April 5, 1938. H. H. BUNKER 2,112,949

SLAB

Filed Oct. 9, 1935 2 Sheets-Sheet 1

Fig. 1

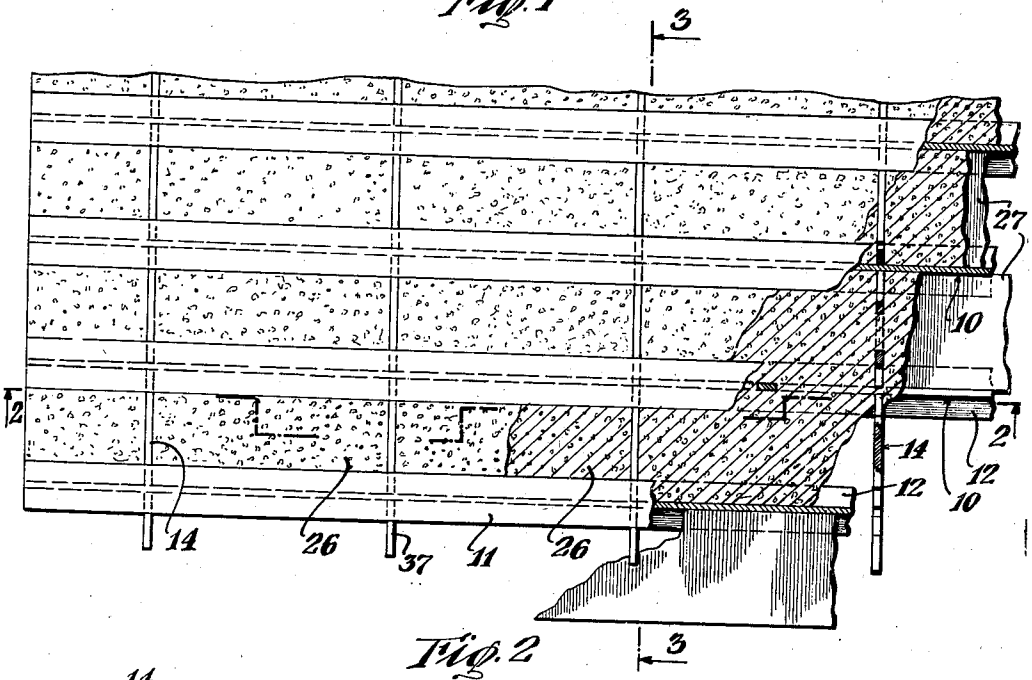


Fig. 2

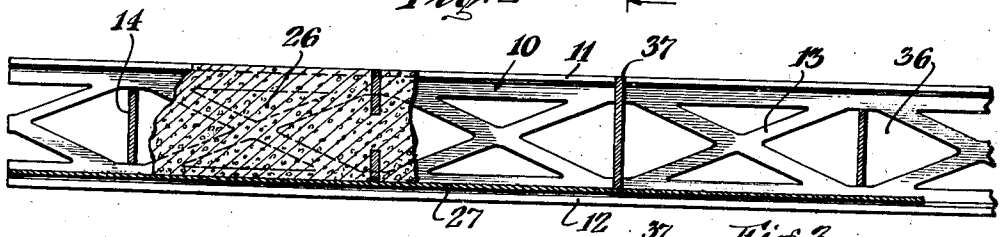


Fig. 3

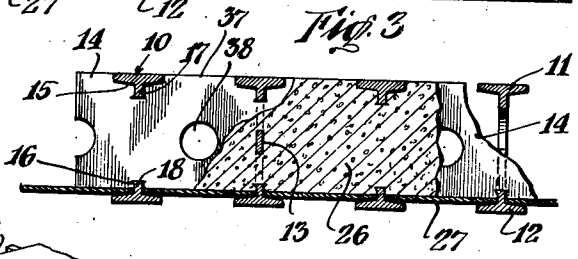
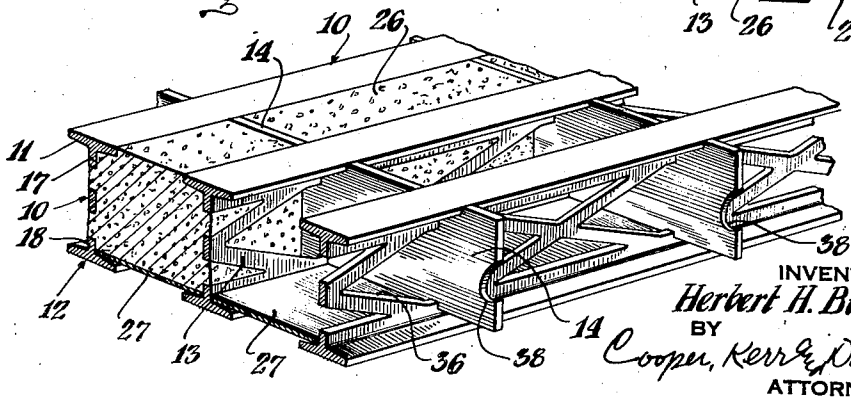


Fig. 4

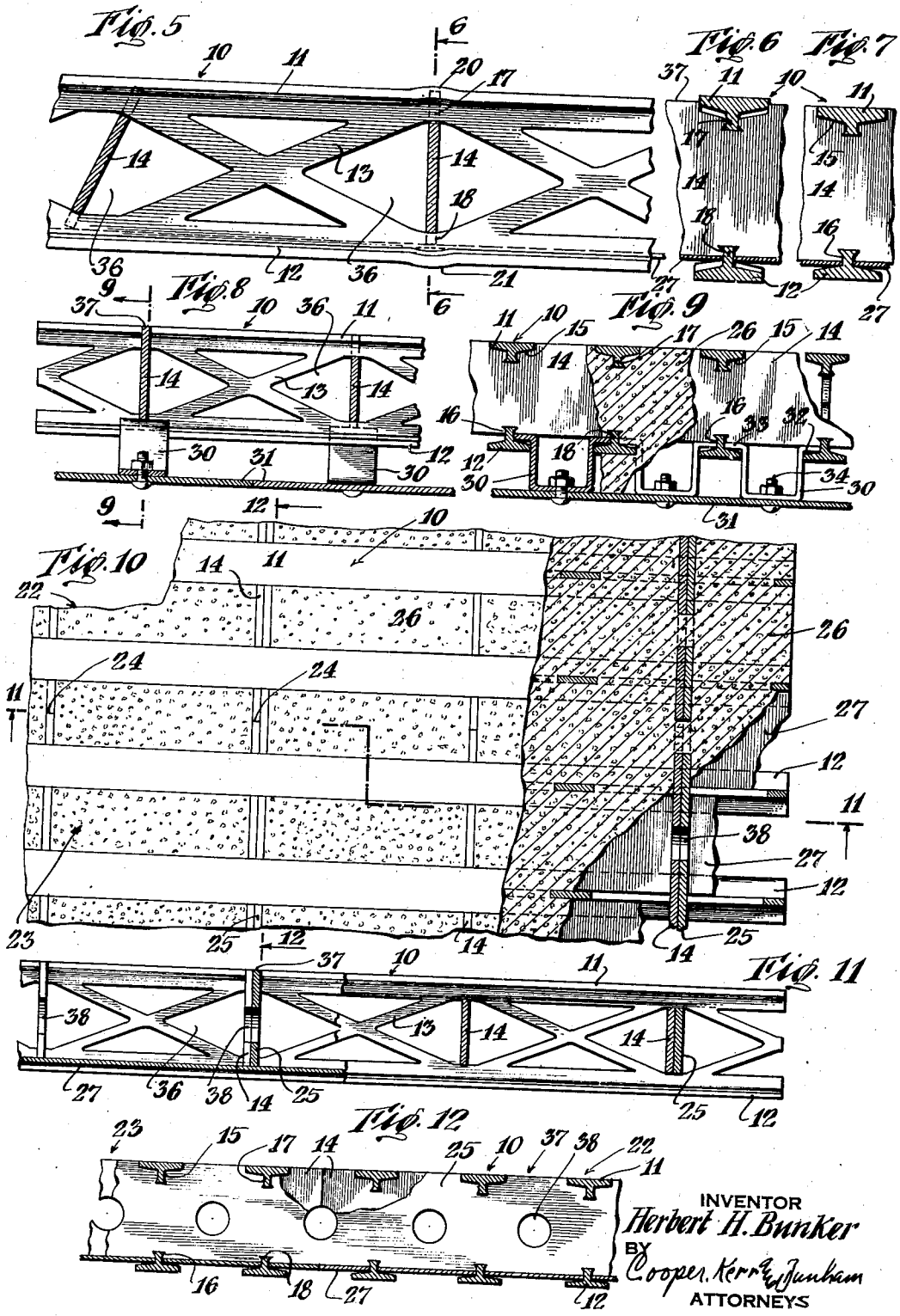


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UNITED STATES PATENT OFFICE

2,112,949

SLAB

Herbert H. Bunker, Jersey City, N. J.

Application October 9, 1935, Serial No. 44,167

4 Claims. (Cl. 72—71)

This invention relates to slabs and particularly to slabs for roadways on bridges and viaducts and for all structural uses in which it is desirable that the roadbed and road supporting structure be of minimum weight per unit area. Composite steel and concrete slabs have been used with success for bridge roadways owing to the facility afforded thereby in the building of a roadway and to the fact that no paving or road-surfacing other than that provided by the slabs is necessarily required. But to the extent that the usual forms of open grating have entered into the design of concrete slabs, concrete slabs so designed have failed to produce the economy in construction and the load carrying capacity per dead weight of slab as are desired, particularly for bridge roadways, and it is among the objects of my invention to provide a roadbed construction of metal and concrete having much less weight per unit area and for a given strength than the filled-in open mesh grating type of slab. To this end I use a metallic truss beam providing material in those portions of the slab where the stresses are greatest and in such quantity as to provide no more than the strength required whereby I obtain a slab strong enough to meet given specifications but lacking such weight as would otherwise be present on account of the use of excessive metal. There are also associated with the truss beams, and constituting therewith principal stress carrying elements, a number of cross bars which are so related to the truss beams that, in addition to serving as separators for the truss beams and as load-distributing members, function to prevent deflection of the upper and lower chords of the truss beams in vertical and lateral directions.

It is therefore among the objects of my invention to provide a metallic skeleton for concrete-filled slabs so constructed as to provide a relatively strong slab for the amount of metal entering into its construction.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and demonstrated by the drawings which show by way of illustration a preferred embodiment and the principle of my invention, and what I now consider the best mode in which I have contemplated applying that principle. Other embodiments of the invention employing the same principle may be used and structural changes made as desired by those skilled in the art within the spirit of the appended claims without departing from the present invention.

In the drawings:

Fig. 1 is a plan view of a filled slab with portions thereof broken away.

Fig. 2 is a longitudinal section on line 2—2 of Fig. 1.

Fig. 3 is a transverse section on line 3—3 of Fig. 1.

Fig. 4 is a perspective view of the slab partly filled with cementitious material.

Fig. 5 is a view illustrating the manner of assembling the longitudinal and transverse members.

Fig. 6 is a section on line 6—6 of Fig. 5.

Fig. 7 is a sectional view similar to Fig. 6, with the members engaged as in use.

Fig. 8 illustrates a modified form of slab with a form plate suspended therebelow.

Fig. 9 is a section on line 9—9 of Fig. 8.

Fig. 10 is a plan showing abutment of two slabs along their longitudinal contacting edges and an arrangement for connecting such slabs together across their line of separation.

Fig. 11 is a section on line 11—11 of Fig. 10.

Fig. 12 is a section on line 12—12 of Fig. 10.

Having reference to the drawings, the essential load carrying members of the slab are in the form of a metallic frame or skeleton consisting of longitudinally and transversely extending members. As indicated hereinabove, it is of particular importance that the weight of slabs, such as are used for roadways, be maintained at a minimum for a given strength. Slabs for roadways are frequently made of steel and concrete, and it is desirable that the amount of steel used be maintained at a minimum so as not to provide a slab of excessive weight.

The metallic frame or skeleton of my invention includes longitudinal members or truss beams 10 having upper and lower chords 11, 12, with flanges, and an open-work web 13 providing truss-like members extending between the upper and lower chords. I have chosen to illustrate truss beams 10 in the form of I-beams having symmetrical chords and flange portions, but beams having flanges of different shapes, weights and widths at their top and bottom chords may be used. The shape of the openings in the webs of the truss beams is determined by the slope and configuration of the truss members extending between the chords but must be of such dimensions as will accommodate the maximum height of the cross bars. In assembling, the cross bars are passed through the series of truss beams which are to constitute a finished frame.

Each cross bar is notched as at 15, 16, to ac-

commodate and engage the upper and lower chords of the truss beams. To make certain that the cross bars will contribute to the vertical and lateral support of the upper and lower chords of the truss beams, all surfaces of a notch should contact with its associated chord and the notches are so designed that they will accomplish this and be tightly engaged at their bottom portions with the inner edges of the chords. The proportions should preferably be such that when each cross bar is passed through aligned openings in the webs of the truss beams and turned angularly, the vertical portions **17**, **18** of the chords of the truss beams will be forced to the full depth of their respective notches **15** and **16**. Turning the cross bars to vertical position may cause a slight outward bulging of the upper and lower chords, as indicated at **20**, **21**, Fig. 5. After all of the cross bars have been positioned vertically, the bulging portions of the truss beams may be returned to normal by passing the slab under a press. This manner of constructing the metallic skeleton is desirable because it ensures the obtaining of a tight vertical contact with the upper and lower chords.

This method of locking the upper and lower chords to the cross bars also affords a means of obtaining dove-tail connections between the cross bars and the chords of the truss beams, as shown in Fig. 7, if such is desired. The compression of the chords of the truss beams towards each other in a press causes metal of the truss beams to flow into the dove-tail slots in the cross bars. While the use of dove-tail connections between the slots **15** and **16** and chord elements **17** and **18**, respectively, is not indispensable, the rigidity of the skeleton may be improved by utilizing dove-tail connections at either the upper or lower bottom chord or at both chords. Without the dove-tails a secure connection may be had because the material of the cross bars may be made to bite into the chords of the truss beams which may be comparatively softer than the cross bars. The firmer the engagement between the cross bars and truss beams, the more accurately the truss beams will be held in alinement and the more certain it is that the upper and lower chords of the truss beams be prevented from buckling or twisting under load.

One advantage of my invention is that adjacent slabs may be rigidly connected together along their abutting longitudinal edges, as illustrated in Figs. 10 and 11. In these figures, adjacent slabs **22**, **23** abut on line **24**, and in the absence of supporting structure passing between these two slabs, neither one of the slabs will provide support for a load carried by the other slab. The construction of my slab enables the use of an auxiliary cross bar **25** adapted to be placed alongside of a regular cross bar **14** and extend across the parting line **24** of the adjacent slabs, or, if desired, every fifth or tenth regular cross bar may be omitted from placement in the skeleton until the skeleton is laid, and then be so placed as to cross the parting line. The overlapping cross bar will lock the adjacent slabs together and tend to prevent unequal deflection between adjacent slabs.

When the skeleton is to be used as a slab for a roadbed, it is filled with concrete or other filling-in material **26**, and in order to support this material when being poured, strips of sheet metal **27** constituting forms may be availed of between the truss beams. These strips are preferably positioned before the cross bars are turned to their normal positions so that they may be held in place by the pressure of the cross bars against their upper surfaces. The strips are thereby held firmly in place upon the upper surfaces of the lower flanges of the truss beams.

In some districts it is not permissible to leave exposed the steel underside of a slab, and in order to meet regulations of this sort the lower chords of the truss beams must be covered with concrete. The design of my slab is well suited for this purpose because it provides a means for fastening hangers **30** whereby a supporting plate or form **31** may be suspended. These hangers may take any suitable form having lips **32**, **33**, supported upon the lower flanges of adjacent truss beams and held in place by the wedging action of the cross bars **14** which bear upon their upper surfaces. The form plate **31** may be affixed to the hangers as is customary in the trade, as by bolts **34**.

While I have illustrated my slab as being filled with concrete up to the upper surfaces of the truss beams **10**, it is to be understood that the concrete may extend above these surfaces and also that the portions **37** of the cross bars **14** intermediate the upper chords and flanges of the truss beams may also extend thereabove, so that they may be used for aligning and holding in place asphalt planking, bricks or other road-surfacing material carried by the slab or metallic frame. In the design of a metallic skeleton having portions of the cross bars extending above the upper surfaces of the truss beams, it will be understood that they may not extend any further than would produce an over-all depth in the cross bars greater than the available maximum dimension of the openings **36** in the webs of the truss beams.

While the truss-like members constituting the web of the truss beam may be built up from individual pieces, I preferably employ a truss beam formed in one piece. This type of construction may be obtained from a rolled I-beam suitably punched or cut and expanded to cause openings in its web of the desired configuration.

It will be observed that the mesh or open-work nature of the webs of the truss beams affords opportunity for the material, such as concrete, to be thoroughly distributed throughout the slab, and in order to facilitate further distribution of the filling material, I have provided holes **38** in the cross bars. These holes are so located that the loss of material from the cross bars does not sacrifice needed strength.

A desirable feature of my invention is that no welding, riveting or other means of fastening for holding the truss beams and cross bars together is necessary owing to the manner of assembling such members, and this is particularly so when the skeleton is filled with concrete. The concrete contributes such solidity to the construction as to fortify the joints against loosening on account of vibration.

I wish it to be understood that in referring to concrete herein as a form of filling material I do not mean to limit myself to the use of a particular kind of filling-in material, it being understood that the use of any of the usual cementitious materials is contemplated which will provide the service required in any particular use that may be made of the invention.

The skeleton is suitable for use as a floor or support for flooring and as such the use of concrete or other filling material embedding the truss beams is optional.

I claim:

1. A roadbed comprising a plurality of composite metal and concrete slabs, each slab having a metallic skeleton including spaced longitudinally extending beams having upper and lower chords and diagonally extending truss-like elements connecting the upper and lower chords and leaving openings therebetween; cross-bars in the form of vertically disposed strips extending laterally to said beams and through aligned openings in said beams, said cross-bars being notched for engaging the upper and lower chords of the beams to provide support therefor; and other cross-bars similar to said first mentioned laterally extending cross-bars and arranged in staggered relation thereto across the slabs so as to extend beyond the longitudinal edge of one slab and into the adjacent slab, said other cross-bars being in locking engagement with at least the outside longitudinally extending beam of the adjacent slab into which they extend so as to constitute adjacent slabs of the roadbed into one substantially rigid slab construction free from apparent deflection between the metallic skeletons of the individual slabs when in use.

2. A skeleton for a slab comprising spaced longitudinally extending I-beams with their webs disposed in vertical planes, the webs having aligned openings therein leaving upper and lower chords connected by diagonally extending truss-like elements in the webs of said beams; cross-bars extending laterally to said beams and through aligned openings in the webs of said beams, said cross-bars being provided with notches for engaging the beams, the configuration of said notches and the spacing between upper and lower notches being such as to cause each cross-bar to act as a vertical strut between the upper and lower chords of the I-beams; a forming plate below said I-beams and means suspended from the lower flanges of the I-beams for supporting said forming plate, said means being supported upon the lower flanges of said I-beams and maintained in engagement therewith by the lower edges of said cross-bars.

3. A metallic structure comprising a plurality of beams spaced from each other and in parallel arrangement, said beams having openings through their webs which are aligned laterally of the structure; cross-bars extending laterally to said beams and through aligned openings in said beams, said cross-bars serving to unite said beams in interlocking relationship and into a unitary metallic skeleton unit forming one of several units of a fabricated structure, said cross-bars having notches in their upper and lower edges in engagement with the upper and lower chords of the beams of a unit of the fabricated structure, and additional cross-bars overlapping the ends of said first named cross-bars and extending across the parting line of adjacent units of the fabricated structure and into said adjacent units, said last named cross-bars also having notches in their upper and lower edges cooperating with the upper and lower chords of beams of adjacent units whereby relative deflection between adjacent units of the structure is prevented and the adjacent units are maintained in locked relation in respect to each other.

4. A metallic skeleton structure comprising a plurality of beams spaced from each other in parallel arrangement, said beams having upper and lower flanges and open webs formed by openings in their webs which are of less height than the height of the webs thereby providing parallel sided web portions below the upper flanges and above the lower flanges; and cross-bars extending laterally to said beams and in supporting relation to their upper and lower chords, said cross-bars extending through aligned openings in the webs of adjacent beams and having notches in their upper and lower edges in engagement with the upper and lower chords of the beams, said notches having oppositely facing vertical edges engaging the parallel sides of the web portions of the beams below the upper flanges and above the lower flanges of the beams and having dove-tail interlocking relationship between the bottoms of the notches and the engaging web portions of the beams, whereby the beams and the cross-bars are firmly secured together at the intersections of the chords and cross-bars.

HERBERT H. BUNKER.