Jan. 1, 1935. W. A. WILSON 1,986,171

STEEL AND CONCRETE CONSTRUCTION

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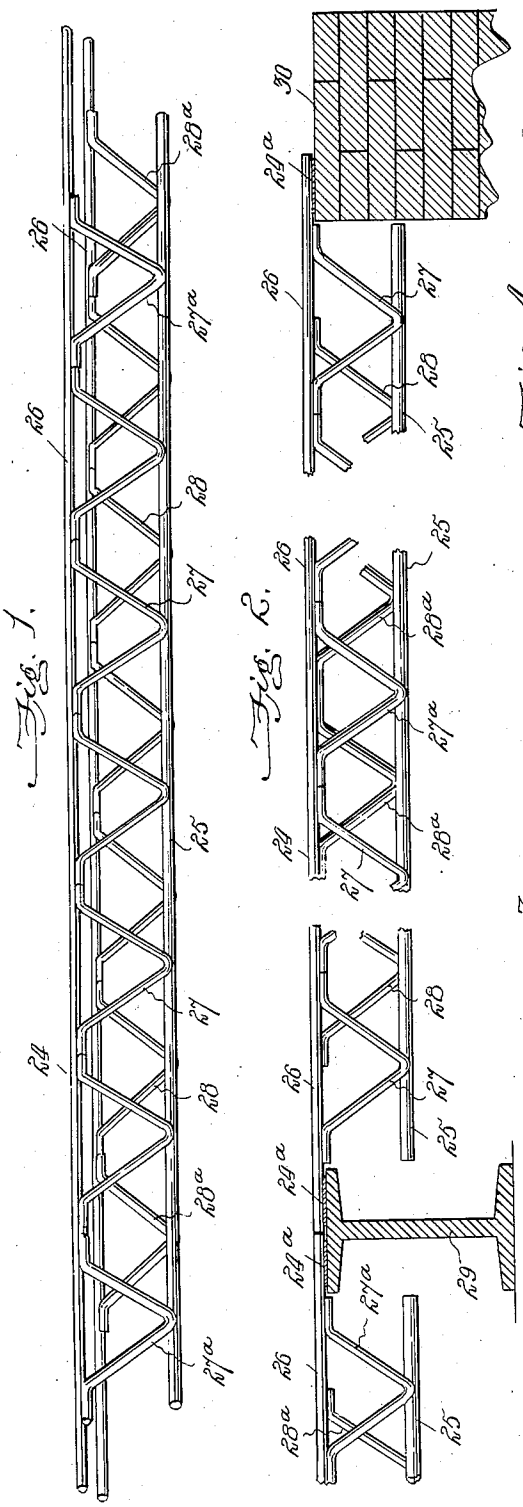

Fig. 1.

Fig. 2.

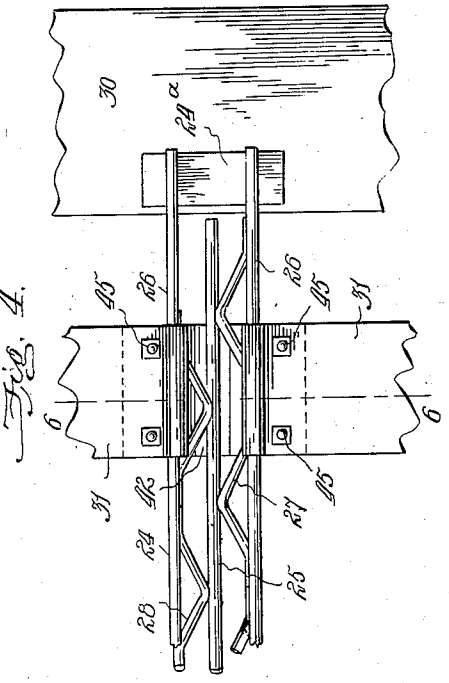

Fig. 4.

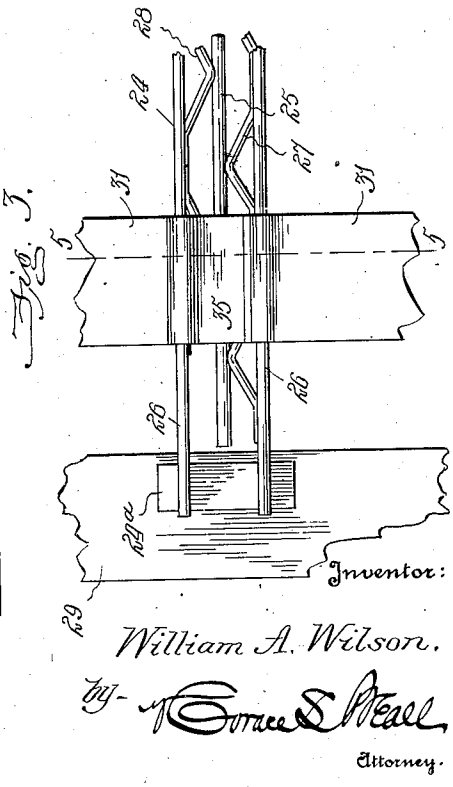

Fig. 3.

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Fig. 6.

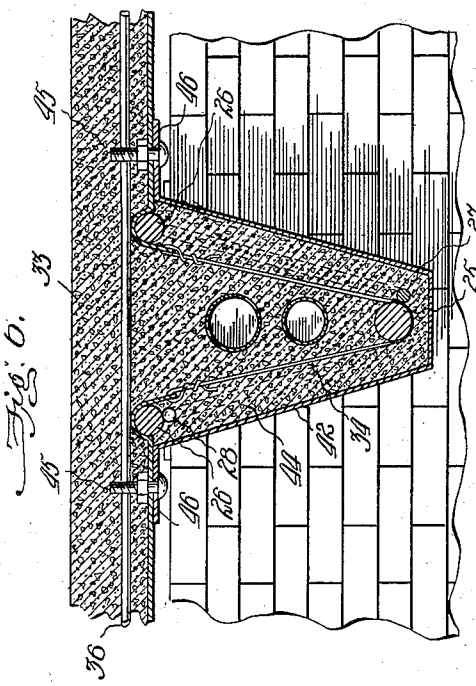


Fig. 8.

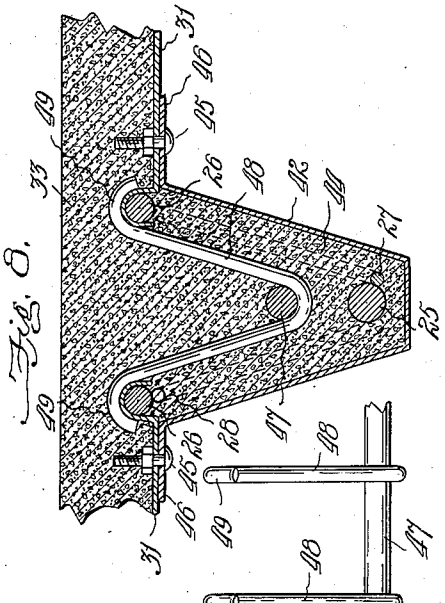


Fig. 5.

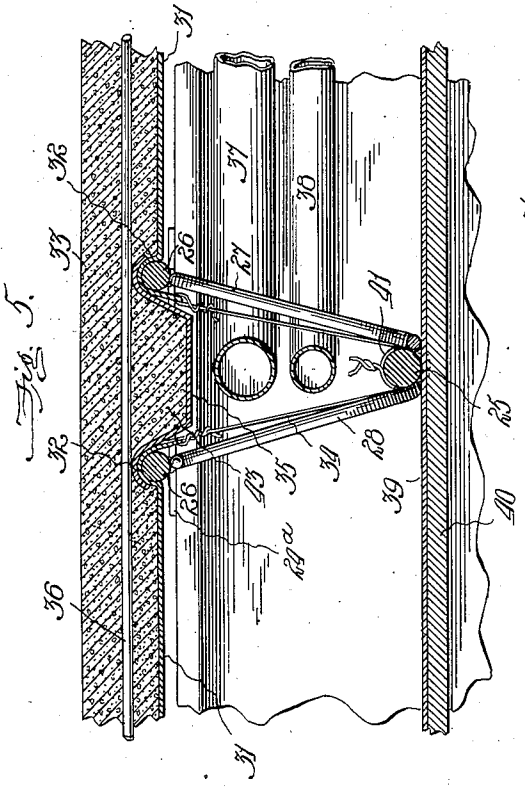
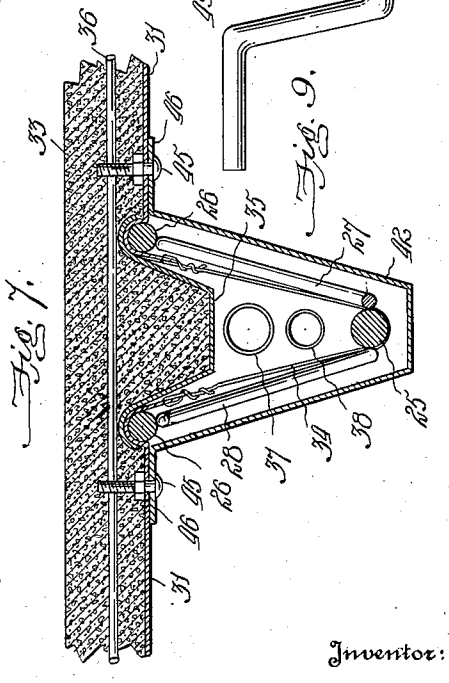


Fig. 7.



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STEEL AND CONCRETE CONSTRUCTION

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Fig. 12.

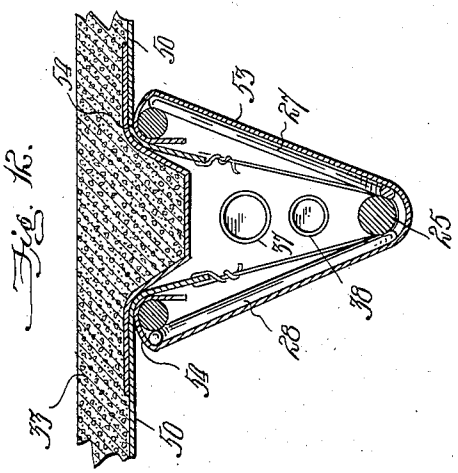


Fig. 14.

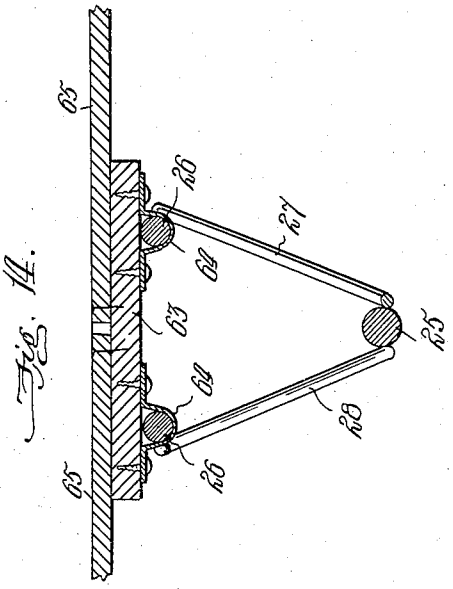


Fig. 11.

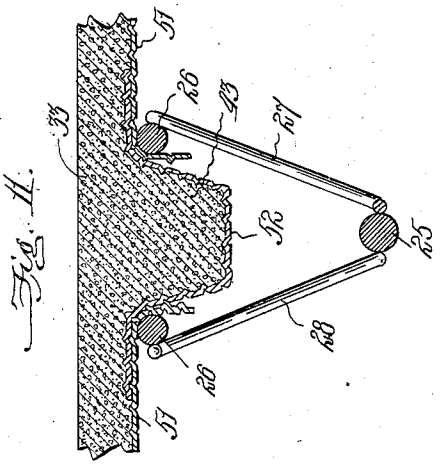


Fig. 13.

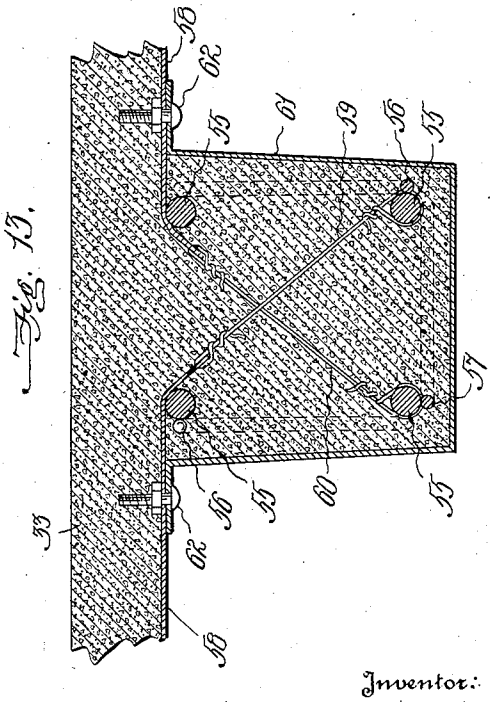
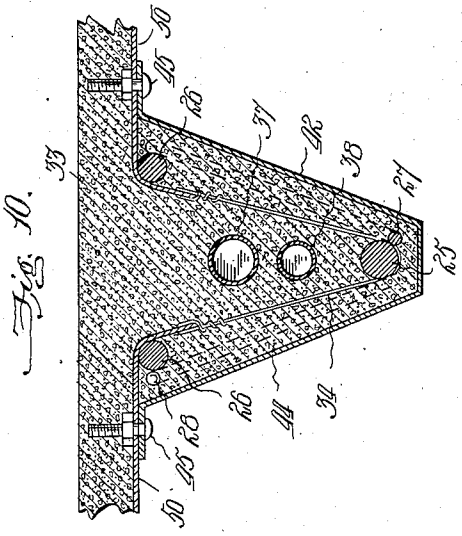


Fig. 10.



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STEEL AND CONCRETE CONSTRUCTION

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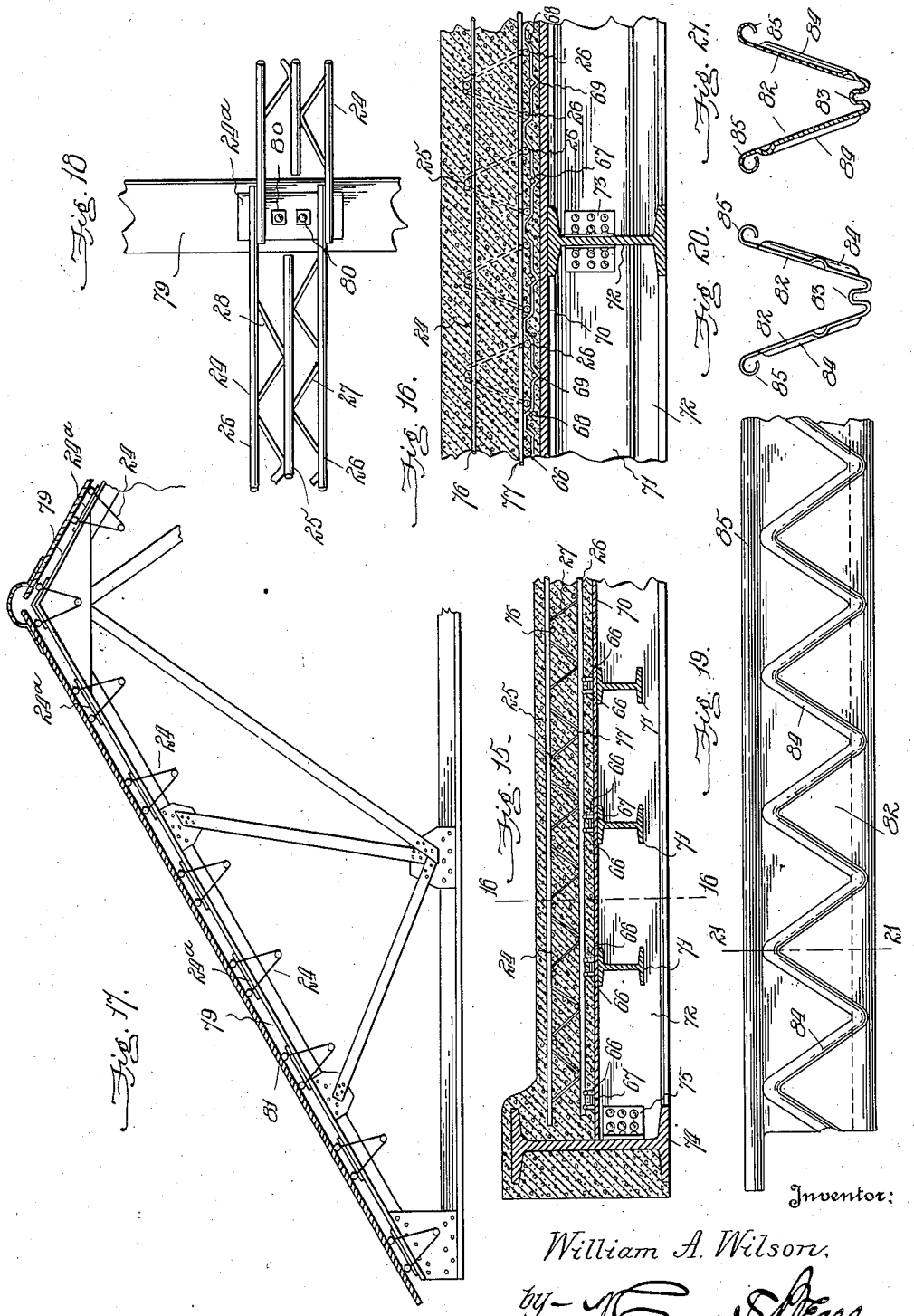

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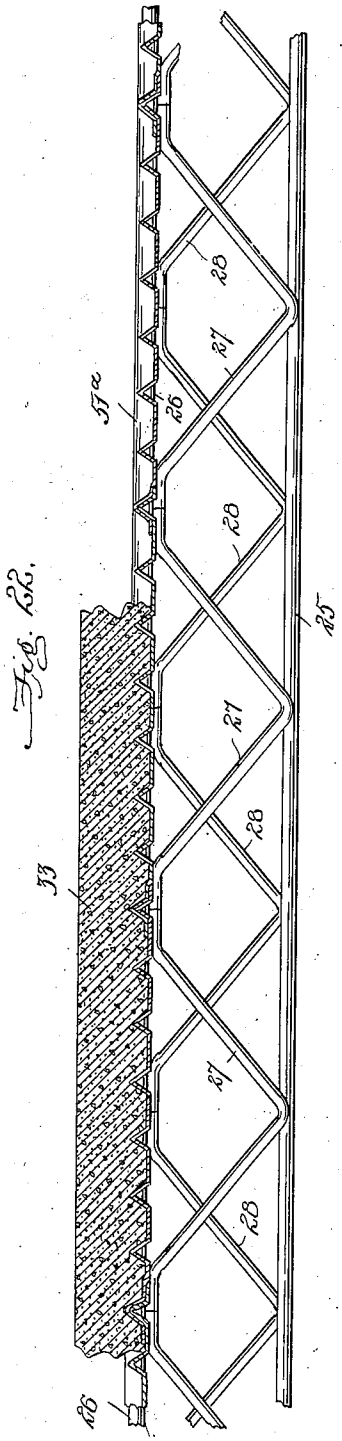
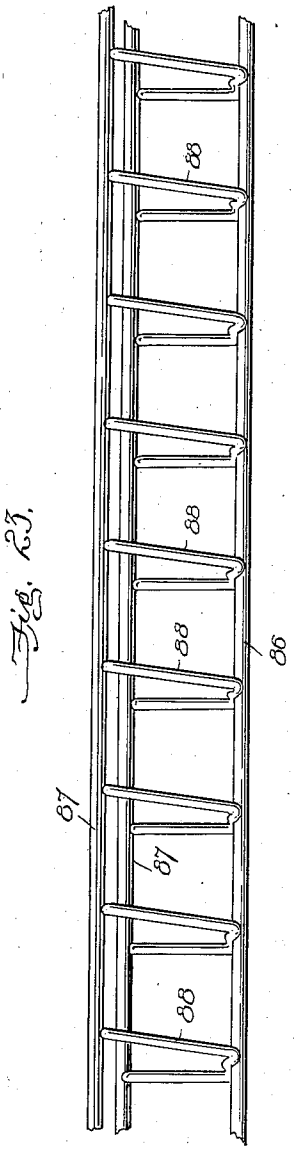
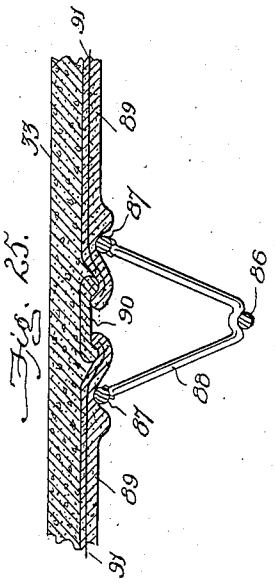
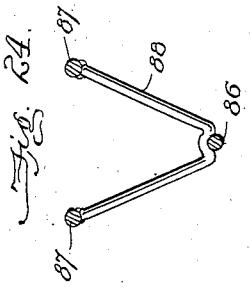
STEEL AND CONCRETE CONSTRUCTION

Filed June 16, 1931 5 Sheets-Sheet 5









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UNITED STATES PATENT OFFICE

1,986,171

STEEL AND CONCRETE CONSTRUCTION

William A. Wilson, Canonsburg, Pa., assignor of three-fourths to Frederick R. Wilson and one-fourth to Elmer Leach, both of Canonsburg, Pa.

Application June 16, 1931, Serial No. 544,863

10 Claims. (Cl. 72—110)

My invention relates to steel and concrete construction for buildings, including bridge work, and has particular reference to the provision of a form of bar joist or truss especially adapted for reinforcing floors, for purlins in roof construction, and for various other structural work.

The primary object of my invention therefore is to provide a structural unit in the form of a bar joist or truss member of light construction consistent with the required strength, in the present instance the unit being fabricated at comparatively small cost and contemplates strengthening of the same at those points required to overcome the greatest amount of stress thus permitting spans of greater length to be used in the construction of floors, etc.

A further object of my invention is to provide an improved construction for concrete floors in which the bar joist or structural unit will facilitate the application of the floor material upon which the concrete is poured, in some instances the said bar joist being encased with sheet metal to give a finished or exposed beam appearance to the ceiling below the floor.

Other objects and advantages of my improved steel and concrete construction will appear in the following description of my invention, and what I particularly claim as new and desire to protect by Letters Patent is more specifically set forth in the appended claims.

In the drawings:—

Figure 1 is a perspective view of the structural unit or bar joist.

Fig. 2 is a side elevation showing the bar joist supported in position to receive the floor material.

Fig. 3 is a plan view showing one form of floor plates used in connection with the structural unit or bar joist.

Fig. 4 is a similar view showing another form of floor plates.

Fig. 5 is an enlarged transverse sectional view on the line 5—5 of Fig. 3, with the addition of the concrete surface and reinforcing element.

Fig. 6 is a similar view on the line 6—6 of Fig. 4.

Figs. 7 to 13 inclusive are transverse sectional views illustrating modifications in the use of floor plates and casings supported by the bar joist.

Fig. 14 is a sectional view showing the use of the bar joist in supporting wood floors.

Fig. 15 is a sectional view of a floor construction employing the structural unit or bar joist in reverse position.

Fig. 16 is a sectional view thereof on the line 16—16 of Fig. 15.

Fig. 17 is a sectional view of a roof construction employing the structural unit or bar joist as purlins.

Fig. 18 is a detail view showing the manner of connecting the purlins to the rafters.

Fig. 19 is a side elevation illustrating a modification which contemplates the formation of the structural unit of sheet metal.

Fig. 20 is an end view of the modified form of structural unit.

Fig. 21 is a transverse sectional view on the line 21—21 of Fig. 19.

Fig. 22 is a further modification of a concrete flooring, and

Figs. 23, 24, and 25 show a modification of the bar joist.

Like numerals of reference indicate like parts in the several views of the drawings.

