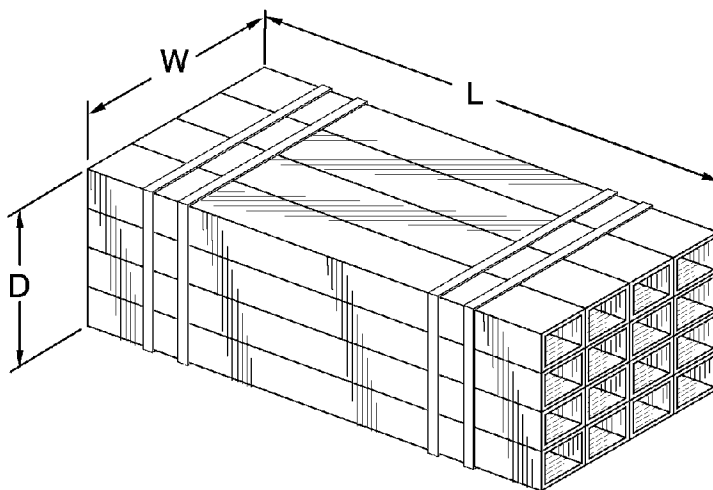




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(54) Titre : PROCEDE D'EMPILAGE DE TUBES SOUDES
(54) Title: METHOD FOR STACKING WELDED TUBE



(57) **Abrégé/Abstract:**

The method involves a pipe bundle arrangement, each bundle having a length, a width and a depth and being a shape bundle having a rectangular or a round bundle having a hexagonal cross-section. Each bundle has a type, each type having predetermined ranges of length and width, the bundle being assigned to that type in respect of which the length and width falls within the predetermined ranges. In the arrangement: no stack exceeds a predetermined height; no round bundle has stacked thereupon a shape bundle nor a round bundle of another type; the predetermined length range of each bundle in a stack is common; the predetermined width range of each shape bundle in a stack is common; and in no stack is a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than the predetermined width range of the shape bundle.

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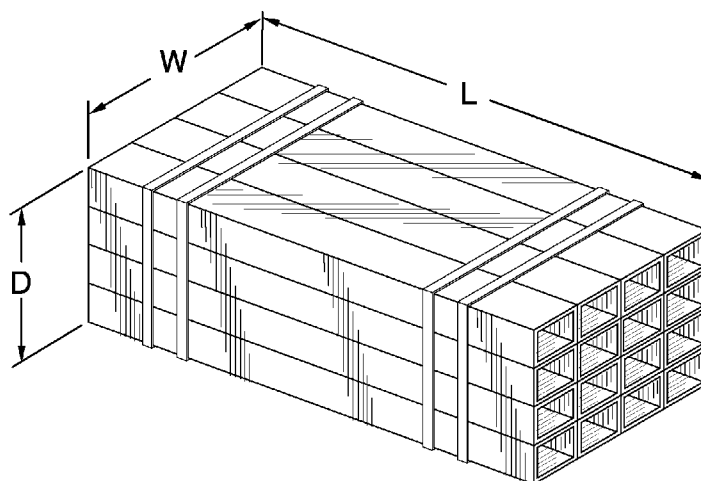


FIG.1

(57) Abstract: The method involves a pipe bundle arrangement, each bundle having a length, a width and a depth and being a shape bundle having a rectangular or a round bundle having a hexagonal cross-section. Each bundle has a type, each type having predetermined ranges of length and width, the bundle being assigned to that type in respect of which the length and width falls within the predetermined ranges. In the arrangement: no stack exceeds a predetermined height; no round bundle has stacked thereupon a shape bundle nor a round bundle of another type; the predetermined length range of each bundle in a stack is common; the predetermined width range of each shape bundle in a stack is common; and in no stack is a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than the predetermined width range of the shape bundle.

WO 2015/172242 A1

METHOD FOR STACKING WELDED TUBE**Field of the Invention**

[0001] The invention relates to the field of warehousing.

Background of the Invention

[0002] In modern commerce, there exists a need to warehouse bundled pipe. There also exists a desire to handle warehousing through automation. The geometry, mass and variations therein render the automation of bundled pipe handling difficult, particularly in the context of magnetic lifting operations.

Summary of the Invention

[0003] Forming one aspect of the invention is an arrangement of a plurality of bundles of pipes in a storage area having a rectilinear polygonal floor surface. Each bundle has a length, a width and a depth and is either a shape bundle having a rectangular cross-section or a round bundle having a hexagonal cross-section. The arrangement is characterized: (i) in that each bundle is assigned to one of a plurality of types, each type having a predetermined length range and a predetermined width range, the bundle being assigned to that type in respect of which the width of the bundle falls within the predetermined width range and the length of the bundle falls within the predetermined length range; and (ii) by compliance with a rule set.

[0004] The rule set prescribes that: no stack of bundles may exceed a predetermined height; no round bundle may have stacked thereupon a shape bundle; no round bundle may have stacked thereupon a round bundle of another type; the predetermined length range of each bundle in a stack is common; the predetermined width range of each shape bundle in a stack is common; and no stack may include a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than the predetermined width range of the shape bundle.

[0005] The arrangement and storage area can be used, along with a further bundle of pipes of the type having a length, a width and a depth and being either a shape bundle having a rectangular cross-section or a round bundle having a hexagonal cross-section, in a method which forms another aspect of the invention.

[0006] The method comprises the steps of:

- assigning the bundle to that type in respect of which the width of the bundle falls within the predetermined width range and the length of the bundle falls within the predetermined length range; and
- placing the bundle: (i) on another bundle in the storage area, if placement would not result in a violation of a rule set; or (ii) on the floor surface, if placement would otherwise result in a violation of the rule set.

[0007] According to another aspect of the invention, the rule set can further prescribe that no stack can exceed a predetermined number of bundles.

[0008] According to another aspect of the invention, the rule set can further prescribe that no round bundle can be stacked upon a shape bundle.

[0009] According to another aspect of the invention, the rule set can permit a round bundle to be stacked upon a shape bundle provided that at least a predetermined minimum number of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height and no more than a predetermined maximum number of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height.

[0010] According to another aspect of the invention, the predetermined minimum number can be two and the predetermined maximum number is three.

[0011] According to another aspect of the invention, in the method, if a round bundle could be placed upon more than one stack without violation of the rule set, the round bundle can be placed, in descending order of preference:

- upon a round bundle of the same type;
- upon a shape bundle of the same type; and
- upon a shape bundle having the same predetermined length range and a larger predetermined width range.

[0012] According to another aspect of the invention, the rule set can further prescribe that, in respect of each bundle placed upon the floor surface, said each bundle and any bundles stacked thereupon shall be centrally disposed with respect to a notional rectangular column having a length equal to the maximum length of the predetermined range of the bundle placed upon the floor and a width equal to the maximum width of the predetermined range of the bundle placed upon the floor.

[0013] According to another aspect of the invention, the rule set can further prescribe that no notional rectangular column may be within a predetermined distance of another notional rectangular column.

[0014] According to another aspect of the invention, the rule set can further prescribe that bundles are placed such that all of the pipes are parallel to one another.

[0015] According to another aspect of the invention, the bundle can be placed upon the floor surface such that, of a plurality of possible positions on the floor surface wherein the bundle could be placed without violation of the rule set, the space surrounding the bundle is minimized, such space being defined, in respect of each possible position of the bundle, by that area of the floor surface lying between the notional rectangular column of the bundle and the largest rectangle that can be defined wholly on the floor surface that surrounds the bundle, does not intersect any other rectangular column and has dimensions parallel to those of the rectangular columns.

[0016] According to another aspect of the invention, the plurality of possible positions can be all possible positions.

[0017] According to another aspect of the invention, the plurality of possible positions can be a plurality of positions regularly spaced apart from one another.

[0018] According to another aspect of the invention, the positions can be spaced apart lengthwise a distance equal to the nominal differential in lengths between bundle types and spaced apart widthwise a distance equal to the width variance of each bundle.

