Aug. 23, 1966 M. I. HUDIS 3,267,824

PAVEMENT LAYING APPARATUS

Filed May 22, 1963 5 Sheets-Sheet 1

FIG. 1.

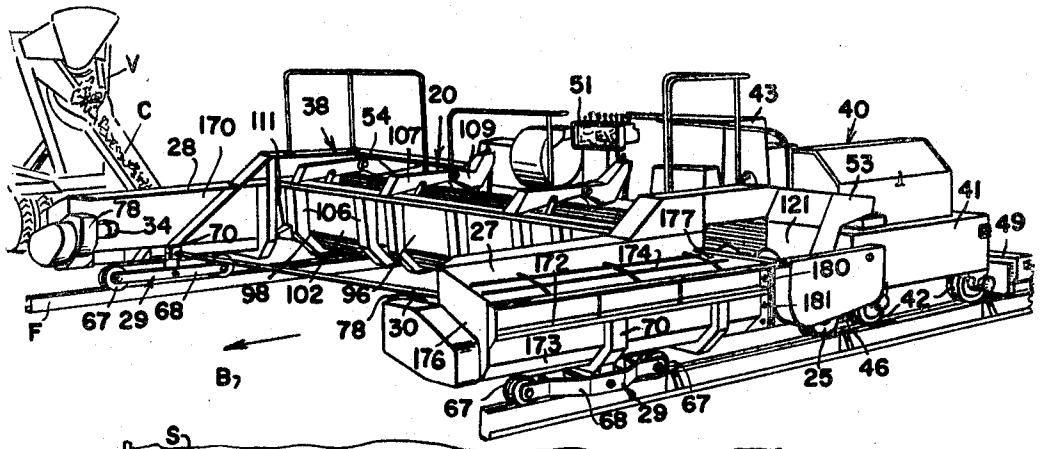
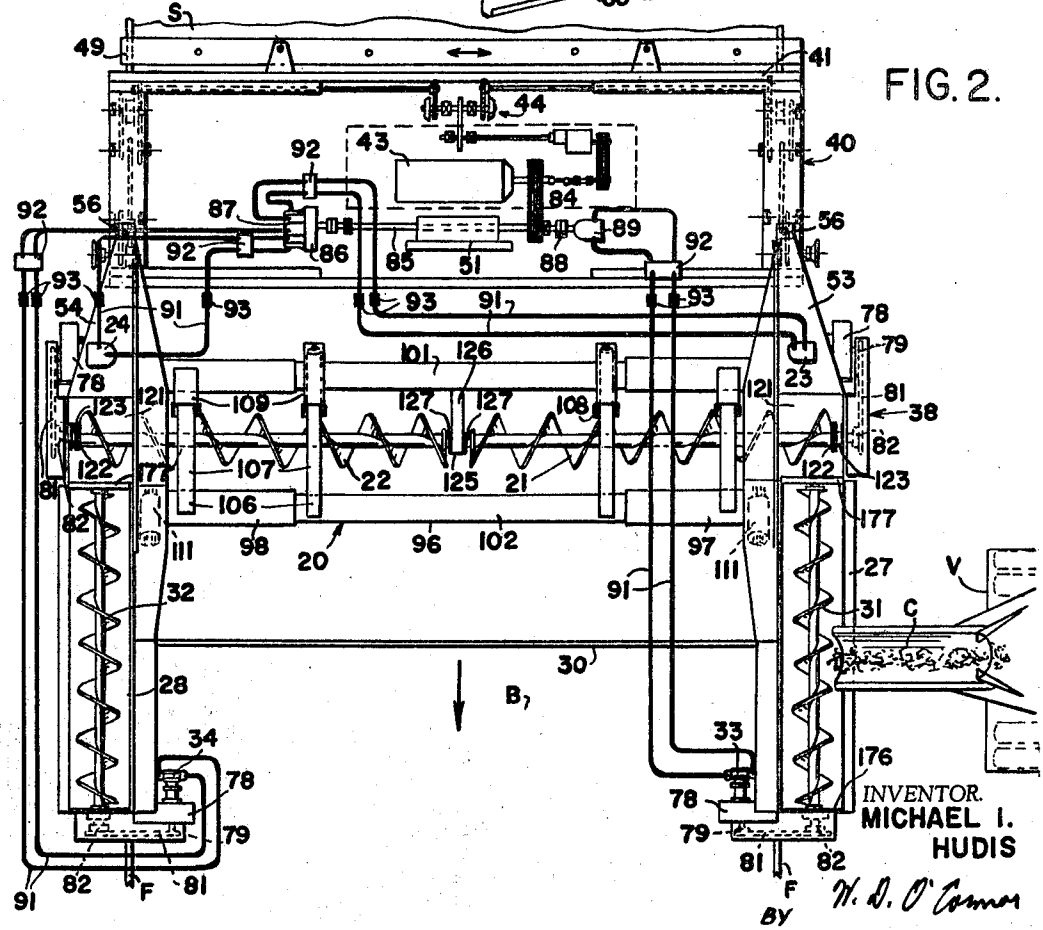


FIG. 2.



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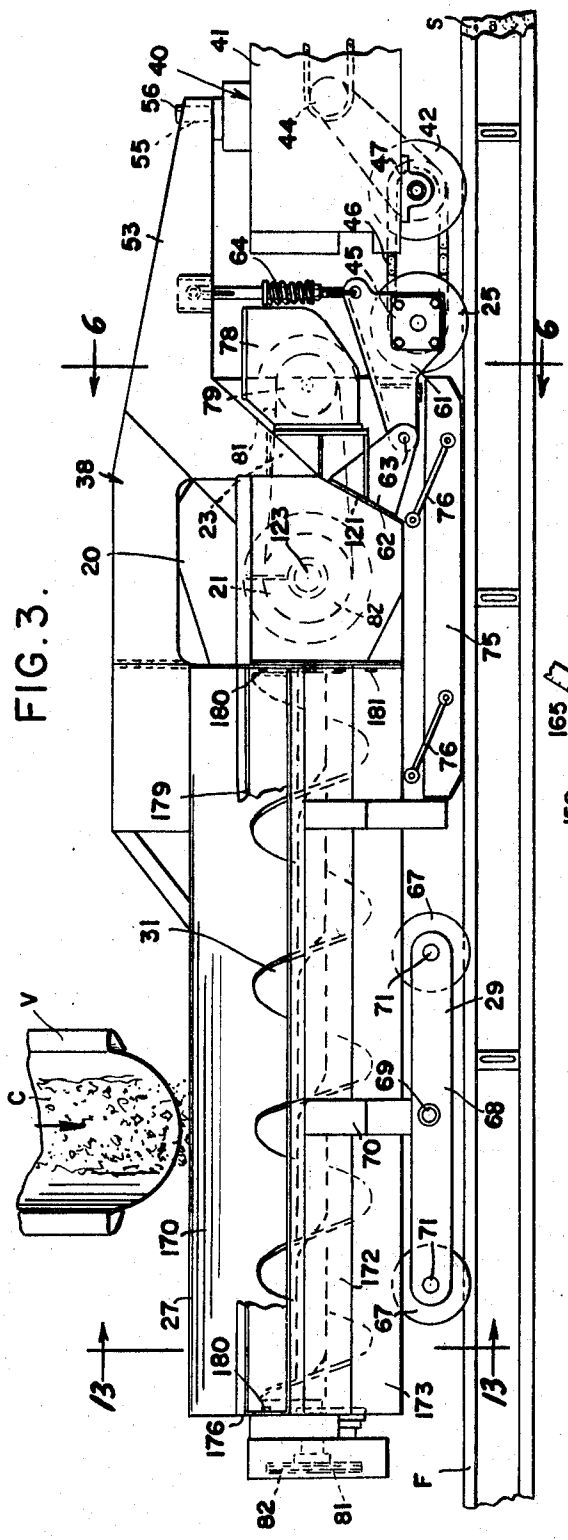


FIG. 3.

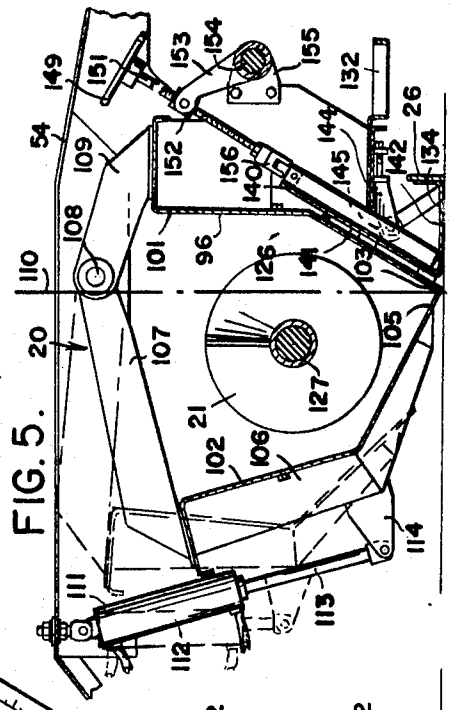


FIG. 5.

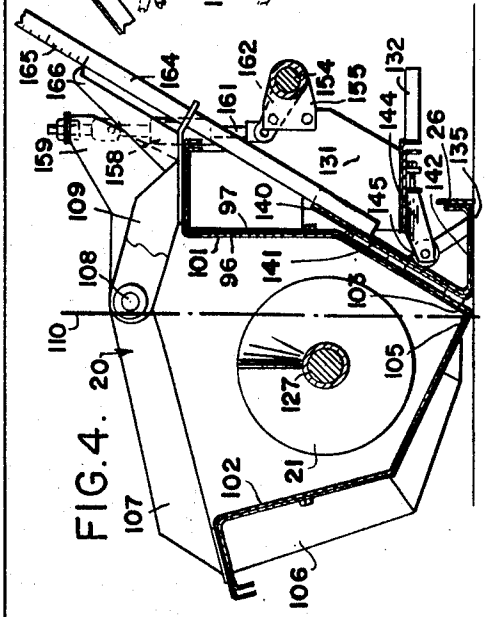


FIG. 4.

INVENTOR.
MICHAEL I. HUDIS

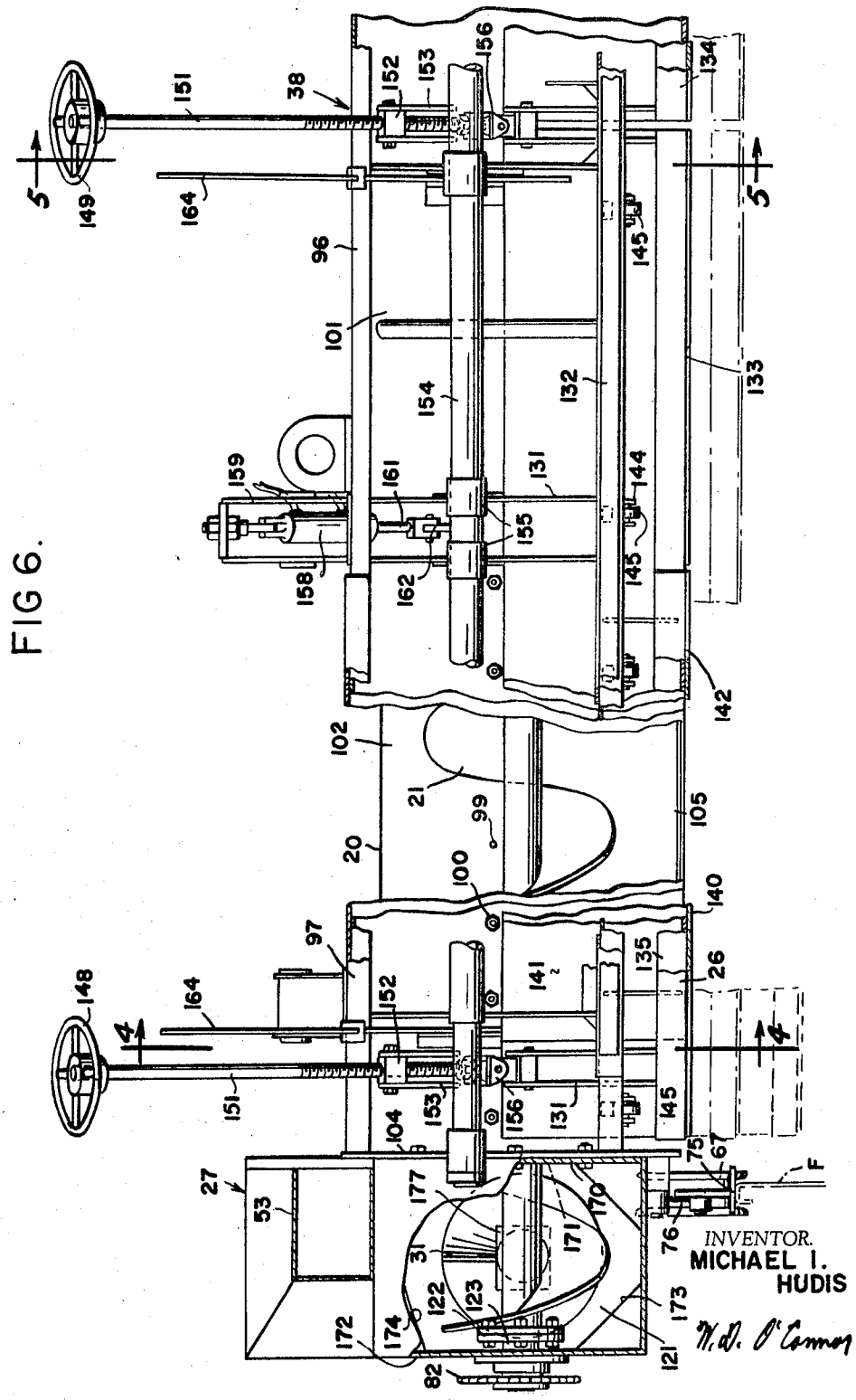
BY W. D. O'Connor

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FIG 6.



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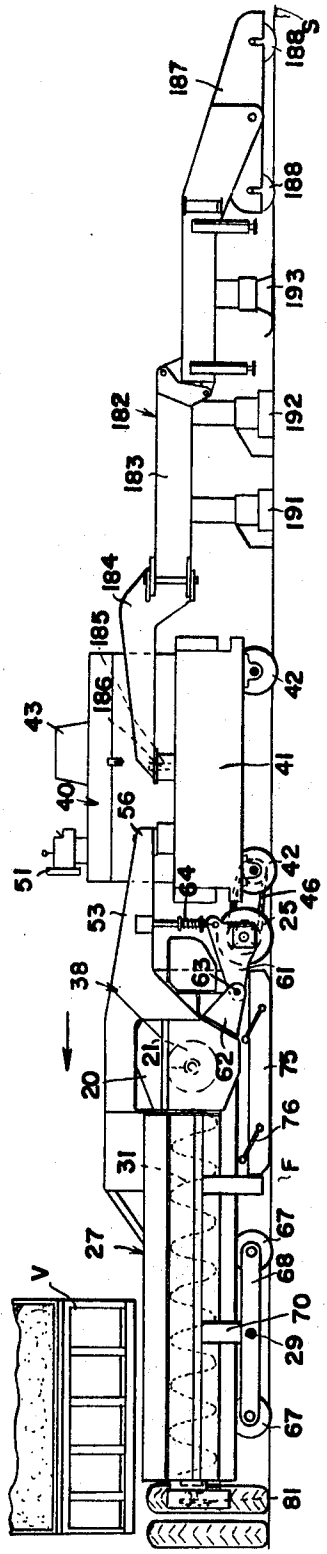


FIG. 7.

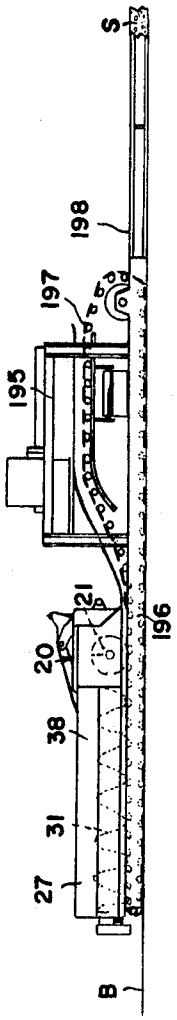


FIG. 8.

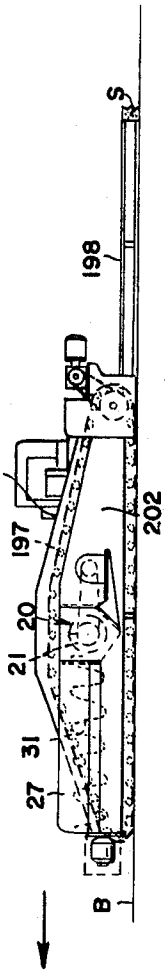


FIG. 9.

INVENTOR.
MICHAEL I. HUDIS
BY
W. D. O'Connor

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FIG. 10.

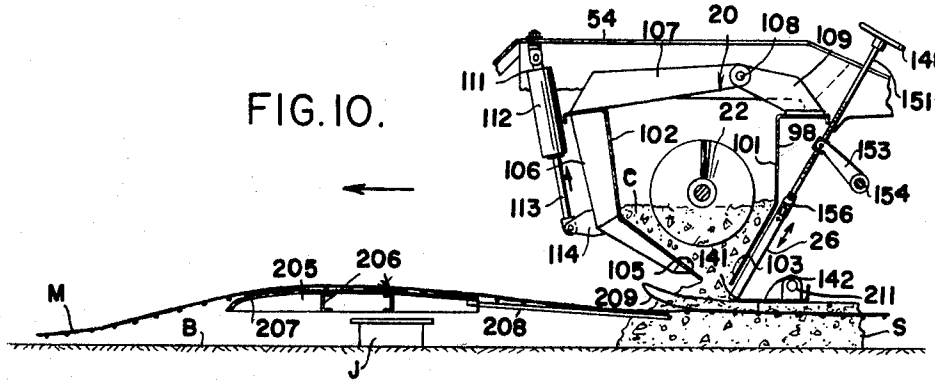


FIG. 11.

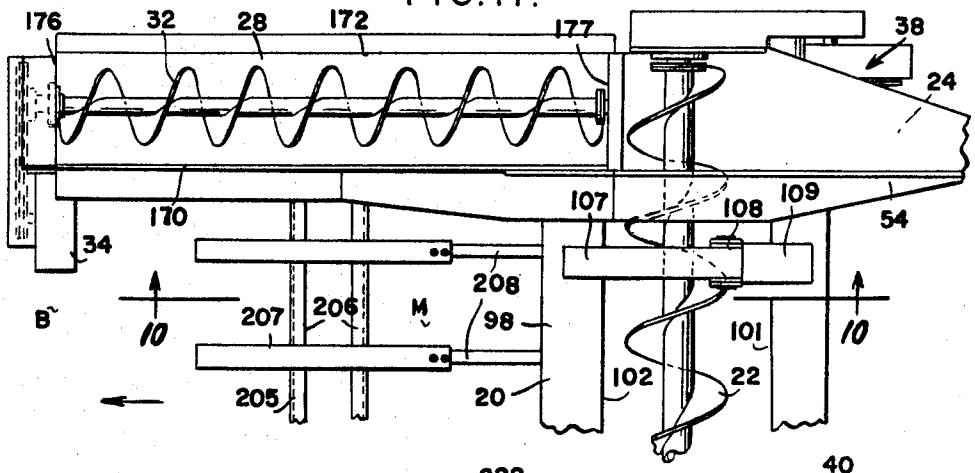


FIG. 12.

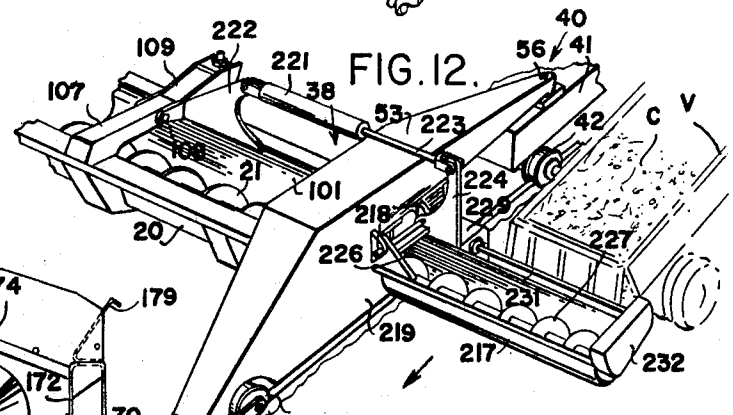
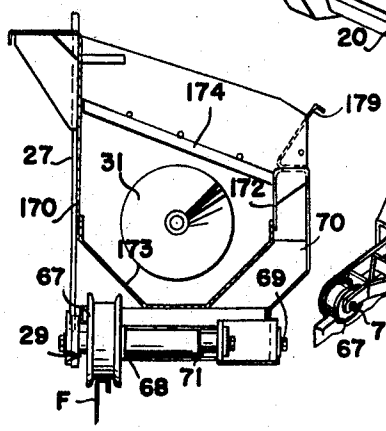


FIG. 13.



INVENTOR.
MICHAEL I. HUDIS
BY W. A. O'Connor

United States Patent Office 3,267,824 Patented August 23, 1966

3,267,824

PAVEMENT LAYING APPARATUS

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

Filed May 22, 1963, Ser. No. 282,295
8 Claims. (Cl. 94—46)

This invention relates generally to pavement laying apparatus and more particularly to new and improved arrangements for expeditiously and uniformly distributing and placing paving material in plastic condition upon a site to form a homogeneous monolithic slab of pavement.

In the placing of paving material such for example as freshly mixed concrete in plastic condition to form a slab of pavement, it is highly desirable that the plastic material be distributed throughout the full breadth of the slab site as expeditiously as possible and with a minimum of disturbance to the intermixed constituent materials. Furthermore, it is required that the material be distributed in a uniform manner to avoid unequal compaction upon the base and it is preferable that the equipment used be capable of moving rather large quantities of the plastic material rapidly and smoothly to its final position in forming the slab thereby to expedite the work. Since hauling vehicles ordinarily used to transport freshly mixed concrete carry heavy loads and operate on close schedules, it is desirable that the placing equipment be capable of receiving and rapidly placing a large volume of the material as fast as it can be discharged from successive vehicles thereby to avoid sustaining at any time the concentrated load of a large mass of material at one side of the machine which might otherwise be injurious either to the machine or to the supporting trackway form.

It is accordingly, a general object of the present invention to provide improved apparatus for distributing and placing paving material in plastic condition to form a slab of pavement.

Another object of the invention is to provide an improved paving material placer that is adapted to accept a full load of freshly mixed concrete poured rapidly from a parked transportation vehicle while simultaneously distributing the concerte expeditiously across the site being paved.

Another object is to provide an improved paving material distributor including a conveyor screw operating in a transverse distributing box, that is adapted to receive plastic paving material in large quantities and to place it rapidly and uniformly in position to form a pavement slab.

Another object is to provide an improved pavement laying machine that is adapted to receive and to transport a heavy load of plastic paving material with the weight of the material so distributed as to avoid exerting excessive forces upon the machine or the supporting trackway structure.

Another object is to provide an improved pavement material placing apparatus that is arranged to receive a full load of the material from a parked hauling vehicle while the apparatus is traveling forward in distributing the load of material upon the slab site.

Another object is to provide an improved pavement laying machine whereby the paving material is applied evenly and continuously upon the site being paved in a manner to avoid uneven compaction of the material on the base.

Another object is to provide improved mesh laying equipment for positioning reinforcing mesh within a monolithic slab of pavement being laid.

Another object is to provide an improved pavement laying method in which the plastic paving material is poured through the reinforcing mesh to embed it and the mesh then is positioned within the material at the required depth.

Another object is to provide an improved pavement laying machine of the slip-form type in which plastic paving material is distributed transversely of the machine between the slip forms by a screw conveyor operating within a spreading trough.

According to the present invention, paving material in plastic condition such as freshly mixed concrete may be handled in large quantities expeditiously distributed across and placed uniformly in its final position upon a prepared base in the form of a broad ribbon or strip that constitutes a pavement slab. This rapid distribution is accomplished by means of improved placing apparatus including a large trough or box constituting a reservoir for plastic concrete that extends transversely of the slab site and that opens along the bottom under operator control to discharge the concrete onto the base as the apparatus moves forward. Within the transverse reservoir or trough there is provided a conveyor constituted by two transfer screws arranged end to end and individually operated for distributing the material transversely along the trough. The apparatus is arranged to receive and distribute plastic concrete as rapidly as it can be delivered to the site by the usual hauling equipment ordinarily employed for that purpose. This expeditious placing of the material is facilitated by auxiliary feeder units that extend forwardly from each end of the transverse trough. Each feeder unit is of such length and capacity that the full load of a parked hauling vehicle may be dumped into it as the placing machine advances without requiring movement of the vehicle from its spotted position. Each of the feeder units is in the form of a trough that houses a longitudinal feeder screw conveyor which feeds the material into the adjacent end of the transverse distributing trough. The feeding and distributing screws are of sufficient capacity to move the material as rapidly as it pours into the feeding trough from the hauling vehicle whereby the material is transferred quickly into the transverse trough and promptly flows down onto the base at it is being distributed transversely by the distributing screws. In this manner, much of the weight of the material is transferred at once to the slab base while in the course of being distributed transversely across the base by the machine. By this arrangement the weight of a full load of heavy concrete is never allowed to be concentrated on one side of the machine and the one line forms that support it. Furthermore, the weight of the material that is being distributed transversely within the machine is likewise distributed longitudinally of the supporting forms by an equalizing arrangement of the several wheels that support the machine on the forms. In distributing the material, the conveyor screws operate also to remix and unify the concrete as it is dumped from the hauling vehicle. Furthermore, as the material is spread transversely, it may be maintained at a substantially uniform depth throughout the width of the slab being formed and therefore is evenly compacted in a manner to promote uniform solidification of the pavement. An adjustable strike-off apparatus operates to limit the rate of flow of the material rearwardly from the trough opening and serves to extrude the pavement slab to the desired thickness and contour as the machine advances along the forms. A separate hydraulic motor is utilized to drive each of the feeding screws and each of the aligned distributing screws the motors all being alike and interchangeable. The motors are provided with control apparatus whereby

each screw may be operated in either direction selectively and independently as may be required in transferring and placing the material. Preferably, a separate hydraulic pump is provided for supplying each motor independently, the several pumps likewise being interchangeable. The machine may be fitted at the rear with the usual transverse screed to smooth the slab surface or the entire placer unit may be incorporated as the forward part of a combined spreading and finishing machine either of the type adapted for operating on forms or of the slip-form type. Furthermore, mesh placing equipment may be provided within the placer unit whereby the concrete flowing from the trough opening pours down through the mesh while held in an elevated position after which the mesh is forced downward to its precise final position in the slab.

The foregoing and other objects of this invention will become more readily apparent upon perusing the following detailed description of embodying apparatus in conjunction with its representation in the accompanying drawing that shows an improved pavement laying machine and modifications thereof illustrative of the invention in its presently modified form, wherein:

FIGURE 1 is a view in perspective of an improved pavement material placing machine embodying the invention and shown mounted in operating position upon spaced side forms that define the site of the pavement slab being laid;

FIG. 2 is a diagrammatic plan view of the improved pavement laying machine shown in FIG. 1, with much of the operating mechanism being indicated schematically;

FIG. 3 is an enlarged fragmentary view in left side elevation of the forward or placing unit of the pavement laying machine shown in FIGS. 1 and 2, part of the propelling power unit having been broken away;

FIG. 4 is a view in longitudinal section through the transverse distributing box of the placing machine, taken on the vertical plane represented by the line **4—4** in FIG. 6;

FIG. 5 is another view in vertical longitudinal section generally similar to FIG. 4 but taken on another plane represented by the line **5—5** in FIG. 6 and showing in broken lines the manner in which the clamshell distributing box opens to discharge material;

FIG. 6 is an enlarged fragmentary view of the left half of the transverse distributing box, partly in rear elevation and partly in transverse section, taken on the plane represented by the line **6—6** in FIG. 3, with parts broken away to show internal structure;

FIG. 7 is a view in left side elevation on a reduced scale of a combined pavement laying and finishing machine in which the apparatus embodying the invention is incorporated as the forward part;

FIG. 8 is a view somewhat similar to FIG. 7 but showing the placing machine of this invention incorporated as the forward part of a paver of the slip-form type;

FIG. 9 is another view generally similar to FIGS. 7 and 8 but showing a modified slip-form paver with the material placing apparatus of this invention integrated into it;

FIG. 10 is a partly diagrammatic view in vertical longitudinal section through the distributing box, generally similar to FIG. 5 but showing in addition improved mesh placing apparatus that may be used in conjunction with the placing machine, the view being taken on the plane represented by the line **10—10** in FIG. 11;

FIG. 11 is a fragmentary plan view of the right side part of the placing machine equipped with the mesh placer shown in section in FIG. 10;

FIG. 12 is a fragmentary view in perspective of the left side part of the placing machine showing a modified form of feeder hopper extending laterally therefrom; and,

FIG. 13 is a view in transverse section through one of the other longitudinally disposed feeder hoppers and its supporting bogie, taken on the vertical plane represented by the line **13—13** in FIG. 3.

The particular improved pavement slab laying machine that is shown in the drawing as the principal embodiment illustrative of the present invention, is especially adapted for distributing and placing large quantities of paving material in plastic condition such as freshly mixed concrete upon the site of a pavement slab being laid. By means of this machine, the freshly mixed concrete or other plastic paving material may be received from either or both sides of the slab site alternately or simultaneously as rapidly as it can be delivered by and discharged from any of the usual material hauling or mixing equipment now in general use in the paving of highways, airport landing strips and the like. As fast as the material is received at the placing machine of the invention, it is distributed and placed expeditiously and uniformly upon the slab site in the form of a molded continuous ribbon or slab of pavement.

This rapid placement of the paving material is accomplished by means of a large transverse conveyor constituted by aligned transfer screws operating within a trough-like box or hopper of clamshell construction that spans the pavement site and is normally open at the bottom to deposit the material upon the ground in a uniform, equally compaced layer without exerting concentrated loads upon the machine as it advances along the site.

As appears in the drawing, according to one well-known method of laying pavement, temporary forms F are laid on the ground in spaced parallel relationship along the sides of a prepared sub-base B constituting the site of a pavement slab S being laid. The forms F define and shape the respective edges of the pavement slab S and are positioned and levelled in such manner that their top surfaces serve as guides to establish the elevation of the top surface of the finished slab. The tops of the levelled forms F serve also as trackways or rails for supporting and positioning whatever machinery may be operated along the site to distribute the paving material and to finish the traffic supporting surface of the slab S to the desired contour at the required elevation.

Referring now more specifically to the drawing and particularly to FIGS. 1 and 2 thereof, the improved pavement laying machine there illustrated as the principal exemplifying embodiment, represents the presently preferred and best mode contemplated for practicing the invention. As shown in the drawing, the improved pavement laying machine is adapted to operate along the forms F as a supporting and guiding trackway and comprises essentially a long open distributing box or placing hopper **20** of trough-like construction that forms a reservoir extending transversely of the sub-base B between the forms F. The transverse distributing hopper **20** is arranged to be opened selectively along the bottom under the control of the machine operator to the extent required to discharge the plastic paving material, such as newly mixed concrete C, upon the sub-base B in the form of a continuous ribbon as the machine advances along the forms F in laying a pavement slab S of the desired thickness.

Within the trough **20**, the transverse conveyor is constituted by two large distributing screws or transfer augers **21** and **22** arranged in axial alignment to distribute the material transversely of the slab site. The two screws **21** and **22** are preferably about twenty-four inches in diameter and they are driven at about fifty-five revolutions a minute by independent hydraulic motors **23** and **24**, respectively, mounted at the opposite ends of the box **20**. By this arrangement, each of the two screws may be operated independently in either direction of rotation selectively under the control of the machine operator for transferring and distributing the plastic concrete C across each half respectively of the sub-base B as

may be required to maintain a substantially uniform depth of the concrete being fed onto the base.

The transverse distributing box or hopper **20** is supported at each end upon the respective spaced forms F by means of a spring mounted flanged track wheel **25**. Along its rear edge, the hopper **20** is provided with an adjustable strike-off mechanism **26** that serves both to regulate the rate of discharge of material from the hopper as the machine advances and to establish the thickness of the slab S. Furthermore, the strike-off **26** may be adjusted to smooth and shape the top surface of the slab S to a required crowned contour.

In order that successive loads of plastic concrete may be received from hauling vehicles expeditiously and more or less continuously, the transverse hopper **20** has connected to its respective ends forwardly extending longitudinal feeding or receiving hoppers **27** and **28** disposed parallel with and above the respective side forms F. The two feeding or charging hoppers **27** and **28** are each about twelve feet long and each is supported upon the associated form F by a bogie truck **29** spaced forwardly of the corresponding spring mounted track wheel **25**. To strengthen the structure, the two parallel feeding hoppers are interconnected by a transverse tie rod **30**.

Within the respective feeding hoppers **27** and **28**, longitudinally disposed transfer augers or feeding screws **31** and **32** are provided for feeding the concrete C rearwardly into the associated outer ends of the transverse hopper **20** for distribution therealong by the transverse screws **21** and **22**. As indicated in the drawing, the feeding screws **31** and **32** are driven individually by hydraulic motors **33** and **34**, each being controlled independently by the machine operator. By this arrangement, the plastic concrete C may be delivered to either or both sides of the sub-base B to be received in either or both of the feeding hoppers **27** and **28**, as the occasion may require, for feeding into the transverse distributing hopper **20**.

The longitudinal feeding screws **31** and **32** are somewhat smaller than the transverse screws **21** and **22** being in this instance about twenty inches in diameter and they operate somewhat faster preferably being driven at about seventy revolutions a minute. Their capacity is sufficient to move the plastic material rapidly into the open transverse hopper **20** as fast as it is poured into the feeding hoppers **27** and **28** from the transport vehicles.

The material handling capacity of the cooperating hoppers and screws is such that when a full load of plastic concrete C is being poured rapidly into the one or the other of the feeding hoppers, the material is carried away by the screws almost as rapidly as it is received and is expeditiously deposited on the slab base B throughout the full length of the open hopper **20**. By this rapid transfer of the material, much of the weight of the concrete C being received is transferred quickly to the sub-base B since it is flowing down through the discharge opening while it is being distributed along the hopper **20**. Furthermore, the portion of the concrete that is supported by the machine is so distributed along that its weight is divided between and sustained by both of the supporting side forms F.

Accordingly, when a full load of up to eight cubic yards of plastic concrete is poured from a hauling vehicle into one of the feeding boxes **27** or **28** at a rapid rate, the material is distributed so quickly that by the time the last of the load is received in the charging hopper much of the first part of the load has already been placed upon the sub-base B. Consequently, the full weight of a load of concrete is never imposed solely upon one side of machine and upon the one side form F that supports it. Furthermore, since the concrete being distributed along the transverse trough **20** is supported to a large extent directly upon the sub-base B, the machine never sustains the weight of a full load of concrete because it is continuously being relieved of the weight of the part of the load that is flowing onto and supported by the sub-base B.

Although the bottom of the transverse box **20** is normally open in order to discharge the plastic concrete as rapidly as it flows into the ends of the box, under some circumstances it may become desirable to close the bottom of the distributing box and then load the machine with the concrete C for hauling it along the forms F. This arrangement may be convenient when it is necessary to place the plastic concrete C in some relatively inaccessible position such as in laying a slab beneath an overhead bridge or out on the deck of a narrow bridge where hauling trucks cannot very well be operated.

When using the machine in this manner, the closed transverse box **20** may be filled from end to end with the plastic concrete and, if desired, the two feeding hoppers may be filled also. The entire machine with its load of up to eight or so cubic yards of concrete may then be moved along the forms F to the position of placement, whereupon the bottom of the box may be opened the required amount and the concrete discharged in the usual way as a ribbon slab while advancing the machine along the forms over the area being paved. This process then may be repeated as often as necessary until the paving operation passes the otherwise inaccessible position whereupon the continuous placing operation may be resumed with the concrete being laid as rapidly as it can be delivered to the machine and charged into the feeding troughs.

As may best be seen in FIGS. 1, 2 and 3, the improved pavement laying apparatus is formed in two distinct and separable sections or units, a forward or distributing section **38** and a rear propelling section or power unit **40** that are detachably connected together. The distributing section **38** is constituted by the transverse distributing hopper **20** together with the attached longitudinal feeding hoppers **27** and **28** and is supported by the spring mounted wheels **25** and the bogie trucks **29**. The cooperating propelling section **40** may assume various forms and in the particular arrangement shown is generally similar to a conventional concrete spreading machine except that it does not have the usual spreader screw and strike-off apparatus which in this combined machine are provided by the forward distributing section **38**.

As shown in the drawing, both the forward section **38** and the propelling section **40** are of the extensible type arranged to permit adjusting the width of the combined machine for operating along the forms of varying spacings within limits of the machine adjustment. The particular machine illustrated in FIG. 1 of the drawing is designed for use in laying pavements from twenty feet to twenty-six feet in width while another model of this machine is adjustable to pavement slab widths varying between twelve feet and eighteen and one-half feet. Obviously, machines having other ranges of adjustment may be provided as required by suitably proportioning the various transverse members and other parts of the machine units.

The power unit **40** comprises a rectangular transverse frame **41** that is supported upon the forms F at its respective corners by flanged traction wheels **42** in the usual manner to constitute a four-wheeled vehicle capable of independent operation along the supporting forms F. The frame **41** of the power unit **40** carries a driving engine **43** that is preferably of the internal combustion type and that is arranged to provide power for propelling and operating the entire machine. The engine **43** is operatively connected by power transmission mechanism **44** of conventional construction to drive the four traction wheels **42** in a manner to move the combined machine along the forms F selectively in either direction at a desired speed.

Means also are provided whereby the engine **43** operates to drive in addition the two spring mounted wheels

25 at the respective ends of the transverse box 20. This is accomplished as best shown in FIG. 3 by providing on each of the spring mounted wheels 25 a sprocket wheel 45 that is operatively connected by a power transmission chain 46 to be driven by a sprocket wheel 47 on the adjacent forward traction wheels 42 of the power unit 40. By this arrangement, each side of the combined machine is provided with three traction wheels which serve to propel the machine along the forms F and that support it in cooperation with the two wheels of the forward bogie truck 29 thereby making a total of five wheels arranged in spaced relationship along each side of the machine.

The power unit 40 may if desired be provided at the rear with an adjustable outboard transversely reciprocating screed 49 that operates in the well-known manner of the usual finishing machine screed for smoothing and finishing the upper surface of the newly laid slab S to the required contour as the machine travels along the forms F. Power for driving the reciprocating screed 49 is derived from the engine 43 through the usual screed driving mechanism in a well-known manner. The engine 43 also furnishes the power for operating the hydraulic motors that drive the feeding screws and the distributing screws as well as the power to provide hydraulic pressure for actuating various other hydraulic operating and control mechanisms on the machine. A centrally located operator's station is provided on the power unit 40 including a control console 51 from which the operator of the machine has control of the various power driven elements of the apparatus.

As appears in the drawing, the arrangement whereby the propulsion section or power unit 40 is mechanically connected to the forward section or distributing unit 38 to push it along the forms F includes a pair of pusher arms or shafts 53 and 54 that are secured to and constitute rearwardly extending elements of the respective feeding hopper structures 27 and 28. As shown in FIG. 2, the arms 53 and 54 are disposed substantially above the forms F and extend rearwardly over and beyond the respective ends of the transverse box 20 to terminate above the end members of the frame 41 of the power unit 40. Each of the pusher arms 53 and 54 is provided at its distal end with a vertically extending opening or socket 55 that fits loosely over an upwardly projecting pin or post 56 rigidly fixed on the associated end member of the power unit frame 41.

The posts 56 at the respective ends of the frame 41 constitute king pins that are pivotally received and loosely fitted in the sockets 55 of the arms 53 and 54 in such a manner that when the power unit 40 advances along the forms F the distributing unit 38 is pushed ahead of it. The cooperating loosely fitted pins and brackets provide a loose jointed lost motion connection between the two units that has a limited degree of flexibility to permit each unit to adjust itself to the forms F being traversed.

Furthermore, these pin and socket connections provide a convenient arrangement whereby the forward unit 38 may be disconnected readily from the pusher unit 40. Thus by simply lifting the forward unit to disengage sockets 55 of the arms 53 and 54 from the king pins 56 and then disengaging the chains 46 and the other power lines, the two units may be disconnected for separate transportation. When thus disconnected, the power unit 40 is self-sustaining through engagement of its four flanged wheels 42 with the forms F and likewise the distributing unit is supported by its wheels 25 and bogie units 29 for independent movement along the forms. When separated in this manner, the two units may be lifted from the forms for separate transportation to another pavement laying site for instance, the distributing section 38 being preferably taken apart by removing the feeding hoppers 27 and 28 from the transverse hopper 20 to facilitate loading for transportation.

As best shown in FIG. 3, each of the spring mounted driven wheels 25 that support the distributing unit 38 near the ends of the transverse hopper 20, is rotatably journalled in a movable wheel housing 61 that is pivotally connected at its forward end by a pivot pin 63 to a bracket 62 that is secured to and projects rearwardly from a part of the adjacent feeding hopper that forms a continuation of each end of the distributing box 20. At its other or rearward end, each wheel housing 61 is pivotally connected to the lower end of a resilient compression spring strut 64 the upper end of which is pivotally connected to the lower side of the associated pushing arm 53 or 54. By reason of this resilient supporting arrangement in the region of each end of the distributing box 20, the maximum load that can be exerted upon the supporting forms F by each wheel 25 is limited to the force exerted by the resilient strut 64. In the particular machine shown, the resilient strut 64 is designed to sustain approximately five thousand pounds and any load in excess of that amount causes the strut to compress to the extent that the pushing arms 53 and 54 bear down upon the end members of the pushing unit frame 41 thereby transferring part of the load to the pushing unit wheels 42 which act in tandem as bogie trucks to further distribute the load along the forms F.

The forward bogie trucks 29 that support the respective longitudinal feeding hoppers 27 and 28 are each provided at each end with a flanged wheel 67 the two wheels of each bogie fitting upon the forms F in tandem relationship. As shown in FIGS. 1 and 3, the two flanged wheels 67 of each bogie truck are journalled in the respective ends of a longitudinal equalizing truck frame 68 which is pivotally mounted at its mid point upon a pivot pin 69. Each pivot pin 69 is carried at the lower end of a strut member 70 one of which depends from each of the two feeding hoppers 27 and 28. By reason of the pivoted equalizing frame 68, the load imposed by each feeder unit is distributed substantially equally between the forward and rear wheels 67 of each bogie truck and is thereby imposed upon the forms F at spaced position some distance from the other wheels 25 and 42.

As may be seen best in FIG. 13, each bogie truck wheel 67 is rotatably mounted on a supporting axle 71 that extends through and is fixed in the end of the associated bogie frame 68. The wheels 67 are mounted loosely on the respective axles 71 in a manner to provide for limited endwise floating movement thereby to accommodate minor sidewise movements of the feeding hoppers relative to the forms F that may occur for instance when negotiating a curved section of the slab site defined by the forms.

By this arrangement, the five separate wheels that support each side of the combined machine upon the corresponding form F are spaced along the form from end to end of the machine as best shown in FIG. 1 in a manner adapted to distribute the weight of the machine and its load of concrete over a considerable length of the supporting form structure. Furthermore, the bogie and spring mounted arrangements for the several wheels are adapted to equalize the loads between the various wheels in such manner that a heavy load of concrete may be carried by the machine without imposing excessive individual wheel loads upon the forms F.

As previously mentioned, three of the five wheels on each side of the machine are traction wheels driven by the engine 43, steering clutches and brakes being provided in the driving mechanism 44 in a well-known manner in order that the wheels on either side of the machine may be stopped momentarily while the wheels on the other side continue to rotate thereby enabling the operator to steer the machine for correcting its alignment upon the forms F whenever that may become necessary. Although flanged wheels are shown in the drawing, it is to be understood that they may be replaced by rubber tired wheels or the like for use under special circumstances.

In order to prevent plastic concrete descending from the hopper **20** from being deposited upon or flowing over the tops of the forms F thereby interfering with the wheels, there is provided just ahead of each spring mounted wheel **25**, a form shoe or shield **75** that is resiliently supported by spaced spring arms **76** beneath each of the feeding hoppers **27** and **28** in position to slide along the top of the form F

The propulsion engine **43** provides power for driving the feeding and transverse screws by means of a hydraulic transmission system that is indicated schematically in simplified form in FIG. 2 of the drawing. As previously mentioned, the two distributing screws **21** and **22** are driven by the hydraulic motors **23** and **24** at the respective ends of the transverse trough **20**. Likewise the two feeding screws **31** and **32** are driven by the hydraulic motors **33** and **34**, respectively, mounted at the forward ends of the feeding troughs **27** and **28** The four hydraulic motors **23**, **24**, **33** and **34** are identical and interchangeable and each is connected by means of a speed reducing mechanism **78** to drive a sprocket **79**. From the sprocket **79** a chain **81** transmits power at reduced speed to a large sprocket **82** operatively connected to the end of the associated screw. Pressure fluid for operating each of the motors is supplied from a separate pump, the four pumps likewise being identical and interchangeable and all being driven by the engine **43**.

As shown in FIG. 2, a belt drive **84** connects the engine **43** to a jack shaft **84**. At the left end of the jack shaft, as viewed in FIG. 2, a gear box **86** is provided and this is connected to and drives a group of three pumps **87** that are shown as connected respectively to drive the motors **23**, **24** and **34**. At the other end of the shaft **84**, a coupling **88** effects a disengageable connection with a fourth pump **89** that in this instance is connected to drive the motor **33**. Each pump is connected to its respective motor by a separate hydraulic system including a pair of hydraulic lines **91** that pass through a control valve **92**. Where the lines cross from the power unit **40** to the distributor unit **38** they are of flexible material and are provided with quick disconnecting couplings **93**. The control valves **92** are indicated diagrammatically in the drawing on the respective hydraulic lines but they are actually all mounted in the console **51** for convenient manipulation by the machine operator.

By this arrangement, if plastic concrete is being fed into the machine as indicated in FIG. 1 from a transit mixer or similar hauling vehicle V that discharges only into the feeding hopper **28** at the far side of the machine, the feeding hopper **27** will not be used. When only the feeding hopper **28** is being used, the other hopper **27** does not require power and its driving pump **89** may be disconnected by disengaging the coupling **88**. The three pumps **87** will then operate the motor **34** driving the feeding screw **32** in the hopper **28** and the two motors **23** and **24** driving the distributing screws **21** and **22**. In the event that instead of charging into the hopper **28**, the feeding hopper **27** is being used as indicated in FIG. 2, the conduit connections at the pumps can be changed readily to provide for driving the hydraulic motor **33** from one of the three pumps **87** instead of from the pump **89**.

When the concrete is being delivered from both sides of the slab site, the coupling **88** is engaged and all four pumps are utilized to drive the four screws respectively. Since each pump is controlled by an independent valve **92**, each motor may be started and stopped and operated in either direction selectively and entirely independently of the other motors. It is to be understood that the hydraulic system includes the usual fluid supply tank (not shown) to which the several pumps are connected through the various control valves **92** in a well-known manner. When the two units **38** and **40** of the combined machine are being prepared for transportation, the disconnecting couplings **93** in the flexible conduits **91** are all uncoupled to permit separation of the two sections.

Since all of the four screw driving motors are interchangeable and likewise all of the four pumps are interchangeable, it is possible to provide for continued operation of the machine should any one of the pumps and/or any one of the motors become disabled. In that event the other motors may be shifted about and/or the pumps reconnected to enable the machine to continue operating although it will then be capable of receiving concrete from only one side of the slab site. For example, if one of the two motors **23** or **24** driving the two distributor screws should require repair, it may be replaced with either the motor **33** or the motor **34** taken from one of the feeding hoppers. The machine then can continue to operate, the concrete being fed only into the other feeding hopper until the disabled motor can be repaired or replaced.

The power unit **40** is furthermore provided with the usual pump (not shown) that is driven by the engine **43** for supplying hydraulic pressure to various other hydraulically operated and controlled apparatus in the usual manner.

The transverse distributing hopper or trough **20** constitutes in effect the main frame or backbone tying together the feeder troughs **27** and **28** to form the distributing section **38** of the placing machine. In order that the machine may be extensible as previously indicated, the distributing trough **20** is made up of telescoping sections. As best shown in FIGS. 2 and 6, the trough or box **20** is constituted by a central section **96** to which is slideably fitted extensions or end sections **97** and **98** that are connected at their outer ends to the feeder troughs **27** and **28** respectively. Where the central section and the end sections overlap, they are provided with lines of matching bolt holes **99** preferably spaced at six inch intervals. By sliding the end sections **97** and **98** along the central section **96**, the width of the machine may be adjusted by six inch increments throughout the full range of adustment. After the adjustment has been effected and the bolt holes in the overlapping areas brought into alignment, coupling bolts **100** are passed through the aligned holes and tightened to clamp the sections together in a manner to form a rigid unitary transverse beam member spanning the distance between the side forms F.

When thus bolted together, the transverse hopper or box **20** is constituted essentially by a fixed rear or back wall **101** and a cooperating relatively movable front wall **102** that forms a clamshell type gate or movable jaw to provide for opening the trough along the bottom selectively in order to discharge plastic concrete onto the base B.

As may be seen best in FIGS. 4 and 5, the back wall **101** of the hopper **20** is formed in its upper part as a substantially vertical plate. At its upper edge the vertical rear wall plate is bent rearwardly and then downwardly to form a top beam flange whereby the back wall constitutes in effect a transverse structural beam forming the principal element of the main frame of the distributing unit **38**. In its lower portion, the back wall **101** is bent forwardly to slope downwardly and forwardly at an obtuse angle with its lower edge constituting a horizontal discharge lip **103**. The lower edge of the plate that forms the discharge lip **103** is positioned about five inches above the level of the forms F in order to provide adequate room for the discharge of concrete thereunder when the following strike-off member **27** is adjusted to form a crown in the center of the slab being laid. As may be seen in FIG. 6, the respective ends of the back wall **101** are provided with flanges each of which is secured by bolts **104** to the adjacent feeding hopper **27** or **28**.

The forward wall **102** of the trough **20** that forms the movable jaw of the clamshell hopper is spaced forwardly from the back wall and is constituted by a plate that is disposed more or less vertically in its upper portion and that is bent at its top edge to extend forwardly and then downwardly to provide a stiffening upper beam flange. The lower portion of the front wall plate is bent rearwardly to slope downwardly at an obtuse angle in such

manner that its lower edge or lip **105** engages the discharge lip **103** of the back wall when the clamshell is in closed position as shown in the drawing. The front wall **102** is provided on its outer forward surface with a series of spaced, vertically disposed reinforcing elements **106** that serve to prevent bending of the wall plate when subjected to the weight of a load of concrete in the hopper **20**.

Along its upper edge, the front wall **102** is provided with a series of spaced rearwardly extending pivot arms **107**, the arms each being preferably secured to the top flange of the front wall plate in alignment with the top of one of the vertical reinforcing members **106**. In the particular machine shown, four of the pivot or hinge arms **107** are utilized, the center two of the arms being in the region of the central section **96** of the trough **20** while the outer arms **107** are at the outer ends of the extensible end sections **97** and **98** respectively, as may best be seen in FIG. 2.

As appears in FIGS. 4 and 5, each of the hinge arms **107** extends rearwardly over the trough **20** to a position slightly to the rear of the discharge lip **103** of the back wall **101**. At their distal ends, the pivot arms **107** are hingedly connected by axially aligned horizontal pivot pins **108** to a series of forwardly projecting brackets **109**, respectively, each of which is secured to the top flange of the back wall **101**. With the front wall pivoted in this manner upon a horizontal axis disposed rearwardly of a vertical plane represented by the broken line **110** in FIGS. 4 and 5 through the discharge lip **103**, when the front wall or jaw **102** is moved toward open position by pivoting it upon the pins **108** its lower lip **105** moves upwardly as well as forwardly thereby lifting above the level of the discharge lip **103** as it moves away to permit the concrete to discharge from the hopper in a downward and forward direction. Furthermore, this upward movement of the front wall keeps its inwardly sloping lower portion close to the distributing screws to facilitate movement of the concrete along the hopper **20**.

This clamshell action provides a longitudinal discharge opening in the bottom of the transverse distributing hopper **20** of sufficient width for discharging concrete onto the base B as rapidly as required in forming the slab S. In this machine the discharge opening thus provided between the fixed discharge lip **103** and the cooperating movable lip **105** may be as much as fourteen inches. The width of the opening is under the control of the machine operator and it has been found that under most circumstances an opening considerably narrower than the full width is sufficient to provide for controlled discharging of the concrete as rapidly as it may be required to form the slab S as the machine advances.

Movement of the front wall **102** in opening the clamshell gate is effected by power through operation of a pair of hydraulic actuators **111**, one actuator being arranged at each end of the hopper **20**. As shown in FIG. 5, each actuator includes a double acting cylinder **112** that is pivotally suspended at its closed upper end from the interior of the adjacent pusher arm **53** or **54** that extends over the end of the hopper. A piston rod **113** extending downward from the lower end of the cylinder **112** is pivotally connected at its lower end to a bracket **114** that projects forwardly from the lower portion of the front wall **102** near its end adjacent to the feeding hopper.

Hydraulic pressure for operating the two actuators **111** at the respective ends of the front wall **102** is derived through the control console **51** from the fluid pressure pump that is driven by the engine **43** in the usual manner, as previously indicated. By actuating appropriate valves on the console **51**, the machine operator may raise or lower the front jaw member **102** to open or close the hopper **20** in a well-known manner. The hydraulic control system is preferably so arranged that when the clamshell hopper is opened to provide a discharge opening of desired width the jaw gate may be locked in its adjusted position by preventing flow of hydraulic fluid to or from the cylinder **112** thereby retaining the adjustment.

The transverse distributing screws **21** and **22** each extend outward beyond the ends of the distributing hopper **20** into complementary hopper extension elements **121** that are formed within the feeder hopper structures **27** and **28** and that are closed at the bottom but open at the inner side for discharging into the end of the hopper **20**. Within the hopper extensions **121** the shaft of each transverse screw **21** and **22** is connected at its outer end by a detachable coupling **122** to the inner end of a stub shaft **123** that extends through and is journalled in the outer wall of the associated feeding hopper. The outer end of the stub shaft **123** carries the sprocket **82** that serves to drive the screw, the arrangement being such that by disconnecting the coupling **122** the transverse screw may be uncoupled from its supporting stub shaft **123** to provide for dismantling the apparatus when necessary.

At its inner end, each of the screws **21** and **22** is journalled in a self-aligning bearing **125**, the bearings being carried by a bracket **126** that projects forwardly from the back wall **101** of the trough **20** at the center of tthe central section **96**. The central bearings **125** receive the ends of screw shafts **127** that are telescopically fitted within the shafts of the screws **21** and **22** to provide for widening of the machine. When the machine is widened and the shafts **127** drawn out of the screws, additional screw flights may be clamped to the shafts **127** to lengthen the screws in a well-known manner.

As best shown in FIGS. 4, 5 and 6, the back wall **101** of the distributing box **20** is provided on its rear or outer surface with spaced vertically disposed reinforcing members **131**. At their lower ends, the vertical members are connected to a flat horizontal reinforcing beam **132** that extends transversely along the back of the hopper **20** and that operates also to reinforce and support the adjustable strike-off member **26**.

The strike-off member **26** is extensible with the trough **20** and for this purpose it is provided with a central section that is associated with the central section **96** of the trough. As best shown in FIG. 6, the central section of the strike-off member **26** is divided at the midpoint of the hopper **20** into two hingedly connected elements **133** and **134** in order to provide for deflecting the strike-off member **26** at the center to form a crown on the highway slab being deposited as hereinafter described in greater detail. End sections **135** of the strike-off **26** are telescopically fitted on the ends of the central sections **133** and **134** and are associated respectively with the end sections **97** and **98** of the trough **20**.

As shown in FIGS. 4 and 5, each of the two hingedly connected half sections of the strike-off member **26** is constituted by a plate **140** presenting a forward surface **141** that is disposed adjacent to and parallel with the forwardly inclined lower portion of the fixed back wall **101** of the hopper. At its lower end, the plate **140** is bent rearwardly to form a horizontal screed surface **142**. The forward surface **141** of the plates operates as a bulldozer to strike off the plastic concrete flowing down over the discharge lip **103** of the hopper **20** at a desired elevation depending upon the adjustment of the strike-off member **26**. The rearwardly extending horizontal screed surface **142** tends to smooth the top of the slab at the elevation struck off by the forward surface **141** and is of sufficient width to prevent the deposited concrete from surging upward behind the strike-off **26** as the result of hydrostatic pressure imposed by the downwardly flowing plastic concrete in the hopper **20**.

To provide sufficient forward thrust for striking off the plastic concrete, the horizontal reinforcing beam **132** is equipped at spaced intervals along the strike-off **26** with forwardly projecting brackets **144** each of which carries at its forward end a roller **145** that bears against the back of the plate **140** behind the strike-off portion **141** of the strike-off element **26**. The rollers **145** push the strike-off

plate **140** into the plastic concrete in the manner of a bulldozer blade while also providing for vertical sliding movement of the strike-off member **26** in effecting adjustments thereof.

As previously mentioned, the discharge lip **103** of the distributing trough is in this machine spaced about five inches above the level of the forms F. As shown in FIGS. 4 and 5, the screed **142** forming the bottom of the strike-off **26** has been elevated to a position at the level of the discharge lip **103**. The adjusting arrangement for the strike-off **26** is such that when laying the usual slab in one course, the strike-off may be moved downward five inches to the tops of the forms F and may be deflected upward at its center as much as three inches or more to form a crown at the center of the slab. Furthermore, when laying concrete pavement in two courses, the strike-off **26** may be moved downward a further amount to the extent of about four inches below the tops of the forms F for striking off the first course at a selected elevation adapted to position reinforcing mesh.

When operating at any selected elevation, the strike-off mechanism **26** serves to meter the flow of concrete from the distributing box **20** and also acts as an extrusion plate to mold the top surface of the slab to the desired contour at the required elevation. Although the usual crown provided in the center of the slab is ordinarily about three inches in height, the strike-off apparatus can be adjusted to provide a crown of five or six inches in height if this is required. Furthermore, the strike-off **26** can be redesigned readily to provide for striking off the slab at either a higher or a lower elevation than has been shown and described herein.

As indicated in FIG. 6 of the drawing, each end of the strike-off member **26** is provided with an adjusting hand wheel **148** and another hand wheel **149** is provided at the center of the strike-off for effecting adjustment of the crowning action. The respective hand wheels **148** and **149** are mounted on the upper ends of threaded shafts **151** which operate in complementary nuts **152**. The threaded nuts **152** are pivotally mounted at the forward ends of actuating arms **153** projecting forwardly from a torque shaft **154** that is journalled in bearings **155** supported on the rear edges of the vertical reinforcing plates **131** at the back of the hopper **20**.

The lower ends of the two threaded shafts **151** at the respective ends of the strike-off **26** are connected by rotary swivel joints **156** to the upper edge of the plate **140** that constitutes the forward surface **141** of the strike-off member **26**. When the hand wheels **148** are turned to rotate the threaded shafts **151** in the nuts **152**, the respective ends of the strike-off plate **140** may be raised or lowered as desired to adjust the exact position of the strike-off **26** relative to the slab defining forms F, both ends of the screed being ordinarily adjusted to substantially the same elevation. The lower end of the threaded shaft **151** at the center of the strike-off **26** is connected to the upper edge of one of the plates **140** in the region of the hinged connection between them. When the center hand wheel **149** is turned, the hingedly connected central section of the two screed halves **133** and **134** may be adjusted upwardly to a position higher than the ends of the screed thereby providing for forming a peaked crown upon the pavement slab of selected height.

When it is desired to raise or lower the strike-off member **26** bodily without changing its crown adjustment, the three threaded shafts **151** may be lifted simultaneously through operation of the actuating arms **153** by turning the torque shaft **154**. This is accomplished by means of two hydraulic actuators **158** that are suspended from brackets **159** that project rearwardly from the top flange of the rear hopper wall **101** in alignment with the respective pivot arms **108** on the central section **96** of the trough **20**. Piston rods **161** depending from the actuators **158** are pivotally connected at their lower ends to actuating arms **162** fixed on and projecting forwardly from the torque shaft **154** as best shown in FIG. 4.

Hydraulic pressure may be admitted to both of the actuators **158** through operation of valves in the console **51** in a well-known manner to extend or retract the piston rods **161** simultaneously thereby turning the shaft **154** to lower or raise the strike-off **26** for moving it between its various operating and nonoperating positions. After the strike-off **26** has been moved bodily to a selected operating position by the hydraulic actuators, the hand wheels **148** and **149** may be turned manually as required to effect and maintain precise adjustment of the ends and center of the screed element **142**. If desired, similar hydraulic actuators may be substituted for the hand wheels **148** and **149** and their associated mechanism in order that all positioning and crowning adjustments of the strike-off may be accomplished by remote control from the console **51**.

A gauge bar **164** is connected and extends upward from the upper edges of the strike-off plates **140** at each end of the strike-off **26** and at its center as indicated in FIGS. 4 and 6 of the drawing. Each gauge bar **164** is provided at its upper end with indicia **165** which cooperate with a pointer **166** fixed on the flange of the back wall **101** of the distributing trough. By reading the indicia **165** against the pointer **166**, the position of each end and of the central section of the screed may be ascertained to serve as a guide in adjusting the screed elevation and the extent of the crown for forming the slab as desired.

As previously indicated, each of the feeding hoppers **27** and **28** is secured to a flange on the associated end of the back wall **101** of the transverse distributing box **20** by means of a series of bolts **104**. The two feeding hoppers **27** and **28** are symmetrical in construction, each presenting an inner wall plate **170** through which the bolts **104** extend to secure the feeding hoppers to the transverse hopper wall **101**. Each side plate **170** is provided with a large opening **171** in alignment with the transverse hopper **20** as best shown in FIG. 6 in connection with the feeding hopper **27**. The opening **171** is of sufficient size to admit the end of the associated distributing screw **21** and constitutes a passageway for concrete moving from the hopper extension area **121** into the distributing trough **20**. The distributing hopper extension **121** forms the closed discharge end of the feeding hopper **27**, for example, the distributing trough **20** being open at the bottom to place the concrete on the base B.

The other or outer side of each feeding hopper is constituted by an outer side plate **172** that is somewhat lower than the inner side plate **170** to facilitate charging the hopper from the outer side of the machine. As may be seen best in FIG. 13, the bottom of the hopper is constituted by a plate **173** that is bent upwardly at each side to join the lower edges of the the side plates **170** and **172** thereby forming a trough in which the screw **31** operates. The upper edge of the hopper **27** is flared outwardly as shown in the drawing to receive the plastic concrete and above the screw the hopper is provided with a guard grill or grate **174** as a safety measure.

The strut **70** which extends downward to carry the bogie truck **29** serves also as a reinforcing member that stiffens the bottom plate **173** of the hopper in supporting the weight of the concrete. The associated pusher arm **53** is connected to and extends rearwardly primarily from the inner side plate **170** of the hopper. The forward end of each feeding hopper is closed by a front plate **176** that serves also to support the drive mechanism for the feeding screw and the bearing for the front end of the screw shaft. The other end of the screw shaft is journalled in a transverse brace or bracket **177** extending from side to side near the forward side of the distributing hopper extension **121**.

As best shown in FIG. 3, the upper part of the outer side plate **172** of each feeding hopper is constituted by a removable section **179** that is secured at its ends to the

ends of the hopper by bolts **180**. Upon removing the bolts **180**, the side pieces **179** may be detached in order that the outer side wall **172** may be reduced in height to better accommodate certain types of hauling vehicles that may be used to charge the hopper with plastic concrete.

The two screws **31** and **32** in the feeding hoppers **27** and **28** are right hand and left hand respectively in order that when feeding concrete rearwardly they turn in the proper direction to facilitate the flow of concrete inwardly through the opening **171** into the distributing trough **20**. In the event that the placing machine is to be used for paving operations in which material is to be delivered to the machine along only one side of the base B, the machine may be equipped with only one feeding screw and its associated driving mechanism on the side of the machine that is to receive the concrete.

Each of the feeding hoppers **27** and **28** is arranged to be removed readily in order to reduce the size of the distributing section **38** for transportation from one to another job site, as previously mentioned. For this purpose, the forward part of each feeding hopper is connected to the rearward part or distributing hopper extension **121** by a series of removable bolts **181** that pass through matching flanges on the respective hopper parts. After the distributing section **38** has been disconnected from the power section **40**, the bolts **181** may be removed and the forward parts of the feeding hoppers **27** and **28** detached. As shown, the bolted flanges are disposed just rearwardly of the transverse bracket **177** that carries the rearward end of the feed screw shaft. By this arrangement, when the forward parts are removed the feed screws are carried with them in their bearings and likewise the transverse screws remain in their bearings within the transverse part of the distributing section.

The charging area presented at the top of each of the feeding hoppers **27** and **28** is approximately twelve feet long. When laying a pavement the placing machine travels along the forms F at a substantially constant, slow speed as it places the concrete continuously upon the base B. Likewise, the plastic paving material being placed is charged into one or both of the feeding hoppers, more or less continuously. To this end, successive hauling vehicles such as the vehicle V, may be spotted at the side of the paving site as shown in FIG. 1 in position to discharge into the forward end of the feeding hopper. As the plastic concrete is charged into the hopper, the placing machine continues its forward movement relative to the stationary vehicle V. The feeding hopper, however, is of such length that the entire load of the hauling vehicle V may be discharged into the hopper while the placer is moving forward relative to the parked vehicle without the necessity of changing the position of the vehicle. When the empty vehicle moves away, another hauling vehicle V is brought into position to discharge into the forward end of the hopper and the operation continued with the plastic concrete being fed into either hopper or into both hoppers simultaneously as may be convenient. In this manner, the paving material may be delivered to the placing machine as rapidly as the hauling vehicles can be discharged into the hoppers **27** and **28**, the forward travel of the machine being limited only by the rate at which the paving material can be delivered to it and dumped into the feeding hoppers.

As previously mentioned, the feeding screws **31** and **32** move the material rearwardly and inwardly into the transverse hopper extensions **121** in the ends of the feeding hoppers and through the openings **171** with the distributing screws **21** and **22** carrying the material along the transverse hopper **20**. The action of the screws in moving the plastic concrete operates to remix the material and thereby overcomes any segregation of ingredients that may have occurred in the material while being transported in the hauling vehicle. As rapidly as the material is moved from the hopper extension **121** through the opening **171** into the distributing hopper **20**, it is spread transversely of the site and at the same time flows downward through the open bottom of the hopper onto the base B. Through proper operation of the distributing screws **21** and **22**, the material flowing downward through the hopper **20** may be maintained at a substantially uniform depth throughout the width of the slab being laid.

By maintaining the depth of the concrete in the hopper substantially constant, the weight of the material bearing down on the base B is substantially uniform at all times and, therefore, the material as it is formed into the slab S is compacted uniformly and solidifies into a uniform, level homogeneous structure. Furthermore, the uniform depth of material provides a constant hydrostatic head upon the concrete being leveled by the strike-off **26** thereby avoiding surging of the plastic material behind the strike-off. While the material in the lower part of the transverse trough **20** is moving downward onto the base B, the material above it is being distributed transversely of the base and along the trough **20** by the screws **21** and **22**. Since the screws are some distance above the base B, the force required to move the material transversely is not transmitted to the base in any appreciable amount but is exerted as friction upon the inner surface of the trough. Accordingly, the reaction to this force is not exerted against the forms F but rather is absorbed within the structure of the transverse trough itself. As a result, no racking forces are exerted upon the forms F when reversing the screws **21** and **22** in distributing the material transversely of the slab site.

As may best be seen in FIG. 10, the concrete C flowing down through the open bottom of the trough **20** tends to roll forwardly from the discharge opening. To control the flow of material, the movable forward wall or jaw **102** of the clamshell trough is adjusted to provide a discharge opening of a width best suited to the proper discharge of the material. Also in FIG. 10 it may be seen that the strike-off member **26** limits the flow of material rearwardly from the hopper to the amount required to form the slab S of the desired thickness. Furthermore, the screeding surface **142** of the strike-off member operates to extrude the slab S onto the base B and prevents upward surging of the material flowing under the strike-off **26**.

After the plastic material has been struck off and smoothed by the screeding surface **142**, it is further smoothed and finished by the operation of the transverse screed **49** and any other finishing apparatus that may be applied subsequently to smooth the traffic supporting surface of the slab. To this end, the placing machine of this invention may if desired be combined with other apparatus such as a surface finishing machine of the screed and float type as shown in FIG. 7.

The combined placing, transverse screeding and float finishing machine shown in FIG. 7 includes a finishing section **182** that is disclosed and claimed in copending application Serial No. 180,141 filed March 16, 1962, and entitled "Pavement Laying and Finishing Apparatus." Through operation of this combined equipment as a unit, a slab of pavement may be completely laid and finished by the one machine in a single continuous traverse of the site. The finishing section **182** of the combined machine includes a relatively long framework **183** that is provided at each side with a forwardly extending towing arm **184**. Each of the towing arms **184** is provided at its forward end with an aperture **185** that fits over a king pin **186** projecting upward from the end member of the frame **41** of the pushing unit **40**. The trailing ends of the framework **183** are supported pivotally upon tandem bogies **187** provided with forward and rear wheels **188** that run on the forms F.

As more fully explained in the copending application, the framework carries two oppositely reciprocating transverse metering screeds **191** and **192** that are adjustable to provide the desired finished shape or contour to the upper surface to the slab S. Following the second screed **192**, a smoothing float pan **193** slides over the shaped

surface of the slab S and imparts to it the final contour and finish required on the traffic supporting surface of the pavement.

In this combined laying machine, the forward distributing unit **38** may be identical with the unit hereinbefore described. The pushing power unit **40** likewise may be substantially as previously described, with the exception that the rear screed **49** has been replaced by the two screeds **191** and **192** of the finishing unit **182** and by the addition of the second king pin **186** at each side of the machine frame which provide lost motion connections with the towing arms **184** at the respective sides of the finishing unit.

In utilizing a combined machine of the type shown in FIG. 7, freshly mixed concrete in plastic condition may be dumped into one or the other of the feeding hoppers **27** and **28** from a transportation vehicle V which is shown in the drawing in the form of the usual rear opening dump truck. The plastic concrete is then distributed and placed upon the base B from the transverse hopper **20** and struck off to the desired elevation and approximate shape by the adjustable strike-off **26**. The two reciprocating screeds **191** and **192** then finish the upper surface of the slab to the desired contour whereupon the float plate **193** smooths the surface and leaves it in finished condition for solidifying in the required shape without any further finishing operation.

Although the placing machine as shown in FIGS. 1 through 7 is arranged for operation upon the forms F defining the sides of the slab, the apparatus also is applicable to paving equipment of the slip-form type. As shown in FIG. 8, a slip-form paver **195** provided with forwardly projecting side forms or slip-form beams **196** is arranged to carry the spreading unit **38** as an integral part of the machine. As indicated in the drawing, the transverse distributing hopper **20** extends from one to the other of the slip-form beams **196** and is supported upon them.

From the respective ends of the hopper **20**, the feeding hoppers **27** and **28** project forwardly along and are secured to the forward parts of the respective slip-form beams **196**. Treads or tracks **197** operating around the beams from end to end in a well-known manner provide for advancing the machine along the site being paved. Plastic concrete charged into either of the feeding hoppers is placed by the transverse hopper **20** upon the base B between the slip-forms **196**. As the machine advances, the slip-forms **196** shape the edges of the slab while the surface thereof is shaped by the forming plate of the slip-form paver **195** in the usual manner. Trailing forms **198** are towed behind the paver to maintain the edges of the slab while they are solidifying. By utilizing this machine, the plastic concrete is properly distributed and molded into the form of a monolithic pavement slab in a single operation and without the necessity of providing temporary side forms.

As shown in FIG. 9 of the drawing, the distributing apparatus of this invention may be integrated somewhat more completely into a slip-form paver combination. As there shown, a modified slip-form paver **201** is provided with relatively high side elements or plates **202** that constitute the slip-forms and that are shaped to carry the crawler tracks **197** at an elevation higher than the transverse trough **20**. By this arrangement the trough **20** is extended on each side of the machine through openings in the side forms **202**.

This permits the charging hoppers **27** and **28** to be mounted on the outer sides of the side forms **202** communication being had through the openings therein with the ends of the distributing trough. The machine is thereby made somewhat more compact but operates in the same manner in that material fed into the charging hoppers flows from them through the openings in the side forms **202** and is distributed by the transverse conveyor. The extrusion plate of the paver **201** then molds the top surface and the side edges of the monolithic slab S in the usual manner, leaving it ready for use as soon as it solidifies.

The combined placer and slip-form machines shown in FIGS. 8 and 9 may be equipped with reinforcing mesh laying arrangements as shown in FIGS. 10 and 11, the mesh layer shown being applicable as well to the other machines that operate on the forms F. As previously indicated, reinforcing mesh is usually incorporated in a pavement slab by laying a first course of concrete, then placing the mats of mesh on top of the first course after which a second or top course of concrete is laid over the mesh and bonded to the first course. In the apparatus shown in FIGS. 10 and 11, the reinforcing mesh is embedded in the plastic concrete at a position within the pavement slab at the proper elevation above the base as the monolithic slab is being formed by the placer of this invention in a single continuous operation.

To this end, steel reinforcing mesh M is laid on the sub-base B ahead of the placing machine as indicated in FIG. 10, individual mats or sections of the mesh being secured together to form a continuous ribbon or strip of mesh. If dowel chairs are to be used for expansion joints J, they are placed on the base B first and the mesh M then laid loosely over them. As the placing machine advances, a mesh elevating bridge **205** extending between the feeding hopper **27** and **28**, slides under the mesh M in a manner to lift it from the base B to an elevation considerably higher than the elevation at which it is to be embedded within the slab S. As shown in FIGS. 10 and 11, the elevating bridge **205** is high enough to pass over the dowel chair joints J and is constituted by a pair of spaced transverse beams **206** that are secured at their respective ends at the inner sides of the feeding hoppers **27** and **28** thereby serving also to brace each hopper against the other for the purpose of stabilizing the forward end of the placing machine.

Longitudinally disposed mesh elevating runners **207** are secured to the transverse beams **206** at spaced intervals therealong transversely of the base B as shown in FIG. 11. The runners or lifts **207** are curved downwardly at their forward ends as shown in FIG. 10 to engage beneath and guide the mesh M being lifted from the base B. At their trailing ends, the elevator runners **207** are provided with rearwardly extending lifting fingers **208** that are preferably of tempered spring steel and that extend back beneath the distributing hopper **20**. As best shown in FIG. 10, the mesh lifting fingers **208** support the mesh M in its elevated position but somewhat below the level of the top of the slab S. With the mesh thus supported the plastic concrete C discharging out of the trough **20** flows downwardly and forwardly through the elevated mesh onto the base B. This results in the mesh being embedded within the plastic concrete at an elevation somewhat higher than its preferred final position in the slab S.

To position the mesh M precisely in the slab, there is provided a series of depressor fingers **209** that are fastened beneath and extend forwardly from the screed surface **142** of the adjustable strike-off member **26**. As shown in FIG. 10, the depressor fingers **209** are turned up at their forward ends to engage and ride over the mesh M in the region of the trailing ends of the cantilevered mesh lifting fingers **208**. As the mesh M becomes embedded in the downwardly flowing concrete C, the upturned mesh depressor fingers **209** in riding over it press it down gradually into the plastic concrete to the precise level which it is to assume within the slab S to provide the optimum reinforcing effect.

When the concrete C flows down through the mesh M small voids may be left below each wire of the mesh, but since the mesh is moved downward by the depressor fingers **209** to its final position, these voids are closed and the wires of the mesh are solidly embedded in the concrete. Whatever voids may occur above the mesh

wires and behind the depressor fingers 209 are closed by the extrusion meter action of the screed plate element 142 that extends rearwardly from the forward face plate 140 of the strike-off element 26. To assist in this finishing operation, the screed plate 142 may be provided with a vibrator 211 that operates in a well-known manner to fluidize the concrete and close the voids in its upper surface. This results then in the mesh M being placed at a precise elevation within the slab S and completely embedded within the plastic material in a manner to remain in its proper position as the material solidifies thereby to afford maximum reinforcement and unified structural strength to the monolithic slab.

Although the placing machine of this invention has been shown and described as equipped with feeding hoppers 27 and 28 that extend forwardly along the sides of the base B, under some circumstances it may be more desirable to extend the feeding hoppers laterally. In the modified form of the invention shown in FIG. 12, a laterally extending feeding hopper 217 is shown projecting outward from the machine in position to receive the plastic paving material C from a hauling vehicle V positioned parallel with and outside of the forms F. The outwardly projecting feeding hopper 217 is pivotally connected by hinges 218 to the outer surface of a side plate or frame member 219 that takes the place of the longitudinally feeding hopper previously described.

In operation, the feeding hopper 217 first may be folded upward to a vertical position upon the hinges 218 whereupon the vehicle V may be driven along the side of the site past the placing machine and spotted at a position rearwardly of the hopper 217. The feeding hopper 217 then may be lowered behind the vehicle V to its horizontal outwardly projecting position, whereupon the concrete C may be dumped from the rear of the vehicle into the hopper 217. Upward pivoting movement of hopper 217 is effected by means of a hydraulic actuator including a cylinder 221 that is pivotally connected to its closed end to a bracket 222 on the back wall 101 of the distributing hopper 20. A piston rod 223 projecting from the other end of the cylinder 211 is pivotally connected at its outer end to a bell crank arm 224 extending upward from the hopper 217. When pressure fluid is admitted to the cylinder 221 in a manner to retract the piston rod 223, the crank arm 224 operates to pivot the hopper 217 upward on its hinges 218 to its vertical position.

When the feeding hopper 217 is in its lowered outwardly projecting position it is in axial alignment with the distributing hopper 20 and communicates with it through an opening 226 in the side plate 219. The hopper 217 is provided with a feeding screw 227 that is disposed in axial alignment with the distributing screw 21 and in effect constitutes an extension of it. Driving mechanism 229 that is mounted on the rearward side of the hopper 217 is connected by a shaft 231 to a speed reducer 232 at the outer end of the hopper 217 by means of which power is transmitted to the outer end of the screw 227. Since the driving mechanism for the screw 227 is all mounted on the hopper 217 it moves with the hopper when tilted to its vertical position and does not need to be disconnected.

The driving mechanism for the feeding screw 227 operates also to drive the adjacent distributing screw 21 through connection therewith by means of a positive clutch (not shown). The positive clutch disconnects in the usual manner when the hopper 217 is pivoted upward and the driving connection is reestablished when the hopper is in its lowered position with the screws in axial alignment. By this arrangement, rear dumping hauling vehicles may be operated along the shoulder of the slab being laid and dumped successively into the trough 217 upon it being lowered in turn behind each vehicle. Accordingly, the hauling vehicles all may proceed in the same direction without the necessity of turning or other maneuvering.

From the foregoing description of apparatus exemplifying pavement material placing equipment embodying the present invention and the accompanying explanation of the manner in which it operates, it will be apparent that a new and improved arrangement has been provided by this invention for distributing and placing plastic paving material to form a monolithic pavement slab in a single continuous operation. This improved result is achieved by providing placing apparatus that is arranged to receive a full load of freshly mixed concrete poured rapidly from a hauling vehicle while simultaneously distributing it quickly across the site being paved. By this means, a heavy load of material may be placed so rapidly that its weight is never concentrated entirely on one side of the machine and its supporting forms. Furthermore, the material is distributed uniformly across the paving site in such a manner that it is evenly compacted upon the base and solidifies evenly and smoothly.

Although specific examples of paving material distributing and placing machines have been set forth herein by way of a full disclosure of practical and useful embodiments of the invention, it is to be understood that the improved features disclosed herein may be incorporated in somewhat different apparatus by those familiar with the art of pavement laying without departing from the spirit and scope of this 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 apparatus for distributing and placing newly mixed concrete in plastic condition to form a slab of pavement, a framework adapted to extend over and to be advanced along the site of a pavement slab being laid, a distributing trough for concrete carried by said framework in position to extend transversely of the slab site and provided along the bottom thereof with an adjustable concrete discharging opening, two conveyor screws arranged in end-to-end alignment within said distributing trough for moving concrete therealong, driving means operatively connected to each of said conveyor screws in manner to drive each screw independently in either direction selectively, a feeding trough connected to and extending forwardly from each end of said distributing trough, a feeding screw arranged within each of said feeding troughs for moving concrete deposited therein into said distributing trough, driving means operatively connected to each of said feeding screws in manner to drive each screw independently and selectively, and an adjustable strike-off member carried by said framework behind and closely adjacent to said distributing trough in position to engage and strike off the plastic concrete discharged from the bottom of said distributing trough through said adjustable concrete discharging opening, the arrangement being such that concrete may be charged into either or both of said feeding troughs as said apparatus advances along the site being paved and fed therefrom into said distributing trough for prompt placement upon the site the deposited concrete then being leveled by said strike-off member to form the slab of pavement.

2. In a placer for laying a slab of concrete pavement in plastic condition continuously and progressively, a transverse distributing trough arranged to discharge a ribbon of plastic concrete onto the site being paved as the placer travels along the site, a wheel disposed at each end of said transverse trough for movably supporting it at the respective edges of the site being paved, resilient force limiting means arranged to connect each of said wheels to one end of said trough respectively to support said trough thereon resiliently, a feeding trough extending forwardly from each end of said transverse trough and arranged to feed plastic concrete into said transverse trough, a tandem bogie having two wheels arranged under each of said forwardly extending feeding troughs to support it for movement, a pushing arm extending rearwardly from each of said feeding troughs, a power unit including

a rectangular frame disposed transversely of the site being paved and arranged behind said transverse distributing trough with its respective ends beneath the distal ends of said rearwardly extending pushing arms, means on the respective ends of said power unit frame disposed to engage and push against the distal ends of said arms, and two wheels disposed at each end of said power unit frame in tandem relationship and mounted thereon in manner to support said power unit for movement along the site, the arrangement being such that when plastic concrete is poured into said feeding troughs and feed therefrom into said distributing trough the weight thereof is sustained by said tandem bogies and by said resiliently mounted wheels until the weight on said wheels exceeds the sustaining capacity of said force limiting resilient connecting means whereupon said troughs settle downward sufficiently to cause said overlying distal ends of said rearwardly extending pushing arms to bear down upon the respective ends of said power unit frame and thereby transfer some of the weight thereto which is then sustained by the two wheels at each end of said power unit, whereby the weight of the load of concrete in said troughs is thereby distributed among five wheels spaced along each side of said placer.

3. In a concrete placing machine for distributing freshly mixed concrete in plastic condition upon a site to form a slab of pavement, a framework adapted to span and arranged to advance along the site of the pavement slab being formed, a transverse concrete distributing trough carried by said framework and having a discharge opening along its lower surface positioned to deposit concrete onto the site to form the slab, two conveyor screws arranged in end-to-end relationship within said trough for distributing plastic concrete therealong, a longitudinal feeder trough carried by said framework and extending forwardly from and connected to each end of said transverse distributing trough, a feeding conveyor screw arranged within each of said feeder troughs for feeding plastic concrete therealong into the associated end of the distributing trough, an hydraulic motor for driving each of said feeding and distributing screws, power transmission mechanism interconnected between each hydraulic motor and its associated conveyor screw to drive it, an hydraulic pump for driving each of said hydraulic motors, fluid pressure transmitting and control apparatus interconnecting each of said hydraulic pumps individually with its associated hydraulic motor to drive it, a source of power mounted on said framework, and driving mechanism interconnecting said source of power and said hydraulic pumps to drive them, the arrangement being such that each of said feeding and distributing conveyor screws is driven and controlled by a wholly independent hydraulic power transmission system.

4. In apparatus for placing concrete in plastic condition to form a pavement slab, a transverse trough-like distributing hopper adapted to span the site of a slab being laid and arranged to open at the bottom for discharging concrete, a longitudinal feeding hopper connected to and extending forwardly from each end of said distributing hopper in manner to feed concrete into said distributing hopper, two conveyor transfer screws disposed end to end in said distributing hopper and operative therein in manner to distribute concrete therealong, a conveyor transfer screw disposed in each of said longitudinal feeding hoppers for feeding concrete therefrom into said distributing hopper, an hydraulically operated motor arranged to drive each of said conveyor screws independently, a speed reducing mechanism connected between each of said hydraulic motors and the associated conveyor screw driven thereby in manner to drive the screw at reduced speed, a source of power for driving said motors and screws, three hydraulic pumps connected to said source of power in manner to be driven thereby, separate hydraulic conduit systems connecting said three pumps respectively to the two said motors driving said distributing screws and one of said motors driving one of said feeding screws, a fourth hydraulic pump, a separate conduit system connecting said fourth pump to the other of said motors driving the other of said feeding screws, and a disconnectable coupling selectively connecting said fourth hydraulic pump to said source of power, the arrangement being such that when concrete is being delivered to only the first of said feeding hoppers, said coupling may be disconnected to uncouple said fourth pump from said source of power.

5. In a machine for laying plastic concrete to form a pavement slab, a frame adapted to span and to travel along the site of a slab of pavement being laid, a transverse placement hopper carried by said frame in position to span and to discharge plastic concrete on to the site, two transfer screws arranged transversely end to end within said placement hopper for distributing concrete therealong, a longitudinal feeding hopper extending forwardly from and connected to each end of said transverse placement hopper for receiving plastic concrete, feeding screws arranged longitudinally in each of said feeding hoppers for feeding concrete into the ends of said transverse placement hopper, an hydraulic system including a motor connected to and arranged to drive each of said distributing screws and each of said feeding screws individually all of said four motors being similar and interchangeable, a source of power mounted on said frame, four hydraulic pumps operatively connected to said source of power in a manner to be driven thereby all of said four pumps likewise being similar and interchangeable, and an hydraulic control circuit interconnecting each of said four pumps individually with one of said motors respectively to drive said screws selectively and independently, the arrangement being such that should any one of said pumps or any one of said motors become disabled said hydraulic system may be rearranged to interchange pumps or to interchange motors as may be required to provide for driving said two distributing screws and a selected one of said feeding screws.

6. In a machine for laying reinforced concrete pavement, a transverse distributing trough open at the bottom for discharging concrete in ribbon form onto a site being paved as said trough advances along the site to form a slab of pavement, means to feed plastic concrete into said transverse trough and to distribute the concrete along said trough transversely of the site, mesh supporting fingers projecting forwardly from said transverse trough in position to lift reinforcing mesh and to support it at an elevation somewhat higher than its normal position within the slab being formed but below the elevation of the top of the slab, said fingers serving to hold the mesh in elevated position while under said trough and while the plastic concrete flows down from said trough through the mesh onto the pavement site to embed the mesh in the slab being formed, mesh depressing fingers extending rearwardly from said transverse trough in position to depress the embedded mesh within the slab of plastic concrete to its normal desired position within the slab, and a strike-off member arranged to follow said distributing trough and operative to strike off and smooth the top surface of the plastic concrete on the pavement site above the embedded mesh to form the reinforced monolithic slab to the desired thickness and surface contour.

7. In apparatus for placing concrete in plastic condition to lay a slab of pavement, a frame adapted to span and to travel along a site being paved, a transverse distributing hopper arranged to open at the bottom and carried by said frame in position to discharge plastic concrete in the form of a down flowing ribbon extending across the full width of the site being paved as the apparatus travels along the site, said hopper comprising a fixed back wall element secured to said frame and extending downwardly and forwardly to terminate in a transverse discharge lip at its lower forward edge, a movable front wall spaced forwardly from said back wall at its top and extending downwardly and rearwardly to

engage said discharge lip of said back wall when in closed position, a plurality of pivot arms spaced transversely of the distributing hopper, each arm extending rearwardly from the top of said front wall, means projecting forwardly from said back wall to which said arms are pivotally connected intermediate said walls, and power operated gate opening apparatus connected between said frame and said movable front wall and operative to pivot said front wall forwardly and upwardly to disengage it from said discharge lip and to open said clamshell hopper a selected predetermined distance both horizontally and vertically to provide for discharging the ribbon of plastic concrete therefrom over said discharge lip onto the site being paved.

8. In combination with apparatus as set forth in claim 7, mesh supporting members projecting forward of said hopper arranged to support the mesh while the concrete flows from the hopper through the mesh, and means to depress the mesh within the slab to the desired depth below the discharge lip of said hopper.

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JACOB L. NACKENOFF, *Primary Examiner.*