Dec. 7, 1965 M. I. HUDIS 3,221,618

PAVEMENT LAYING AND FINISHING APPARATUS

Filed March 16, 1962 4 Sheets-Sheet 1

FIG. 1.

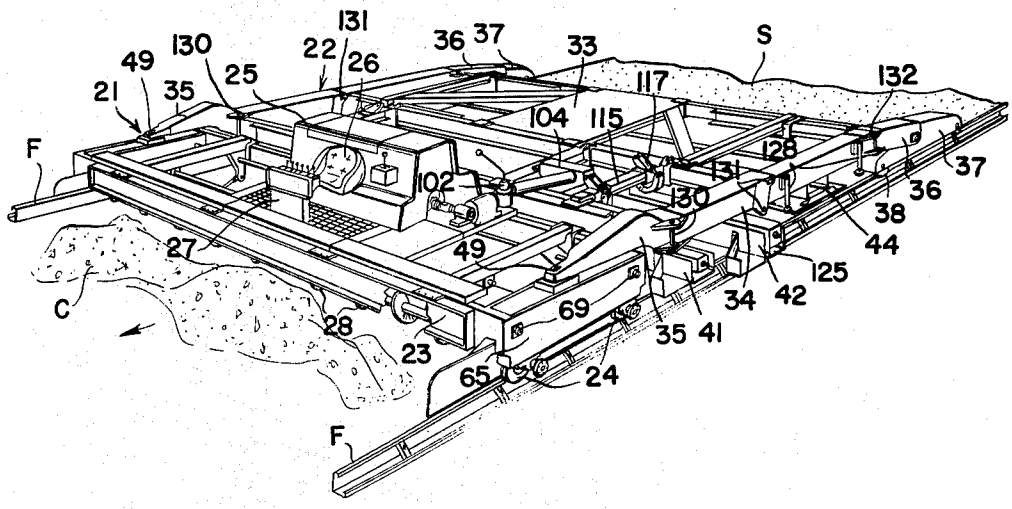
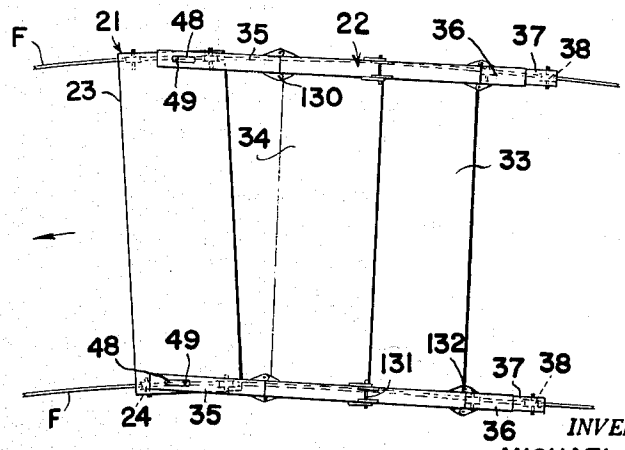


FIG. 2.



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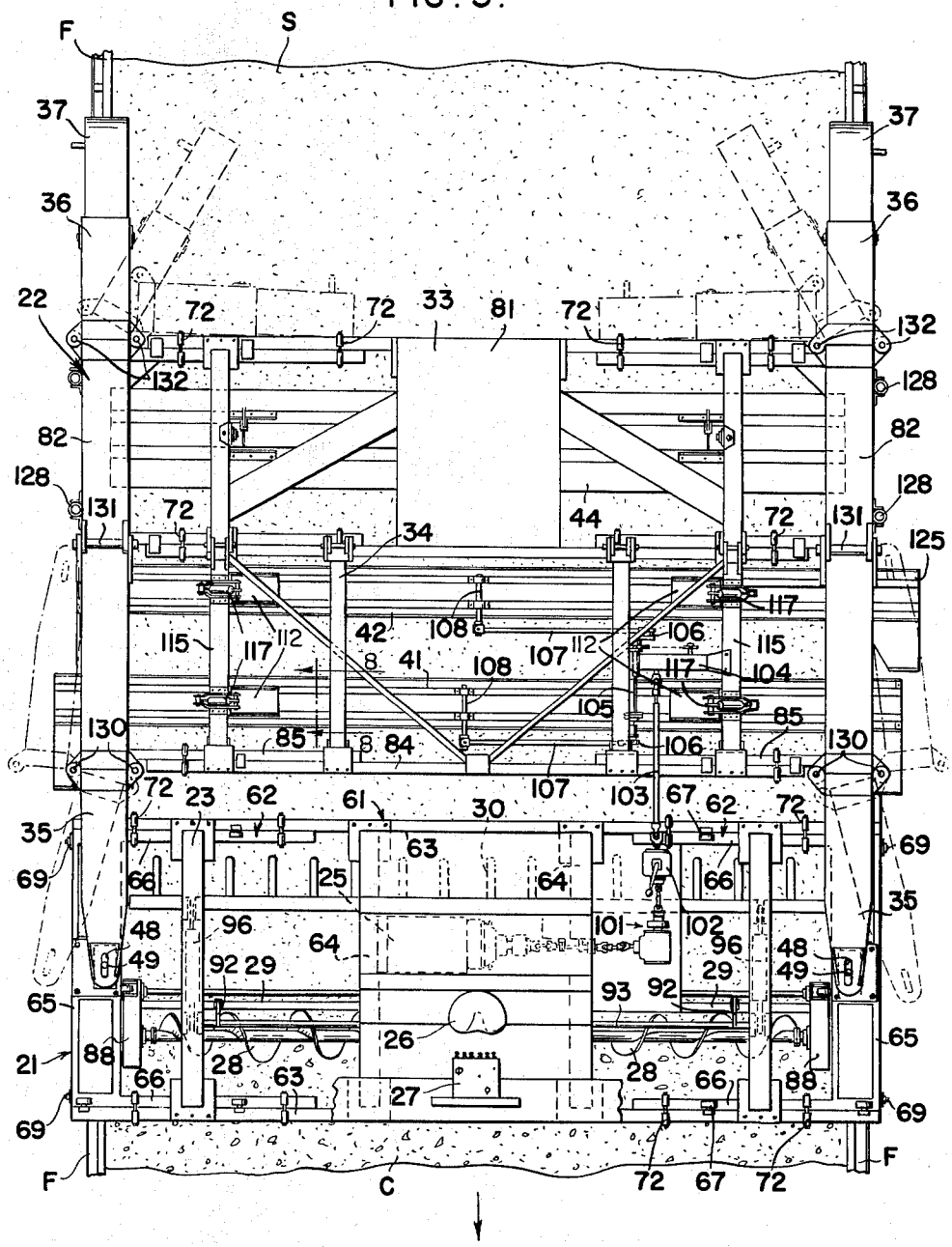
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PAVEMENT LAYING AND FINISHING APPARATUS

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FIG. 3.



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PAVEMENT LAYING AND FINISHING APPARATUS

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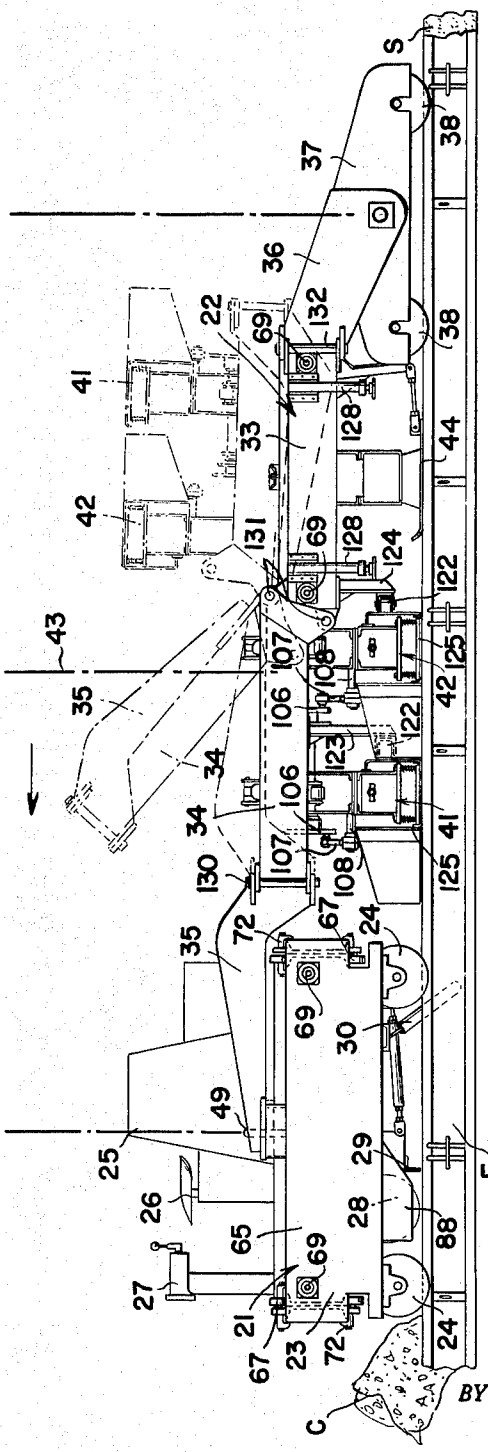


FIG. 4.

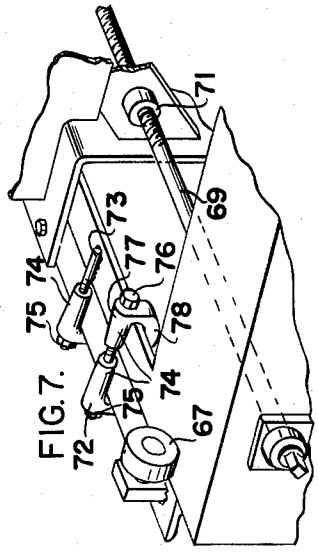


FIG. 7.

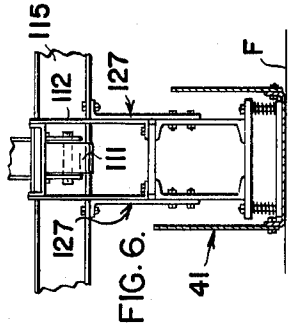


FIG. 6.

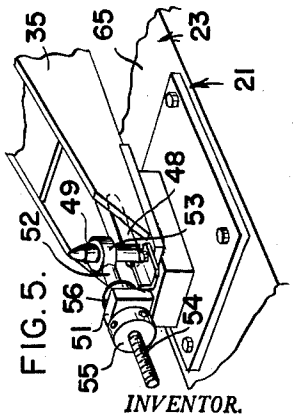


FIG. 5.

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PAVEMENT LAYING AND FINISHING APPARATUS

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FIG. 8.

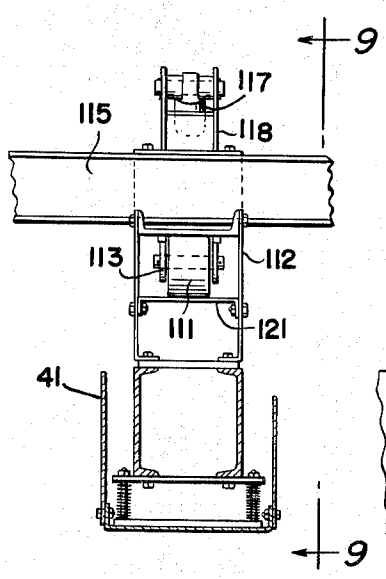


FIG. 9.

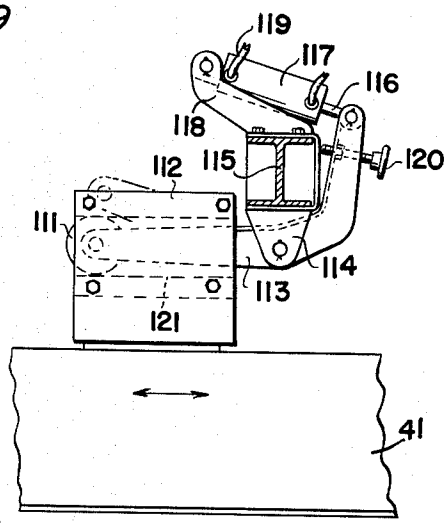


FIG. 10.

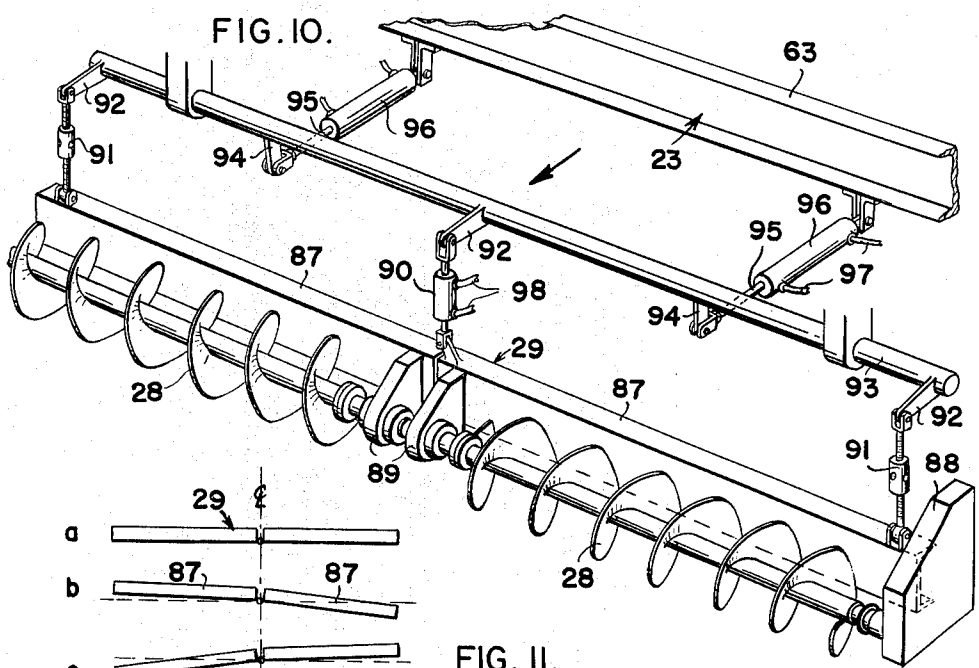


FIG. 11.

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United States Patent Office

3,221,618

Patented Dec. 7, 1965

3,221,618

PAVEMENT LAYING AND FINISHING APPARATUS

Michael I. Hudis, Brookfield, Wis., assignor to Rex Chainbelt Inc., a corporation of Wisconsin

Filed Mar. 16, 1962, Ser. No. 180,141
11 Claims. (Cl. 94—45)

This invention relates, generally, to improved apparatus for laying pavement and more particularly to a new combined machine for spreading paving material in plastic condition on a site being paved, and then consolidating, shaping and smoothing the material to form in one continuous operation a finished slab of desired thickness and surface contour.

In the usual pavement laying procedure, the slab base is prepared on the site in advance and temporary side forms are laid on the base in spaced parallel relationship to define the edges of the pavement and to establish the elevation of the slab surface. Freshly prepared paving material in plastic condition is then deposited progressively on the base between the side forms which confine it to the slab area. As the material is placed on the site, it is spread between the forms to the required thickness and the upper surface of the slab so formed is then leveled and shaped to the contour and smoothness required in the finished pavement.

Ordinarily this series of operations is accomplished by a so-called "spread" of paving apparatus consisting of several independent machines operating at spaced intervals along the forms and performing sequentially the various functions of spreading, shaping, finishing and smoothing that are required to form the pavement slab. Certain disadvantages arise from the use of a series of machines in this manner in that each machine in moving along the side forms has a tendency to deflect and shift the forms to some extent with the result that the repetition of such disturbances may cause the forms to become so displaced that they no longer accurately define the desired slab surface by the time the last and final smoothing machine passes along them. Furthermore, it is generally recognized that in working with a paving material such as concrete in plastic condition, it is preferable to place the freshly mixed material in its final position as directly and expeditiously as possible in order to avoid disturbing it after it begins the setting and curing process. This principle of expeditiously placing and finishing the material cannot be adhered to properly when the plastic concrete is operated upon by a series of machines necessarily spaced considerable distances apart and working the concrete successively at varying time intervals.

It is, therefore, a general object of the present invention to provide an improved combined pavement laying machine that is adapted to spread plastic paving material upon a paving site and then expeditiously form and smooth the spread material to constitute a paving slab of desired characteristics in a single continuous operation.

Another object of the invention is to provide an improved combined pavement laying machine that operates to spread plastic paving material, consolidate it, level and shape it and then smooth it to its final desired condition in a continuous and expeditious manner with a minimum of disturbance to the internal structure of the material mixture.

Another object of the invention is to provide an improved unitary pavement laying machine involving separable elements operating sequentially on plastic paving material and coupled together in such manner that each element operates to stabilize and steer the movement of the other element in advancing along the pavement slab defining side forms.

Another object is to provide an improved arrangement for grouping together a plurality of pavement laying machines for unitary sequential operation in forming a pavement slab, involving means whereby the elements interconnecting the machines provide for steering of the apparatus in negotiating curves.

Another object is to provide an improved combined pavement laying machine that may be separated readily into sections and folded compactly for convenience in transportation.

Another object is to provide improved apparatus in the form of an attachment for a concrete spreading machine that operates to finish the spread concrete expeditiously and that may be detached readily and folded compactly for transportation.

Another object is to provide an improved arrangement for suspending a reciprocating screed in working position beneath a pavement laying machine including power operated means for lifting and lowering the screed and manually adjustable means to establish the screed operating position.

A further object is to provide an improved screed supporting system wherein the screed is carried by rollers to provide for reciprocating movement, the rollers being adjustable for regulating the working elevation of the screed and being movable by power for lifting the screed to a travelling position.

According to the present invention, there is provided a unitary combined paving machine adapted for operation upon paving material in plastic condition such as freshly mixed concrete to spread and level the material upon the site being paved and then to finish and float its surface to the required contour and degree of smoothness in a single continuous operation. To this end, the combined machine includes a spreading unit that operates, as the machine advances, to distribute and consolidate paving material placed ahead of it between confining side forms which serve also to support and guide the machine. The spreading unit may include spreading screws followed by a strike-off member that establishes the depth or thickness of the pavement slab and a vibrator that consolidates the material of the slab. These elements are all mounted in a spreader vehicle that operates along the forms on power driven traction wheels and that constitutes in itself a complete unit adapted for independent operation. Attached to and following this spreading unit is a finishing unit constituted by a folding framework mounted at its trailing end upon pivotally connected tandem bogies that run on the forms. The folding framework carries two reciprocating transverse metering screeds that move endwise in opposite directions respectively to finish and shape the upper surface of the slab. Following the second screed, a smoothing float pan slides over the surface of the slab to impart to it the final contour and finish required. The finisher framework is provided at each side with a forwardly extending towing arm, the forward end of each arm being connected through lost motion mechanism to the corresponding side of the spreader vehicle at a position midway between its front and its rear wheels. By this arrangement, the wheels of the spreader unit act as forward bogies that cooperate with the rear tandem bogies to provide equalizing mechanism for minimizing the effect on the screeds of irregularities encountered by the individual wheels. The towing arms at the sides of the machine serve also to stabilize and steer the combined machine, each unit thereof operating through the interconnecting arms and the lost motion mechanisms to effect steering of the other unit. Furthermore, the lost motion connections permit each unit to align itself with the side forms when negotiating curves. The metering screeds are suspended by

improved roller mountings beneath the foldable forward part of the finisher framework for adjustment in elevation and for lifting to travelling position. With the screeds lifted, the framework may be folded by disconnecting the towing arms from the spreader vehicle and folding them onto the folding framework. The framework may then be folded into a compact unit for transportation separately from the spreader unit.

The foregoing and other objects will become more fully apparent upon perusing the following description of improved combined pavement laying apparatus constituting an exemplifying embodiment of the invention in conjunction with the accompanying drawings illustrative thereof, wherein:

FIGURE 1 is a view in perspective of a combined pavement laying machine embodying the invention, the machine being shown mounted upon spaced side forms that define the site of the pavement slab being laid;

FIG. 2 is a diagrammatic plan view representing the combined machine of FIG. 1, the diagram indicating the manner in which the two sections of the machine operate in negotiating a curve;

FIG. 3 is an enlarged plan view of the combined machine shown in FIGURE 1, with parts repeated in broken lines to indicate their folded positions;

FIG. 4 is a view in side elevation of the machine shown in FIG. 3, also with parts repeated in broken lines to indicate their folded positions;

FIG. 5 is a fragmentary detail view in perspective of modified apparatus for effecting steering of the machine in negotiating a curve;

FIG. 6 is a fragmentary detail view in cross-section generally similar to FIG. 8 but showing the arrangement for clamping the screeds in raised position when the machine is folded for transportation;

FIG. 7 is a fragmentary detail view in perspective of part of the extensible frame of the machine together with the adjusting screw and the clamps that serve to clamp the frame to secure it in adjusted position;

FIG. 8 is a fragmentary detail view in longitudinal cross-section taken on the plane indicated by the line 8—8 in FIG. 3 and showing an improved arrangement for supporting and lifting the screeds;

FIG. 9 is a view in transverse cross-section of the screed supporting arrangement, taken on the plane indicated by the line 9—9 in FIG. 8 and showing the screed lifting mechanism together with an adjusting device for establishing the working elevation of the screed;

FIG. 10 is a diagrammatic fragmentary view in perspective of the spreading screw and strike-off elements of the machine, showing an improved arrangement for adjusting the vertical position and angular disposition thereof for forming the pavement slab; and,

FIG. 11 is a diagrammatic representation illustrating a series of the various angular positions that may be assumed by the strike-off member in working the surface of the pavement slab to the required shape.

The particular combined spreading and finishing machine that is shown in the drawings as illustrative of pavement laying apparatus embodying the invention, is capable of spreading newly deposited paving material in plastic condition, such as freshly mixed concrete, over the area of a site being paved, then striking off and consolidating the spread material to form a slab of the required thickness and then finally finishing and floating the surface of the slab to impart to it the desired final contour and degree of smoothness required, all in a single continuous operation. In the laying of a strip of pavement on a prepared base, temporary forms are ordinarily arranged in generally parallel spaced relationship along the base in positions to define the edges of the site of the pavement slab being laid, the forms being leveled to establish the elevation of the traffic supporting surface of the slab as well. Once the forms are properly set and leveled, it is important that they remain undisturbed until the final finish has been imparted to the slab surface.

As appears in the drawing, spaced parallel forms F serve to confine between them plastic paving material such as newly mixed concrete C that is ordinarily deposited on the base between the forms F in successive batches in a more or less continuous manner as it is delivered from the mixing plant. The tops of the forms F serve also as track-ways or rails to support and position the machinery that operates along the site to spread and smooth the paving material, the forms being laid in such manner that the position of the form tops determines the elevation of the desired pavement surface.

As shown, the combined spreading and finishing machine embodying the present invention is arranged to run on the forms F as rails in advancing along them as the concrete C is deposited between the spaced forms upon the prepared base ahead of the machine. In advancing along the forms F over the plastic concrete C, the single combined paving machine embodying the present invention operates to position, shape and float the plastic material to form a pavement slab S that is of the desired thickness and surface contour thereby completing in one continuous operation the spreading, finishing and smoothing functions heretofore necessarily required to be performed separately by several independently operating machines. Since the single machine of this invention moves over the forms F only once in completing the spreading and finishing of the pavement slab S, the forms F are not subject to repeated deflections that might otherwise result in shifting them from their predetermined leveled position.

The improved apparatus set forth herein for accomplishing these new results illustrates the presently preferred or best mode now contemplated by the inventor for carrying out this invention.

Referring now more specifically to the drawings and particularly to FIGS. 1 to 4 thereof, the combined paving machine there shown as exemplifying the invention is conveniently formed in two separable sections or units that ordinarily operate coupled together as a unitary apparatus when laying pavement but that may be separated readily for transportation and storage or for operating separately. A forward section **21** constitutes the spreading unit of the machine that operates to spread the newly deposited plastic concrete C evenly over the site area between the forms F then level it to a predetermined depth and also vibrate and consolidate it. A following or trailing section **22** constitutes the finishing unit of the combined machine which operates to shape the surface of the slab S and to smooth it to its final contour.

The forward section or spreader unit **21** of the combined machine corresponds generally to the usual conventional concrete spreading machine and it may, if desired, be operated independently of the trailing section **22** for spreading the material. As appears in the drawings, the spreader machine unit **21** comprises essentially a transverse rectangular spreader frame or body element **23** that is adapted to span the site of the pavement slab defined by the forms F and that is made laterally extensible in order that the machine may be adjusted to the exact width of the forms F as spaced for the particular pavement slab being laid. As shown, each side of the spreader frame **23** is provided with and supported upon two flanged wheels **24** arranged in tandem relationship to engage and operate along the forms F thereby constituting the unit **21** a four-wheeled vehicle, the set of tandem related wheels at each side operating in the manner of a bogie truck.

A propulsion motor **25**, which is preferably in the form of an internal combustion engine, is mounted on the frame **23** midway of its width and is operatively connected to drive the four traction wheels **24** in a well-known manner for propelling the machine along the forms F. In front of the motor **25** at the middle of the machine, a

seat 26 is provided for the machine operator and in front of the seat 26, there is disposed a control console 27 presenting various control elements by means of which the operator may control the functioning of the machine.

Beneath the forward edge of the frame 23 is rotatably mounted a pair of horizontal transverse spreading screws 28 arranged in end to end axial alignment and oppositely threaded. The two screws 28 are likewise operatively connected to be driven independently by the engine 25 in a well-known manner whereby they may be rotated individually and selectively in either the same or opposite directions under control of the operator at the console 27 for moving the plastic concrete C laterally of the slab site as may be required in distributing the material evenly between the side forms F. The spreading screws 28 are followed by a strike-off member 29 that strikes off the upper surface of the spread concrete C in a manner to form the concrete bed or slab S of the desired thickness.

Following the strike-off member 29, as best shown in FIG. 4, a vibrator 30 operates to vibrate and consolidate the plastic concrete C of the slab. Although the particular vibrator 30 shown in the drawing is of the penetrating or submerged stringer type especially adapted for consolidating deep slabs of plastic concrete, it is to be understood that various other types of vibrating apparatus may be substituted for the specific vibrator shown, as may be required by the circumstances of the pavement laying operation in progress. For instance, in laying some pavements, particularly relatively thin slabs of concrete, it may be desirable to utilize a vibrator of the pan or surface type that effects vibration of the concrete from the upper surface only.

The finisher machine unit 22 that constitutes the following or trailing section of the combined machine, comprises essentially a folding framework including a float or pan frame or body element 33 that is somewhat similar to the previously mentioned frame 23 of the spreader unit 21 in that it is of generally rectangular shape and is adapted to span the pavement slab. Between the float or pan frame 33 and the spreader unit 21 there is arranged a folding intermediate or screed frame 34 that is generally similar in size but more lightly constructed than the float frame 33. As appears in the drawings, the intermediate frame 34 is hingedly connected to the forward edge of the float frame 33 on a transverse axis in such manner that it may be folded upwardly and rearwardly on to the top or deck of the float frame for transportation. Both the float frame 33 and the intermediate frame 34 are arranged to be laterally extensible in the manner of the spreader frame 23 whereby they may be adjusted to the width of the slab being laid.

The forward outer corners of the intermediate frame 34 have hingedly connected to them forwardly extending towing struts or arms 35 that are of goose-neck shape in order that they may extend above and along the respective ends of the spreader frame 23 and operate as a pair of shafts or thills in towing the finisher unit 22. As best shown in FIG. 4, the forward distal end of each goose-neck arm 35 rests upon the end member of the frame 23 of the spreader unit 21 midway between the front and rear flanged wheels 24 at the corresponding side of the machine whereby the end member and wheels constitute in effect a supporting bogie truck. In a generally similar manner, the rear outer corners of the float frame 33 are provided respectively with hingedly connected rearwardly extending supporting arms 36. As shown, the distal end of each rear supporting arm 36 is pivotally connected to the mid-point of a supporting bogie truck 37 which carries at its respective ends, flanged wheels 38 arranged in tandem relationship for engaging the forms F.

As may be seen best in FIG. 3, the towing arms 35 and the rear supporting arms 36 when pinned in operating position are arranged in alignment with and form extensions of the end members of the float frame 33 and of the intermediate frame 34 of the finishing unit in the manner to constitute therewith in operating effect a continuous composite side beam or side frame member that extends from a point midway between the front and rear spreader wheels 24 along the side of the finishing unit to a point midway between the front and rear bogie wheels 38. By this arrangement, should vertical movement of any wheel occur, for example, through running over an obstruction on the side form, only one-half of the movement will be transmitted by the bogie truck to the adjacent end of the composite side beam structure that carries the finishing apparatus. Furthermore, only one-half of the vertical movement of the end of the composite side beam will be transmitted to the mid-section of the beam. Consequently, the surface finishing apparatus carried by the spreader unit in the region of the beam mid-section will be moved vertically only about one-fourth as much as any one supporting wheel may move vertically because of running over an irregularity in the track surface presented by the side forms F.

The finishing apparatus carried by the finisher unit 22 includes two transverse metering screeds 41 and 42 that are suspended beneath the intermediate frame 34 and are operatively connected to be driven by the engine 25 of the spreader unit 21 to reciprocate laterally of the slab S for leveling and shaping its surface. The two metering screeds 41 and 42 are arranged to move endwise alternately in opposite directions to balance sidewise forces that might otherwise be exerted upon the machine frame and the supporting forms. As best shown in FIG. 4 the forward screed 41 follows the vibrator 30 and operates as a primary metering screed to preliminarily shape and level the top surface of the slab S as established by the strike-off element 29. The second screed 42 then operates as a final metering or finishing screed to effect final leveling and shaping of the surface of the slab to the exact elevation and contour required in the finished structure. As indicated by the construction center line 43, the forward edge of the second or final finishing screed 42 is positioned midway between the respective ends of the side beam structure that is supported by the two bogies constituted by the forward spreader wheels 24 and the rear finisher wheels 38. As previously explained, vertical movement resulting from irregularities in the trackway is at a minimum at this position thereby enabling the final finishing screed 42 to establish the surface contour of the slab with the highest degree of accuracy in accordance with the average elevation of the tops of the forms F.

Following the two screeds 41 and 42, a float pan or smoothing plate 44 is suspended beneath the float frame 33 of the finisher unit 22 in such manner that it is free to slide over or float upon the shaped surface of the slab S to trowel it to its final contour and required degree of smoothness. Obviously this complete finisher machine unit 22 also is adapted to be operated independently of the particular spreading machine unit shown, in that it may be attached to a powered primary machine of some other type or it may be provided with its own forward wheels and power unit for operating by itself as a separate finishing machine.

For moving or storing the machine, the entire finisher unit 22 may be separated readily from the towing spreader unit 21 by disconnecting the towing arms 35 from the spreader frame and folding them outwardly and backwardly about a vertical axis along the sides of the intermediate frame 34. The intermediate frame 34 may then be lifted at its forward edge together with the folded towing arms 35 and the suspended screeds 41 and 42 to fold it upward and back on top of the float frame 33. The rearwardly extending bogie arms 36 may then be folded inwardly to form a compact unit for transportation such as from one job site to another.

When the finisher unit 22 is disconnected from the spreader unit 21 in this manner, the spreader unit may be operated independently along the forms F to effect spread-

ing of paving material in the manner of the usual concrete spreading machine. Since the spreading unit **21** is wide enough to span a pavement slab such as, for example, a roadway 24 feet wide or wider, and on the other hand is relatively short in its dimension longitudinally of the roadway, it is in consequence subject to steering difficulties. For example, if the spreading screw at one side of the spreading unit **21** meets with unusual resistance through engaging a large heap of plastic concrete to be spread, the traction wheels **24** at that side of the machine may slip on the forms F thereby permitting the other side of the machine to advance in manner to turn or cant the machine from its normal transverse position on the forms. This misalignment of the machine with respect to the forms F necessitates corrective action by the machine operator through operating controls to declutch the traction wheels **24** at the side of the machine which is too far advanced in order that the screw on the lagging side may have opportunity to overcome the resistance of the heap of concrete and the machine regain its proper position of alignment wherein it is positioned at right angles to the forms.

These steering difficulties, which are at times encountered by spreader units of this general type when operating independently, are in large measure overcome through combining the spreader unit **21** with the finisher unit **22** in the particular manner herein set forth in accordance with the present invention. As shown in the drawings, the forward or distal end of each towing arm **35** is provided with a lost motion connection in the form of a longitudinal slot **48** constituting at its forward end a towing abutment by means of which it is coupled or hooked to the spreader frame **23**. To this purpose, the longitudinal slots **48** in the forward ends of the arms **35** are adapted to fit over and receive upwardly projecting steel towing posts **49** mounted on the tops of the respective side members of the spreader frame **23** and midway between the front and the rear traction wheels **24**, the arrangement being such that the posts **49** form cooperating towing abutments that are free to slide within the slots to constitute lost motion mechanisms. Although the posts **49** are shown in FIG. 3 of the drawing as positioned in the middle of the slots **48** for clearness of illustration, when the combined machine is travelling along a straight section of the forms F, the towing posts **49** will engage or abut the towing abutments constituted by the forward ends of the respective slots **48** in the towing arms **35** in effecting towing of the finisher unit **22** with each towing arm sustaining its share of the towing effort. Furthermore, the towing arms **35** also transmit to the spreader frame **23** approximately half of the weight of the entire finisher unit **22**, the other half being carried by the rear bogie wheels **38**. This added weight tends to increase the tractive action of the wheels **24** and considerably reduces the likelihood of the wheels slipping on the forms F.

In the event that in spite of this added weight the traction wheels **24** at one side of the spreader unit **21** should slip, the towing post **49** at that side of the machine will tend to become disengaged rearwardly from the towing abutment at the forward end of its cooperating slot **48** in the respective towing arm **35**. This abutment disengaging action of the lost motion connection brings about a shifting of the towing effort in that all of the force required for towing the finisher unit **22** is then shifted to the engaged towing abutment at the side of the machine with the non-slipping wheels while the slipping wheels at the other side of the machine are entirely relieved of the towing effort. Thus this shifting action has the effect of automatically compensating for and overcoming the previously described steering difficulties in that the slipping wheels are immediately relieved of the towing force thereby checking their tendency to slip while at the same time the non-slipping wheels at the other side of the machine are restrained by the increased towing force from their tendency toward further advancing ahead of the slipping wheels along the forms F.

In this manner the towed finishing unit **22** tends to stabilize and to effect an automatic steering action upon the power driven spreader unit **21** whereby it is maintained at right angles to the forms F and constrained to progress along them in a straight forward manner without requiring the constant attention of the operator to correct misalignment of the machine. Thus it may be said that each of the two machine units operates through the spaced towing arms and their lost-motion abutment connections to effect steering of the other unit as the machine operates along the forms.

When in paving a highway, for example, the combined machine encounters a curved section such as is represented diagrammatically by the curved forms F indicated in FIG. 2 of the drawing, the post and slot towing abutment connections between the frame **23** of the spreader unit **21** and the towing arms **35** of the finisher unit **22** constitute cooperating lost motion mechanisms that permit the spreader unit **21** to assume an angular position relative to the finisher unit **22** thereby hinging the relatively long machine for negotiating the curve. Under these circumstances the post **49** at the side of the machine on the outside of the curve and that is in engagement with the towing abutment in the forward end of the cooperating slot **48** takes over all of the effort of towing the finishing unit **22**. At the near or inner side of the curve, the towing abutment constituted by the post **49** moves rearwardly or lags back relative to the cooperating abutment in the lost motion slot **48** thereby permitting the spreader frame **23** to assume a radial position relative to the curved forms F, which is necessarily somewhat at an angle to the position of the finisher unit **22**, in following the curve of the forms.

In accordance with a variation of the towing connection that is shown in FIG. 5 as a modification of the invention, the towing arms **35** may be restrained relative to the towing posts **49** by means of manually operated steering mechanisms that take the place of the lost motion abutment mechanisms and that may be adjusted to accommodate the combined machine to curves in the forms being followed. To this end, there is provided at the forward end of each towing arm **35** an upstanding bracket **51** having a longitudinally disposed opening that receives a threaded eye bolt **52**. The appertured end **53** of the eye bolt **52** is fitted over the towing post **49** thereby to constitute cooperating tow abutments while the threaded end **54** extends forwardly and passes through and is adjustable in the longitudinal opening in the upstanding bracket **51**. As shown, the threaded end **54** is engaged by a nut **55** that is rotatably mounted in the bracket **51** in such manner that it is restrained from longitudinal movement relative to the bracket but is free to be turned upon the threaded part **54** of the eye bolt **52**.

When the machine is operating along a straight section of the forms F, the nuts **55** are ordinarily turned on to the eye bolts **52** a sufficient amount to permit the towing posts **49** to move forwardly and engage the forward ends of the slots **48** in the towing arms **35** in the manner previously described. When negotiating a curve in the forms F, the nut **55** at the side of the machine on the inside of the curve is turned manually as required to advance the slotted end of the towing arm **35** relative to the post **49** in order to accommodate the combined machine to the curve. By properly adjusting the nut **55**, the towing force exerted by the inner or lagging side of the spreader unit **21** will be maintained substantially equal to the towing force exerted by the leading end at the outer side of the curve. This is ordinarily accomplished simply by observing the action of the towed finisher unit **22** and adjusting one or the other of the nuts **55** as the curvature of the forms F changes in such manner as to cause the towed unit to track centrally on the forms F. In order to facilitate this adjustment, the rotatably mounted nuts **55** are preferably mounted in the

brackets 51 by means of anti-friction thrust bearings 56 which permit rotation of the nuts while transmitting the towing forces from the post 49 to the towing arm 35.

Although the appertured end 53 of the eye bolt 52 constitutes a towing abutment that effects a universal connection with the towing abutment constitued by the post 49, this connection may be if desired in the form of a ball and socket joint through substituting a ball shaped towing post and a complementary socket in place of the cylindrical post and the apperture 53 of the cooperating eye bolt 52. Furthermore, this manually adjustable steering mechanism may be arranged for power operation under automatic control or it may be replaced by hydraulically operated steering apparatus, although in practice it has been found that the previously described plain post and slot lost motion connections operate generally satisfactorily in negotiating curves.

As previously mentioned, the forward element or spreader section 21 of the combined machine constitutes in itself the equivalent of a conventional concrete spreading machine of the screw type that may be operated independently if desired. As most clearly shown in FIG. 3, the transverse frame 23 of the spreader element 21 is made extensible and in the particular machine illustrated is adapted for manual adjustment whereby the machine may operate to lay pavement slabs of any desired dimensions between twenty feet and twenty-five feet in width, although it is to be understood that machines of this type may be manufactured in sizes adapted for operation upon either narrower or wider slabs and with different ranges of adjustment, as will be readily appreciated.

To provide for the required degree of adjustment in width, the spreader frame 23 comprises a central frame member 61 the ends of which telescopically receive end frame members 62. The central frame member 61 is constituted primarily by a pair of spaced transverse beams 63, in this instance outwardly facing channel members, that are interconnected by a plurality of cross beams 64 to form a hollow rectangular supporting structure. Each of the ends frame members 63 includes a bolster or side piece 65 of box beam construction that carrier the front and rear form engaging wheels 24 in tandem relationship. From the inner side of each end of each bolster 65 a beam 66 constituted by an inwardly facing channel, extends inwardly in abutting parallel relationship with the corresponding channel beam 63 of the frame central section. The spaced inner beams 66 formed by the inwardly facing channel members are arranged in sliding back-to-back relationship with the respective conversely facing outer spaced beams 63.

As shown in FIGS. 3 and 4 and in detail in FIG. 7, load transferring rollers 67 interconnect the end frame beams 66 with the central frame beams 63 in manner to constitute continuous transverse beams, with the rollers operating to carry the weight imposed by the beams 63 when the beams 66 slide along them in abutting parallel relationship. For effecting relative sliding movement between the respective beams of the frames in adjusting the width of the machine, there are provided a series of width adjusting screws 69 each screw being rotatably mounted in the associated bolster 65 in the region of the end frame beam 66 and presenting on its outer projecting end a wrench receiving surface by means of which it may be turned manually. As shown in detail in FIG. 7, the inner end of each screw 69 has cooperating threaded engagement with a complementary nut 71 that is fixed on the main frame beam 63 in such manner that when the screws are turned the bolster 65 is moved in or out as required.

As the machine is shown in FIG. 3, the spreader frame 23 is adjusted to its narrowest position for convenience in illustrating the apparatus in the drawing. After the machine has been adjusted to the required width for operating on the spaced forms F by turning the screws 69, the relatively slidable beams 63 and 66 are clamped together to maintain the adjustment and to draw the separate frame elements into a unitary rigid frame structure. As shown in FIG. 3 of the drawing, clamping of the juxtaposed beams is effected at any degree of overlapping therebetween by means of a plurality of clamps 72 suitably positioned in spaced relationship thereon, there being preferably two clamps on the top flange and two clamps on the bottom flange of each pair of slidably engaged beams.

As best shown in the detailed view FIG. 7, the beam clamps 72 may be of either the fixed or movable type. In the fixed type, a clamp bolt 73 is welded to the flange of one of the beams or otherwise permanently secured and carries a slidable dog 74 that is shaped to engage the flange of the other beam. A nut 75 threaded on the clamping bolt 73 may be tightened to engage the dog 74 with the beam flange and thereby draw the beams together into frictional interlocking contact. If it is desired to provide for adjusting the position of the clamp 72 along the beams, the clamp may be of the other or movable form shown in FIG. 7 in which two opposed clamp dogs 74 are provided on opposite ends of a headed clamping bolt 76 with the dogs engaging the flanges of the respective beams in such manner that when the nut 75 is tightened on the bolt 76 the opposed dogs and the two beams are drawn together in clamping relationship. Each of the clamping dogs 74 comprises a frusto-conical body or barrel 77 that is bored to receive the clamp bolt 76 and that is flattened on one side to engage and rest upon the flange of the beam. At its larger end, the barrel 77 is provided with an inturned depending lip 78 that hooks over and is shaped to engage the outer edge of the beam flange as shown in the drawing. When the nut 75 is loose, the clamp 72 is released and may be slid along the beam flanges to any desired position.

In a similar manner the finisher framework constituted by the float frame 33 and the intermediate frame 34 is also arranged for manual widening adjustment. As shown in FIG. 3, the float frame 33 comprises a central or main frame section 81 provided at each end with telescopically connected end sections 82 that are clamped together by a series of clamps 72 as previously explained, there being preferably four clamps at each sliding joint, two on the upper flanges and two on the lower flanges and spaced apart to insure rigidity. The intermediate frame 34 is constituted by a central or main section 84 likewise provided with telescopically received adjustable end sections 85 secured by a plurality of clamps 72. The adjustment is effected for both frames of the finisher section 22 by means of a pair of the adjusting screws 69 that are provided in the float frame 34 and that operate as previously explained, the relatively light intermediate frame moving with the float frame.

At the front end of the spreader unit or section 21, as shown somewhat diagrammatically in FIG. 10, the two spreader screws 28 are suspended beneath the forward edge of the spreader frame 23 in conjunction with the strike-off member 29 that likewise is formed in two halves or parts 87. Each of the strike-off parts 87 corresponds in length to one of the spreader screws 28 and is provided with bearing brackets 88 and 89 at its respective ends which rotatably support the opposite ends of the corresponding screw 28 in well-known manner. The two strike-off parts 87 are hingedly connected together at the lower edges of their adjacent or inner ends whereby they may be adjusted in angular relationship to accommodate the strike-off member to the general contour desired on the surface of the slab S being formed. When the supporting frame 23 of the spreading unit 21 is adjusted in width to the width of the slab being laid as previously explained, the two spreader screws 28 and the associated strike-off parts 87 may be replaced by equivalent members of suitable length, or alternatively, these elements may be of the well-known adjustable type whereupon they may be adjusted simultaneously with the adjustment of the frame 23.

As shown in FIG. 10, the strike-off member **29** is suspended at the center in the region of the hinged connection by means of a hydraulic cylinder adjusting mechanism **90** and at each end by means of manually adjustable turnbuckles **91**. The cylinder **90** and the turnbuckles **91** depend from the ends of supporting and lifting arms **92** that project in generally horizontal direction from a torque tube **93** that is rotatably mounted in the spreader frame **23**. A pair of actuating arms **94** depending from the torque tube **93** are connected to piston rods **95** extending from actuating cylinders **96** which are pivotally connected at their closed ends to the spreader frame **23**. The cylinders **96** are connected with hydraulic lines **97** through which hydraulic pressure fluid may be admitted from control elements on the control console **27** to effect turning of the torque tube **93** thereby lifting or lowering the entire unit comprised of the two spreader screws **28** and the two hingedly connected parts **87** of the strike-off member **29**.

Although vertical adjustment of the combined spreader and strifle-off unit as a whole is effected by means of the hydraulic cylinders **96**, fine adjustment of both the vertical position and the angular relationship between the strike-off units **87** is effected by operation of the supporting and adjusting cylinder mechanism **90** and the turnbuckles **91**. The suspending cylinder mechanism **90** and the turnbuckles **91** may be adjusted individually to effect any desired angular relationship between the two parts **87** of the strike-off **29** within the range of adjustment provided as illustrated diagrammatically in FIG. 11. Thus, the strike-off **29** may be adjusted as shown in position "*a*" at the top in FIG. 11 to form a plain level surface on the slab S or as shown in position "*f*" at the bottom of FIG. 11 to form a peaked crown on the slab S. Between these positions, as indicated by the several intermediate positions "*b*," "*c*," "*d*" or "*e*," the hinged strike-off may be adjusted to form any of various combinations of horizontal and inclined surfaces on the respective halves of the slab S. It is to be understood, however, that the inclined surfaces thus formed on the slab by the hingedly connected parts **87** of the strike-off **29** are preliminary shapes only and that the final preferred surface shape is established on the top of the slab S by operation of the two reciprocating transverse screeds **41** and **42** of the trailing finisher unit **22** which are more precisely adjustable to effect the desired crown contour.

In adjusting the strike-off **29** to form a desired preliminary shape, the two turnbuckles **91** are turned manually to effect individual adjustment of each end of the strike-off **29** to the proper elevation for forming the corresponding edge of the slab. The central part of the strike-off is then positioned vertically as required, by operation of the adjusting cylinder **90**. The cylinder mechanism **90** is connected with hydraulic lines **93** through which hydraulic pressure fluid may be admitted from control elements on the control console **27** in well known manner. By this arrangement, the strike-off **29** may be adjusted as indicated at "*f*" in FIG. 11 to form a crowned slab on a straight section of a highway, for example. Then upon entering a curved section of the highway the machine operator at the control console **27** may lower the central part of the strike-off gradually through operation of the adjusting cylinder mechanism **90** to the flat position indicated at "*a*" in FIG. 11 for forming a superelevated curve. Upon moving out of the curved section, the operator gradually raises the central part of the strike-off to restore the crown on the slab, the screeds **41** and **42** being adjusted simultaneously to establish the desired crowned contour on the pavement surface.

As best shown in FIG. 3, the connections by means of which the adjustable transverse screeds **41** and **42** are driven by the engine **25** includes a disconnecting friction clutch **101** through which power may be transmitted selectively to a speed selecting gear box **102** that may be shifted in the usual manner to establish the rate of reciprocation of the screeds. From the gear box **102** a disconnectible cardan shaft **103** transmits power to a speed reducing gear box **104** that is mounted in the intermediate frame **34**. The gear box **104** drives a crank shaft **105** that is rotatably mounted in the frame **34** and is provided at each end with a crank arm **106**. Each crank arm **106** is pivotally connected to one end of a pitman rod **107**, the other ends of the two pitman rods being pivotally connected to actuating arms **108** on the respective transverse screeds **41** and **42**. The cranks **106** are spaced out of phase at 180 degrees to each other on the crank shaft **105** whereby when the shaft is rotated by the engine **25** the screeds **41** and **42** are caused to reciprocate endwise alternately in opposite directions. In this manner inertial and frictional forces resulting from operation of the two screeds are substantially balanced against each other and therefore are not transmitted to the machine frame nor to the supporting forms F.

In the finishing unit **22** of this combined machine, the metering screeds **41** and **42** do not rest directly upon the forms F but are supported from the machine framework in order to establish the surface of the slab S at the elevation determined by the average of the elevations of the several points on the forms that are engaged by the various wheels of the machine. To this end, the screeds **41** and **42** are each supported from the framework near each side as shown in FIGS. 4 and 6 upon a plurality of rollers **111** that are adjustably suspended beneath the intermediate frame **34** of the finishing section **22**. As appears in FIG. 3, each of the screeds **41** and **42** is provided with two spaced roller trackways or boxes **112** that engage and ride upon the rollers **111**. As shown in the sectional views FIGS. 8 and 9, each roller box is disposed longitudinally of the screed and is attached to the top surface thereof with its ends open and with the inner lower surface of its upper side constituting the trackway for the roller **111**, the box being sufficiently long to maintain contact with the roller **111** throughout the maximum stroke of reciprocation of the screed.

As best shown in FIG. 9, each screed supporting roller **111** is rotatably mounted on the distal end of a horizontally disposed arm constituting a part of an adjustable bell crank **113** and that extends within the trackway box **112**. The horizontal arm of the bell crank **113** is sufficiently long to accommodate the reciprocating movement of the box without interference. Each bell crank **113** is pivotally supported by a bracket **114** that depends from a hanger beam **115** that constitutes part of the intermediate frame **34** and that extends longitudinally of the machine.

An upwardly extending arm of the bell crank **113** is pivotally connected to a piston rod **116** extending from a power cylinder **117** disposed above the hanger beam **115** and pivotally connected at its closed end to a bracket **118** mounted on the top of the beam. Hydraulic connecting lines **119** at the respective ends of the cylinder **117** are connected by means of suitable control conduits (not shown) to corresponding control elements of the control console **27** whereby the piston rod **116** may be actuated under control of the machine operator to pivot the bell crank **113** and raise or lower the screed between its travelling position and its working position as required.

In order that the elevation of the screed when in its lowered or working position may be adjusted precisely, the upwardly extending arm of the bell crank **113** has threaded through it a manually operated elevation adjusting screw **120** the inner end of which bears against the hanger beam **115** when the screed is in the lowered or working position. By turning the adjusting screw **120** manually, the bell crank **113** may be pivotally adjusted and the screed supporting roller **111** thereby adjusted vertically to establish the desired elevation of the lower or working surface of the screed relative to the frame of the machine in order that the surface of the slab S may be established at the desired elevation relative to the tops of the forms F upon which the machine is supported.

Upward movement of the screed from its established working position is prevented by operation of a lower trackway **121** that engages the lower side of the roller **111**.

By this arangement, each of the two metering screeds **41** and **42** is adjustably supported at two spaced positions when working on the slab surface whereby the respective ends of each screed may be adjusted independently and the two screeds may be adjusted relative to each other as well as relative to the machine frame. When the two screeds are being reciprocated by power from the engine **25** the trackways boxes **112** roll back and forth over the respective screed supporting rollers **111** with a minimum of frictional resistance and with the screed bottoms in accurately pre-determined position with respect to the slab surface at the desired elevation established from the tops of the precisely set forms F.

As the machine advances along the forms with the screeds reciprocating, each screed is maintained in its proper position longitudinally of the machine frame and moved forward along the slabs by means of a series of pushing rollers **122** that engage the rearward faces of the screeds and that are mounted on the frame with their axes disposed vertically. As shown in FIG. 4 of the drawing, the pushing rollers **122** for the forward screed **41** are rotatably carried at the lower ends of depending brackets **123** secured to and extending downward from the hanger beams **115** of the intermediate frame **34**. The pushing rollers **122** that engage the second screed **42** are carried rotatably at the lower ends of brackets **124** depending from the float frame **33**. By this arrangement of depending brackets and rollers the screeds are pushed forward as they reciprocate in order that surplus plastic concrete that may accumulate at their forward faces may be pushed along the top of the slab S in a manner to be available for filling any slight depressions that might be encountered in the slab surface.

Each of the transverse screeds **41** and **42** is preferably of the adjustable crowning type set forth and claimed in co-pending application, Serial No. 806,003 filed April 13, 1959 and entitled Pavement Surface Finishing Apparatus that issued June 18, 1963 as Patent Number 3,094,048. As more fully described in this co-pending Patent Number 3,094,048, the lower working surface of each screed is curved to define and mold the particular crowned contour that it is desired to establish upon the finished surface of the slab S. The first metering screed **41** operates as a preliminary screed that levels the concrete to approximately its finished surface contour, while the second metering screed **42** operates as a final screed to establish more exactly the elevation and contour of the desired finished surface. As explained with reference to similar screeds in the previously mentioned copending Patent 3,094,048, the screeds **41** and **42** also are adjustable in length to correspond with the adjustment of the intermediate frame **34** to the width of the slab being laid.

As previously mentioned, the forward edge of the second or final finishing screed **42** lies midway between the forward tandem wheel set and the rear tandem wheel set as indicated by the construction center line **43** in FIG. 4 whereby any disturbances in elevation arising from irregularities in the tops of the forms F are minimized. Since the screeds are controlled in elevation from the machine frame rather than directly from the form surfaces, spring pressed wear plates **125** are provided at the end of each screed to bear upon the tops of the forms, the plates **125** being free to move vertically relative to the screeds in such manner that their contact with the forms does not influence the elevation of the screeds.

After the contour of the surface of the slab S has been established by the final finishing screed **42**, the previously mentioned pan float **44** is drawn over the surface to smooth it to its final finish. The pan float **44** is suspended beneath the float frame **33** in such manner that it exerts upon the surface of the slab only the force of its own weight and therefore does not displace the concrete of the slab but merely smooths the surface. The arrangement for supporting the pan float and its mode of operation are more fully explained in the previously mentioned co-pending Patent No. 3,094,048 which shows in detail the crown adjusting mechanism whereby the pan float **44** is adjusted in accordance with the crown adjustment of the screed **42** in order that the slab surface may be molded and smoothed precisely to the desired contour and finish. As set forth in Patent 3,094,048, the pan float **44** is also adjustable in length in such manner that it may be adjusted with the float frame **33** to the width of the slab being finished.

When it is desired to separate the combined machine into two units for transportation such as from one job site to another, the screeds **41** and **42** are lifted by operation of the power cylinders **117** to their raised positions and are then secured to the hanger beams **115**. This is accomplished as shown in detail in FIG. 5 by inserting temporary supporting brackets **127** that are bolted to and extend upwardly from each side of the screed beam and are then bolted at their top ends to the bottom flange of the hanger beam **115**. With the screeds thus secured to the hanger beams, lifting jacks **128**, two of which are provided on each end of the float frame **33**, are extended downward to engage the ground for lifting and supporting the float frame. The hydraulic lines leading from the console **27** on the spreader unit **21** to the finisher unit **22** are then disconnected and likewise the disconnectible cardan shaft **103** is disengaged.

With the power lines disconnected and the finisher framework supported on the jacks **128** the goose-neck arms **35** may be lifted, by operating the jacks **128** or otherwise, to disengage the slots **48** in their ends from the towing posts **49** on the spreader frame whereupon the forward or spreader unit is released and may be moved separately. As shown, the forwardly extending towing arms **35** are attached to the forward edge of the intermediate frame **34** by means of inner and outer vertically disposed pins **130**. Upon removing the inner pin **130**, each towing arm **35** may be pivoted upon the outer pin as a vertical axis to fold it outwardly and back along the side of the intermediate frame as previously mentioned.

The intermediate frame **34** is connected to the forward edge of the float frame **33** at each side of the machine by means of horizontally disposed upper and lower pins **131**. Upon removing the lower pin at each side of the machine, the intermediate frame **34** may be lifted at its forward edge and folded upward and backward about its transverse pivot axis, together with the screeds **41** and **42** that are secured to the hanger beam **115** and the folded towing arms **35**. The lifting of the intermediate frame is ordinarily accomplished by means of a crane or the like which may be operated to fold it over rearwardly with the screeds uppermost on to the deck or top of the float frame **33** that is supported upon the jacks **128**. The rearwardly extending bogie arms **36** are secured to the rear corners of the float frame **33** by means of vertically disposed inner and outer pins **132** and upon removing the outer pins the arms **36** together with the bogies **37** may be pivoted upon the inner pins as vertical axes to fold them inwardly against the back of the float frame **33** as indicated in broken lines in FIG. 3.

When disconnected and folded in this manner the combined spreading and finishing machine is converted to two compact independent units each of suitable size to be transported readily along highways or railways in moving the machine to a new paving site, for example. To this end, each detached unit may be provided with its own transportation wheels in well-known manner in order that it may be toward behind a powered vehicle.

When the folded machine arrives at the new site, the spreader section **21** is first adjusted by extending it to the spacing of the side forms F that define the new slab to be laid. This is accomplished by loosening the frame clamps **72** and actuating the width adjusting screws **69** until the frame width is properly adjusted to engage the

wheels 24 with the tops of the side forms F. After the frame has been adjusted to track the wheels on the side forms, the clamps 72 are again tightened thereby adapting the spreading section for operation upon the new forms F.

The fiinishing section 22 is then placed behind the spreader section 21 and supported by means of its central frame section 81 upon blocks or the like after which the intermediate frame 34 is folded forward from the deck of the float frame 33 and is pinned in its extended position by inserting the lower pins 131. The towing arms 35 then may be folded forward and inward over the spreader section 21 and is pinned in position by inserting the inner pins 130. The bogie arms 36 are likewise folded rearwardly and outwardly and pinned to the float frame 33 by inserting the outer pins 132. The width of the finisher section is then adjusted by releasing the clamps 72 and turning the width adjusting screws 69 to adjust the framework to the width of the spreader unit and thereby position the rear bogie wheels 38 in engagement with the forms F. The spreader section 21 is moved to position it relative to the towing arms and the slots 48 at the forward ends of the towing arms 35 are then positioned directly over the towing posts 49. The machine then may be lifted by the jacks 128 to remove the blocks after which the jacks 128 may be retracted to lower the rear bogie wheels 38 on to the forms and the slotted forward ends of the towing arms 35 onto the posts 49. After the machine has been fitted to the forms and coupled together, the screeds may be lowered and the disconnectible screed driving shaft 103 and the hydraulic lines connected to ready the combined machine for operation along the forms F as previously explained.

From the foregoing description of exemplary pavement laying and finishing apparatus embodying the present invention and the accompanying explanation of the manner in which it operates, it will be apparent that a new and novel arrangement has been provided by this invention for spreading, consolidating, shaping and smoothing plastic paving material to form a pavement slab in a single continuous operation. This is accomplished by providing an improved combined pavement laying machine constituted essentially by a spreading unit and a finishing unit so coupled together that each unit operates to steer the other unit as the combination advances along the slab being laid. Furthermore, the coupled units constitute in effect spaced bogie trucks that cooperate to form an equalizing structure whereby the surface determining screeds are carried in a manner to be least affected by irregularities in the trackway over which the machine may be operating. An improved arrangement is provided for supporting and lifting the screeds and for securing them in raised position. With the screeds lifted, the two units may be uncoupled and the finishing unit folded compactly for transportation.

Although a specific example of an operative combined pavement slab laying and finishing machine has been set forth in detail herein by way of a full disclosure of a practical and useful embodiment of the invention, it is to be understood that other arrangements of the improved features disclosed may be incorporated in different apparatus 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 novel features of the invention having now been fully set forth and explained, I claim as my invention:

1. In a combined machine for finishing the surface of a pavement slab, a spreading unit comprising a spreader frame adapted to span and to move along the site of a slab of pavement being laid between spaced confining side forms, wheels arranged in tandem relationship at each side of said spreader frame in position to engage and support said frame upon the side forms respectively, a spreader carried by said spreader frame in position to engage and spread paving material in plastic condition that has been deposited between the forms ahead of said machine, a strike-off carried by said spreader frame in position to strike off the spread plastic material as said machine moves along thereby to define the slab, a vibrator carried by said spreader frame in position to vibrate and consolidate the plastic material of the slab, a finishing unit comprising a finisher frame including a screed frame and a float frame said finisher frame being adapted to span the slab site and to follow said spreading unit in moving along the site, side beam extensions arranged at each side of said finisher frame in a manner to extend forwardly and rearwardly therefrom, means pivotally connecting the forward ends of said forward side beam extensions to the respective sides of said spreader frame at positions thereon midway between said tandem arranged wheels for equalizing action, a bogie pivotally connected to each of the rearwardly extending ends of said rearward side beam extensions, wheels arranged on each of said bogies in tandem relationship at equal distances from said pivotal connection for equalizing action, a first transverse reciprocating screed supported beneath said screed frame in position to engage and preliminarily level the surface of the slab, a second transverse reciprocating screed supported beneath said screed frame behind said first screed in position to engage and finally level the surface of the slab, said second screed being disposed midway between said forward pivotal supporting connections and said rearward pivotal supporting connections of said side beam extensions thereby lying in the longitudinal position on said finishing unit least affected by vertical movement of said wheels in passing over irregularities in the side forms, power operated means connected to effect reciprocation of said screeds in opposite directions respectively, and a float pan suspended beneath said float frame behind said screeds in position to float and smooth the leveled surface of the slab as said machine moves along the slab site, the arrangement being such that as said combined machine advances along the forms and paving material in plastic condition is deposited continuously between the forms ahead of said machine, the paving material is spread, leveled and smoothed to form the pavement slab, the final leveling action taking place midway between supporting bogies for least influence by irregularities in the forms.

2. In a pavement slab laying machine, a spreading unit comprising a spreader frame adapted to span the site of a slab being laid as defined by spaced side forms, traction wheels on said spreader frame at each side thereof adapted to support said spreader frame on the spaced side forms for movement therealong, spreader mechanism mounted on said spreader frame in position to engage paving material on the site and spread it laterally between the side forms as said frame moves along the forms, a source of power mounted on said spreader frame and operatively connected to drive said traction wheels and said spreader mechanism, there being a tendency for said traction wheels to slip on one or the other of the side forms when said spreader machanism engages the paving material on the site thereby adversely affecting steering of said spreading unit and causing misalignment thereof in moving along the forms, a finishing unit including a finisher frame likewise adapted to span the slab site, wheels on the trailing end of said finisher frame on the side forms, finisher mechanism mounted on said finisher frame in position to engage and finish the surface of the paving material therefor spread by said spreader mechanism, an abutment on each side of said spreader frame, a pair of towing arms connected to and projecting from the corresponding sides of said finisher frame, said towing arms being provided with guide means movably engaging said abutments for limited movement relative thereto in the forward and rearward direction, said guide means being engageable with said abutments with movement of the spreader frame forwardly in a straight path whereby the finishing unit is towed directly behind the spreader frame in the same path, said towing arms and said guide means and abut-

ments allowing either towing arm to move forwardly respecting the spreader frame with a given change in direction of the movement of the spreader frame whereby said abutments and guide means serve to facilitate operation of the combined machine along curved side forms by providing for angular relative movement between said spreader frame and said finisher frame and also serve to relieve towing forces from the side of said spreader frame on which said traction wheels may happen to slip thereby counteracting the tendency of said spreading unit to become misaligned with respect to said side forms.

3. In a combined machine for spreading and finishing paving material in plastic condition to form a pavement slab between confining side forms, a spreading machine unit adapted to operate along the side forms to spread paving material therebetween, and a finishing machine unit arranged to be towed along the side forms behind said spreading machine unit to finish the surface of the material spread thereby; said finishing machine unit comprising a pan frame, running gear supporting said pan frame for operation along the side forms, a screed frame hingedly connected on a transverse axis to the forward edge of and extending forwardly from said pan frame in manner to be foldable upward and backward onto said pan frame, towing arms hingedly connected to the forward corners of and extending forwardly from said screed frame in manner to be foldable backward onto said screed frame, means to detachably connect the forward ends of said towing arms to said spreading machine unit for towing said finishing machine unit thereby, a finishing screed carried by said screed frame in position to finish the surface of the paving material spread by said spreading machine unit as it operates along the side forms, and a pan float carried by said pan frame in position to smooth the finished surface of the paving material, the arrangement being such that said finishing machine unit may be detached from said spreading machine unit and folded compactly for transportation between job sites.

4. In a finishing attachment for connection to a pavement laying machine, a float frame adapted to span a slab of pavement being laid, a smoothing float suspended beneath said float frame in position to smooth the surface of the pavement slab, an intermediate frame hingedly connected to the forward edge of said float frame on a transverse axis in position to extend forwardly therefrom in manner adapted to fold upward and backward on top of said float frame, running gear extending rearwardly from said float frame in manner to support said float frame in advancing along the pavement slab, a pair of transverse screeds disposed beneath said intermediate frame in position to level and shape the surface of the pavement slab for smoothing by said float, rollers movably carried by said intermediate frame to support said screeds for reciprocatory movement in operating upon the slab surface, means on said intermediate frame to lift said movable rollers for raising said screeds from the slab surface to a traveling position, means on said roller lifting means to adjust the lowermost position of said rollers for regulating the working position of said screeds to determine the elevation of the surface of the slab being leveled, and towing arms hingedly connected to the forward corners of said intermediate frame and adapted to be attached to the pavement laying machine for interconnecting it and said finishing attachment to form a cooperative pavement slab laying and finishing combination, the arrangement being such that when said screeds are raised to traveling position and said towing arms are disconnected from the pavement laying machine, said hingedly connected towing arms may be folded rearwardly onto said intermediate frame and then said hingedly connected intermediate frame together with said raised screeds and said folded towing arms may be folded upwardly and backwardly onto said float frame for transportation as a compact unit.

5. In a combined spreading and finishing machine for laying pavement, a mobile spreader frame adapted to span and to move along the site of a slab of pavement being laid, a spreading screw rotatably mounted in said spreader frame in position to engage and spread paving material newly deposited in plastic condition ahead of said machine, a source of power mounted on said spreader frame, transmission mechanism operatively connecting said source of power to drive said mobile frame selectively and to drive said spreading screw selectively, a finisher float frame adapted to follow said spreader frame in moving along the slab being laid, an intermediate frame hingedly connected on a transverse axis to the forward edge of said float frame and extending forwardly therefrom in a manner such that it is arranged for folding upward and rearward onto said float frame, towing means detachably connecting the forward edge of said intermediate frame to said spreader frame to constitute therewith a unitary paving machine, a screed reciprocably suspended beneath said intermediate frame in position to engage and level the surface of the plastic paving material spread by said spreading screw, drive mechanism mounted on said intermediate frame and operatively connected to effect reciprocation of said screed, disconnectible power transmission mechanism operatively connecting said source of power on said spreader frame to drive said drive mechanism on said intermediate frame for operating said screed, and a finishing float supported by said float frame in position to engage and finish the surface of the plastic material leveled by said screed, the arrangement being such that said combined machine will both spread and surface finish the plastic paving material placed before it to form a pavement slab and is adapted to be disconnected and folded for transportation from one to another job site.

6. In a combined machine for laying and finishing a slab of pavement, a spreader frame adapted to span and to traverse the site of a pavement slab being laid, spreading apparatus carried by said spreader frame in position to engage and spread paving material as said machine passes over it in traversing the slab site, a finisher framework adapted likewise to span the slab site and to follow said spreader frame in traversing the site, said finisher framework comprising a float frame and an intermediate frame said intermediate frame being hingedly connected to the leading edge of said float frame on a transverse axis so that it can be folded upwardly and backwardly onto said float frame, towing arms hingedly connected to the leading corners of said intermediate frame on vertical axis to be folded rearwardly alongside thereof and adapted to be releasibly connected at their forward ends to the respective sides of said spreader frame in such manner that said spreader frame operates to tow said finisher frame, metering screeds suspended beneath said intermediate frame in position to engage and level the surface of the spread paving material as said machine traverses the slab site, and a smoothing float suspended beneath said float frame in position to engage and smooth the leveled surface of the paving material, the arrangement being such that to transport said combined machine said hingedly connected towing arms are disconnected from said spreader frame and folded alongside of said intermediate frame whereupon said hingedly connected intermediate frame together with said folded towing arms and said suspended metering screeds is folded onto said float frame to constitute a compact traveling unit.

7. In a combined paving machine for spreading and finishing concrete in plastic condition to form a slab of pavement between confining side forms; a spreading machine unit comprising a spreader frame adapted to span the site defined by the side forms, wheels on the respective sides of said spreader frame in positions to engage the spaced side forms, spreading mechanism carried by said

spreader frame in position to engage and spread plastic concrete between the side forms, a towing pin projecting from said spreader frame at each side thereof, a towing arm at each side of said frame, each arm having in its forward end a longitudinal slot disposed to receive said associated towing pin in manner to constitute therewith a pin and slot lost-motion mechanism at each side of said spreader frame respectively; a finishing machine unit comprising a finisher frame adapted to span the spaced side forms behind said spreader frame and connected at its sides to said towing arms respectively in manner to be towed by said spreading machine unit, wheels on the respective sides of said finisher frame in positions to engage the spaced side forms, and finishing mechanism carried by said finisher frame in position to engage and finish the surface of the plastic concrete spread by said spreading mechanism of said spreading machine unit, the arrangement being such that should said spreading machine unit become misaligned with respect to said finishing machine unit the lagging side thereof will be relieved of towing force by operation of said associated lost-motion mechanism constituted by said slot in said towing arm moving in cooperating sliding engagement with said towing pin on said spreader frame.

8. In a combined machine for operating along spaced side forms to spread and finish concrete in plastic condition confined between the forms to constitute a pavement slab, a finisher frame adapted to span the space between the side forms, wheels on the respective sides thereof for supporting said finisher frame on the side forms, towing arms extending forwardly from the respective sides of said finisher frame to constitute therewith a rigid structure said towing arms each presenting a towing abutment at its forward end, a spreader frame adapted to span the space between the side forms and disposed ahead of said finisher frame, towing abutments secured to the respective sides of said spreader frame in position to engage with said towing abutments on the forward ends of said towing arms in manner to hook them onto and to interconnect them with the respective sides of said spreader frame, finishing apparatus carried by said finisher frame in position to engage and finish the surface of the concrete between the side forms, wheels on the respective sides of said spreader frame disposed to support it on the side forms, spreading screws carried by said spreader frame at the respective sides thereof in positions to spread plastic concrete between the forms, a source of power mounted on said spreader frame, and power transmission mechanism connected to be driven by said source of power and connected to transmit power to said wheels and to said spreading screws selectively to drive said machine along the forms and to spread the concrete therebetween while towing said finishing apparatus, the arrangement being such that should one of said spreader screws meet with unusual resistance in spreading the concrete to the extent that it tends to cause the driven wheels on the corresponding side of said spreader frame to lag behind the other side thereof, said towing abutment at the lagging side of said spreader frame will become disengaged from its cooperating towing abutment on the corresponding towing arm in manner to relieve that side of the frame of the towing force thereby permitting the full tractive effort of the wheels on that side to overcome the resistance met with by the screw whereby misalignment of the spreader frame with respect to the supporting forms is avoided.

9. In a machine for laying a pavement slab, a frame adapted to span the site of a slab of pavement being laid as defined by spaced side forms, said frame comprising a central section including spaced channels each having edge flanges, an end section including spaced channels likewise each having edge flanges said end section channels being arranged in back-to-back sliding relationship with said central section channels respectively, wheels mounted on said end section in position to engage and roll upon one of the side forms, said end section being movable relative to said central section to align said wheels with the side form through sliding said end section channels along said center section channels, clamps disposed to clamp together said relatively sliding channels said clamps each including a pair of hook-like dogs shaped and disposed to engage said flanges of said respective back-to-back channels said dogs each presenting a bolt receiving opening and the dogs of each clamp pair being oppositely positioned to hook over said opposed flanges of said relatively sliding channels, and a threaded bolt having a tightening nut received within said bolt receiving openings of said dogs of each clamp pair to interconnect them, the arrangement being such that when said nut is tightened upon said interconnecting bolt said dogs of said clamp pair are drawn into clamping contact with said respective channel flanges and said back-to-back channels are thereby clamped together to constitute a rigid frame.

10. In a machine for spreading freshly mixed concrete in plastic condition to form a slab of pavement, a frame adapted to span the site of a pavement slab being laid, running gear supporting said frame for advancing it along the slab site, a concrete spreading apparatus comprising a pair of strike-off members disposed in end-to-end relationship in manner to extend transversely of the slab site beneath said frame in position to strike off plastic concrete spread on the site to form a slab, manually adjustable screw and nut supporting means arranged to suspend the distal end of each of said strike-off members from said frame in manner to provide for adjusting the operating elevations of their outer ends to establish the height of the respective edge portions of the slab being formed, and power operated piston and cylinder supporting means connected to and arranged to suspend the inner proximal ends of said strike-off members from said frame in manner to provide for adjusting the operating elevation thereof by power to establish the height of the center portion of the slab being formed, the arrangement being such that as the machine advances along the site of the pavement slab being laid the height of the center portion of the slab may be changed readily by operating said power operated adjustable supporting means to accommodate the requirements of superelevated curves in the pavement slab and the like.

11. A combined machine for spreading and smoothing freshly mixed concrete in plastic condition to form a pavement slab, comprising a spreader unit including a spreader frame adapted to span a slab site defined by side forms, front and rear wheels mounted in tandem relationship on each side of said spreader frame in position to engage the side forms and support said frame thereon in the manner of a four-wheeled vehicle, a source of power mounted on said spreader frame, means operatively connecting said source of power to said wheels in manner to drive them selectively for advancing said unit along the side forms, spreading screws rotatably mounted on said spreader frame in position to engage plastic concrete placed on the site before said machine for spreading it laterally between the side forms, means operatively connecting said source of power to said spreading screws to drive them selectively in spreading the concrete, a strike-off member carried by said spreader frame behind said screws in position to strike-off the spread plastic concrete thereby to form a pavement slab of the desired thickness, a finisher unit including a finisher frame adapted to span the slab site and disposed to follow said spreader unit, side frame extension members disposed to extend forwardly and rearwardly from the respective sides of said finisher frame, means pivotally connecting the forwardly extending ends of said forward side frame extension members to the respective sides of said spreader unit frame at positions thereon midway between said front and said rear wheels, bogie trucks pivotally connected to the rearwardly extending ends of said rearward

side frame extension members respectively, front and rear wheels mounted in tandem relationship on each of said bogie trucks at positions equally spaced from said pivotal connections with said side frame extension members and positioned to engage the side forms, screeding apparatus including a final finishing screed that is carried by said finisher frame at a position to extend transversely of the slab site midway between the pivotal connections at the forwardly and the rearwardly extending ends of said side frame extension members respectively wherein said final finishing screed of said screeding apparatus is least affected by vertical movement of any wheel in encountering an irregularity in the side form, power transmitting means operatively connecting said source of power on said spreader frame to said screeding apparatus on said finisher frame to reciprocate it in screeding the surface of the slab for establishing its surface elevation and contour, and a smoothing plate suspended beneath said finishing frame behind said screeding apparatus in position to smooth the surface of the slab established by said screeding apparatus as said machine advances along the side forms.

References Cited by the Examiner

UNITED STATES PATENTS

Re. 20,611	1/1938	Nickerson	94—44
1,887,195	11/1932	DeJoy	94—39
2,054,263	9/1936	McCrery	94—45
2,054,436	9/1936	Mosel	94—46
2,358,085	9/1944	Millikin	94—45
2,847,917	8/1958	Heer	94—46
3,015,257	1/1962	Apel	94—45
3,015,258	1/1962	Apel	94—46
3,051,062	8/1962	Apel	94—45
3,137,219	6/1964	Hudis	94—45

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