[0019] According to another aspect of the invention, in the method:

in respect of each point,

- a first line can be extended parallel to one of the dimensions from the point until such time as the line reaches the edge of the surface or a notional column associated with another bundle, and thereafter widened in directions parallel to the other dimension until such time as the first line reaches the edges of the surface or a notional column associated with another bundle;
- a first rectangle can be defined by the perimeter of the first (widened) line;
- a second line can be extended parallel to the other of the dimensions from the point until such time as the line reaches the edge of the surface or a notional column associated with another bundle and thereafter be widened in directions parallel to the one dimension until such time as the line reaches the edge of the surface or a notional column associated with another bundle;
- a second rectangle can be defined by the perimeter of the second (widened) line;
- if the length and width of the first rectangle are larger than the length and width of the type of the bundle to be placed, the ratio of the area of the type to the ratio of the first rectangle can be calculated; and
- if the length and width of the second rectangle are larger than the length and width of the type of the bundle to be placed the ratio of the area of the type to the ratio of the second rectangle can be calculated;

the highest calculated ratio can be selected; and

in the event that: (i) only one of the calculations resulted in the selected ratio, the bundle can be placed within that rectangle that resulted in the selected ratio; and (ii) a plurality of the calculations resulted in the selected ratio, the bundle can be placed within the rectangle that resulted in the selected ratio and is nearest a predetermined point.

[0020] According to another aspect of the invention, the bundle can be placed in a corner of the rectangle within which the bundle is placed.

[0021] Advantages, features and characteristics of the invention will become evident upon a review of the following detailed description, the accompanying claims and the appended drawings, the latter being briefly described hereinafter.

Brief Description of the Drawings

- [0022] Figure 1 shows a prior art bundle having a rectangular cross section
- [0023] Figure 2 shows a prior art bundle having an hexagonal cross section
- [0001] Figure 3 shows an exemplary storage area in plan view
- [0024] Figure 4 shows an arrangement of bundles in the storage area of Figure 3
- [0025] Figure 5 shows the structure of Figure 4 with the notional columns superimposed
- [0026] Figure 6 shows the structure of Figure 5 with a plurality of points P defined therein and point P^s
- [0027] Figure 7 shows a line drawn through P^s
- [0028] Figure 8 shows the line of Figure 7 widened into a first rectangle R1 for point P^s
- [0029] Figure 9 shows another line drawn through P^s
- [0030] Figure 10 shows the line of Figure 10 widened into the second rectangle R2 for point P^s
- [0031] Figure 11A-C shows the rectangles possible for the structure of Figure 4
- [0032] Figure 12 shows a further bundle positioned in the structure of Figure 4
- [0033] Figure 13 is a perspective view showing a visualization of a storage area employing the method.

Detailed Description of the Arrangement and the Method

Background

[0034] As an initial matter, the inventive arrangement will be understood to be for use with bundles of pipes and a storage area. In the exemplary embodiment:

- each bundle of pipes is well known in the prior art and has a length L, a width W and a depth D and is either a shape bundle having a rectangular cross-section as shown in Figure 1 or a round bundle having a hexagonal cross-section as shown in Figure 2; and
- the storage area is of the type having a rectilinear polygonal floor surface A, as is shown in Figure 3

[0035] The floor surface A in Figure 3 is actually defined by a plurality of steel sleepers S to which is welded a plurality of steel columns C. It will be understood that storage areas with floor surfaces of this type are known in the prior art and form no part of the invention.

Arrangement

[0036] The arrangement is characterized: (i) in that each bundle is assigned to one of a plurality of types, each type having a predetermined length range and a predetermined width range, the bundle being assigned to that type in respect of which the width of the bundle falls within the predetermined width range and the length of the bundle falls within the predetermined length range; and (ii) by compliance with a rule set.

[0036] In the exemplary embodiment, the lengths of the types are defined in the following increments (inches):

MIN	MAX
216	239.988
240	251.988
252	288
288.012	335.988
336	383.988
384	431.988
432	479.988
480	528
528.012	540
540.012	575.988
576	624
624.012	672
672.012	722

and the widths in the following increments (inches)

ROUND		SHAPE	
MIN	MAX	MIN	MAX
12	13	7	9
13	14	9	11
14	15	11	13
15	16	13	15
16	7	15	17
17	8	17	19
18	19	19	21
19	20	21	23
20	21	23	25
21	22		
22	23		
23	25		
25	27		
27	29		

[0038] The rule set prescribes that: no stack of bundles may exceed a predetermined height; no round bundle may have stacked thereupon a shape bundle; no round bundle may have stacked thereupon a round bundle of another type; the predetermined length range of each bundle in a stack is common; the predetermined width range of each shape bundle in a stack is common; and no stack may include a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than the predetermined width range of the shape bundle.

[0039] An exemplary arrangement is shown in Figure 4. In this arrangement, two stacks S1 and S2 are shown.

- Stack S1 consists of two bundles: a lower bundle, disposed upon the floor surface, that is a shape bundle having a length of 21'6" and a width of 18"; and an upper bundle, disposed upon the lower bundle, that is a shape bundle having a length of 21'3" and a width of 18".
- Stack S2 consists of two bundles: a lower bundle, disposed upon the floor surface, that is a shape bundle having a length of 21'9" and a width of 20"; and an upper bundle, disposed upon the lower bundle, that is a round bundle having a length of 21'6" and a width of 18".

Method

[0040] The arrangement and storage area can be used, along with a further bundle of pipes of the type having a length, a width and a depth and being either a shape bundle having a rectangular cross-section or a round bundle having a hexagonal cross-section, in a method that comprises an assignment step and a placement step.

[0041] In the assignment step, the bundle is assigned to that type in respect of which the length of the bundle falls within the predetermined length range and the width of the bundle falls within the predetermined width range.

[0042] The placement step involves:

- (i) placement of the bundle on another bundle in the storage area, if placement would not result in a violation of a rule set; or
- (ii) on the floor surface, if placement of the bundle on another bundle cannot be carried out otherwise than in violation of the rule set.

[0043] The exemplary rule set prescribes various rules regarding (i), namely:

- no stack of bundles may exceed a predetermined height, specifically 12'
- no round bundle may have stacked thereupon a shape bundle;
- no round bundle may have stacked thereupon a round bundle of another type;
- the predetermined length range of each bundle in a stack is common;
- the predetermined width range of each shape bundle in a stack is common;
- no stack may include a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than that of the shape bundle
- no stack can exceed a predetermined number of bundles , specifically, five (5)
- a round bundle to be stacked upon a shape bundle provided that at least a predetermined minimum number (2) of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height and no more than a predetermined maximum number (3) of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height
- if a round bundle could be placed upon more than one stack without violation of the rule set, the round bundle is placed, in descending order of preference: (i) upon a round bundle of the same type; (ii) upon a shape bundle of the same type; and (iii) upon a shape bundle having the same predetermined length range and a larger predetermined width range.

Thus, in the context of the arrangement shown in Figure 2, a bundle of the type shown in Figure 2 having a length of 21'4" and a width of 18" could be placed upon either stack S1 or S2.

[0044] The exemplary rule set further prescribes a plurality of rules regarding (ii), namely:

- in respect of each bundle placed upon the floor, said each bundle and any bundles stacked thereupon shall be centrally disposed with respect to a notional rectangular column having a length equal to the maximum length of the predetermined range of the bundle placed upon the floor and a width equal to the maximum width of the predetermined range of the bundle placed upon the floor
- no notional rectangular column may be within a predetermined spacing distance of another
- the bundles are placed such that all of the pipes are parallel to one another

[0045] Figure 5 shows the structure of Figure 4 with the notional columns NC superimposed.

[0046] The actual placement of bundles on the floor is carried out to optimize the amount of space on the floor occupied by stacks.

[0047] In the exemplary method, as an initial step in this regard, in respect of each of a plurality of points regularly spaced from one another on the floor surface:

- a first line is extended parallel to one of the dimensions from the point until such time as the line reaches the edge of the surface or a notional column, and thereafter is widened in directions parallel to the other dimension until such time as the first line reaches the edges of the surface or a notional column;
- a first rectangle is defined by the perimeter of the first line and, if the length and width of the first rectangle are larger than the length and width of the type, the ratio of the area of the type to the ratio of the first rectangle is calculated;
- a second line is extended parallel to the other of the dimension from the point until such time as the line reaches the edge of the surface or a notional column and thereafter is widened in directions parallel to the one dimension until such time as the line reaches the edge of the surface or a notional column; and
- a second rectangle is defined by the perimeter of the second line and, if the length and width of the second rectangle are larger than the length and width of the type, the ratio of the area of the type to the ratio of the second rectangle is calculated.

[0048] Figures 7-8 and 9-10, respectively, show the progression of the definition of the first and second rectangles for sample point P^S. It will be appreciated that this same exercise will be repeated at each point P.

