(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 719 477 A2**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.04.2014 Bulletin 2014/16

(51) Int Cl.:
B21D 22/02 *(2006.01)* ***B21D 22/04*** *(2006.01)*
B21D 53/06 *(2006.01)*

(21) Application number: **13156543.4**

(22) Date of filing: **25.02.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **10.10.2012 CZ 20120689**

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Remarks:
A request for correction of the drawings has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) Forming device for deforming tubes of heat exchangers

(57) The present invention relates to the forming device for carrying out controlled deformation of tubes, especially tubes (4) of heat exchangers, which are placeable between the table and pressure bar of the mechanical press, whereby it comprises a lower forming plate (1) and an upper forming plate (2) that are coupled by guide devices. It further comprises die elements (12) arranged on mutually counter surfaces (11, 24) of the lower forming plate (1) and the upper forming plate (2). The die elements (12) are connected to a corresponding forming plate (1, 2) in an demountable and adjustable, whereas the forming plates (1, 2) being coupled to devices for adjusting the position of the processed tube (4) with respect to the forming plates (1, 2) along the longitudinal axis of the tube (4) and in the direction of shifting the tube (4) round its longitudinal axis, and to means which secures the tube (4) in the set position.

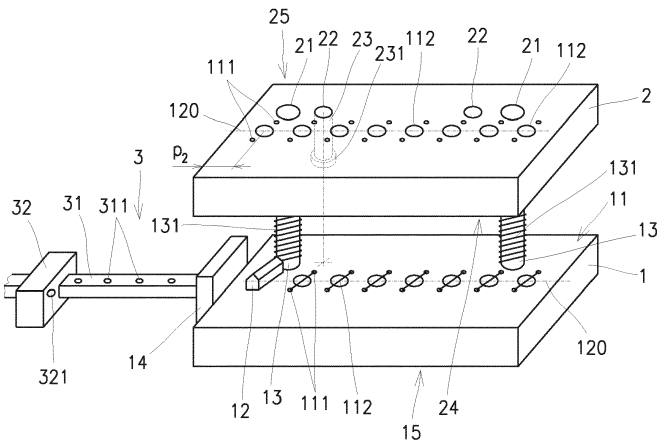

Fig. 4

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Description

Field of the invention

[0001] A forming device for carrying out controlled deformation of tubes, especially tubes of heat exchangers, placeable between the table and pressure bar of the mechanical press, which comprises a lower forming plate and an upper forming plate that are coupled by guide devices, and die elements arranged on mutually counter surfaces of the lower forming plate and upper forming plate.

Prior state of the art

[0002] An important type of heat exchangers, whose essential function is transferring heat between two fluids at different temperatures, are tube heat exchangers. They are used for heat transfer between two gases, between two liquids, or between a liquid and a gas.

[0003] An important type of such heat exchangers are exchangers whose heat exchange element is a tube. It is apparent that in the case of streaming fluid, especially when the liquid flows in a tube, the amount of released or gained heat depends on the flow rate and flow characteristics.

[0004] For example, transferring heat from hot water flowing in a tube to the surrounding environment is more intensive if the water flow is turbulent. Transition from laminar to turbulent flow is due to local alterations in water flow rate which are caused by obstacles standing in the way of the flowing water, that means by irregularities in the inner wall of the tube. These have been formed as raised surface irregularities of different shapes projecting in the internal diameter of the tube.

[0005] In accordance with EP165583B1 a direct tube of the heat exchanger accommodates individual dimples arranged in the shape of a spiral which form protrusions on the inner wall of the tube. The instrument of production is the forming head which rotates against the tube and at the same time both the forming head and the tube are mutually longitudinally shifted. The head has three form blocks, the outer cylindric surface of which has circumferentially a row of individual moulding protrusions which are during the industrial process pushed into the outer surface of the tube from the outside.

[0006] DE102008031158A2 and DE102008062704A1 disclose a modification of a tube of circular, elliptical or other cross section which has at least one longitudinal division plate. Tubes of rectangular cross-section are shown having at least one side into which point or crosswise protrusions are pushed from the outside. Their shape and slope with respect to the longitudinal axis of the tube is achieved by the forming roller, which accommodates, for instance, circumferential oblong protrusions sloping with respect to the axis of the rotation of the forming roller. The tube is shifted with respect to the forming roller perpendicularly to the axis of the rotation thereof.

[0007] DE102009051280A1 devises forming a flat tube of the heat exchanger from a long semi-finished product which has in certain longitudinal sections moulding dimples forming internal protrusions on wide areas of the tube which alternate regularly with longitudinal sections which have no dimples. Such a semi-finished product which is actually endless is then in the areas without dimples divided into final products having lentgths that are multiples of the length of the module defined by the section without dimples and that with dimples.

[0008] The above mentioned embodiments according to the prior state of the art solve production of conventional long semi-finished products manufactured by relatively complicated stationary machine equipment either for producing the tube itself, or subsequently from a long semi-finished product. The desired specific shape of deformation is achieved by replaceable tools, which are actually costly single-purpose forming rollers, or by appropriate heads. An object of the invention is making the forming device more simple and highly variable regarding the profile of a semifinished product of a tube intended for the forming operation as well as regarding the shape and mutual arrangement of obstacles on the inner wall of the tube.

Summary of the invention

[0009] An object of the present invention is to provide a forming device for carrying out controlled deformation of tubes comprising a lower forming plate, an upper forming plate and die elements arranged on mutually counter surfaces of the lower forming plate and upper forming plate, wherein its essential feature is the fact that the die elements are coupled to the corresponding forming plate in a manner such that they can be demounted or adjusted, the forming plates being coupled to devices for adjusting the position of the processed tube with respect to the forming plates along the longitudinal axis of the tube and along the direction of shifting the tube round its longitudinal axis and to devices that secure the tube in the set position. This device is universal, easily adjustable, wherein it is possible simply to choose the length of the processsed tube and the shape of individual irregularities. It can be used for tubes of different diameters and made of various plastically deformable materials. Another advantage is relatively high manufacturing productivity.

[0010] Die elements are mounted to a corresponding forming plate at equal mutual distances or at different mutual

distances. Preparatory time for changing the mutual position of the die elements represents only a little waste of production time.

[0011] At least one forming plate comprises an adjustable stop device defining the mutual distance between the forming plates at the end of the moulding stroke. With advantage, by means of a stop device the device is adjusted according to the diameter of the processed tube and desired depth of deformation of the tube surface.

[0012] Between the forming plates there is a spring device the force of which acts in the direction against the forming plates approaching each other. Thus after the working stroke is performed the forming plates automatically move away from each other, which enables to transfer the processed tube before another squeezing stroke, or remove it from the gap between the forming plates.

[0013] As a suitable spring device at least one pressure spiral-shaped spring is employed. It is advantageous when the spiral-shaped spring is coupled to a guide device by which it is guided.

[0014] The die elements connected to the lower forming plate differ in the profile of the forming portion from those connected to the upper forming plate and /or die elements connected to one forming plate differ from each other in the profile of the forming portion. That further extends the variability of the forming device according to the invention.

Brief description of the drawings

[0015] A scheme of an embodiment of the forming device is shown in the drawing where figure 1a represents a top view of an embodiment of a deformed tube, figure 1b shows a bottom view of an embodiment of a deformed tube, figure 2 shows a tube from figure 1 a in S direction view, figure 3 shows a longitudinal cross-section of the tube of figure 1 a taken along the line A-A, figure 4 represents an angle view of the forming device assembly, figure 5 shows a top view of the lower plate of the forming device, figure 6a is a scheme side view of a die element in an example of embodiment and figure 6b shows a front view of a die element in an embodiment from figure 6a.

Examples of embodiment of the present invention

[0016] The forming device according to the present invention is intended with advantage for carrying out controlled deformation of tubes, made especially of steel or copper, having small and very small diameters. In examples of embodiment there are steel tubes (outer diameter x thickness of the wall) 6 x 1 mm, 5 x 1 mm, and copper tubes 8 x 1 mm and 6 x 1 mm. These tube dimensions are mostly used in lesser heat exchangers, where, besides shape alterations in the inner wall of tubes, also a small inner diameter of the heat exchanger tube itself contributes to intensification of heat transfer.

[0017] An example of embodiment of the forming device according to the present invention as illustrated comprises a lower forming plate **1** and an upper forming plate **2**. To the lower forming plate **1** is fixed a hand-held stabilizer **3** of the processed workpiece, which is in the example of embodiment a semifinished product in the form of a circular tube. The final product is a tube **4** formed by controlled deformation designed for instance for a heat exchanger.

[0018] In an example of embodiment eight oblong die elements **12** are attached to the top surface **11** of the the lower forming plate **1** arranged in a row along the length of the lower forming plate **1** (for simplification, only one die element **12** is shown). The die elements **12** are positioned towards the top surface **11** of the lower forming plate **1** always by pins (not shown) in two end guide holes **111** and are fixed to the lower forming plate **1** always by means of a bolt (not shown) through a mounted fastening hole **112** in the lower forming plate **1.** They are arranged in the cross direction with respect to the axis **120** of their row, with respect to which they are all sloped under specific angle α. In an example of embodiment the angle α equals 45°. In an embodiment that is not shown a diffferent number of die elements **12** is mounted to the forming plate, wherein a plurality of guide holes **111** and their respective fastening holes **112** enables to arrange the die elements **112** which are being used and fixed at equal or different mutual distances, for example when some guide holes **111** and their respective fastening holes **112** are not occupied.

[0019] An example of embodiment of a die element **12** is shown in Figure 6a, 6b. The die element **12** has a profile of a bar whose fastening portion 121 with which it engages with the top surface **11** of the lower forming plate 1 has a rectangular cross-section, and the moulding portion **122** itself has a roof-like profile. Near the edges on the engaging surface of the die element **12** there are two centering holes **123** for pins (not shown) and a threaded hole **124** for a fastening bolt (not shown). It is apparent that in other embodiments the profile of the moulding portion **122** can be any suitable different shape, such as cylindric shape and the like.

[0020] Next to the row of the die elements in the holes **113** of the lower forming plate **1** there are fixed two guide bolts **13** on which a spiral-shaped spring **131** is always fitted.

[0021] A holder **14** carrying a stabilizer **3** of the processed workpiece is mounted to one butt of the lower forming plate **1**. The stabilizer **3** comprises an overhung guide bar **31** with a row of perpendicular through holes **311** having equal mutual pitches. In an embodiment which is not shown these pitches can differ, their size being firmly set. A workpiece grip **32** provided with a through grippping device **321** of workpiece (not shown) and a device for securing the workpiece

grip **32** (not shown) in a specific through hole **311** is placed in a sliding manner on the guide bar **31.** The workpiece grip **32** is located in a manner such that the processed tube is placed above the lower forming plate **1** above the row of die elements **12** in parallel to this row. The mechanism of the hand-held stabilizer **3,** or more precisely its workpiece grip **32.** enables to shift the workpiece in any way round its longitudinal axis and secure it in this position.

[0022] The upper forming plate **2** is substantially a mirror reflection of the lower forming plate **1**. That applies to the position of the axis of the row of die elements **12** and to the angle α of their slope with respect to the axis **120** of their row and to the pitch distances of the die elements **12**. However, along the axis **120** of the row of die elements **12** these axes of the forming plates 1, **2** towards each other are shifted in the lengthwise direction. The size of this shift **p** is apparent from Figures **4** and **5**, where it is illustrated by means of the distance **p1** of the centre of the first die element **12** from the left edge of the lower forming plate **1** and the distance **p2** of the centre of the first die element **12** from the the left edge of the upper forming plate **2**, wherein the shift **p** = **p1** - **p2** (or vice versa). In an example of embodiment **p** equals 5 mm. In areas corresponding to the position of guide bolts **13** with respect to the lower forming plate **1** guide holes **21** for these guide bolts **13** are formed in the upper forming plate **2**. Further the upper forming plate has threaded holes **22**, in which adjusting screws **23** (illustrated by the hatched part) protruding from the bottom surface **24** of the upper forming plate **2** are located. The adjusting screws **23** are at their lower end counter towards the top surface **11** of the lower forming plate **1** provided with stop heads **231**.

[0023] When the forming device is assembled the upper forming plate **2** is fitted by the guide holes **21** on the guide bolts **13** fixed in the lower forming plate **1**, whereby spiral-shaped springs **13** are partly preloaded. This assembled position is reached after the forming device is set into preparatory position in which the bottom surface **15** of the lower forming plate **1** lies on the table of the press (not shown), wherein the pressure bar of the press (not shown) is in contact with the top surface **25** of the upper forming plate 2.

[0024] During pressing tube semifinished-product, the tube is put in the grip device **321** of the workpiece grip **32** which is shifted on the guide bar **31** of the hand-held stabilizer **3** into the desired position. If the workpiece is to be deformed from the end portion, it is gripped in the hand-held stabilizer in a position where its end is at the desired small distance behind the last die element **12**. At the same time the workpiece grip **32** of the stabilizer **3** is secured with regard to its longitudinal position towards the forming plates **1**, **2** in the corresponding hole **311** of the guide bar **31**, the workpiece being ensured against turning round its longitudinal axis.

[0025] By setting the position of the adjusting screws **23** the backstop position of the device is defined, that is the maximum approach of the upper forming plate **2** to the lower forming plate **1**, which defines the depth of the deformation of the tube walls. The stroke itself is performed mechanically either by employing the press drive, or manually on a non-powered press, for example a press with a pressure ridge bar. With regard to the size and material of the tubes even hand drive is convenient.

[0026] If the forming device is set as described above in an example of embodiment, eight pairs of direct dimples **41** arranged in parallel against each other and mutually shifted at distance **p** are led into the tube from the top as well as from the bottom. In case a longer tube **4** is manufactured, the upper forming plate **2** moves up after the stroke of the pressure bar. The workpiece grip **32** of the stabilizer **3** is released and moves along the guide bar so that a new row of prepared deformations can extend the previous row. At the same time it is possible to maintain the position of the tube **4** without rotating it around its axis and form other direct dimples on the same plane surfaces, alternatively i tis possible to shift the tube **4** in the workpiece grip **32** by any desired angle and form another row of direct dimples on shifted plane surfaces which are parallel to each other.

[0027] The main advantage is simplicity of the forming device and relatively high productivity of labour. It is also possible to make alterations to the arrangement of protrusions around the axis of the tube **4** rotation, their pitches and the angle α of the slope of their direction with respect to the longitudinal axis of the tube **4** by means of a guide bar **31**. By effortless replacement of the die elements **12** it is possible to modify the shape of the protrusions.

List of references

[0028]

1	lower forming plate
11	top surface (of lower forming plate)
111	guide holes (for pins of die elements)
112	fastening hole (for fastening bolt of die elements)
113	hole (for guide bolt in lower forming plate)
12	die element
120	axis of row of die elements
121	fastening portion (of die element)

(continued)

122	moulding portion (of die element)
13	guide bolt
131	spiral-shaped spring
14	holder (of stabilizer)
15	bottom surface (of lower forming plate)
2	upper forming plate
21	guide hole (for guide bolts)
22	threaded hole (for adjusting screw)
23	adjusting screw
231	head (of adjusting screw)
24	bottom surface (of upper forming plate)
25	top surface (of upper forming plate)
3	hand-held stabilizer
31	guide bar (of stabilizer)
311	through hole (of guide bar)
32	workpiece grip
321	gripping device (of workpiece)
4	tube
41	dimple (in tube)
p	shift (of die elements of the first and second forming plate - mutual)
p1	distance (of the centre of the first die element from the left edge of the lower forming plate)
p2	distance (of the centre of the first die element from the left edge of the upper forming plate)
α	slope angle (of die element with respect to axis of row of die elements)

Claims

1. A forming device for carrying out controlled deformation of tubes, especially tubes (4) of heat exchangers, placeable between the table and pressure bar of the mechanical press, which comprises a lower forming plate (1) and an upper forming plate (2), which are coupled by guide devices, and die elements (12) arranged on mutually counter surfaces (11, 24) of the lower forming plate (1) and the upper forming plate (2), **characterized in that** the die elements (12) are coupled to the corresponding forming plate (1, 2) in an demountable and adjustable manner, whereas the forming plates (1, 2) being coupled to devices for adjusting the position of the processed tube (4) with respect to the forming plates (1, 2) along the longitudinal axis of the tube (4) and in the direction of shifting the tube (4) round its longitudinal axis, and to means that secures the tube (4) in the set position.

2. The forming device according to claim 1, **characterized in that** the die elements (12) are mounted to a correspondong forming plate (1, 2) at mutually equal distances.

3. The forming device according to claim 1, **characterized in that** the die elements (12) are mounted to a correspondong forming plate (1, 2) at mutually different distances.

4. The forming device according to any of the preceding claims, **characterized in that** at least one forming plate (2) comprises an adjustable stop device defining mutual distance of the forming plates (1, 2) at the end of the moulding stroke.

5. The forming device according to any of the preceding claims, **characterized in that** it comprises a spring device arranged between the forming plates (1,2), the force of which is induced in direction against their approaching each other.

6. The forming device according to Claim 5, **characterized in that** the spring device is at least one pressure spiral-shaped spring (131).

7. The forming device according to Claim 6, **characterized in that** the spiral-shaped spring (131) is coupled to a guide

device.

8. The forming device according to any of the preceding claims, **characterized in that** the die elements (12) connected to the lower forming plate (1) differ by the profile of their moulding portion (122) from the die elements (12) connected to the upper forming plate (2).

9. The forming device according to any of the preceding claims, **characterized in that** the die elements (12) connected to one forming plate (1, 2) differ from each other by the profile of their moulding portion (122).

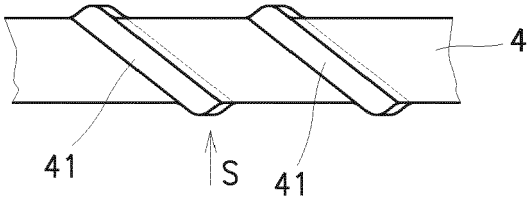

Fig. 1a

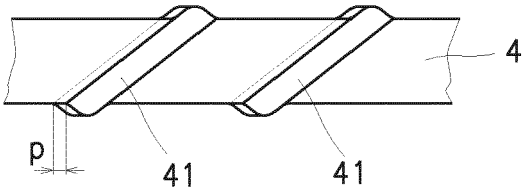

Fig. 1b

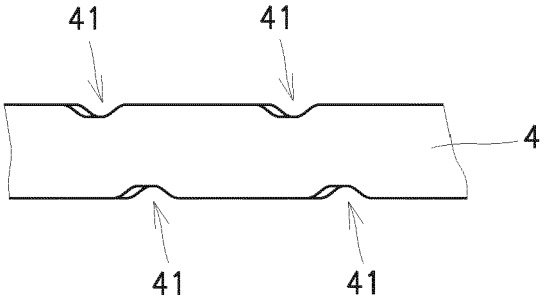

Fig. 2

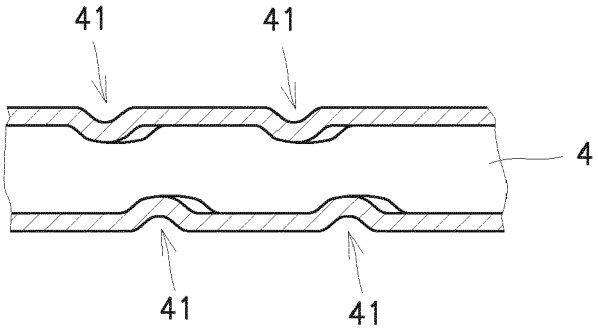

Fig. 3

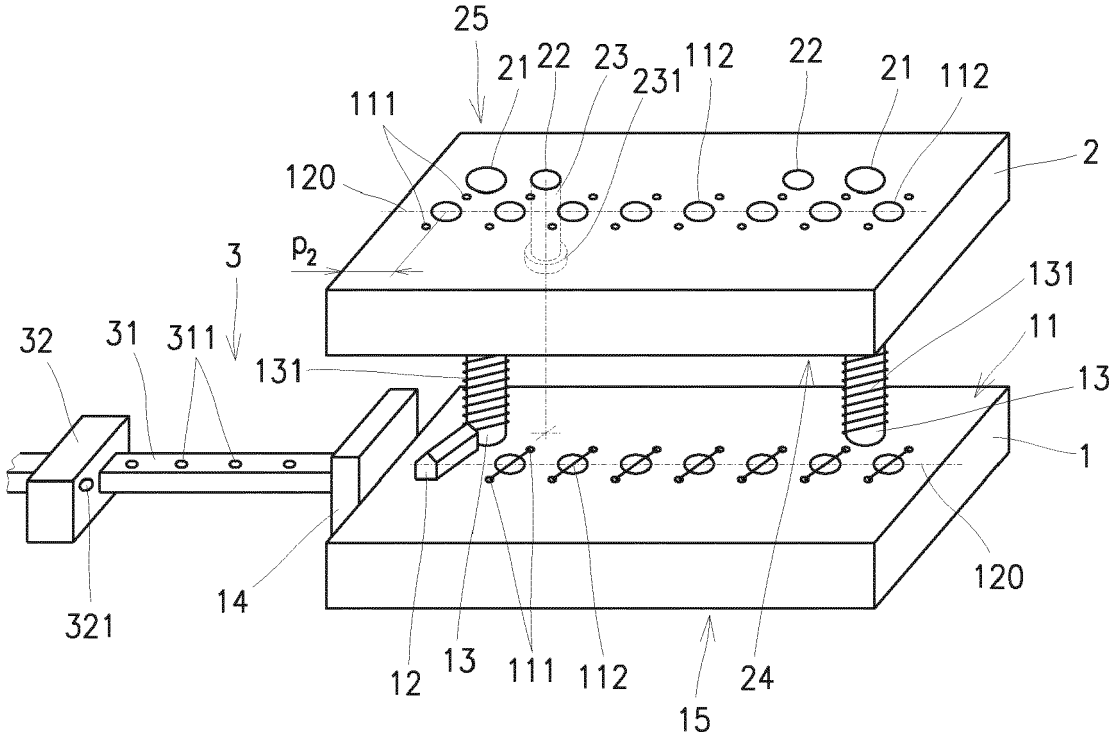
25
21
22
23
231
112
22
21
112
111
120
2
p_2
3
131
11
13
1
32
31
311
131
321
14
120
12
13
111
112
24
15

Fig. 4

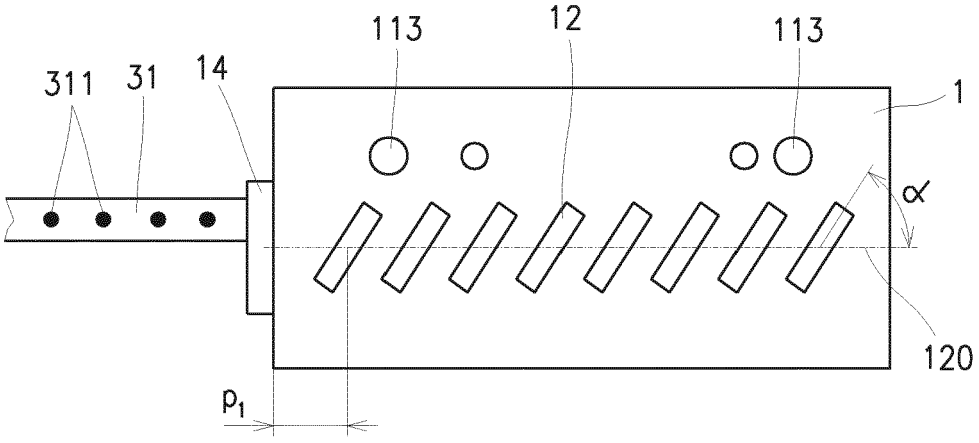
113
12
113
311
31
14
1
α
120
p_1

Fig. 5

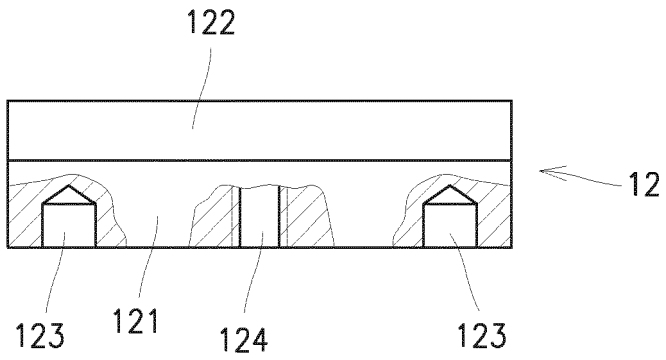

Fig. 6a

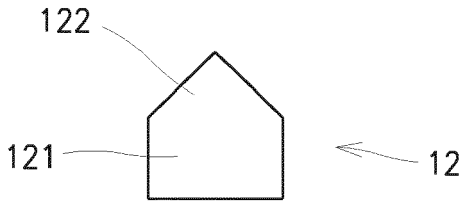

Fig. 6b

REFERENCES CITED IN THE DESCRIPTION

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