United States Patent

Chan

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[45] **July 11, 1972**

[54] METHOD OF CONSTRUCTING PARKING GARAGE STRUCTURES

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[73] Assignee: **Metallic Building Company**, Houston, Tex.

[22] Filed: **Feb. 16, 1970**

[21] Appl. No.: **11,466**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 808,854, March 20, 1969, abandoned.

[52] **U.S. Cl.**.....52/741, 52/177, 52/650

[51] **Int. Cl.**.....**E04h 6/08**

[58] **Field of Search**.....52/489, 175, 483, 174, 176, 52/177, 579, 488, 650, 742, 690–695; 94/2, 3, 4, 5, 6

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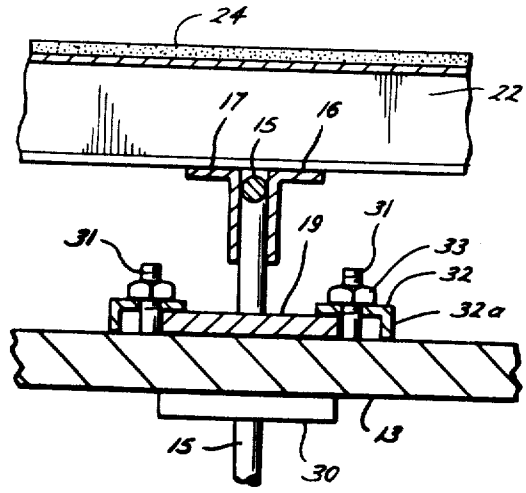
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Primary Examiner—John E. Murtagh
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[57] **ABSTRACT**

The structure includes a plurality of horizontal primary beams, a series of joists supported between the primary beams, and a metal deck formed by laying deck formed of beams or members across the joists in a side-by-side manner. Releasable clamping and fastening devices are used for fastening the joists to the primary beams and the deck to the joists. The joints between the deck members are waterproofed with a sealant material and a chemical-repellent waterproof friction coating is bonded to the upper surface of the metal deck. The invention also contemplates a metal deck arrangement which can be employed in a conventional concrete garage construction.