In carrying out my invention one of the important features thereof consists in providing a structural unit 24 made up of three bars spaced apart to form an arrangement of said bars triangular in cross section with diagonal rods of different thicknesses connecting one of the bars to the other two respectively leaving an open side to the structural unit, and to this end a main longitudinal bar 25 is connected to a pair of spaced apart parallel bars 26, 26, by diagonal rods or webs 27 and 28 extending in opposite directions from the main bar and out of line with each other transversely of the unit, said diagonal rods being in V-shape sections with their ends bent outwardly and welded to the bars 26, 26 respectively while the angle thereof is welded to the bar 25. The ends of these V-shape rods or webs may be and preferably are welded to the under or inner side of the pair of bars while the angle portion is welded to one side of the main bar, although in some instances it may be desired to weld the extended ends to the outer side of the pair of bars as illustrated in Figs. 10 to 14 inclusive. By forming the diagonal rods or webs of the structural unit in V-shape sections and welding them to the longitudinal bars or chords it not only facilitates the fabrication of this type of bar joist or structural unit as to length, etc., but what is more important it provides that web sections or V-shape rods of different thicknesses may be employed throughout the length of the joist or strut to increase the strength thereof at desired points where a greater amount of stress may be imposed, as for instance at the ends alone (see sections 27*a*, 28*a* Fig. 1) or at the ends and center, and of course the thickness of these sections may be graduated; in other words, in making up the

structural unit with sectional V-shape webs the latter may be of the same thickness throughout the length of the bar joist or truss or of different thicknesses to meet varying conditions, whereby in either instance a light but strong structural unit is provided having a wide range of use in steel and concrete construction. When the structural unit is complete the ends of the pair of bars project beyond the webs so as to rest on a girder 29 or wall 30, as the case may be, and it will be obvious that the main rod may be bent upwardly and outwardly to also rest on the supporting element for the structural unit, and of course it can be shortened when required in certain situations by simply sawing off either end portion thereof. It will thus be seen that I provide a structural unit in the form of a bar joist or truss that may be conveniently and effectively used in various building structures, as for instance in steel, terra cotta, wooden and reinforced concrete floor construction, as well as roof construction, examples of which are illustrated in the accompanying drawings and hereinafter particularly described, and for convenience in setting the structural unit or bar joist in place on the supports the ends of the pair of bars may be and preferably are connected by short plates 24*a* welded to the underside of said ends.

In using the structural unit or bar joist 24 in laying a concrete floor with a plain plastered ceiling below, as illustrated in Fig. 5, the said bar joists are spaced apart the required distance and floor plates 31 employed to extend between them with the ends 32 of the plates bent up and over the upper pair of bars 26, 26 and said plates held in place to prevent sagging during the operation of pouring the concrete flooring 33 by means of wires 34 attached to said ends and extending downwardly around the lower bar 25 of the joist, the upper end of the latter being closed by a U-shape plate 35 the ends of which are curved over the bent ends of the floor plates, and to reinforce the concrete temperature rods 36 are laid before the concrete is poured. In a plate so constructed the bar joist or structural unit employed permits pipes 37, 38 to be extended through the same, and for supporting the expanded metal 39 to receive the plaster 40 for the ceiling below said expanded metal is attached to the bar joist by means of wires 41. In this instance that portion of the concrete contained within the U-shape plate 35 at the upper ends of the bar joists form bracing ribs, and of course said U-shape plates may be deeper, as shown in Fig. 7, to provide thicker reinforcing ribs, or as shown in Fig. 6 the bar joist and pipes may be enclosed in concrete by using a sheet metal casing 42 instead of the U-shape plate, in this latter instance said casing in connection with the floor plates 31 providing a finished ceiling below of the exposed beam type, and a similar arrangement may be carried out with respect to the floor construction shown in Fig. 7 employing a U-shape plate for a concrete rib 43 instead of a concrete beam 44, Fig. 6. In each instance the sheet metal casing is secured to the floor plates by bolts 45 extending through flanges 46 at the upper ends of said casing and through the floor plates, with the ends of said bolts embedded in the concrete floor. As will be obvious the bending of the ends of the floor plates up and over the upper bars 26 of the bar joists and tying said plates to the lower bar 25 in the manner hereinbefore described will resist the weight of the workers during the operation of laying and finishing the concrete flooring.

As illustrated in Figs. 8 and 9 using the bar joist to reinforce the concrete beam depending from and forming a part of the concrete floor said beam is further reinforced by longitudinal and transverse rods 47 and 48, respectively, located within the bar joist with the transverse rods bent into V-shape with the upper ends 49 thereof curved over the bent ends of the floor plates 31, in this instance also the concrete beam enclosing the bar joist and reinforcement described being encased to provide a finished ceiling below the concrete floor.

In the modifications shown in Figs. 10 to 13 inclusive the ends of the floor plates 50, 50 are merely bent over the upper bars 26, 26 of the floor joist, and the diagonal rods or webs 27, 28 are welded to the outer sides of said upper bars, while in Fig. 11 instead of using wires for holding the ends of the plates in engagement with said upper bars both the floor plates 51, 51 and U-shape plate 52 are made of corrugated metal so that the extended upper ends of the U-shape plates will interlock with the floor plates, a similar arrangement being shown in Fig. 22, but in this instance the corrugated floor plates extend at right angles to the bar joists, and in Fig. 12 instead of bolting the casing 53 to the floor plates the flanged ends 54 of said casing are turned inwardly between the floor plates 50 and upper pair of bars of the joist. As a further modification, for the purpose of providing an encased concrete beam of rectangular formation, the bar joist may consist of four longitudinal bars 55 connected by diagonal rods or ribs 56 in a manner similar to the triangular shaped bar joist with the lower longitudinal bars connected by diagonal or zigzag rods 57. With this last mentioned construction of flooring the floor plates 58, 58 may be merely bent over the upper longitudinal rods or bent up and over as hereinbefore described with the downwardly extended ends connected to the lower longitudinal bars by wires 59 and 60, the casing 61 being clamped to the floor plates by bolts 62.

The constructions of concrete flooring hereinbefore described serve to illustrate various different ways of utilizing the structural unit, bar joist or truss shown in Figs. 1 and 2, and of course where an ordinary wooden floor is to be laid wooden strips 63 may be attached to the upper bars of said bar joist or structural unit by metal straps 64 so that the floor or subflooring 65 can be nailed thereto; in other words, I wish to stress the point that the application of the structural unit is not limited to any particular character of building construction, nor to uses as a joist or truss, for as illustrated in Figs. 15 and 16 said unit may be embedded within the concrete floor as a reinforcement thereof, as for instance in bridge work, and in this instance it may be reversed so that the pair of bars 26, 26 will be at the lower end of the reinforcement, and for spacing them apart in regular or predetermined order spacing rods 66 are employed, said rods being in pairs connected by short pieces 67 welded thereto and bent to form seats 68 for the lower bars of the units and depending portions 69 so as to raise the body of the rods and reinforcing units mounted thereon above the floor plates 70, so as to be embedded in the concrete floor 78. The floor plates are supported on transverse I-beams 71 connected at their ends to I-beams 72 by plates 73, and the last mentioned I-beams connected by plates 75 to larger I-beams 74, and in this instance additional reinforcing rods 76 and 77 are extended transversely with respect to the struc-

tural units passing between the diagonal rods or webs 27, 28 thereof. By this arrangement using structural units to reinforce the concrete floor supported by the longitudinal and transverse I-beams a very strong structure is provided especially adapted for bridge work to withstand heavy traffic, and of course different thicknesses of V-shape rods forming the webs of the reinforcing units may be used either throughout the length of the unit or distributed according to strength required, and in laying the reinforcing units the pairs or spacing rods will not only facilitate the operation but will also insure equal spacing of said units apart as the said rods are bent so that the seats 68 which receive the units are equidistant.

In addition to the use of the structural unit for the purposes hereinbefore described I have shown a further application of the same in Figs. 17 and 18, where it is used as purlins in roof construction, said structural unit or purlins 24 welded at their ends to the plates 24a being secured to the rafters 79 by bolts 80, the other parts of the roof being of a conventional or approved construction with the sheathing 81 resting on the purlins to receive the roofing material. Of course any other means may be employed for attaching the structural units or purlins to the rafters, but by providing them with end plates by which they are bolted or welded in place on the inclined rafters it facilitates their application in the building of the roof.

In Figs. 19 to 21 I have illustrated a modification of the structural unit by which it is proposed to roll the same from a plate of sheet metal to present the general characteristics hereinbefore set forth with reference to the construction employing bars and the V-shape rods forming the bracing members or webs, in the modification the sides 82, 82 of the rolled plate being joined at the bottom by an inwardly bent longitudinal rib 83 while said sides are provided with outwardly projecting zigzag ribs 84, and the upper ends 85 rolled to receive the curved ends of the floor plates for engagement of the latter therewith. In this instance also the rolled upper ends of the structural unit project under the body portion so that they may be welded to plates for securing the structural unit in place. By providing the longitudinal rib at the bottom or angle of the structural unit and having the ribs at the sides thereof disposed diagonally in opposite directions they form important reinforcing elements of the structure to withstand strain when the unit is in use, and of course it may be employed in the numerous situations shown in connection with the preferred form of structural unit or bar joist. It will be understood that in both forms of joists described, the V-shape rods or webs 27, 28 of the bar joist and ribs 84, 84 of the plate joist are staggered at opposite sides of the structural unit so as to increase stability.

As a still further modification of the bar joist I propose to connect the short rods bent into V-shape form to the lower and upper bars or chords so that the two members or webs will extend vertically between the three rods at opposite sides of the unit, as shown in Figs. 23, 24, and 25 of the drawings, in this instance the V-shape rods 88 being bent upwardly at the angle so as to seat on the lower bar or chord 86 to which it is welded with the upper ends of the members or webs welded to the under side of the upper bars 87, 87, and as shown in Fig. 25 the floor plates 89, 89 to receive the concrete may be made of terra cotta or gypsum with a closing section 90 of like material as the floor plates. The floor plates are shaped as shown to fit over the upper bars of the bar joist and are reinforced with steel rods 91.

From the foregoing description it is apparent that my invention provides a structural unit for building constructions of all kinds that can be fabricated at comparatively small cost by welding the V-shape webs to the longitudinal bars of the structure permitting the use of webs or rods of different diameters according to strength required, and the length of the unit will be determined by the lengths of the longitudinal rods. Furthermore, as the structural units are V-shape in cross section they may be nested for compactness in transportation one within the other, and should it be required to shorten any of the units at the building site it may be done by simply sawing through the chords and webs.

In the use of the ordinary forms of bar joists it is customary to space them from 11¼" to 15" apart, but by reason of the rigidity provided in the construction of my improved bar joist herein shown and described they may be spaced 24" apart without requiring lateral bracing or bridging between them, the webs at opposite sides of the unit being staggered so that their connection to the bottom chord is also staggered and at opposite sides thereof to reduce strain on said bottom chord; in other words, the particular construction of bar joist in accordance with my invention, having V-shaped rods forming the web, provides a structural unit having greater strength than other forms of bar joists to receive plates in forming all steel flooring, terra cotta, or composition floor plates, a concrete surface, or other material for flooring or roof construction.

I claim:—

1. A structural unit comprising three longitudinal bars spaced apart triangular in cross section to present a main bar and a pair of bars spaced therefrom and from each other, and short rods each bent into V-shape with outwardly extended ends welded at the angle to the main bar and at the ends to the pair of bars respectively, said V-shape rods being in series at opposite sides of the unit; together with plates welded to the ends of the pair of longitudinal bars.

2. A structural unit comprising three longitudinal bars spaced apart triangular in cross section to present a main bar and a pair of bars spaced therefrom and from each other, and short rods of different thicknesses each bent into V-shape with outwardly extended ends welded at the angle to the main bar and at the ends to the pair of bars respectively, said V-shape rods being in series at opposite sides of the unit to form diagonal bracing members or webs; together with transverse plates welded to the ends of the longitudinal bars.

3. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom and from each other with short bent rods in series at opposite sides of the unit welded to the main bar and pair of upper bars, floor plates extending between the bar joists and bent over the upper bars thereof, wires connecting the ends of the floor plates to the lower bar of the bar joists, and U-shape plates connected at their ends to the floor plates, with a layer of concrete supported by said plates and bar joists.

4. A concrete floor construction comprising

structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joist, floor plates extending between the bar joists and bent over the upper bars thereof, and U-shape plates curved outwardly at their upper ends to fit over the bent ends of the floor plates and depending into the bar joists, with a layer of concrete supported by said plates and bar joists.

5. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joist, floor plates extending between the bar joists and bent over the upper bars thereof, and U-shape plates curved outwardly at their upper ends to fit over the bent ends of the floor plates and depending into the bar joists; together with temperature rods laid upon the bent ends of the aforesaid plates, said plates and bar joists being adapted to support a layer of concrete.

6. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joist, floor plates corrugated longitudinally with respect to the bar joists and extending between said bar joists and bent over the upper bars thereof, and U-shape corrugated plates curved outwardly at their upper ends to fit over the bent ends of the floor plates for interlocking engagment therewith, said plates and bar joists being adapted to support a layer of concrete.

7. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joist, floor plates extending between the bar joists and bent over the upper bars thereof, wires connecting the ends of the floor plates to the lower bar of the bar joist, and a casing enclosing the bar joist and attached at its upper ends to the floor plates.

8. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joist, floor plates extending between the bar joists and bent over the upper bars thereof, wires connecting the ends of the floor plates to the lower bar of the bar joist, a casing enclosing the bar joist and having flanges at its upper ends by which it is connected to the floor plates, and bolts securing the casing to the floor plates, said bolts projecting above the floor plates to be embedded in a layer of concrete supported by said plates and bar joists.

9. A concrete floor construction comprising structural units or bar joists each consisting of a plurality of longitudinal bars connected by short V-shape rods welded to said bars, floor plates bent over the upper bars of the floor joist, wires connecting the ends of the floor plates to the lower bars, and casings enclosing the floor joists and secured at their upper ends to the floor plates, the concrete being poured upon the plates and into the casings to form an exposed beam ceiling below the flooring.

10. A concrete floor construction comprising structural units or bar joists each consisting of three longitudinal bars spaced apart triangular in cross section to present a lower main bar and an upper pair of bars spaced therefrom with short V-shape rods welded to the lower main bar and upper pair of bars at opposite sides of the bar joists, floor plates extending between the bar joists and bent over the upper bars thereof, a reinforcing element consisting of longitudinal rods and U-shape rods welded thereto with the upper ends of the U-shape rods extending over the upper bars of the bar joist, and a casing enclosing the bar joist and reinforcing element, said casing being secured at its upper ends to the floor plates, the said floor plates and casing being adapted to receive the concrete in which said bar joist and reinforcing element are embedded.

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