather than eccentrics), while the units at the center are all active.

Additionally, component A includes a spreading assembly **84** made up primarily of a stationary support **85**, a movable housing **86** and a spreader **87**. The spreader is so shaped that the fluent material is caused to be re-mixed gently by being turned over as the spreader oscillates across the front of the machine. This is done to overcome segregation of the material. As shown in FIGURES 7 and 16, the support is substantially U shape in cross section, the mouth of the U projection into the housing **86**. By this arrangement, the top and bottom of support **85** provide flat surfaces, each of which has a track **88** near its free edge. The housing **86** is equipped with upper and lower double-flanged rollers **89**, which complement and are adapted to roll on the tracks **88**, when motion is imparted to the housing **86**, for effecting operation of the spreader **87**. The motion-imparting means includes a drive sprocket **90** and idler **91** over which an endless sprocket chain **92** is trained, all being mounted in support **85**, as shown in FIGURES 15 and 16. A motor **93** imparts rotation to the drive sprocket **90**. For effecting oscillating movement of spreader **87**, between the confines of sides **46**, there is provided an actuating unit including a cylinder **94** depending from, and fixed to the top of housing **86**. A ram **95** within cylinder **94** reciprocates under pneumatic or hydraulic pressure supplied through conduits **96**. The unit further includes a lateral arm **97**, having one end connected to the lower terminal of the ram **95**, and the opposite end fixed to an ovoid sprocket **98** having upper and lower chain-engaging surfaces **98'**. As shown in FIGS. 15 and 16, the ram **95** is in its lowermost position and the sprocket **98** is engaged with the lower run of the sprocket chain. When the direction of movement of the housing and spreader is to be reversed, the ram **95** is retracted, by pressure adjustment in the cylinder **94**, causing the upper row of chain engaging members **98'**, on the sprocket **98**, to engage the upper run of the chain **92**. When it is desired to lengthen or shorten the throw of the spreader **87**, this is effected by changing the interval of engagement of the sprocket **98** with the chain. The sprocket chain is held in positive engagement with the sprocket **98** by pressure rollers **99** positioned at intervals on the inner faces of the top and bottom of the support **85**.

This machine may be operated, as are its appurtenances and adjuncts, for the most part, by its own power plant, which here has been designated component B. This may be any one of several power supplying media. We have found that good results are obtained by using a generator **100**, centrally located as shown, or mounted perpendicularly, to obtain certain advantages, already referred to, which are particularly desirable in paving work. The generator is adapted for operating motors **101** for supplying power for operating the machine. These motors are in circuit with the generator **100** through conventional wiring, for individually operating cable drums **102** mounted on opposite sides of the machine (FIG. 6). The drums may be chain operated by chains **103**, through standard gearing, for reeling a cable **104** on each drum, to which latter one end of the cable is anchored. The generator is also in circuit with motors adapted to be located at different points on the machine, for operating the various machine appurtenances.

Component C includes an auxiliary or sub-frame **106** secured to the aft end of main frame **30** (FIG. 7). A part, **107**, of the auxiliary frame, underhangs the main frame and extends, in spaced relation, for a considerable distance forwardly, with its front end resting on one of the main frame supports **34**. The part of the auxiliary frame, rearward of the main frame **30**, carries an assembly for forming contraction joints in the pavement, before it sets and hardens. The assembly embodies a pair of like hangers **108**, mounted in and carried by the auxiliary frame **106** (FIGS. 6, 7, 23 and 24). These hangers are constructed and mounted as shown in detail in FIGS. 23 and 24. A pair of independent upper and lower mobile carriages, **109** and **110** respectively, are mounted in each of the hangers **108**. The carriages are operatively connected, as indicated at **111**, to move in unison when power is applied to connecting means **111**. The power may be fluid under pressure, forced through one of the conduits **112** into cylinder **113**, to move one end of piston shaft **114** through one end of the cylinder. The free end of the shaft is anchored to a sub-assembly **115** which latter includes the contraction joint forming blade, and operating means therefor.

