June 18, 1963 M. I. HUDIS ETAL 3,094,048

PAVEMENT SURFACE FINISHING APPARATUS

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FIG. 1.

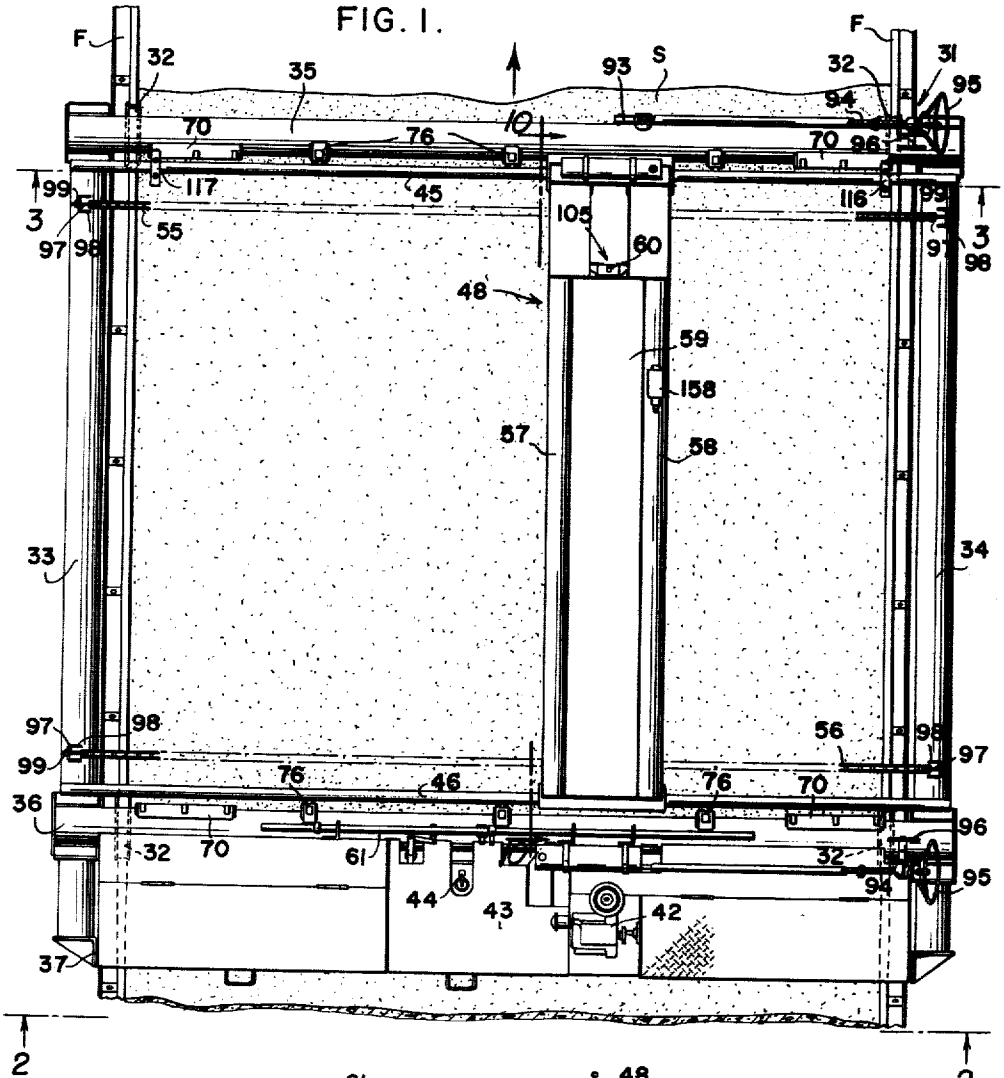
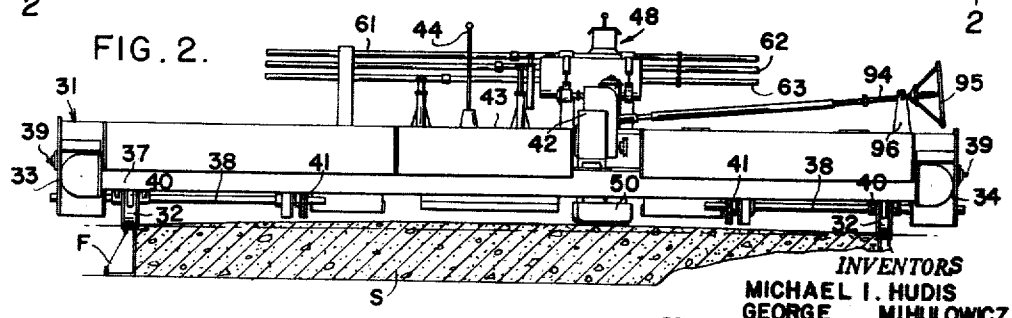


FIG. 2.



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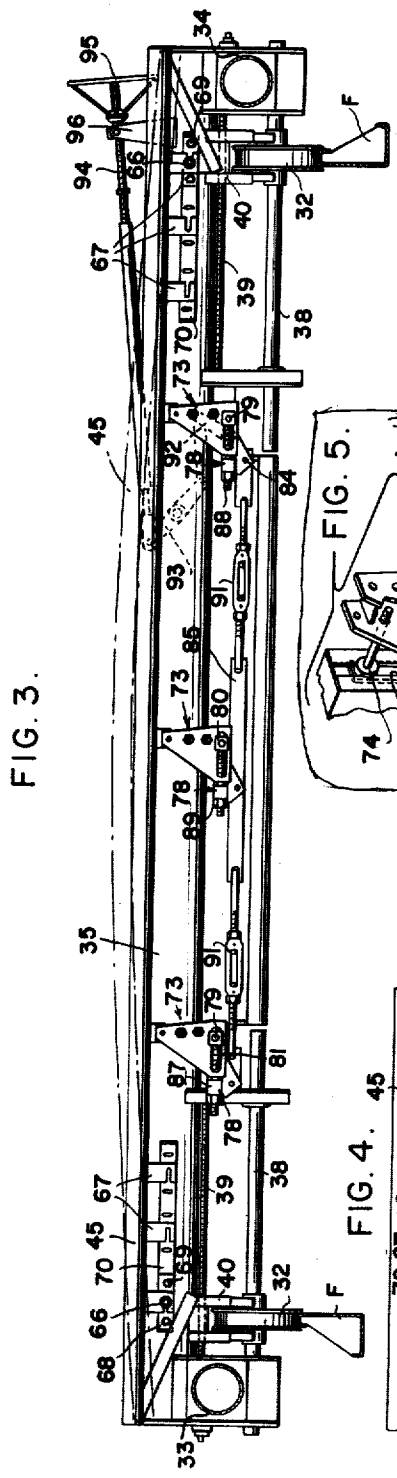


FIG. 3.

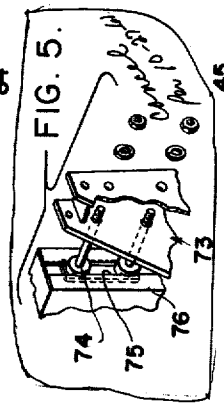


FIG. 5.

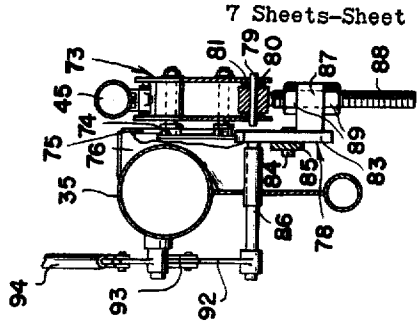


FIG. 9.

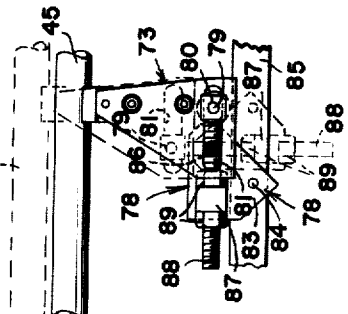


FIG. 8.

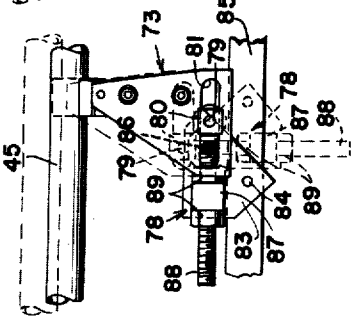


FIG. 7.

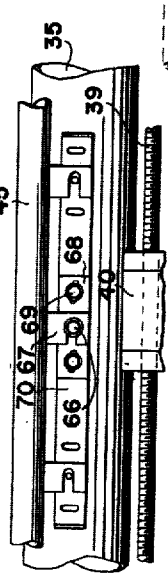


FIG. 4.

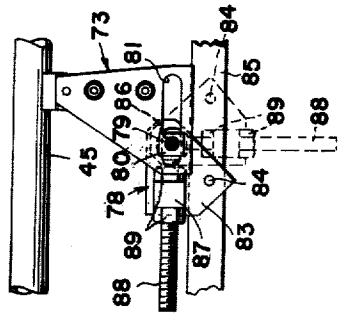


FIG. 6.

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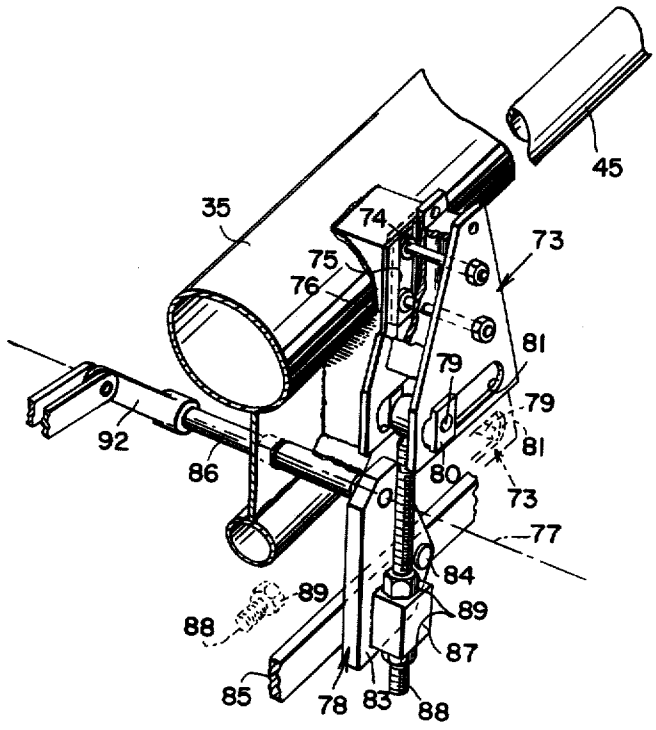
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FIG. 5.



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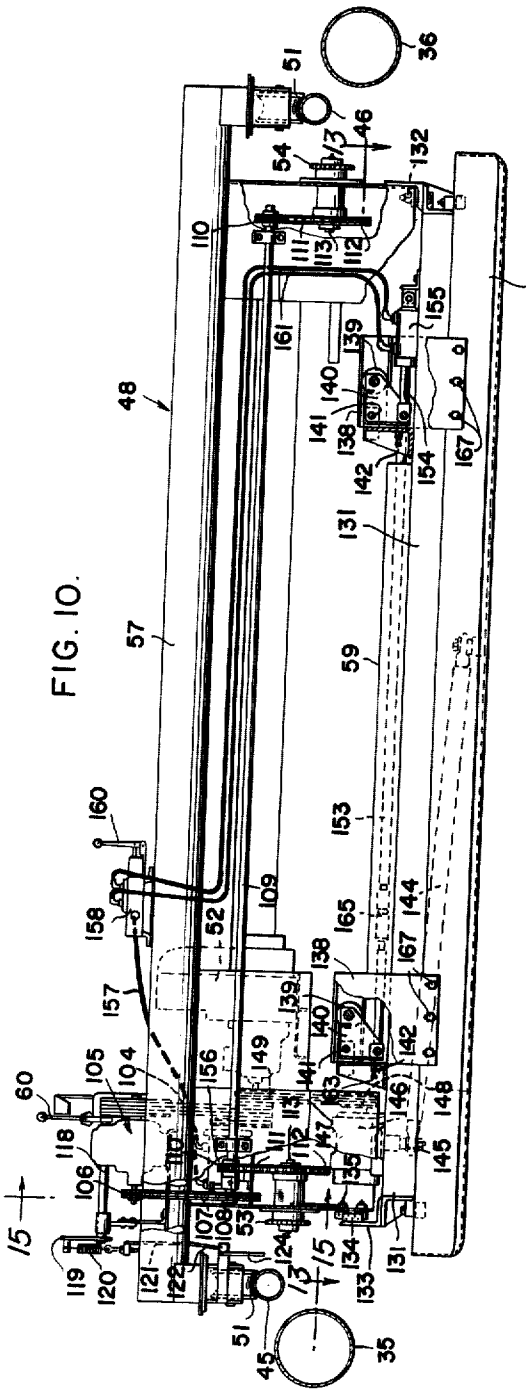


FIG. 10.

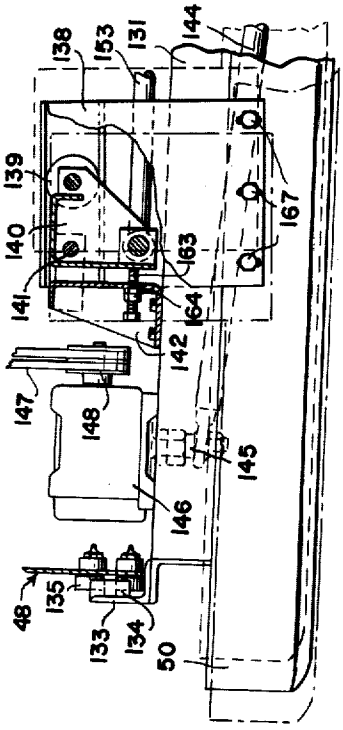


FIG. 12.

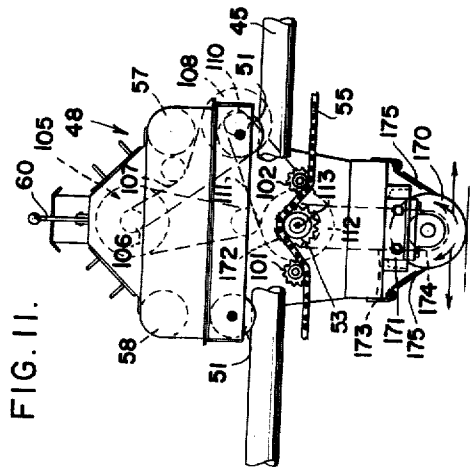


FIG. 11.