1 Claim, 13 Drawing Figures



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SHEET 1 OF 6

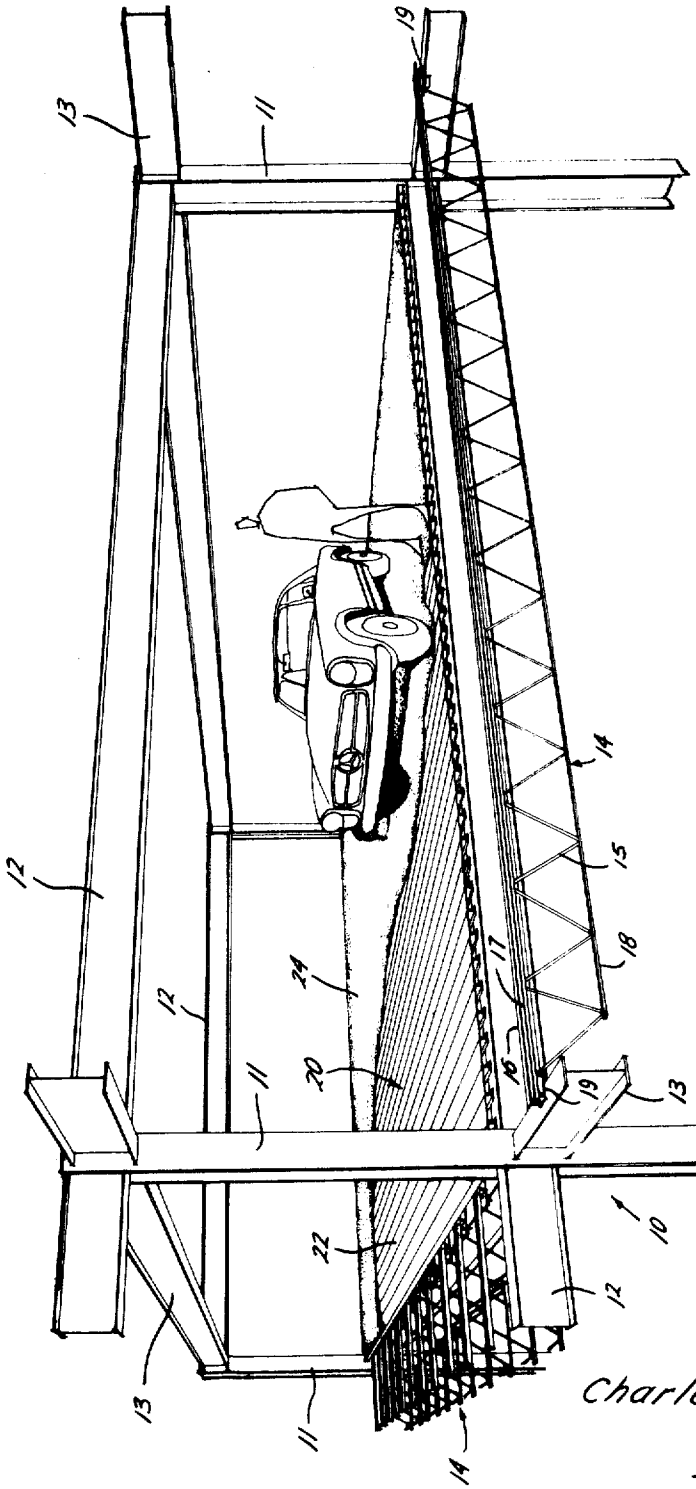


Fig. 1

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Fig. 2

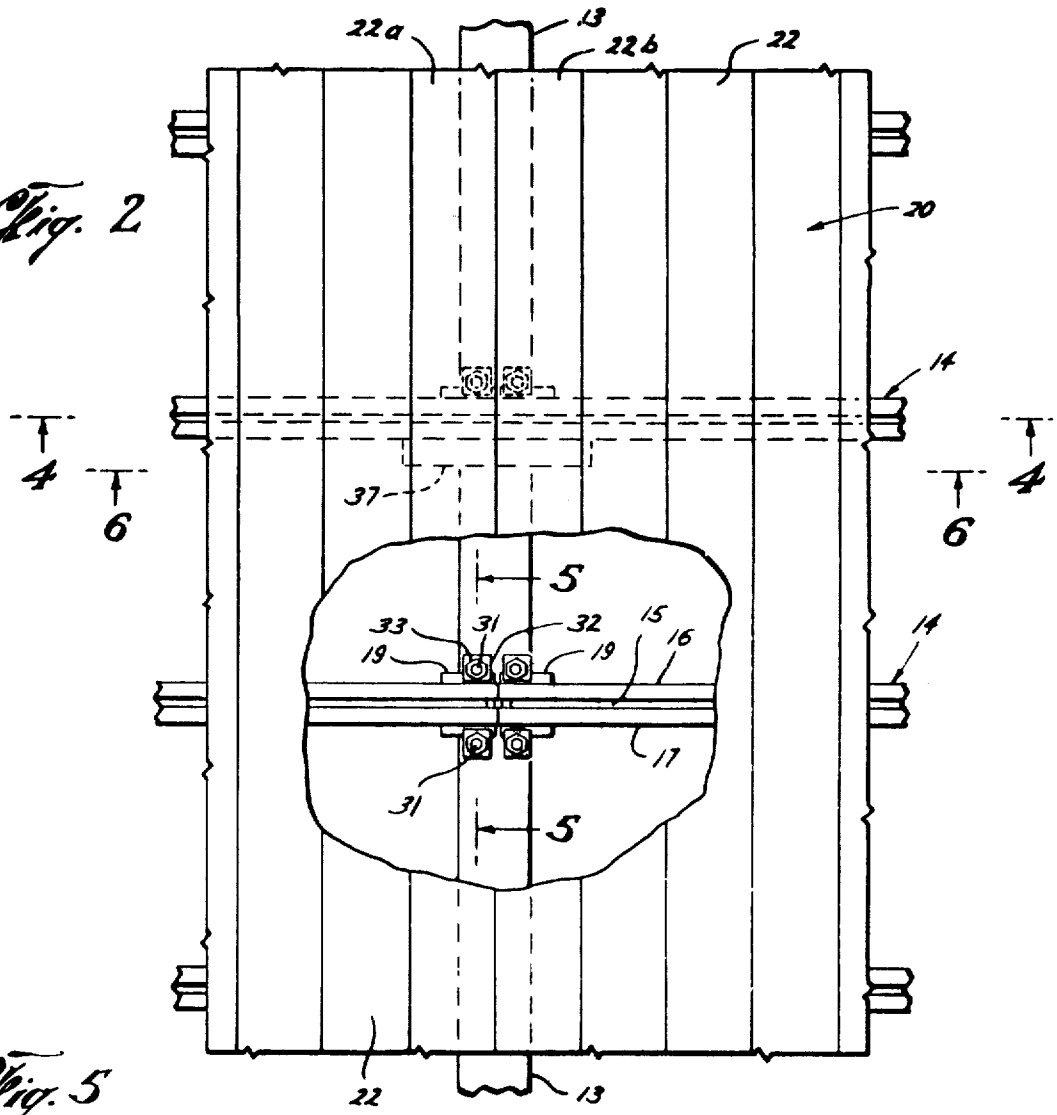


Fig. 5

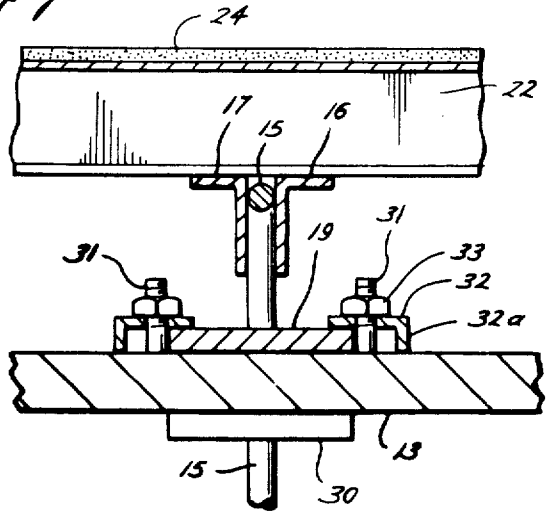
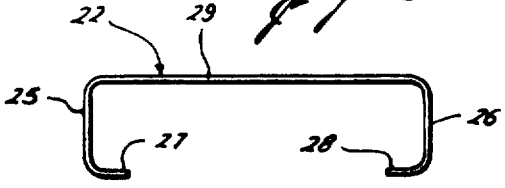


Fig. 3



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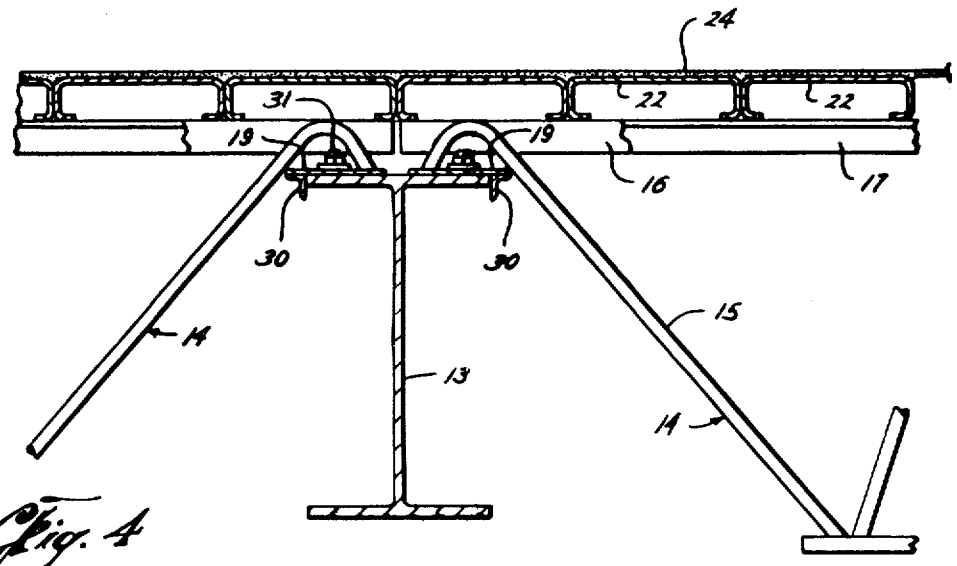