The sub-assembly includes a block **116** tied to a power cylinder **117** by U bolts **118** after the fashion shown to advantage in FIGS. 7 and 24. The upper end of cylinder **117** is suspended from the upper mobile carriage **109** by lugs **119** (FIG. 23). The cylinder **117** is tied to the lower carriage **110** by a locking ring **120** (FIG. 23). Pressure for operating a piston in cylinder **117** may be supplied through one of the conduits **121**, for imparting movement to a piston shaft **122** connected to a T-shape blade **123** through a bracket **124**. As shown in FIG. 27, when the blade-operating mechanism has finished completing its downward stroke, the top of the T is contiguous to the upper surface of the pavement **125**.

In operation, the blade **123** is forced into the paving material by piston shaft **122**, in response to fluid pressure supplied to cylinder **117**. Reverse movement of piston shaft **114** is simultaneously effected by release of fluid pressure in cylinder **113**. This permits the wheel carriages **109** and **110** to move rearwardly within the limits of their hangers **108**, when the machine is working on an upslope. Since blade **123** is mounted in operative engagement with the mobile carriages, the blade temporarily remains stationary, with respect to the paving material, notwithstanding the forward movement of the machine. At a predetermined interval, the blade **123** is elevated by reversing the fluid supply in cylinder **117**. After the lifting stroke of the blade has been completed, fluid under pressure is supplied to cylinder **113**, forcing piston shaft **122** against sub-assembly **115**, which returns the blade entity to its starting position.

Component C also includes surface finishing means (FIGS. 6, 7 and 19) which, of course, operates in advance of the contraction joint forming means, but which pends from the sub-frame **106**, in which the operating mechanism for the joint forming means is mounted. For the above reason, even though it forms a very important part of the invention, description of the surface finishing means has awaited description of the joint forming means, also supported by sub-frame **106**. The finishing means floats and trowels the already-laid paving material and comprises an elongated float pan **126** with upturned inclined fore and aft edges **127**. The top of the pan carries upwardly extending lugs **128** rearward of the longitudinal center of the pan (FIGS. 19 and 19A). Each lug is slotted horizontally at **129**, each of said slots having a pin **130** extended therethrough. The pins are each carried by the bifuracted end **131** of a spring-loaded plunger **132**, housed as indicated at **133**. The housings depend from pressure blocks **134** on arms **135** supported by one of the cross beams of the machine frame (FIG. 6). The degree of compression of the coil spring **133'** is adjusted by adjustment of nut **134'** threadably engaged with bolt **132**, to raise or lower the plunger **132'** with respect to the frame member **107**. By the loading springs, a controllable downward pressure may be maintained on the paving material by the float pan **126**. The angle of attack of the pan may be changed by adjusting pins **130** in slots **129** through release of the bolt and nut clamp **130'** which positions stopbar **131'** in slot **129**. Since the loading is back of the longitudinal center of the float pan **126**, the latter will ride at a controlled angle and the

finishing or trowelling of the paving surface will be controlled to produce a smooth surface.

In actual use of the machine, as the float body engages the fluent paving material, the slightly angular attitude of flat panel **32** thereof effects a floating and trowelling action, resulting in an initial encrustation of the material to a depth of approximately one-sixteenth of an inch to one-eighth of an inch, which produces an increase in the waterproofing qualities of the material. This is followed by engagement of trowelling float pan **126** with the encrusted paving material to effect a finishing, floating and trowelling thereof to produce a smooth surface. With the method and apparatus of the present invention, these operations are carried out successively in a single pass over the area of the slope being paved, and with a minimum of hand labor.

