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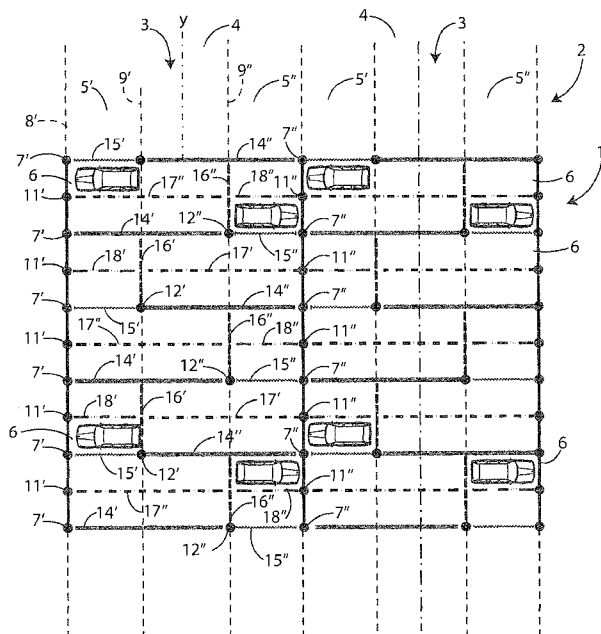


Fig. 4

(57) Abstract: The invention relates to a modular system for the construction of prefabricated structures, in particular modular structures suitable for realizing semi-permanent or temporary parking lots of a modular type comprising a series of modules adjacent each other and complementary two by two, each of which includes two main structural elements (7', 7''), at least one aisle pillar (12', 12''), two main beams (14', 14'', 15', 15''), a secondary beam (16', 16'') and a pair of tertiary beams (17', 17'', 18', 18''), at least a pair of secondary structural elements (11', 11''), arranged in an intermediary position between two main structural elements. The main beams of two adjacent complementary modules are spaced between them in such a way that the parking surface portion formed by the two modules includes at least three parking spaces (6) for each lateral strips (5', 5'') and not more than two aisle pillars (12', 12'').



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## MODULAR CAR PARKING STRUCTURE

### DESCRIPTION

#### 5    **Field of the invention**

The present invention relates to a modular system for the construction of prefabricated structures. More particularly, the invention relates to modular structures suitable for realizing semi-permanent or temporary parking lots of a modular type.

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#### **Background of the invention**

Prefabricated or metal steel structures are normally used for the realization of elevated installations when, in the absence of sufficient space, it is necessary to create, temporarily or semi-permanently, a mezzanine floor, and, at the same time, a certain speed of realization it is required. In fact, prefabricated structures of this type generally do not require the presence of conventional foundations and are not affected by the conformation of the ground, thereby allowing to keep underground elements, such as technical sub-services or artifacts of historical and archaeological importance.

20        In addition, such prefabricated structures allow to organize the construction site in an advantageous manner in the various steps of the construction, as they have no need to occupy particularly large areas, and use structural elements of such a size as to be easily transported and assembled on site.

25        A further advantage of the mentioned foundationless structures lies in the simplicity and speed of assembly, disassembly and reassembly, which take place using the same building elements and without any modifications of the territory.

30        Prefabricated modular structures can be used, for example, for the construction of temporary parking lots, when it is necessary and urgent to find additional space for parking vehicles.

At the state of the art temporary or semi-permanent modular parking

lots are known providing two levels, one on the ground and the other one raised, which do not use conventional foundations. Each floor of such parking structures provides at least one parking area, referred to herein by the English term "bin" (shown by the reference B in Figures 1 and 2 appended hereto, which represent the prior art), which consists of the ensemble of a central driving aisle and two lateral strips for the vehicles parking (indicated in the figures with C and F, respectively). The lateral strips F are arranged opposite each other relative to the central aisle C and are delimited by the longitudinal sides of the bin B (with respect to the longitudinal direction of the aisle). Each of said lateral strips F comprises a plurality of parking spaces A, arranged in an orthogonal fashion and accessible at least from said central aisle C.

Currently, some modular parking lots, such as for instance the one disclosed in the European patent **EP 0364414**, include in correspondence of the bin B, at the ground floor, a plurality of pillars P arranged, on both longitudinal edges of the bin B and on both edges of the aisle C, every two parking spaces A, as shown in Figure 1. In the same Figure 1, the ensemble of the beams T is shown, connected to the pillars P, and forming a regular structural grid, with the aim of supporting the ceiling of the upper floor. This configuration, although structurally efficient, turned out to be not particularly easy for drivers during parking maneuvers, which are partially hindered by the pillars P located along the edges of central driving aisle C.

On the other hand, the configuration described allows to transfer to the ground the loads of the upper floor, with a good distribution of the loads among the pillars P. Actually, considering that a street pavement must be able to support, at least, the load transmitted from a wheel of a heavy vehicle, that is about  $4 \text{ kg/cm}^2$ , consequently the road bearing capacity is at least  $6 \text{ kg/cm}^2$ . Given that, in broad terms, the weight per square meter to be taken in account in the structural calculation for modular parking lots of the described type is equal to about  $600 \text{ kg/m}^2$  (which includes both dead and live loads), and given that in the configuration of Figure 1 each pillar is loaded by about  $25 \text{ m}^2$ , the load transmitted to the pillar base (usually a plate of about  $3600 \text{ cm}^2$ ) is approximately equal to  $4 \text{ kg/cm}^2$ . The load transmitted to the ground by each pil-

lar is therefore compatible with the normal load-bearing capacity of an existing street pavement, which, therefore, does not need, in general, to be reinforced with additional conventional underground foundations.

Another known configuration for modular parking lot without conventional foundations, is described in the European patent **EP 1507053**, which provides the presence of pillars P supporting of the upper floor slab, one for each parking space A, located only in correspondence of the longitudinal edges of the bin B and not along the sides of the aisle C, as shown in **Figure 2**. The beams T supporting the upper floor are arranged transversely to the longitudinal direction of the aisle C and rest on two opposing pillars P with respect to the aisle C. A similar configuration, although undoubtedly advantageous for the maneuver comfort, is instead disadvantageous for the operations of transport and assembly/disassembly of the structure, because of the excessive sizes of the modular elements constituting the structure. As a matter of fact, the beams T connecting the pillars P appear to be considerably long, generally around 16 meters or more, and therefore they are not easy to be managed during the production, in the galvanizing operations, as well as for transportation and handling in the construction site. The handling within the construction site is particularly problematic when the operational spaces are reduced, as is very often the case in this type of construction.

But the main limitation of the above solution consists in that it can be used without conventional fixed foundations only with the condition of using a lightweight structure floor for the raised level, for example an entirely metallic deck. In fact, where a slab of the type described above in connection with the first prior art document cited (for example, reinforced concrete or concrete with corrugated metal sheet cooperating) was used, weighing about  $600 \text{ kg/m}^2$ , the central pillars between two adjacent bins should bear the load of about  $40 \text{ m}^2$  ( $16 \text{ m} \times 2.5 \text{ m}$ ) of deck, i.e. over 24,000 kg each. This is equivalent to a ground load of more than  $6.5 \text{ kg/cm}^2$ , a value exceeding those normally applied for street pavements.

Despite the need for structures lightening, imposed by the absence of foundations, has induced the technicians to try the use of any kind of light-

weight materials in place of concrete for slab construction, decades of use of these modular structures of parking have shown that concrete, suitably waterproofed and equipped with a suitable wear layer, remains to date the only material able to provide a performance in line with the expectations and needs of car parking operators. These include a lifespan allowing the structure to be used not only temporarily, but also, if desired, in a semi-permanent manner.

Actually, the solution with steel deck has proved to be suitable only for a short period of use (from few weeks to few months), due to the problems connected to excessive noise during the passage of vehicles and the low sealing for rainwater, potentially loaded with oils, provided by the metal sheets and the joints between them.

Finally, other problems of the structures described in **EP 1507053** consist in that it is impossible to arrange cross-bracings in the direction transversal to the aisle. This fact involves the creation of an expensive interlocking device between beam and column in the transverse direction to the aisle, and the consequent presence of a bending moment in the pillar, scarcely compatible with the bayonet and screw joints adopted therein in order to enable height adjustment and the easy dismantling of the structure. This fact adds to the problem that the beams are not transportable unless use is made of an "exceptional transport", unless the beams are be composed *in situ* by joining the various components with complex joints, which may be able to restore the passage of the shear stress and the bending moment over the beam length.

Other parking facilities existing on the market or projects for two levels parking without foundations, or with modest foundations, show, with minor variations, technical characteristics, advantages and disadvantages analogous to those of one of the prior art structures analyzed above.

In addition, it is noteworthy that none of the prior art modular systems for parking lots solves the problem of providing a two raised levels structure without conventional foundations.

### Summary of the invention

The object of the present invention is therefore to obtain structures for

the realization of modular parking lots without foundations with the following features:

a) a limited number of pillars on the driving aisle edges in order to improve the maneuvering of entry in and exit out from the parking place;

5        b) structural elements of such size as to be easily transported and handled on site by working means of common use;

c) slabs of durable material, with the aim to realize temporary structures with long lifespan (semi-permanent);

and, at the same time,

10        d) structure expandable vertically, i.e. having the possibility of adding a second level above ground while maintaining the absence of foundations.

This is achieved, according to the present invention, by means of a new and original combination between the plan position of the pillars and the relative arrangement of the beams supporting the deck.

15        In the frame of the studies that gave rise to the present invention it was considered that, in general, the beams of a structure frame support the slab and transmit the load to the pillars normally in such a way that the load is divided in a balanced and symmetrical manner on each pair of pillars bearing a beam.

20        In the configuration of both structures of Figures 1 and 2 (prior art), on the assumption that the transverse beams of the aisle are all equal to each other, all the pillars transmit to the ground the same load, with the obvious exception of the pillars on the external border of the structure, which transmit lower loads. In the case of a structure like that of Figure 2, in which the parking lot consists of two bins arranged side by side, the pillars of the outer edge  
25        of the structure bear a load that is half the load supported by the central pillars.

Based on these considerations, new combinations of the frame beams scheme have been realized, according to the present invention, in order to  
30        convey differentiated loads on the underlying load-bearing pillars, said pillars being positioned preferably not at the edges of the driving aisle but concentrated away from it, and being of a size (length and weight) as small as possi-

ble.

The constructive solutions proposed according to the invention are thus combinations of beams having a different order, with bearing elements also of a different nature. In particular, the slab of the proposed structure rests  
5 on tertiary beams, which are in turn supported by transverse secondary beams which may have a variable position, within a certain range, resting their ends on respective main beams. The variation of the point of support of the secondary beams causes a differentiated redistribution of the loads on the main beams, with a consequent variable distribution of the loads on the sup-  
10 porting elements which transmit the loads to the ground.

By suitably modifying the position of the secondary transversal beams it is possible, according to the various embodiments of the present invention, to reduce the number of pillars placed at the edges of the aisle, thereby considerably facilitating the comfort of maneuvering for the drivers, without load-  
15 ing excessively the remaining pillars on the aisle edge, and achieving a controllable redistribution of the loads on the pillars at the edges of the structure.

The same arrangement of the primary, secondary and tertiary beams makes it possible to realize raised parking lots with more of one raised levels, which are obtained by superimposing two similar modular structures, with the  
20 proviso that the underlying structure is also designed to accommodate the pillars of the top structure, the pillars being partially shared between the two structures and partly exclusive for each one of them.

### **Brief description of the drawings**

25 The specific features of the invention, as well as the advantages thereof and the modes of carrying it out, will become more apparent with reference to the detailed description presented hereafter, and to some specific embodiments of the concerned modular structure. The latter are depicted by way of example in the attached drawings, wherein:

30 **Figure 1** is a carpentry of the raised deck of a modular parking realized with a first modular structure of the prior art;

**Figure 2** is a carpentry of the raised deck of a modular parking real-

ized with a second modular structure of the prior art;

**Figures 3a and 3b** are the carpentries of a modules pair respectively, complementary each other, in a first embodiment of the modular structure according to the invention;

5       **Figures 3c and 3d** are the carpentries of two exemplary modules respectively, different each other, which represent variations of the modules of Figures 3a and 3b, with two or three intermediate tertiary beams respectively.

**Figure 4** is a carpentry of the raised deck with a view from the top of the ground floor of a modular parking lot realized with a structure according  
10       the first embodiment of Figures 3a and 3b;

**Figures 5a and 5b** are the carpentries of a module pair respectively, complementary each other, of the modular structure according to the invention in a second embodiment.

**Figure 6** shows the carpentry of an exemplary module similar to those  
15       of figures 3 and 5, wherein one of the main beams and one of the tertiary beams are in a cantilever fashion in respect of the related supporting elements.

**Figure 7** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according  
20       the first embodiment of Figures 3a and 3b and the main and tertiary beams in a cantilever fashion according to the scheme of Figure 6.

**Figure 8** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the second embodiment of Figures 5a e 5b and with the main beams only in a  
25       cantilever fashion according to the scheme of Figure 6;

**Figure 9** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the second embodiment of Figures 5a e 5b and the main and tertiary beams in a cantilever fashion according to the scheme of Figure 6;

30       **Figures 10A and 10B** show the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a and 3b and in the en-

semble configuration according to Figure 4, wherein the aisle pillars 12' e 12", here re-named 12'A e 12"A respectively, each flanked by a further pillar da un 12'B e 12"B, respectively, in two similar variations;

5       **Figure 11** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a e 3b in a first variation;

**Figure 12** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a e 3b in a second variation;

10       **Figure 13** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a e 3b in a third variation;

**Figure 14** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according 15 the first embodiment of Figures 3a e 3b in a forth variation;

**Figure 15** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a e 3b in a variation which represents three car spaces for each side strip between two main beams;

20       **Figure 16** is the carpentry of the raised deck with view from the top of the ground floor of a modular parking lot realized with the structure according the second embodiment of Figures 5a e 5b in a variation which presents three car spaces for each side strip between two main beams;

**Figure 17** is the carpentry of the raised deck with view from the top of 25 the ground floor of a modular parking lot realized with the structure according the first embodiment of Figures 3a e 3b in a variation which presents alternatively two or three car spaces for each side strip between two main beams; and

**Figure 18** is the carpentry of the raised deck with view from the top of 30 the ground floor of a modular parking lot realized with the structure according the second embodiment of Figures 5a e 5b in a variation which presents alternatively one or four car spaces for each side strip between two main beams.

