Sept. 12, 1967 J. D. NAILLON 3,341,639

METHOD FOR GROUTING GIRDERS SUPPORTING CONCRETE SLABS

Filed Dec. 21, 1964

2 Sheets-Sheet 1

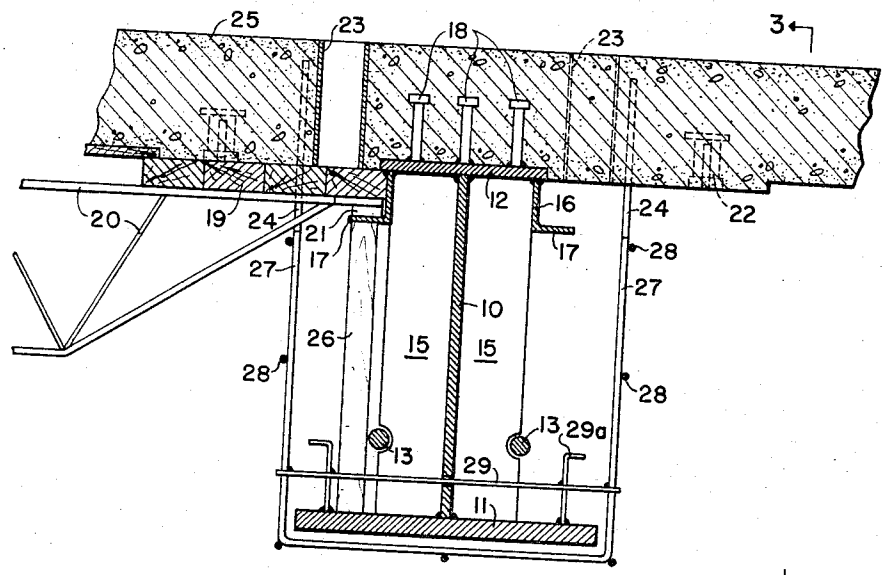

FIG. 2

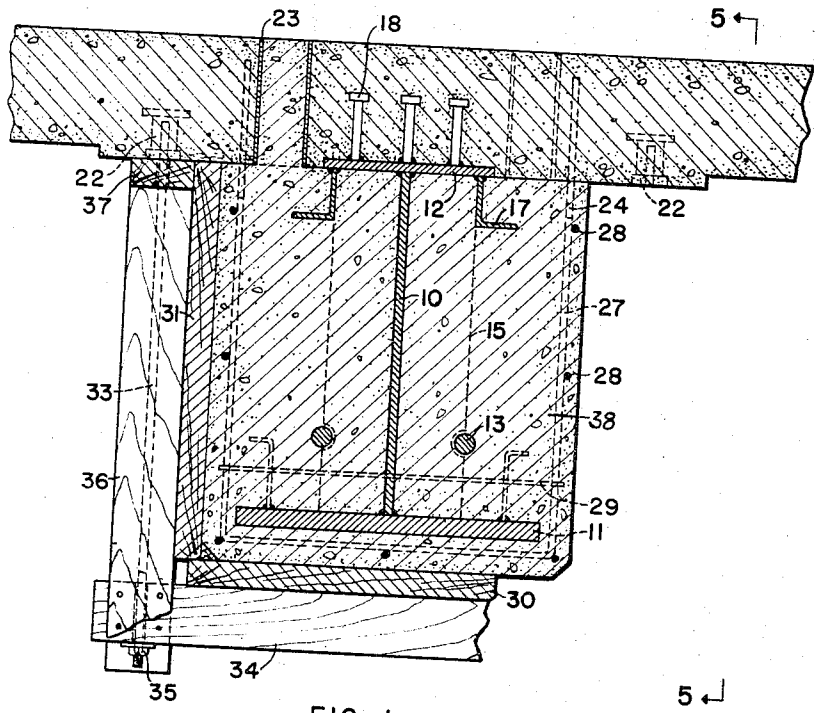

FIG. 1

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2 Sheets-Sheet 2

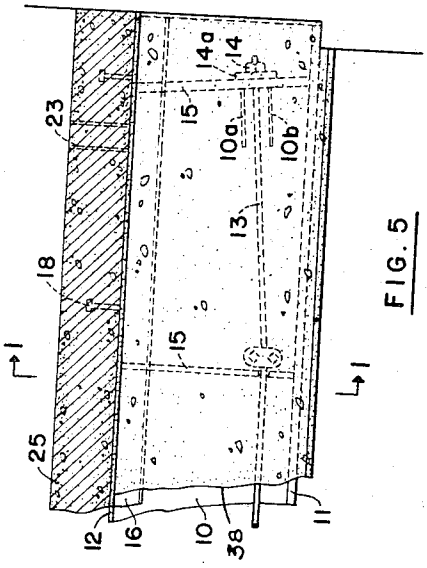

FIG. 5

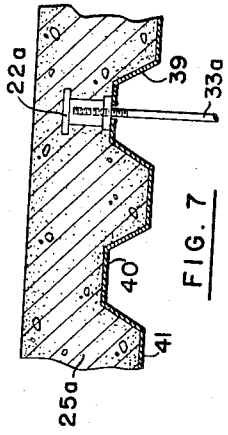

FIG. 7

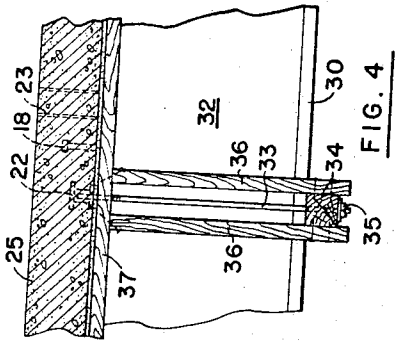

FIG. 4

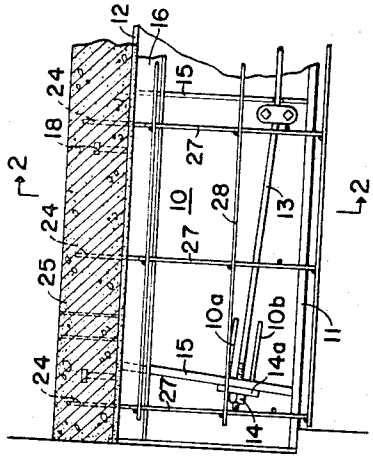

FIG. 3

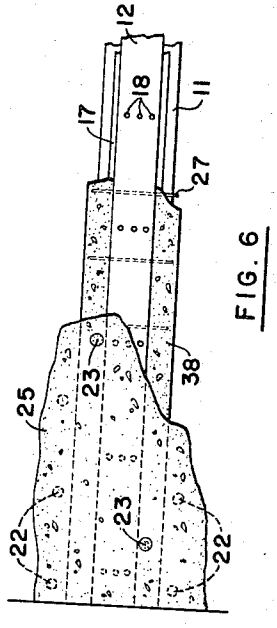

FIG. 6

United States Patent Office 3,341,639
Patented Sept. 12, 1967

3,341,639

METHOD FOR GROUTING GIRDERS SUPPORTING CONCRETE SLABS

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Filed Dec. 21, 1964, Ser. No. 419,714
3 Claims. (Cl. 264—35)

The invention relates to a method of applying grout to a metallic beam, truss or girder (all herein generically called girders, for convenience) which girder supports a concrete slab, and to a grouting form, including supporting means therefor, suitable for practicing the method. The invention is, for example, suitable for applying grout to a girder which is situated wholly or partly below a concrete slab, such as a floor slab of a building or roadway of a bridge, to fire-proof the girder.

In many constructions the concrete slab is bonded to the supporting girder so as to carry a part of the compressive stress of the top flange or, in some constructions, even to replace the top flange, and the invention is applicable to such constructions. The girder may be of any desired construction, e.g. a truss, an I-beam, or a composite beam, such as a prestressed girder with tensioning cables or rods, as shown in my U.S. Patent No. 3,010,257.

A difficulty in applying grout to encase such support girders has been that of mounting and supporting the grouting form in a manner to permit the form to be stripped from the hardened grout, and such forms have usually been supported from below, e.g., on posts or on scaffolding resting on the ground or floor below the girder. Also, the injection of the grout into the form through holes provided through the form walls is inconvenient and has made it difficult to fill the form completely with grout to the level of the underside of the supported concrete slab.

According to this invention these difficulties are obviated by providing a grouting form under the concrete slab adjacently to the girder and surrounding the latter, providing one or more holes which extend through the slab and communicate with the interior of the form, and injecting grout through said hole(s) to fill the form completely from the top. Further, according to a feature of the invention the form is supported from the concrete slab, e.g., by connectors, such as internally threaded ferrules embedded in the concrete slab. These ferrules may be carried by, e.g., fixed to, a sheet-metal or other structural element that forms a part of the concrete slab.

Usually the grouting form encloses the bottom and both sides of the girder, and the concrete slab projects bilaterally from the girder. In such cases it is advantageous to provide holes in the concrete slab on both sides of the girder, preferably arranged in rows and staggered longitudinally. However, in some instances, as when the girder is situated at a wall, the supported slab may extend to only one side of the girder, away from said wall, and the form then encloses only the bottom and one side of the girder.

The grouting holes in the supported concrete slab may be formed by placing plugs at the hole locations before casting the slab and removing the plugs after partial or complete set of the slab. However, other techniques may be used, e.g., mounting metallic sleeves at locations to extend through the concrete slab and permitting the sleeves to remain in the slab after hardening. It is preferred to fill the grouting form and these holes with grout,

e.g., while pouring the grout into the form, and to finish the grout within the holes to be flush with the top surface of the slab.

Any type of grout conforming to building codes may be used. This may include refractory or fire-resistant aggregate.

The connectors for suspending the grouting form from the slab may be internally threaded, metallic ferrules, secured to the slab, e.g., embedded within the concrete slab and/or fixed, as by welding, to a metallic deck that forms a part of or supports the slab. However, any type of connector supported by the slab or a part thereof which permits the grouting form to be detached therefrom may be used.

The grouting form includes confining walls of any desired outline and number, in accordance with the desired shape of the finished, hardened grout casing. In the simplest embodiment illustrated, the walls include a flat bottom and flat vertical side walls, and U-shaped hangers, the latter comprising vertical suspension rods having threaded connections with the connectors, specifically, rods having external threads engaging internally threaded ferrules in the slab. However, other forms of connection, such as bayonet-type fittings, may be used. The side walls of the form preferably extend fully to the underside of the slab, but a hermetic seal to the slab at the top of the side walls is not essential. In fact, at least at one region of the form, it is desirable that a clearance for the escape of air be provided.

The invention will be further described with reference to the accompanying drawings, forming a part of this specification and showing two preferred embodiments, wherein:

FIGURE 1 is a sectional view of the grout-encased girder, taken on the line **1—1** of FIGURE 5 but shown to an enlarged scale, a part of the form being broken away to show the finished grouting;

FIGURE 2 is a similar sectional view, taken on the line **2—2** of FIGURE 3 but shown to an enlarged scale, showing the construction of the truss-work employed in emplacing the slab;

FIGURES 3, 4 and 5 are fragmentary views of successive portions of the girder along its length, the first showing the girder before applying the grouting form, the second showing the outside of the grouting form and support hanger, and the third the exteriors of the grout-encased girder, FIGURES 3 and 5 being taken on the lines indicated by the section lines shown in FIGURES 2 and 1, respectively;

FIGURE 6 is a fragmentary plan view of the slab, parts being broken away to show the girder and grout; and

FIGURE 7 is a fragmentary sectional view of a modified deck to which the invention may be applied.

Referring first to FIGURES 2, 3, 5 and 6, the girder may be a prestressed girder of the type described and shown in my aforesaid patent, U.S. No. 3,010,257, including a vertical web **10**, lower and upper flanges **11** and **12**, and a pre-stressing system including cables or rods **13**, situated one on each side of the web and preferably secured thereto at intervals and anchored at their ends to the girder by suitable means under high tension so as to reduce the compressive stress on the upper flange **12**. For example, the web may carry vertical stiffening plates **15** welded thereto and having recesses to accommodate the cables **13** and at least the plates at the ends being welded to the bottom and lower flange. Each end of the cables

13 is anchored to the girder through one of the end stiffening plates by a nut 14 and a washer 14*a*, in the manner described in the aforesaid patent.

According to an optional feature, horizontal stiffener plates 10*a*, 10*b*, are welded to the web and to the end vertical plates 15, situated respectively above and below the cable or rod 13, to transmit stress to the web, as also described in the aforesaid patent.

Also according to an optional feature, a scaffold-supporting ledge is provided by the girder, e.g., in the form of a structural angle 16 which is welded to the top flange 12 at each side of the web, adjacently to the stiffening plates 15, the angle being positioned so that the horizontal flanges 17 extend laterally outwards from both sides of the girder in spaced relation beneath the upper girder flange 12. The top of the girder may further carry, e.g., have welded to the upper flange 12, bonding members 18 which extend upwardly into the concrete slab to be described. These bonding members may take the form of transverse plates or, as shown, studs; they serve to transmit compressive stress from the top of the girder to the supported concrete slab.

The supported concrete slab is cast on temporary planks 19 (which may be made suitably impervious to leakage) supported on truss works 20 which extend transversely to the girder at intervals, each truss spanning the interval between parallel girders. The ends of the truss works may be supported at their ends on the flanges 17 through removable bearing plates 21, which are of thickness to bring the planks 19 to the desired level. The planks and truss works are, therefore, supported from the girders. Connectors, e.g., internally threaded metal ferrules 22, are mounted on the planks, preferably in pairs on opposite sides of the girder, well clear of the girder flange 12. Also, metallic or plastic sleeves 23 are emplaced on the planks, preferably in two rows, one row on each side of the flange 12. Advantageously the sleeves of one row are staggered in relation to those of the other row as shown in FIGURE 6, e.g., 8 ft. apart within each row. These sleeves are situated inwardly of the connectors 22 and provide communication through the sleeves to the interior of the grouting form to be described. Steel reinforcing rods for the slab and for the encasing grout are emplaced as desired; the latter may include vertical dowels 24 extending a few inches below the planks 19. The concrete slab 25 is then cast. When the slab has hardened, the plates 21, truss works 20 and planks 19 are removed. If desired, prior to casting the slab, temporary wooden struts 26 may be emplaced between the lower girder flange 11 and the scaffold-supporting flange 17 to reinforce the latter, the struts 26 being removed with the truss works.

Optionally, prior or, more usually, after casting the slab, reinforcing bars for the grout are applied, for example, by welding to the dowels 24 steel reinforcing stirrups 27 which have their upper ends juxtaposed to the dowels. Further, horizontal reinforcing rods 28 and 29 and vertical rods 29*a* may be applied and wired or welded.

Referring to FIGURES 1 and 4, the grouting form includes a floor 30, side walls 31 and 32 sealed to the floor and extending upwards to the concrete slab, and hangers which are situated at longitudinal intervals along the girder. Each hanger is situated beneath a pair of connectors in the slab, specifically, a pair of ferrules 22, to which are detachably connected the upper ends of a pair of vertical suspension rods 33. The upper end of each rod may have threaded engagement with a ferrule. Each hanger further includes a horizontal beam 34 which supportingly engages the form floor 30 and is, in turn, supported at each end by one of the rods 33. These rods carry nuts 35. A pair of posts 36 is situated at each side of each hanger in engagement with the outer faces of the side walls 31, 32. A horizontal stiffening beam 37, extending parallel to the girder and having holes to receive the vertical rods 33, is mounted along the top of each side wall 31, 32, to restrain the latter against outward deformation due to the grout. It is not necessary that the form be fitted in hermetically sealed relation to the slab; in fact, as will appear, a slight passage for the escape of air from the form is desirable. The posts 36 are fixed at the top and bottom ends to the beams 37 and 34, respectively.

Wet grout is then injected into the form through the sleeves 23, which form grouting holes. Injection may be effected, for example, by pumping the grout from a grout pump into a grouting hole 23 at one end of the girder. After the adjacent part of the form is filled, the discharge end of the hose is applied to the next hole, this shifting being continued, preferably by shifting the hose in zigzag fashion to fill the holes of the two rows in alternation. The grout form is filled completely and advantageously to the extent that a standing body of grout fills each hole. Thereafter the grout within each hole is troweled flush with the top surface of the slab. While the form is being filled trough the last hole air escapes principally from the air-gaps between the tops of the side walls 31, 32, and the underside of the concrete slab 25.

The grout is permitted to harden, forming a casing 38 which has a smooth exterior surface, shown in FIGURES 1 and 5 and the center of FIGURE 6, and extending fully to the slab. The form is then removed by removing the nuts 35, unscrewing the rods 33 from the ferrules 22, dropping the hangers, and stripping the form floor and side walls from the casing 38.

FIGURE 7 shows a modified embodiment wherein the concrete slab 25*a* includes metal decking including inclined traverses 39 joining upper and lower traverses 40 and 41. The decking is known per se and is available in pieces that may be mounted with the inclined traverses extending transversely to the girders; however, it may be installed parallel to the girders. The decking may be optionally supported during erection by the truss works 20 previously described and shown in FIGURE 2. The metallic connectors, such as internally threaded ferrules 22*a*, are fixed to the decking, e.g., by welding at holes provided in the upper traverses 40, and extend upwards so as to be embedded within the concrete slab 25*a*, for subsequent support of suspension rods 33*a*. Grouting holes, not shown, are provided as previously described.

Although threaded connectors 22, 22*a* were shown, it is evident that other forms of connectors, e.g., bayonet-type fittings, may be used.

I claim as my invention:

1. A method of applying grout to a metallic girder which supports a concrete slab, said slab being positioned above the girder and extending laterally therefrom, said method comprising the steps of:

(a) suspending from said slab a form which encloses the bottom and at least one side of said girder,

(b) providing said slab with at least one hole extending therethrough and communicating with the interior of said form, and

(c) injecting wet grout through said hole into the said form.

2. A method of applying grout about a metallic girder which supports a concrete slab, said slab being positioned above the girder and extending bilaterally therefrom, said method comprising the steps of:

(a) suspending from said slab from suspension points on both sides of the girder a form which encloses the bottom and sides of the girder and extends upwardly to the slab,

(b) providing in said slab two rows of holes extending therethrough and communicating with the interior of said form, one of said rows being situated on each side of the girder,

(c) injecting wet grout through said holes successively along the length of the girder in amount to fill the form completely to the level of the slab,

(d) permitting the grout to harden, and

(e) stripping the form from the hardened grout.

3. A method as defined in claim 2 wherein step *c* includes filling the said holes with grout to the upper surface of the slab.

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