Fig. 4

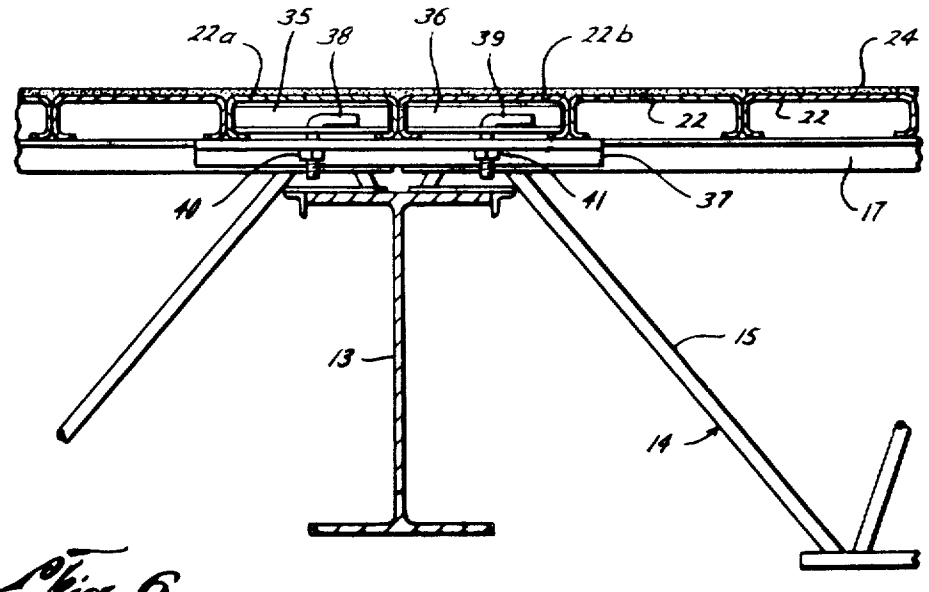


Fig. 6

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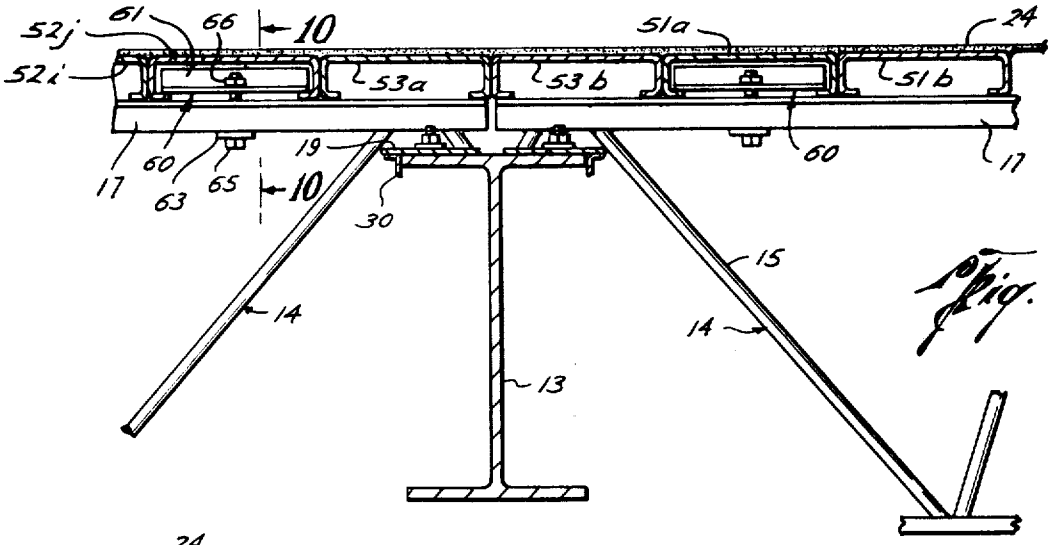


Fig. 9

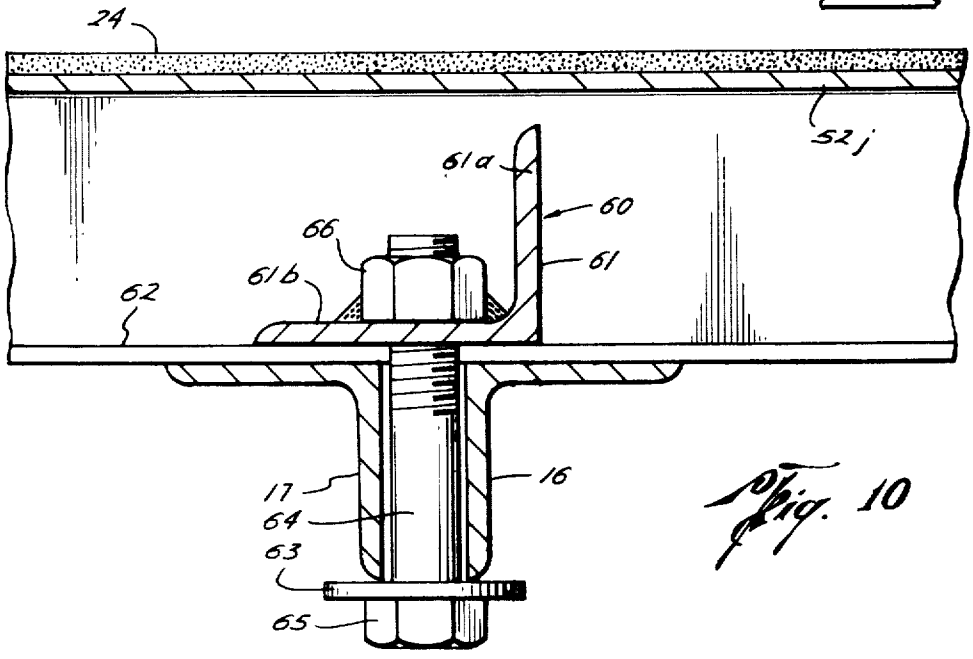


Fig. 10

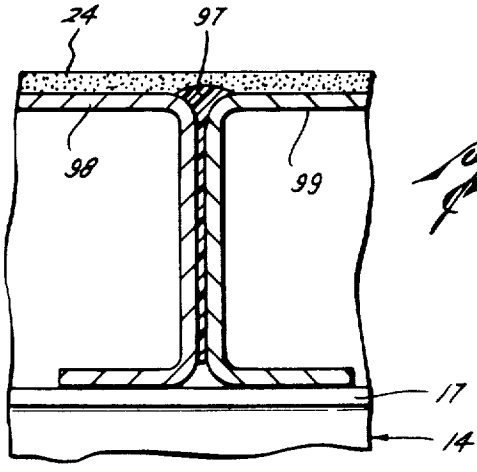


Fig. 7

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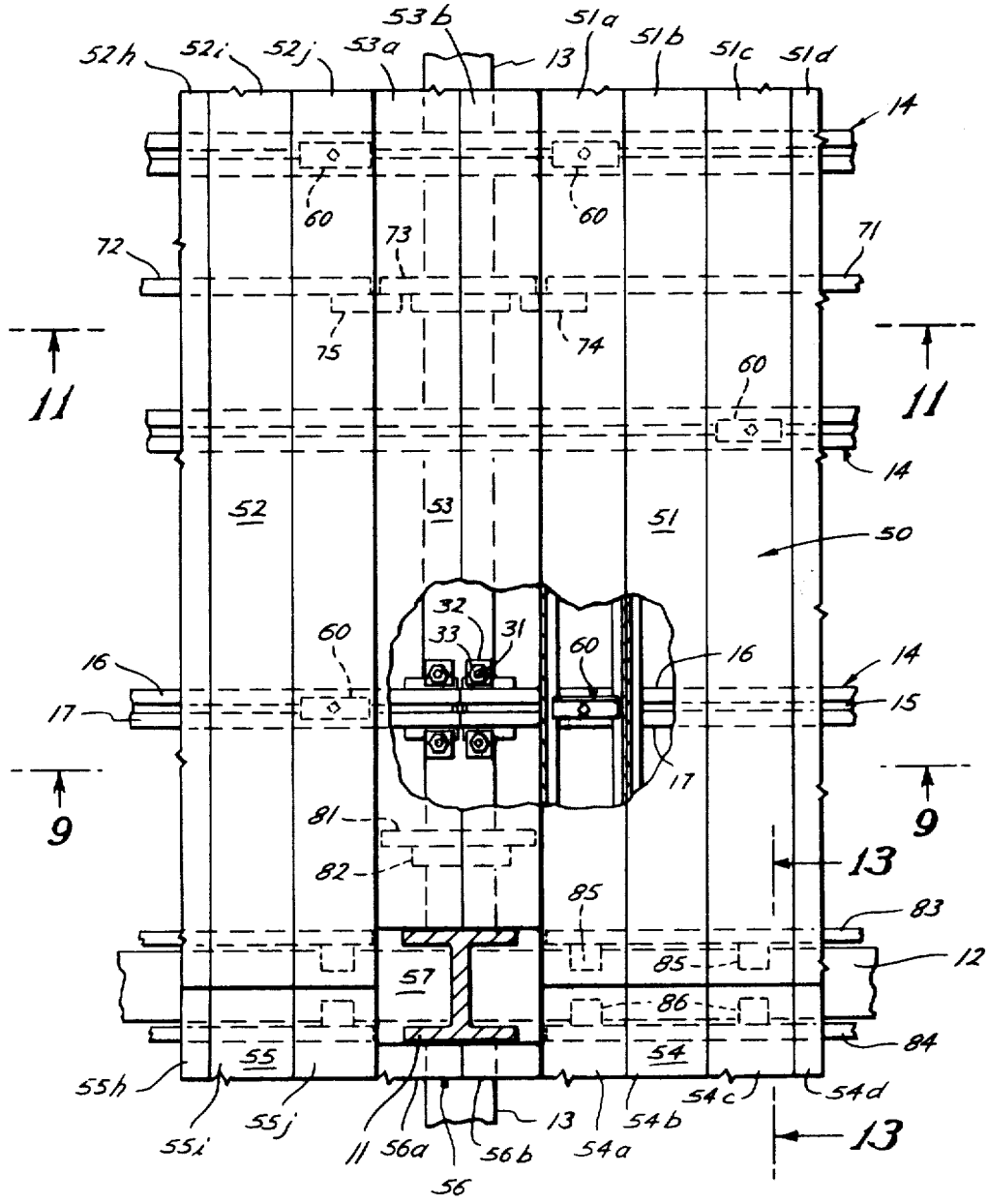