[0049] From the foregoing, the highest calculated ratio is selected, and the bundle is placed as follows:

- in the event that only one of the calculations resulted in the selected ratio, the bundle is placed within that rectangle that resulted in the selected ratio; and
- in the event that a plurality of the calculations resulted in the selected ratio, the bundle is placed within the rectangle that resulted in the selected ratio and is nearest a predetermined point, specifically, one corner of the warehouse.

[0050] Thus, in the context of the warehouse shown in Figure 5, a bundle of the type shown in Figure 1 that could not otherwise be placed upon an existing stack without violation of the rule set would be placed in that of the three available rectangles R1, R2 and R3 which the bundle could fit within and most fully occupy. In the simplified example shown, rectangle R3 is slightly wider than R2 and of the same length; a bundle longer than the notional columns applicable in the case of stacks S1 and S2 would be placed in the corner of rectangle R3, as in Figure 12. More particularly, a new stack S3 would be defined, occupying a new notional column NC, which would be placed nearest the upper, left corner of the floor space A and spaced predetermined distance D from the adjacent notional column. The predetermined distance is defined by, *inter alia*, the force of the magnet [if the stacks are too close to one another, magnetic attraction between the stack being moved and an adjacent stack may result in movement] and the size of the magnet [if the magnet is wider than a stack, the predetermined distance around the stack will need to be sufficient to ensure that the magnet can fit within adjacent stacks].

[0051] For greater clarity, it will be appreciated by persons of ordinary skill that the methodology mentioned hereinbefore results in placement of the bundle on the floor surface such that the open space surrounding the bundle is minimized without violation of the rule set, such space being defined, in respect of each possible position of the bundle, by that area of the floor surface lying between the notional rectangular column of the bundle and the largest rectangle that can be defined wholly on the floor surface that surrounds the bundle, does not intersect any other rectangular column and has dimensions parallel to those of the rectangular columns.

[0052] In the exemplary method, the positions P in respect of which the ratios are calculated are spaced apart lengthwise a distance equal to the nominal differential in lengths between bundle types and are spaced apart widthwise a distance equal to the width variance of each bundle.

[0053] Whereas the description makes specific mention of certain locations, and describes a specific embodiment and implementation, it should be understood that variations are possible.

[0054] For example, whereas a specific warehouse is illustrated in Figure 3, it will be appreciated that this warehouse is exemplary, only.

[0055] Further, whereas the warehouse shown in Figure 3 has a visible rectilinear floor surface, it will be appreciated that rectilinear floor surfaces can be found within floors having, for example, round or oval perimeters and the invention should be understood accordingly.

[0056] Further, whereas the exemplary method has been described with reference to a single floor surface A, the floor surface A shown will be seen to be one of a plurality available in the exemplary warehouse, each separated one from another by a row of columns C. It will be evident that, if no room exists in an existing floor space A, a new stack can be created in one of the other available floor spaces (bays).

[0057] Moreover, whereas in the exemplary embodiment, round bundles can be stacked upon shape bundles in certain situations, the rule set can prescribe that no round bundle can be stacked upon a shape bundle.

[0058] As well, whereas a specific selection of possible positions is used for the optimization step in the exemplary embodiment, the plurality of possible positions can be all possible positions, if advanced mathematical techniques are employed.

[0059] Further, whereas round bundles having a hexagon cross-section are discussed, other bundle cross-sections are possible.

[0060] Accordingly, the invention should be understood to be limited only by the accompanying claims, purposively construed.

CLAIMS

1. An arrangement of a plurality of bundles of pipes in a storage area having a rectilinear polygonal floor surface, each bundle having a length, a width and a depth and being either a shape bundle having a rectangular cross-section or a round bundle having a hexagonal cross-section, the arrangement being characterized:

in that each bundle is assigned to one of a plurality of types, each type having a predetermined length range and a predetermined width range, the bundle being assigned to that type in respect of which the width of the bundle falls within the predetermined width range and the length of the bundle falls within the predetermined length range; and by compliance with a rule set that prescribes that

no stack of bundles may exceed a predetermined height;

no round bundle may have stacked thereupon a shape bundle;

no round bundle may have stacked thereupon a round bundle of another type;

the predetermined length range of each bundle in a stack is common;

the predetermined width range of each shape bundle in a stack is common; and

no stack may include a round bundle stacked upon a shape bundle wherein the predetermined width range of the round bundle is greater than the predetermined width range of the shape bundle.

2. A method for use with the arrangement and storage area of claim 1 and with a further bundle of pipes of the type having a length, a width and a depth and being either a shape bundle having a rectangular cross-section or a round bundle having a hexagonal cross-section, the method comprising the steps of:

assigning the bundle to that type in respect of which the width of the bundle falls within the predetermined width range and the length of the bundle falls within the predetermined length range; and

placing the bundle: (i) on another bundle in the storage area, if placement would not result in a violation of a rule set; or (ii) on the floor surface, if placement would otherwise result in a violation of the rule set.
3. A method according to claim 2, wherein the rule set further prescribes that no stack can exceed a predetermined number of bundles.
4. A method according to claim 2, wherein the rule set further prescribes that no round bundle can be stacked upon a shape bundle.
5. A method according to claim 2, wherein the rule set permits a round bundle to be stacked upon a shape bundle provided that at least a predetermined minimum number of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height and no more than a predetermined maximum number of round bundles of the same type could be stacked upon the shape bundle without exceeding the predetermined height.

- 6 A method according to claim 5, wherein the predetermined minimum number is two and the predetermined maximum number is three.
7. A method according to claim 5, wherein, if a round bundle could be placed upon more than one stack without violation of the rule set, the round bundle is placed, in descending order of preference:

upon a round bundle of the same type;

upon a shape bundle of the same type; and

upon a shape bundle having the same predetermined length range and a larger predetermined width range.
8. A method according to claim 2, wherein the rule set further prescribes that, in respect of each bundle placed upon the floor, said each bundle and any bundles stacked thereupon shall be centrally disposed with respect to a notional rectangular column having a length equal to the maximum length of the predetermined range of the bundle placed upon the floor and a width equal to the maximum width of the predetermined range of the bundle placed upon the floor.
9. A method according to claim 8, wherein the rule set further prescribes that no notional rectangular column may be within a predetermined distance of another notional column.
10. A method according to claim 2, wherein the rule set further prescribes that bundles are placed such that all of the pipes are parallel to one another.

11. A method according to claim 9, wherein the bundle is placed upon the floor surface such that, of a plurality of possible positions on the floor surface wherein the bundle could be placed without violation of the rule set, the space surrounding the bundle is minimized, such space being defined, in respect of each possible position of the bundle, by that area of the floor surface lying between the notional rectangular column of the bundle and the largest rectangle that can be defined wholly on the floor surface that surrounds the bundle, does not intersect any other rectangular column and has dimensions parallel to those of the rectangular columns.
12. A method according to claim 11, wherein the plurality of possible positions is all possible positions.
13. A method according to claim 11, wherein the plurality of possible positions is defined by a plurality of positions regularly spaced apart from one another.
14. A method according to claim 13, wherein the positions are spaced apart lengthwise a distance equal to the nominal differential in lengths between bundle types and are spaced apart widthwise a distance equal to the width variance of each bundle.

15. A method according to claim 11, wherein

in respect of each point,

a first line is extended parallel to one of the dimensions from the point until such time as the line reaches the edge of the surface or a notional column;

the first line is widened in directions parallel to the other dimension until such time as the first line reaches the edges of the surface or a notional column;

a first rectangle is defined by the perimeter of the first line;

a second line is extended parallel to the other of the dimension from the point until such time as the line reaches the edge of the surface or a notional column;

the second line is widened in directions parallel to the one dimension until such time as the line reaches the edge of the surface or a notional column;

a second rectangle is defined by the perimeter of the second line;

if the length and width of the first rectangle are larger than the length and width of the type, the ratio of the area of the type to the ratio of the first rectangle is calculated;

if the length and width of the second rectangle are larger than the length and width of the type, the ratio of the area of the type to the ratio of the second rectangle is calculated;

the highest calculated ratio is selected; and

in the event that (i) only one of the calculations resulted in the selected ratio, the bundle is placed within that rectangle that resulted in the selected ratio ; and (ii) a plurality of the calculations resulted in the selected ratio, the bundle is placed within the rectangle that resulted in the selected ratio and is nearest a predetermined point.

16. A method according to claim 15, wherein the bundle is placed in a corner of the rectangle within which the bundle is placed.

1/12

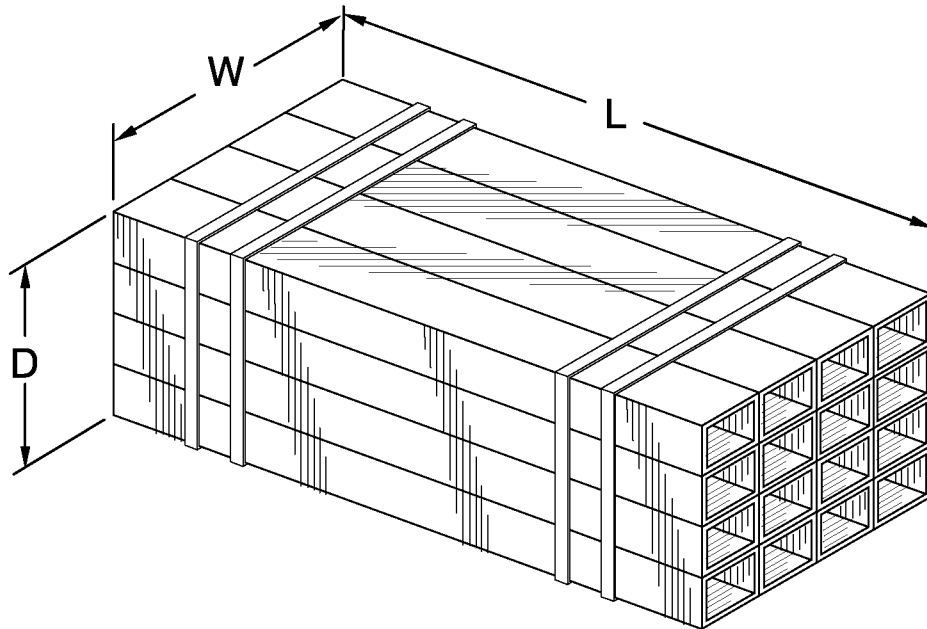


FIG. 1

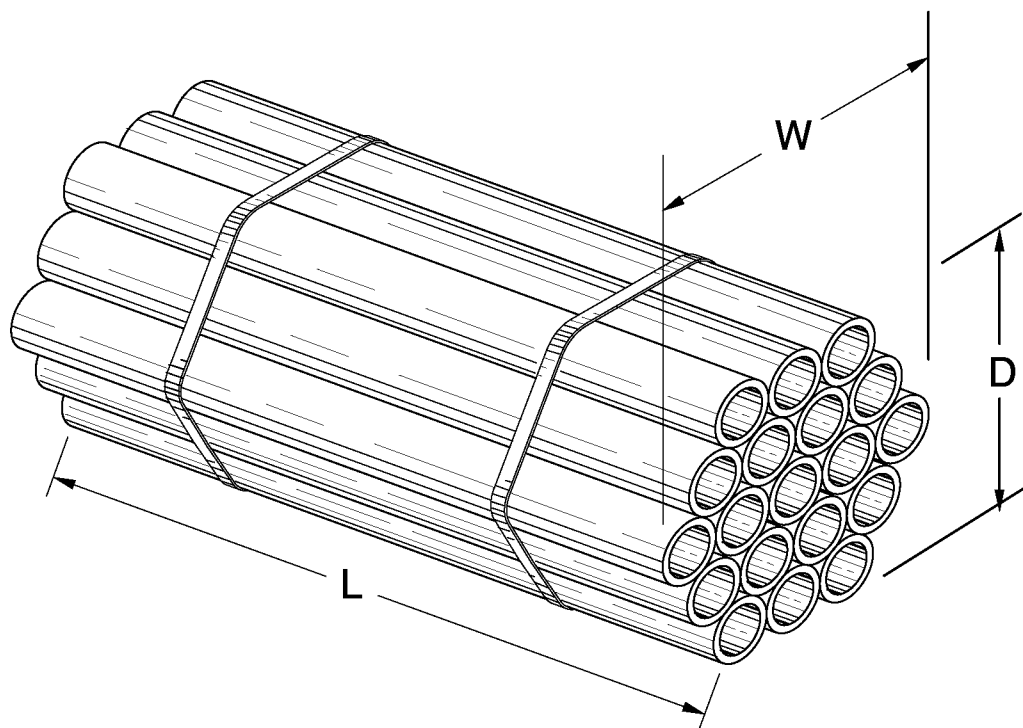


FIG. 2

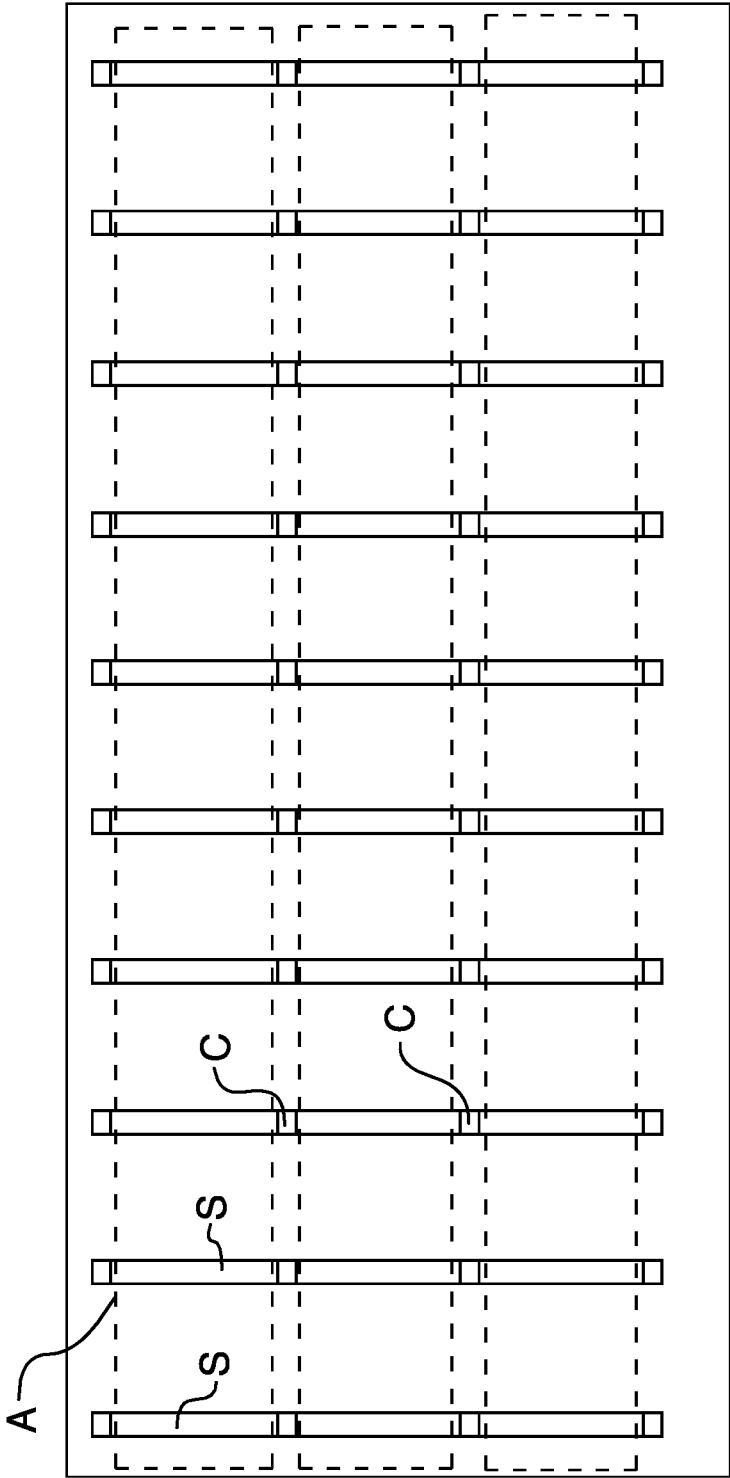


FIG.3

3/12

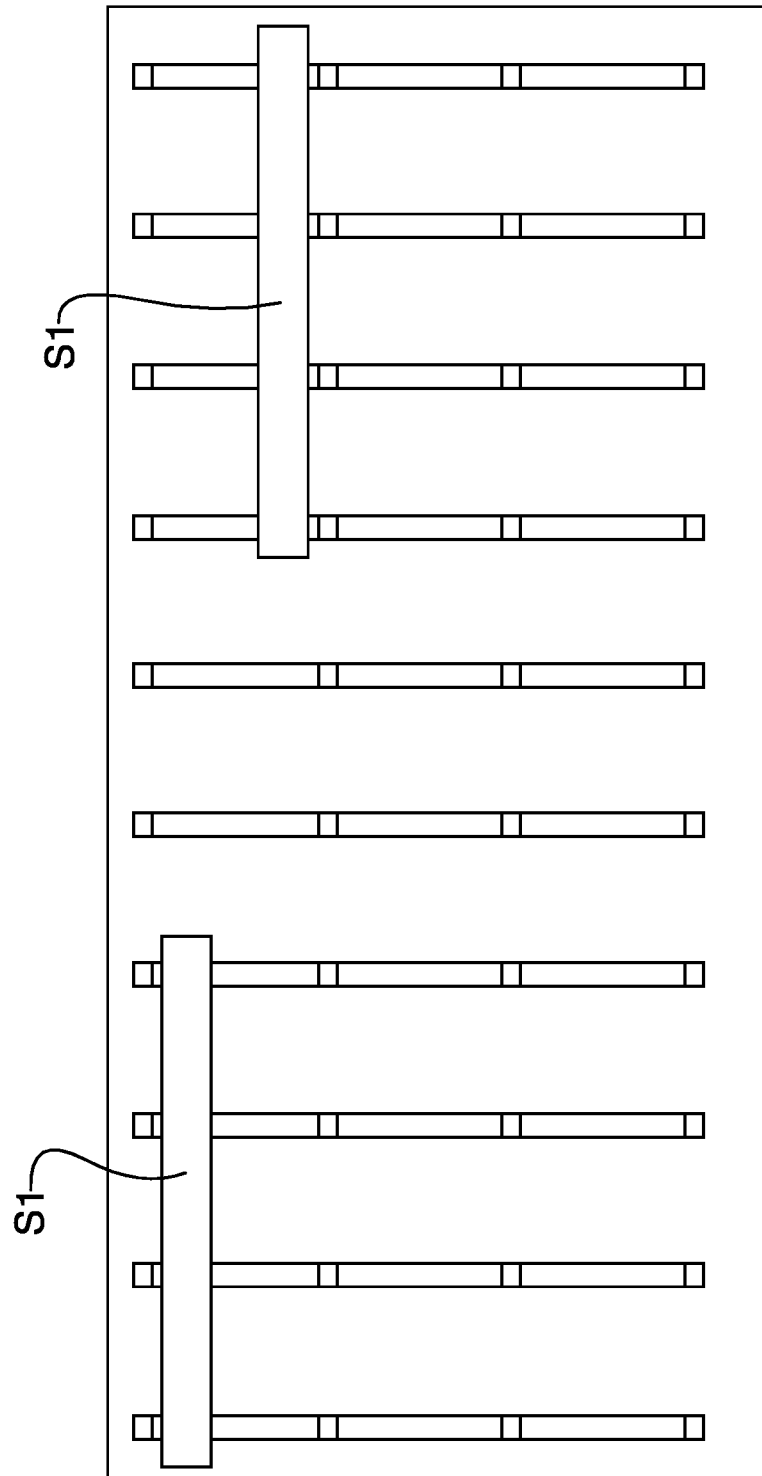


FIG. 4

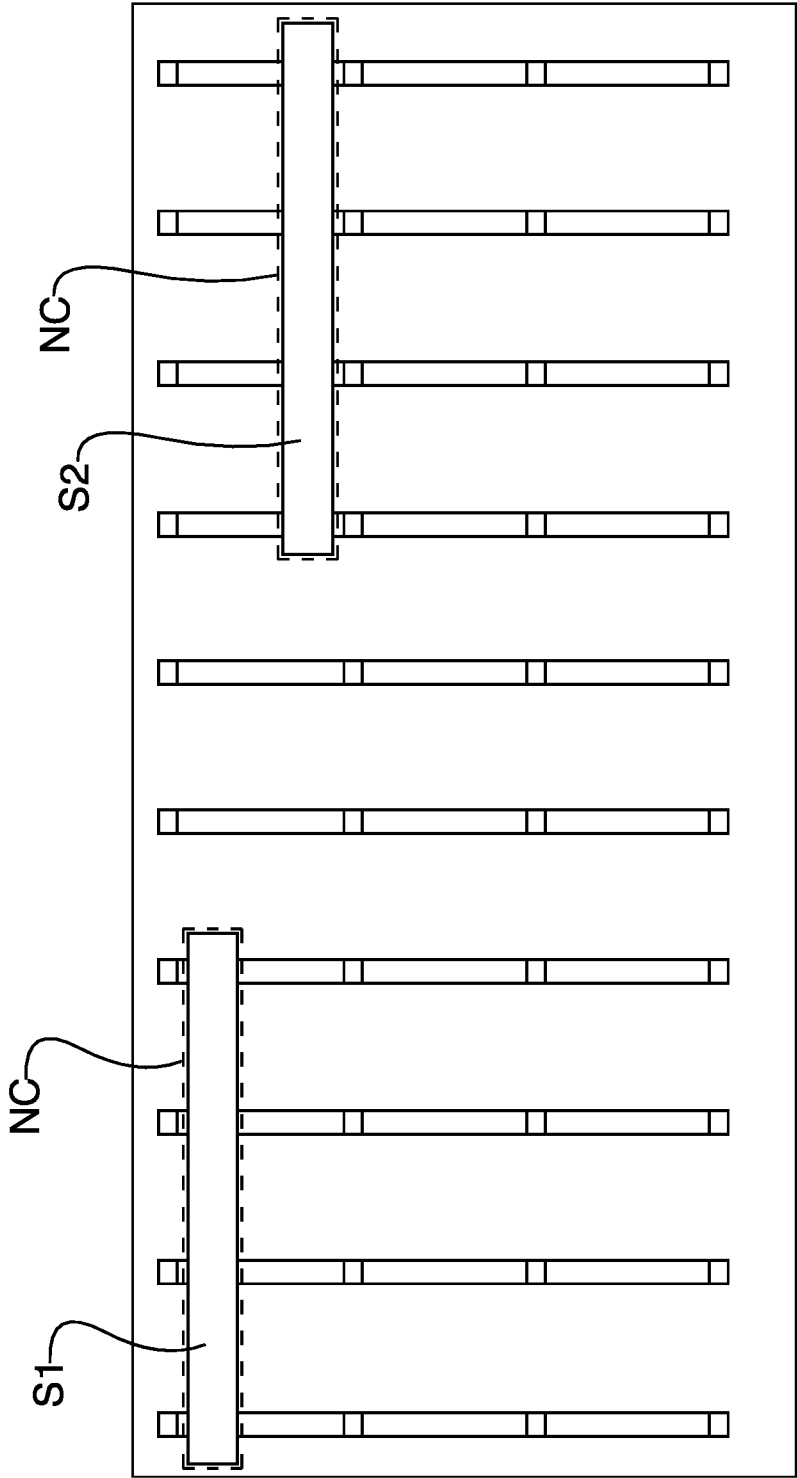


FIG. 5

5/12

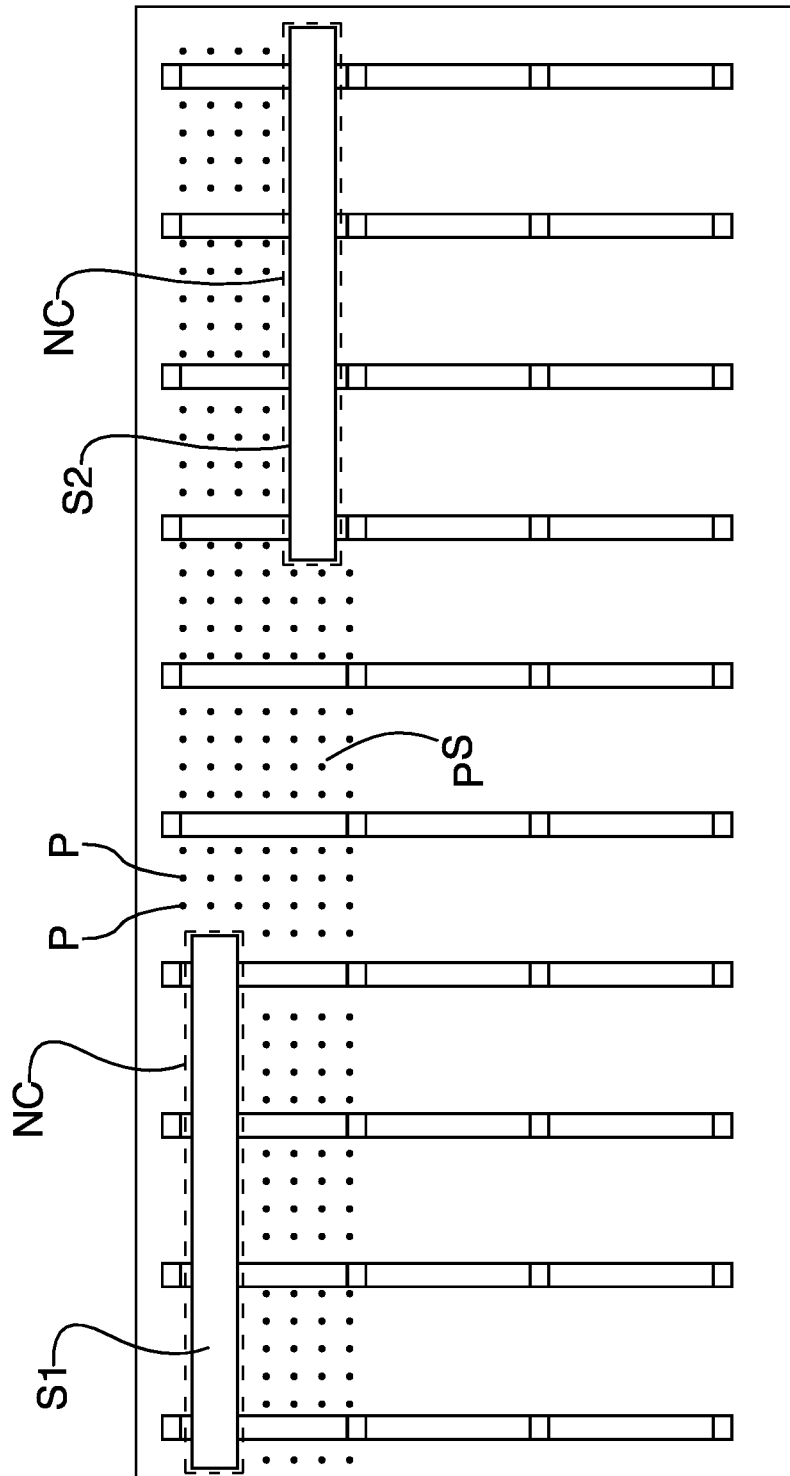
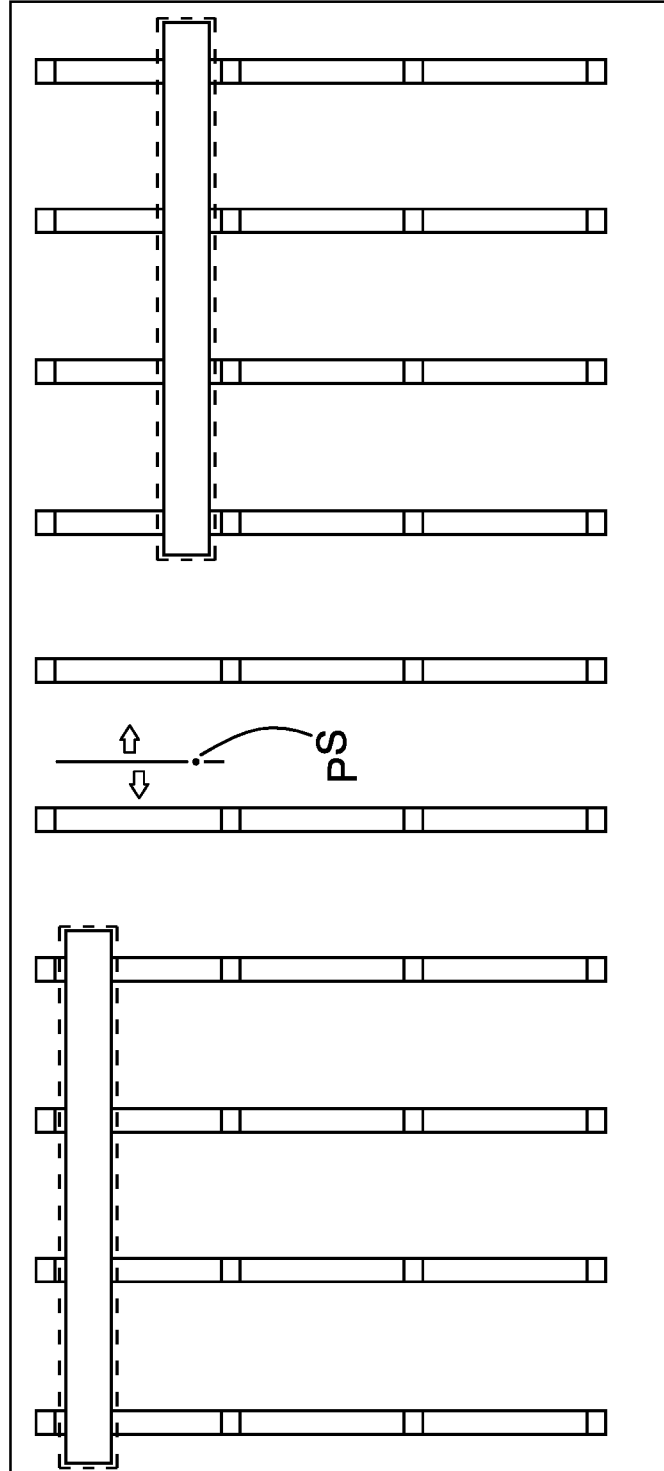


FIG. 6

6/12



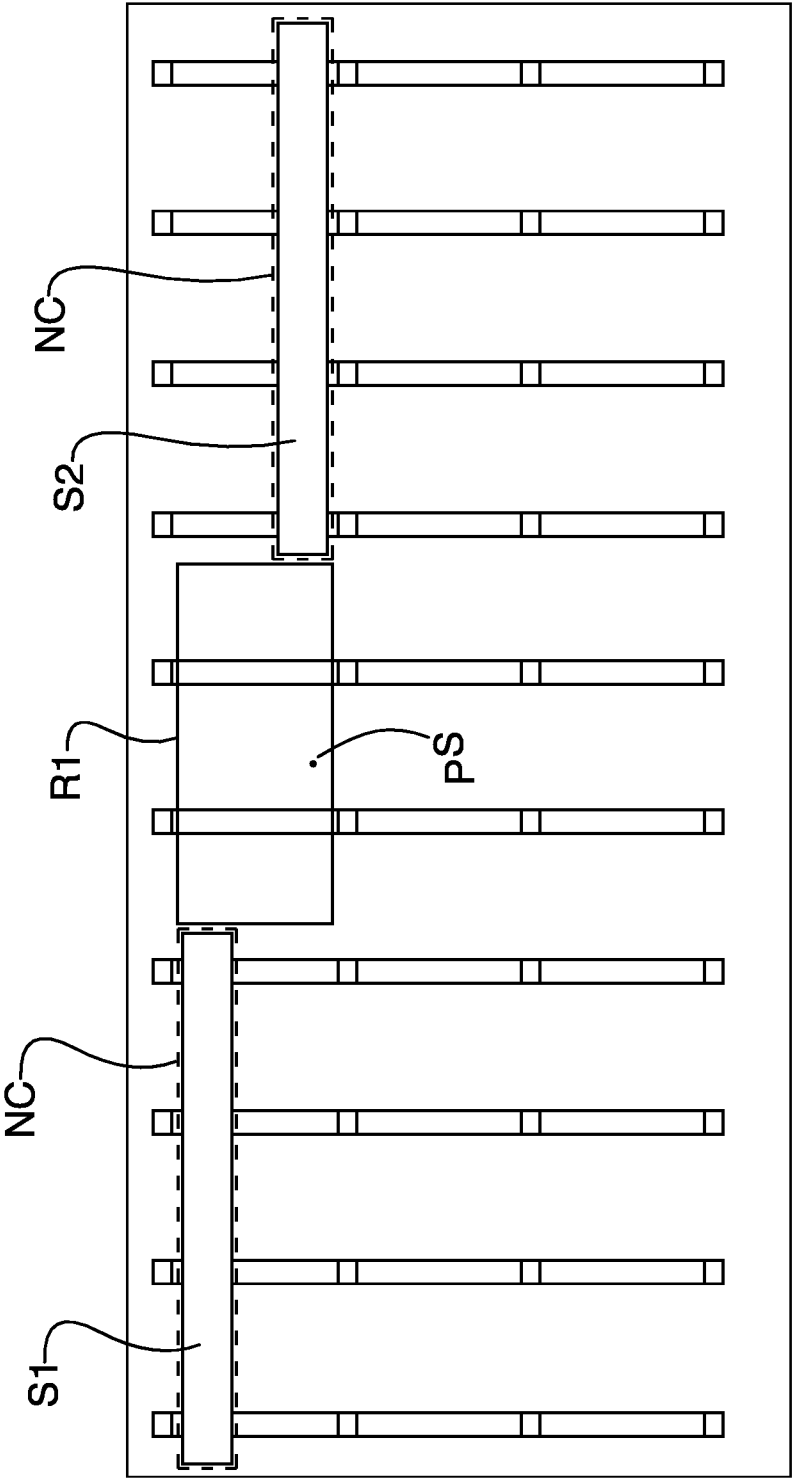


FIG.8

8/12

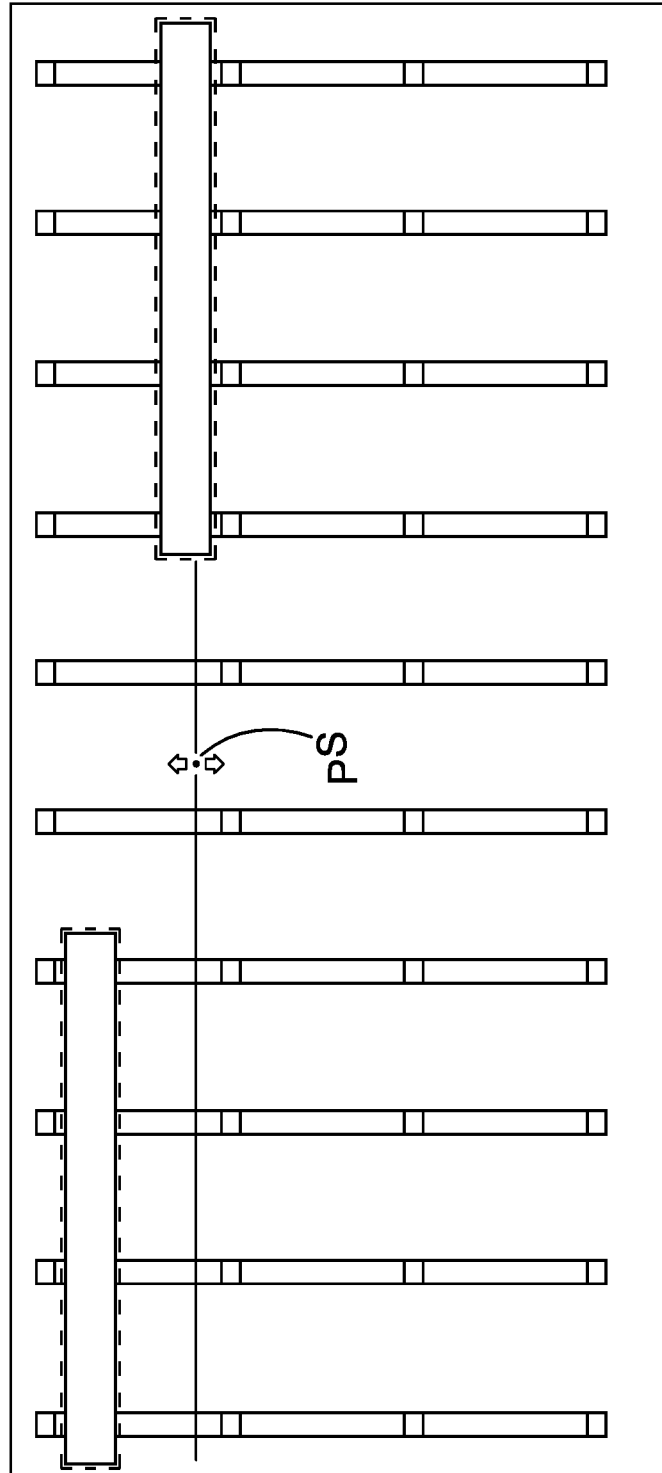


FIG. 9

9/12

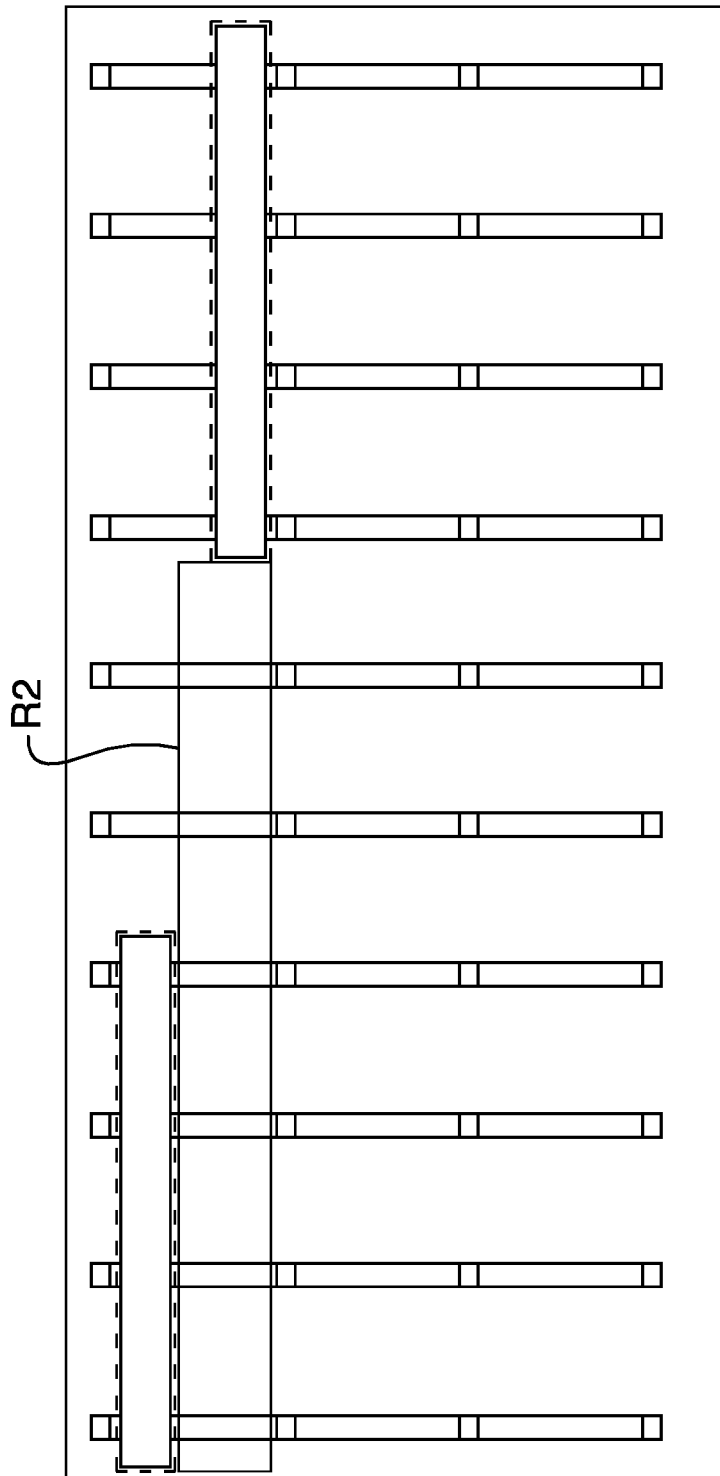


FIG. 10

10/12

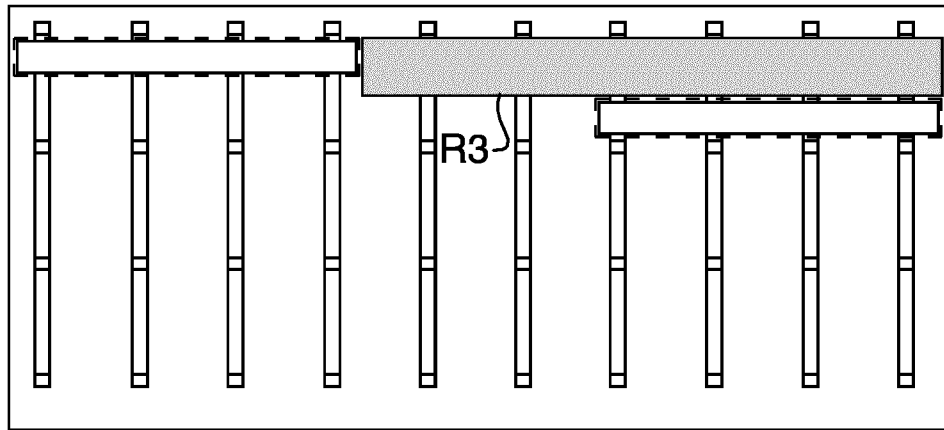


FIG. 11A

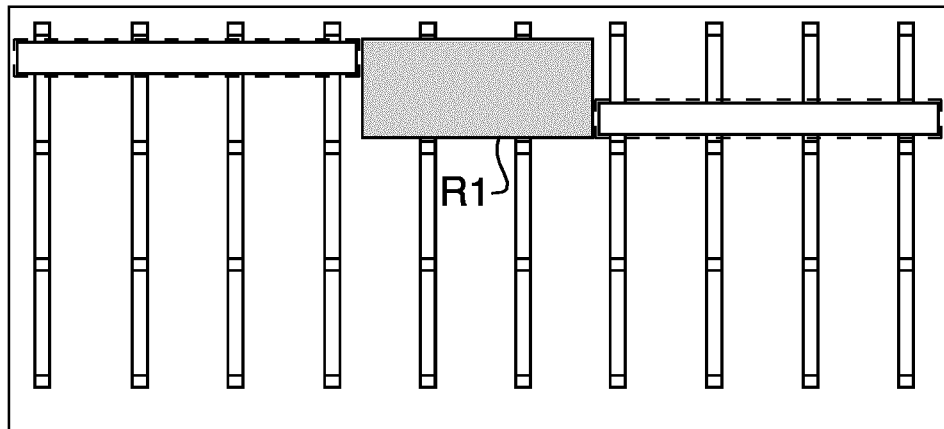


FIG. 11B

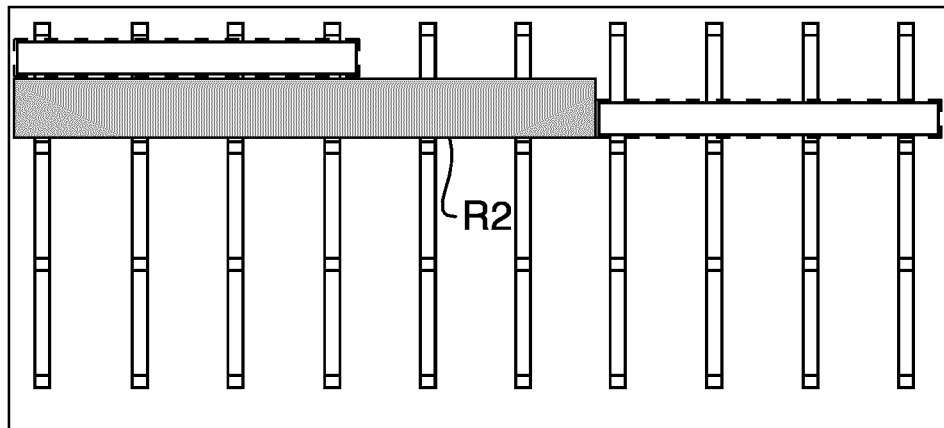


FIG. 11C

11/12

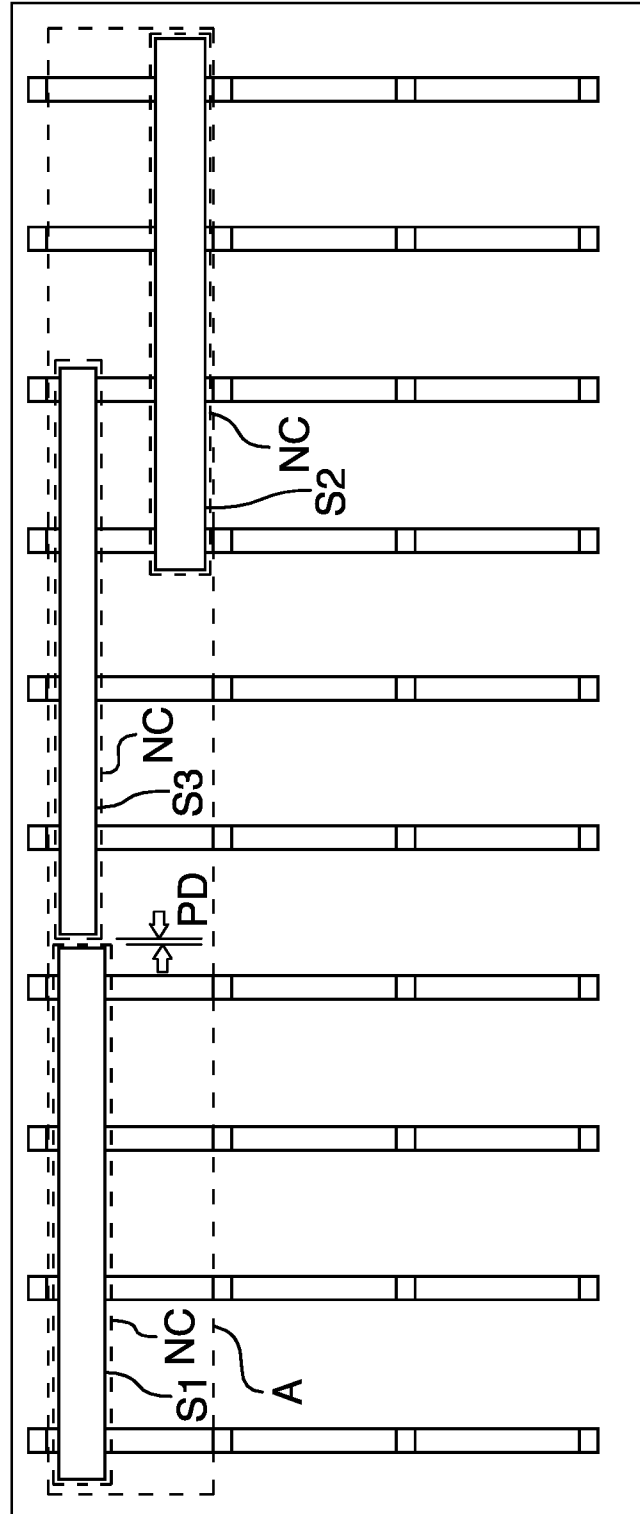


FIG. 12

12/12

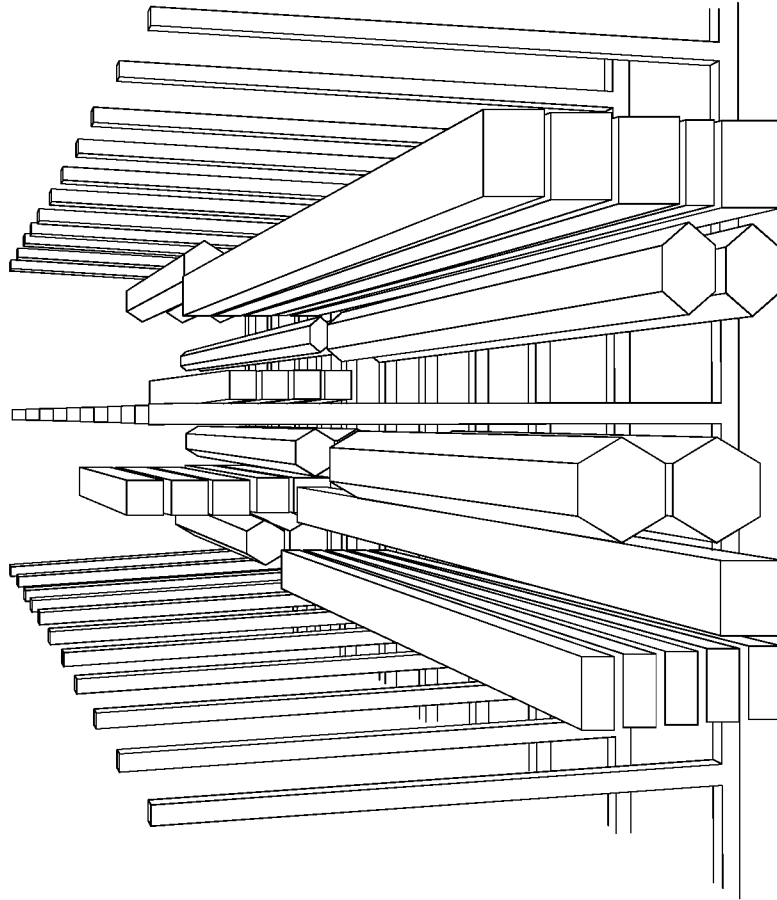


FIG.13