A means employed for effecting the dirigibility of the wheels of the front and rear wheel assemblies, **35** and **36** respectively, is shown in detail in FIGS. 25 and 26. In each assembly, housings **136** are suspended front and back in the frame **30**, as shown in FIGS. 1 and 2. Each housing **136** (FIGS. 25 and 26) includes a pressure chamber **137** in which a housing-carried ram **138** is reciprocably mounted. The rams reciprocate in response to fluid supplied or withdrawn from the pressure chambers **137** through the conduits **37**. In this way, the front or back of the frame may be raised or lowered, for most effective use of the machine, for initiating and completing a pass of the machine, from one extremity of a slope to the other, as shown in FIGS. 1 and 2. Dirigibility is effected through cog wheels **139**, one being secured to each pressure chamber, near its top (FIGS. 25 and 26), and complemental gears **140** are carried by a shank **141** of each steering element **38**. The said shanks are rotatably mounted in bearings **142**, which latter are secured to the side walls of housing **136**, as also shown in FIGS. 25 and 26. All wheels may be turned in unison or in pairs, by the use of conventional steering mechanism, if desired, instead of singly, as herein shown and described.

In the embodiment of the invention shown in FIGS. 1 and 2, starter screed forms **45** are located at the bottom of the slope in the manner shown in FIG. 1. It is within the contemplation of this form of the invention to provide screed means forming an integral part thereof for use after the strike-off assembly clears the forward end of the screed forms, at which time the machine lies parallel to the slope. The screed means include screed shoes **143** preferably comprising rigid metal blades perpendicularly juxtapositioned to the proposed work face at the side limits thereof and extending to the foundation therebeneath. The shoes are arranged in parallel relationship from the front bottom portion of side panels **46** to the aft extremity of sledge **31** (see FIGS. 7 and 8). Shoes **143** are preferably bolted to the sledge and side panels as indicated at **144** to permit ready removal thereof under certain operating conditions. As shown to advantage in FIGS. 1, 2, 7 and 8, shoes **143** serve to retain the paving material therebetween in the manner of screed forms. The length of the constantly moving shoes, in conjunction with the low water content of the paving material employed, enables the freshly paved section to set for a sufficient period of time to obviate casual displacement thereof after the screed shoes have moved out of supporting engagement with the lateral margins of the section. It has been found that optimum results are obtained with the use of the method and apparatus of the present invention, by laying the sections alternately i.e., in spaced relationship, in order to avoid contact of any part of the machine with freshly laid paving sections. For paving the alternate or unpaved sections between previously laid sections, screed shoes **143** are removed and replaced by a wiper blade **145** as illustrated in FIG. 20. It will be noted that wiper blade **145** is bolted or secured in any other suitable manner at **146** to hopper-forming side walls **46** only and is substantially coextensive therewith. Wiper blade **145** is preferably made of flexible material such as rubber and extends below the lower limits of side panels **46** to the earth foundation. Wiper blade **145** functions to retain the plastic or semi-plastic paving material within the intended work area and prevent the aggregate from working up and jamming the machine as the paving material is being pressed down beneath sledge **31**. It will be noted that wiper blade **145** is so mounted to permit adjustment of side walls **46** in accordance with the present invention.

In FIGS. 5 and 6, there is illustrated the use of the machine of the present invention in paving transition sections of the slope where, for example, the width of the section to be paved narrows from the bottom to the top. As illustrated, screed forms **147** extend in spaced angular relationship to the length of the slope. For this operation, wiper blades **145** are employed in lieu of screed shoes **143** in order to permit progressive adjustment of sides **46** so that the latter remain in adjacent relationship to screed forms **147** as the machine traverses the slope.

In FIGS. 21 and 22 there is illustrated a modified form of wheel assembly. The modified wheel assembly includes a support assembly **148**, pendently supported by frame **30**. Support assembly **148** comprises a jack screw portion **149** and jack body **150**. A truck **151** is fixed to the lower terminal of portion **149**, which truck supports flanged wheels **152** which are engaged with screed forms **147'**. The main advantage of such units is that the slope direction and elevation of the machine is automatically controlled by the truck riding on the screeds.

Conventional means may be suitably located on the machine of the present invention to effect operation of the various hydraulic or pneumatic assemblies herein shown and described. Although we have herein shown and described preferred combinations and sub-combinations of the present machine and method, it is, of course, to be understood that various changes may be made herein. More particularly, as indicated earlier in this specification, the entire machine described hereinabove is of great utility in paving road beds, for example, as well as steep slopes. Moreover, the more advantageous features of the invention, forming sub-assemblies of the complete machine, are usable apart from each other. Accordingly, the invention is not to be considered limited to the structure and uses particularly described herein, but rather only by the scope of the appended claims.

We claim:

1. A paving machine which comprises a traveling frame, an underslung float body including a float panel and a strike-off nose portion carried by said frame and curving rearwardly at its lower end to issue into said float panel, said float panel having a flat under surface extending in a single plane continuously to the rear edge of said float panel to smooth and express paving material therebeneath, said float body being so connected to said frame that the rear end of said flat surface is slightly depressed with respect to the front end thereof when the machine is in use, said plane thereby extending at a small angle to the surface being paved, said nose portion being operable to push excess paving material forwardly and being inclined forwardly and upwardly from the forward end of said flat panel at an angle thereto determined by the slope of the surface being paved and the angle of repose of the paving material on that slope, a pair of side walls carried by said frame and extending forwardly from said strike-off nose portion generally parallel to the direction of travel of the frame, said side walls together with said nose portion defining a hopper for receiving paving material deposited in the path of travel of the frame, said hopper having an open front to leave material pushed forward by said nose portion unconfined at the hopper front, means to consolidate the paving material ahead of said float panel without substantially vibrating said float panel, said float panel being free between its lateral sides of any structure depending from said undersurface which would

cause said float panel to be supported by the surface on which the paving material is to be deposited, whereby the float panel is free to move over the paving material and sealingly adhere thereto without being raised by the paving material above the desired pavement surface, a troweling pan carried by said frame and spaced rearwardly from said float panel, and resilient mounting means for yieldingly urging said pan downwardly into troweling engagement with the surface of the paving material which has been smoothed by said float panel.

2. The apparatus of claim 1 wherein said float body includes a further portion extending substantially vertically upwardly from said nose portion and substantially coextensive in length transverse to the direction of travel of the frame with both the nose portion and float panel.

3. The apparatus of claim 1 wherein said troweling pan mounting means permits said pan to be tilted about an axis transverse to the direction of travel of the frame.

4. The apparatus of claim 1 including a pair of spaced slip form shoes carried by said frame and extending downwardly below the under surface of said float panel to define the sides of the pavement being laid, said shoes and said float panel providing an extrusion conduit for the paving material.

5. A paving machine which comprises a traveling frame, an underslung float body including a float panel and a strike-off nose portion carried by said frame and curving rearwardly at its lower end to issue into said float panel, said float panel having a flat undersurface extending in a single plane continuously to the rear edge of said float panel to smooth and express paving material therebeneath, said float body being so connected to said frame that the rear end of said flat surface is slightly depressed with respect to the front end thereof when the machine is in use, said plane thereby extending at a small angle to the surface being paved, said nose portion being operable to push excess paving material forwardly and being inclined forwardly and upwardly from the forward end of said float panel at an angle thereto determined by the slope of the surface being paved and the angle of repose of the paving material on that slope, a pair of side walls carried by said frame and etxending forwardly from said strike-off nose portion generally parallel to the direction of travel of the frame, said side walls together with said nose portion defining a hopper for receiving paving material deposited in the path of travel of the frame, said hopper having an open front to leave material pushed forward by said nose portion unconfined at the hopper front, said float panel being free between its lateral sides of any structure depending from said undersurface which would cause said float panel to be supported by the surface on which the paving material is to be deposited, whereby the float panel is free to move over the paving material and sealingly adhere thereto without being raised by the paving material above the desired pavement surface, a troweling pan carried by said frame and spaced rearwardly from said float panel, and resilient mounting means for yieldingly urging said pan downwardly into troweling engagement with the surface of the paving material which has been smoothed by said float panel.

6. A paving machine which comprises a traveling frame, an underslung float body including a float panel and a strike-off nose portion carried by said frame and curving rearwardly at its lower end to issue into said float panel, said float panel having a flat undersurface extending in a single plane continuously to the rear edge of said float panel to smooth and express paving material therebeneath, said float body being so connected to said frame that the rear end of said flat surface is slightly depressed with respect to the front end thereof when the machine is in use, said plane thereby extending at a small angle to the surface being paved, said nose portion being operable to push excess paving material forwardly and being inclined forwardly and upwardly from the forward end of said float panel at an angle thereto determined by the slope of the surface being paved and the angle of repose of the paving material on that slope, and a pair of side walls carried by said frame and extending forwardly from said strike-off nose portion generally parallel to the direction of travel of the frame, said side walls together with said nose portion defining a hopper for receiving paving material deposited in the path of travel of the frame, said hopper having an open front to leave material pushed forward by said nose portion unconfined at the hopper front, said float panel being free between its lateral sides of any structure depending from said undersurface which would cause said float panel to be supported by the surface on which the paving material is to be deposited, whereby the float panel is free to move over the paving material and sealingly adhere thereto without being raised by the paving material above the desired pavement surface.

7. The apparatus of claim 6 including a diverter member extending forwardly from said further portion of the float body at an angle to said nose portion such as to be generally parallel to the surface being paved, said diverter member being substantially coextensive in length with said further portion of the float body and being operable to push excess paving material downwardly as its rises up from the nose portion, to prevent the paving material from rising up over the top of the float body and onto the frame.

8. The apparatus of claim 7 in which the angle of depression of said float panel is between about 20 minutes and 1 degree and 40 minutes.

9. The apparatus of claim 8 in which said nose portion is inclined with respect to said float panel at an angle of between about 30° and 60°, and including means for raising the forward end of said frame, including the nose portion of the float body, a distance of up to about 2 feet with respect to the rear end of the frame.

10. The apparatus of claim 9 in which said float panel is at least about 3 feet and no longer than about 4 feet in length in said direction of travel and the rear end thereof is about ½ inch below the front end.

11. The apparatus of claim 10 including a starter strike-off bar extending transversely of said direction of travel substantially coextensively with said nose portion and being lowerable from a rest position to a position forward of said nose portion low enough so as to push excess paving material forward.

12. The apparatus of claim 6 in which said float body further includes a further portion extending substantially vertically upwardly from said nose portion, and a diverter member extending forwardly from said further portion of the float body at an angle to said nose portion, the diverter member and the nose and further portions of said float body being substantially coextensive in length transverse of the direction of travel and at least as long as the distance between said side walls, said nose portion being operable to push excess paving material ahead of it while the diverter member is operable to push such paving material downwardly to mix it and prevent it from rising up over the top of the float body and onto the frame.

13. The apparatus of claim 12 having a pair of laterally spaced screed shoes carried by and movable with said frame at the sides of said float panel, said shoes extending downwardly below said flat undersurface to define the side limits of the paved panel laid by the machine.

14. The apparatus of claim 12 including a plow shaped spreader carried by said frame in advance of the float body, and means for moving said spreader transversely of the direction of travel of the frame to spread paving material in front of the float body.

15. The apparatus of claim 12 including a starter strike-off bar extending transversely of said direction of travel substantially coextensively with said nose portion and being lowerable from a rest position to a position forward of said nose portion low enough so as to push excess paving material forward.

16. The apparatus of claim 12 including a tubular vibrator mounted on the frame to extend generally parallel to the lower portion of said nose portion, and positioned forwardly thereof, said vibrator being operable in use of the machine to vibrate paving material to consolidate it as it is laid.