Fig. 8

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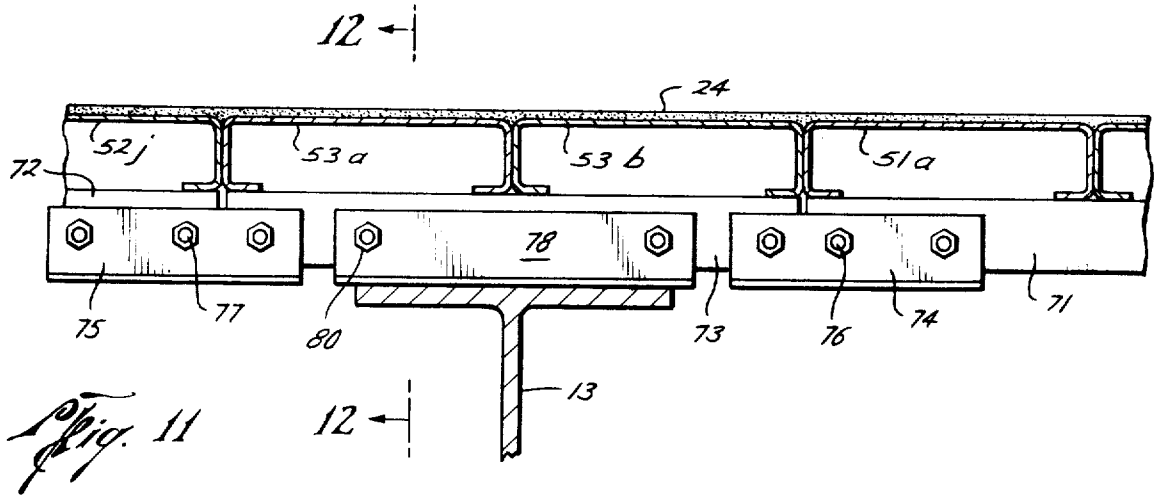


Fig. 11

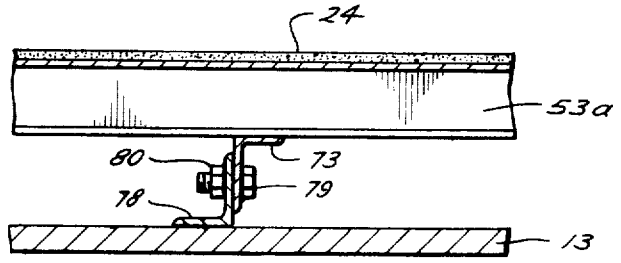


Fig. 12

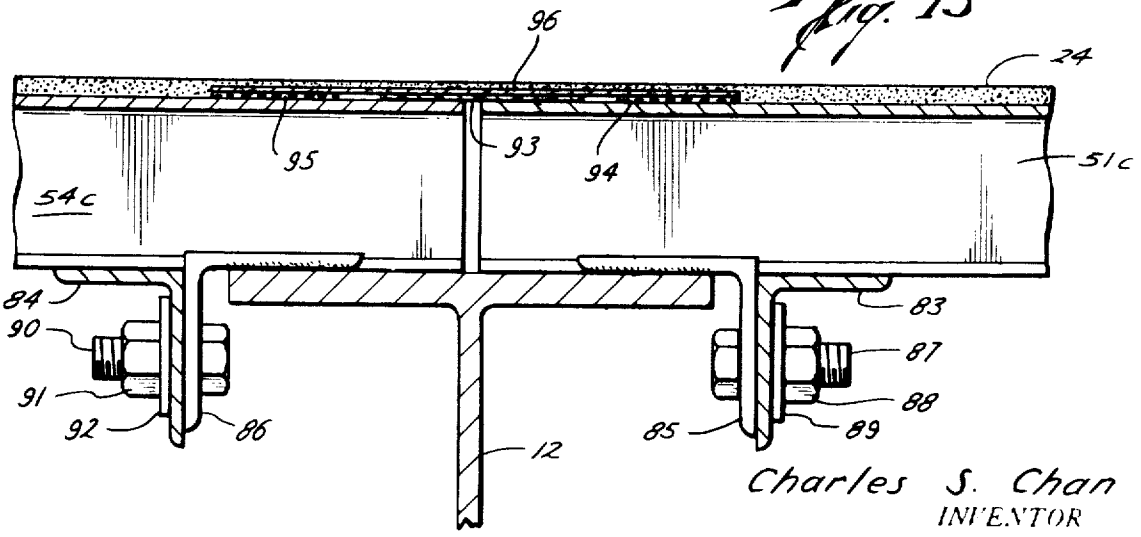


Fig. 13

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METHOD OF CONSTRUCTING PARKING GARAGE STRUCTURES

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of applicant's copending application Ser. No. 808,854 filed on Mar. 20, 1969 for "Parking Garage Structure," now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to parking garage structures for automobiles and other motor vehicles and systems and methods of construction for such structures.

Multistory or multilevel parking garages are frequently built in downtown or other business areas. It sometimes happens that the growth of the business area requires that the parking garage be taken down and replaced by an office building or other commercial structure of greater economic importance. In such cases, it is sometimes desired that a second or replacement parking garage be built at a nearby location to provide the parking facilities formerly provided by the original parking garage.

In these cases, it would be desirable if the original parking garage could be dismantled in such a way that most, if not all, of the structural materials used in its construction could be reused in the construction of the second parking garage. Unfortunately, presently used methods of parking garage construction do not lend themselves very readily to this purpose. Much of the structure would normally be damaged beyond the point of reuse in the process of dismantling the original parking garage.

It would also be desirable if the original parking garage were constructed in such a way that it could be dismantled in less time and with less effort than is required with presently used construction methods.

SUMMARY OF THE INVENTION

It is an object of the invention, therefore, to provide new and improved methods of constructing parking garage structures which are especially adapted to be dismantled and relocated at a future date. The invention contemplates a prefabricated parking garage structure whose components can be erected in the field with a minimum of time and labor. It can also be disassembled and relocated and its components are interchangeable with similar components in other parking garage structures.

It is another object of the invention to provide new and improved parking garage structures which can be dismantled and relocated and wherein practically all of the structural material in the original structure suffers no substantial damage in the process and is usable in the relocated structure.

It is a further object of the invention to provide new and improved methods of constructing parking garage structures which, in many cases, reduce the total construction time and cost and enable the garage to be put into use at an earlier date.

It is an additional object of the invention to provide new and improved parking garage structures having vehicle bearing surfaces which are easy to repair and maintain.

It is a further object of the invention to provide new and improved parking garage structures which require less maintenance and have reduced operating costs over a period of years.

In accordance with one feature of the invention, a parking garage structure comprises a metal support frame including a series of joists spaced apart from one another in a side-by-side manner and releasably clamped to a supporting structure. The parking garage structure further includes a metal deck formed by laying a series of structural shapes across the joists in a side-by-side manner and releasably clamped on the joists. The parking garage structure also includes a chemical-repellent waterproof coating bonded to the upper surface of the metal deck for providing a vehicle bearing surface.