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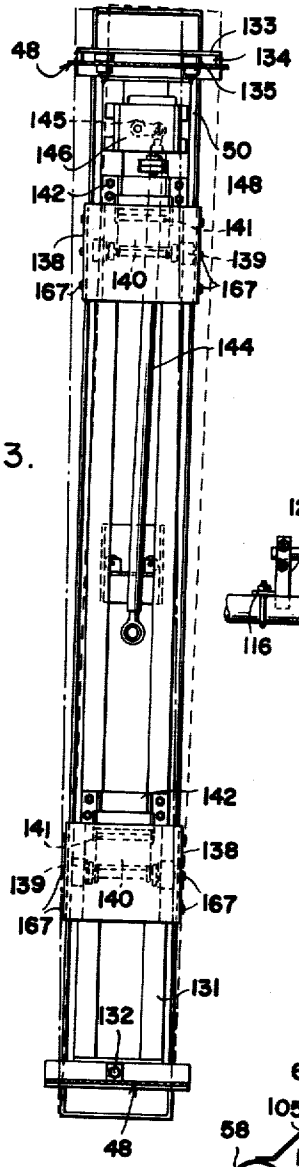
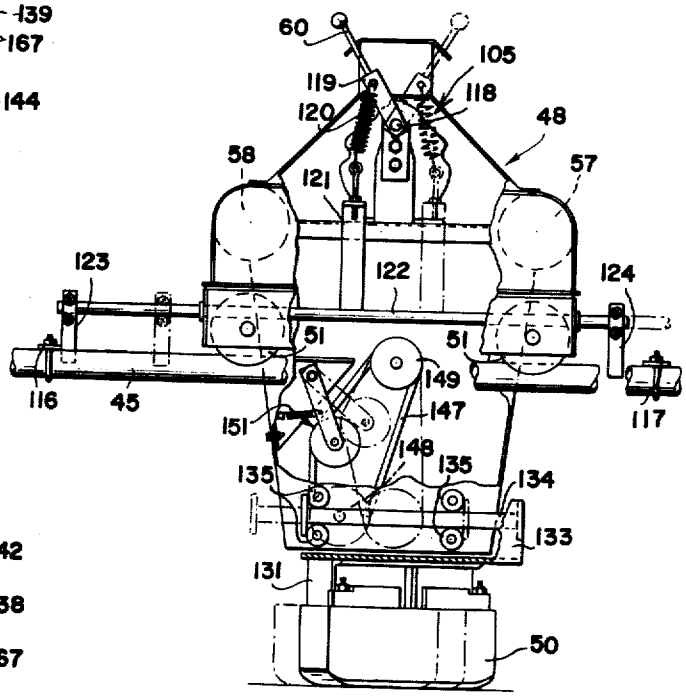


FIG. 13.

FIG. 14.



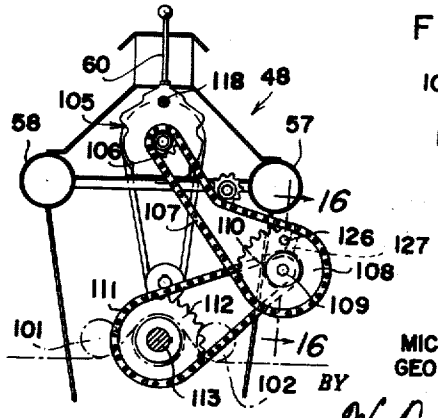


FIG. 15.

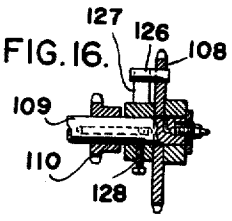


FIG. 16.

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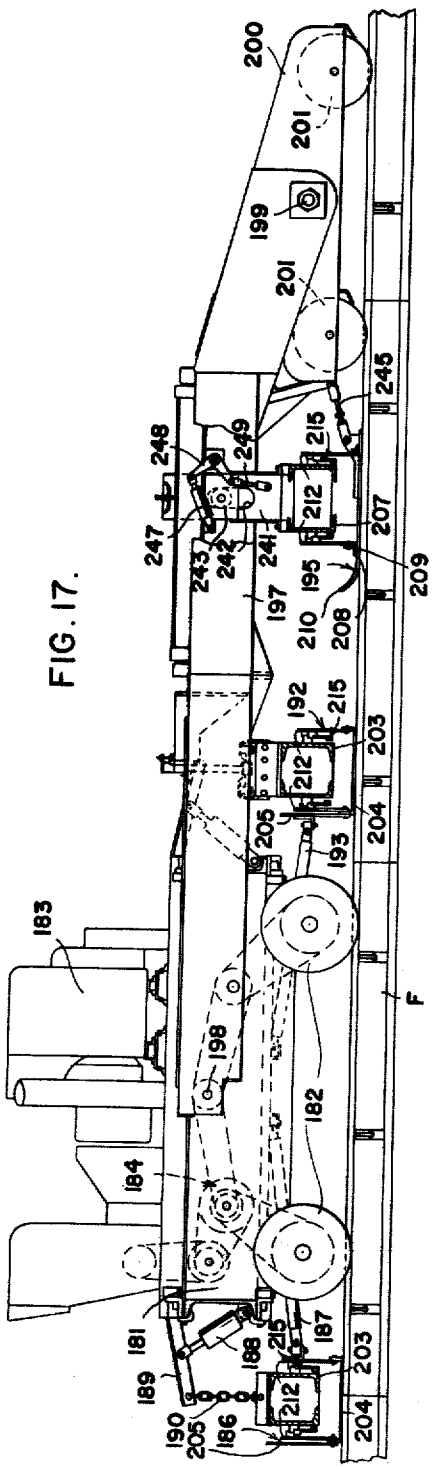


FIG. 17.

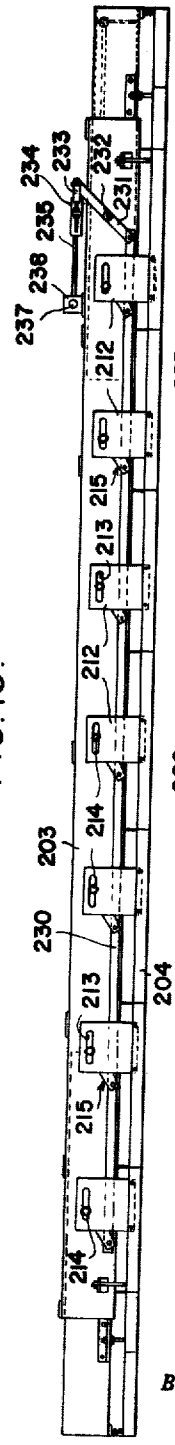


FIG. 18.

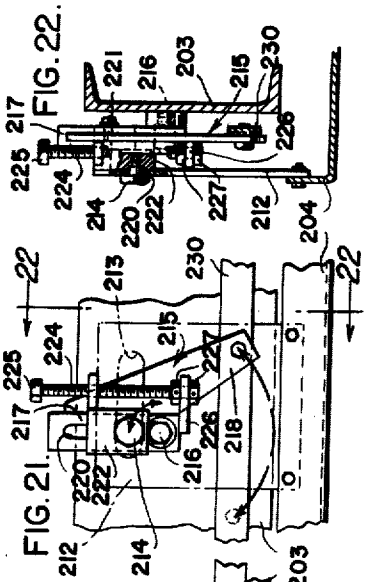


FIG. 22.

FIG. 21.

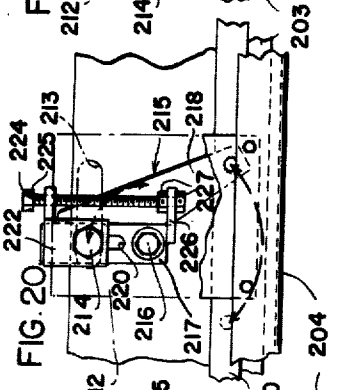


FIG. 20

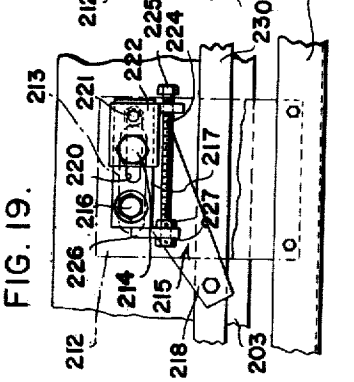


FIG. 19.

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FIG. 23.

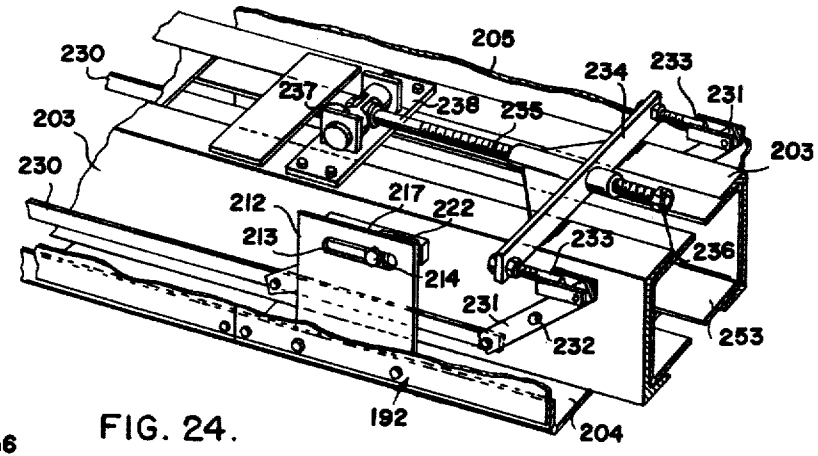


FIG. 24.

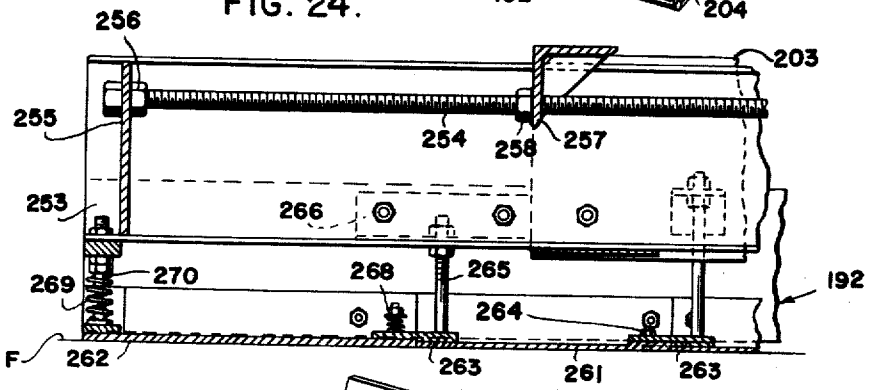
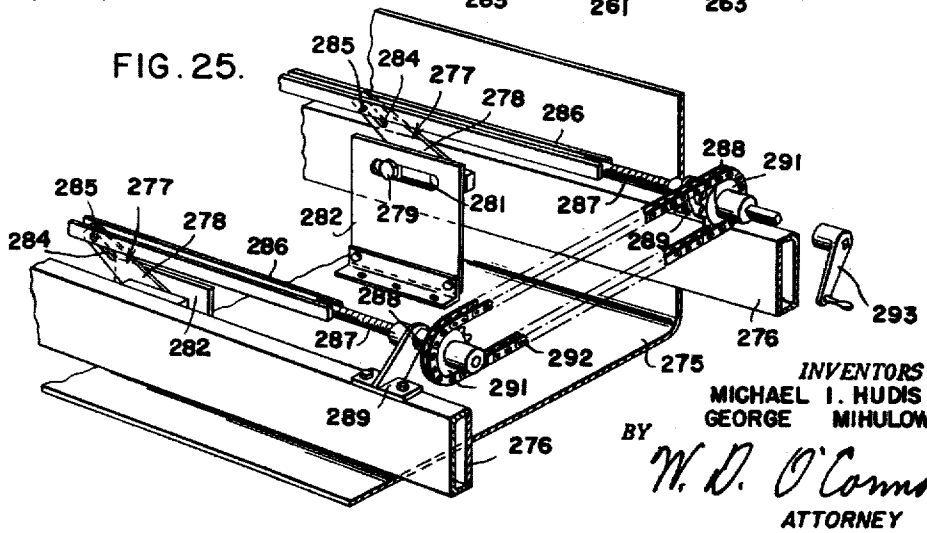


FIG. 25.



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United States Patent Office 3,094,048
Patented June 18, 1963

3,094,048

PAVEMENT SURFACE FINISHING APPARATUS

Michael I. Hudis, Waukesha, and George Mihulowicz, Milwaukee, Wis., assignors to Chain Belt Company, Milwaukee, Wis., a corporation of Wisconsin

Filed Apr. 13, 1959, Ser. No. 806,003
14 Claims. (Cl. 94—45)

The present invention relates generally to apparatus for producing a predetermined configuration of the surface of a pavement slab or the like while in a plastic condition and more particularly to improved readily adjustable and versatile means for finishing the slab surface to a crowned contour of selected profile.

In finishing the surface of a pavement slab such as for a highway, an airport runway or any similar purpose, the center portion of the slab is usually formed slightly higher than the edges to provide a so-called crown that facilitates proper drainage, thereby obviating the accumulation of rain water on the pavement. This crowning of the pavement slab is usually effected by elevating the center element to an extent in the order of three inches more or less in the case of a pavement slab that it twenty feet or more in width. The crowned slab surface may be of a contour that is arcuate in section or its profile may be in the form of a parabola or some other curve that is deemed best suited to circumstances of use for which the pavement is intended.

Accordingly, machinery for finishing the surfaces of pavement slabs of concrete or other material in plastic condition must be arranged to provide for forming the desired crowned contour in accordance with the specifications established for various paving operations undertaken from time to time. This is accomplished with machines of different types either by suitably adjusting the shape of the actual slab-engaging and forming surface itself to the required contour, as is done in some machines or, as in others, by providing trackways that are adjustably shaped for guiding a surface forming element in moving transversely over the surface of the slab as the machine progresses along the pavement being finished. Furthermore, the crowning or shaping apparatus must be adjustable during operation of the machine to provide for changing the extent and contour of the crown being formed as the work progresses in a manner to meet the precise specifications for various elements of the pavement being finished.

In paving a highway, for example, the straightaway sections are usually crowned uniformly from end to end in accordance with a specified predetermined contour established by an initial precise adjustment of the machine. However, on banked or superelevated curves the slab surface is preferably formed flat without any crown. It therefore becomes necessary to form transitional pavement elements leading smoothly into and out of any curved section of the highway wherein the degree of crowning is changed progressively and gradually from the fully crowned condition to the flat condition in the curve and then back again to the fully crowned condition. This requires, then, that the finishing machine crowning apparatus be provided with an additional controlling arrangement whereby the crown shaping element of the machine may be changed progressively and with facility from its fully crowned condition to the flat condition and back to the previously established fully crowned condition to effect blending of the different surfaces as the machine moves through a curved section of the pavement slab being finished, all without disturbing the initilal precise adjustment of the crown shaping apparatus to form the specified crown contour.

It is therefore a general object of the present invention to provide an improved apparatus for finishing the surface

of a slab of plastic pavement material to a predetermined contour.

Another object of the invention is to provide a pavement surface finishing apparatus that may be adjusted readily to shape the surface of a pavement slab to a desired profile and that is arranged to be regulated conveniently during operation to modify the adjusted profile shaping action temporarily when required.

Another object is to provide an improved crown determining arrangement for a pavement slab finishing machine wherein a deformable element is deflected by spaced infinitely variable individually adjustable force exerting units to a desired shape to form the crown and wherein the adjusted crown shape may be modified by actuating all of the force exerting units simultaneously.

Another object is to provide an improved quick-change crown adjusting mechanism for pavement finishing apparatus in which spaced eccentrics are turned in unison in changing from the fully crowned condition and in which the fully crowned contour is established by adjusting the degree of eccentricity of each eccentric individually by means of an infinitely variable throw adjusting arrangement.

Another object is to provide improved crowning apparatus for a pavement slab finishing machine having infinitely variable screw and nut adjusting apparatus for establishing the desired crown forming contour, combined with cooperating eccentric crank mechanism for reducing and reestablishing the degree of crowning.

Another object is to provide an improved pavement finishing apparatus of the longitudinal float type.

A further object is to provide an improved pavement finishing apparatus of the transverse float type.

According to this invention, a finishing machine for smoothing and shaping the surface of a slab of plastic pavement material being laid is provided with apparatus for controlling a deformable contour establishing element whereby the contour or crown of the slab may be established initially with a high degree of accuracy and then may readily be reduced temporarily and the initial setting as readily reestablished accurately as required by the circumstances. In a finishing machine of the transverse type, the deformable contour forming element may be the flexible bottom plate of a transverse screed or float that extends from side to side of the pavement slab being finished and that operates directly upon the plastic material of the slab to form its upper surface to the required crowned contour. In a finishing machine of the longitudinal float type, the deformable contour establishing element may be a flexible trackway extending from side to side of the slab being laid and operating to guide a carriage moving transversely of the slab and carrying a longitudinally disposed float or pan that forms the upper surface of the slab to the crowned contour determined by the configuration of the flexible trackway. In either case it is desirable that the contour of the pavement crown to be formed be established by adjusting the shape of the deformable contour establishing element through exerting bending forces upon it at spaced positions throughout its length. Furthermore, the forces exerted at the several spaced positions should be adjustable individually to establish the desired curve and also be changeable collectively for modifying the contour.

To apply the required bending forces incrementally under positive control it is preferable to utilize infinitely variable self-locking arrangements such as screw and nut mechanisms at the several spaced positions whereby the deformable member may be deflected precisely to the required contour through successive adjustments of the individual mechanisms. This is necessarily a rather slow procedure requiring careful measurements of the positions of various elements of the deformable member as the

adjustment proceeds. Once the proper adjustment of the crowning member has been effected for use in the construction of a particular highway slab for instance, no further adjustment is needed on straight sections of the slab since the degree and shape of the crown required ordinarily remains the same throughout the entire project. In order to preserve this precise screw and nut adjustment and to obviate the necessity for readjusting the crowning member each time the finishing machine operates along a banked curve for example, there is provided a supplemental quick-change adjustment that cooperates with, yet operates independently of the screw and nut adjusting apparatus to effect temporary reduction of the crowning action in going into a curve and to reestablish the crown effect upon coming out of the curve without changing the initial screw and nut setting. This quick change adjusting arrangement involves essentially a series of cranks or eccentrics which are turned simultaneously and are so arranged that when in one position the full preselected crowning effect is achieved. Upon turning the eccentrics from the fully crowned position the degree of crowning may be reduced uniformly until the crown is completely neutralized.

In entering a curved section of pavement from a fully crowned straight section, for example, the eccentrics are turned gradually to reduce the crowning action by increments until no crowning effect remains. Then in coming out of the curve the eccentrics are turned by increments in the other direction to reestablish the preadjusted crowning action of the machine. This new combination of screw and nut adjustment and eccentric crank quick-change action is accomplished by arranging the screw and nut crowning adjustment in a manner to establish the degree of eccentricity of each of the several cranks or eccentrics. Thus with the eccentrics in the fully crowned position, the screw and nut devices may be actuated to adjust the degree of eccentricity of each crank independently thereby deflecting the associated element of the deformable crowning member to the desired crowned position. With each of the eccentrics so adjusted as to establish the desired crowning contour throughout the deformable crown establishing member, the degree of crowning may be reduced incrementally and completely neutralized temporarily by turning the eccentrics simultaneously and then may be reestablished in the same manner without disturbing the individual adjustments. This is accomplished by interconnecting individual lever arms on the several cranks or eccentrics by linkage that is operated through a common actuating mechanism.

The foregoing and other objects of this invention will become more fully apparent upon reading the following detailed description of embodying apparatus in conjunction with the accompanying drawings thereof in which:

FIGURE 1 is a plan view of a longitudinal float finishing machine shown mounted above a pavement slab on forms that define the sides of the slab, the machine constituting one typical structure in which the present invention may be embodied;

FIG. 2 is a view in end elevation of the finishing machine of FIG. 1 with the forms and pavement slab shown in section taken on the plane represented by the line **2—2** in FIG. 1;

FIG. 3 is an enlarged sectional view showing the forward cross frame member of the machine and its associated flexible crown determining rail, the view being taken on the plane represented by the line **3—3** in FIG. 1;

FIG. 4 is an enlarged fragmentary view of the left end portion of the flexible rail shown in FIG. 3 and illustrating the method of attaching it to the cross frame at different positions;

FIG. 5 is an enlarged fragmentary detailed view in perspective of one of the variable throw trackway crown changing crank mechanisms shown in FIG. 3 but turned to crowning position;

FIG. 6 is a detailed view in elevation of one of the trackway lifting mechanisms shown in FIG. 3, the broken line posture illustrating its operation when the crank is adjusted to its neutral position;

FIG. 7 is a view similar to FIG. 6 but showing the lifter adjusted to effect a moderate lifting action on the trackway;

FIG. 8 is a view similar to FIGS. 6 and 7 but showing the lifter adjusted to effect a still greater deflection of the trackway element;

FIG. 9 is a view in transverse section through the cross frame and the trackway and showing one of the lifters turned as shown in FIG. 5 but adjusted to correspond with the neutral position shown in FIG. 6;

FIG. 10 is an enlarged view in longitudinal section through part of the machine taken on the plane represented by the line **10—10** in FIG. 1 and showing in side elevation the float pan and its actuating carriage;

FIG. 11 is a view in end elevation of the carriage taken from the left in FIG. 10, but showing instead of the float a modified form of surface smoothing element;

FIG. 12 is an enlarged view in side elevation of the forward end of the float pan and its supporting and driving mechanism;

FIG. 13 is a plan view of the float pan and its supporting mechanism taken partly in section on the plane represented by the line **13—13** of FIG. 10;

FIG. 14 is an end view of the carriage and float pan taken from the left in FIG. 10 with parts broken away to show the driving and controlling mechanism;

FIG. 15 is a fragmentary view of the carriage generally similar to FIG. 14 but taken in section on the plane represented by the line **15—15** in FIG. 10 to show the internal driving mechanism;

FIG. 16 is a detailed view of part of the driving mechanism taken in section on the plane represented by the line **16—16** in FIG. 15;

FIG. 17 is a view in side elevation of a pavement finishing machine of the transverse screed and float type shown mounted on side forms and constituting another typical structure embodying the invention;

FIG. 18 is a view in rear elevation of one of the screeds shown in FIG. 17 and illustrating the mechanism for deflecting the screed to effect crowning;

FIG. 19 is an enlarged view of one of the crowning lifters shown in FIG. 18;

FIG. 20 is another view of the lifter shown in FIG. 19 but after having been turned to the crowned position;

FIG. 21 is a view similar to FIG. 20 but showing the lifter after having been adjusted to effect a smaller crowning deflection of the screed;

FIG. 22 is a sectional view of the lifter taken on the plane represented by the line **22—22** in FIG. 21;

FIG. 23 is a view in perspective of part of the screed showing the actuating mechanism that is mounted on the right end of the screed as illustrated in FIG. 18;

FIG. 24 is an enlarged view in longitudinal section through the left end of the screed as shown in FIG. 18 and illustrating the arrangement for extending the end of the screed to lengthen it, and;

FIG. 25 is a fragmentary view in perspective showing another embodiment of the invention that is utilized to deflect an extrusion plate of a pavement laying machine for adjusting and modifying the crowning action thereof.

The various drawings illustrate several different forms of pavement slab finishing machines, all provided with contour establishing members arranged for precise adjustment in forming the surface of a pavement slab in plastic condition to a predetermined crowned contour and likewise all having arrangements for readily reducing or eliminating the crowning effect temporarily and then restoring the crown determining element to its original precisely adjusted crowning contour in accordance with the invention.

Referring now more specifically to the drawings, the particular finishing machine shown in FIGURES 1 to 16

thereof is of the type in which the crowning effect is obtained by means of curved trackway rails that guide the movement of the finishing or floating element in operating back and forth across the pavement slab. Surfacing machines of this type are generally known as longitudinal float finishing machines since the surface smoothing or floating element is disposed lengthwise of the pavement slab as distinguished from the transversely disposed finishing elements of other machines.

As best shown in FIGURES 1 and 2, a strip of pavement, such as a slab S, is usually laid by depositing freshly mixed concrete or other suitable material in plastic condition, between temporary confining forms F that extend along the sides of and define the area being paved. Ordinarily the forms F are positioned some twenty to twenty-five feet apart, although narrower slabs are formed in the same manner when circumstances require them, the particular slab S shown in the drawings being representative of slabs in the order of 15 feet in width since it is more convenient to illustrate a compact machine of this width. The plastic concrete or other plastic material is placed and spread between the forms F in sufficient quantities to form the slab S of the desired thickness by any suitable well known procedure and then its upper surface is smoothed and shaped while still plastic to the desired contour by the finishing machine to form a traffic sustaining working surface having the required crown and surface smoothness.

The longitudinal float finishing machine shown generally in FIGURES 1 and 2 comprises essentially a main body or frame **31** that is preferably in the form of a hollow rectangle and that is adapted to straddle or span and to move over and along the pavement slab S being finished. To this end, the frame **31** is supported at each side of the slab S by suitable running gear to provide for movement of the apparatus along the slab as the finishing operation progresses. The running gear in the particular structure shown is in the form of four-flanged wheels **32** disposed to support the respective corners of the frame **31** as shown in FIG. 1 and arranged at each side in tandem pairs to engage and roll upon the tops of the respective forms F which serve as tracks or rails for supporting and guiding the machine in its movement lengthwise of the slab S. Although the particular running gear shown in the drawing is adapted to support the finishing machine on the forms F, it is to be understood that the running gear may take other forms, for example it may be adapted for operation upon adjacent previously laid pavement slabs or directly upon the ground as circumstances may acquire.

The rectangular main frame **31** is made up primarily of large tubular elements including two tubular longitudinal side pieces **33** and **34** disposed above the respective edges of the slab S and joined at their forward ends by a transverse tubular front cross frame member **35**. A rear main cross frame member **36** that carries the propulsion mechanism, is mounted between and just forwardly of the trailing ends of the side pieces **33** and **34**, and a parallel supplemental tubular cross frame member **37** of smaller diameter joins the trailing ends of the side pieces, to complete a light but very rigid supporting structure.

As shown in FIGS. 2 and 3, each of the flanged wheels **32** is slideably mounted on an axle **38** that is rotatably mounted beneath and parallel with the respective cross frames **35** and **36**. Rotatable adjusting screws **39** disposed above and extending parallel with the axles **38** have threaded engagement with forked wheel guides **40** which straddle the wheels **32** and serve to move the wheels along the axles when the screws are turned. As may be appreciated from the drawing, by moving the wheels **32** in this manner the width or tread of the running gear may be adjusted to correspond to the spacing between the side forms F.

The rear axles **38** carrying the flanged wheels **32** associated with the rear frame member **36** are each provided with sprockets **41** shown in FIG. 2 by means of which the wheels are driven to propel the machine along the forms F. Power for turning the wheels to advance the machine is derived from an engine **42** that is carried on the rear cross frame members **36** and **37** and that is connected through the usual reversible speed reducing and selecting mechanism to the sprockets **41** whereby the machine may be driven in either direction at any one of a plurality of different speed ratios. By selecting the speed ratio and regulating the speed of the engine **42**, the machine can be driven along the forms F as desired. The transmission mechanism is housed beneath a platform **43** extending rearwardly from the rear cross frame member **36** to the supplemental frame member **37** and the speed ratio is selected by manipulating the usual gear shifting lever **44** protruding upwardly from the platform.

As previously mentioned, in this machine the crowning action is predetermined by curving deformable flexible trackway elements to the desired configuration. In the particular construction shown, the trackway for guiding the movement of the float is constituted by a pair of flexible rails **45** and **46** that are supported adjacent to and in parallel relationship with the respective front and rear cross frame members **35** and **36**. The trackway rails **45** and **46** are likewise in the form of tubular members but are of relatively small diameter to facilitate bending in order that they may be deflected readily to predetermine the contour of the crown to be established on the slab S. The slender and flexible spaced tubular rails **45** and **46** support the respective ends of a float carriage **48** which has suspended beneath it a longitudinally disposed float pan **50** that engages and shapes the surface of the slab S. As best shown in FIGS. 10, 11 and 14, the carriage **48** is provided at each end with two spaced wheels or rolls **51** presenting concave peripheries or rims which engage and roll in tandem relationship upon the respective tubular rails **45** and **46**, the arrangement being such that as the carriage travels back and forth from side to side of the slab S the float pan **50** follows a path determined by the curvature of the flexible rails **45** and **46** in shaping the surface of the slab.

Movement of the carriage **48** along the rails **45** and **46** is effected by means of a a separate engine **52** that is mounted in the forward end of the carriage and that is operatively connected to drive a pair of sprocket wheels **53** and **54** projecting at the respective ends of the carriage. The sprocket wheels **53** and **54** engage respectively with fixed strands of chain **55** and **56** disposed adjacent to the flexible rails **45** and **46** as shown in FIG. 1 and secured at their ends respectively to the side frame members **33** and **34** and constituting in effect a pair of flexible racks. The carriage **48** is constituted primarily by spaced parallel longitudinally extending tubular members **57** and **58** that carry suspended beneath and between them an operator's platform **59**. From the platform **59** an operator can start, stop or reverse the movement of the carriage **48** in traversing the slab S by manipulating a hand lever **60** at the forward end of the carriage. Likewise from the platform **59** the operator can start, stop or reverse the propulsion apparatus for moving the entire machine along the forms F by means of a control rod **61** connected with the transmission mechanism and that is slideably mounted on and in parallel relationship with the rear cross frame **36** in a position to be grasped by the operator from his station between the carriage side members **57** and **58** at any position of the carriage **48** in traversing the slab. A pair of additional control rods **62** and **63** arranged beneath and parallel with the control rod **61** serve to operate steering clutches that control the steering of the machine in advancing along the forms F.