### Detailed description of the invention

The present invention, thus, specifically concerns a modular structure for supporting a deck of at least a first floor for the construction of modular parking lots, said modular parking lots comprising at least one parking surface having a central driving aisle with a central longitudinal axis (y) and two side strips arranged opposite to one another with respect to said central aisle and each bounded, in the longitudinal direction of the aisle, by a side edge lateral to said parking area and by an aisle edge adjacent to the central aisle, each of said side strips comprising a plurality of car spaces accessible at least from the central aisle

said modular structure being characterized in that it comprises a series of modules adjacent to each other and complementary two by two in the direction of the longitudinal axis (y) of said aisle, each module comprising:

**two main structural elements** (which may be, in alternative, two pillars or two beams) arranged close to the same side edge of a first one of said two side strips;

**at least one aisle pillar**, placed close to the aisle edge of the second one of said two side strips, said aisle pillar being substantially aligned in a direction orthogonal to the longitudinal axis with the center of gravity of a first one of said two structural elements (pillars or beams) of the same module, and also being substantially aligned with the center of gravity of the second structural element (pillars or beams) of an adjacent complementary module,

**two main beams** substantially transverse to the longitudinal axis of said aisle, a first main beam being arranged between said first structural element and the aisle pillar of the same module, a second main beam being arranged between the second structural element (pillar or beam) of said module and the aisle pillar of an adjacent complementary module,

**a secondary beam** arranged substantially in the direction of the longitudinal axis of said aisle, said secondary beam being in an intermediate position between a first side edge and the longitudinal axis of the aisle, with its two ends which can be placed at different positions along a line that contains one

of the respective main beams.

**at least one pair of secondary structural elements** (beams or pillars) arranged in an intermediate position between two main structural elements, each secondary structural element being placed close to the side edge  
5 of a respective side strip, in a position opposite, with respect to the longitudinal axis of the said aisle, to the other secondary structural element, and

**a pair of tertiary beams** for each of at least one pair of secondary structural elements, arranged substantially transverse to the longitudinal axis of said aisle, between a respective secondary structural element and said  
10 secondary beam,

said main beams of two adjacent complementary modules being spaced between them in the direction of the longitudinal axis of the aisle in such a way that the parking surface portion formed by said two modules include at least three car spaces in each side strip and not more than two aisle  
15 pillars.

Further characteristics of the modular structures according to the invention are set out in the dependent claims.

With specific reference to the attached **Figures 3a** and **3b**, which show a first embodiment of the modular structure for car parking according to  
20 the invention, the parking surface 3 (also referred, hereinabove and hereafter, with the British term "bin") presents a central driving aisle 4 having a central longitudinal axis  $y$  and two side strips 5' and 5'' arranged opposite to one another with respect to said central aisle 4. Each of said side strips 5' and 5'' is bounded, in the longitudinal direction of the aisle, by a side edge lateral to  
25 parking area 3, referred with 8' and 8'' respectively, and by aisle edges, referred with 9' and 9'' respectively, adjacent to said central aisle 4.

Each of said side strips 5', 5'' comprises a plurality of car spaces 6 accessible from said central aisle 4. In general in a car parking may be also provided more parking areas 3, side by side and transversally adjacent to said  
30 longitudinal axis  $y$ .

Figures 3a and 3b respectively show two of a series of modules 10' and 10'' adjacent and complementary one with the following, for the composi-

tion of the modular structure according to the invention. Each module 10' or 10" comprises a couple of main structural elements, the pillars 7' or 7", arranged close to the same side edge 8' or 8" of a first side strip 5' or 5", only one aisle pillar 12" or 12', placed close to the aisle edge 9" or 9' of the second one side strip 5" or 5'. The aisle pillar 12" or 12' is substantially aligned in a direction orthogonal to the longitudinal axis  $y$  with the center of gravity of a first main pillar 7' or 7" of the couple of main pillars of the same module 10', 10", with the center of gravity of a second main pillar 7", 7" of the couple of main pillars of the adjacent complementary module 10" or 10'.

Each module 10' or 10" also comprises two main beams 14', 15' or 14", 15", substantially transverse to the longitudinal axis  $y$ . a first main beam 14' or 14" is arranged between a first main pillar 7' or 7" and the aisle pillar 12" or 12' of the same module 10' or 10", and the second main beam 15' or 15" is arranged between a second main pillar 7' or 7" of the same module 10' o 10" and the aisle pillar 12' or 12" of the adjacent complementary module 10" or 10'.

Each module 10' or 10" also comprises a secondary beam 16' or 16", arranged substantially in the direction of the longitudinal axis  $y$  of the aisle 4. Said secondary beam 16' or 16" is in an intermediate position between the side edge 8' or 8" and the longitudinal axis  $y$  with its two ends which can be placed at different positions along a line that contains one of the respective main beams 14', 15' or 14", 15". It is to be noted that, in the particular embodiments of Figures 3, said secondary beams 16 are arranged in such a way as to convey their own load on the respective main beams 14 and 15.

Each module 10' or 10" further comprises at least a couple of secondary structural elements, 11' and 11", arranged in an intermediate position between the couples of main pillars 7' and 7". Each secondary pillar 11' or 11" is placed close to the side edge 8' or 8", and it is placed opposite, with respect to the longitudinal axis  $y$ , to the other secondary pillar 11' or 11".

Each module 10' or 10" finally comprises a pair of tertiary beams 17' and 18' or 17" and 18" for each of said at least one pair of secondary pillars 11' and 11", arranged substantially transverse to the longitudinal axis  $y$  of the

aisle 4, between one of the secondary pillars 11' or 11" and the respective secondary beam 16' or 16". It is to be noted that as the position of the secondary beams 16 "slide" along the main beams 14 and 15, (including the case of direct support on the pillar 12), the lengths of the beams 17 and 18 change  
5 accordingly, effecting the redistribution of the whole loads of the deck on the pillars.

Again with reference to the Figures 3a and 3b, then it will be noted that the main beams 14', 15' or 14", 15" of the adjacent complementary modules 10', 10" are spaced between them, in the direction of the longitudinal axis  
10 y, by a distance such that the parking surface portion formed by the two modules 10', 10" comprise three car spaces 6 for each side strip 5', 5", and two aisle pillar 12', 12", in such a way to present the aisle pillars 12' e 12" in an alternate position on the aisle edges 9' e 9" with respect to the longitudinal axis y. This fact advantageously allows having a smaller number of aisle pillars, so  
15 as to ensure greater comfort for maneuver and at the same time to employ beams of a size such as to be easily transported and assembled *in situ*.

By way of example, in **Figure 3c** is shown a second module of the type of 10' in which there are three pairs of tertiary beams 17' and 18', while in **Figure 3d** is shown a second module of the type of 10" in which two pairs of  
20 tertiary beams 17" and 18" are present.

Differently from what is shown in Figures 3a e 3b, in which between each pair of main beams 14 and 15 of the same module may be located two car spaces 6, in the configurations of Figures 3c e 3d, three or four car spaces are present respectively between the pairs of main beams 14 and 15 of the  
25 same module.

Starting from the partial graphical representations of Figures 3a and 3b, it is possible to construct an aggregation of the unit modules illustrated therein to compose a complete carpentry of the structure for parking lots of the invention, as shown in **Figure 4**. In comparison with the modules of Figures  
30 3a and 3b, the solution of Figure 4 represents a variant in which the secondary beams 16 rest directly on the relevant pillars 12.

Referring to **Figures 5a** and **5b**, a second embodiment of the modular

structure according to the invention is shown, wherein, differently from the embodiment of Figures 3a and 3b, the main and secondary structural elements of each module 10' or 10'' (i.e., the pillars 7', 7'', 11', 11'') are the supporting beams 19', 19'', 21', 21'', arranged in a direction parallel to the longitudinal axis y and along the respective side edge 8' or 8'', and resting on respective supporting pillars 20' or 20'', in common between adjacent beams 19', 21' o 19'', 21''.

With reference to the foregoing, it can be noted that, as regards the loads distribution, the secondary beam 16', 16'' located between the longitudinal axis y of the aisle and the respective side edge 8', 8'' bears a role for the distribution, in a differentiated way, of the slab loads to the underlying pillars. A typical embodiment of the invention involves that the secondary beam 16', 16'' is at an equal distance, on two adjacent complementary modules, from the respective side edge 8, 8'. Each pair of tertiary beams 17', 18' and 17'', 18'' transfers the 50% of the load collected by the overlying floor slab directly to the secondary pillars 11', 11'' on which these beams rest, while the other 50% of the load is transferred between to the secondary beam 16', 16''. The more the secondary beam approaches the respective side edge 8', 8'', the greater will be the share of the load which is transferred by the secondary beam to the main beam, and then from the latter transferred to the structural element located on the side edge. Similarly, the longer the secondary beam moves away from the edge of the aisle 9', 9'', the smaller will be the share of the load which is transferred by the secondary beam to the main beam, and from the latter transferred to the pillar of the aisle. The system of the secondary beam and related tertiary beams, therefore, performs both a function of load distribution, as the pairs of secondary pillars 11, 11' are called in, and of load transfer from the edge of the aisle, where the pillars are fewer in number, towards the side edge, where the pillars are more in number.

It is noted that in the various preferred applications of the invention that will be now passed in review, the primary aim is to reduce the load transferred to the ground of the most loaded pillar. If the transferred load of the most loaded pillar is in fact lower than the maximum tolerable load in the ab-

sence of foundations, then you can do without the foundations for all the pillars. The maximum load that a single pillar with a single base plate can transmit to the underlying ground surface of bituminous conglomerate is not so much an accurate value, but rather a range of values. Site specific factors, in fact, have an influence in determining it, as the mechanical characteristics of the ground surface and the ground below. The size of the base plate is assumed equal to the size most commonly used today for these applications, namely 600x600 mm. However, such a field of values is not very extensive, and therefore, to develop an usable solution for a high number of sites, it is considered not to exceed 16 tonnes (16 Mg), in the present case of pillars which transmit to the ground a load by a 600x600 mm plate.

The operating load generated by 1 m<sup>2</sup> of the upper deck is considered equivalent to about 5.0 kN/m<sup>2</sup> (Permanent loads: assumed equal to about 2.5 kN/m<sup>2</sup>, with an estimated reinforced concrete floor with collaborating steel sheet, total thickness 130/140 mm, a waterproof coat 4 mm with bituminous armed sheath and surface wear layer of 30 mm asphalt. Accidental loads: 2.5 kN/m<sup>2</sup>, fixed by car parking legislation. Snow was not considered).

The discharge of the pillars of the known art solution in Figure 1 is 12.5 Mg. The value of 16 Mg represents therefore an increase of approximately 30%, which is deemed acceptable. Taking reference to Fig.1, the solutions of the present invention subtract pillars from the aisle, moving them in whole or in part on the side edges 8' and 8'', thus reducing the step of the edge pillars and increasing the step of the aisle pillars. It is therefore evident that the most loaded pillars are those that remain on the aisle and which are fewer in number. The aim is therefore to bring the load on the remaining aisle pillars below the maximum threshold, while monitoring the load on the pillars of the side edge 8', 8''.

Therefore, taking into account an area of parking 3 having a total width of 16 m (distance between the side edges 8' and 8''), the aisle 4 of 6 m width (distance between the aisle edges 9' and 9''), and a width of each car space 6 of 2.5 m (considered in a parallel direction to the longitudinal axis y of the aisle 4) and by using, for example, a beam IPE 500 with a length of 11 m

for the first main beam 14' and 14" of each module 10' and 10", a beam IPE 220 of 5 m for the length of the second main beam 15' and 15", a beam IPE 300 having a length of 5 m for the secondary beam 16' and 16", a beam IPE 220 with a length of 5 m for the first tertiary beam 17' and 17" and a beam IPE  
5 400 with a length of to 11 m for the second tertiary beam 18' and 18", a maximum load of about 18.5 Mg is achieved among all pillars (as explained, the maximum load is reached on the aisle pillars).

Such discharge is higher by about 50% than the maximum of the prior art solution of Fig. 1, but the maneuver comfort is greatly improved, being present only half of the aisle pillars. To obtain a more reduced load, it appears  
10 necessary to move the beam 16' further towards the axis 8', and the beam 16" further toward the axis 8". Bringing for example the beam 16' at a distance of 3.5 m from the axis 8', and the beam 16" to a distance of 3.5 m from the axis 8", a reduction of the maximum load of about 16.0 Mg is achieved for this configuration, that is an acceptable value for a system without foundations. Over-  
15 all, the weight of the beams turns out to be in both cases about 30 kg/m<sup>2</sup> and that is about one and half times the weight of the beams in the solution of the known art of Fig. 1. The maximum load can be further reduced even more approaching the beam 16' to the side edge 8' and the beam 16" to the side edge  
20 8", but it follows a further increase of the weight and length of the beams. This means that the pattern of Figure 4 is of less interest when foundation loads smaller than 16.0 Mg are necessary.

In **Figure 6** a series of elements of the configurations variability already described in Figures 3 and 5 is shown schematically, consisting in the  
25 arrangement of some of the main and tertiary beams in a cantilever fashion on the main and secondary structural elements already seen previously. Specifically the figure represents an adaptation of the diagram of Figure 5a to which possible cantilevered configurations of the main beam 15' on the structural elements 19' and 12' and of the tertiary beam 18' on the structural element 21' are  
30

Said cantilevered configurations are in generally defined by the following details:

- **a**, length of the cantilevered portion of the second main beam 15' or 15" of a module 10' or 10" with respect to the second main structural element 7' or 7" , 19' or 19" of the same module 10' or 10";
- 5        - **b**, length of the cantilevered portion of the second main beam 15' or 15" of a module 10' or 10" with respect to the aisle pillar 12' or 12" of the complementary module 10" or 10';
- **c**, length of the cantilevered portion of the first tertiary beam 18' or 18" of a module 10' or 10" with respect to the respective secondary
- 10       structural element 11' or 11" , 21' or 21" of the same module 10' or 10";
- **t**, distance, transversally to the longitudinal axis *y* of aisle 4, between secondary beam 16' or 16" and side edge 8' or 8".

Looking at **Figure 7**, which shows a solution of a modular aggregation

15       based on the first embodiment, differently from the variation of Figure 4, in order to decrease the load on the aisle pillars 12' and 12", as well as the length and the weight of the beams provided, the second main beam 15' or 15" of each module 10' or 10" has such a length as to be arranged cantilevered on the second main pillar 7' or 7" of the module 10' or 10" and on the aisle pillar

20       12' or 12" of the complementary module 10" or 10', in such a way that the first main beam 14' or 14" is loaded and supported by the second main beams 15' or 15" of the adjacent complementary modules 10" or 10' in the longitudinal and transversal direction to the longitudinal axis *y* of the aisle 4.

In an equivalent fashion, the length of the pair of tertiary beams 17' and 18', 17" and 18" is also varied in such a way that the second tertiary beam

25       18' or 18" results to be arranged cantilevered with respect to the respective secondary pillar 11' or 11", and that the first tertiary beam 17' or 17" is supported and loaded in one of its ends, on the second tertiary beam 18' or 18" of an adjacent module 10' or 10" in a direction transverse to the longitudinal axis

30       *y* of the aisle 4.

The length and section of the second main beams 15', 15", and consequently, of the first main beams 14' and 14", and the tertiary beams 17' and

17" and 18" and 18" are established taking into account the following parameters **a**, **b**, **c**, **t** previously seen.

The variations of these parameters result in variations of the sections of the main beams 14', 15', 14", 15", of the length of the first tertiary beam 18',  
 5 18" and of the load on the aisle pillars 12', 12" and on the edge 7', 7", 11', 11" pillars.

In particular:

In case of **a** increasing e **t** decreasing,

the cross-section of beam 14', 14" decreases,  
 10 the cross-section of beam 15', 15" increases  
 the load on pillars 11', 11" increases  
 the load on pillars 12', 12" decreases

In caso of **b** increasing,

the cross-section of beam 14', 14" decreases,  
 15 the load on pillars 11', 11" decreases  
 the load on pillars 12', 12" increases

In particular, with respect to the variation of Figure 4, wherein the parameters **a**, **b**, e **c** are equivalent to 0 and **t** = 5 m, in the variation of Figure 7 the parameters are equivalent to: **a** = 2,0 m, **b** = 0,5 m, **c** = 2,0 m, e **t** = 5 m.

20 This allows to have all beams with smaller cross-section than, or equal to, IPE450 and to obtain a considerable reduction of the load of the upper deck on the aisle pillars 12' and 12" with respect to the embodiment of Figure 4. In particular, on each aisle pillar 12' or 12" a load of about 11.5 Mg in weight is obtained, meanwhile on each main pillar 7" or 7' a load of about 17  
 25 Mg in weight is achieved. The mechanism used in this case is so effective that the aisle pillars resulted unloaded 'too much' and it is now found to have the pillars 7', 7" are outside of the self-imposed limit of 16 Mg.

It is then sufficient to reduce **a** to 1.5 m, to increase again the load on the aisle pillars 12' and 12" and to unload the pillars 7', 7" below the threshold.  
 30 It should be noted that, remaining in the scope of solutions without conventional foundations, there are more solutions to be used for the load transmission from the pillar to the ground that are in correspondence of the side edges

8', 8", compared to those available for the aisle edge, where any alternative to the tested plate 600x600 mm gives rise to problems of obstruction and conflict with the flow and the maneuver of the cars.

Remaining within the context of Figure 7 it is observed that, while  
5 maintaining  $a = 2$ , and activating in a more drastic manner the load transfer mechanism connected to the parameter  $t$ , thus shifting the beam 16', 16" to 3.5 m from the respective side edge 8', 8", it is achieved a situation in which the load on the aisle pillar comes to about 8.0 Mg.

**Figure 8** shows a first variant of the second embodiment of the modu-  
10 lar structure according to the invention, which differs from the embodiment shown in Figure 7 for the use of the beam-supporting pillar system 19', 20' and 19", 20" in place of the main and secondary pillars and in that the tertiary beams 17', 18', 17", 18" do not use the cantilever system.

In particular, compared to the size of the beams of Figure 7, for  $a =$   
15 2.0 m,  $b = 0.5$  m,  $c = 0$  m e  $t = 5$  m, for each module 10', 10" a first main beam 14', 14" of IPE450 type, a second main beam 15', 15" of IPE450 type, a secondary beam 16', 16" of IPE360 type, a first tertiary beam 17', 17" of IPE450 type and a second tertiary beam 18', 18" of IPE220 type, are employed. On each aisle pillar 12' or 12" a load of 13.9 Mg in weight is achieved, as well as  
20 on each pillar support 20' or 20" a load of 13.9 Mg in weight is obtained.

Compared to the solution of Fig. 7, the solution of Fig.8 balances the load between all the pillars (20', 20") located on the side edge 8', 8". Each pillar receives in fact half the load of the beam 18', half the load of the beam 17", half of the load of the beam 15'. This fact means that it is possible, if neces-  
25 sary, to subtract a greater quantity of load from the aisle pillars, without pillar 20' going quickly into fail risk as is the case of Fig. 7. As a matter of fact, the pillar 20' will be 'helped' by all the other pillars of the edge 8', 8", which should all 'saturate' before getting at fail risk all together.

Looking to **Figure 9** a second variation of the second embodiment of  
30 the modular structure according to the invention is shown, wherein, differently from the solution of Figure 8, there are provided cantilevers also for the second tertiary beam 18', 18" of each module 10' and 10", while the secondary

beam 16', 16" of each module 10', 10" is arranged so as to be loaded onto the respective main beams 14', 15' o 14", 15" of the same module 10', 10". The effect of the parameter **c** is similar to that of the parameter **a**. If one of the two increases, a part of the load moves from the aisle pillars to the pillars of the edge 8', 8". To obtain the passage of a given rate of load on the edge 8', 8", it is preferable to use a combination of increase of **a** and **c**, rather than to an increase of **a** only. In fact, the increase of **c** has the further advantage of unloading the secondary beam 16', therefore decreasing its section, and thereby unloading the beam 14', 14", in turn decreasing its section.

10 In **Figure 10A** it is shown an assembly scheme analogous to that of Figure 4 in which the aisle pillars 12' and 12", here renamed 12'<sub>A</sub> and 12"<sub>A</sub>, are each flanked by a further pillar, 12'<sub>B</sub> and 12"<sub>B</sub>, respectively. These new pillars are coupled to the respective aisle pillars 12'<sub>A</sub> and 12"<sub>A</sub> in the orthogonal direction to the driving aisle *y* and on the side of the side strips 5' and 5", respectively.

15 The additional pillars 12'<sub>B</sub> and 12"<sub>B</sub> have the aim to reduce the loads on the aisle pillars 12'<sub>A</sub> and 12"<sub>A</sub> in the case where the existing supporting ground has characteristics of low bearing capacity, however without falling into a configuration similar to that of the prior art of Figure 1, i.e. with a higher number of aisle pillars.

20 Furthermore, in the case where it is expected the super-elavation of the single-storey structure with another car parking level above the first, the new pair of pillars, 12'<sub>A</sub> and 12'<sub>B</sub> or 12"<sub>A</sub> and 12"<sub>B</sub>, would share the doubled weight of the two floors of the parking lot in order to bring back the load transmitted to the ground by each of them within the limits of the load-bearing capacity of a good or average quality ground paved surface.

25 In order to expose a numerical example, while in the solution shown in Figure 4. each pillar 12' and 12" transmits to the ground a load of about 16 Mg, in case where the soil presents a low bearing capacity, or this is expected, the new supporting pillar (12'<sub>B</sub> or 12"<sub>B</sub>) may assume at least half of this load, therefore leading the load for each aisle pillar 12'<sub>A</sub> or 12"<sub>A</sub> to about 8 Mg. In case of an additional level of parking is added, that is, two raised lev-

els, each of the pillars of the pair should support about 16 Mg, that is within the above-discussed limitations.

In the case of a ground paved surface with low bearing capacity, and still willing to realize a structure with two raised levels, the load on the pairs of  
5 pillars 12'<sub>A</sub> and 12'<sub>B</sub> or 12''<sub>A</sub> and 12''<sub>B</sub> could be reduced as described in the following **Figure 10B**.

Figure 10B shows a variation of Figure 10A in which the step between the structural beams transversally to the y axis has been reduced, reducing the space between the aisle pillars for the parking of cars, that are reduced  
10 from four to three. Once reduced said step, the load on a pillar pair 12'<sub>A</sub> and 12'<sub>B</sub> or 12''<sub>A</sub> and 12''<sub>B</sub> will be reduced to 11.5 Mg for each pillar.

The frame of Figure 10B would find a greater chance of application in the practice, in the cases of structures with two raised levels (that is, the ground floor plus 2 new levels of parking) and in which there is, or is envis-  
15 aged, limited load-bearing capacity of the soil. This allows to maintain a better level of maneuvering comfort with 3 cars between the aisle pillars, in comparison to the prior art solutions, with 2 cars between the aisle pillars.

In **Figure 11** a variant of the modular structure according to the first embodiment of the invention is shown, representing a parking area 3. In the  
20 figure is also visible the following further parameter *d*:

*d*, distance, in a direction transverse to the longitudinal axis y of the aisle 4, between the main pillar 7', 7'' and the respective side edge 8', 8''.

Each module 10', 10'' provides that the main pillars 7', 7'' are arranged at a distance equivalent to the parameter *d* from the respective side edge 8' or  
25 8'' internally to the respective side strip 5' or 5'' and that the main beams 14 and 15 resting on said pillars 7', 7'' are arranged in a cantilever fashion on said pillars 7', 7'' so as to have one end in correspondence of the respective side edge 8', 8'' of a distance equivalent to the parameter *d*. Furthermore, secondary beams 16 and tertiary beams 17, 18 and the secondary pillars 11', 11'' are  
30 provided, as in the solutions previously described.

Also in **Figure 12** a further variant of a modular structure according to the invention is shown, representing a parking area 3. Differently from the var-

iant of Figure 11, the main pillars 7', 7" of each module 10', 10" are located in correspondence of the relative side edges 8', 8" and the main beams 14', 14", 15', 15" are not arranged in a cantilever fashion but with the ends loading on said pillars 7', 7".

5           Therefore, for the following values of parameters:  $a = 0$ ,  $b = 0$ ,  $c = 0$ ,  $d = 0$  and  $t = 3.0$  m, a load on the aisle pillars 12', 12" equivalent to 15.4 Mg is achieved. Compared to the previously described variant, a better maneuvering comfort is advantageously achieved, since the border pillars are aligned all along the side edge. However, the beams 17" are quite long, 13.0 m, resulting  
10   in an increase of the weights in the handling.

Yet, in **Figure 13** a further variant of the modular structure according to the first embodiment of the invention is shown, representing a parking area 3. This variant differs from that of Figure 12 in that the main pillars 7' of the first module 10' are spaced apart by two parking spaces 6 in a direction paral-  
15   lel to the longitudinal axis  $y$  of the aisle 4, while the main pillars 7" of the second module 10" are spaced from one car space 6 only, in such a way that the area of parking formed by the two modules 10', 10" comprises three parking spaces 6 for each lateral band 5', 5" and three aisle pillars 12', 12". The aisle pillar 12' and 12" are in alternating position on said aisle edges 9' and 9" with  
20   respect to the longitudinal axis  $y$ . Moreover, the main pillars 7 which carry the main beam 14 are in a retracted position  $d$  respect to the edge 8.

Compared to the variant of Figure 12 the loading on the aisle pillars 12', 12" is reduced by 25%, or equal to 11.5 Mg.

A further embodiment is presented in **Figure 14** in which the main and  
25   secondary support elements are aligned.

Reference is now made to **Figure 15** in which a further variant of the modular structure according to the first embodiment of the invention is represented, with the application to two adjacent bins 3.

In this variant, each module 10', 10" provides main pillars 7', 7" spaced, by a parameter  $d$ , from the respective side edge 8', 8", internally to  
30   the respective side strip 5', 5". The main beams 14', 15', 14", 15" load directly up said pillars 7', 7" and therefore result to be shorter (for example, with re-

spect to the variant of Figure 4). The main pillars 7', 7" of each module 10', 10" are spaced between them by three parking spaces 6, in the direction parallel to the longitudinal axis  $y$  of the aisle 4.

In further embodiments of the modular structure according to the invention, for example, the distance between the main pillars 7', 7" of a module may be of two parking spaces 6 and in second module 10" of three parking spaces 6, as shown in the variant of **Figure 17**, in which each main pillar 7" arranged in the vicinity of the side edge 8" coincident with the side edge 8' to another parking area 3 is connected to the adjacent pillar 7' by means of a connecting beam 13.

By way of example, for the parameters  $a = 0$ ,  $b = 0$ ,  $d = 1,25$  e  $t = 4,25$ , by the use of beams having maximum section of IPE500, it is achieved a load on the aisle pillars equal to 16.8 Mg and a load on the main pillars 7', 7" equal to 16,5 Mg. This variant allows a better maneuvering comfort along the aisle with respect to the variants of Figures 4 and 7.

Another solution having most parking comfort is shown in the variant of **Figure 16**, the modular structure according to the second embodiment of the invention.

The modular structure of **Figure 17** differs from that of Figure 7 in that the main beams 14', 15', 14", 15" of each module 10', 10" are spaced between them in the longitudinal axis  $y$  of the aisle 4 by either three or two parking spaces 6

In further embodiments, for example, the distance between the main beams 14', 15' of a module 10' may be of one parking space 6 and of four parking spaces 6 in a second module 10", as shown in the variant of **Figure 18**.

Therefore, by way of example, for the following values of the parameters:  $a = 2.0$  m,  $b = 0$ ,  $c = 0$ ,  $d = 0$  e  $t = 4.0$  m, the load on the aisle pillars 12', 12" results to be 17.1 Mg, as that on the edge pillars 20', 20" of each structural element results to be equal to 17.1 Mg and that on the secondary edge pillars 20', 20 is equal to 10,0 Mg.

The modular structure according to the invention may use, preferably,

steel beams and a deck for the upper floor in reinforced concrete or a steel/concrete composite. Finally, the modular structure according to the invention may employ suitable devices adapted to transmit the loads to the underlying ground in simple support on the pavement in bituminous conglomerate of an existing ground level car park. Such devices may have a square  
5 base, usually 600 x 600 mm, used for individual columns, already known from the art. Or they may have a rectangular base, with dimensions approximately equal to 3.0 x 0.5 m, or with sizes that are at most suited to existing geotechnical conditions, capable, by a bigger area of contact with the supporting surface, to upload higher loading than those permitted from two single plates of  
10 the prior art.

The present invention has been disclosed with particular reference to some embodiments thereof, but it should be understood that modifications and changes may be made by the persons skilled in the art without departing  
15 from the scope of the invention as defined in the appended claims

## CLAIMS

1. A modular structure for supporting a deck of at least a first floor for the construction of modular parking lots, said modular parking lots comprising  
 5 at least one parking surface (3) having a central driving aisle (4) with a central longitudinal axis (y) and two side strips (5', 5'') arranged opposite to one another with respect to said central aisle (4) and each bounded, in the longitudinal direction of the aisle (4), by a side edge (8', 8'') lateral to said parking area (3) and by an aisle edge (9', 9'') adjacent to said central aisle (4), each of said  
 10 side strips (5', 5'') comprising a plurality of car spaces (6) accessible at least from said central aisle (4),

said modular structure being characterized in that it comprises a series of modules (10', 10'') adjacent to each other and complementary two by two in the direction of the longitudinal axis (y) of said aisle (4), each module  
 15 (10' or 10'') comprising:

two main structural elements (7'; 19' or 7''; 19'') arranged close to the same side edge (8' or 8'') of a first one (5' or 5'') of said two side strips (5', 5'');

at least one aisle pillar (12'' or 12'), placed close to the aisle edge (9'' or 9') of the second one (5'' or 5') of said two side strips (5', 5''), said aisle pillar  
 20 (12'' or 12') being substantially aligned in a direction orthogonal to the longitudinal axis (y) with the center of gravity of a first one (7'; 19' or 7''; 19'') of said two structural elements (7'; 19' or 7''; 19'') of the same module (10' or 10''), and also being substantially aligned with the center of gravity of the second structural element (7'', 19'' or 7'; 19') of an adjacent complementary module (10'' or  
 25 10'),

two main beams (14', 15' or 14'', 15''), substantially transverse to the longitudinal axis (y) of said aisle (4), a first main beam (14' or 14'') being arranged between said first structural element (7'; 19' or 7''; 19'') and said aisle pillar (12'' or 12') of the same module (10' or 10''), a second main beam (15' or  
 30 15'') being arranged between the second structural element (7'; 19' or 7''; 19'') of said module (10' or 10'') and the aisle pillar (12' or 12'') of an adjacent complementary module (10'' or 10'),

a secondary beam (16' or 16") arranged substantially in the direction of the longitudinal axis (y) of said aisle (4), said secondary beam (16' or 16") being in an intermediate position between a first side edge (8' or 8") and the longitudinal axis (y) of the aisle (4), with its two ends which can be placed at  
5 different positions along a line that contains each one of the respective main beams (14', 15' or 14", 15"),

at least one pair of secondary structural elements (11', 11"; 21', 21") arranged in an intermediate position between said two main structural elements (7' or 7"; 19' or 19"), each secondary structural element (11' or 11"; 21'  
10 or 21") being placed close to the side edge (8' or 8") of a respective side strip (5' or 5"), in a position opposite, with respect to the longitudinal axis (y) of the aisle (4), to the other secondary structural element (11" or 11'; 21' or 21"), and

a pair of tertiary beams (17', 18' or 17", 18") for each of said at least one pair of secondary structural elements (11', 11"; 21', 21"), arranged substantially transverse to the longitudinal axis (y) of said aisle (4), between a re-  
15 spective secondary structural element (11' or 11"; 21' or 21") and said secondary beam (16' or 16"),

said main beams (14', 15' or 14", 15") of two adjacent complementary modules (10', 10") being spaced between them in the direction of the longitudinal axis (y) of said aisle (4) of such a distance that the parking surface portion formed by said two modules (10', 10") includes at least three car spaces  
20 (6) in each side strip (5', 5") and not more than two aisle pillars (12', 12").

2. A modular structure according to claim 1, wherein the distance (t) in a direction transverse to the longitudinal axis (y) of said aisle (4) between said secondary beam (16', 16") and the side edge (8', 8") wherein said main structural elements (7', 19', 7", 19") of the same module (10', 10") are placed  
25 is comprised between 2 and 8 m.

3. A modular structure according to claim 2, wherein said secondary beam (16', 16") is arranged between a first main beam (14' or 14") and a second main beam (15', 14" or 15", 14') of the same module or of a complementary adjacent module.  
30

4. A modular structure according to claim 2, wherein said secondary

beam (16', 16'') is arranged between a main beam (14' o 14'') of the same module and an aisle pillar (12' o 12'') of the complementary adjacent module (10'', 10').

5        5. A modular structure according to claims 1 or 2, wherein at least one of said tertiary beams (17', 18' or 17'', 18'') of each module (10', 10'') has at least one cantilever arranged end with respect to the center of gravity of the secondary structural element (11' o 11''; 21' o 21'') on which it rests, said cantilever arranged end being of a length (c) not above 3 m.

10       6. A modular structure according to any one of the preceding claims, wherein at least one of said two main beams (14', 15' o 14'', 15'') of each module (10', 10'') has at least one cantilever arranged end with respect to the aisle pillar (12', 12'') on which it rests, said cantilever arranged end being of a length (b) not above 1,0 m.

15       7. A modular structure according to any one of the preceding claims, wherein at least one of said main beams (14', 15' or 14'', 15'') of each module (10', 10'') has at least one cantilever arranged end with respect to the center of gravity of the structural element (7', 7'', 19', 19'') on which it rests, said cantilever arranged end being of a length (a) not above 3,0 m.

20       8. A modular structure according to any one of the preceding claims, wherein each aisle pillar (12'' or 12') is constituted by a couple of adjacent aisle pillar (12''<sub>A</sub> and 12''<sub>B</sub>; 12'<sub>A</sub> and 12'<sub>B</sub>) aligned and paired in a direction transverse to the longitudinal axis (y) of said aisle (4).

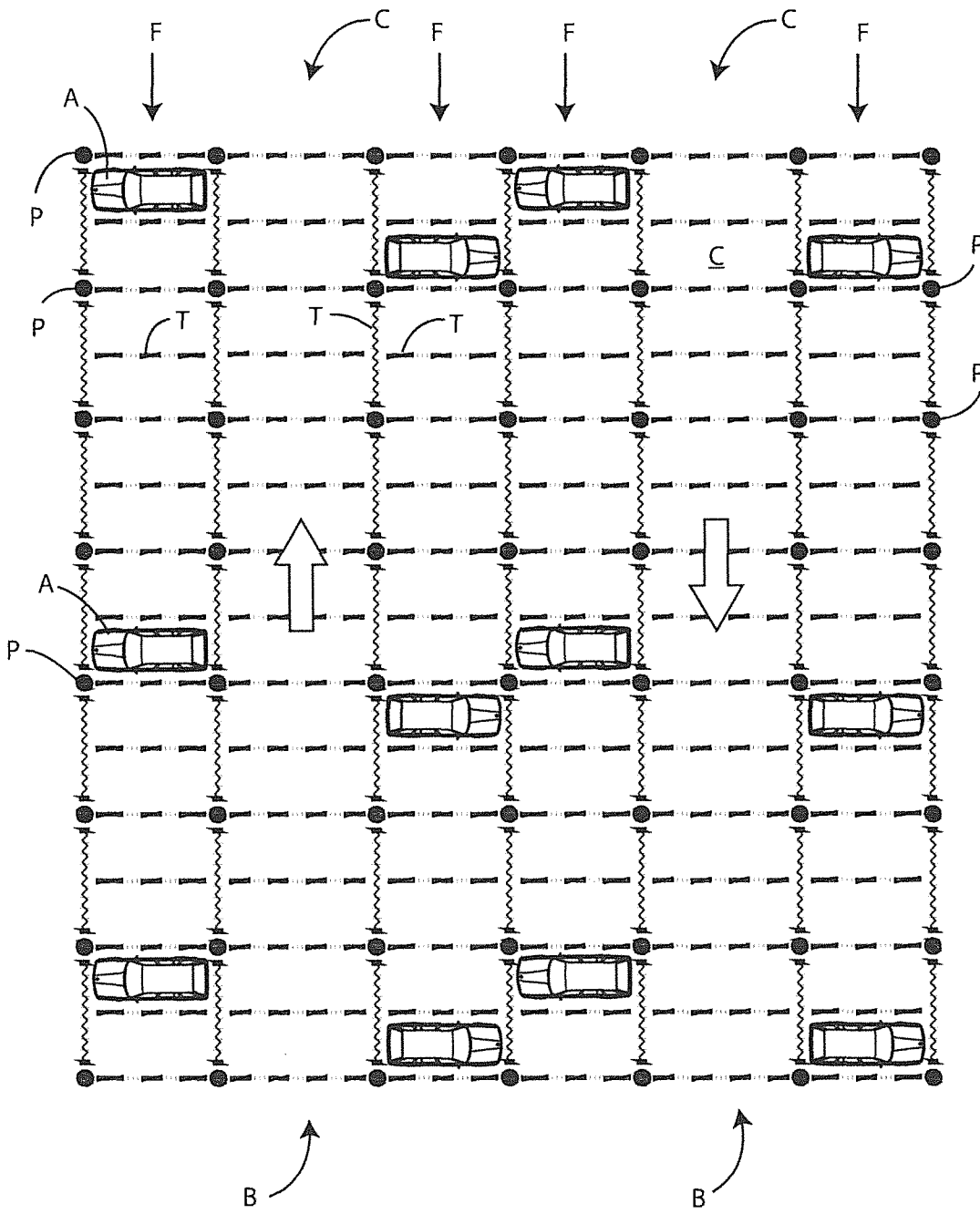


Fig. 1  
(Prior Art)

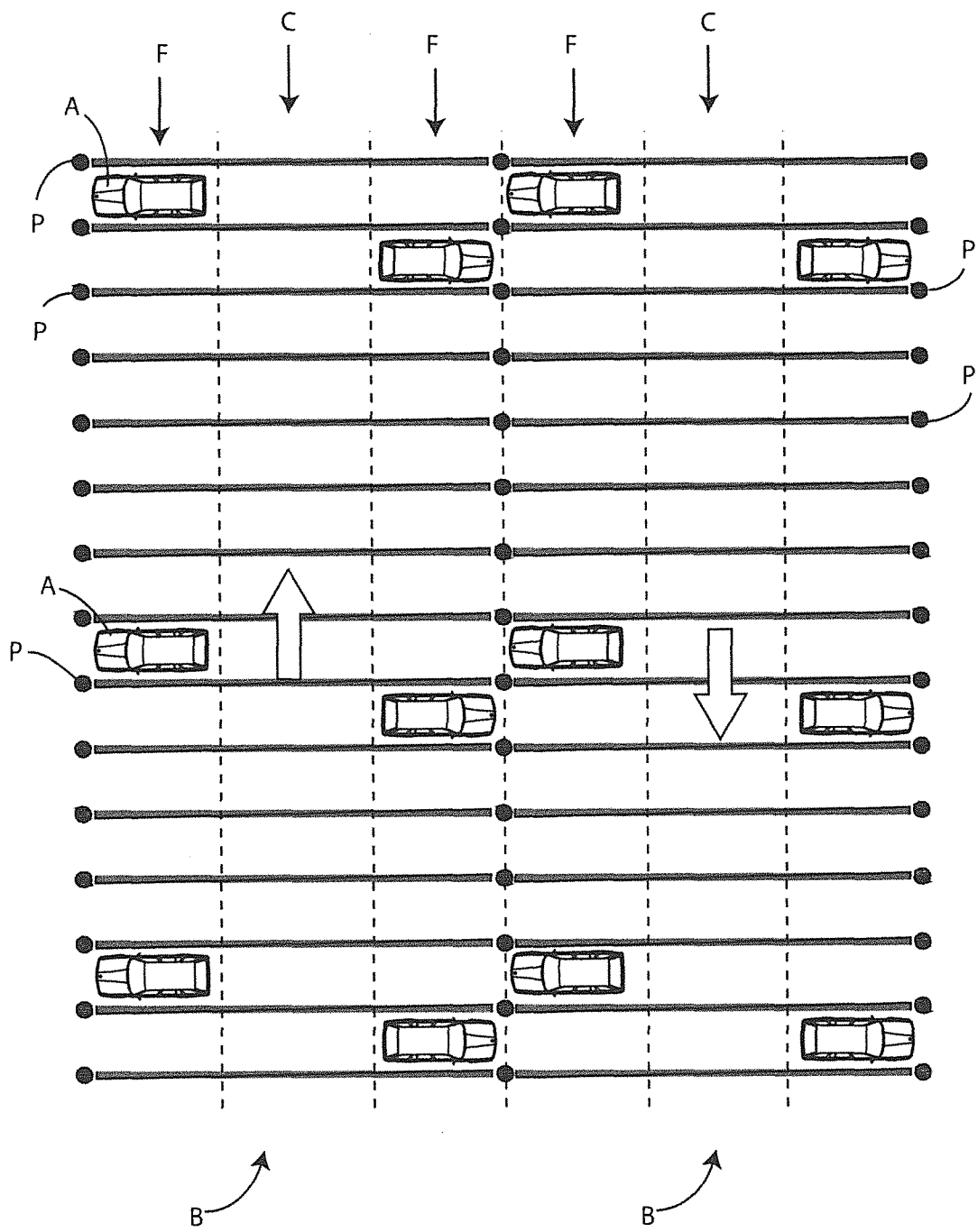


Fig. 2  
(Prior Art)

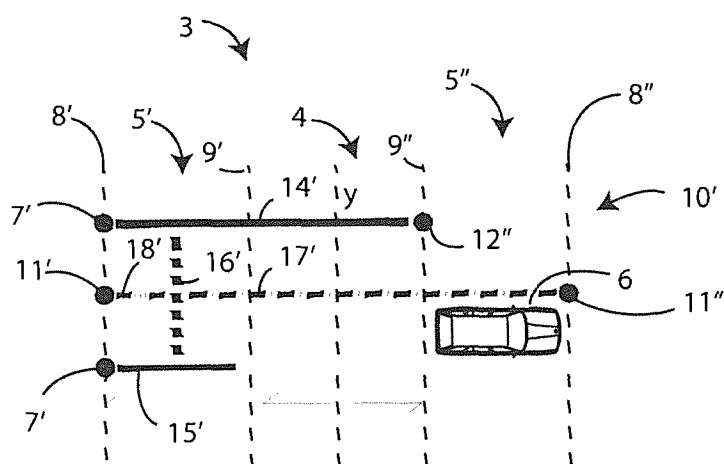


Fig. 3a

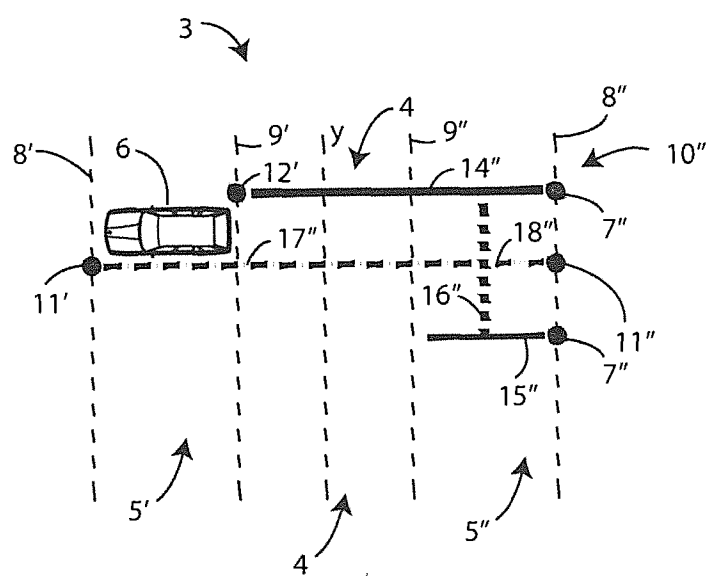


Fig. 3b

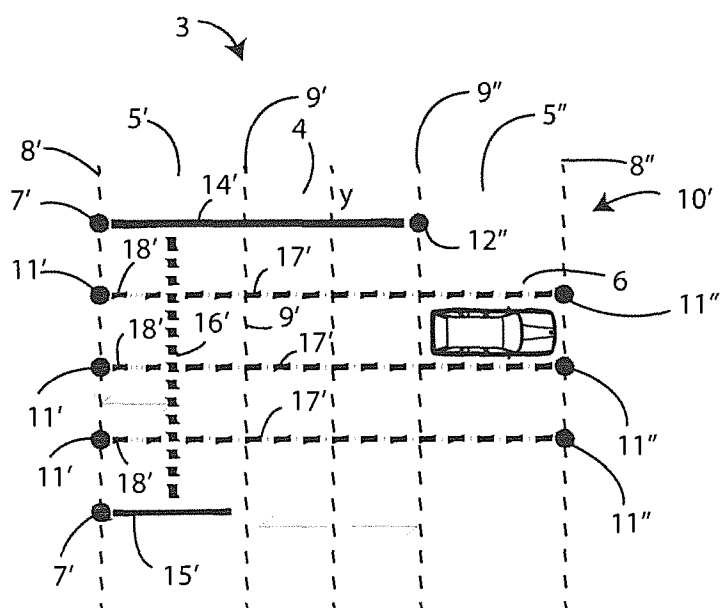


Fig. 3c

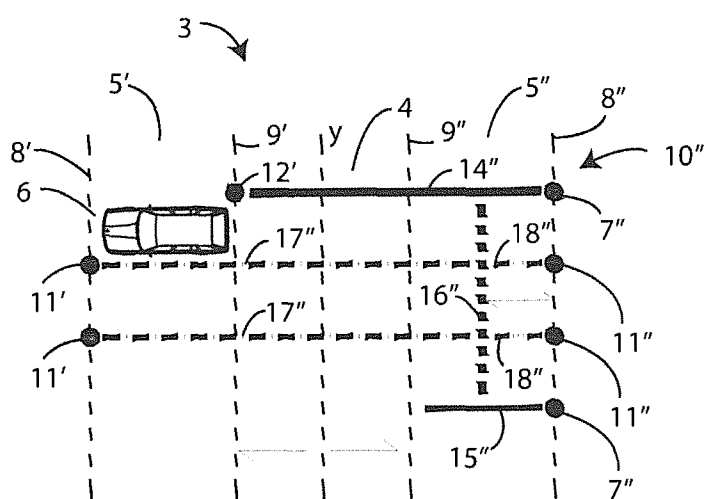


Fig. 3d

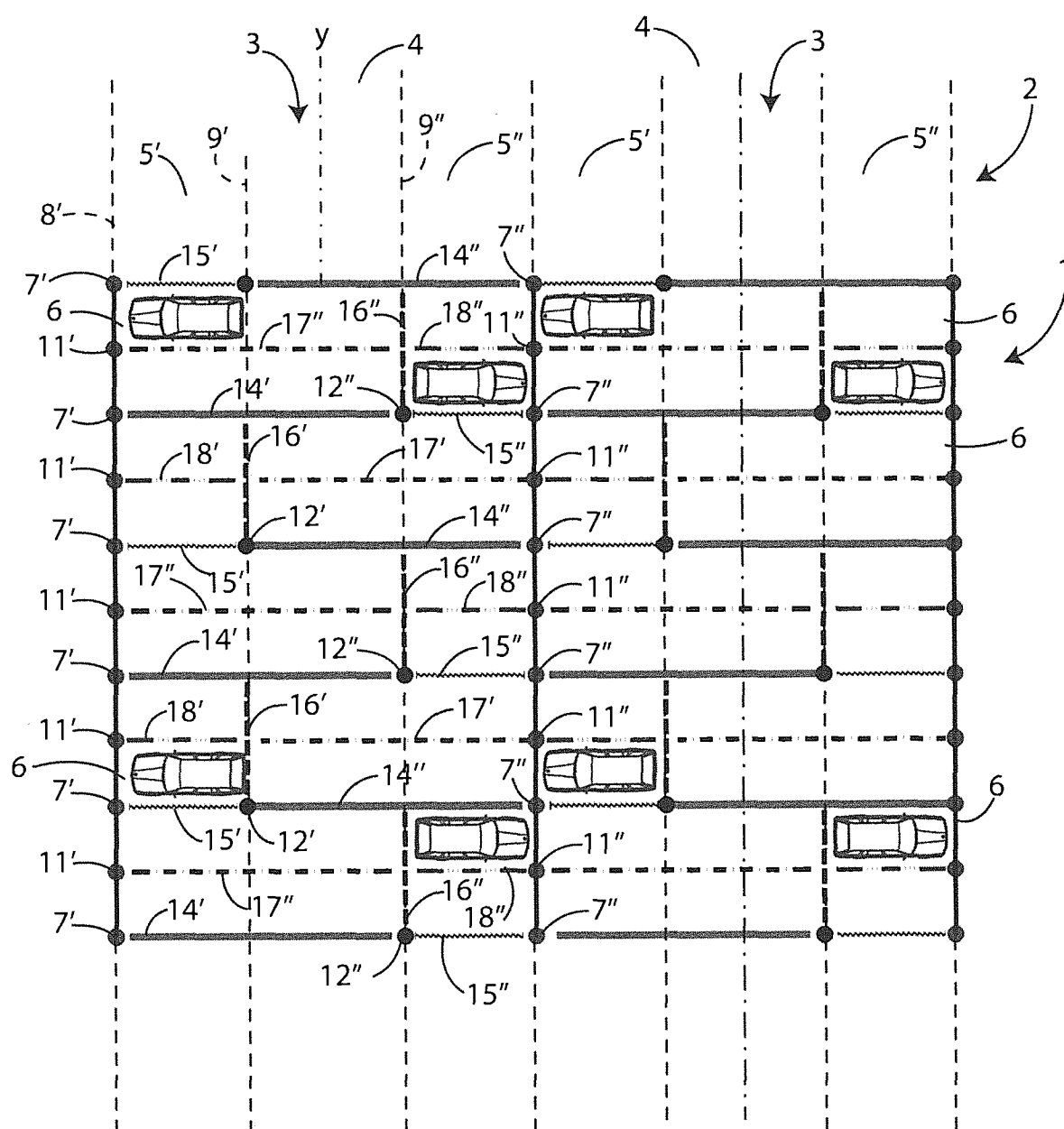


Fig. 4

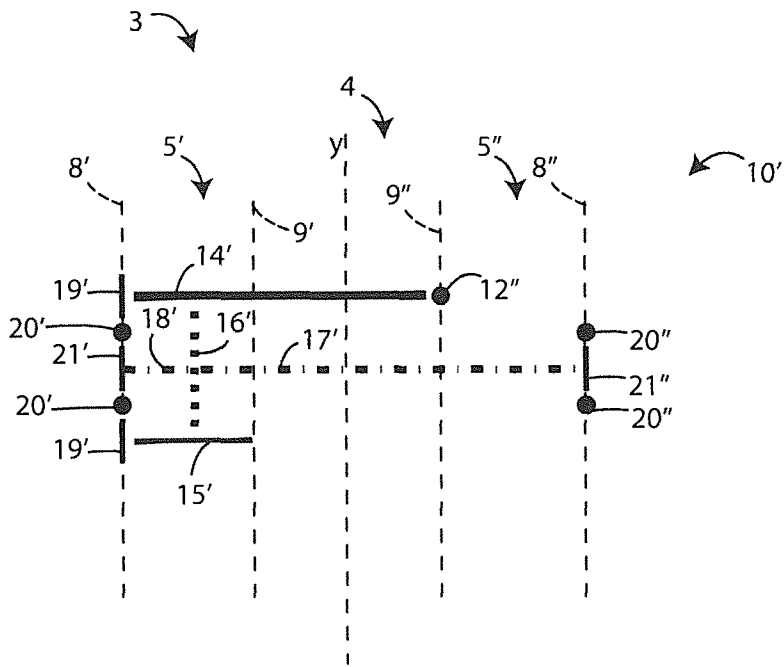


Fig. 5a

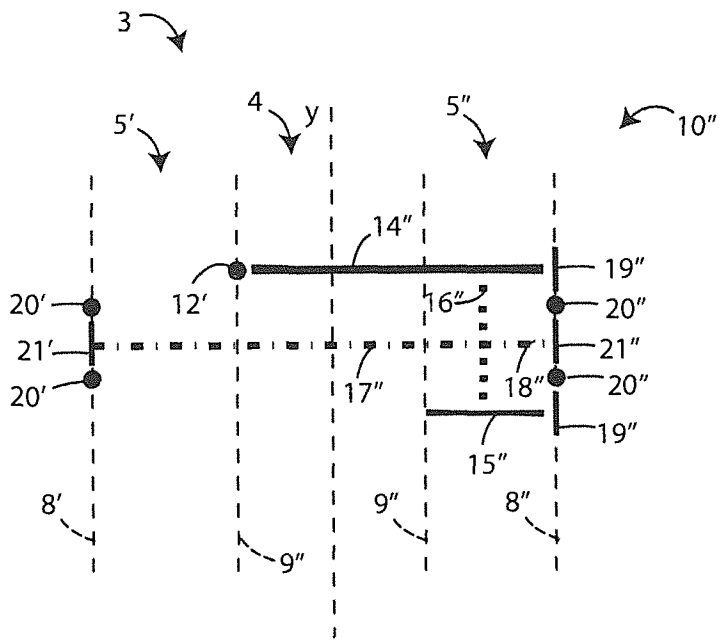


Fig. 5b

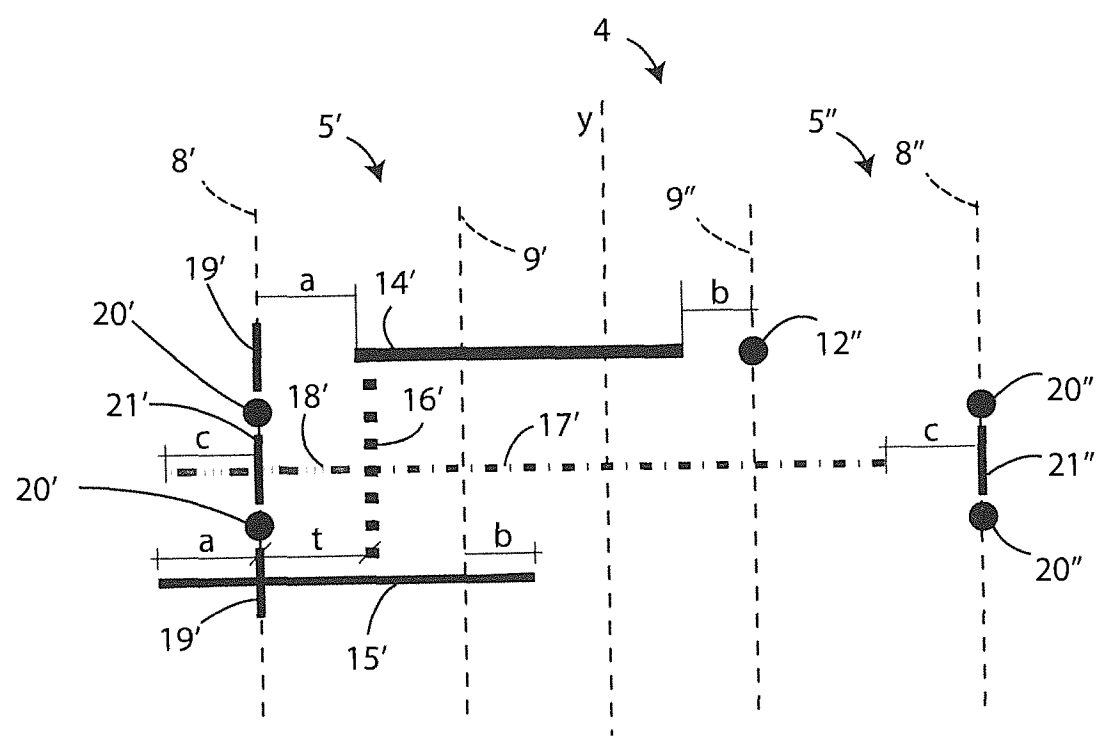


Fig. 6

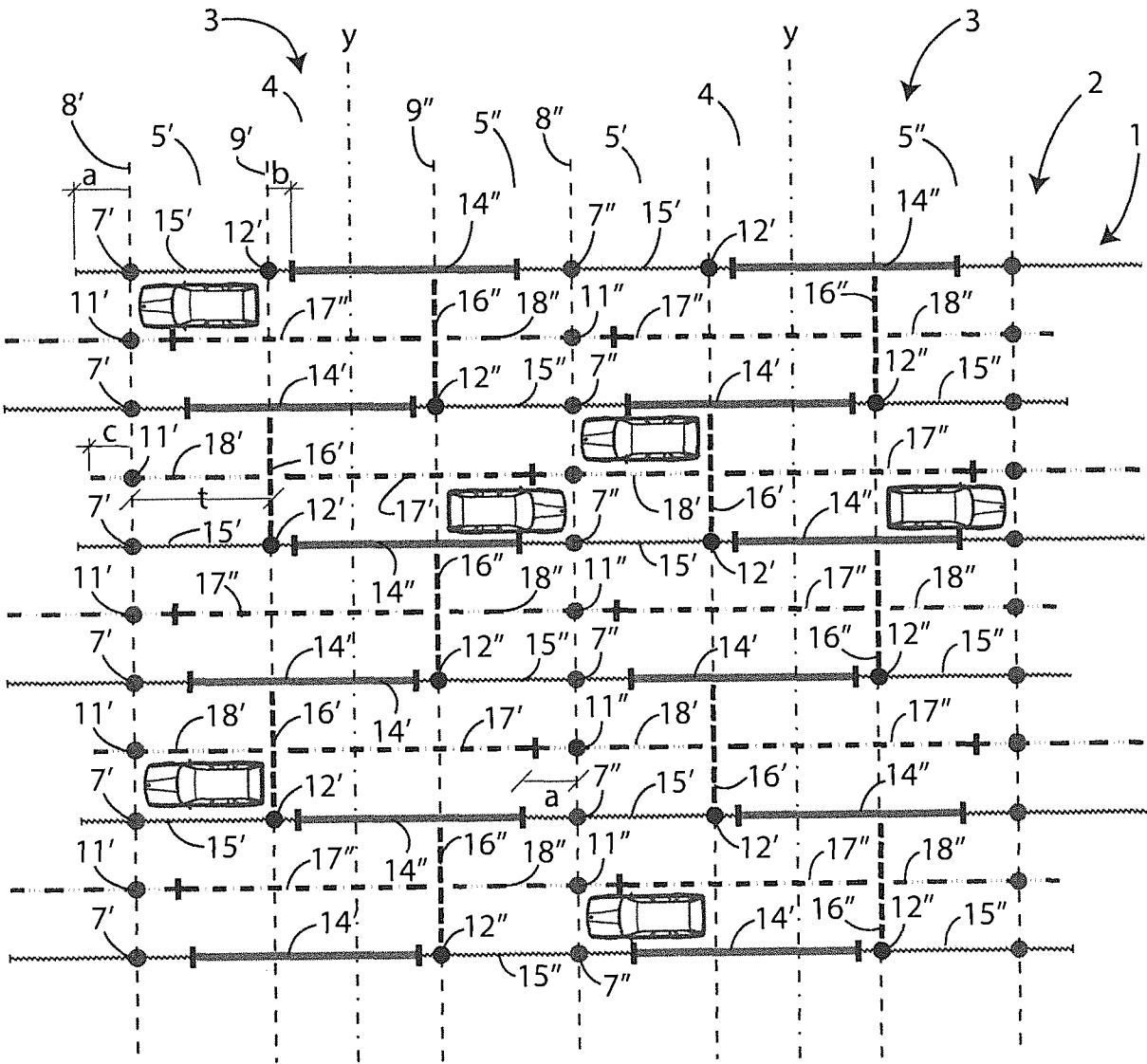


Fig. 7

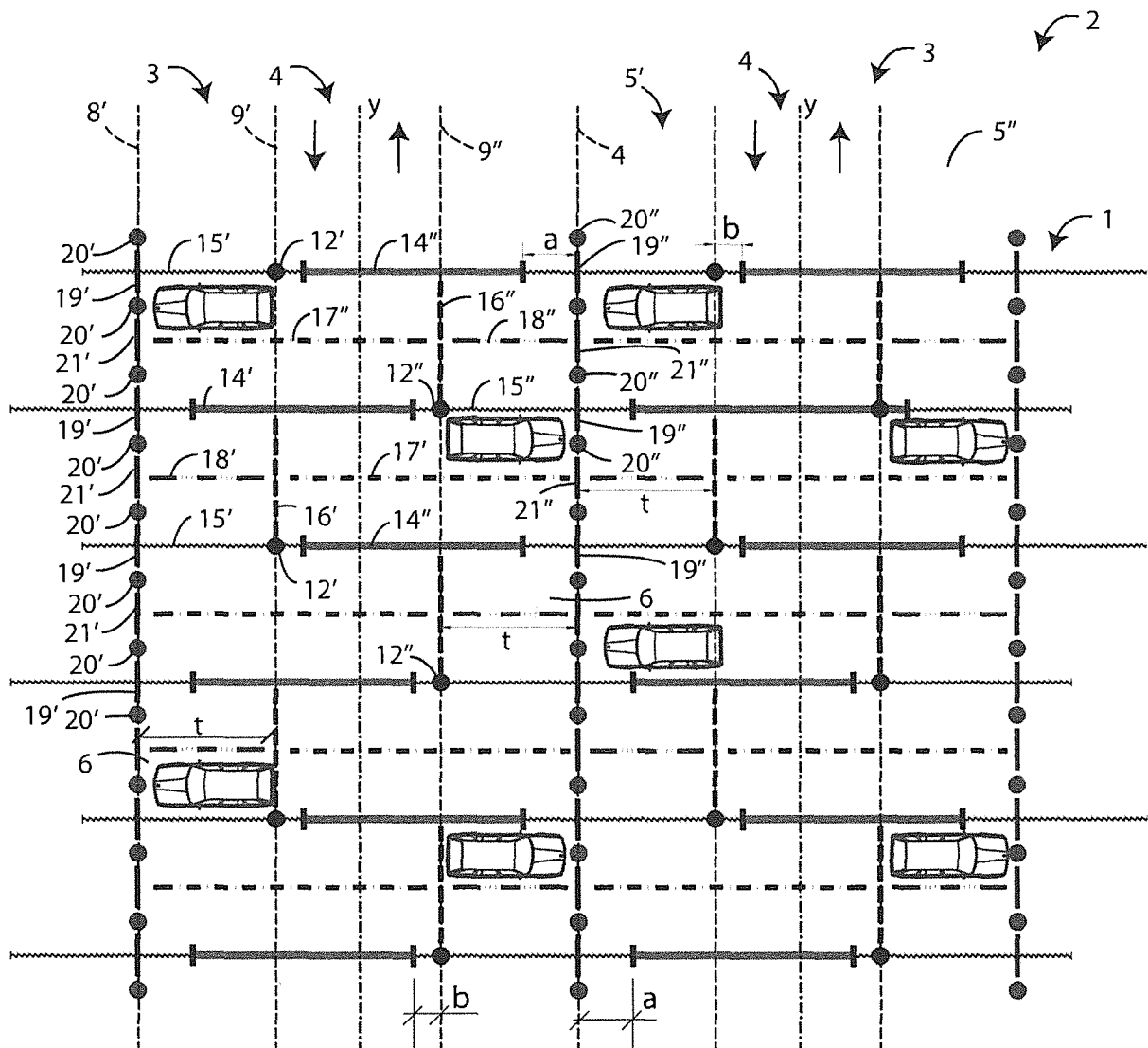


Fig. 8

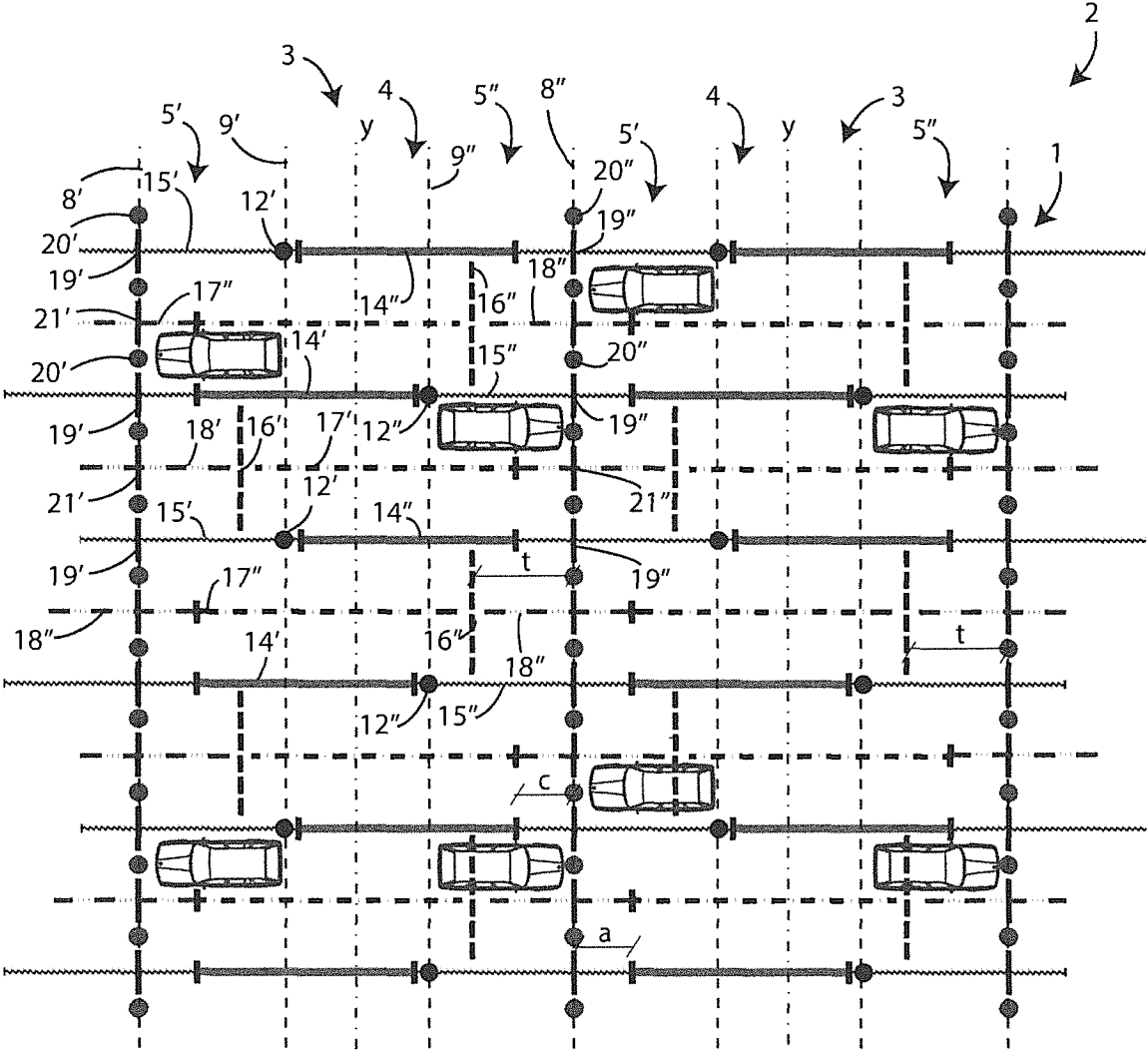


Fig. 9

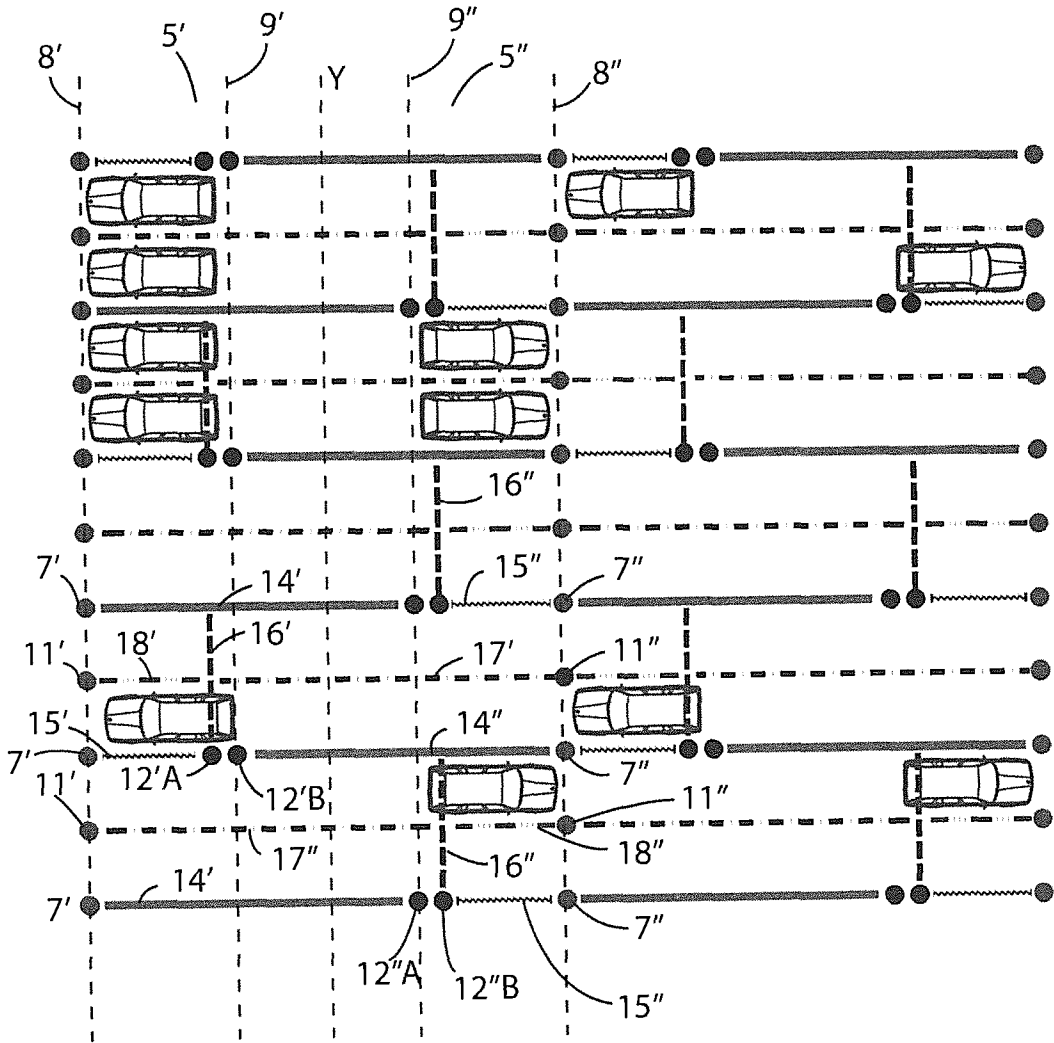


Fig. 10A

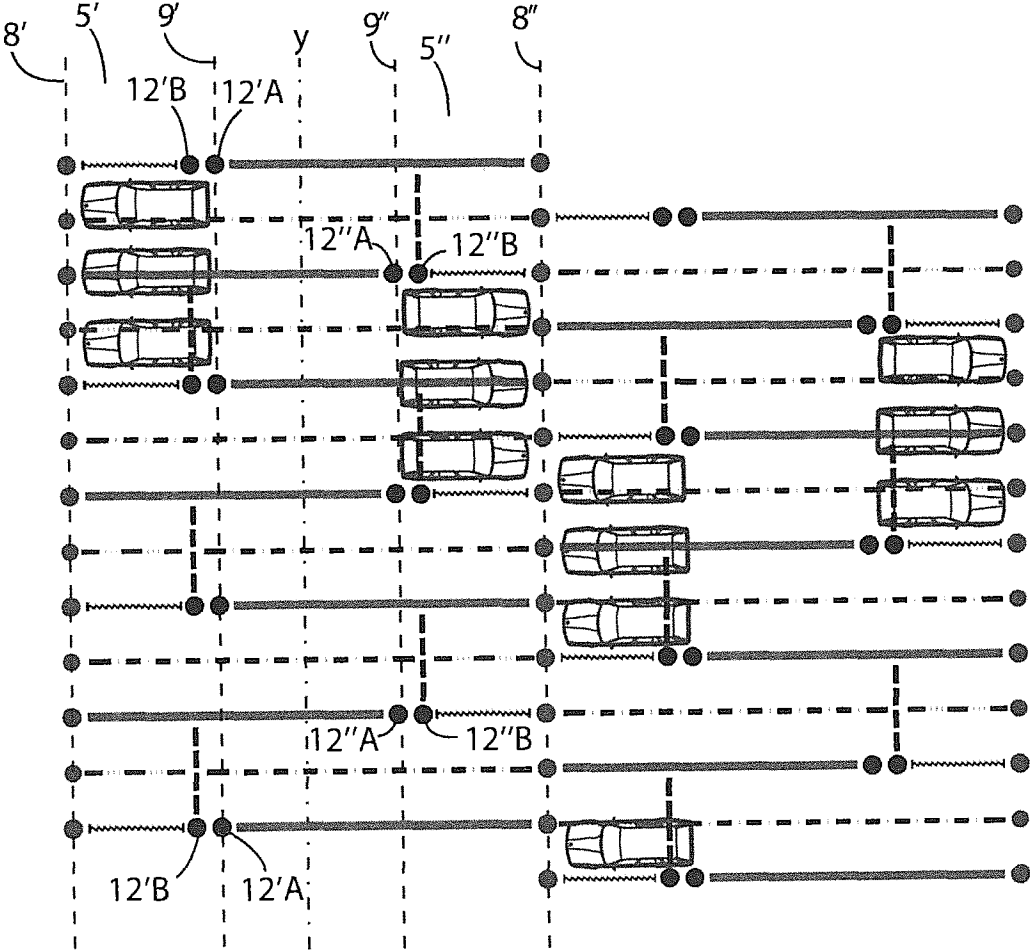


Fig. 10B

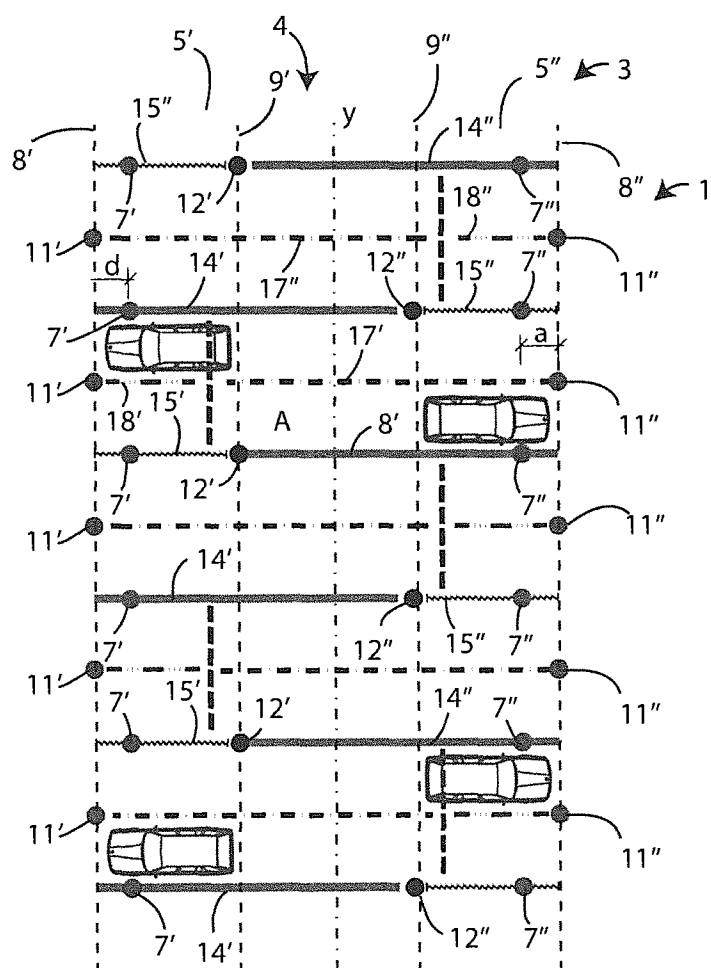


Fig. 11



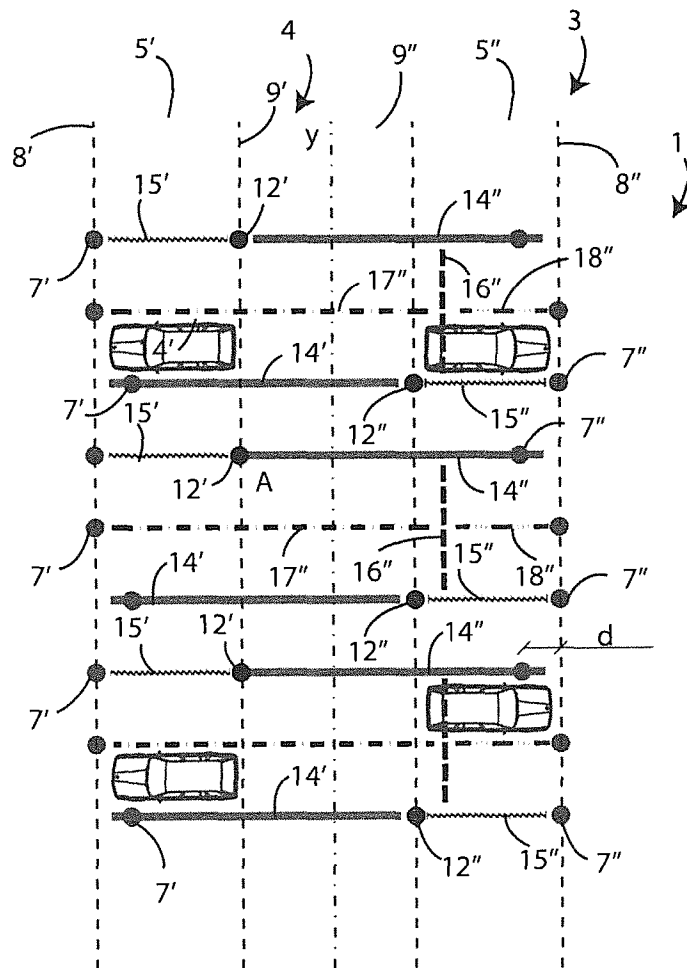


Fig. 13

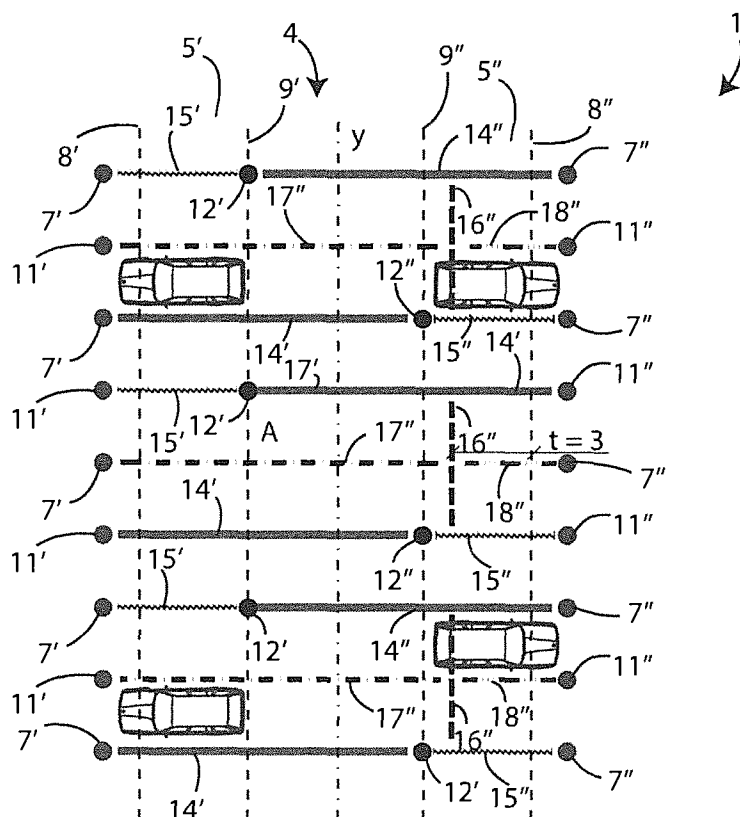


Fig. 14

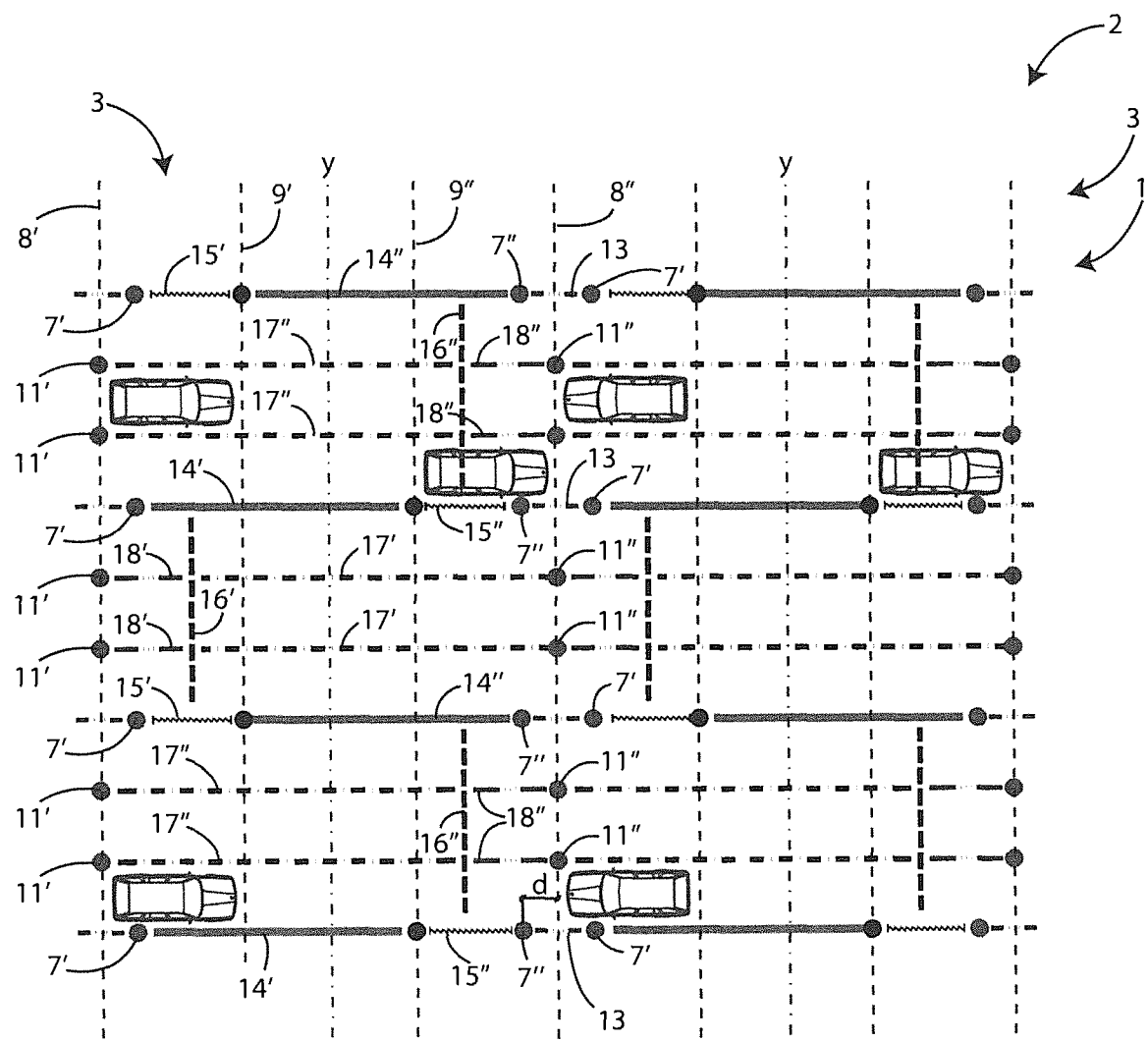


Fig. 15

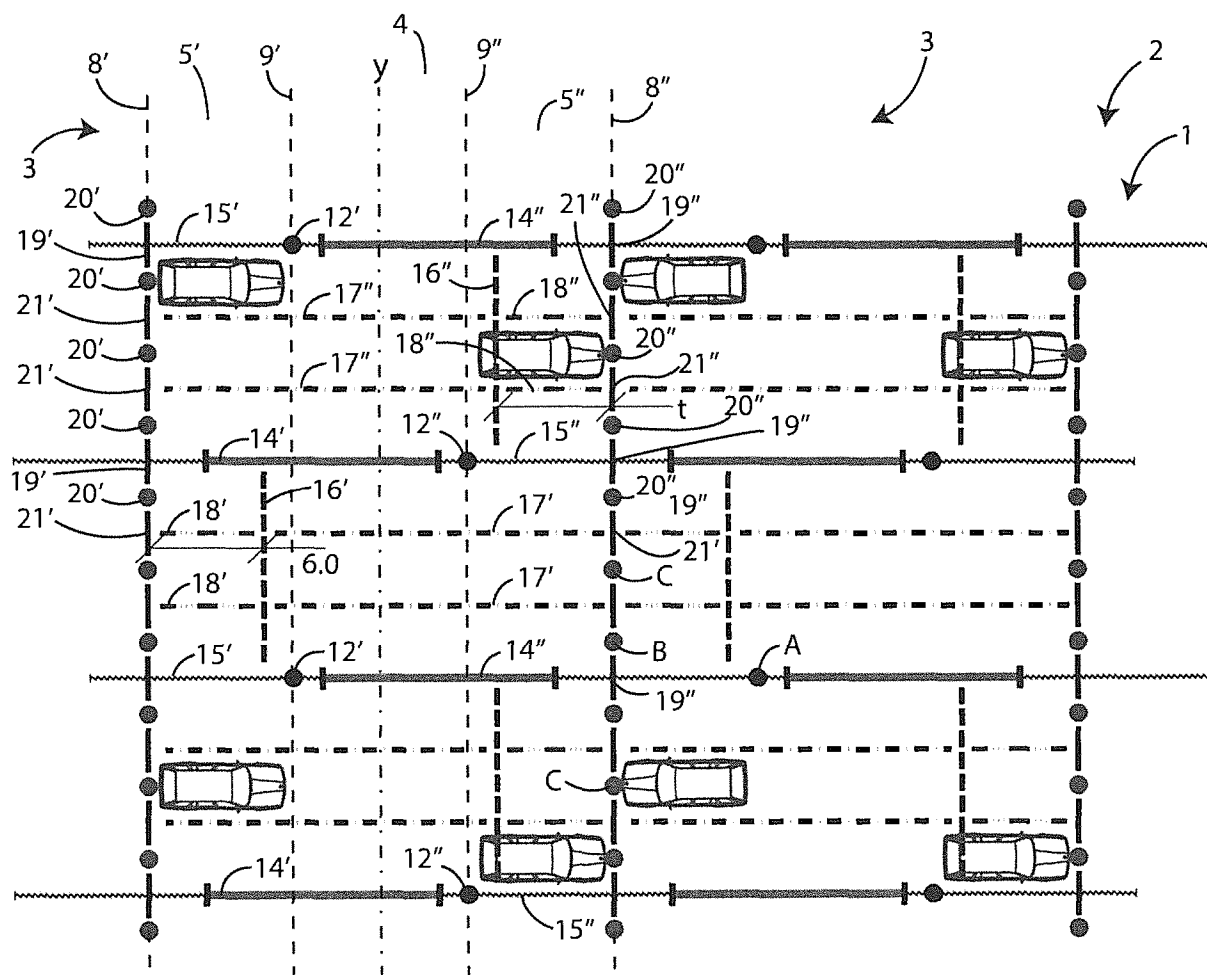


Fig. 16

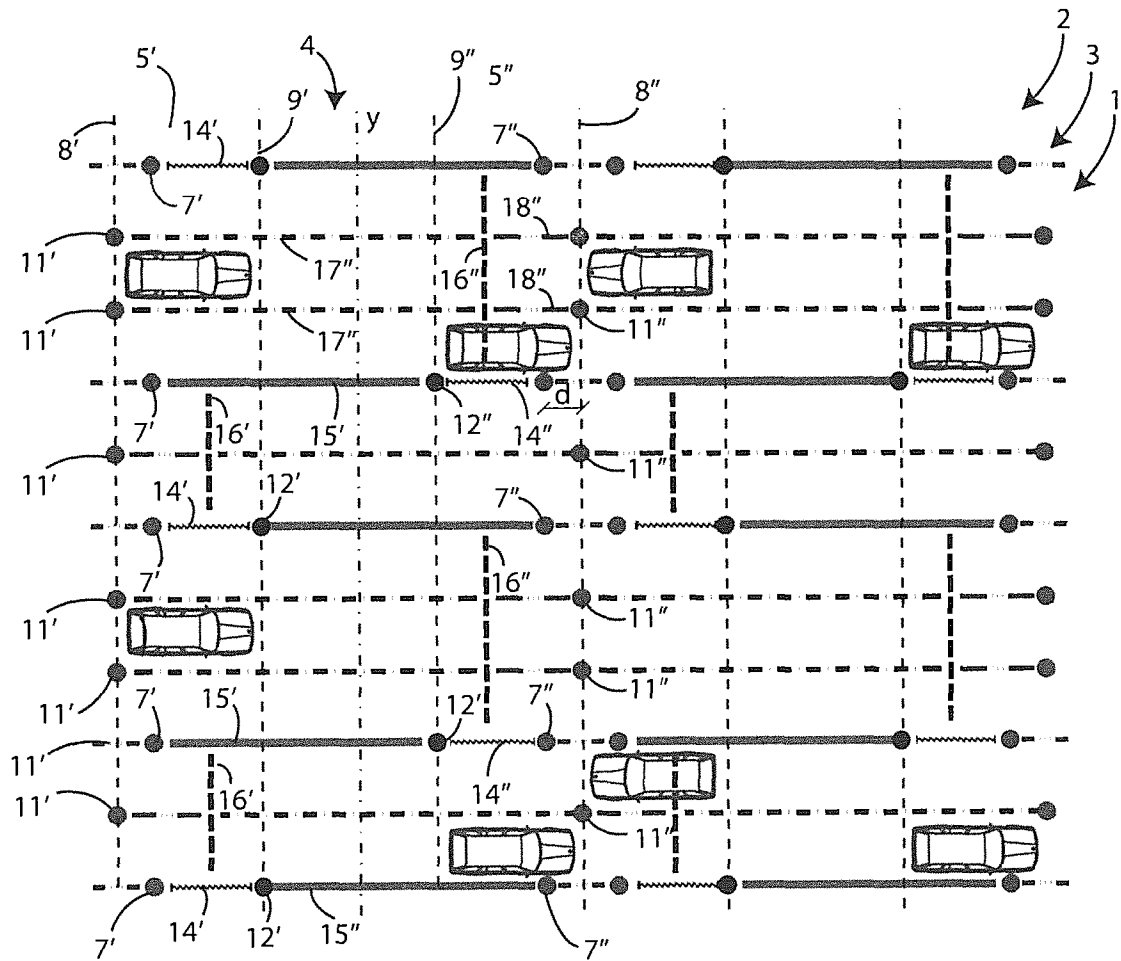


Fig. 17

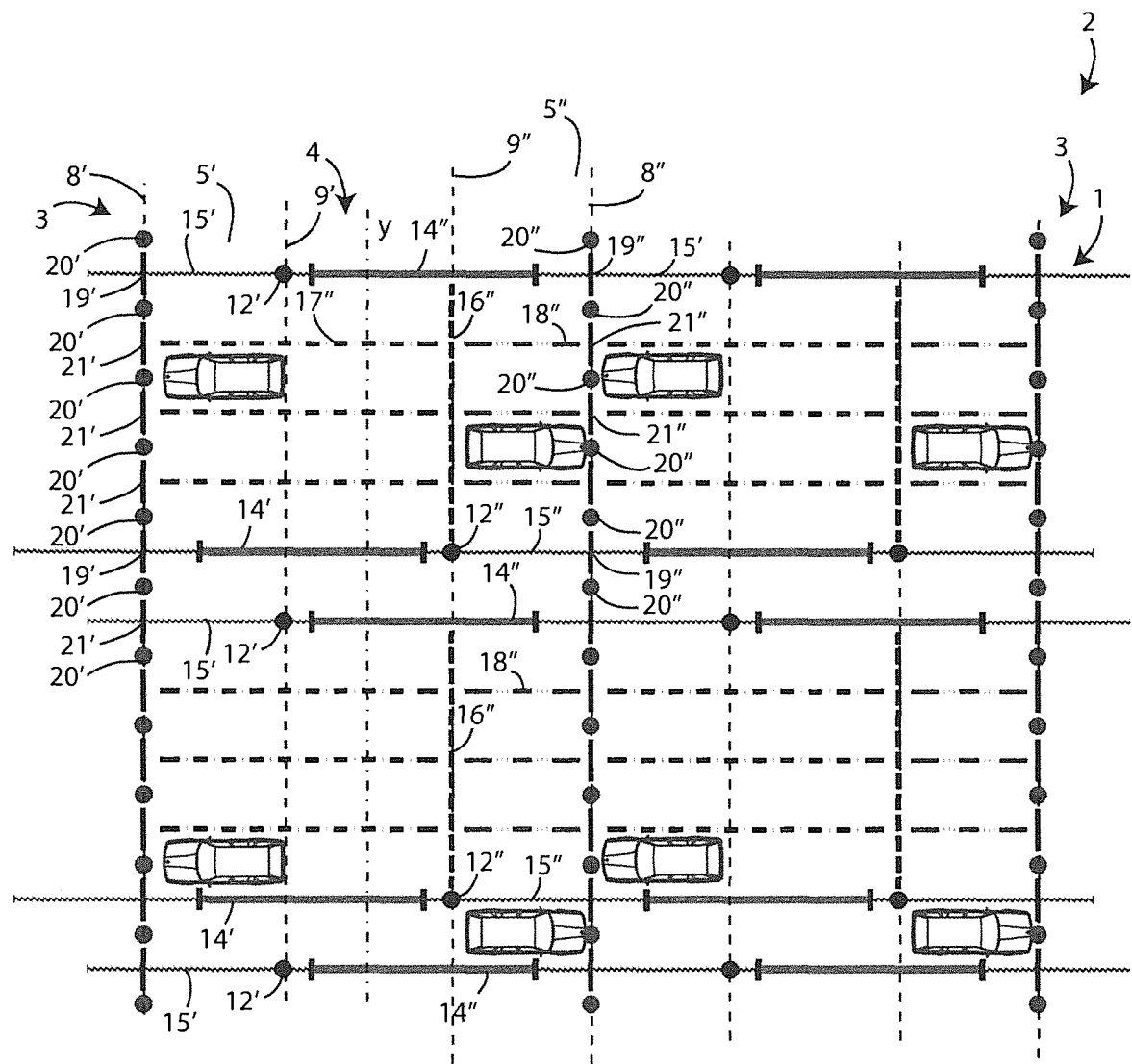


Fig. 18

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IT2016/000016

## A. CLASSIFICATION OF SUBJECT MATTER

INV. E04H6/10

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                   | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | EP 2 441 903 A1 (FAST PARK SIST S R L [IT]) 18 April 2012 (2012-04-18)<br>the whole document                                         | 1-8                   |
| A         | EP 0 364 414 A1 (CENT PROGETTAZIONI COORDINATE [IT])<br>18 April 1990 (1990-04-18)<br>cited in the application<br>the whole document | 1-8                   |
| A         | WO 2011/135546 A2 (FRIDERICI PAUL [CH])<br>3 November 2011 (2011-11-03)<br>the whole document                                        | 1-8                   |



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents :

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search

13 June 2016

Date of mailing of the international search report

24/06/2016

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IT2016/000016

| Patent document<br>cited in search report |    | Publication<br>date |      | Patent family<br>member(s) |  | Publication<br>date |
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