In accordance with another feature of the invention, a method of constructing a parking garage structure comprises

erecting a metal support frame including a series of joists spaced apart from one another in a side-by-side manner. The method also includes the forming of a metal deck by laying a series of structural shapes across the joists in a side-by-side manner. The method further includes coating the upper surface of the metal deck with a resilient plastic material for providing a chemical-repellent waterproof vehicle bearing surface.

For a better understanding of the present invention, together with other and further objects and features thereof, reference is had to the following description taken in connection with the accompanying drawings, the scope of the invention being pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the drawings:

FIG. 1 is a perspective view of a portion of a parking garage structure constructed in accordance with a representative embodiment of the present invention;

FIG. 2 is a plan view of a portion of the parking garage structure of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of one of the deck structural members;

FIG. 4 is an enlarged cross-sectional view taken along section line 4—4 of FIG. 2;

FIG. 5 is an enlarged cross-sectional view taken along section line 5—5 of FIG. 2 and assuming that the overlaying deck is in place;

FIG. 6 is an enlarged cross-sectional view taken along section line 6—6 of FIG. 2 and showing with greater particularity a first form of means of releasably clamping the deck in place;

FIG. 7 is an enlarged cross-sectional view of the joint between a pair of adjacent deck members;

FIG. 8 is a plan view corresponding to a portion of the parking garage structure of FIG. 1 and showing further details and certain modifications;

FIG. 9 is an enlarged cross-sectional view taken along section line 9—9 of FIG. 8 and showing a second form of deck fastening means;

FIG. 10 is an enlarged cross-sectional view taken along section line 10—10 of FIG. 9 to illustrate in greater detail the alternate form of fastening means;

FIG. 11 is an enlarged cross-sectional view taken along section line 11—11 of FIG. 8 and showing in greater detail fastening means for interconnecting deck panels and fastening means for fastening a deck panel to a primary support beam;

FIG. 12 is a cross-sectional view taken along section line 12—12 of FIG. 11; and

FIG. 13 is an enlarged cross-sectional view taken along section line 13—13 of FIG. 8 and showing in greater detail means for fastening the ends of the deck to a primary support beam.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a portion of a representative embodiment of a parking garage structure constructed in accordance with the present invention. The complete structure may be, for example, a multistory or multilevel structure occupying a goodly portion of a complete city block. FIG. 1 shows in detail only a part of one floor level, this being sufficient to understand the system of construction provided by the present invention. Also, for simplicity of illustration, various auxiliary structures, such as entrance and exit ramps, guardrails, handrails, drain gutters, drain pipes, and so forth, are not shown in the drawings, it being understood that the complete garage will include such structures as needed.

The parking garage structure of FIG. 1 includes a metal support frame 10 formed by a series of vertical primary beams 11, a first series of horizontal primary support beams 12, and a second series of horizontal primary support beams 13 running at right angles to the series 12. These beams 11, 12, and 13 are heavyweight steel I-beams and are welded or bolted together to form the basic skeleton of the structure. The lower extremi-

ties of the vertical primary beams 11 rest on a suitable foundation structure (not shown).

The metal support frame 10 further includes a series of steel bar joists 14 spaced apart from one another in a side-by-side manner. These joists 14 are supported between pairs of the primary beams 13 by resting the ends of the bar joists 14 on the tops of the primary beams 13. For ease of visualization, one of the bar joists 14 is shown by itself in the foreground of FIG. 1. As there indicated, each of the bar joists 14 is formed by a vertically zigzagging steel bar 15 the upper peaks of which are welded in place between a pair of elongated horizontal flange members 16 and 17 which run the length of the joist. The lower ends or tips of the zigzag bar 15 are welded between a pair of elongated horizontal bars 18. A bearing plate 19 is welded to each end of the bar joists 14, these bearing plates 19 resting on top of the primary beams 13.

The parking garage structure also includes a metal deck 20 formed by laying a series of structural shapes 22 across the joists 14 in a side-by-side manner. For purposes of obtaining maximum strength with minimum weight, the structural shapes 22 are preferably in the form of elongated and bent or folded steel plates. A preferred form of channel member or beam for use as the structural shapes 22 will be considered hereinafter.

The parking garage structure further includes a chemical-repellent waterproof coating 24 bonded to the upper surface of the metal deck 20 for providing a vehicle bearing surface. This waterproof coating 24 covers the entire deck surface though, for purposes of explanation, part of the deck surface in FIG. 1 is shown as being uncovered. This coating 24 is preferably a composition comprising a resilient base material loaded with a hard granular material, the latter providing a friction surface for the vehicle bearing surface. The base material is preferably a plastic material or some type of synthetic rubber or elastomer material. The material forming the waterproof coating 24 is applied to the surface of the metal deck 20 while in a molten condition, such material thereafter being allowed to harden to form the desired vehicle bearing surface. The nature of the waterproof coating 24, the manner of applying such coating, and the initial preparation of the deck surface will be considered in greater detail hereinafter.

Referring to FIG. 2, there is shown a plan view of a portion of the parking garage structure of FIG. 1. For purposes of explanation, the overlaying waterproof coating 24 is not shown in FIG. 2.

Referring to FIG. 3, there is shown a cross-sectional view of a preferred form of construction for the structural shapes or deck members 22 of FIGS. 1 and 2. As indicated in FIG. 3, each of the deck members 22 is preferably a C-section wherein the extremities of the flanges 25 and 26 of the C-channel are bent inwardly to form horizontal legs 27 and 28 running parallel to the body portion or web 29 of the channel. Thus, each deck member 22 is provided with a generally C-shaped cross section. In use, the horizontal legs 27 and 28 are rested on the top surfaces of the supporting joists 14. Each deck member 22 is formed from a narrow elongated steel plate by rolling same in a rolling mill or bending same in a plate press. By way of example only, each of the deck members 22 may be provided with a width of 8 inches, a height of 2 inches, and a length on the order of 30 to 40 feet. The steel plate material may be, for example, No. 10 gauge steel plate having a yield strength of preferably 30,000 to 35,000 pounds per square inch.

The parking garage structure also includes means for holding the bar joists 14 in place on the primary beams 13. This means will be explained with the aid of FIGS. 4 and 5, which are cross-sectional views taken along the correspondingly numbered section lines in FIG. 2. Referring first to FIG. 4, there are shown the two bearing plates 19 which are welded to the ends of the two bar joists 14 which rest on top of one of the beams 13 on opposite sides thereof. A transverse angle member 30 is welded to the underside of each bearing plate 19 so as to provide a downwardly depending lip which rests against the edge of the top flange of the beam 13 when the bar joist 14 is in place. Since the bearing plate 19 and depending angle members 30 are attached to each end of any given bar joist 14 during fabrication of the bar joist 14 and since the bar joist is supported between a pair of the primary beams 13, the angle members 30 at the two ends initially guide the bar joists into position on the beams 13, prevent longitudinal movement of the bar joist 14, and enable the bar joist 14 to provide lateral support for the primary beams 13.

The means for further holding the bar joists 14 in place and preventing lateral movement thereof is best seen in the cross-sectional view of FIG. 5. As there indicated, upwardly extending threaded studs 31 are secured to the beam 13 alongside the bearing plate 19 attached to the end of the joist. These threaded studs 31 may be, for example, welded to the beam 13 by means of conventional stud welding equipment during fabrication of the beam 13. For example, when the beam 13 is cut to length in the shop, the studs 31 are welded in place. These studs further aid in initially positioning the bar joists 14 on the beams 13. After the bar joists are positioned on beams 13, clamp members 32 are positioned on the studs 31. These clamp members 32 are sized so as to overlap the top surface of the bearing plate 19, as shown in FIG. 5, and they are also provided with downwardly depending legs 32a which rest against the top surface of the primary beam 13. A threaded nut 33 is threaded onto each stud 31 for urging the corresponding clamp member 32 downwardly against the underlying surface portion of the bearing plate 19. Nut 33 may be of the self-locking type. This same manner of construction, using threaded studs 31, clamp members 32, and nuts 33, is provided for each end of the bar joists 14. A plan view of this construction is shown in that portion of FIG. 2 wherein the deck beams 22 have been broken away for explanatory purposes.