17. The apparatus of claim 16 including resilient hangars supporting said tubular vibrator from said frame operable to minimize transmission of vibratory forces from the vibrator to the frame and float body.

18. The apparatus of claim 17 including at least one support bracket engaging said tubular vibrator between the ends thereof and resiliently supported from said nose portion of the float body.

19. The apparatus of claim 6 in which said side walls are movable toward and away from each other to vary the width of the hopper formed thereby with said nose portion of the float body and thereby of the panel of paving material laid by the machine and motor-operated means for so moving the side walls toward and away from each other.

20. The apparatus of claim 19 in which said diverter member is formed by telescopic housings within an enclosure, the bottom surfaces of said housings and enclosure being adapted to intercept the paving material, said side walls being carried by said housings, said motor-operated means being operable to move said telescopic housings longitudinally with respect to said enclosure to effect corresponding inward and outward movement of said side walls to permit changing the width of the paving material laid, while the machine is in motion.

21. The apparatus of claim 6 in which said angle is between about 20 minutes and 1° and 20 minutes.

22. The apparatus of claim 21 in which said float panel is at least about 3 feet and no longer than about 4 feet in length along said direction of travel and the rear end thereof is about ½" below the front end.

23. The apparatus of claim 6 in which said nose portion is inclined with respect to said float panel at an angle of between about 30° and 60°, and including means for raising the forward end of said frame, including the nose portion of the float body, a distance of up to about two feet with respect to the rear end of the frame.

24. A paving machine which comprises a traveling frame, a float body carried by said frame and including a float panel having a flat undersurface to smooth and express paving material therebeneath and a strike-off nose portion inclined upwardly and forwardly from said float panel, a trowelling float pan carried by said frame and spaced rearwardly from said float panel, said float pan having a flat lower face of substantial length transverse to the direction of travel thereof for engagement with the surface of the paving material, means mounting said float pan for adjustment of tilt thereof with respect to the frame to vary the attitude of the plane of said lower face with respect to the plane of the surface of the paving material, and resilient mounting means supporting the float pan with respect to the frame and urging it downwardly so that the lower face thereof will be yieldingly forced against the paving material when the frame and the pan are in operative position with respect to paving material, said adjustment means being operable to vary the angle of intersection of the said plane of said lower face with the plane of the surface of the paving material to vary the depth and glaze of encrustation of the paving material formed by the float pan.

25. The apparatus of claim 24 in which said resilient mounting means is controllable to adjust the force with which the float pan is urged against the paving material.

26. The apparatus of claim 24 in which said resilient mounting means includes spring-urged plungers, said adjustment mounting means including lugs fixed to and extending upwardly from the upper face of the float pan rearward of the longitudinal center thereof, said lugs having slots therein extending parallel to the float pan upper face and along the direction of travel of the float pan, and a pin extending through each said slot, the said plungers having bifurcated lower ends embracing the respective lugs and journalling the respective pins, and releasable tightening means for holding the pins at desired positions in their slots, the said plungers having upper ends in cylindrical housings fixed to the frame, with compression springs in such housings urging the plungers downwardly.

27. In a paving machine including a travelling frame, a tubular vibrator mounted on said frame in position such as to extend into paving material during operation of the machine to vibrate such material and consolidate it as it is laid, said vibrator comprising a plurality of detachably connected cylindrical units, each such unit housing one of a connecting shaft and an eccentric power shaft with the shafts of adjoining units in detachable engagement to transmit rotary movement from one end of the assembly to the other; each of said power shafts having a weighted body portion, a shaft reinforcing strut portion, and shaft extensions at opposite ends thereof; bearings at opposite ends of each power shaft rotatably supporting the extensions thereof in the respective cylindrical units, the units housing eccentric power shafts being replaceable by units housing connecting shafts so that the intensity of vibration in unit lengths of the assembly may be changed.

28. The apparatus of claim 27 in which each connecting shaft and eccentric power shaft has a longitudinal keyway in one terminal end and a complementary key in the opposite terminal end to permit interengagement and removal of adjacent connecting shafts and eccentric shafts.

29. The apparatus of claim 27 including an intermediate drive coupling assembly to permit a plurality of vibrator sections, each formed of a plurality of cylindrical units, to be driven from the same source at the same frequency, said drive coupling comprising a resilient tubular sleeve, means for connecting said sleeve to adjacent cylindrical units at opposite ends thereof, a flexible shaft extending through said tubular sleeve, the terminal ends of said flexible shaft being in operative engagement with terminal ends of adjacent eccentric shafts.

30. A machine for blanketing a sloping foundation with paving material laid in sections by movement of the machine up the slope, including a frame, means for moving said frame, a horizontal strikeoff bar suspended from the front end of said frame, said strikeoff bar extending transversely of said frame, means for raising and lowering said strikeoff bar during movement of said frame up or down the slope, confining side walls for the paving material supported near the front of said frame, means for varying the distance between said side walls, a spreader supported by said frame between said confining side walls, means for moving said spreader in a reciprocating motion between said side walls, to distribute and mix paving material poured on the slope in advance of the machine, a float body suspended from said frame aft of said spreader, the float body including a panel, the lower face of which is adapted for engagement with the paving material, the forward terminal of said panel extending upwardly at an angle to provide a forward, upwardly inclined nose portion for pushing ahead of the machine surplus material placed in its path, said nose portion being in contiguous engagement with said confining side walls, thereby forming a hopper-like member for receiving the paving material, material intercepter means transversely of the float body at the upper terminal of said nose portion, and protruding outwardly therefrom, to prevent paving material from rising over the nose portion to the upper face of the float body, said panel being slightly downwardly inclined, with respect to the frame, from the nose portion to the aft edge thereof, to form a depressed encrusting pan for effecting a floating and troweling of the paving material as the float body moves thereover, a tubular vibrator between said nose portion of the

float body and said spreader extending transversely of the frame through said side walls, spaced brackets carried by said nose portion, and extending forwardly thereof, in supporting engagement with said tubular vibrator, resilient means interposed between each of said brackets and nose portion of the float body, to prevent transmission of vibrations to the float body, means for actuating said vibrator to densify the paving material, a finisher depending from said frame aft of said float body and operable on the surface crust formed by said depressed encrusting pan of the float body, means for setting the angle of attack of said finisher with respect to the paving material, to determine the depth and glaze of the encrustation to be formed by the finisher, means for effecting constant downward pressure of said finisher on the paving material, and an assembly on said frame aft of said finisher, for forming transverse contraction joints in said paving material, said assembly including a blade depending from said frame transversely of the direction of movement of said frame, power means for forcing said blade into the paving material and for withdrawing the blade therefrom, the assembly further including means for preventing forward movement of said blade with respect to the paving material during engagement of the blade therewith, said latter means effecting movement of the blade

with respect to the frame toward its initial position after the blade is withdrawn from the paving material.

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CHARLES E. O'CONNELL, *Primary Examiner.*

JACOB L. NACKENOFF, *Examiner.*

N. C. BYERS, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

May 9, 1967

Patent No. 3,318,208

Harry D. Durston, et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 67, for "machines" read -- machine --; column 4, line 47, for "said" read -- side --; column 6, line 14, for "or" read -- to --; line 33, for "apposite" read -- opposite --; line 72, after "adhesion" insert -- is --; column 8, line 12, for "membrance asphat" read -- membrane asphalt --; line 42, for "wheel" read -- wheels --; column 14, line 60, for " bifuracted" read -- bifurcated --; column 16, line 62, for "flat" read -- float --.

Signed and sealed this 21st day of November 1967.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents