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METHOD AND MEANS FOR ERECTING ELONGATED STRUCTURES OF CONCRETE

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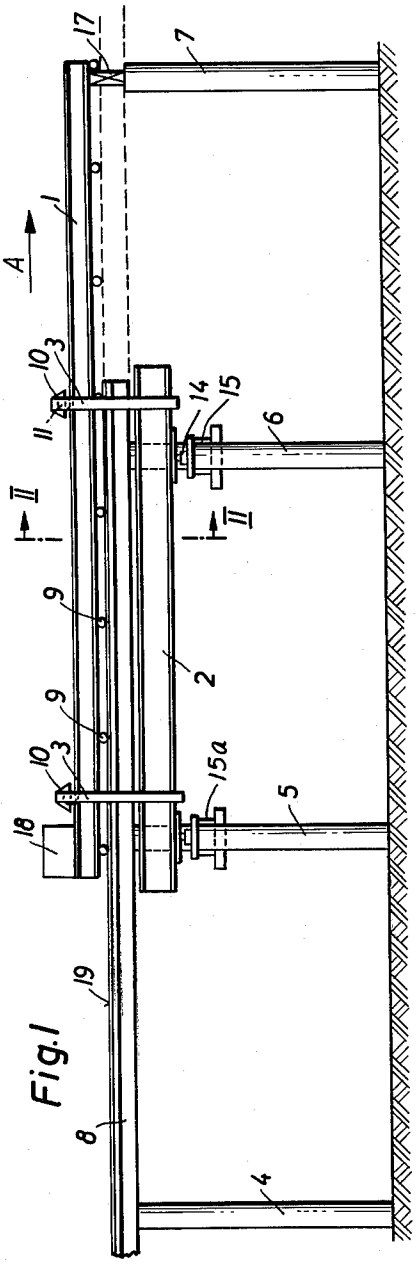


Fig. 1

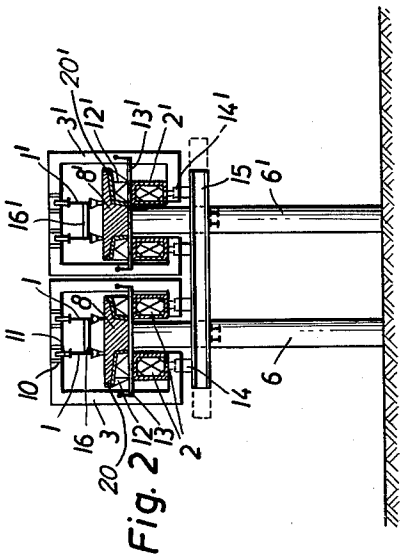
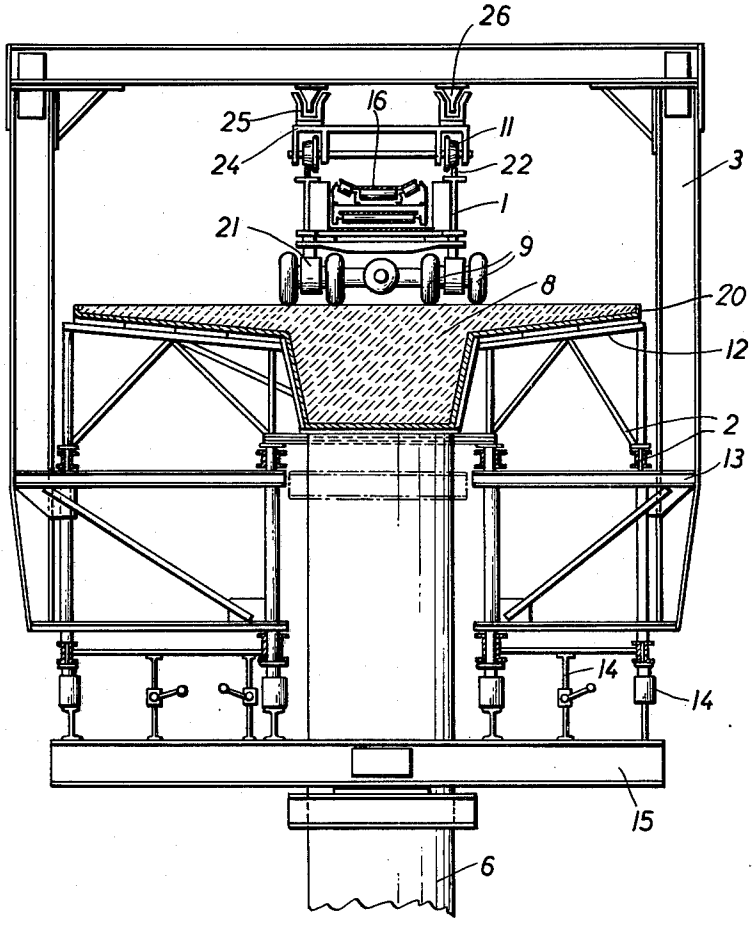


Fig. 2

METHOD AND MEANS FOR ERECTING ELONGATED STRUCTURES OF CONCRETE

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Fig. 3



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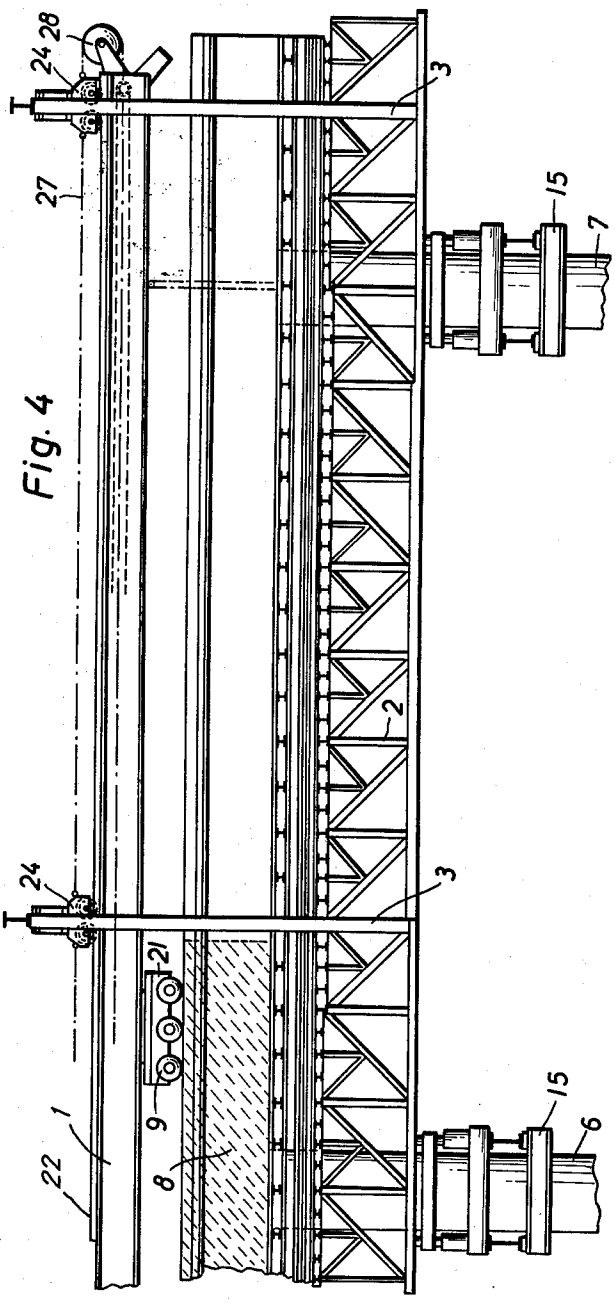


Fig. 4

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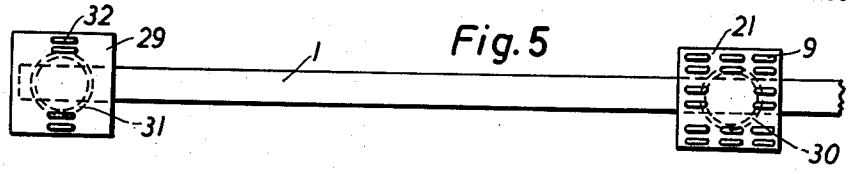


Fig. 5

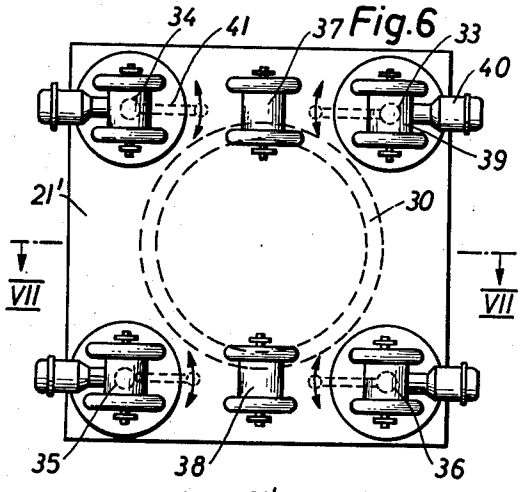


Fig. 6

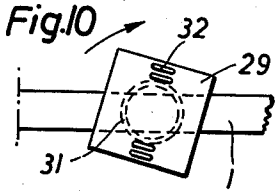


Fig. 10

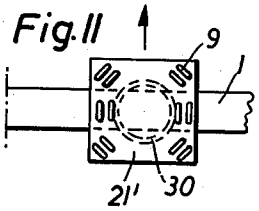


Fig. 11

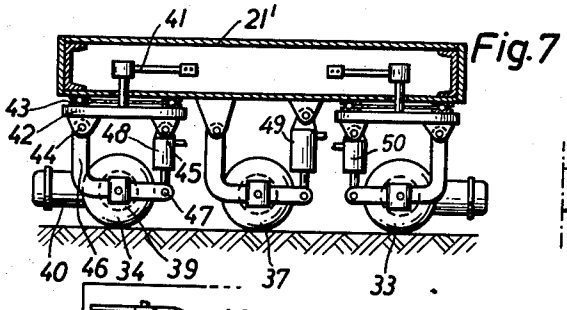


Fig. 7

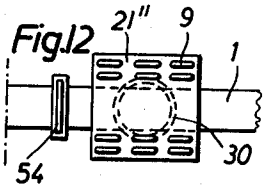


Fig. 12

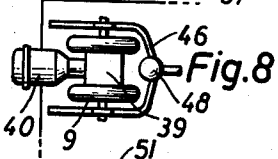


Fig. 8

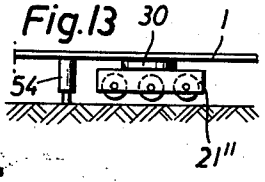


Fig. 13

Fig. 9

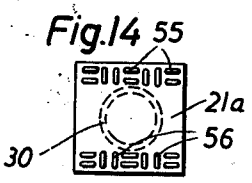


Fig. 14

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Fig. 15

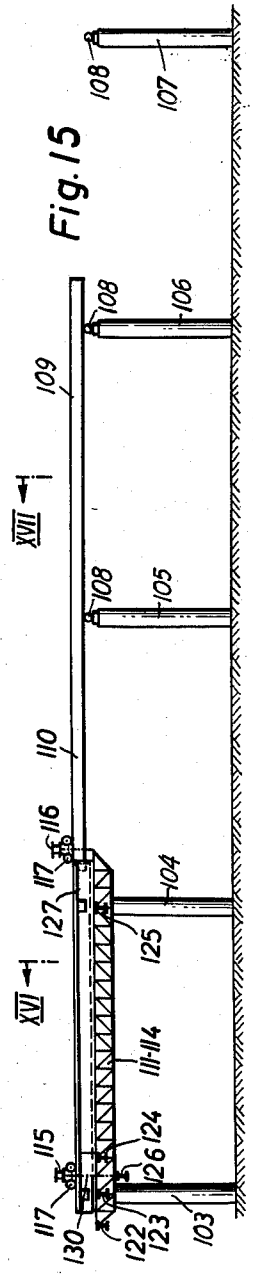


Fig. 16

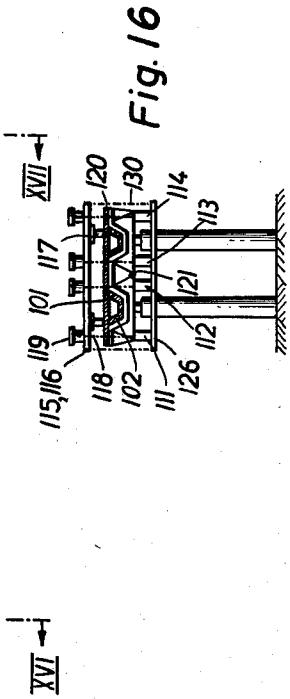
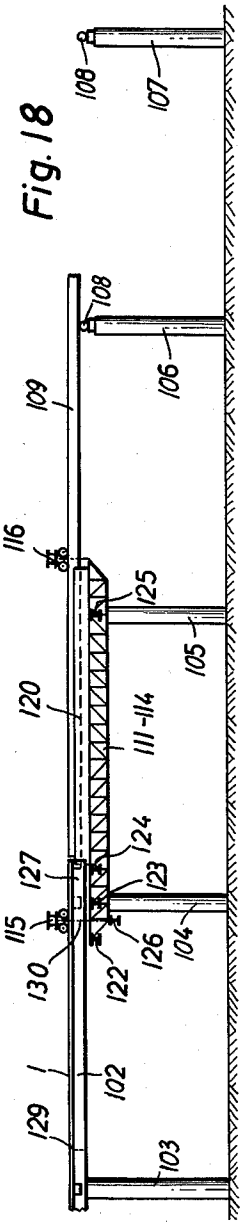


Fig. 18



METHOD AND MEANS FOR ERECTING ELONGATED STRUCTURES OF CONCRETE

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Fig. 19

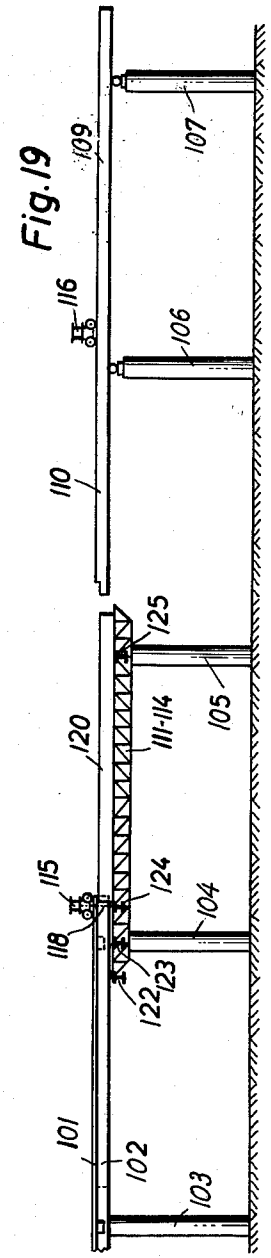
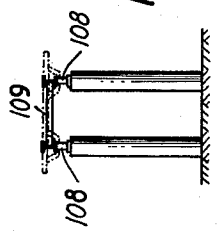


Fig. 17



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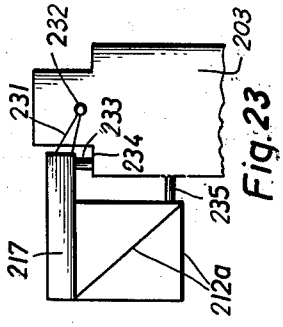


Fig. 23

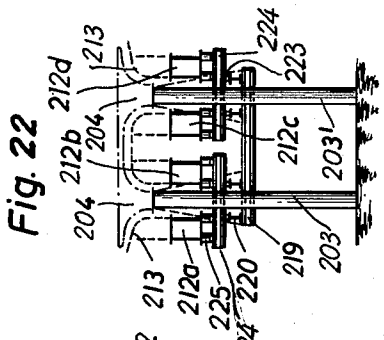


Fig. 22

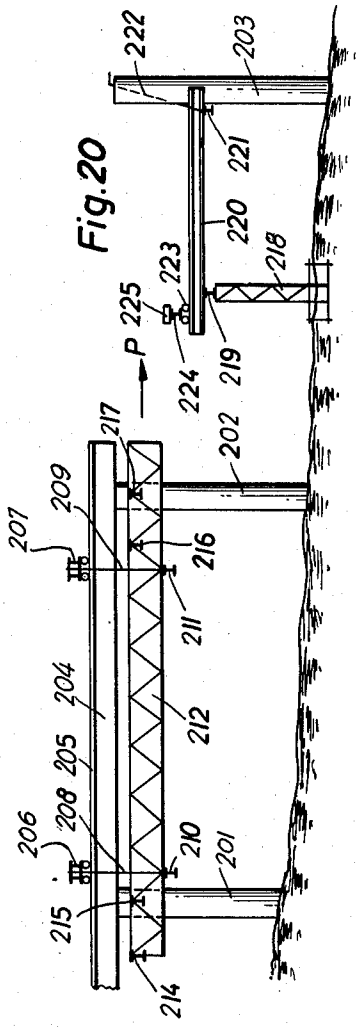


Fig. 20

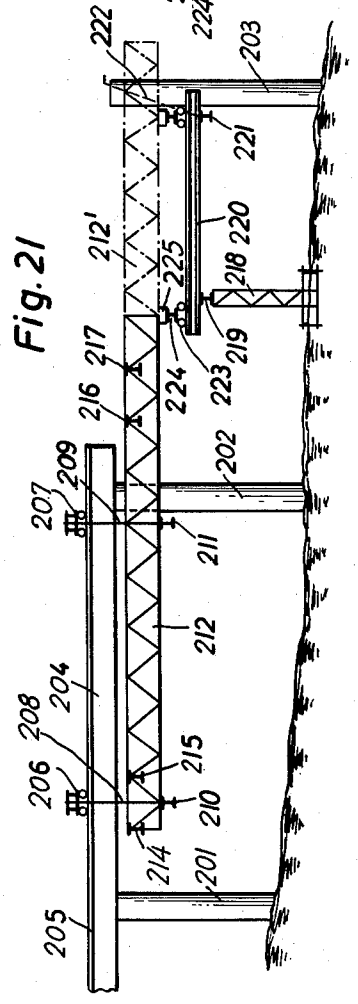


Fig. 21

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Fig. 26

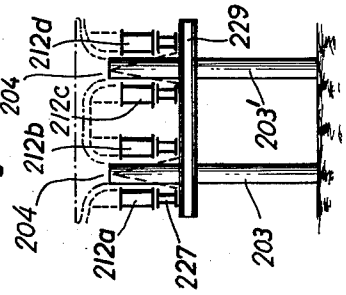


Fig. 24

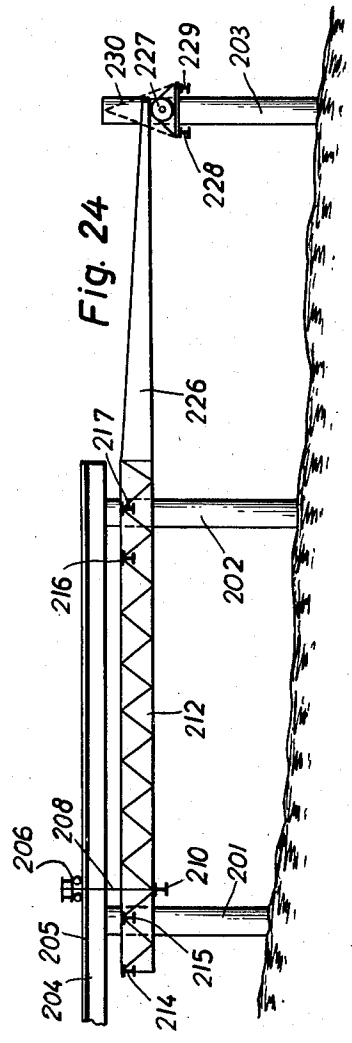
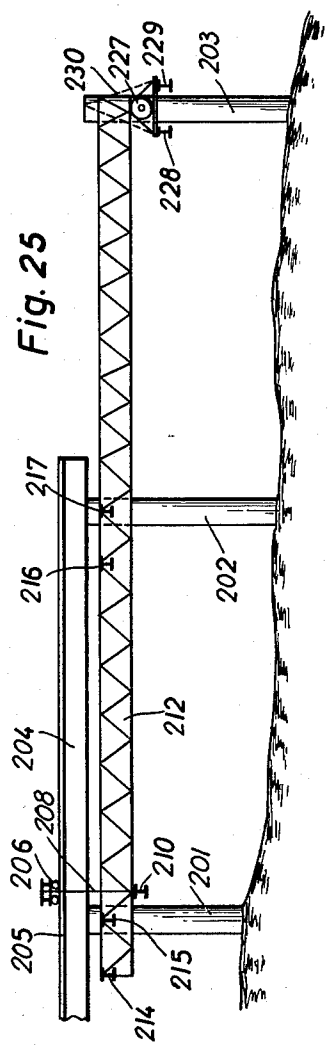


Fig. 25



United States Patent Office 3,003,219 Patented Oct. 10, 1961

3,003,219

METHOD AND MEANS FOR ERECTING ELONGATED STRUCTURES OF CONCRETE

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Filed May 9, 1960, Ser. No. 27,793
Claims priority, application Germany May 23, 1959
30 Claims. (Cl. 25—131.6)

Our invention relates to methods and means for erecting horizontally long structures of concrete, such as elevated highways, bridges and like elevated traffic structures. More particularly, our invention concerns a method and means for pouring in situ a plurality of elongated, longitudinally consecutive structural sections of concrete which extend horizontally between elevated portions of horizontally spaced upright supports.

Elevated roadways, bridges, and other traffic structures are commonly built by erecting a row of upright concrete columns spaced at substantially uniform distances from each other, and then joining the top portions of the columns by horizontal members which are poured in situ from a concrete mixture which may be reinforced with steel tension members in a well known manner. The forms in which the horizontal members are poured are relatively costly and it would be desirable to use the same forms for a plurality of consecutive horizontal structural members. Because of the long spans which can be bridged by a single horizontal concrete section, forms which extend from one upright to the next were heretofore not capable of being moved between consecutive pouring sites.

It has been previously proposed to build forms which extend beyond a completed horizontal section of the structure toward the next column to the extent necessary for the cantilevered mass of concrete to be secured to the finished structure, and to connect successive sections by interlocking their reinforcing tension members. However, a structure produced in this manner is unsatisfactory because of the resulting relatively close spacing of the joints in the concrete, which make it difficult, if not impossible to place such joints so as to correlate them with areas of low or zero bending moment. Furthermore, it is usually impractical to support such forms by scaffolding based on the ground beneath the structure where the columns are of substantial height or where the ground beneath is under water, covered by a building or structure, or otherwise not readily accessible.

Relating to the erection of elevated long structures of the general type described, it is an object of our invention to afford relatively long spans to be poured in a form or an assembly of forms which is readily movable along the length of the structure while being supported only by the columns, whereby the cost of forms and of supporting scaffolding is greatly reduced.

Another object of the invention is to permit placing the joints in the concrete substantially at will, and preferably at the areas of minimum or zero bending moment.

With these and other objects in view, and in accordance with the invention, we provide an elongated track member which has a longitudinal face portion adapted to form a track between adjacent elements of a pre-existing structure, which elements are to be joined by concrete sections poured in situ. The pre-existing structure consists essentially of a completed concrete section having a substantially horizontal surface which is to be extended by the newly poured sections, and of a plurality of upright support columns spaced from each other a predetermined distance. The track member is partially supported by elevated portions of these upright support columns which are aligned with each other and with the completed section.

We further provide means for mounting the track member on the pre-existing structure in such a manner that the track member may move longitudinally toward and away from a position in which one portion of the track member is supported on the completed concrete section, and so that another portion of the track member longitudinally spaced from the one portion mentioned is supported by one of the elevated support portions.

The form carrier member, on which the form assembly is to be erected for pouring additional concrete sections, is carried by the apparatus described so far and has at least one portion mounted on the track member for movement along the track formed by the face portion of the track member.

In a preferred specific embodiment of the invention, we provide a track member which is shaped and dimensioned to define a horizontally extending elongated track between adjacent upright supporting columns. We further provide means for mounting the track member on a completed horizontally extending concrete section adjacent to a free longitudinal end of the latter in such a manner, that the track member can be moved on the completed concrete section between a position in which a portion of the track is transversely aligned with the completed section, and another position in which the same track portion overhangs the free end of the completed section at least by the distance between the free end and the next adjacent supporting column so that the track member can be secure to the last-mentioned column. A form carrier member which is mounted on the track member can be moved along the track of the latter, and thus into a position in which it bridges the span between the free end of the completed concrete section and the adjacent column.

According to a preferred feature of the invention, the form carrier is suspended from the track member by means of a plurality of supporting frames which are in turn movable along the track. The track member which is located above the form carrier advantageously supports a conveyor for supplying a concrete mixture to a form carried by the form carrier.

Under special conditions, the apparatus of the invention may be employed without a track member if otherwise suitably modified.

Other features and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description of preferred embodiments thereof when considered in connection with the accompanying drawings in which like reference numerals designate like or corresponding parts throughout the several figures, and wherein:

FIG. 1 is a view in side elevation of a first embodiment of the invention;

FIG. 2 is a sectional view taken along the line II—II of FIG. 1;

FIG. 3 shows a detail of a second embodiment of the invention in a view corresponding to that of FIG. 2, but on an enlarged scale;

FIG. 4 is a fragmentary side elevation view of the apparatus of FIG. 3;

FIG. 5 shows a somewhat schematic fragmentary bottom view of the apparatus of FIG. 4;

FIG. 6 illustrates a modified detail of the apparatus of FIG. 5 on an enlarged scale, with some elements omitted for the sake of clarity;

FIG. 7 is a sectional view taken along the line VII—VII of FIG. 6;

FIG. 8 shows in plan view a detail of the device of FIG. 6;

FIG. 9 schematically illustrates in side elevation the hydraulic circuit of the device of FIG. 6;

FIG. 10 shows a detail of the apparatus of FIG. 5 in a different operating position;

FIG. 11 is a schematic view of the apparatus of FIG. 6, illustrating a different operating position;

FIG. 12 shows a modification of the apparatus of FIG. 6;

FIG. 13 is a simplified view in side elevation of the device of FIG. 12;

FIG. 14 is a bottom view of an additional modification of the apparatus of FIG. 6;

FIG. 15 is a side elevation of a further embodiment of the invention;

FIG. 16 is a front elevation view in section taken along the line XVI—XVI of FIG. 15;

FIG. 17 shows a corresponding section of the apparatus of FIG. 15 taken along the line XVII—XVII.

FIGS. 18 and 19 illustrate the apparatus of FIG. 15 in different respective operating positions;

FIG. 20 shows in side elevation a modified embodiment of the invention without a track member;

FIG. 21 shows the apparatus of FIG. 20 in a different operating position;

FIG. 22 is a front elevation of the apparatus of FIG. 21;

FIG. 23 is a schematic front elevational view on an enlarged scale of a detail of the apparatus of FIG. 20;

FIG. 24 illustrates an additional embodiment of the invention without a track member, the view being in side elevation;

FIG. 25 shows a modified version of the apparatus of FIG. 24 in a corresponding view; and

FIG. 26 is a front elevation of the devices of both FIGS. 24 and 25.

Referring now to the drawings in detail, and initially to FIG. 1, there is shown an elevated traffic structure in the process of erection by means of the apparatus of the invention. Four columns 4, 5, 6 and 7 are intended to support a continuous horizontal beam 8 of reinforced concrete. As may be seen in FIG. 2, there are two identical concrete structures side by side. Each element of the first structure has a counterpart in the second structure which is designated by the same reference numeral and distinguished by a prime. For the sake of simplicity, only one of the structures will be described in detail.

A track member or carrier track 1 is supported on the last completed section of the concrete beam 8, namely the section between the columns 5 and 6, by means of rollers 9 so that it is longitudinally movable on the upper face of the completed beam section. A form carrier 2 is suspended from the track member 1 by means of two C-shaped suspension frames 3 each of which is equipped with mounting blocks 10 in which wheels 11 are journaled. The wheels 11 travel along the top face of the track member 1 which constitutes a track therefor. To reduce friction between the beam 8 and the rollers 9, the upper face of the beam is protected by a track 19 on which rollers 9 travel.

In FIG. 1, the movable track member 1 is shown in a position in which its forward portion, as viewed in the direction of the arrow A, overhangs and extends beyond the free longitudinal end of the completed section of the beam 8, and this forward portion is supported on the column 7 by means of a block 17. To prevent any deviation of the track member 1 from straight horizontal motion when traveling on the rollers 9, the tail end of the track member 1 is held down by a counterweight 18.

A cross beam 15 connects the column 6 and 6' and a similar cross beam 15*a* connects column 5 with its corresponding opposite column (not shown). The cross beams 15, 15*a* support lifting devices or jacks 14 which can be reaised to support the form carrier 2 so as to transmit the weight of the carrier directly to the columns. The cross beams 15, 15*a* and the associated elements 14 are only temporarily secured to the columns 5 and 6. They are moved from column to column as the construction proceeds in the direction of the arrow A in FIG. 1.

The form assembly 12, 13, 20 has been omitted from the illustration of FIG. 1 in order not to obstruct the view of other elements, but it is clearly shown in FIG. 2.

The concrete beam 8 is of approximately T-shaped cross section and is enveloped by the C-shaped frames 3. The bight portion of each frame 3 is supported on the track member 1 which is an I-beam member. The pair of I-beams of track 1 enclose a conveyor 16, more clearly visible in FIG. 3 and further described below. The inwardly turned free bight ends of the frames 3 carry the twin beams of the form carrier 2 on which a platform 13 is mounted. The form 20 rests on the platform 13 and is reinforced by props 12 in a manner well known in itself.

The preferred material of construction for the form carrier 2 and for the structural elements by which it is secured to the elevated portions of columns 5 and 6 is steel, whereas the form 20 and its supporting props 12 may be of steel or wood.

The modified embodiment of the invention illustrated in FIGS. 3 and 4 differs from that shown in FIGS. 1 and 2 in a number of details. The track member 1 in this embodiment is supported by two trucks, of which only the front truck 21 is shown. The rollers or wheels 9 are rotatably mounted on the truck. A troughed belt conveyor 16 of usual construction is mounted in the space formed by the pair of I-beams of track member 1 and permits concrete mixture to be delivered to the form 20 in a particularly convenient manner. The free upper edges of the track member 1 are equipped with rails 22 on which the wheels 11 travel when the form carrier 2 longitudinally moves relative to the track member 1.

The wheels 11 are mounted on a carriage 24 equipped on its top side with mounting saddles 25. The suspension frame 3 is provided with mating wedge shaped projections 26 which are seated in the mounting saddles 25 and are held in firm engagement therewith by the weight of the frame 3 and of the elements carried by the frame. Screw jacks 14 are mounted on the cross beams 15 and permit the load of the form carrier 2, together with that of the form 20 and of its contents, as well as that of the frames 3, to be transmitted directly to the column 6 and 7. When the load is thus carried, the projections 26 are thereby disengaged from the mounting saddles 25, and the track member 1 together with its truck 21 and carriage 24 can be readily moved forward preparatory to pouring of the next section of the beam 8, or may even be withdrawn and employed on a laterally adjacent structure while the concrete of the last poured section is permitted to set or cure.

As shown schematically in FIG. 4, the carriages 24 are connected by a traction cable 27 which is trained around a pulley 28. This pulley is mounted by means of a bracket on the front end of the track member 1 for movement of the form carrier 2 along the track defined by the rails 22. While it is convenient to move the frames 3 jointly in the manner indicated, individual drive arrangements for each carriage 24 are also entirely feasible.

The two embodiments of the invention illustrated in FIGS. 1–4 are operated in substantially the same manner as follows:

A section of the concrete beam 8 approximately the same length as the spacing of the columns 4, 5, 6, 7 is poured in each step. The joints between sections are preferably located at the points of zero moment. The track member 1 is movably supported on the last completed section and overhangs the end of this section by the length of the next section to be poured. The forward

end of track member 1 is supported on the next column 7 by block 17. The form carrier 2 with the form 20 is then advanced into its new position. By adjusting jacks 14, the form carrier 2 is secured on the columns between which it now extends in such a manner that the weight of the concrete mixture poured from conveyor 16 is transmitted directly to the columns, and by raising projections 26 from saddle 25, the track member 1 is disengaged and free to be moved forward and backward for proper distribution of the concrete mixture in the form. When the form 20 is filled, the track member 1 may be withdrawn entirely and employed in the construction of an adjacent beam while the poured concrete mixture is permitted to set and cure.

As illustrated in FIG. 2, the apparatus of the invention may be used to advantage to construct two adjacent structures consisting of laterally spaced horizontal beams 8 and 8'. The steel reinforcing bars of the two concrete beams 8, 8' are positioned in the form to project into the gap between the beams 8, 8', so that the gap can later be filled with concrete mixture in the usual manner to form a closed reinforced concrete bridge deck or highway foundation.

FIGS. 5 to 14 illustrate several modifications of details in the means for supporting the track member 1 on the top face of the beam 8 so as to move the track member as required by the particular construction operations.

FIG. 5 shows in a schematic bottom view the track member 1 of FIG. 4 and also illustrates two trucks, a front truck 21 and a tail truck 29. Since, during operation of the apparatus of the invention, the front truck 21 carries the major portion of the load, it is equipped with a greater number of wheels 9 and these are mounted on the truck 21 in a more elaborate arrangement than are the wheels 32 of the tail truck 29, as is more fully described hereinafter. As shown in FIG. 4, the front truck 21 is secured to that portion of the track member 1 which is vertically aligned with the front end of the last finished section of the beam 8 when the track member 1 is in the forward position illustrated in FIGS. 1 and 4, that is, when the overhanging end of track member 1 bridges the gap between the two columns 6, 7 in which the next beam section is to be poured. The tail truck 29 is mounted under the rear end of the track member 1, preferably beneath counterweight 18 (FIG. 1). Both trucks 21 and 29 are rotatably mounted on the track member 1 by means of respective turntables 30 and 31.

The modified example 21' of a front truck, shown in some detail in FIG. 6, differs from the truck 21 of FIG. 5 essentially only by having two less pairs of wheels or rollers 9. It will be understood that the specific number, size and shape of the wheels or rollers employed to support any movable element of the structure described is generally a matter of design to suit specific conditions of loading. Generally, the term "wheel" as herein employed will be understood to include various substantially cylindrical means rotatably mounted on one element and making rolling contact with another element to transmit a load from one element to the other.

As seen in FIG. 6, the truck 21' is of substantially square outline when viewed from the bottom, and is equipped with four sets of wheels 33, 34, 35 and 36 which are mounted on swivel supports 46 (FIG. 8). These swivel supports are omitted in FIG. 6 for the sake of clarity. Each set of two wheels are respectively mounted on the two output shafts of a differential gear 39, the input shaft of each gear being driven by an individual electric drive motor 40. This differential gear arrangement permits the two wheels of each set to travel on a curved path at respectively different circumferential speeds in the manner well known from automotive vehicles. The differential gears 39 may also be employed to cause swiveling of a particular set of wheels when rotation of one of the two wheels is impeded.

The motors 40 are preferably geared down internally and are arranged to provide a selection of two speeds by change of pole connections so that the track member 1 may be advanced or retracted longitudinally at a relatively high speed, whereas the lower motor speed is available for actuating turning movement of the truck or for transverse movement. Alternately, instead of changing pole connections of a single motor 40, there may be provided two electric motors of different output speeds which may be selectively engaged with the input shaft of the differential gear 39 by means of electrically operated clutches (not shown).

Swiveling movement of each set of gears 39 can also be produced by a radial arm 41 which is the terminal element of an interconnecting control linkage not otherwise shown, causing the four wheel sets 33–36 to be swiveled in unison.

FIG. 6 shows also two fixed sets of idler wheels 37 and 38. The common axis of these wheels extends in the direction of a diameter of the turntable 30 and their fixed mounting on truck 21' thus does not interfere with rotation of the truck 21' on its turntable 30.

As may be seen from FIG. 7, which shows an elevational section of the truck 21' of FIG. 6, each set of swiveling wheels has an individual swivel turntable 42 supported on ball bearings 43. Forked angular wheel brackets 46 are pivoted to the turntable 42 by means of a pin 44, each bracket carrying a pair of wheels and their coordinated differential gears 39 and motors 40. A hydraulic jack 48, 50 (FIG. 7) is hingedly connected to each respective turntable 42 and to the free end of the corresponding forked wheel bracket 46 by means of respective pins 45 and 47. The fixed wheel sets 37 and 38 are similarly fastened directly to the body of the truck 21' by means of a forked pivoted bracket and a hydraulic jack 49.

FIG. 8 illustrates one of the swiveling wheel sets in a fragmentary plan view which shows the swivel supports 46 omitted from FIG. 6.

In FIG. 9 the hydraulic circuit of the several wheel sets of one side of the truck 21' of FIGS. 6 and 7 is shown schematically. A pressure line 51 connects the hydraulic jacks 48, 49, and 50 to a source (not shown) of hydraulic fluid under pressure, which source is connected to the pressure gauges 52. A surge tank 53, in which a fixed amount of gas such as air is trapped by the hydraulic fluid, communicates with the pressure line 51 and provides resilient action to the hydraulic medium. The several hydraulic wheel jacks are all of substantially identical construction with the same effective cylinder cross section, and the hydraulic system ensures that they all exert equal hydraulic pressure. The load is thus equally distributed over the wheels and their traction force is also equal because of the equalized friction.

The hydraulic system also compensates automatically for any major unevenness of the beam face over which the track member 1 travels, as shown in FIG. 9. Minor surface defects can be compensated for by using resilient wheel tires of solid rubber, foam rubber, or even pneumatic tires.

It will be understood that the desirable equalization of wheel load and wheel traction may also be accomplished by means other than the hydraulic system illustrated. There may be provided a compensating lever system, known as such, in which two sets of wheels coact and are pivotally connected with a cross member similar to the beam of a balance and on which two additional sets of wheels are pivotally mounted.

The hydraulic system described has the advantage of permitting the wheel sets to be raised and lowered. If separate hydraulic controls for the wheel sets of each side of the truck are available, it is possible to compensate for a slight slope of the face of the structure. An inclination of 3°, such as may be encountered in road bridges and the like, can readily be balanced. The hy-

draulic system also may be used to advantage if the track member **1** is to be raised or lowered for the purpose of setting it on stationary supports, as will be described in more detail below.

FIG. 10 shows the tail truck **29** of the apparatus of FIG. 5. Truck **29** is of much simpler construction than the front truck **21** since it is not called upon to sustain such great loads. Since only one set of wheels **32** is required on each side, the wheels can be arranged with their axes on a diameter of the turntable **31**, and the wheel sets need not be capable of swiveling individually on the truck **29**.

FIG. 11 shows the front truck **21'** in the position assumed after rotation through an angle of 90° from the position illustrated in FIG. 6 when it is desired to move the track member **1** transversely in the direction indicated by the arrow in FIG. 11. The movable sets of wheels **9** located in the corners of the square truck **21'** are first swiveled through 45° before the truck is rotated on its turntable **30** so that the axes of all wheels intersect the axis of rotation of the truck. The positions of the wheel sets may be altered by actuating movement of the respective differential gear while one of the wheels is arrested, or by means of the above-mentioned control linkage which acts on the radial arms **41** (FIG. 7). After the desired angular position of the truck **21'** is reached as shown in FIG. 11, the individual wheel sets are again rotated until the plane of rotation of each wheel is parallel to the intended direction of movement of the track member **1**.

The truck **21''**, shown in FIGS. 12 and 13 in bottom view and side elevation respectively, is equipped with six sets of wheels having axes of rotation fixed relative to the truck. Not all the wheel axes of truck **21''** pass through the axis of rotation of the truck turntable **30**. To permit rotation of the truck **21''**, from a position for example, of longitudinal to a position of transverse movement, there is provided a hydraulic jack **54** mounted on the track member **1** adjacent the truck **21''**. The piston member of the jack **54** forms an extensible leg for raising the track member **1**, and thereby the truck **21''**, from the face of the concrete beam section so that the truck may readily be turned, whereupon the extensible leg of jack **54** is retracted and the truck **21''** is lowered.

Another arrangement for permitting longitudinal and transverse movement of a track member is schematically shown in FIG. 14. The truck **21***a* is rotatably mounted on a turntable **30** and is equipped with a plurality of wheel sets **55** having transverse axes of rotation for longitudinal movement of the coordinated track member, and a plurality of wheel sets **56** having longitudinally extending axes for transverse movement of the track member. Each of the wheel sets is equipped with hydraulic lifting means similar to jacks **48**, **49** and **50** illustrated in FIG. 7, but the individual wheel jacks for truck **21***a* are individually controlled so that either the wheel sets **55** or the wheel sets **56** may be selectively lowered for contact with the face of the concrete beam while the other set is retracted.

Finally, for transverse movement of track **1**, only those wheel sets whose axes intersect the axis of rotation of the turntable **30**, such as the center sets of group **55**, may be lowered when it is desired to turn the truck **21***a* to an angular position intermediate those for longitudinal and transverse movement.

In all the embodiments of trucks illustrated, the drive motors **40** are preferably centrally controlled, and equipped with automatic devices which limit the movement of the track member during both longitudinal and transverse movement, as to the distance or the arc traveled during pivoting movement of the turntable, and also as to the speed during such linear or arcuate travel.

It has been found practical to dimension the track members for bridging gaps between columns as long as those commonly bridged by self-supporting reinforced concrete structures. Where the gaps are exceptionally long and the elevation above the ground is only moderate, it may be more advantageous, however, to erect temporary auxiliary columns bi-secting or even tri-secting the spacing between successive permanent columns. Except for dimensional changes, the arrangement of the invention is equally applicable to a method of construction in which such temporary auxiliary columns are employed. The auxiliary columns will support the apparatus of the invention in the same manner as the permanent columns described and illustrated.

Where the columns are of relatively small height, one end of the track member **1** may be supported in all successive steps on auxiliary columns which are movable and which are advanced with the track member as construction proceeds. With such an arrangement the front end of the track member need not necessarily be supported on the permanent columns. Such a modification will be understood not to exceed the scope of this invention.

The embodiment of the invention illustrated in FIGS. 15 to 19 is particularly well suited to the pouring of sections for a bridge or like structure which is either straight or uniformly curved. It has the added advantage over the examples of the invention illustrated and described so far, in that the completed sections of the structure are substantially unencombered and form a convenient work platform for transportation of the concrete mixture and for other building operations.

FIGS. 15, 18 and 19 show this embodiment of the invention in side elevation in somewhat schematic view, in several respective positions during the operation of the apparatus. A bridge slab **101** supported by a reinforced concrete beam **102** is to be extended over the tops of a row of consecutive upright columns **103** to **107**. The columns designated by odd reference numerals are permanent elements of the bridge to be built, whereas the columns **104** and **106** are temporary auxiliary structures and are intended to be removed after completion of the bridge. The temporary or auxiliary columns **104** and **106** are movable substantially without disassembly from one pouring site to another. As may be seen from FIGS. 17 and 18, the bridge structure includes two parallel rows of aligned columns and associated structures, each substantially a mirror image of the other, so that the detailed description of the elements of one row will be understood to apply to the other row as well.

Each of the columns **105**, **106**, and **107** in FIG. 15 carries a removable, block mounted roller **108** on which an elongated track member **109** is supported. The columns **103–107** of each row are arranged at equal distances from each other, and the length of the track member **109** is such that it is adapted to bridge the gaps between three consecutively adjacent columns. As shown in FIG. 15, the track member portion **109** is mainly supported by the columns **105** and **106**, and its cantilevered or overhanging portion **110** is releasably secured to the free end of the completed concrete member formed by the slab **101** and the beam **102** so that the weight of the track member **109** and of structural elements mounted thereon is partly transmitted to the column **104** which supports the free end **127** of the completed concrete member.

A form carrier **111–114** (FIG. 18) of a length exceeding the distance between two successive upright columns, such as **4**, **5**, and of an overall width similar to that of the finished bridge structure is suspended at its longitudinal ends from the cantilevered portion **110** of the track member **109** and from the completed concrete section **101**, **102** respectively. As better visible in FIG. 16, the form carrier consists of four longitudinal girder sections **111**, **112**, **113**, and **114** which are arranged in parallel alignment so that one pair of the girder sections flanks each row of upright columns. The two inner girders **112** and **113** thus are arranged between the two rows of

columns. It will be understood that the shape and size of the form carrier will depend on the dimensions and the weight of the concrete sections to be poured in a form at one time, and that the details shown are merely illustrative of a preferred embodiment of the invention.

For moving the form carrier, two trolleys **115** and **116** are movably mounted on the slab **101** and the cantilevered portion **109** of the track member respectively. The trolley wheels **117** travel along the substantially horizontal top surfaces of the slab **101** and track portion **110** to carry the form carrier **111–114** from the position illustrated in FIG. 15 to that shown in FIG. 18.

The several girder sections **111**, **112**, **113**, and **114** of the form carrier are provided with five cross members **122** to **126**. The cross members **122**, **123**, **124** and **125** are each interrupted in line with the two rows of upright columns, and the several sections of each of these cross members are fixedly fastened to the girder sections. The cross member **126** extends over the full width of the form carrier, as can best be seen from FIG. 16, and is releasably fastened to the several girder sections **111–114**. The columns **103–107** are equipped with removable projecting carrier elements (not shown) in the same manner as shown in FIG. 3, for example, to provide support for the cross beams, when desired.

As best seen from FIG. 16, the two trolleys **115**, **116** are each equipped with four hoists **119**, the cables **118** which can be respectively fastened to the four girder sections **111–114**. Additional hoisting members **130**, such as steel cables connected to winches (not shown), suspend the cross member **126** from the trolley **115**. The form **120** of wood or sheet metal is assembled on the form carrier and is reinforced by saddle-shaped props **121**.

The device illustrated in FIGS. 5 to 19 operates as follows:

As shown in FIG. 15, the pouring of the concrete section between the columns **103** and **104** has been completed and the concrete of this section has set and cured sufficiently to carry not only its own weight, but also to support the form and its contents during the pouring of the subsequent section. The free end **127** of the completed section projects beyond the column **104** a predetermined distance so that the joint with the succeeding section will be located in the area of zero moment.

The cantilevered end portion **110** of the track member **109** is secured to the free end **127** of the completed concrete section, and the form carrier is then lowered by means of the hoists **119** so that the form **120** is separated from the set concrete. The trolley **115** is positioned just ahead of the column **103** and the cross member **126** is suspended therefrom. The forward end of the form carrier is suspended from the trolley **116** which travels on the track member **109**.

The trolleys **115** and **116** are then moved along their respective tracks until the form carrier **111–114** reaches a position in which the releasable cross member **126** has almost reached the column **104** and the cross member **124** is aligned with this column and can be temporarily fastened to it. The cross member **126** is then detached from the cables **130**, the trolley **115** is moved rearward and the cross member **126** is again secured to the cables **130** in a position near the rear end of the form member. It is now possible to advance the form carrier to the longitudinal position shown in FIG. 18 in which a cross member **125** is aligned with the next column **105**, and the cross member **123** is aligned with the column **103**. The form carrier can be secured directly to the column **105** by means of the cross member **125** so that the trolley **116** is not loaded during the subsequent pouring operation.

When the trolley **116** is separated from the form carrier, the track member **109** can be released from the free end **127** of the completed concrete member and is removed from the pouring area by being rolled on the rollers **108** toward the column **107**. The form **120** is now accessible as seen in FIG. 20.

In order to reduce the free span of the form carrier during the subsequent pouring of concrete mixture, we prefer not to rely on the support given the rearward end of the form carrier by the cross member **123**, but to transmit at least a portion of the load to the projecting free end **127** of the previously completed concrete section. For this purpose, the free end **127** is formed with several vertical holes through which the cables **118** of the hoists **119** are passed from the trolley **115** to the cross member **124** or directly to the corresponding girder sections. When the holes are positioned very close to the end of the completed section, the joint formed with the subsequently poured section is particularly smooth and level. If desired, by thus supporting the end of the form carrier on cables, the cross member **123** may be entirely disconnected from the column **104**. The cross member **126** may be removed from the form carrier as shown in FIG. 19, during the concrete pouring, to be again attached to the form carrier on the other side of column **104** in a position similar to that shown in FIG. 15 relative to column **103**.

The trolleys **115**, **116** and their hoisting gear can be made lighter and less powerful if the several girder sections **111**, **112**, **113** and **114** are not to be moved jointly between successive pouring sites. The internal girder sections **112**, **113** may be transferred separately together with the corresponding portions of the form **120**, and the external sections **111**, **114** may then follow either jointly or in two separate operations. The form **120** is preferably arranged in such a manner that the portions which are in line with the two rows of columns can be folded over so that the form **120** will not interfere with movement of the form carrier, yet will not require complex disassembly and re-assembly during each pouring cycle. The proper vertical position of the form **120** is reached by hoisting the form carrier, and the form is secured in its properly aligned position with the previously completed concrete section when the carrier rests on the cross member **25** as shown in FIG. 19.

The embodiment of the invention illustrated in FIGS. 15 to 19 was described above in connection with the pouring of a straight, horizontal portion of a bridge. It is also well suited for curved portions, particularly when the radius of curvature of the successive sections is equal, and the use of the apparatus is not limited to perfectly horizontal structures. Inclined bridge ramps may readily be constructed with the aid of our apparatus, and it will be understood that the term "substantially horizontal" is deemed to apply to all traffic structures the slope of which is substantially less than 45°.

In FIGS. 20 to 26, there are shown several further embodiments of our invention in which a form carrier is capable of being moved forward along the intended location of elongated longitudinally consecutive concrete sections without requiring a track member.

Referring first to FIGS. 20–23, there are visible three columns **201**, **202**, and **203**, equally spaced from each other to support sections of a continuous bridge slab of which one section **204** is already completed. Section **204** is provided with rails **205** on which trolleys **206** and **207** travel in the longitudinal direction of the slab. Cables **208** and **209** are suspended from the trolleys and carry respective cross members **210** and **211**. The cross members support the form carrier **212** during the movement of the latter from one pouring site to the next. The form carrier **212** is equipped with cross ties **214**, **215**, **216** and **217** in two groups so that corresponding ones i.e., **214**, **216** and **215**, **217** are longitudinally spaced from each other by approximately the distance between two of the columns **201**, **202**, **203**. The function of these cross ties will become apparent later.

An auxiliary column **218** is arranged between the columns **202** and **203**, approximately equidistant from both, and supports a transverse beam **219**. This transverse beam carries one end portion of a quadruple auxiliary

track 220, the other end portion of which is suspended from the column 203 by means of a tension member 222. Trolleys 223 are guided on the track 220. As best visible in FIG. 22, the columns such as 203, 203' of the structure illustrated are arranged in twin rows with paired elements of the quadruple track 220 flanking each row. The trolleys 223 which travel on each of the tracks 220 carry twin beams 224 on which the four sections 212*a*, 212*b*, 212*c* and 212*d* of the carrier can be supported by means of pads 225.

The auxiliary column 218 (FIG. 20) and the quadruple track 220 are portable and relatively light in weight so that they can be shifted from one pouring site to the next as construction proceeds. The auxiliary structure can be moved by a revolving crane commonly available at construction sites for raising concrete mixture and other building materials, and such a crane greatly facilitates the assembly of the auxiliary structure. This crane is needed only during the forward movement of the form carrier from one pouring site to the next.

During pouring and during the subsequent setting or curing period of the concrete, the form carrier is supported at its forward end by the column 203 which is part of the lasting bridge structure. The engagement between the front portion of the form carrier and the top portion of the column 203 is shown in some detail in FIG. 23, which illustrates a front elevation of the apparatus of FIG. 20 on an enlarged scale.

The cross tie 217 projects laterally beyond the form carrier section 212*a* and extends into a recess 234 at the top of the column 203. The cross tie 217 is secured in its engaged position by means of chains or cables 231 which pass through a horizontal opening 232 in the column. A hydraulic jack 233 is interposed between the cross tie 217 and the horizontal face of the recess 234 on which the weight of the form carrier section 212*a* rests. A spacer block 235 secures the carrier section against accidental tilting.

The apparatus illustrated in FIGS. 20 to 23 operates as follows:

In the position illustrated in FIG. 20, the form carrier 212 is ready for forward movement to the next pouring site. During the preceding pouring operation it was suspended from the columns 201 and 202 in the manner indicated in FIG. 23, but it is now to be lowered as shown in FIG. 22 so that the form 213 is no longer in contact with the completed section 204. The spacer blocks 235 have been removed, and the weight of the form carrier 212 with the empty form 213 is carried by the trolleys 206 and 207 which are equipped with hoists (not shown) as previously described in connection with FIG. 16.

The form carrier 212 is moved forward in the direction of the arrow P from the position illustrated in FIG. 20 towards that shown in FIG. 21 through a distance equal to the spacing between the cross ties 214 and 215 (or between the ties 216 and 217) whereby the ties 214 and 216 are aligned respectively with the columns 201 and 202 and are then secured to these columns. This permits the trolleys 206, 207, with their cables 208 and 209 and the suspended cross members 210, 211, to be shifted rearwardly by a distance about equal to the spacing between the cross ties 214 and 215. The form carrier 212 is then released from the columns 201 and 202 and can be carried by the trolleys 206, 207 to the position shown in fully drawn lines in FIG. 21 in which the front end of the form carrier 212 is seen to overhang the cross member 211 to such an extent that it must be supported for further forward movement.

The trolley set 223 is placed under the form carrier 212. After a further short advance, the front end is lifted off the pad 225 by the cross member 211 and the trolley 223 is moved rearward, whereupon the final position 212' indicated in FIG. 21 by broken lines, can be reached. The form carrier is then secured on the columns 202 and 203 by means of the cross ties 215 and 217, and raised to the proper pouring position of the form 213. The auxiliary column 218 and the quadruple track are shifted to the space between the next two columns for a subsequent cycle of operations.

The spans between permanent columns that can be erected with the apparatus shown in FIGS. 20 to 23 are relatively short, but the equipment is quite simple, easily transported, and suitable for both straight and curved traffic structures.

The need for an auxiliary column such as 218 can be avoided by the modified embodiments of our invention shown in FIGS. 24 to 26. The form carrier 212 is substantially identical with that of the aforedescribed apparatus of FIGS. 20–23. Its front end carries a longitudinal extension member 226, relatively light in structural strength and weight and adapted only to carry the form carrier 212 with the empty form across the gap between successive columns. The length of the extension member 226 is approximately equal to that of the form carrier 212 and to the spacing between successive columns so that the overall length of the form carrier with its extension member is sufficient to bridge the gap from column 201 to column 202, and further to column 203.

Rollers 227 are mounted on a frame which includes two beams 228 and 229 and which is suspended from the top of the column 203 by means of tension members 230 such as chains or cables. The front end of the extension member 226 rests on the rollers 227 when the form carrier 212 is longitudinally positioned for pouring a concrete section between the columns 201 and 202.

The condition of the apparatus illustrated in FIG. 24 is reached after completion of the concrete section 204 when the form can be lowered from the adequately cured concrete. The weight of the form carrier 212 and of the empty form has been transferred to the trolley 206 near the rear end of the form carrier, and at the front end to the rollers 227. When the trolley 206 is moved along the top surface of the concrete section 204 toward the right, as viewed in FIG. 24, the extension member 226 moves on the rollers 227 until it eventually engages a similar roller arrangement on the next column (not shown) and the form carrier 212 is in longitudinal position for the next pouring step. The form carrier of the apparatus of FIG. 24 is raised and lowered by hydraulic jacks in the manner shown in FIG. 23.

The embodiment of the invention illustrated in FIG. 24 is of greatest simplicity both in its structure and in its operating characteristics, but it is limited in its economical application to straight or slightly curved roads or bridges. Curves of relatively short radius of curvature can be negotiated without special adaptation of the apparatus only when the radius of curvature is constant.

For relatively short spans between columns and straight lengths of roadway or bridge slab, the embodiment shown in FIG. 25 is most adaptable. It differs from the device shown in FIG. 24 mainly in a form carrier 212 the length of which is adequate to bridge the gaps between three successive columns. A form carrier of such length can be advanced without any auxiliary columns or special extension members. Its front end is supported on rollers 227 in the same manner as the extension member 226 illustrated in FIG. 24. Although the form carrier has almost twice the length of those heretofore described, it is used with a form of usual dimensions, that is, of a length about equal to the spacing of two successive columns. Whereas the position of the form is rather closely determined on the form carriers shown in the preceding examples of the apparatus of the invention in which the length of the form carrier varies substantially between the spacing of successive columns and a value one-and-one-half times this spacing, the location of the form may be selected more freely on the form carrier shown in FIG. 25. The apparatus of this embodiment is thus bet-

ter adapted to irregularly spaced columns and other variations in operating conditions.

Rapid and convenient shifting of the form carrier in the several embodiments of the invention in which the rear end of the form carrier is directly supported on the pre-existing structure, that is, on the surface of a completed concrete section, is greatly facilitated by the fact that the form carrier is somewhat longer than the spacing between successive columns, and that its rear end thus projects rearward in the pouring position beyond the column which bounds the gap over which a concrete section is being poured. A transverse member located on the projecting portion (**214** in FIGS. 20, 24, 25; **122** in FIG. 15) is adapted to carry the load of the form carrier for the brief period required for shifting trolleys to permit completion of the advance movement in a single additional stroke.

The form carrier as well as the forms for pouring the concrete sections are preferably made of light metals such as aluminum alloys to reduce their weight, for greater portability, which has an important bearing on the ease of operation of our apparatus.

It is to be understood, of course, that the foregoing disclosure relates only to preferred embodiments of the invention, and that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of the disclosure which do not constitute departures from the spirit and scope of the invention set forth in the appended claims.

We claim:

1. The method of erecting an elevated horizontally long structure of concrete by consecutively pouring in situ a plurality of elongated longitudinally consecutive concrete sections extending between elevated portions of a row of upright supports horizontally spaced from each other, which comprises the steps of suspending an assembly of forms between a first and a second one of the upright supports, pouring concrete for a first horizontally extending section into said assembly to connect said first and second supports, mounting a track member between said first section and a third one of said upright supports, releasing said form assembly from said first section and suspending said form assembly from said track member, moving said form assembly along said track member to a position between said first section and said third upright support, suspending said form assembly between said first section and said third upright support, and pouring the next section of concrete into said form assembly.

2. In an apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between elevated portions of upright supports horizontally spaced from each a predetermined distance, a track member adapted to define a horizontally extending elongated form-supporting track of a length at least sufficient to span the distance between adjacent ones of said upright supports; means for movably mounting said track member on a completed one of said sections so that its forward end can be temporarily located at a first position adjacent to and transversely aligned with a free longitudinal end of said completed section and for longitudinal movement of said track member on said completed section between said first position and a second position in which said forward end of said track member overhangs said free end of said completed section at least by the distance between said free end and a next adjacent one of said supports, means for temporarily supporting said forward end of said track member on said next adjacent support; and a form carrier member movably mounted on said form-supporting track for movement therealong to support said movable forms while concrete is poured in the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

3. Apparatus for erecting horizontally long concrete structures by consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between elevated portions of upright supports horizontally spaced from each a predetermined distance, comprising a track member adapted to define a horizontally extending elongated form-supporting track of a length at least sufficient to span the distance between adjacent upright supports; means for movably mounting said track member on a completed one of said sections so that its forward end can be positioned at a first position adjacent to and transversely aligned with a free longitudinal end of said completed section and for longitudinal movement of said track member on said completed section between said first position and a second position in which said forward end of said track member overhangs said free end of said completed section at least by the distance between said free end and a next adjacent one of said supports, whereby said forward end of said track member is in a position to be secured to said next adjacent support; a plurality of supporting frames each mounted on said track member for movement along said track, and a form carrier member secured to said supporting frames for movement together therewith along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

4. Apparatus as set forth in claim 2, comprising conveying means mounted on said track member for conveying a concrete mixture along said track member to a form carried by said form carrier member.

5. Apparatus for erecting horizontally long concrete structures by consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between elevated portions of upright supports horizontally spaced from each a predetermined distance, comprising a track member adapted to define a horizontally extending elongated form-supporting track of a length at least sufficient to span the distance between adjacent upright supports; means for movably mounting said track member on a completed one of said sections so that its forward end can be positioned at a first position adjacent to and transversely aligned with a free longitudinal end of said completed section and for longitudinal movement of said track member on said completed section between said first position and a second position in which said forward end of said track member overhangs said free end of said completed section at least by the distance between said free end and a next adjacent one of said supports, whereby said forward end of said track member is in a position to be secured to said support; said means for mounting said track member comprising two truck means longitudinally spaced on said track member, and wheel means on said truck means arranged for supporting said track member and alternatively rotatable about two horizontally extending axes respectively transverse of and parallel to the direction of elongation of said track, and a form carrier member mounted on said track member for movement therealong to support said movable forms while concrete is poured in the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

6. Apparatus as set forth in claim 5, comprising pivot means interposed between said track member and one of said truck means for pivoting movement of said truck means about an upright axis.

7. In apparatus as set forth in claim 5, said wheel

means including a plurality of wheels arranged for supporting said track member and rotatable about respective horizontally extending axes, and a plurality of bracket means interposed between said truck means and respective ones of said wheels, each of said bracket means being pivotable on said truck means about an upright axis.

8. In apparatus as set forth in claim 2, said means for movably mounting said track member including a plurality of wheels arranged for supporting said track member and rotatable about respective horizontally extending axes transverse of the direction of elongation of said track, and hydraulic means interposed between said track member and at least one of said wheels for varying the spacing between the axis of said wheel and said track member.

9. In apparatus as set forth in claim 2, said means for mounting said track member including a plurality of wheels arranged for supporting said track member and rotatable about respective horizontally extending axes transverse of the direction of elongation of said track, and hydraulic means interposed between said track member and said plurality of wheels for jointly varying the spacings between the respective axes of said wheels and said track member.

10. In apparatus as set forth in claim 9, said hydraulic means including a plurality of hydraulic pressure elements interposed between said track member and respective ones of said wheels for urging movement of the axes thereof in a direction away from said track member with substantially equal respective forces.

11. In apparatus as set forth in claim 10, said pressure elements including each a hydraulic cylinder of substantially equal effective cross sectional area, and said hydraulic means further including a common source of hydraulic fluid connected to each of said cylinders.

12. In apparatus as set forth in claim 2, said means for movably mounting said track member including two sets of wheels arranged for alternatingly supporting said track member, said wheels being rotatable about respective horizontally extending axis, the axes of one set of wheels being transverse of the direction of elongation of said track, and the axes of the other one of said sets being transverse of the axes of said one set; and means interposed between said track member and one of said sets for moving the wheels of the latter between a position in which they project beyond the wheels of the other set for supporting said track member, and a second position in which they are retracted behind the wheels of the other set for support of said track member by said other set of wheels.

13. Apparatus as set forth in claim 2, comprising a plurality of drive means, said means for movably mounting said track member having a plurality of wheels, each of said wheels being driven by a respective one of said drive means.

14. Apparatus as set forth in claim 2, comprising drive means, said means for movably mounting said track member having two wheels; and a differential gear interposed between said drive means and said wheels for transmitting movement of said drive means to said wheels at different respective speeds.

15. In apparatus as set forth in claim 2, said means for movably mounting said track member comprising a wheel and a leg member mounted on said track member and having respective supporting portions spaced from said track member for contact with said completed element; and pressure actuated extension means interposed between said track member and one of said supporting portions for varying the spacing of said one supporting portion from said track means, whereby said track member may be alternatively supported on said completed element by said wheel and said leg member.

16. Apparatus as set forth in claim 2, comprising means for controlling the movement of said track member relative to said completed section.

17. Apparatus as set forth in claim 2, comprising a plurality of supporting frames, a plurality of carriage means mounted on said track member for movement along said track, a first connecting means on each of said carriages, a second connecting means on each of said supporting frames and releasably engageable with a corresponding one of said first connecting means, said form carrier being secured to said supporting frames and releasably mounted by said connecting means on said track member.

18. Apparatus as set forth in claim 17, comprising a tension member connecting said plurality of carriage means for joint movement along said track.

19. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between elevated portions of upright supports horizontally spaced from each other, comprising a completed structural section having a horizontally extending elongated face portion, the face portion having a longitudinal end; a track member defining an elongated form-supporting track thereon; means for mounting said track member on said face portion adjacent said end with said track extending longitudinally in the direction of elongation of said face portion, said track member being longitudinally movable relative to said face portion into and out of a position in which a portion of said track member overhangs said end; and a form carrier member mounted on said track member for movement along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to said position to form a next section to be poured.

20. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between a completed concrete section having a substantially horizontal face and elevated portions of upright supports, said elevated portions being horizontally spaced from each other and from said completed section a predetermined distance in aligned relationship, said initial section and said elevated portions constituting the elements of a pre-existing structure, the apparatus comprising an elongated track member having a face portion adapted to form a track between three adjacent ones of said elements; means for movably mounting said track member on two of said elevated portions consecutively adjacent said completed section for longitudinal movement of said track member between a first position in which one portion of said track member is supported on said completed section and another portion of said track member longitudinally spaced from said one portion is supported by said two elevated portions, and a second position in which said one portion is spaced from said completed section, an elongated form carrier member having an end portion mounted on said track member for movement along said track; and carrier means secured to a portion of said form carrier member longitudinally spaced from said end portion and adapted to move on said horizontal face of said completed concrete section, whereby said form carrier member is jointly supported by said completed section and said track member and longitudinally movable relative thereto along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

21. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending from a completed concrete section having a sub-

stantially horizontal face, comprising a plurality of upright supports each having an elevated portion, said elevated portions being horizontally spaced from each other and from said completed section a predetermined distance in aligned relationship, said initial section and said elevated portions constituting the elements of a supporting structure; an elongated track member having a face portion adapted to form a track between adjacent ones of said elements; means for movably mounting said track member on said supporting structure for longitudinal movement of said track member toward and away from a position in which one portion of said track member is supported on said completed section and another portion of said track member longitudinally spaced from said one portion is supported by one of said supports; and a form carrier member having a portion mounted on said track member for movement along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

22. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending from a completed concrete section having a substantially horizontal face, comprising a plurality of upright supports each having an elevated portion, said elevated portions being horizontally spaced from each other and from said completed section a predetermined distance in aligned relationship, said initial section and said elevated portions constituting the elements of a supporting structure; an elongated track member having a face portion adapted to form a track between adjacent ones of said elements; means for mounting said track member on said supporting structure for longitudinal movement of said track member toward and away from a position in which one portion of said track member is supported on said completed section and another portion of said track member longitudinally spaced from said one portion is supported by one of said supports; an elongated form carrier member; and alternative mounting means for movably mounting said carrier member movable along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured on said track member for movement along said track, and for releasably securing said form carrier member to one of said upright supports.

23. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between a completed concrete section having a substantially horizontal face and elevated portions of upright supports, said elevated portions being horizontally spaced from each other and from said completed section a predetermined distance in aligned relationship, said initial section and said elevated portions constituting the elements of a pre-existing structure, the apparatus comprising an elongated track member having a face portion adapted to form a track between adjacent ones of said elements; means for mounting said track member on said pre-existing structure for longitudinal movement of said track member toward and away from a position in which one portion of said track member is adjacent said completed section and another portion of said track member longitudinally spaced from said one portion is supported by one of said upright supports for releasably securing said adjacent portion to said completed section, and a form carrier member having a portion mounted on said track member for movement along said track to support said movable forms while concrete is poured into the latter to produce a respective section and for subsequently advancing said forms along said track member to a location between said free end and said next adjacent support to form a next section to be poured.

24. In an apparatus for consecutively pouring in situ a plurality of elongated longitudinally consecutive concrete sections horizontally extending between a completed concrete section having a substantially horizontal face portion and elevated portions of upright supports, said elevated portions being horizontally spaced from each other and from said completed section in aligned relationship, an elongated form carrier member adapted to extend from said completed concrete section to an adjacent one of said upright supports; mounting means secured to said form carrier member and movable on said face portion of said completed concrete section for longitudinal movement of said form carrier member toward and away from a position in which a front portion of said form carrier engages said adjacent upright support; and means for releasably securing said front portion to said upright support.

25. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between a completed concrete section having a substantially horizontal face portion and a plurality of upright supports horizontally spaced from each other and from said completed section a predetermined distance in aligned relationship, the apparatus comprising an elongated form carrier member having a length not substantially smaller than said predetermined distance and not substantially greater than one-and-one-half times said distance, whereby said form carrier member is adapted to extend from said completed concrete section to an adjacent one of said upright supports to support said movable forms while concrete is poured into the latter to produce a respective section; mounting means secured to said form carrier member and movable on said face portion of said completed concrete section for longitudinal movement of said form carrier member toward and away from a position in which a front portion of said form carrier member engages said adjacent upright support; an auxiliary upright support spaced from said front portion when in said position by substantially one half of said distance along said form carrier member; means for releasably securing said front portion to said adjacent upright support; and means for supporting a portion of said form carrier member on said auxiliary upright support.

26. Apparatus for consecutively pouring in situ and into movable forms a plurality of elongated longitudinally consecutive concrete sections, comprising a completed concrete section having a substantially horizontal face portion; an upright support horizontally spaced from said completed section by a predetermined distance; an elongated form carrier member having a length not substantially smaller than said predetermined distance and not substantially greater than one-and-one-half times said distance, whereby said form carrier member is adapted to extend from said completed concrete section to said upright support to support said movable forms while concrete is poured into the latter to produce a respective section; mounting means secured to said form carrier member and movable on said face portion of said completed concrete section for longitudinal movement of said form carrier member toward and away from a position in which a front portion of said form carrier member engages said upright support; auxiliary support means extending from said upright support in a direction toward said completed concrete section; means for releasably securing said front portion to said upright support; and means for movably supporting a portion of said form carrier member on said auxiliary support means as said carrier member moves toward said position thereof.

27. Apparatus for consecutively pouring in situ and into

movable forms a plurality of elongated longitudinally consecutive concrete sections horizontally extending between a completed concrete section having a substantially horizontal face portion and elevated portions of upright supports, said elevated portions being horizontally spaced from each other and from said completed section in aligned relationship, the apparatus comprising an elongated form carrier member adapted to extend from said completed concrete section to an adjacent one of said upright supports; a longitudinal extension member on a front portion of said form carrier member; mounting means secured to said form carrier member and movable on said face portion of said completed concrete section for longitudinal movement of said form carrier member toward and away from a position in which said front portion is aligned with said upright support in a transverse direction and said extension member projects beyond said adjacent upright support; and means for releasably securing said front portion to said upright support.

28. Apparatus as set forth in claim 27, the length of said form carrier member being at least equal to the spacing of said adjacent upright support from said completed concrete section.

29. Apparatus as set forth in claim 27, the combined length of said form carrier and of said extension member being substantially equal to twice the spacing of said adjacent upright support from said completed concrete section.

30. Method according to claim 1, said form assembly being positioned between said first and second upright supports and subsequently between said first section and said third support in such manner that a gap is formed between said first section and said next section which gap is located at the point of zero moment of said sections.

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