Some areas do not permit ironworkers to work on I beams with projections thereon. If for this or any other reasons the threaded stud 31 cannot be welded to beam 13, then holes can be punched in the beams 13 at locations to correspond with where the studs 31 would have been located, and then the joists 14 are fastened down with standard machine bolts and locking nuts, in lieu of the foregoing description.

Preferably, a plurality of the deck members 22 can be welded together in any suitable manner to form deck panels at the place of fabrication and before delivery of the construction site. For example, the deck members might be welded either in sets of five or in sets of 10 which, for the case of an 8-inch width of member 22, would provide panel widths of 40 inches and 80 inches, respectively. Among other things, the use of these prefabricated deck panels would save assembly time at the construction site. Further details of the panel construction will be given.

The panels are releasably connected to the bar joists 14 at the construction site by suitable means, one alternate form of which is shown in FIG. 6, and the preferred form in FIGS. 9 and 10. In FIG. 6, such connection or fastening means is shown as securing a deck panel formed of two deck members in position over and along the beam 13.

The fastening means includes a pair of short structural angle members 35 and 36 which are transversely nested inside the deck members 22a and 22b, such angle members 35 and 36 resting on the tops of the horizontally extending legs located at the bottoms of each of the deck members 22*a* and 22*b*. The fastening means also includes a retaining member in the form of a long structural angle member 37 located below the deck members 22*a* and 22*b* in line with the short angle members 35 and 36 and extending transversely beyond the members 22*a* and 22*b* so as to underlie parts of the neighboring end members 22 of adjacent panels. The long angle member 37 is coupled or connected to the short angle members 35 and 36 by means of hook bolts 38 and 39 and cooperating nuts 40 and 41. The threaded stem of the hook bolt 38 passes through aligned bolt holes drilled through the horizontal portions of

the angles 35 and 37. Similarly, the threaded stem of the other hook bolt 39 passes through aligned bolt holes drilled through the horizontal portions of the angle members 36 and 37. Nuts 40 and 41 may be of the self-locking type.

The outline of the long angle member 37 is indicated in broken line form in FIG. 2. As there seen, it is located alongside the end portions of the bar joists 14 at the place where they meet atop the primary beam 13. A similar fastening means using long and short angle members may be located at each of the other intersections of the bar joists 14 and the primary beams 13.

Similarly, the panels, either 40 or 80 inch, may be secured to bar joists 14 by the foregoing disclosed means. It can be appreciated that at least several of such fastening means will be used for each panel to insure that the panels are firmly secured to the joists.

While the foregoing description has set forth in detail the manner of construction of only a relatively small portion of one floor of a complete parking garage structure, it is to be understood that this same manner of construction is applied not only to the remainder of the illustrated floor level but also to each of the other floor levels which go to make up a complete multilevel parking garage.

As is seen from the foregoing description of a preferred embodiment of the invention, a parking garage structure constructed in accordance with the present invention is especially adapted to be dismantled and relocated. In terms of the foregoing embodiment, this is accomplished by cutting the waterproof coating 24 along the lines of the joints between the deck beams 22 (or deck beam panel groups, if panels are used). The angle members 35, 36, and 37 comprising the fastening means for the deck panels formed of deck members are then unbolted and the deck panels removed. The nuts 33 and the clamp members 32 holding the bar joists 14 in place are then removed. After this, the bar joists 14 may be removed and the remainder of the frame structure dismantled in a conventional manner.

An important advantage of this system is that practically all of the structural materials, including the bar joists and deck beams, are salvageable and are usable in the construction of the relocated parking garage. After the relocated parking garage is assembled, the cuts in the waterproof coating are resealed by patching same with more of the coating material.

In those instances where the structure is to be in a permanent location, the beams 11, 12, and 13 are not only welded or bolted together, but the bar joists 14 are welded to the beams 13 and the deck panels welded to the bar joists 14.

Referring now to FIG. 8, there is shown a plan view corresponding to a portion of the parking garage structure of FIG. 1 but showing various modifications. The parts of the FIG. 8 structure which correspond to those of the earlier embodiment are identified by the same reference numerals as used in such earlier embodiment. The portion of the garage structure shown in FIG. 8 is not precisely the same as that shown in FIG. 2. More particularly, FIG. 8 shows one of the vertical primary beams 11 (in cross section) together with portions of the various deck members of the deck panels which lie about such vertical beam 11. As indicated in FIG. 8, the horizontal primary beams 12 and 13 which run at right angles to one another are secured to the vertical beam 11 to provide a common intersection point for the three sets of primary beams 11, 12, and 13. As before, series of bar joists 14 are supported between adjacent pairs of the horizontal primary beams 13, one of which is shown in FIG. 8. As in the earlier embodiment, the bar joists 14 are clamped to the primary beams 13 by means of the clamping mechanism provided by the threaded studs 31, the clamp members 32, and the nut members 33.

Some areas do not permit ironworkers to work on I beams with projections thereon. If for this or any other reason the threaded stud 31 cannot be welded to beam 13, then holes can be punched in the beams 13 at locations to correspond with where the studs 31 would have been located, and then the joists 14 are fastened down with standard machine bolts and locking nuts, in lieu of the foregoing description.

In FIG. 8, a metal deck, generally indicated at 50, is again formed by laying prefabricated structural panels across the joists 14 in a side-by-side manner. A portion of one such panel is indicated at 51. The portions shown includes deck members 51*a*, 51*b*, 51*c*, and 51*d* welded together at longitudinally spaced intervals. For sake of an example, it will be assumed that the panel 51 includes 10 such deck beams which are welded together at spaced intervals in a side-by-side manner and which, when laid in place, extend from the center line of one transverse primary beam 12 to the center line of the next transverse primary beam 12. For the sake of a name, a deck panel of this character will be termed a full-sized deck panel.

A portion of a second full-sized deck panel is indicated at 52 and the portion shown includes deck members 52*h*, 52*i*, and 52*j*. As indicated, this deck panel 52 is on the opposite side of the horizontal primary beam 13. Located intermediate the deck panels 51 and 52 is a smaller sized deck panel 53 formed by a pair of deck beams 53*a* and 53*b* which are welded together. This deck panel 53 extends in length to a point just short of the vertical beam 11.

Located on the opposite side of the crosswise or transverse primary beam 12 is another set of deck panels 54, 55, and 56 corresponding to those just considered. The first four deck members of full-sized panel 54 are designated as 54*a*, 54*b*, 54*c*, and 54*d*, while the last three deck members of full-sized panel 55 are designated at 55*h*, 55*i*, and 55*j*. The smaller sized deck panel 56 includes deck members 56*a* and 56*b*.

A cover structure of closure structure 57 covers the hole or opening formed at the meeting place of the panels 51–56, which meeting place is the area immediately surrounding the vertical beam 11. Through not shown for sake of simplicity, this closure structure 57 in practice includes flap portions which overlap the neighboring deck beams and skirt portions which extend a short distance upwardly on the various portions of the vertical beam 11, the object being to completely close off the opening which would otherwise surround the vertical beam 11.