The spaced parallel tubular rails **45** and **46** constituting the curved crown determining trackway for the float carrying carriage **48** are each supported on the adjacent cross frame members **35** and **36** respectively by a pivotal con-

nection at each end. As best shown in FIG. 3, the forward tubular rail 45, for example, is supported at its ends on the front cross frame member 35 by means of adjustably mounted pivot pins or bolts 66. Since the curve of the crown desired on the surface of the slab S ordinarily extends from the top of the form F on one side of the slab to the top of the form F at the other side thereof, it is desirable that the pivot bolts 66 be positioned approximately above the respective edges of the slab in order that the end elements may remain in fixed position while the intermediate portions of the flexible rail 45 may be deflected upward to form the crown. As shown in FIG. 3, the pivot bolts 66 are arranged directly above the wheels 32 on the forms F, the wheels being positioned in this view at their outermost positions on the axles 38. When the wheels 32 are moved inwardly to accommodate a narrower pavement slab, it is desirable that the pivot bolts 66 also be moved inwardly and for this purpose arrangements are made for mounting the bolts 66 in three different positions.

As shown in FIGS. 3 and 4, each end of the flexible rail 45 is provided with 3 spaced depending pivot lugs 67 each provided with an open ended horizontal slot to receive one of the movable pivot bolts 66. The outermost lug 67 at each end is above the wheel 32 when the wheel is in its outermost position as shown in FIG. 3, whereas the innermost lug 67 lies above the wheel when moved to its innermost position, the intermediate lug 67 being the one most nearly above the wheel 32 when in an intermediate position. As best shown in FIG. 4, the pivot bolt 66, there illustrated in the intermediate position, is carried by a bracket 68 that may be adjustably mounted at any one of three positions by means of two retaining bolts 69 operating in horizontal slots in the movable bracket 68 and in vertical slots in a bar 70 that is secured to the cross frame member 35. Thus by properly positioning the brackets 68 on the bars 70 at the respective ends of the cross frame member 35, the stationary pivot points for the ends of the rail 45 may be established at positions substantially above the respective edges of the slab S, whatever its width within the range of the machine. In making the connection, the pivot bolts 66 are left sufficiently loose to permit pivoting and sliding movement of the slotted lug 67 relative to the bolts when the flexible rail is deflected. The other flexible rail 46 at the rear of the machine is provided with a similar supporting arrangement.

Deformation or deflection of the flexible tubular rails 45 and 46 to form the crown determining curve is effected by exerting forces upward at various positions spaced along the rails and to the extent necessary to bend them to the desired contour. As shown in FIG. 3 with respect to the forward rail 45, in this machine the bending forces are applied to each rail by three spaced lifters or struts 73, one being positioned at the mid-point of the rail and the other two at positions intermediate the mid-point and the respective ends of the rail. Although only three lifters 73 are employed in the illustrated machine, which is adapted for use on relatively narrow pavement slabs, machines for use on slabs of twenty or more feet in width are ordinarily provided with at least seven of the lifters 73 spaced equally along each flexible rail. Each of the several lifters 73 is arranged for independent adjustment vertically whereby the flexible rail 45 may be deflected to approximate any desired curve. For example, if only the center lifter 73 is moved upward to deflect the rail 45, the crown curve effected in the rail will be peaked, that is, it will have a relatively sharp bend at the center with gradually sloping sides leading toward the edges of the slab. If now the other lifters 73 also are adjusted upwardly, the curve of the rail may be modified to approximate some other desired curve such as a parabola or an arc of a circle that may be selected to provide a suitable guiding shape for establishing the desired crown on the pavement slab.

As best shown in FIG. 5, each of the rail deflecting lifter struts 73 is slidably mounted for vertical movement on the associated tubular cross frame member. For this purpose each lifter is provided at its back with a rectangular slide block 74 that is arranged to slide up or down in a complementary vertically disposed guiding slot 75 formed in a bracket 76 that is secured to the cross frame member. Although the several lifters 73 are adjusted individually to establish the desired curve in the track rail 45, once the proper deflection of the rail has been effected, the series of lifters may be operated in unison to reduce temporarily and then restore the crown curve. For example, in deflecting the track rail 45 from its slack or straight position shown in solid lines in FIG. 3, to a predetermined curved position such as indicated in the drawing by broken lines, the several lifters 73 may be moved upward simultaneously along their respective guide slots 75.

This is accomplished in accordance with the invention by the concerted operation of a series of associated independently adjustable infinitely variable throw eccentrics or crank mechanisms 78 each lifter strut 73 being moved upwardly the appropriate distance to effect the required curvature of the trackway rail. As shown, the several crank mechanisms 78 are pivotally mounted in spaced relationship along the cross frame member at positions adjacent to the respective lifters 73 and are interconnected for simultaneous operation.

As best shown in FIGS. 5 and 9, each of the adjustable throw crank mechanisms 78 is mounted to turn on a horizontal pivot axis 77 that is constituted by a crank shaft 86 journalled in the cross frame member. At its outer end the crank shaft 86 has secured to it a radially depending actuating arm or crank arm 83 that forms the main part of the crank mechanism 78. An inwardly projecting pivot pin 84 on the depending part of each actuating arm 83 connects the crank to a horizontally disposed tie rod linkage 85 by means of which all of the series of cranks associated with the rail 45 for instance may be turned simultaneously. An outwardly projecting lug 87 also on the depending part of the crank arm 83 presents a radially disposed bore which slidably receives a threaded adjusting screw 88 that carries at one end a radially adjustable crank pin 79 movable with the slidably mounted screw 88. As shown, the crank pin 79 carries a slipper 80 that is received within and slides along a horizontal slot 81 in the associated lifter strut 73. Since the adjusting screw is restrained from turning by the attached crank pin 79 and slipper 80 that operate in the slot 81, radial adjustment of the crank pin position is effected by shifting the adjusting screw bodily endwise in direction diametrically of the crank shaft 86 within the bore of the lug 87. This is accomplished by means of a pair of locking nuts 89 that are threaded on the screw 88 at the respective sides of the lug 87. By loosening one nut 89 and tightening the other nut the adjusting screw 88 may be moved endwise within the lug 87 to move the crank pin 79 radially relative to the pivot axis 77 and thereby vary the effective throw of the crank mechanism 78.

With the crank pin 79 adjusted to an eccentric position relative to the pivot axis 77, as indicated in FIG. 3 of the drawing, turning movement of the crank mechanism 78 in counterclockwise direction will cause the crank pin 79 to move upward and raise the lifter 73 toward the position shown in FIG. 5. In moving the lifter 73 upward the slipper 80 on the crank pin 79 slides along the slot 81 in the lifter to accommodate the angularity of its upward movement, the amount of the upward movement depending upon the radial position to which the crank pin 79 has been adjusted relative to the crank pivot axis 77.

On the other hand, with the crank mechanism 78 adjusted in the manner shown in FIGS. 6 and 9, the crank pin 79 is placed in axial alignment with the pivot axis 77 of the crank shaft 86. With the crank pin 79 in this aligned neutral position, the crank mechanism 78 may

be rotated upon the pivot axis 77 without effecting any movement of the lifter 73. That is, the crank pin 79 merely turns in its slipper 80 resting in the slot 81 without effecting any translatory movement since it turns concentrically upon the pivot axis 77 with the crank mechanism as a whole. If now the locking nuts 89 are turned and the screw 88 readjusted to move the crank pin 79 out of alignment with the pivot axis in the crank shaft 86, as shown for instance in FIGS. 3, 7 and 8, and then the crank 78 is turned counterclockwise, the crank pin 79 moves in an arc to the position illustrated in FIG. 5, the slipper 80 sliding in the slot 81 in a manner to effect upward movement of the lifter 73 as indicated in broken lines in the drawing. The extent of movement of the lifter 73 is dependent upon the throw or adjusted distance between the crank shaft pivot center 77 and the center of the crank pin 79, the lifting effect being greater as the throw or eccentricity of the crank pin is increased as illustrated in FIGS. 5 and 8, for example.

When it is desired to deflect the tubular rails 45 and 46 to the shape corresponding with the particular curve of the crown to be formed on the pavement slab S, the pivot bolts 66, that support the respective ends of the rails 45 and 46 are positioned as previously explained as nearly as possible directly above the forms F that define the edges of the slab. The several crank mechanisms 78 associated with the rail 45 for instance are then turned by the interconnecting linkage 85 to the position in which the radial adjusting screws 88 are disposed vertically as shown in FIGS. 5 and 9. The locking nuts 89 on each screw 88 are then loosened and the screws 88 shifted endwise by turning the nuts 89 to move the crank pins 79 and the lifters 73 vertically in a manner to position the various parts of the flexible tubular rail 45 by a continuous infinitely variable adjustment to define the desired curve. To this end, measurements are taken from the plane defined by the tops of the forms F, to the rail 45 at the position of each of the lifters 73 and the adjustment operation continued incrementally until the rail 45 assumes the desired curve as defined by the several points established thereon through the measurements. The lock nuts 89 are then tightened on each of the screws 88 associated with the rail 45 and the process is then repeated for the other flexible tubular rail 46. The float carrying carriage 48 should then be run back and forth over the curved rails a few times after which the measurements are repeated to check the adjustments and corrections made if found necessary.

With the spaced track rails 45 and 46 thus adjusted to the required crowning configuration, the machine is prepared for effecting the desired crowned contour on the surface of the slab S by operating the float pan 50 back and forth over the slab surface along the path determined by the curvature of the track rails that support the float carriage as the machine progresses along the forms. This operation may continue without further adjustment so long as the pavement slab S continues to be laid along a substantially straight course. However, when the pavement slab curves, as in a highway, the curve is ordinarily banked or superelevated and crowning of its surface is then undesirable. Since superelevated curves are finished flat without any crowning effect, transitional sections of the pavement are formed leading into and out of the superelevated curve wherein the crowning effect is gradually reduced and then gradually increased to blend the straight and curved sections of the highway.

It is for convenience in effecting this gradual transitional or blending action between the crowned condition and the flat condition that the several eccentrics or crank mechanisms 78 are interconnected by the linkage 85. As shown in FIG. 3 the interconnecting linkage 85 is provided with turnbuckles 91 for adjusting its length between the respective cranks 78 whereby the several cranks may be initially adjusted and synchronized to turn in precise angular relationship. The crank mechanism 78 shown at the right end in FIG. 3 and enlarged in FIGS. 5 and 9 is provided on the inner end of its crank shaft 86 with a lever arm 92 that is connected by linkage 93 to a threaded adjusting shaft 94 that extends nearly to the end of the cross frame member at the edge of the pavement slab. The threaded shaft 94 is engaged by a threaded nut in the form of a hand wheel 95 that is rotatably mounted in a bracket 96 on the cross frame member 35 and that may be turned to exert a pulling force on the shaft 94 and the linkage 93 for turning the cranks 78. A similar interconnecting adjusting mechanism is provided in connection with the other rail 46.

As the finishing machine moves from a straight section of pavement into a transitional section, the hand wheels 95 are turned manually by increments to gradually turn the cranks 78 in the clockwise direction to lower the several lifters 73 and thereby reduce the crowning effect of the rails 45 and 46. This simultaneous adjusting action is continued intermittently throughout the transitional section of the pavement slab in such a manner that the cranks 78 are turned through ninety degrees by the time the machine enters the superelevated curve section, the tubular rails 45 and 46 having thereby been lowered to their straight positions in order that the carriage 48 may traverse them without causing the float to effect any crowning action on the slab surface.

At the end of the superelevated curve, as the machine enters the outgoing transitional section, the hand wheels 95 are turned by increments in the other direction to exert pulling force upon the shafts 94 that operate through the interconnecting linkages 93 to turn the cranks 78 simultaneously in the direction to raise the lifters 73 and deflect the trackway rails. Suitable indicators are provided on each shaft 94 in the region of the hand wheel 95 whereby the increments of movement may be estimated in changing the degree of crowning throughout the transitional section. At the end of the outgoing transitional section, the cranks 78 will have again been turned through ninety degrees to move the adjusting screws 88 to the vertical position shown in FIGS. 5 and 9 whereupon the deflected curvature of the rail 45 will be reestablished to correspond exactly to the precisely predetermined curve defined through the measuring and adjusting process previously explained. Accordingly, by this arrangement the carefully adjusted crowning effect may be gradually eliminated and then gradually reestablished upon passing around a superelevated curve, without the necessity of disturbing the precise adjustment of the several adjusting screws 88 that are secured by the lock nuts 89. If desired, the hand wheels 95 may be replaced by hydraulic cylinders or other power actuated means with suitable control apparatus for effecting the transitional adjustments.

During the various changes in the curvature of the flexible rails 45 and 46, the stationary chain strands 55 and 56, being flexible, readily accommodate themselves to the movement of the carriage 48 in traversing the deflected trackway rails regardless of their curvature, the chains operating in a sense like flexible racks in cooperating with the driving sprockets 53 and 54 on the respective ends of the carriage 48. As shown in FIG. 1, each of the chains 55 and 56 is connected at each end to a threaded bolt 97 that passes through a slotted opening in a lug 98, the lugs being secured respectively on the side frames 33 and 34. Each bolt 97 is fitted with a nut 99 whereby the chains are adjustably secured to the lugs 98. As best shown in FIG. 11, at the forward end of the carriage 48, the chain 55 passes over the driving sprocket 53 and is held down by a pair of idler sprockets 101 and 102 at the respective sides thereof that are rotatably mounted on the carriage 48 and are arranged to cause the chain 55 to wrap partly around the sprocket 53 for driving engagement therewith. The sprocket 54 at the opposite end of the carriage 48 is similarly provided with idler sprockets (not shown) which hold the chain 56 in

engagement with it in the same manner. With the chains thus threaded over the driving sprockets, the nuts **99** at the respective ends thereof may be adjusted to position the carriage **48** squarely on the rails and to tighten the chains sufficiently to insure against slipping on the sprockets, it being preferable not to tighten the chains so tight as to impose unnecessary loads on the sprockets and other parts of the machine.

As best shown in FIG. 10, the engine **52** on the carriage **48** is connected by a V-belt drive mechanism **104** to drive a reversing gear mechanism **105** which carries and is controlled by the reversing hand lever **60**. From the reversing gear **105**, power is transmitted through a sprocket **106** thereon and a chain **107** running over it to a sprocket **108** on the forward end of a long shaft **109** that extends lengthwise of the carriage **48** just below the tubular side member **57**. The long shaft **109** is provided near each end with a sprocket **110** from which a chain **111** transmits power to a sprocket **112** on the inner end of a stub shaft **113**. The outer ends of the two stub shafts **113** protrude from the opposite ends of the carriage **48** and carry respectively the carriage driving sprockets **53** and **54**. By this arrangement, an operator standing on the platform **59** in the carriage **48** may move the reversing lever **60** in the one or the other direction to engage the drive connection from the engine **52** for causing the carriage **48** to travel along the trackway rails **45** and **46** in the corresponding direction.

In order to relieve the operator from the necessity of reversing the direction of carriage travel manually at each edge of the pavement slab, an automatic reversing mechanism is provided which causes reversal to occur upon engagement with the one or the other of a pair of carriage reversing stop dogs **116** and **117** that are shown in FIGS. 1 and 14, and that are adjustably positioned on the track rail **45** near its respective ends. As shown in FIG. 10, the reversing mechanism **105** is provided with a forwardly projecting shaft **118** that is connected with the hand lever **60** and that carries at its forward end an upwardly projecting crank arm **119**. The upper end of the crank arm **119** is connected to a depending over-center tension spring **120** the lower end of which is connected to a bracket **121** upstanding from a horizontal slidably mounted control rod **122** as best shown in FIG. 14. The control rod **122** is disposed parallel with the track rail **45** and carries at its respective ends depending actuating lugs **123** and **124** that are adapted to engage the stop dogs **116** and **117**, respectively.

With the reversing lever **60** inclined to the left as shown in FIG. 14, the carriage **48** will move to the left along the rail **45** and will eventually bring the lug **123** into contact with the reversing stop dog **116** on the rail as the carriage approaches the end of its travel near the edge of the pavement slab. When this occurs, movement of the lug **123** and the control rod **122** ceases while the carriage continues to the left, which has the effect of causing the bracket **121** and the over-center spring **120** to be shifted to the right relative to the shaft **118** as it moves with carriage **48**. As the spring **120** passes the center of the shaft **118** by reason of this encounter with the stop dog **116**, the reversing lever **60** will be thrown to the right as shown in broken lines in FIG. 14 thereby reversing the driving action of the gear mechanism **105** to cause the carriage to reverse its direction of movement. The position at which this carriage reversal occurs may be regulated by adjusting the reversing dog **116** along the rail **45**.

Since the carriage is moving at its full speed when the automatic reversal occurs, a time delay arrangement is provided to permit the carriage to stop its movement and the drive mechanism to become fully engaged before power is applied to move it in the other direction. This is effected by means of a lost motion connection between the driving sprocket **108** and the long shaft **109** from which the carriage propelling sprockets **53** and **54** are driven. As best shown in FIG. 16 the sprocket **108** is loosely mounted to revolve on the end of the shaft **109** and has projecting axially from it a driving pin **126**. The driving pin **126** is positioned to engage the one or the other side of a radially projecting driving arm **127** that is secured to the shaft **109** by a key and set screw **128**. Thus when automatic reversal is effected by the over center mechanism in consequence of engagement with one or the other of the reversing dogs **116** and **117**, the driving sprocket wheel **108** will be reversed instantly through operation of the reversing gear **105** but since it is loosely mounted on the shaft **109** it merely moves the driving pin **126** away from the arm **127** and turns freely in the opposite direction. By the time that the sprocket wheel **108** has turned through nearly one revolution the carriage **48** had come to a stop through frictional action between the float pan **50** and the pavement surface and the reversing gear clutch has been fully engaged, whereupon the driving pin **126** comes into engagement with the opposite side of the arm **127** and turns the shaft **109** oppositely to move the carriage **48** in the other direction along the rails **45** and **46**. Since the automatic reversing action is effected through the yieldable over center spring **120**, it is possible for the operator to override the automatic reversing mechanism and to either stop or reverse the direction of movement of the carriage **48** at any time through manipulating the hand reversing lever **60**.

The float pan **50** that is suspended beneath the carriage **48** is as previously mentioned disposed longitudinally of the slab being finished with its leading end at the forward end of the carriage under the engine **52**. The pan is supported beneath the carriage by means of an intermediate pivoted pan carrier or frame **131**. As best shown in FIG. 10, the pan carrier frame **131** is connected to the carriage **48** at the trailing end by means of a vertically disposed pivot pin or pivotal connection **132** whereby the carrier **131** and the float pan **50** may have pivotal movement relative to the carriage **48** in a horizontal plane. The forward or leading end of the float carrier **131** is supported from the carriage **48** by means of a horizontally disposed bearing system involving a lost motion arrangement which serves to limit the extent of the pivotal movement to provide for controlled skewing of the float pan. As best shown in FIGS. 12 and 14, the horizontal lost motion arrangement at the forward end of the pan carrier **131** is provided with a horizontal bearing system including an upwardly and outwardly projecting bracket **133** that carries a horizontal raceway member **134** that is disposed between upper and lower guide rollers arranged in two spaced pairs on the front of the carriage **48**. The rollers **135** restrain the raceway **134** from movement in a vertical direction but permit limited movement of the raceway and the attached leading end of the carrier horizontally relative to the carriage **48**.

As shown in FIG. 14, since the carriage **48** is moving to the left, the carrier and the float **50** are displaced to the right from the center line of the carriage, to an extent limited by engagement of the left hand rollers **135** with the left end of the bracket **133** on the carrier **131**. As indicated in broken lines, the leading end of the float pan **50** also can be displaced to the left an equal distance from the center when the carriage moves in the other direction. By reason of the pivotal connection at its trailing end and the lost motion connection at its leading end, the float pan **50** skews automatically when the carriage **48** reverses because of frictional resistance between the float pan and the surface of the slab being finished. Thus as seen in FIG. 14 with the carriage **48** travelling toward the left the leading end of the float pan **50** drops back or lags to the right of the center line thereby presenting the side of the float pan to the slab surface at a slight angle which has a tendency to urge or push forward along the slab any excess material that may be encountered in moving over the surface of the

slab. In like manner when the carriage **48** reverses, the forward end of the float pan resists movement in the other direction and lags behind by reason of the lost motion connection thereby skewing the pan in the other direction to present its other side at the angle which urges the excess material forward along the slab.

As best shown in FIG. 10, the longitudinal float pan **50** is moveably support for longitudinal reciprocating or oscillating movement beneath the pivotally mounted pan carrier **131**. For this purpose the float pan **50** is provided near each end with an upstanding hanger **138** of generally inverted U-shape, each hanger being connected at one of its open ends to one side of the pan **50** and extending therefrom upwardly and over the carrier **131** and then downwardly in position to be similarly connected at its other open end to the other side of the pan **50**. The closed ends of the U-shaped hangers **138** serve as trackways which rest upon rollers **139** rotatably mounted on the carrier **131** in a manner to provide for limited longitudinal oscillating movement of the pan **50**. As shown in FIG. 10, the rollers **139** are each rotatably mounted on a horizontally extending arm of a bell crank **140** that is connected by a horizontal pivot pin **141** to an up-standing bracket **142** on the top of the carrier **131**, the arrangement being such that the bell cranks **140** may be pivoted about the pins **141** to elevate the rollers **139** thereby lifting the float pan **50** from the surface of the pavement slab being finished.

Longitudinal oscillating or reciprocating movement of the float pan **50** as it operates over the pavement slab is effected by means of a connecting rod or pitman **144** that is pivotally connected at one end to the midportion of the pan **50** as shown in FIG. 13, and is connected at the other end to a crank **145** depending from a speed reducing driving mechanism **146** mounted on the pivoted float carrier **131**. The crank driving mechanism **146** is in turn driven by multiple belts **147** that operate over a driven pulley **148** on the mechanism **146** and a driving pulley **149** on the engine **52**. As best shown in FIG. 14, the belts **147** are tightened by means of a spring urged idler mechanism **151**. By reason of the spring urged tightener **151** the belts **147** are always maintained in driving engagement with the cooperating pulleys regardless of the fact that the pulley **148** on the crank driving mechanism **146** moves with the carrier **131** when it is pivoted to provide for skewing of the float pan, as indicated by the broken lines in FIG. 14. By this arrangement the float pan **50** is caused to reciprocate or oscillate while transversing the pavement slab in either skewed position thereby urging forwardly along the slab any excess material that may be encountered by the sides of the pan.

As shown in FIG. 10, the downwardly projecting arms of the roller carrying bell cranks **140** are interconnected by means of a horizontal actuating rod **153** whereby the two bell cranks may be pivoted simultaneously to lift both ends of the float pan **50** at the same time. For this purpose the bell crank **140** at the right in FIG. 10 has connected to its depending arm a piston rod **154** extending from a hydraulic cylinder **155**. Hydraulic pressure for operating the piston rod **154** is derived from a pump **156** that is driven by the engine **52** and that is connected by a pressure conduit **157** to a control valve **158** mounted on the carriage side member **58** at the operator's station. A control lever **160** on the valve **158** may be actuated by the operator to admit pressure fluid through the one or the other of a pair of conduits **161** leading to the respective ends of the hydraulic cylinder **155**. With the lever **160** in one position the piston rod **154** is extended as shown in FIG. 10 and the rollers **139** are in their lower positions with the pan **50** thereby lowered into operating engagement with the top of the pavement slab. When the lever **160** is moved to the other position, the piston rod **154** is retracted whereupon both of the bell cranks **140** and turned counterclockwise about their pivot pins **141** thereby moving the rollers **139** upwardly and lifting the float pan **50** out of contact with the pavement slab.

When the float pan **50** is lowered into working engagement with the pavement slab surface, its precise elevation or vertical position is determined by an adjustable stop screw **163**, best shown in FIG. 12, the inner end of which engages and constitutes a stop for the depending arm of the bell crank **140** at the forward end of the carriage. By turning the screw **163**, both bell cranks **140** may be adjusted angularly about their pivot pins **141** in synchronism by reason of the interconnecting rod **153** thereby raising or lowering both ends of the pan **50** simultaneously to establish its vertical position. Lock nuts **164** are provided on the screw **163** for locking it in adjusted position to retain the pan **50** at the predetermined adjusted height. If it becomes desirable to regulate the height of one end of the float pan relative to the other, the length of the connecting rod **153** may be changed by adjusting a turnbuckle **165** therein to change the angular relationship between the two bell cranks. For example if it is desired to operate the trailing end of the float **50** somewhat lower than the leading end thereof, the interconnecting link **153** may be shortened by turning the turnbuckle **165** whereby the bell crank **140** at the trailing end will be turned clockwise to lower that end of the pan.

As shown in FIG. 10, the pan hangers **138** are disposed horizontally in order that when they move over the rollers **149**, the float pan **50** will oscillate in a horizontal plane in operating upon the surface of the pavement. Under some circumstances it is desirable that the float pan **50** be raised slightly when moving longitudinally in one direction and permitted to drop back when moving in the other direction to effect a patting action upon the surface of the slab. For this purpose one or both of the pan hangers **138** may be inclined slightly relative to the pan itself as shown in FIG. 12. This is accomplished by loosening bolts **167** that pass through slotted holes in securing the hangers to the sides of the float pan. With the bolts loosened, the hanger **138** may be tilted to the desired angle whereupon the bolts are tightened to hold it in the adjusted position. When the hangers **138** are thus suitably inclined, the pan **50** is caused to have the desired vertical movement as the hangers move over the rollers **139** during oscillation of the pan. This vertical movement or patting action on the surface of a slab of concrete being finished has the effect of bringing additional water to the surface thereby facilitating the finishing action by lubricating the float pan element that trowels the pavement surface.

In the normal operation of the finishing machine, the carriage **48** is caused to traverse the pavement slab S being finished, back and forth from edge to edge under the control of the automatic reversing mechanism as the machine advances along the forms F, the path of travel of the carriage being determined by the adjusted contour of the flexible trackways **45** and **46** to cause the float pan **50** to form the surface of the slab to the desired crowned contour. In order to form the surface properly, the float pan **50** is adjusted beneath the carriage **48** to a predetermined vertical position and is caused to skew automatically at each reversal of its direction of travel. Simultaneously the pan is caused to oscillate longitudinally as it traverses the slab surface in its skewed position and it may also be caused to have a limited vertical or patting motion as it is oscillated, the combined motions cooperating in a manner to achieve the best results in shaping and smoothing the surface of the pavement slab to the desired crowned contour and texture.

Under some circumstances it may be desirable to replace the float pan **50** with some other form of surface contacting and shaping element such as a power driven roller **170** that is bodily movable with the carriage **48**, as shown by way of a modification in FIG. 11. The roller **170** may be mounted on the pan carrier **131** in order to provide for the previously explained skewing action or

it may be mounted directly on the carriage 48 by means of depending brackets 171 as shown in FIG. 11. In either event it is preferable that the roller 170 be driven in such direction of rotation that the lower side of its surface contacting periphery moves in the direction of movement of the carriage 48 in traversing the slab being finished. This then requires that the direction of rotation of the roller be reversed at each reversal of the direction of movement or travel of the carriage 48. In order to accomplish this reversing action automatically the roller 170 is preferably driven by power transmitted through the reversing gear box 105 whereby reversal of its direction of rotation is effected by means of the automatic reversing mechanism. As shown in FIG. 11, this is accomplished by providing an additional sprocket 172 on the stub shaft 113 that drives the carriage propelling sprocket 53. From the additional sprocket 172, a chain 173 transmits power to a sprocket 174 secured on the forward end of the roller 170. As indicated by the arrows in FIG. 11, the roller 170, through being driven in synchronism with the propelling sprocket 53, is turned in the proper direction to cause the operating or lower side of its surface smoothing periphery to move in the direction of travel of the carriage whereby any excess material encountered by the roller is forced ahead of it in a manner to fill depressions and to smooth the surface of the slab precisely to the contour predetermined by the shape of the deflected rails 45 and 46. To prevent the accumulation of material on the surface of the roller 170, a pair of scraper blades 175 are mounted on the carriage 48 in position to engage and scrape the respective sides of the roller as it turns in either direction.

In order that the finishing machine may be transported readily from one operating site to another, arrangements are made for dismounting some elements to rearrange the structure in a more compact form. To this end, the chain strands 55 and 56 are removed and the carriage 48 lifted from the rails 45 and 46. The tubular side pieces 33 and 34 are then removed and replaced by short pieces of similar diameter in order to move the forward cross frame member 35 closer to the rear cross frame member 36. The carriage 48 is then turned through ninety degrees and mounted between the two cross frame members whereupon the entire machine may be loaded upon a truck or trailer of the usual width for transportation upon the highway.

Referring now to FIGS. 17 to 25 of the drawings, the particular pavement finishing apparatus there shown as illustrative of additional forms in which the invention may be embodied, is of the other or transverse finisher type in which the surface finishing elements are disposed transversely of the pavement slab being finished instead of longitudinally thereof. In machines of the transverse type, the finishing element ordinarily extends entirely across the slab in contact with the pavement surface and the crowning effect is obtained by suitably curving the surface contacting parts of the finishing element itself, whereby to mold and shape the surface of the pavement slab to the predetermined curved contour.

The particular apparatus shown in side elevation in FIG. 17 is of the combined transverse screed and float pan type, and is shown as being provided in this instance with two screeds followed by a finishing float pan. The novel construction of this combined machine is the subject matter of a copending applicaion Serial No. 815,427, filed May 25, 1959 by Michael I. Hudis, entitled Road Finishing Float Apparatus. The forward portion or unit of the combined machine shown at the left in FIG. 17 constitutes in itself a complete self-contained transverse screed finishing machine of a well-known type. This finishing machine element of the apparatus comprises essentially a transverse frame member 181 of generally rectangular shape that spans the slab of pavement being finished and that is supported at each end by a pair of wheels 182 arranged in tandem relationship and adapted to operate along the forms F at the respective sides of the pavement slab. The finishing machine is arranged to be driven by power derived from an engine 183 mounted on the frame 181 and connected by suitable selective transmission mechanism, including chain drives 184 as indicated in the drawing, to turn the wheels 182 in the usual manner.

A forward transverse screed 186 is shown suspended from the frame 181 ahead of the forward wheels 182 in position to extend across the pavement slab with its ends resting upon and supported in vertical position by the forms F respectively at the sides of the slab. Pushing struts 187, each hingedly connected at one end to the forward screed 186 and similarly connected at the other end to the machine frame 181, are arranged in a manner to exert force for pushing the screed ahead of the machine to level the plastic pavement material as the machine progresses along the forms F. For lifting the screed 186 out of contact with the forms and the slab, there are provided hydraulically actuated power cylinders 188 each of which may be operated to exert force upward against the center of a lever 189 of the third class which is pivoted at one end to the frame 181 and has depending from its other end a chain 190 that is connected to the screed 186 to lift it. Mechanism (not shown) of well-known type may also be provided for effecting endwise oscillatory or reciprocatory movement of the screed 186 to facilitate its smoothing action upon the surface of the slabs as the machine advances along the forms F.

When the finishing machine constituted by the forward element of the machine shown in FIG. 17 is operating independently, a rear screed 192 is ordinarily supported from the frame 181 in the same manner as the forward screed and is towed behind the machine by means of towing struts 193 each pivotally or hingedly connected at one end to the screed 192 and at the other end to the machine frame 181. However, in the particular combination arrangement shown, the apparatus includes a trailing unit that carries the rear screed 192 and that is also provided with a transverse float pan element 195, both of which are supported and positioned thereby independently of direct positioning by contact with the forms F. As shown, the trailing unit comprises a pair of relatively long frame extensions in the form of side beams 197, one being disposed at each side of the machine substantially above and parallel with the respective side forms F that define the slabs being finished, the two side beams being interconnected by a cross-frame structure. The forward ends of the side beams 197 are connected by pivot pins 198 to the respective ends of the transverse frame 181 at positions thereon substantially midway between the forward and rear tandem wheels 182. In a generally similar manner, the trailing ends of the side beams 197 are connected by pivot pins 199 to the mid portions of the respective supplemental bolster frames or carriages 200 each of which is supported near its ends by boggie wheels 201 operating in tandem relationship on the forms F. As in the case of the forward pivotal connection, the pins 199 supporting the trailing ends of the beams 197 on the bolster frames 200 are disposed substantially midway between the forward and the rear wheels 201 that support each of the auxiliary carriage frames 200.

By this arrangement, should one of the wheels 182 move upwardly because of running over an obstruction or some irregularity on the form F, the pivot pin 198 would move upwardly only half of the distance moved by the wheel 182 since the pin is midway between the front and the rear wheels. By the same token the rear pivot pin 199 will be displaced vertically only half of the distance which either wheel 201 may be displaced because of running over irregularities in the forms F. Furthermore the portions of the beams 197 substantially midway between the pivot pins 198 and 199 will be displaced in a vertical direction only half of the distance through which either pivot pin may be displaced. Consequently the midportion

of the beams **197** will be displaced only about one forth of the distance any one of the wheels **182** or **201** may be displaced vertically in passing over irregularities in the trackway constituted by the forms F. To take advantage of this displacement reducing arrangement, the rear screed **192** is in this instance suspended directly from the side beams **197** and is carried thereby independently of contact with the forms F, whereby disturbances in elevation of the slab surface finishing element is much less than would be the case if the screed depended directly upon the forms F for regulating its position.

As may be seen in FIG. 17, the front screed **186** and the rear screed **192** are very similar in construction and differ primarily only in operation in that the front screed **186** depends upon the tops of the forms F for its vertical position whereas the rear screed **192** is suspended from the trailing equalizing beams **197** in order to effect a more accurate leveling of the slab surface. Both the front screed **186** and the rear screed **192** each consists essentially of a rigid beam **203** extending transversely of the pavement slab and formed in box section by a pair of inwardly facing channel elements that are secured together in the form of a hollow square. The pavement surface contacting and forming element of each screed is constituted by a flexible screed plate **204** that extends from side to side of the slab directly beneath the beam **203** and that in the specific structure illustrated is about sixteen inches in width. The flexible screed plate **204** is turned up at each edge to form a low flange and has secured to its forward edge a series of baffle plates **205** which engage and push along any excess material encountered on the top of the slab being finished. The several baffle plates **205** are yieldably connected to the forward upturned edge or flange of the screed plate **204** in such manner that they do not materially resist flexing of the screed plate when it is bent to conform with the curve of the crown profile being shaped on the surface of the slab.

The transverse pan float **195** that follows the rear screed **192** is generally similar in construction in that it is constituted by a rectangular box section transverse beam **207** that is similar to the beam **203** of the screed but is somewhat wider. The beam **207** carries beneath it a flexible float plate **208** that extends across the slab and is in this instance about thirty inches in width. The flexible float pan **208** is provided with spaced upstanding ribs **209** extending longitudinally of its upper surface and that correspond generally with the upturned flanges of the flexible screed plate **204**. However, instead of being provided with a forward pusher plate, the float pan plate is merely turned up at its forward edge to form a toe **210**. The upturned forward edge or toe **210** causes the plate **208** to ride over the surface of the slab as formed by the preceding screed **192** in a manner to smooth it without removing material or otherwise changing its elevation.

As previously mentioned, the crowning effect is obtained in a machine of this type by bending the slab surface engaging plates to the contour of the desired crown profile. In the machine shown in FIG. 17, the crowning effect is obtained in the same manner in both of the screeds **186** and **192** and in the pan float **195**. FIG. 18 shows one of the screeds in lengthwise elevation as seen from the rear in order to disclose the screed plate deflecting mechanism that is mounted on the back of the beam **203**, it being understood that each of the beams **203** and **207** of the screeds and the pan float respectively are provided on both sides with similar deflecting mechanisms as indicated in FIG. 17.

Forces for bending the flexible crown determining elements are in this instance applied at spaced intervals along the length of each element by means of force transmitting struts in the form of rectangular plates **212** that are secured at their lower edges in equally spaced positions along both upturned flanges of the flexible screed plates **204** and likewise along the two upstanding ribs **209** of the float pan **208**. As shown in FIG. 18, each upturned edge or rib has secured to it in this particular machine a total of seven strut plates **212** equally spaced therealong, although it is to be understood that a different number of strut plates may be used depending upon the length of the screed and other factors.

Each of the strut plates **212** is provided near its upper edge with a horizontal slot **213** that is slidably engaged by an adjustable crank pin **214** of an infinitely variable-throw bell crank **215**. Each of the bell cranks **215** is pivotally mounted on the side of the beam **203** by means of a horizontally disposed pivot bolt **216** and each has an infinitely variable throw crank lever arm **217** and a depending actuating arm **218**. As best shown in FIGS. 19 through 22, the crank arm **217** is provided with a radially disposed slot **220** through which a clamping bolt **221** is fitted for sliding movement. The clamping bolt **221** is threaded into a shoe **222** that is slidably mounted on the forward face of the crank arm **217** and that carries the adjustable pivot pin **214**. The crank pin shoe **222** is provided at one side with an actuating lug having an opening threaded to receive a radially disposed adjusting screw **224**. The adjusting screw **224** is provided at its outer end with an actuating head **225** and is rotatably mounted at its inner end in a lug **226** projecting from the crank **215** in the region of the pivot bolt **216**. A pair of collars **227** are secured on the adjusting screw **224** at opposite sides of the lug **226** respectively to resist longitudinal movement of the screw relative to the crank.

When it is desired to establish the predetermined crown shaping contour in the flexible screed plate **204**, for example, the several cranks **215** are turned to the position shown in FIGS. 20, 21 and 22 wherein the adjustable crank arms **217** and the screws **224** are disposed vertically, the heads **225** of the adjusting screws **224** then being uppermost and readily accessible at the top of the screed. The clamp bolts **221** associated with the different cranks are then loosened and the several adjusting screws **224** are turned by applying a suitable wrench to the screw heads **225** successively. In this manner the shoes **222** carrying the adjustable pivot pins **214** may be moved up or down along the crank arms **217** radially thereof and since the pins **214** are engaged in the horizontal slots **213** of the struts **212**, the struts are also moved vertically to deflect the screed plate **204**. By this arrangement, each element of the flexible screed plate **204** to which a strut **212** is connected may be adjusted vertically by infinite increments and more or less independently of the other elements and struts by turning its adjusting screw. With the ends of the flexible screed plate **204** resting upon the forms F at the sides of the slab the intermediate elements of the screed plate may be raised in this manner by measured amounts to deflect the flexible plate to the predetermined crown curve. This may be effected by stretching a reference line between the forms and measuring from the line to the bottom of the screed plate at various positions therealong while turning the several adjusting screws **224** as required to deflect the screed plate in accordance with the points thus established on the desired profile curve.

After all of the adjusting screws **224** have been turned to lift their associated segments of the flexible screed plate to the predetermined positions in defining the crown of the pavement slab, the various clamping bolts **221** are tightened to clamp the shoes **222** in their adjusted positions on the crank arms **217**. This adjusting process is repeated for the other screed and for the pan float. The machine can then be operated along the pavement slab to form the predetermined crowned contour thereon until circumstances require a change in the surface. If now the machine is to finish a banked section of the pavement such as a superelevated curve that has a flat surface, it becomes necessary to reduce the crowning effect of the two screeds and the pan float and this is accomplished by turning the bell cranks **215** to move the adjustable throw crank arms **217** from the vertical position shown in FIGS. 20 and 21 in a clockwise direction toward the horizontal position shown in FIGS. 18

and 19. In order that a temporary reduction in the crowning action may be accomplished with facility it is preferable to turn all of the cranks **215** associated with each element, for example the flexible screed plate **204** simultaneously as a group. This is effected by means of a tie rod or actuating bar **230** that is pivotally connected to the outer ends of all of the depending crank arms **218** along each side of the supporting beam **203** whereby all of the cranks throughout the length of the screed may be turned simultaneously when the tie rod **230** is moved longitudinally. When the tie rod **230** is moved to the position shown in FIG. 18, all of the cranks **215** on that side are turned to the position in which the variable throw crank arms **217** are disposed horizontally, as also shown in FIG. 19, and the flexible screed plate **204** is then in the unflexed or straight condition defining a horizontal plane across the pavement slab. As shown in FIG. 19, when the crank arm **217** is in this horizontal position the adjustable crank pin **214** is in horizontal alignment with the crank pivot bolt **216**. If now the tie rod **230** is moved to the right to turn the cranks **215** counterclockwise, the pivot pins **214** in revolving about the pivot bolts **216** will exert a lifting action on the strut plates **212** and will slide along the horizontal slots **213** as the strut and its associated part of the screed plate is lifted. If the crank pin **214** is adjusted to a position close to the pivot bolt **216** as shown in FIG. 21 the distance through which the screed element is lifted will be relatively small, since it is equal to the radial distance between the crank pin and the pivot bolt that constitutes the effective crank throw. If the adjusting screw **224** is turned to establish a greater radial distance between the crank pin and the pivot bolt, the lifting action upon the screed segment will be greater as indicated in FIG. 20. Accordingly, the various segments of the screed plate are lifted in accordance with the respective adjustments of their associated cranks, established by turning the infinitely variable adjusting screws **224**. When the crank arms **217** are returned to the vertical position after the machine passes around a curve for example, the profile of the flexible screed plate **204** will be restored precisely to its original carefully adjusted contour since no change is made in the setting of the adjusting screws **224** when the crowning action is temporarily reduced by turning the cranks **215**.

Since it is preferable that the cranks **215** on both sides of the central beam **203** be operated together, a linkage arrangement is provided for this purpose as shown in FIGS. 18 and 23. As there shown, one end of each tie rod **230** is pivotally connected to the depending end of a straight, generally vertical lever **231** that is pivoted at its mid-point to the side of the beam **203** by means of a pivot bolt **232** which is disposed in horizontal alignment with the pivot bolts **216** of the bell cranks. Accordingly, when the lever **231** is pivoted about the bolt **232** the tie rod **230** moves with a straight-line motion action to turn all of the connected cranks **215** in the same manner. As best shown in FIG. 23, the upper ends of the pivoted levers **231** at the respective sides of the hollow beam **203** are connected by adjustable links **233** to the respective ends of a yoke **234** extending across the top of the screed. The center portion of the yoke **234** is provided with a threaded opening that receives an actuating screw **235** that is provided at its outer end with a squared head **236** for receiving a wrench by means of which the screw may be turned. The other end of the screw **235** extends through and is mounted for rotation in a short anchor shaft **237** disposed transversely thereof and pivotally mounted in a bracket **238** on the top of the screed beam **203**. If desirable this manually operated actuating linkage may be replaced by power operated means such as a hydraulic actuator.

If now it is desired to change the curvature of the screed plate **204** from the flat condition shown in FIG. 18 to the crown curve predetermined by adjustment of the several adjusting screws **224**, it is merely necessary to turn the head **236** of the screw **235**. By so doing the yoke **234** may be moved to the left as shown in FIGS. 18 and 23 of the drawing, whereupon the tie rods **230** at both sides of the beam **203** will be moved to the right together and all of the several cranks **215** on both sides of the beam will be turned counterclockwise simultaneously from the positions shown in FIG. 18. If desired, this transitional action may be accomplished by successive increments through turning the adjusting screw **235** intermittently whereby the screed beam **204** may be deflected gradually from its flat condition to its fully crowned condition as may be desirable when operating along a transitional section of pavement leading from a superelevated curve to a straight-a-way section in order that the crown of the slab may be restored gradually to blend the different pavement sections. Because of the combined infinitely variable screw and nut adjusting arrangement and quick changing crank system, the crowning action may be reduced temporarily without disturbing the crown adjustment and likewise the crown curve may be changed at individual points independently of the quick changing action.

The linkage mechanism for actuating the bell cranks on both sides of the screed supporting beam is provided on the forward screed **186** and on the rear screed **192** and also on the pan float **195**. Accordingly, when the machine passes through a transitional section of a pavement slab both of the screeds and the float pan are adjusted more or less simultaneously in order that all three of the flexible crown determining elements may assume substantially the same degree of curvature at all times. The pan float **195** being the last shaping element to act upon the pavement surface determines the final profile of the crown and the smoothness of the crowned surface. Since the curved plate **208** of the float pan does not push any material before it but merely rides over the surface as shaped by the second screed **192**, the float pan operates primarily to press down and iron out any high spots that may have been left on the surface and at the same time closes any cavities or depressions that may have remained in the slab. This final shaping of the crowned surface is accomplished by permitting the float pan plate **108** to ride or float on the slab surface with only its weight and that of the beam **207** and its attachments serving to press it down upon the surface of the slab.

As shown in FIG. 17, the beam **207** of the float element **195** is provided with upwardly projecting float hangers **241** disposed inwardly of the side extension frames **197** and provided with large vertically disposed slots **242**. Each slot **242** receives a guide roller **243** that is rotatably mounted on the frame member **197** and serves to guide the entire pan structure **195** in its pivotal or vertical movements relative to the machine frame.

The float pan structure **195** is maintained in vertical position and is pushed forward along the surface of the slab by means of adjustable struts or thrust links **245** each of which is pivotally connected at its forward lower end to the rear edge of the pan plate **208** and at its other end to a bracket depending from the rear edge of the auxiliary cross frame that interconnects the side frames **197** carried by the boggie trucks **200**. By adjusting the length of the thrust links **245**, the float plate **208** may be moved forward or backward through pivoting the pan structure **195** about the rollers **243**. This results in changing the angle of incidence of the float plate **208** to the slab surface being finished, whereby the forward edge of the plate **208** may be inclined upwardly from the slab by tilting the structure forwardly about the roller **243** and vice versa to adjust the plate to the angle of attack best suited to the finishing operation.

The float pan structure **195** may be lifted out of contact with the slab surface by operation of a hydraulic cylinder actuator **247** which is pivotally connected to turn a bell crank **248** that is rotatably mounted on the frame

member **197**. When the bell crank **248** is turned clockwise as seen in FIG. 17, it exerts a lifting force on a lifting link **249** that is pivotally connected at one end to the bell crank and at the other end to the float hanger **241**. As shown in the drawing, the thrust link **245** is disposed at an angle extending downwardly and forwardly from the cross-frame that interconnects the equalizing frames **197** to the float pan **208**. Accordingly, when the float is lifted by operation of the cylinder **247** and its connected linkage, the angularly disposed link **245** tends to move the surface plate **208** forwardly thereby tilting it slightly to raise the toe **210** from the pavement surface first. Since the surface of the plastic slab tends to adhere strongly to the plate **208**, this combined forward and tilting movement assists greatly in releasing the plate from the surface both because of the forward motion of the plate over the adhesive surface and because of the tilting action which lifts the forward edge of the plate from the surface first, thereby facilitating breaking the adhesive bond progressively.

When the transverse finishing machine shown in FIG. 17 completes one pavement slab and is moved to another of a different width, its wheels may be adjusted to fit the spacing of the side forms in the manner previously explained in connection with the longitudinal float finishing machine illustrated in FIGS. 1 and 2 of the drawing or in any other well known manner. When the width of the machine is changed, the length of the screeds **186** and **192** and of the float pan **195** are also changed to correspond. This is accomplished by adjusting extension elements at both ends of these members as indicated in FIG. 18, which shows the particular arrangement used in connection with the second screed **192**. As shown in greater detail in FIGS. 23 and 24, the hollow rectangular main beam **203** is provided at each end with a short telescoping extension beam **253** which is likewise of rectangular shape and of the proper size to slide within the hollow main beam **203**. A threaded rod **254** extends inwardly within the beam extension **253** and is rotatably mounted at its outer end in an opening formed in an end plate **255** secured to the outer end of the beam extension **253**. As shown, a pair of nuts **256** are threaded on and secured to the rod **254** at opposite sides of the plate **255**, respectively, in a manner to constitute collars that permit rotation by the screw **254** by turning with it while preventing endwise movement thereof relative to the beam extension **253**. The threaded rod **254** also passes through an opening in a bracket **257** that is secured on the end of the main beam **203** and that has attached to it as by welding a nut **258** which has threaded engagement with the screw **254**. When the screw is rotated by turning the nut **256** that is secured to its outer end, the screw threads turn in the fixed nut **258** on the main beam and the extension beam **253** is thereby caused to slide into or out of the end of the main beam for adjusting the beam length.

When the extension beam **253** is moved outward to lengthen the screed structure **192**, the screed plate **204** suspended beneath the beam **203** is extended also by adding to it short extension plates **261** that are provided with upturned edges similar to the flanges of the screed plate **204**. The outer end of the screed bottom is completed by a wear plate **262** that is generally similar to the extension plate **261** but is adapted for sliding engagement with the top of the side form F. The extension plates are interconnected by means of splice bars **263** which are secured over the joints between the plates by bolts **264**. Longer bolts **265** suspend the extension plates from the extension beam **253**, to which they are secured in brackets **266** that are bolted to the outside of the extension beam **253**.

As previously explained, the second screed **192** is carried by the side beams **197** in a manner whereby it is precisely positioned independently of direct support by the side forms F. Because of this arrangement, the wear plate **262** that forms the outer end of the screed bottom is arranged to contact the top of the form F without influencing the elevation of the screed. This is accomplished by securing the inner end of the wear plate to the adjacent splice bar **263** by means of a spring connection **268** that provides for up and down pivotal movement of the wear plate. The outer end of the wear plate **262** is engaged by a spring **269** carried on a bolt **270** extending downward from the beam extension **253**. The spring **269** serves to hold the wear plate **262** in contact with the top of the side form F but is so proportioned as to be sufficiently resilient to permit up and down movement of the wear plate **262** as it rides over irregularities in the forms without exerting any influence upon the vertical position of the remainder of the screed structure which is suspended from the side beams **197**.

The apparatus shown in perspective in FIG. 25 is part of a pavement surfacing machine of a different type that illustrates still another embodiment of the invention. In this modification, the pavement slab surface forming element is constituted by a relatively wide extrusion plate **275** that is turned up at its forward end to form a baffle and that extends transversely of the pavement slab being formed. The upturned forward end or baffle of the plate **275** engages and pushes ahead any surplus plastic material encountered while the wide bottom element molds and smooths the surface in such a manner that the slab is extruded from the trailing edge of the plate in the desired form. To shape the crown on the slab, the entire extrusion plate **275** is deflected to the desired crown contour in the same manner that the screed plates **204** are deflected as previously explained. As shown in the drawing, the extrusion plate **275** is carried beneath a pair of spaced beams **276** that extend transversely of the pavement slab and constitute part of the frame of the paving machine, which may be of the type that operates without side forms. Each of the transverse beams **276** has pivotally mounted on it a series of spaced infinitely variable-throw cranks **277** that are generally similar to the cranks **215** shown in FIG. 17 but are mounted in inverted position with their actuating arms **278** extending upwardly. Infinitely adjustable crank pins **279** of the crank mechanisms **277** each operate in a horizontal slot **281** in a vertically positioned strut plate **282** that is secured at its lower end to the extrusion plate **275** as shown in the drawing. The strut plates **282** are arranged near the leading and trailing edges respectively of the extrusion plate and are spaced along its length in the manner shown in FIG. 18 with respect to the flexible screed plate **204**.

As shown in the drawing, the actuating arm **278** of each crank **277** is provided at its upper end with a radial slot **284** that is engaged by a pin **285** carried by a horizontally disposed link or tie rod **286**. The respective tie rods **286** are slideably mounted for longitudinal movement parallel with the frame members **276** and each rod has connected to its end at the end of the extrusion plate **275**, a threaded bolt **287**. The bolts **287** have threaded engagement with nuts **288** respectively that are rotatably mounted in brackets **289** secured to the frame beams **276**. In order that both edges of the extrusion plate **275** may be deflected simultaneously, the rotatable nuts **288** are each provided with a sprocket wheel **291**, the two sprocket wheels being interconnected by a transmission chain **292** whereby both nuts are turned simultaneously. A hand crank **293** may be fitted to one of the nuts **288** and by rotating the crank both nuts may be turned to move both of the actuating rods **286** at the same time. By this arrangement, all of the infinitely variable throw cranks **277** may be turned simultaneously in changing the extent of the deflection of the extrusion plate **275**. As previously explained, the desired crowning contour is established in the extrusion plate **275** by adjusting the individual screw and nut mechanisms that change the eccentricity of each of the cranks. With the cranks **277**

turned to the fully crowned position, and each properly adjusted as to its infinitely variable crank throw, the degree of crowning may be reduced uniformly by turning the hand crank **293** and then may be restored to the precisely predetermined contour previously established through the individual adjustments of the several variable crank arms.

From the foregoing description of various exemplary pavement slab finishing machines embodying the present invention and the explanation of the manner in which they operate, it will be apparent that new and improved arrangements have been provided by the invention for shaping and smoothing the surface of plastic material in forming a highway slab to a crowned contour of predetermined profile, particularly with respect to features whereby the apparatus may be adjusted readily to establish the predetermined surface shape after which the established profile may be modified conveniently to alter the crowned contour temporarily. This is accomplished by providing means for deforming a flexible contour determining element whereby it is deflected, through forces exerted at several points throughout its length by operation of a series of eccentric crank mechanisms each of which is individually adjustable by means of an infinitely variable crank throw adjustment and all of which are operable simultaneously to modify the contour temporarily. By this arrangement, the contour shape may be adjusted precisely for finishing a pavement slab, then during the finishing operation the crowning action may be reduced for a time and then restored to the original adjusted profile without disturbing the initial precise infinitely variable adjustment.

Although several specific examples of operative pavement slab finishing machines have been set forth in detail by way of a full disclosure of useful embodiments of the invention, it is to be understood that still other arrangements of the improved features may be incorporated in various mechanisms by those familiar with the art of pavement laying, without departing from the spirit and scope of the invention as defined in the subjoined claims.

The various novel features of the invention having now been fully set forth and explained, we claim as our invention:

1. In a pavement slab finishing machine, a frame adapted to straddle a slab of pavement being laid, a flexible crown determining element carried by said frame in position to extend transversely of the slab being laid, a series of actuating cranks each having an infinitely adjustable throw crank arm pivotally mounted on said frame in operative relationship with said flexible crown determining element, said cranks being arranged in spaced relationship therealong, a crank pin movably mounted on each of said crank arms for radial adjustment therealong, screw and nut adjusting means operatively arranged to effect incremental movement of each movable crank pin along its respective crank arm to provide infinitely variable adjustment of the throw of each of said adjustable throw crank arms independently, interconnecting means operatively arranged to pivot all of said independently adjusted pivotally mounted actuating cranks simultaneously, and connecting force transmitting means operatively connecting each of said infinitely adjustable throw crank arms to an adjacent element of said flexible crown determining member, whereby upon pivoting said series of spaced actuating cranks simultaneously said flexible crown determining member may be deflected throughout its length in a manner to establish therein a crown determining contour in accordance with the individual adjustments of said interconnected infinitely adjustable throw crank arms.

2. In a pavement laying machine, a frame adapted to straddle a slab of pavement being laid, running gear arranged to support said frame for movement along the slab of pavement, a deformable contour establishing member carried by said frame in a position to extend transversely of the slab of pavement being laid, means to deform said contour establishing member comprising, a plurality of lever arms each pivotally mounted on said frame said arms being disposed at positions spaced along said contour establishing member for pivoting movement in effecting deformation thereof, linkage pivotally connected to and interconnecting said plurality of lever arms for simultaneous pivoting movement thereof relative to said frame, actuating mechanism operatively connected to actuate said linkage for pivoting said lever arms simultaneously, a pivot pin movably mounted on each of said lever arms for radial adjustment to constitute an infinitely adjustable throw crank, a screw and nut mechanism operatively connected to move each of said movable pivot pins incrementally on its associated lever arm independently in a manner to adjust the radial relationship of said movable pivot pin to the axis of pivoting movement of said lever arm for regulating the throw of its movement when said lever arm is pivoted by action of said linkage, and a force transmitting strut interconnecting each of said radially adjustable pivot pins to an adjacent part of said contour establishing member in manner to exert force thereon, said struts being disposed at spaced positions along said member corresponding to the positions of said pivotally mounted lever arms respectively, the arrangement being such that upon operation of said actuating mechanism said lever arms may be pivoted simultaneously and operate as adjustable throw cranks to move said struts in a manner to effect deformation of said contour establishing member in accordance with the independent radial adjustment of said movable pivot pins on said lever arms for establishing the contour to be formed upon the slab of pavement being laid and likewise said lever arms may be pivoted simultaneously to reduce the extent of deformation temporarily for modifying the contour being formed on the slab of pavement.

3. In a pavement slab crowning apparatus, a frame adapted to span a slab of pavement being formed, a flexible crown determining member carried by said frame and disposed transversely of the slab being formed to shape the crown thereof, force transmitting member flexing struts connected to said flexible crown determining member at spaced positions therealong, each strut having formed therein a slot extending generally parallel with said flexible member, a series of adjustable throw cranks pivotally mounted on said frame for rotation in the plane of said struts at spaced positions therealong corresponding respectively with the positions of said struts on said flexible member, each of said cranks including a crank arm, a crank pin movably mounted for radial adjustment on said crank arm of each of said cranks to adjust the throw thereof, each crank pin being disposed to engage with said slot in the said corresponding strut in such a manner that pivoting of said adjusted cranks will exert force through said crank pins and the corresponding struts to flex said crown determining member, means to effect incremental adjustment of the position of each of said movably mounted crank pins along its associated crank arm in manner to provide infinitely variable throw adjustment of the radial positions of each of said movably mounted crank pins on said cranks individually thereby to establish in said cranks a series of crank throws adapted to deflect said flexible crown determining member to a predetermined contour corresponding to the crown to be formed on the slab, and actuating mechanism interconnecting said individually adjusted cranks of said series for simultaneous operation to decrease or restore the adjusted crowning effect of said apparatus selectively.

4. A longitudinal float finishing machine comprising a frame adapted to straddle a slab of pavement being finished in plastic condition, running gear arranged to support said frame for movement of said machine along the slab as it is finished progressively, a pair of flexible elements constituting spaced parallel trackways carried by

said frame in position to extend transversely of the slab being finished, a carriage mounted on and movable along said trackways back and forth across the slab, a plurality of independently adjustable infinitely-variable-throw cranks disposed in spaced relationship on said frame along each of said trackways respectively, a crank pin movably mounted on each of said infinitely variable throw cranks, means to effect infinite radial adjustment of each of said crank pins, struts operatively interconnecting the crank pin of each of said variable-throw cranks with an adjacent segment of its associated flexible trackway for flexing said trackway, an actuating mechanism operatively interconnecting said variable-throw cranks associated with each flexible trackway for simultaneous operation thereof to cause said crank pins and said interconnecting struts to deflect said trackway to a shape predetermined by the independent adjustment of said movable crank pins on said spaced variable-throw cranks, a float pan disposed longitudinally of the pavement slab beneath said carriage in position to engage and smooth the surface of the slab, a pivotal supporting element operatively connecting the trailing end of said float pan to said carriage for swinging movement of said float pan in a horizontal plane, and a horizontal bearing system constituting a supporting element including a horizontal lost motion device operatively connecting the leading end of said float pan to said carriage in a manner to support it while limiting the horizontal swinging movement thereof to a skewing action, the arrangement being such that as said machine progresses along the slab being finished said float pan is moved back and forth across the slab to finish the slab surface to a contour predetermined by the shape of said flexible trackways as established by individual adjustment of said movable crank pins on said spaced variable-throw cranks with said pan skewing automatically at each reversal of direction in a manner to urge forward any surplus material engaged thereby.

5. In a pavement slab finishing machine of the longitudinal type, a frame adapted to extend over and to move along a slab of pavement being finished, a carriage movably mounted on said frame for bodily movement relative thereto in a direction transversely of the pavement slab, a pavement surface smoothing finishing roller rotatably carried by and bodily movable with said carriage in a position thereon to extend generally longitudinally of the pavement slab and with its lower side in cooperating working relationship with the surface of the slab being finished, a reversible source of power mounted on said carriage, power transmission means operatively connected to be driven in either direction by said reversible source of power and arranged to traverse said carriage in either direction selectively relative to said frame across the slab being finished, other power transmission means also operatively connected to be driven by said reversible source of power in synchronism with said carriage traversing transmission means and arranged to rotate said surface finishing roller in synchronism with the traversing movement of said carriage in manner to cause its pavement contacting lower side to move in the direction of travel of said carriage, and automatically operating reversing means associated with said reversible source of power and operative to reverse it automatically for reversing the direction of movement of said carriage and likewise the direction of rotation of said surface smoothing roller upon said carriage moving to either edge of the slab being finished, whereby said carriage operates back and forth across the slab automatically as said frame moves along the slab and said roller rotates automatically in the direction to cause its pavement contacting lower side to move in the direction of its bodily movement with said carriage regardless of the direction of travel of said carriage.

6. In a pavement slab finishing machine, a frame constituting a vehicle adapted to travel along a slab of pavement being finished, a carriage movably mounted on said frame for operation transversely of the slab, a finishing float carried by said carriage in position to be moved over and to operate upon the surface of the pavement slab being finished, actuating mechanism on said carriage operatively connected to oscillate said float by reciprocating it in a direction substantially parallel with the surface of the slab being finished as said float is moved by said carriage over the slab surface, and inclined trackways on said carriage for carrying said reciprocating finishing float, said trackways being operatively arranged to raise said float during one direction of oscillating movement and to lower said float during the other direction of movement as it is being oscillated thereby to effect a patting action upon the surface of the pavement slab being finished.

7. In a screeding apparatus for forming a surface of desired curved contour on a slab of pavement material in plastic condition, a supporting beam adapted to extend in horizontal position transversely of the pavement slab being formed, a flexible screed plate suspended beneath and disposed substantially coextensive with said beam in position to coact with and form the surface of the pavement slab, a series of cranks pivotally mounted on and spaced along said beam, a crank arm on each of said cranks, each of said crank arms being arranged for operation in a generally vertical direction as said crank is pivoted on said beam in moving toward or from a predetermined contour establishing position, a crank pin movably mounted for continuous radial positioning on each of said crank arms, means to effect infinitely variable adjustment of each crank pin on each crank arm in radial direction therealong, a force transmitting lifter member operatively connecting each of said infinitely adjustable crank pins to an adjacent part of said flexible screed plate for flexing it, and means operatively connected to pivot said series of cranks simultaneously, the arrangement being such that as said crank arms are pivoted to move in a vertical direction toward contour establishing position said flexible screed plate is deflected throughout its length to curve it in accordance with the individual infinitely variable radial adjustments of said movably mounted crank pins.

8. In a longitudinal float finishing machine for smoothing a slab of pavement material being laid in plastic condition, a frame adapted to straddle and to move along the pavement slab, trackways on said frame extending transversely of the slab, a carriage operatively mounted on said trackways for movement therealong back and forth across the slab, a float pan carrier suspended from said carriage and disposed longitudinally of the slab, a longitudinal float pan slidably mounted for longitudinal reciprocation beneath said pan carrier in position to engage and smooth the surface of the slab, a pivotal mounting connecting the trailing end of said float pan carrier to said carriage for pivotal movement of said carrier about a vertical axis, a bearing system providing for limited horizontal movement and connecting the leading end of said float pan carrier to said carriage to support it in a manner to provide for limited skewing of said float pan in a horizontal plane about said trailing pivotal mounting, power reciprocating means operatively connected to effect longitudinal reciprocation of said slidably mounted float pan, and means to effect vertical oscillatory movement of said float pan as it slides longitudinally, the arrangement being such that in traversing the slab said float pan will pat and smooth the slab surface and will be skewed with its leading end retarded in a direction opposite to the direction of its travel whereby any surplus material encountered by said float pan as it reciprocates in the skewed position will be urged longitudinally of the slab in the forward direction regardless of the direction of travel of said carriage across the slab.

9. In a screed for smoothing the surface of a pavement slab as it is being laid in plastic condition, a supporting beam adapted to extend transversely of the pavement

slab, a flexible screed plate disposed below and substantially coextensive with said beam in position to engage and smooth the surface of the slab to a predetermined contour, a plurality of cranks rotatably mounted on said beam in spaced relationship therealong, each of said cranks comprising a crank arm, a crank pin adjustably mounted on each of said crank arms for independent infinitely variable adjustment radially therealong to vary the crank throw selectively, means to effect the adjustment of each of said crank pins individually, force transmitting lifter means operatively interconnecting each of said radially adjustable crank pins with an adjacent element of said flexible screed plate to flex it, and actuating means operatively arranged to turn said adjusted cranks simultaneously in a manner to exert force upon said flexible screed plate through each of said force transmitting means to deflect said plate in accordance with the adjustments of said individual crank pins, the arrangement being such that said flexible screed plate may be deflected through simultaneous operation of said individually adjusted cranks to a predetermined shape adapted to form the surface of the slab to a desired contour.

10. In a longitudinal float finishing machine for finishing the surface of a pavement slab, a frame adapted to straddle and to move along the slab of pavement being finished, a bendable steel tube extending transversely of the pavement slab and supported at its ends on said frame, a wheeled carriage arranged to operate along said tube as a trackway and movable therealong in traversing the slab being finished, a smoothing float carried by said carriage in position to smooth the surface on the slab as said carriage traverses it in operating along said bendable tube, a series of adjustable-throw cranks mounted on said frame at positions spaced along said bendable steel tube, a screw and nut mechanism on each of said cranks arranged to provide for adjusting the throw of each crank independently, a force transmitting lifter strut interconnecting each of said adjustable throw cranks to an adjacent element of said bendable tube in a manner to provide for deflecting each element of said tube in accordance with the adjusted throw of the said associated crank, and actuating linkage interconnecting said several adjustable throw cranks for simultaneous movement in deflecting said bendable tube to establish a crowning contour therein in accordance with the adjustment of the throws of said several cranks, the arrangement being such that said deflected tube guides said carriage in moving said smoothing float in a manner to mold a crowned surface of predetermined contour on the slab of pavement being finished by the machine.

11. In a finishing machine for shaping and smoothing the surface of a pavement slab, a frame adapted to extend over the pavement slab being finished, running gear operatively supporting said frame for movement along the pavement slab, a float pan suspended beneath said frame and extending transversely of the pavement slab in position to contact and operate upon the surface of the pavement slab as said machine moves along the slab being finished, power operated lifting apparatus mounted on said frame and operatively connected to exert force in upward direction to lift said float pan from the slab surface being finished, and an adjustable pusher strut pivotally connected at its rearward end to said frame and inclined therefrom downwardly and forwardly and pivotally connected at its forward lower end to the rearward edge of said float pan to push said pan along the surface of the slab being finished as said machine moves along the slab, the arrangement being such that when said lifting apparatus is actuated to lift said float pan vertically said downwardly inclined pusher strut operates to urge said float pan forwardly thereby tilting its forward edge upwardly and facilitating its disengagement from the surface of the pavement slab.

12. In a pavement slab finishing machine, a frame adapted to travel along a slab of pavement being laid, a pair of deformable tubular crown establishing members carried by said travelling frame in position to constitute spaced transverse trackways spanning the slab being laid, a carriage movably mounted on said deformable spaced trackways for operation therealong transversely of the pavement slab, a surface finishing float carried by said carriage for bodily movement therewith along said trackways transversely of the slab in position to engage and finish the surface of the slab to the contour established by the shape of said deformable trackways as said machine travels along the slab, a series of adjustable throw eccentric cranks pivotally mounted on said frame adjacent to each of said deformable trackways said cranks being spaced at positions therealong for effecting controlled deformation of said trackways, a crank pin movably mounted on each of said eccentric cranks in manner to provide for infinitely variable adjustment of the radial position of said crank pin relative to the pivotal axis of said crank to adjust the degree of eccentricity of said crank, adjusting means arranged to adjust each movably mounted crank pin individually by moving it relative to the pivotal axis of its crank thereby to effect infinitely variable adjustment of the throw of each crank of said series of eccentric cranks individually for regulating the deformation of the associated deformable tubular crown establishing trackway member, force transmitting lifter means connecting said movable crank pin of each of said infinitely variable throw eccentric cranks to an adjacent element of said adjacent trackway member for deforming it, and linkage interconnecting the cranks of said series of eccentric cranks associated with each one of said deformable trackway members for simultaneous pivoting thereof as a group in deforming each trackway, the arrangement being such that a predetermined crown contour shape may be established in each of said spaced trackway members by adjusting each of said movable crank pins individually to regulate the deformation of said trackway members, the predetermined crown contour shape thus established being diminished temporarily and subsequently restored fully through simultaneously pivoting the group of said individually adjusted eccentric cranks associated with each of said trackway members by operation of said interconnecting crank pivoting linkage.

13. In a pavement slab finishing machine, a frame adapted to travel along a slab of pavement being laid, a pair of deformable tubular crown establishing members carried by said frame in position to constitute spaced transverse trackways spanning the slab being laid, a carriage movably mounted on said deformable spaced trackways for operation therealong transversely of the pavement slab, a surface finishing float carried by said carriage for bodily movement therewith along said trackways transversely of the slab in position to engage and finish the surface of the slab to the contour established by the shape of said deformable trackways, a series of adjustable throw eccentric cranks pivotally mounted on said frame adjacent to each of said deformable trackways said cranks being spaced at positions therealong for effecting controlled deformation of said trackways, each of said pivotally mounted cranks comprising a crank arm, a crank pin movably mounted on said crank arm in manner to provide for infinitely variable adjustment of the radial position of said crank pin along said crank arm relative to the pivotal axis of said crank to adjust the degree of eccentricity of said crank, an adjusting screw carried by said crank arm and arranged to adjust said movably mounted crank pin therealong by moving it incrementally relative to the pivotal axis of said crank to effect infinitely variable adjustment of the crank throw whereby each crank of said series of eccentric cranks may be adjusted individually for regulating the deformation of the associated deformable tubular crown establishing trackway member, force transmitting lifter means connecting said movable crank pin of each of said

infinitely variable throw eccentric cranks to an adjacent element of said adjacent trackway member for deforming it, and linkage interconnecting the cranks of said series of eccentric cranks associated with each one of said deformable trackway members for simultaneous pivoting thereof as a group toward or from a predetermined crown establishing position in deforming each trackway, the arrangement being such that when said cranks are in crown establishing position a predetermined crown contour may be established in each of said spaced trackway members by adjusting each of said movable crank pins individually through operation of said associated adjusting screw to regulate the deformation of said trackway members whereupon the adjusted predetermined crown establishing contour may be diminished temporarily and subsequently restored fully by simultaneously pivoting the group of said individually adjusted eccentric cranks associated with each of said trackway members through operation of said interconnecting crank pivoting linkage.

14. In a pavement slab finishing machine, a frame adapted to travel along a slab of pavement being laid, a pair of slender deformable crown establishing members carried by said frame in position to constitute spaced transverse trackways spanning the slab being laid, a carriage movably mounted on said deformable spaced trackways for operation therealong transversely of the pavement slab, a surface finishing float carried by said carriage for bodily movement therewith along said trackways transversely of the slab in position to engage and finish the surface of the slab to the contour established by the shape of said deformable carriage supporting trackways, a series of adjustable throw eccentric cranks pivotally mounted on said frame adjacent to each of said deformable trackways said cranks being spaced at positions therealong for effecting controlled deformation of said trackways, each of said cranks comprising a crank shaft carried by said frame, a crank arm carried by said crank shaft, a crank pin movably mounted on said crank arm in manner to provide for continuous infinitely variable adjustment of the radial position of said crank pin along said crank arm relative to the pivotal axis of said crank shaft to adjust the degree of eccentricity of said crank, adjusting means carried by said crank arm and arranged to adjust the distance of said movably mounted crank pin from said crank shaft by moving it incrementally along said arm relative to the pivotal axis of said crank shaft to effect infinitely variable adjustment of the throw of each crank of said series of eccentric cranks individually for regulating the deformation of the associated slender deformable crown establishing trackway member, force transmitting lifter means connecting said movable crank pin of each of said infinitely variable throw eccentric cranks to an adjacent element of said adjacent trackway member for deforming it, and linkage interconnecting the several cranks of said series of eccentric cranks associated with each one of said deformable trackway members for simultaneous pivoting thereof as a group in deforming each trackway, the arrangement being such that a predetermined crown contour may be established in each of said spaced trackway members by adjusting each of said movable crank pins individually and incrementally to regulate the deformation of said trackway members and the predetermined crown establishing contour may be diminished temporarily and subsequently restored fully through simultaneous pivoting of the group of said individually adjusted eccentric cranks associated with each of said trackway members by operation of said interconnecting crank pivoting linkage.

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