July 18, 1967 G. E. PERKINS ET AL 3,331,296

APPARATUS FOR MAKING CONTINUOUSLY REINFORCED PAVING

Filed Sept. 8, 1966 2 Sheets-Sheet 1

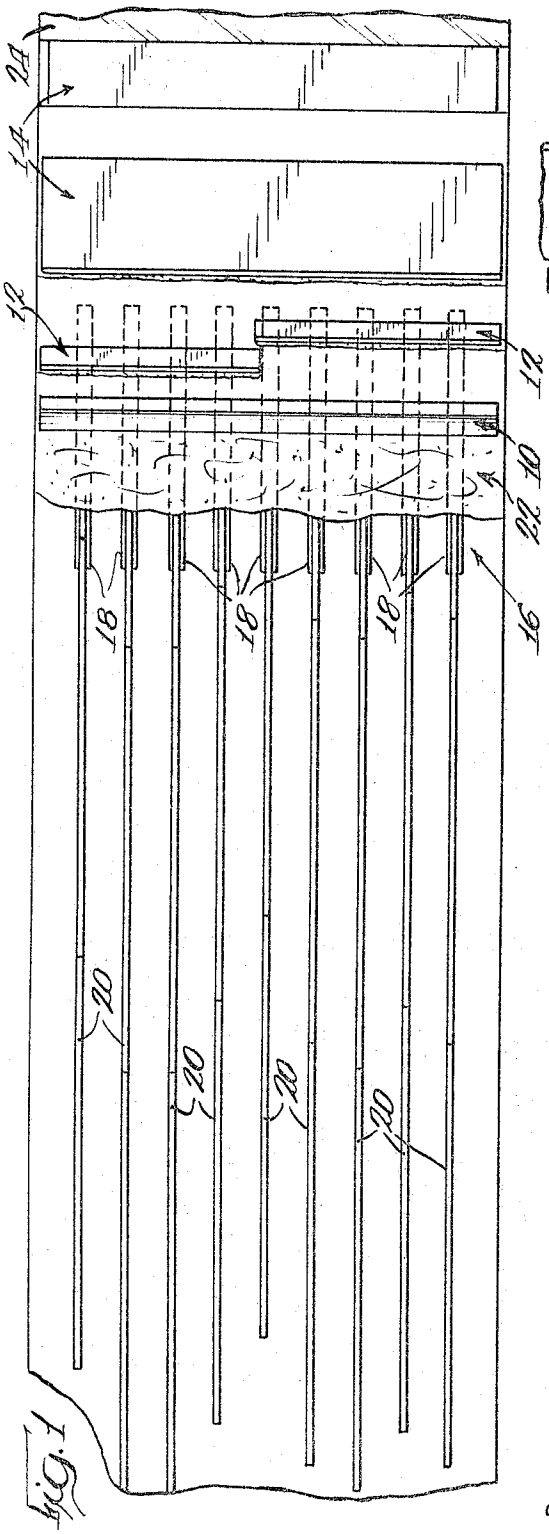


Fig. 1

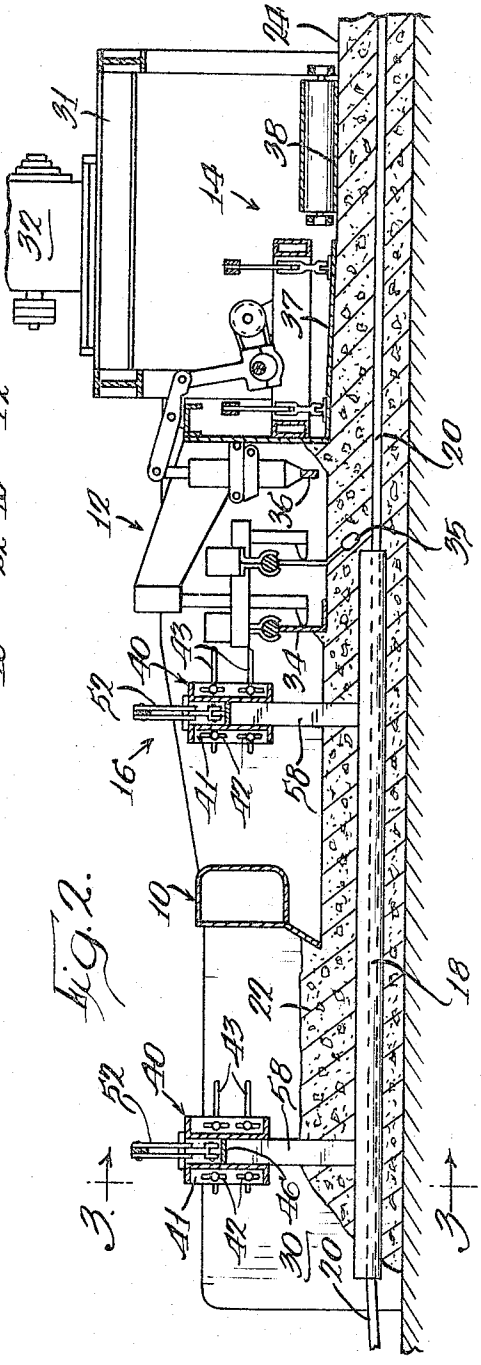


Fig. 2.

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Filed Sept. 8, 1966 2 Sheets-Sheet 2

Fig. 3.

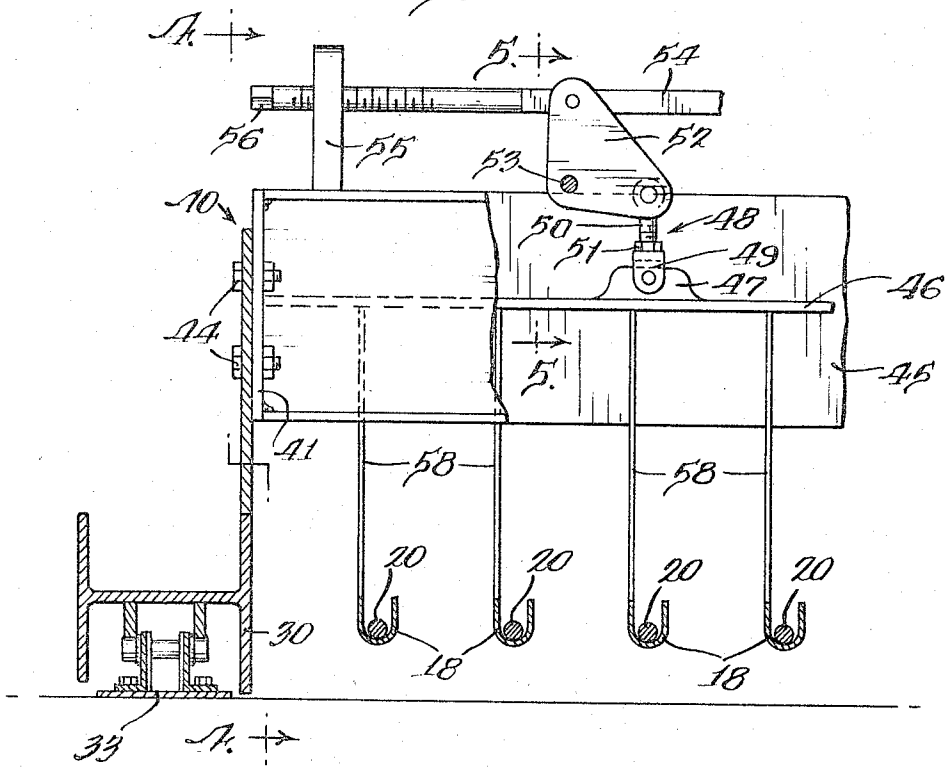


Fig. 4.

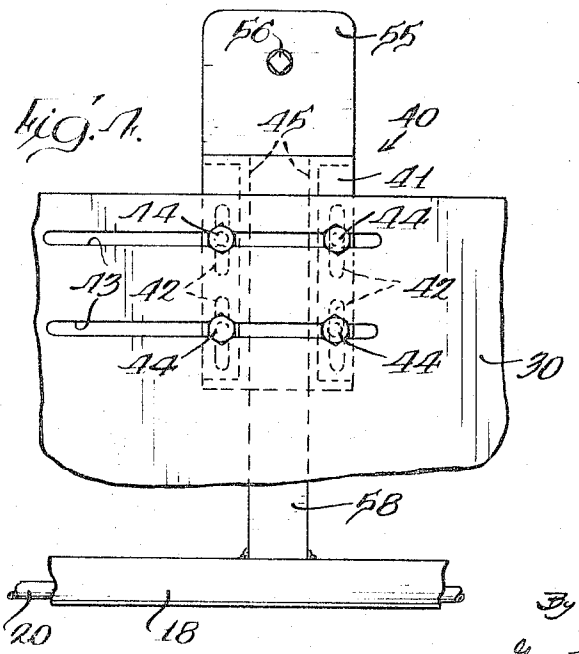
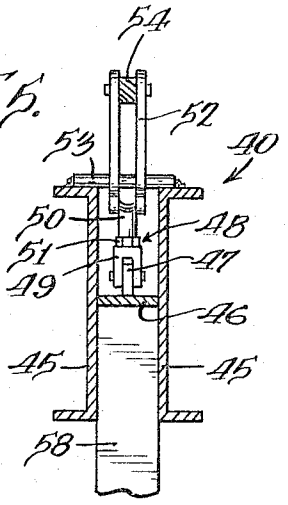


Fig. 5.



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APPARATUS FOR MAKING CONTINUOUSLY REINFORCED PAVING

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ABSTRACT OF THE DISCLOSURE

The present invention relates to a method of and apparatus for directly forming continuously reinforced concrete paving; that is, concrete paving having embedded therein essentially continuous spaced parallel longitudinal reinforcing rods.

Background of the invention

There are essentially two methods of laying concrete pavement: (1) the fixed form method wherein raw concrete is poured between fixed forms previously erected on the road site, the concrete is levelled, vibrated and finished by machines which use the forms as tracks, and the concrete is permitted to dry or set up between the forms; and (2) the slip form method which involves use of a machine which carries its own side forms, strike-off, vibrator means and finishing means, which receives, levels, vibrates and finishes the concrete in a continuous process as it moves along the road site, and which leaves behind it a free standing concrete mass that need only dry to constitute the finished pavement.

With the fixed form method of paving, wire mesh or even rod reinforcing may be incorporated in the paving by a three stage process involving (a) laying of a first or base course of concrete to the elevation at which the reinforcing is to be placed, (b) laying the reinforcing into place on the base course, and (c) laying a second or top course over the base course and the reinforcing. Manifestly, this is a tedious, time-consuming, expensive operation requiring the use of two sets of machines, or twofold use of one set of machines, and substantial labor.

With the slip form method of paving, wherein all of the network must be performed in a single pass of a single machine, the incorporation of any reinforcing had been a problem until we devised the machine shown in our copending application Ser. No. 496,898, filed Oct. 18, 1965. In that machine, we provided, in conjunction with a single pair of slip forms, a head end strike-off unit for laying the first or base course of concrete, a tail end unit for receiving and laying the top course, and sufficient space between the two units to accommodate manual placement of reinforcement between the two courses; the tail end unit actually comprises a slip form paver for compacting and finishing the entire concrete mass with the reinforcement embedded therein. Again, of course, this is a three stage process even though embodied in a unitary machine.

We are aware that machines have been proposed for laying the complete body of concrete, then pressing reinforcing down into the concrete mass while it is still plastic, and thereafter finishing the reinforced mass. However, to the best of our knowledge, these machines have not proven to be practical.

Objects of the invention

The object of the present invention is to provide an improved method of and improved apparatus for laying and forming reinforced concrete paving in a single pass.

Specifically, it is an object of the invention to provide an improved method of directly forming continuously reinforced concrete paving on a road site, comprising the steps of placing on the site a plurality of spaced generally parallel substantially continuous longitudinal reinforcing elements, supporting substantially coextensive longitudinal portions of said elements at the transverse spacings and at the elevation above the site specified therefor, continuously moving the supporting means along the site to progressively support successive longitudinal portions of said elements, depositing concrete on, around and beneath the elements and the supporting means therefor as the supporting means is moved along the site, striking off the deposited concrete to an approximate level above the thus supported elements, vibrating the concrete in the vicinity of the trailing ends of said supporting means to cause the concrete to be densified around said elements, and finishing the concrete rearwardly of said supporting means to compact the concrete about said elements and complete the paving to finished specifications.

A further object is to provide improved apparatus for directly forming continuously reinforced concrete paving including strike-off means for approximately levelling deposited concrete, vibrator means for densifying the depositioned and levelled concrete and finishing means for molding the concrete to finished dimensions, and characterized by a plurality of spaced parallel reinforcing rod support members mounted beneath the strike-off means at a predetermined elevation above the site and at predetermined transverse spacings, said support members extending forwardly of the strike-off means for supporting reinforcing rods while concrete is deposited above, around and beneath the rods and support members, said support members extending rearwardly of the strike-off means and into the vicinity of the vibrator means for supporting the rods while the concrete is struck off and then densified about the rods, the finishing means extending rearwardly of said support members for finishing the concrete with the rods supported at the predetermined spacings and elevation in the concrete mass.

Other objects and advantages of the invention will become apparent in the following detailed description.

The drawings

FIGURE 1 is a schematic diagram, in plan view, illustrating practice of the method of the present invention;

FIGURE 2 is a vertical longitudinal section of a slip form paver embodying the apparatus of the present invention;

FIGURE 3 is a vertical transverse section, on an enlarged scale, taken substantially on line 3—3 of FIGURE 2 and showing the rod supporting members provided by this invention;

FIGURE 4 is a fragmentary side view of the support members and the mounting and adjusting structure therefor, the view being taken substantially on line 4—4 of FIGURE 3; and

FIGURE 5 is a fragmentary cross-section of said mounting and adjusting structure taken substantially on line 5—5 of FIGURE 4.

Description of the invention

In order to acquaint those skilled in the art with the manner of practicing our method and of making and using our apparatus, we have illustrated in the accompanying drawings and will now describe a preferred embodiment of a slip form paving machine presently contemplated by us as the best mode of carrying out our invention, from which our method and its applications will be readily ascertained.

Referring to FIGURE 1, we have diagrammatically depicted the mode of practicing the method of our invention. In the illustration, the top and bottom lines depict the side margins of a previously prepared road site on which a concrete roadway or highway is to be laid. It is to be understood that side forms are provided at these locations to confine the concrete against lateral spreading and to define the side edges of the finished slab. The basic machinery used (in addition to the side forms) comprises any conventional strike-off means **10**, vibrating means **12** and finishing means **14** which perform their functions in the enumerated sequence on raw concrete dumped into the space between the side forms forwardly of the strike-off means. Preferably, at least the strike-off **10** and primary vibrator means **12** are interconnected for correlation with the support member assembly provided by this invention, which is indicated generally at **16**.

In accordance with the present invention, a plurality of longitudinally extending support members **18** are mounted beneath the strike-off **10**, the same extending a reasonable distance forwardly of the strike-off and rearwardly from the strike-off into the vicinity of the vibrator means **12**, especially into the vicinity of the portion of the concrete mass subject to the vibratory action of said means. The support members **18** may take a variety of forms, as will presently appear, and each serves as a support and guide for a respective one of a plurality of substantially continuous reinforcing rod elements indicated at **20**, the supports being mounted at substantially the respective elevations above the site and below the finishing means and at the respective transverse spacings specified for the reinforcing rods in the finished concrete slab.

The required number of reinforcing elements **20** are laid out on the road site forwardly of the paving machinery and preferably are each progressively fabricated into continuous form directly on the site from individual lengths of reinforcing rod united together in essentially end to end relation in any suitable manner, such for example as welding (welded joints being indicated by the black stripes on the elements **20** in FIGURE 1) or overlap splicing. This step or operation may be performed substantially continuously directly on the site at any desired distance forwardly of and essentially in pace with the movements of the paving machinery so that the paving machinery acts essentially on seemingly continuous reinforcing elements.

The number, size and spacing of the elements **20** will vary according to the nature of the work and the engineering specifications therefor. On highways, for example, the reinforcing rod specified might be ⅝ inch diameter rod set at 6 inch transverse spacings, ¾ inch rod set at 8 inch spacings, or other sizes and spacings. In any event, the required number of elements of the required size are assembled on the site forwardly of the machinery and laid on the site in essentially parallel relation, though no great care is required in this respect.

Transverse bars or supports are of practically no structural value in continuously reinforced concrete paving, except as may be required at planned construction joints and emergency joints. The planned construction joints are usually widely spaced, for example, a mile or more, and with proper equipment maintenance and raw material supply facilities emergency stops or joints in paving should be infrequent. Thus, long continuous lengths of the reinforcing elements **20** may be laid out on the site (extending from planned construction joint to planned construction joint) without obstruction for convenient automatic placing by the paving machinery of this invention.

The element supporting members **18** are constructed, mounted and/or adjusted so that the same are fixed the transverse spacings specified for the requisite number of rods, and also at the elevation or spacing above the site (or below the surface of the finished paving) specified therefor by the architect or engineer. Each support receives a respective reinforcing element and thereby supports a longitudinal portion of the element at the specified location therefor in the finished paving, the supports receiving and supporting progressive longitudinal portions of the rod elements as the machinery is moved along the site. As shown, the members **18** extend a sufficient distance forwardly from the strike-off **10** so that loads of raw concrete may be dumped on top of the supports, preferably rearwardly of their forward ends and forwardly of the strike-off, as indicated at **22** in FIGURE 1. The concrete is conventionally dumped between the side forms from batching machines or "pavers," or from mixer trucks or dump trucks operating on the shoulders of the site, i.e., outwardly of the margins of FIGURE 1, as is well known in the art.

The raw concrete **22**, being in semi-fluid or plastic condition, readily flows downwardly over, around and beneath the elements **20** and the supports **18** and thus substantially encases the portions of the elements and supports over which it is dumped, the concrete being supplied to a depth or height somewhat greater than that of the lower or levelling edge of the strike-off means **10** as is conventional in the art. The rods **20** of course remain stationary with and within the concrete, and the paving elements, i.e., the strike-off **10**, vibrator **12**, finishing means **14** and supports **18** move forwardly along the site relative to the concrete and the rod elements **20**; concrete being substantially continuously deposited on the site forwardly of the strike-off.

As the paving machinery moves forwardly, the strike-off **10** preliminarily levels the deposited mass of concrete **22** to a level slightly greater than that of the finished pavement. The vibrator means **12** then acts upon the concrete to densify the mass and to bring some of the fines and some of the water in the mix to the surface. The means **12** of course imparts vibration to a volume of the concrete in the vicinity thereof, especially to the entire thickness of the semi-fluid or plastic mass over an area extending from side form to side form and from a location forwardly of said means to a location rearwardly of said means. This vibration serves to compact and densify the concrete mass and to eliminate voids or air pockets therein. According to the present invention, the supports **18** for the rod elements **20** are extended rearwardly into the volume of the concrete so vibrated whereby the concrete will be densified in, around and beneath said elements while they are so supported. Consequently, when the supports **18** are moved forwardly away from the respective longitudinal portions of the elements, said portions will be positively supported by the concrete in the respective locations specified therefor and the concrete will have been densified around the circumference of each rod without voids or air pockets to insure the necessary bond between the rods and the concrete and thereby the desired reinforcing effect.

After the concrete has been so vibrated and densified about the rods, the surface of the concrete mass may be finished, such for example as by pressing or extruding and/or massaging; an extrusion meter and a transversely reciprocating belt being depicted in FIGURES 1 and 2 for the purpose.

Depending upon the apparatus employed, the nature or character of concrete mix, and the specific results to be attained, the supports **18** for the reinforcing elements **20** may extend to the vibrated portion of the mass, into the vibrated portion, into and through the vibrated portion to adjacent the finishing means, or beyond the vibrator means to a position beneath the leading end portion of the finishing means. Field conditions will ultimately dictate the precise positioning of the supports, but in any event, the supports will maintain the position of the reinforcing

rods until the concrete is deposited and densified about the rods, and in some instances at least partly finished or compacted about the rods, so that the rods may be released (by forward movement of the supports) and thereafter be sustained at their intended locations in the mass with the concrete firmly bonded thereabout.

After passage of the paving elements, there is left therebehind a finished concrete highway **24** having the proper continuous longitudinal reinforcing imbedded and locked therein. The machinery operates continuously in an entirely conventional manner, with the exception of the steps of assembling the continuous rod elements **20** on the site forwardly of the machinery, supporting the elements by the means **18** during the deposit of concrete and passage of part of the machinery, and the leaving behind of a fully reinforced slab. The speed and efficiency of modern concrete laying procedures and equipment are not only not diminished, but actually enhanced by the new capacity for direct incorporation of continuous longitudinal reinforcement.

As the machinery approaches each planned construction joint, it is a relatively simple matter to terminate the reinforcing elements for connection in the transverse bench means and/or expansion-contraction joint structure specified for the highway, to raise the support means **16–18** for movement over the joint structure, and to lower the support means on the other side of the joint for reception and passage therethrough of the next set of substantially continuous reinforcing rod elements. These are substantially the operations necessary for passage over any planned construction joint, and do not detract from the effectiveness and/or practical use of the present invention.

Referring now to FIGURE 2, we have shown a slip form paver adapted to automatic performance of our improved process (except for the step of laying out and assembling the rod elements **20**). The paver illustrated in FIGURE 2 is essentially the same as that shown and described in detail in our Patents 2,976,784 and 3,247,770, to which reference is made for a more complete description. Suffice it to state herein that the machine comprises a pair of rigid spaced parallel side forms, one of which is indicated at **30**, which extend a significant distance forwardly and rearwardly of the concrete working instrumentalities, a rigid frame **31** to which the side forms **30** are secured, a strike-off **10** mounted on the framework and extending from side form to side form, vibrating means **12** mounted on the framework and effectively operative from side form to side form, finishing means **14** mounted on the frame and extending from side form to side form, and means including a motor **32** and endless tracks **33** (FIGURE 3) associated with the side forms for driving the entire machine as a unit over the prepared road site.

In the illustrated embodiment, the vibrator means **12** is comprised of one or more vibratory screeds **34**, one or more submerged finger-type vibrators **35**, and/or one or more tampers **36**. The finishing means **14** is preferably comprised of an extrusion meter **37** and a transversely reciprocated belt **38**. The extrusion meter includes an inclined bottom face extending from side form to side form and having substantial length for causing the entire mass of the machine to be applied to the body of concrete for the purpose of compressively extruding the concrete to finished dimensions. A complete disclosure of these elements and their functions is contained in our earlier patents, with the exception of the finger-vibrators **35** which are well known in the art and have been added to the machine to exemplify the use of additional and/or substitute vibrating mechanisms.

The described machine is adapted to move along a prepared road site, to receive raw concrete in its forward regions, and to leave behind it a free-standing concrete slab that need only dry to constitute a completed concrete highway. The machine advances at a fairly rapid continuous pace and effectively converts raw concrete to a finished slab in a single pass of only a few moments duration.

In accordance with the present invention, this machine is equipped with an assembly **16** of the support members **18**. Specifically, we provide a pair of transverse beams **40** extending from side form to side form above the level to which the concrete is to be laid, one beam being disposed forwardly of the strike-off **10** and the other rearwardly of the strike-off. Each beam is adjustably mounted at each end thereof on the side forms or otherwise on the frame of the machine in such manner as to accommodate vertical and horizontal adjustment thereof, whereby each of the four corners of the assembly **16** is fully adjustable. In the illustrated embodiment, each end of each beam is provided with a mounting flange **41** adapted to abut the adjacent side form or other portion of the machine frame; the flange being provided with vertical slots **42** therein, the side form being provided with horizontal slots **43** and bolts **44** being extended through intersecting pairs of the slots whereby each end of each beam may be adjusted up and down and back and forth and thereafter locked in adjusted position as required by conditions as previously explained.

Each of the beams **40** is comprised of a pair of spaced channels **45** and the respective end flanges **41**. Slidably mounted between the channels for vertical movement is a bendable plate or bar **46** having at spaced locations thereon a plurality of upstanding tabs **47**. Connected to each tab is a vertical link **48** comprised of a clevis **49** pivoted to the tab, an eye-bolt **50** and adjustable connecting means **51** between the bolt and clevis. Each eye-bolt **50** in turn is pivotally connected to a respective triangular plate **52** comprising a bell crank. Each bell crank is pivotally mounted on a respective stationary pin **53** bridging between and secured to the channels **45**, and each crank is further pivotally connected to an operating rod **54** which is mounted above the channels parallel thereto. At its opposite ends, the rod **54** is provided with rotatably mounted extensions which are threaded through upstanding brackets **55** secured to the channels, one or both of said extensions being provided with a wrench fitting **56** whereby the extensions may be threaded in and out and the rod adjusted back and forth in a direction parallel to the beam. Such threaded adjustment of the rod **54** causes movement of the bell cranks about their pivots **53** and this in turn causes warping of the plate or bar **46** to contour the same to the crown of the pavement to be laid, or more properly, to a given contour if the specifications call for the reinforcing rods to be set to a predetermined profile. The connections **51** of the eye-bolts **50** also facilitate this result, as has been explained in detail in conjunction with the strike-off and extrusion meter in our earlier patents.

Depending vertically from the thus adjustable bar or plate **46** are a plurality of spaced parallel knife-like members or plates **58**, which are spaced from one another in accordance with the transverse spacings specified for the rod elements **20** in the finished highway. Preferably, the upper end portion of each of the plates **58** is mounted between and thereby supported and guided by the spaced channels **45** of the respective beam.

The two beams **45** and their associated elements are preferably identical, or substantially so, and the depending plates **58** thereof are thus disposed in longitudinally aligned pairs. The plates of each pair are secured at their lower ends to the forward and rearward end portions of a respective one of the support members **18** so that each member **18** is supported both forwardly and rearwardly of the strike-off; the members **18** thus being mounted in spaced parallel coextensive relation at the transverse spacings specified for the rod elements **20**. Also, by adjustment of the height of the beams **40** and/or the contour of the bars **46**, the supports **18** may be disposed at the proper elevation above the site (or below the finishing

means **14**) to locate the elements **20** in their intended positions.

In the preferred embodiment, the support members **18** are upwardly open elements which support and guide the respective rods from the bottom and the sides only so that the concrete may substantially encase each rod and be vibrated and densified thereabout even while the rods are supported by said members. For this purpose, the members may be upwardly open channels, V-shaped members, or U-shaped members as shown. Other forms of support may of course be used as desired, or as necessary for particular jobs. The supports preferably (though not necessarily) extend forwardly beyond the region of the machine in which the concrete is initially deposited, and extend rearwardly into the vibrated volume of the concrete so that as the supports move forwardly the rods are left in essentially fixed position in a solid densified mass of concrete which is subsequently compacted about the rods and finished. In this manner, continuously reinforced paving is produced in a single pass.

While we have shown and described what we regard to be the preferred embodiment of our invention, it is to be appreciated that various changes, modifications and rearrangements may be made therein without departing from the invention, as defined in the appended claims.

We claim:

1. In concrete paving apparatus including a machine movable along a road site and having means for approximately leveling deposited concrete, vibrator means for densifying the deposited and leveled concrete and finishing means for molding the concrete to finished dimensions as the machine advances along the site, the improvement comprising means for incorporating a plurality of spaced parallel individual reinforcing rods in the concrete as the machine advances along the site, said means consisting essentially of a plurality of spaced parallel reinforcing rod support members of the number, at the transverse spacings and at the elevation above the site specified for the reinforcing rods, each of said members receiving successive portions of a respective rod forwardly of the leveling means as the machine moves along the site and including side and bottom walls for supporting each rod at the bottom and sides thereof to maintain the elevations and transverse spacings of the rods as concrete is deposited about the rods and until the concrete supports the rods, said support members terminating forwardly of the end of the finishing means to accommodate final and intimate compaction of the concrete about the rods.

2. In concrete paving apparatus including a machine movable along a road site and having means for approximately leveling deposited concrete, vibrator means for densifying the deposited and leveled concrete and finishing means for molding the concrete to finished dimensions as the machine advances along the site, the improvement comprising means mounted on said machine for incorporating a plurality of spaced parallel individual reinforcing rods in the concrete as the machine advances along the site, said means consisting essentially of a plurality of substantially co-extensive spaced parallel reinforcing rod support members of the number, at the transverse spacings and at the elevation above the site specified for the reinforcing rods, said members extending below the leveling means to the front and rear thereof, each of said members receiving successive portions of a respective rod as the machine moves along the site and including side and bottom walls for supporting the rod at the bottom and sides thereof to maintain the elevations and transverse spacings of the rods while concrete is deposited upon, leveled above and densified about the rods until the concrete mass is capable of supporting the rods at the specified elevations and transverse spacings, said support members terminating forwardly of the rearward end of the finishing means to accommodate final and intimate compaction of the concrete about the rods.

3. In concrete paving apparatus as set forth in claim **2**, means for adjusting said support members forwardly and rearwardly relative to the leveling, vibrating and finishing means.

4. In concrete paving apparatus as set forth in claim **2**, means forwardly and rearwardly of the leveling means suspending said support members from the machine, each of said means consisting essentially of an individual relatively thin plate independently suspending the respective end of each of said support members and presenting minimum obstruction to the concrete.

5. In concrete paving apparatus as set forth in claim **4**, bar means traversing the machine forwardly and rearwardly of the leveling means above the latter and supporting the upper ends of said plates, each of said bar means including means for adjusting the vertical position thereof and for imparting a crown thereto to adjust the relative positions of said support members.

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