Each of the deck members making up the various deck panels is preferably of the C-shaped channel type shown in cross section in FIG. 3 and discussed in detail at an earlier point herein. This form of construction is the one that will be shown in the more detailed drawings for the present embodiment.

The various full sized deck panels, such as those indicated at 51, 52, 54, and 55, are releasably secured to the bar joists 14 by means of alternate form of releasable fastening mechanisms, several of which are shown in FIG. 8 and are identified by the reference numeral 60. For any given deck panel, the number of fastening mechanisms of devices 60 which are used and the pattern in which they are deployed is selected so as to insure that each of the panels firmly is secured to the joists.

The details of one of the releasable fastening mechanisms 60 is shown in the cross-sectional views of FIGS. 9 and 10. As there indicated, each fastening mechanism 60 includes a structural angle member 61 transversely nested inside one of the deck members (e.g., 52*j*) of a deck panel by resting same on the top of the inwardly extending lips thereof. As indicated in FIG. 10, the nested structural angle 61 includes a vertical leg 61*a* and a horizontal leg 61*b*, the latter resting on top of the inwardly extending lips of the deck beam 52*j*, one of such lips being indicated at 62. The structural angle 61 is coupled to the bar joist 14 by means of a washer member 63 which engages the underside of the joist flanges 16 and 17 and a threaded bolt 64 which extends through the washer 63 and upwardly between the joist flanges 16 and 17 and through a vertically extending passage or hole in the horizontal leg portion 61b of structural angle 61. The head 65 of the bolt 64 is located below the washer 63 and a threaded nut 66 secured to 61b by welding or the like receives the bolt 64. Nut 66 is preferably of the self-locking type. Rotation of the bolt 64 urges the washer 63 and the nested structural angle 61 toward one another, which in turn clamps the deck beam 52j against the joist flanges 16 and 17.

Returning to FIG. 8, there will now be considered the manner in which the smaller sized deck panels (e.g., 53) located over the horizontal primary beams 13 are secured to the adjacent full sized deck panels and to the beams 13. In this regard, it is initially noted that stiffener members running transversely to the deck beams are welded to the undersides of the deck members at periodic locations on each deck panel. One of the stiffeners for the panel 51 is indicated at 71, while one of the stiffeners for the panel 52 is indicated at 72. Each stiffener (e.g., 71) extends transversely from one side of its panel (e.g., 51) to the other. These stiffeners are welded to the panels at the time they are prefabricated at the factory location.

The stiffener members 71 and 72 are in the form of structural angles having a horizontal leg welded to the horizontal leg of the deck members and a vertical leg entending downwardly therefrom. A similar structural angle member 73 is welded across the underside of the smaller sized deck panel 53 in line with the stiffener angles 71 and 72 of the adjacent full sized panels. The small panel angle 73 is coupled to the stiffener angle 71 by way of a short angle member 74 which overlaps angles 71 and 73. The vertical leg of this connecting angle 74 is bolted to the vertical legs of each of the angles 71 and 73. In a similar manner, the small panel angle 73 is coupled to the stiffener angle 72 by way of a second connecting angle 75 which overlaps these two angles and is bolted to each thereof. This manner of construction is perhaps better seen in the cross-sectional view of FIG. 11, typical bolts for the connecting angles 74 and 75 being indicated at 76 and 77, respectively.

As further indicated in FIG. 11, as well as in the additional cross-sectional view of FIG. 12, the smaller sized panel formed by the deck members 53*a* and 53*b* is also connected to the primary beam 13 by means of a further structural angle member 78. The horizontal leg of angle 78 is welded to the top flange of beam 13 while being fabricated and the vertical leg is bolted to the vertical leg of the panel angle 73, a typical connecting bolt being indicated at 79 and a typical connecting nut being indicated at 80 in FIG. 12.

As indicated in FIG. 8, this same type of connecting mechanism may be used for the smaller sized deck panel 53 at a location wherein there are no corresponding stiffener angles on the adjacent full sized deck panels. Thus, near the vertical beam 11, there is provided an angle member 81 which is welded to the undersides of the deck members 53*a* and 53*b* and an angle member 82 which is welded to the top flange of the primary beam 13. The vertical legs of angle members 81 and 82 are bolted together in the same manner as indicated in FIG. 11.

Returning to FIG. 8, there will now be considered the manner in which the ends of the deck members in the full sized deck panels are fastened to the crosswise or transverse primary beams 12. For sake of an example, the ends of the deck members of panels 51 and 54 will be considered in detail, it being understood that the ends of the deck members in the other panels are secured to the primary beams 12 in a similar manner. With this in mind, a stiffener angle is welded across the underside of each of the panels 51 and 54 at locations immediately adjacent the corresponding sides of the upper flange of the primary beam 12. The stiffener angle for panel 54 is indicated at 83, while the stiffener angle for panel 54 is indicated at 84. The stiffener angle 83 is bolted to a series of downwardly extending clip members 85 which are welded to the primary beam 12 at periodic intervals therealong. In a similar manner, the angle stiffener 84 is bolted to a series of downwardly extending clip members 86 which are welded to the beam 12 at periodic intervals therealong, but on the opposite side thereof from the clip members 85.

This manner of construction is better seen in the cross-sectional view of FIG. 13. As there indicated, the vertical leg of stiffener angle 83 is bolted to the vertical leg of each angle clip 85 by means of bolt 87 and nut 88, a washer 89 being located on the bolt 87 intermediate the nut 88 and the vertical leg of the stiffener angle 83. In a similar manner, bolt 90, nut 91, and washer 92 are used for bolting each of the angle clips 86 to the stiffener angle 84 of the second deck panel 54. Each of the various nuts 88 and 91 may be of the self-locking type.

Further shown in FIG. 13 is the manner in which the joint between the ends of the deck panels 51 and 54 is covered and waterproofed. In particular, a strip 93 of gasket material such as, for example, neoprene, is laid down over the joint along the length thereof so as to overlap the ends of the two adjoining deck panels 51 and 54. A strip of molten or unhardened sealant material is then coated onto each of the deck panels 51 and 54 along opposite sides of the gasket strip 93. The strip of sealant material for deck panel 51 is indicated at 94, while the strip of sealant material for deck panel 54 is indicated at 95. These strips 94 and 95 are continuous and run the length of the deck panels. The sealant material for each strip is preferably a material having high strength bonding characteristics, a suitable material being an epoxy resin. A metal cover strip 96 is placed over the gasket strip 93 and the sealant strips 94 and 95, the latter, after they harden, serving to form a strong, but resilient, bond between the cover strip 96 and the two deck panels 51 and 54. Thereafter, the waterproof coating 24 is applied over the cover strip 96 as well as the remainder of the surface area of the deck panels 51 and 54.

Though, for simplicity of explanation, the foregoing explanation referred only to deck panels 51 and 54, it should be understood that the gasket member 93, sealant strips 94 and 95, and the cover strip 96 actually extend in a continuous manner along practically the entire length of the transverse primary beam 12 and, as such, will usually extend over several pairs of abutting deck panels. In other words, in terms of FIG. 1, these strip elements 93–96 extend in a continuous manner from one vertical beam 11 to the next vertical beam 11.

The various nutted bolts considered in any of the various figures heretofore discussed are preferably of such a nature as to prevent the nut from coming loose as a result of vibrations, impact loads, and the like. As indicated at various points hereinbefore, this can be accomplished by utilizing self-locking type nuts. It should be understood, however, that this purpose can also be accomplished by using lock washers or the like.

A more detailed consideration will now be given to the waterproof coating 24 which forms the ultimate vehicle bearing surface and the manner in which such coating should be applied to either the metal deck 20 of the FIGS. 2–6 embodiment or the metal deck 50 of the FIGS. 8—13 embodiment. The following remarks apply equally to both embodiments. In this regard, it is noted that the metal deck 50 of FIG. 8 is, in fact, covered with the waterproof coating 24 after the steel work has been completed and the various deck panels have been secured in place.

The first item that should be considered is the initial preparation of the steel deck surface before the application of the waterproof coating 24. In order to insure a strong bond between the waterproof coating 24 and the steel deck surface, such steel deck surface should be thoroughly cleaned of all rust, dirt, and other foreign matter before the waterproof coating 24 is applied. This cleaning can be accomplished in several ways. It can be accomplished by sandblasting the metal deck surface or by washing the deck surface with a chemical solvent. Both of these methods, however, present certain disadvantages. Consequently, it is preferred to use a somewhat different approach, namely, to precoat the upper surfaces of the C-shaped channel-type deck members with a protective coating which is permanently bonded to the steel surface and also compatible to receiving the waterproof coating thereon. The protective coating preferably resists corrosion, can be easily cleaned to receive the waterproof coating, as well as affording a surface that will intimately adhere and bond with the waterproof coating.

A protective coating material which has been found to be satisfactory for this purpose is zinc-iron alloy. Steel plate having such a zinc-iron coating on one side thereof is presently

available on the commercial market. One such coated plate is referred to as differential coated Wierkote galvanized steel sheet and is marketed by the Wierton Steel Company. Preferably then, the C-shaped deck members are formed from this commercially available coated type of steel sheet stock. The deck members are, of course, formed so that the zinc-iron coating appears on the upper or, more accurately, the outer surface thereof. The underside or interior of each of the C-shaped deck members is preferably galvanized by means of the well-known hot dip galvanizing process. This saves subsequent field painting of these under portions of the deck panels.

After the deck members have been welded into panels and the panels have been secured in place on the steel framework of the garage structure, it is then necessary to clean the coating which in the preferred form is a zinc-iron protective coating before the waterproof coating **24** is applied. This may be accomplished with the type coating in this example by washing the steel deck surface by means of high pressure water hoses. After this, the steel deck is allowed to dry before the next step in the process.

The joint between the deck members of the panels is thoroughly waterproofed during fabrication. This is accomplished by caulking each deck beam joint with a sealant material which forms a positive bond between adjacent deck beams. This caulking of the deck beam joints is illustrated in FIG. **7**, wherein caulking material **97** is shown in the joint between a pair of adjacent deck members **98** and **99**. Typical sealant materials which are suitable for this purpose are epoxy resins and polyurethane. The pot life of the sealant material is adjusted so as to obtain full penetration of the sealant down between the joints before it hardens. Among other things, the caulking of the deck member joints serves to prevent any leakage of fluids between deck members in the event the upper waterproof coating **24** should fail due to some unseen occurrence.

The joints between adjacent panels are caulked after the deck is installed on the joists. The uppermost waterproof coating **24** is then applied to the deck surface. This may be accomplished by pouring the coating material onto the deck surface in a molten state and then squeegeeing and mopping same to provide a uniform coating. This coating is applied over the entire deck surface. It is also applied out over and into all gutter and trim structures which are located on or adjacent the surface of the parking deck. It is also applied to and extended a short distance upwardly on all vertical surfaces, such as the closure structure portions around the vertical beams **11**, which project upwardly adjacent openings in the steel deck proper. After hardening of the first layer of the coating **24**, a second layer of such coating material may be applied in selected high wear areas, such as turning areas, aisle areas, and ramp areas.

The upper coating **24** which provides the ultimate vehicle bearing surface is formed of a resilient, wear resistant, chemical-repellent, water-repellent material. As such, the coating **24** provides two important primary functions. Firstly, it provides a waterproof membrane which prevents leakage of water or the like from floor to floor. Among other things, this is important in order to prevent damage to or soiling of automobiles parked on a lower floor. A second primary function of the coating **24** is to provide protection for the steel deck proper. In this regard, the coating **24** is formed of a chemical-repellent material which is chemically inert to and resists penetration by the various chemicals commonly associated with automobiles. Typical of such chemicals are glycols, oils, and salt containing street deicing compounds. The presence of the chemical-repellent coating **24** prevents such chemicals from attacking the steel deck members and causing corrosion of same, which action if allowed to occur could ultimately reduce the strength and effectiveness of such members. A coating material for forming the coating **24** which has been found to possess these desired characteristics and to be particularly suitable for this purpose is epoxy resin.

A third function which will usually be desired of the coating **24** is that of providing a friction surface for purposes of providing a desired degree of traction for the typical automobile tire. This function is accomplished by mixing with the molten plastic material an appropriate hard granular material. This mixing is done before the plastic material is poured onto the deck surface to form the coating **24**, or it can be distributed by hand or mechanically on the plastic material after the plastic material has been applied to the deck. Various hard granular materials which are suitable for this purpose are sand, gravel, aggregate, chat, grit, steel filing, or the like.

In addition to the field application of the caulking and plastic material to the deck after the garage structure is fabricated; it can be applied to the panels as they are fabricated, and then caulking applied between the panels and plastic material applied thereover. Then, the ends of the panels are sealed as described with regard to FIG. **13**.

The use of the chemical-repellent waterproof coating **24** provides various additional advantages. For one thing, it provides a sound deadening layer which considerably minimizes the clanging and banging noises commonly encountered with metal type structures. Further, the fact that the coating **24** is highly resilient and will not crack very easily if the building settles serves to eliminate costly maintenance repairs through the years. An additional advantage is that if the coating **24** should develop some worn spots, then such spots can be readily repaired by simply applying some more of the coating material and allowing it to harden. This again simplifies maintenance problems and reduces the cost of same.

In some situations, it may be desirable to employ no protective coating to the deck members **22**, and in such event, the deck surface may be sandblasted or otherwise treated to clean it and prepare it for the coating **24**.

Approximately 75 per cent of field labor heretofore required in construction of a garage structure may be eliminated since the present structure is prefabricated before moving its components to the structure site. Also, since it does not employ concrete, it can be assembled under substantially any type weather conditions, and it requires lighter weight foundation and piers.

While there have been described what are at present considered to be preferred embodiments of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, intended to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A method of constructing a parking garage structure comprising:
   a. erecting a metal support frame including a plurality of horizontal primary beams spaced apart from one another in a side-by-side manner;
   b. supporting series of joists between the primary beams by resting the ends of the joists on the tops of the primary beams;
   c. welding upwardly extending threaded studs to the primary beams alongside of the joist ends;
   d. mounting clamping members on the threaded studs for engaging the joist ends and clamping same to the primary beams;
   e. forming a metal deck by laying a series of structural shapes across the joists in a side-by-side manner;
   f. cleaning the upper surfaces of the deck-forming structural shapes;
   g. caulking the joints between the deck-forming structural shapes;
   h. waterproofing the joints between the ends of adjacent deck-forming structural shapes; and
   i. coating the upper surface of the metal deck and over the caulking and waterproofing with a resilient plastic material including a hard granular material whereby the deck coating provides a friction type vehicle bearing surface.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,675,385 Dated July 11, 1972

Inventor(s) Charles S. Chan

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, Line 32 Change "Through" to --Though--.

Column 6, Line 50 After "mechanisms" change "of" to --or--.

Column 7, Line 63 Change the first "54" to --51--.

Signed and sealed this 26th day of December 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents