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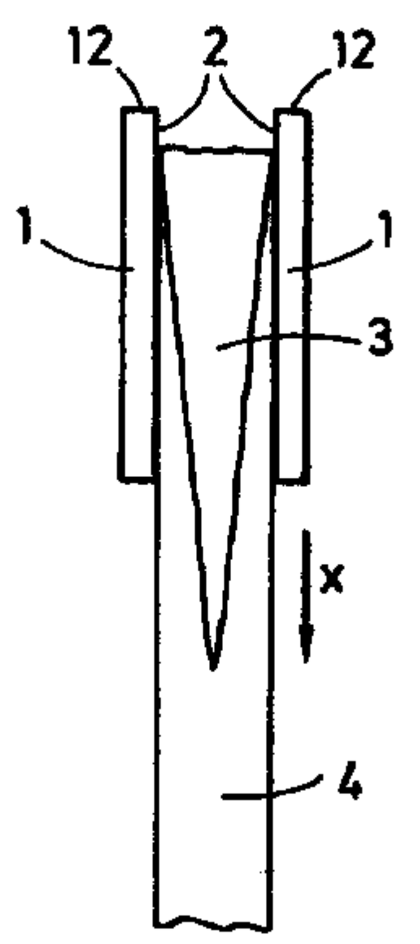
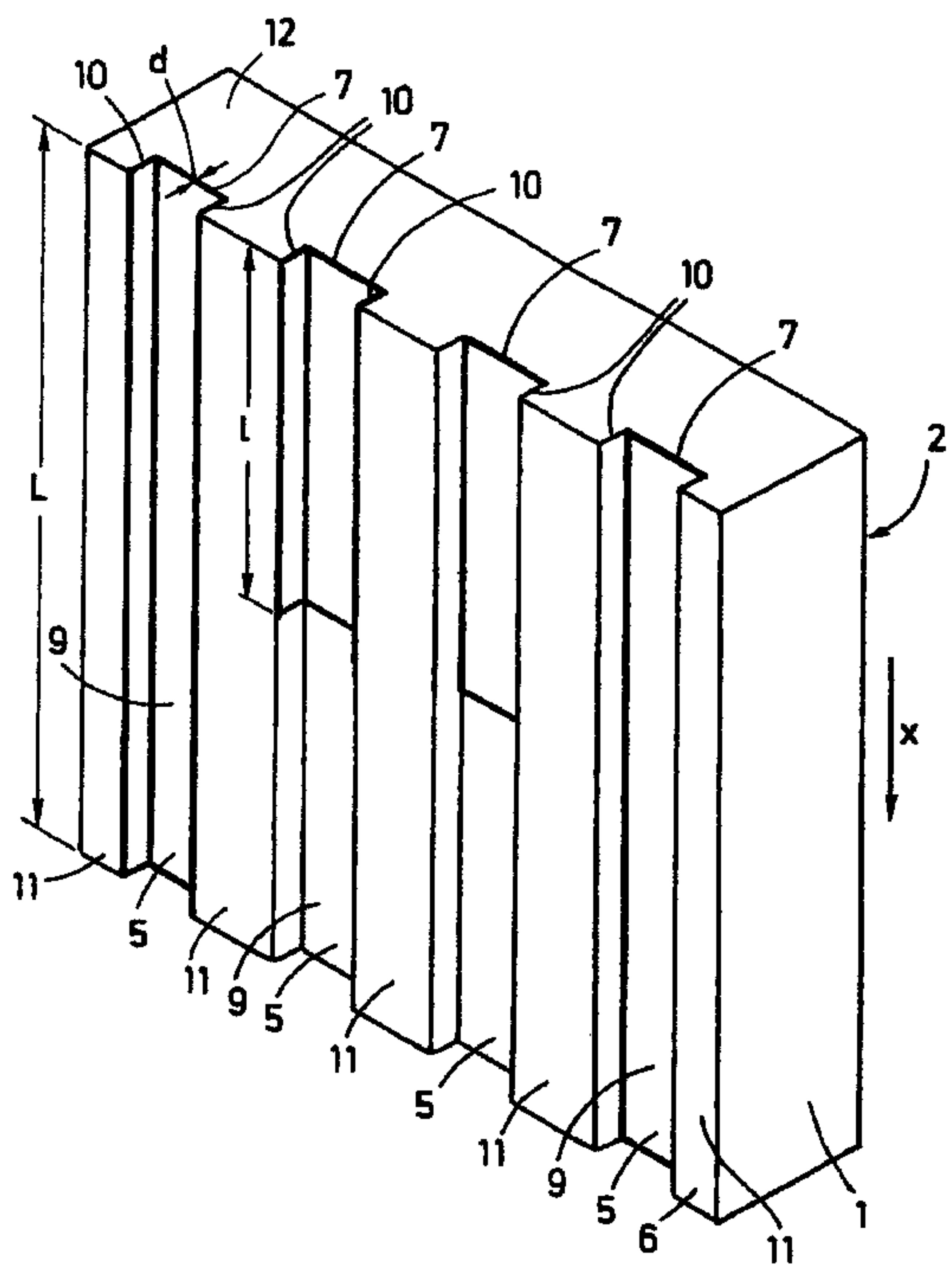
(54) Title: MOLD PLATE OF A CONTINUOUS CASTING PLANT





(57) Abrégé/Abstract:
The invention relates to a mould plate of a continuous casting plant. Said mould plate consists of copper and comprises a working surface (2) which faces a metal melt (3) or a (partially) solidified metal strand when the continuous casting plant is in operation and at least one cooling surface (5, 5') which is in contact with a cooling medium when the continuous casting plant is in operation. The mould plate has a heat conductivity (W) and extends over a mould length (L) in the direction of casting (x). According to the invention, a layer (7) with a heat conductivity (S) which is less than the plate heat conductivity (W) of the mould plate is applied to the cooling surface (5, 5') in at least one partial area.

ABSTRACT

The invention relates to a mould plate of a continuous casting plant. Said mould plate consists of copper and comprises a working surface (2) which faces a metal melt (3) or a (partially) solidified metal strand when the continuous casting plant is in operation and at least one cooling surface (5, 5') which is in contact with a cooling medium when the continuous casting plant is in operation. The mould plate has a heat conductivity (W) and extends over a mould length (L) in the direction of casting (x). According to the invention, a layer (7) with a heat conductivity (S) which is less than the plate heat conductivity (W) of the mould plate is applied to the cooling surface (5, 5') in at least one partial area.

Translated Text of WO 00/29146 (PCT/EP99/08442) with Amended Pages and Claims Incorporated Therein

Mold Plate of a Continuous Casting Plant

The present invention relates to a mold plate of copper for a continuous casting plant, comprising a working surface facing a metal melt or a (partially) solidified metal strand during operation of the continuous casting plant and comprising at least one cooling surface contacting a cooling medium during operation of the continuous casting plant, wherein the mold plate has a heat conductivity and extends along a mold length in the casting direction.

Such a mold plate is known, for example, from EP 0 149 734 B1. The mold plates have in their upper area a reduced heat conductivity and a greater thermal resistance than in the lower area.

When casting metal, in particular, steel, by continuous casting, a high wear occurs on the mold plates. Accordingly, the working surface of the mold plate must be refinished from time to time after a number of ladles which number depends on the conditions of use of the mold plate. When doing so, the thickness of the mold plate continuously decreases.

In order to cast high-quality steel strands, the temperature of the working surface must be within a predetermined range. Moreover, the thickness of the mold plate must be within a permissible thickness range which is greater than the minimum thickness required for mechanical reasons.

The application of layers, in particular, of nickel layers, onto mold plates as such is already known. For example, reference is being had to WO 97/12708 and Herrmann, "Handbook on Continuous Casting", Aluminium-Verlag, Düsseldorf, 1980. In the prior art, a nickel layer is however applied to the working surface of the mold plate. It serves primarily for reducing the mold wear during continuous casting.

It is an object of the present invention to develop a mold plate of the aforementioned kind such that it can be refinished more often than was possible in the past when a minimally permissible copper wall thickness has already been reached.

This object is solved in that onto the cooling surface at least in one portion thereof a layer with a heat conductivity is applied and in that the layer heat conductivity of the layer is smaller than the heat conductivity of the mold plate, that the layer is substantially comprised of nickel, and that the layer is a layer that is applied currentless onto the cooling surface in a nickel bath.

It is particularly advantageous when the layer is comprised substantially of nickel because the thermal expansion coefficient of nickel is smaller than the thermal expansion coefficient of a conventional mold plate of copper. The nickel layer is preferably deposited currentless onto the cooling surface of the mold plate in a nickel bath with additives. This is so because in this situation, contour-sharp coatings of the cooling surface are possible. Moreover, the layer thickness is very uniform and the heat conductivity of the layer is considerably smaller than that of nickel applied by electroplating. Independent of the coating process, the layer heat conductivity should be maximally 10 % of the heat conductivity of the copper of the mold plate.

The insulating properties of the layer are even better when the layer is comprised of five to twenty percent of phosphorus and otherwise - aside from contaminants - of nickel. This is so because in this case, the layer heat conductivity is less than 3 % of the heat conductivity of the mold plate made of copper.

The cooling surface can be formed as a cooling groove arranged on a back side that is located opposite the working surface or a cooling bore closed relative to the back side that is located opposite the working surface.

The cooling groove has a bottom surface and sidewalls. The layer can be applied only onto the bottom surface and/or also onto the sidewalls, as desired.
When the layer extends from an upper edge, viewed in the casting direction, across a layer length and the layer length is smaller than the mold length, the temperature distribution across the mold length can be influenced. The layer length is at least 100 mm, preferably between 300 mm and 500 mm. Alternatively, the layer can also extend over the entire mold length.

Further advantages and details result from the following description of an embodiment in connection with the drawings. In a basic illustration, it is shown in:

Fig. 1 a continuous casting mold in operation;

Fig. 2 a detail of the mold plate with cooling elements;

Fig. 3 a coating method; and

Fig. 4 a further detail of the mold plate with cooling bores.

According to Fig. 1, a continuous casting plant has mold plates 1 made of copper. Each mold plate 1 has a working surface 2 which extends in the casting direction x across a mold length L. During operation of the continuous casting plant, a metal melt 3, in general, a steel melt, is located between the working surfaces 2. The metal melt 3 solidifies gradually to a metal strand 4 which is removed in the casting direction x from the mold plates 1.

For a controlled solidification of the metal melt 3 to a metal strand 4, a considerable energy quantity, the so-called casting heat, must be removed via the mold plates 1. For the purpose of removing the casting heat, the mold plates 1 have according to Fig. 2 cooling surfaces 5 which contact a cooling medium, for example, water (not illustrated) during operation of the continuous casting mold. The cooling surfaces 5 are arranged on the backside 6 which is positioned opposite the working surface 2. They are open toward the backside 6. They are moreover formed as cooling grooves 5.

As already mentioned, the mold plate 1 is comprised of copper. It has therefore a high heat conductivity W of, for example, approximately 377 W/mK. In order to impart to the mold plate 1 a greater thermal resistance, or a reduced total heat conductivity, a layer 7 is applied onto the cooling surfaces 5. This layer 7 has a heat conductivity S which is considerably smaller than the heat conductivity W of the copper plate.

According to the embodiment, the layer 7 is comprised substantially of nickel, having a phosphorus contents of 5 % to 20 %. Preferably, the phosphorus contents is between 9 % and 14 %, for example, 10 % to 12 %. The heat conductivity of the layer can be further reduced in that, in addition to the phosphorus added to the nickel bath, also up to 30 % silicon carbide is added. Otherwise, the layer 7 contains only minimal contaminants.

Preferably, the layer 7, as illustrated schematically in Fig. 3, is applied in that the mold plate 1 is introduced into a nickel bath 8. Here, the layer 7 is applied currentless onto the cooling surfaces 5. Such a nickel layer 7 has a layer heat conductivity S which is, for example, approximately only 5 W/mK.

The layer 7 has a layer thickness d which is, of course, dependent on the residence time of the mold plate 1 in the nickel bath 8. By means of conventional nickel baths 8 layer thicknesses d that are between 40 μm and 80 μm, for example, 60 μm, can be applied to the coating surfaces 5. In a special nickel bath 8 it is however also possible to apply a layer 7 having a layer thickness d of up to 200 μm.

In principle, it is also possible to coat the backside 6 completely. Technically, this is the simplest approach. However, it is also possible to provide the backside 6, before it is being coated with a layer 7, with a protective layer and to apply the nickel layer 7 only onto the portions that are not covered.

For example, the cooling grooves 5 have bottom surfaces 9 and sidewalls 10 while between the cooling grooves 5 stays 11 are arranged. It is, for example, possible to apply the layer 7 only onto the bottom surfaces 9. However, it is also possible to apply the layer 7 onto the bottom surfaces 9 and the sidewalls 10. Finally, it is also possible to apply the layer 7 over the entire surface area, i.e., onto the bottom surfaces 9 and the sidewalls 10 of the cooling grooves 5 as well as onto the intermediately positioned stays 11. According to Fig. 2, the two left cooling grooves 5 are completely coated while only the bottom surfaces 9 of the two right cooling grooves 5 are coated.

It is furthermore possible that the layer 7 extends over the entire mold length L. This is the case for the outer cooling channels in Fig. 2. Alternatively, the layer 7 can extend from the upper edge 12 only across a layer length l when viewed in the casting direction x, wherein the length l is smaller than the mold length L. The layer length l is preferably between 300 mm and 500 mm, at least however 100 mm. This is the case for the inner cooling channels in Fig. 2.

The mold plate 1 according to Fig. 4 differs from the mold plate 1 according to Fig. 2 in that, instead of the cooling grooves 5 which are open toward the backside 6, cooling bores 5' are provided. In this case, the cooling bores 5' are also provided with the layer 7 wherein, as before, alternatively a complete or only a partial coating over the length of the cooling bores 5' is possible.

List of Reference Numerals

1	mold plate
2	working surface
3	metal melt
4	metal strand
5	cooling surfaces/cooling grooves
5'	cooling surfaces/cooling bores
6	backside
7	layer
8	nickel bath
9	bottom surface
10	sidewalls
11	stays
12	upper edge
d	layer thickness
l, L	lengths
N, S, W	conductivities
x	casting direction

Claims

1. Mold plate (1) of copper of a continuous casting plant, comprising a working surface (2) facing during operation of the continuous casting plant a metal melt (3) or a (partially) solidified metal strand (4) and at least one cooling surface (5, 5') contacting during operation of the continuous casting plant a cooling medium, wherein the mold plate has a heat conductivity (W) and extends in a casting direction (x) across a mold length (L),
characterized in
that on the cooling surface (5, 5'), at least on one portion, a layer (7) with a layer heat conductivity (S) is applied and in that the heat conductivity (S) of the layer (7) is smaller than the heat conductivity (W) of the mold plate (1), in that the layer (7) is substantially comprised of nickel, and in that the layer (7) is a layer (7) applied currentless onto the cooling surface (5, 5') in a nickel bath (8).

2. Mold plate according to claim 1,
characterized in
that the layer (7) is comprised of five to twenty percent of phosphorus and otherwise - aside from minimal contaminants - is comprised of nickel.

3. Mold plate according to one of the preceding claims 1 or 2,
characterized in
that the layer (7) is comprised of between five and twenty percent phosphorus, up to 30 volume percent silicon carbide, and otherwise - aside from minimal contaminants - of nickel.

4. Mold plate according to one of the preceding claims 1 to 3, characterized in that the layer (7) has a layer thickness (d) under 200 μm, in particular, between 40 μm and 80 μm.

5. Mold plate according to one of the preceding claims 1 to 3, characterized in that the cooling surface (5) is formed as a cooling groove (5) arranged on a backside (6) positioned opposite the working surface (2) and that the cooling groove is coated on all sides.

6. Mold plate according to one of the preceding claims 1 to 4, characterized in that the cooling groove (5) has a bottom surface (9) and sidewalls (10) and that the layer (7) is applied only onto the bottom surface (9).

7. Mold plate according to one of the preceding claims 1 to 4, characterized in that the cooling surface (5') is a cooling bore (5') closed relative to the backside (6) that is positioned opposite the working surface (2).

8. Mold plate according to one of the preceding claims 1 to 7, characterized in that the layer (7) extends from an upper edge (12), viewed in the casting direction (x), across a layer length (l) and that the layer length (l) is smaller than the mold length (L).

9. Mold plate according to claim 8, characterized in that the layer length (l) is at least 100 mm, preferably between 300 mm and 500 mm.

10. Mold plate according to one of the claims 1 to 7, characterized in that the layer (7) extends across the entire mold length (L).

Fig. 1

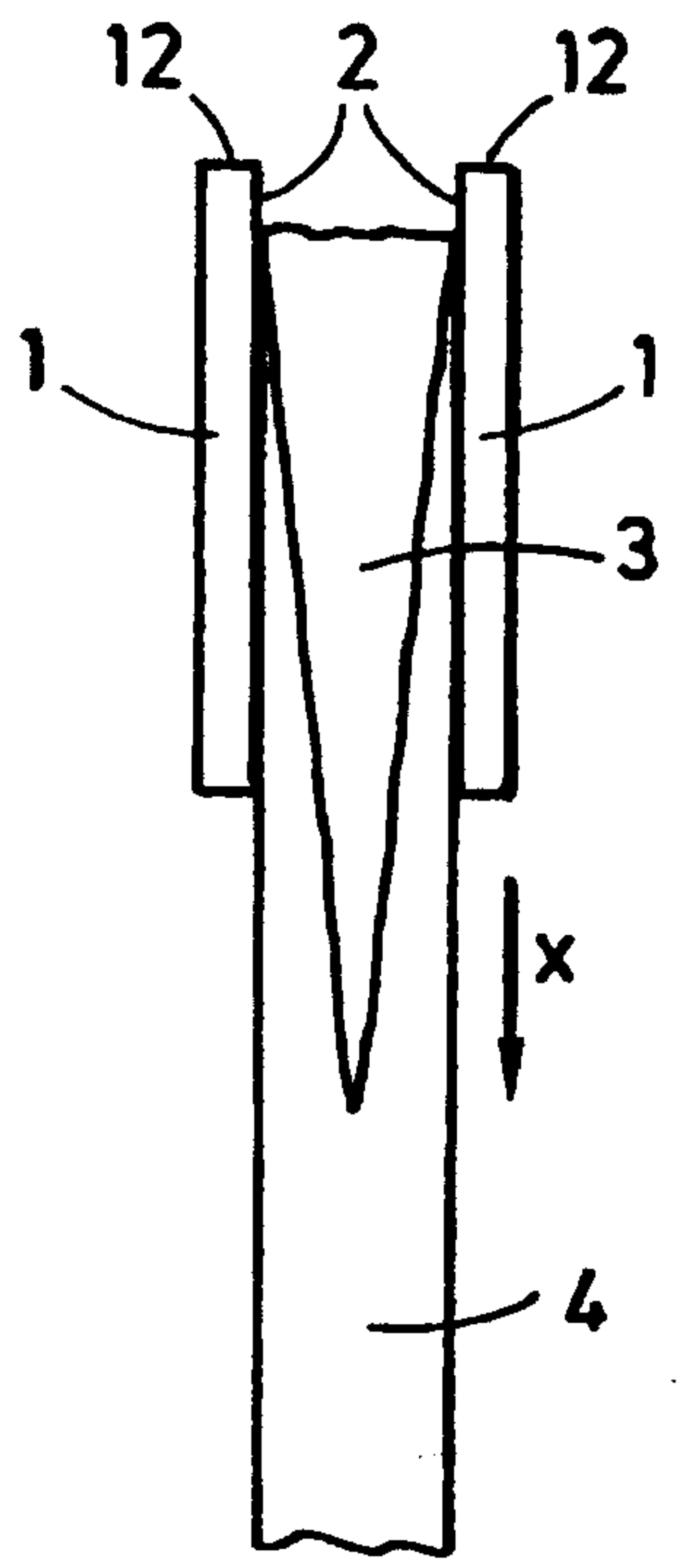


Fig. 3

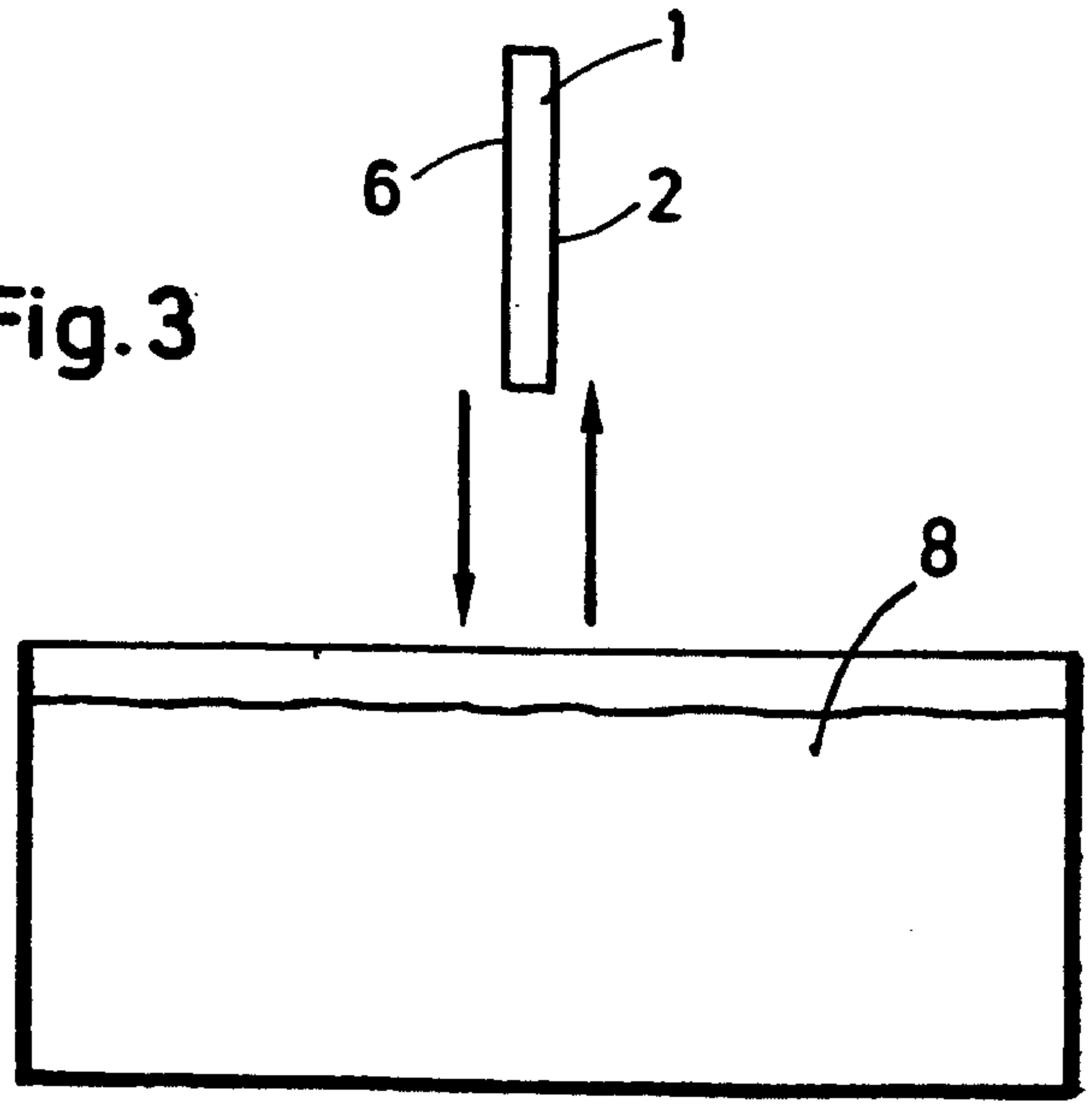


Fig. 2

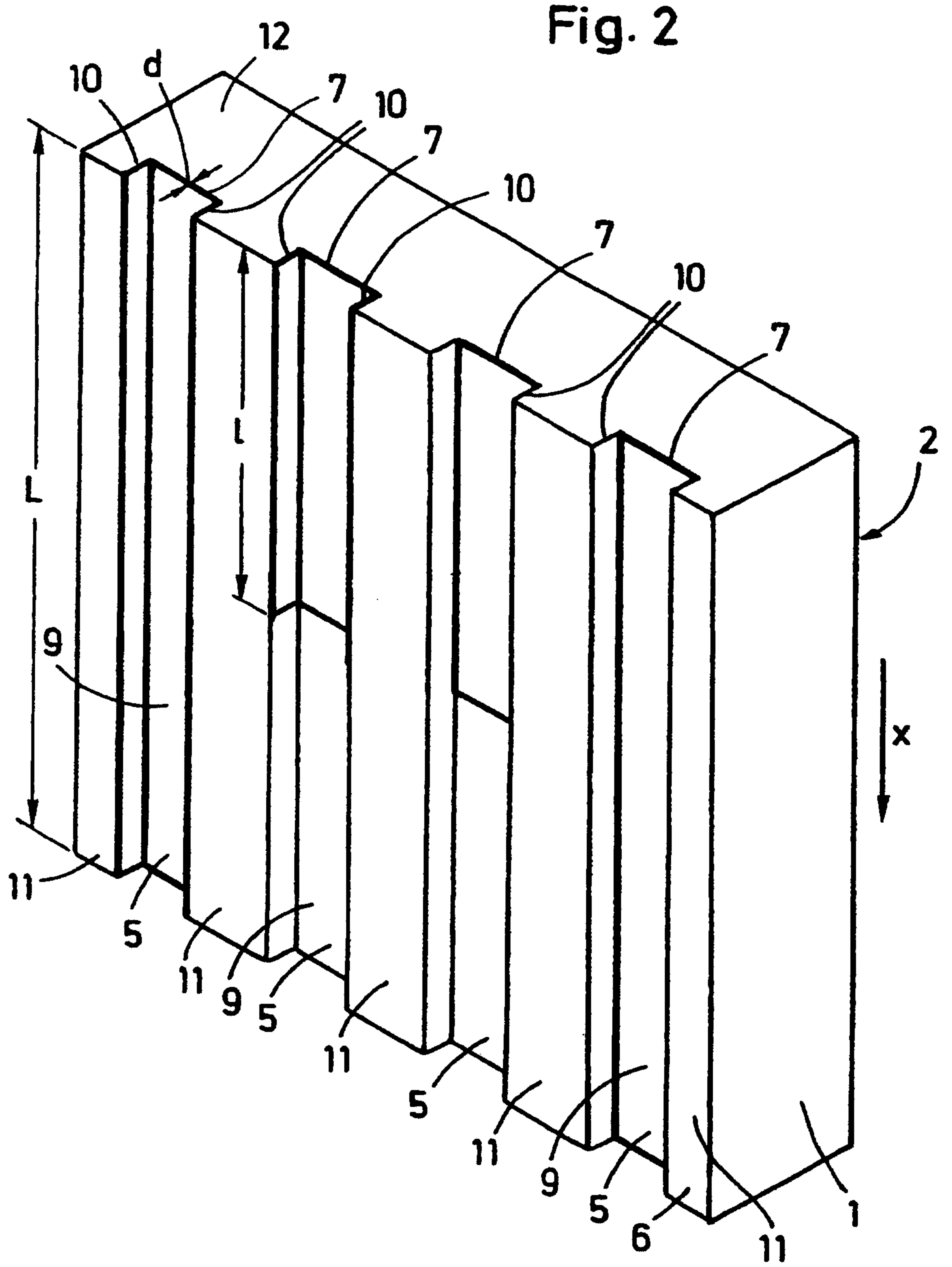
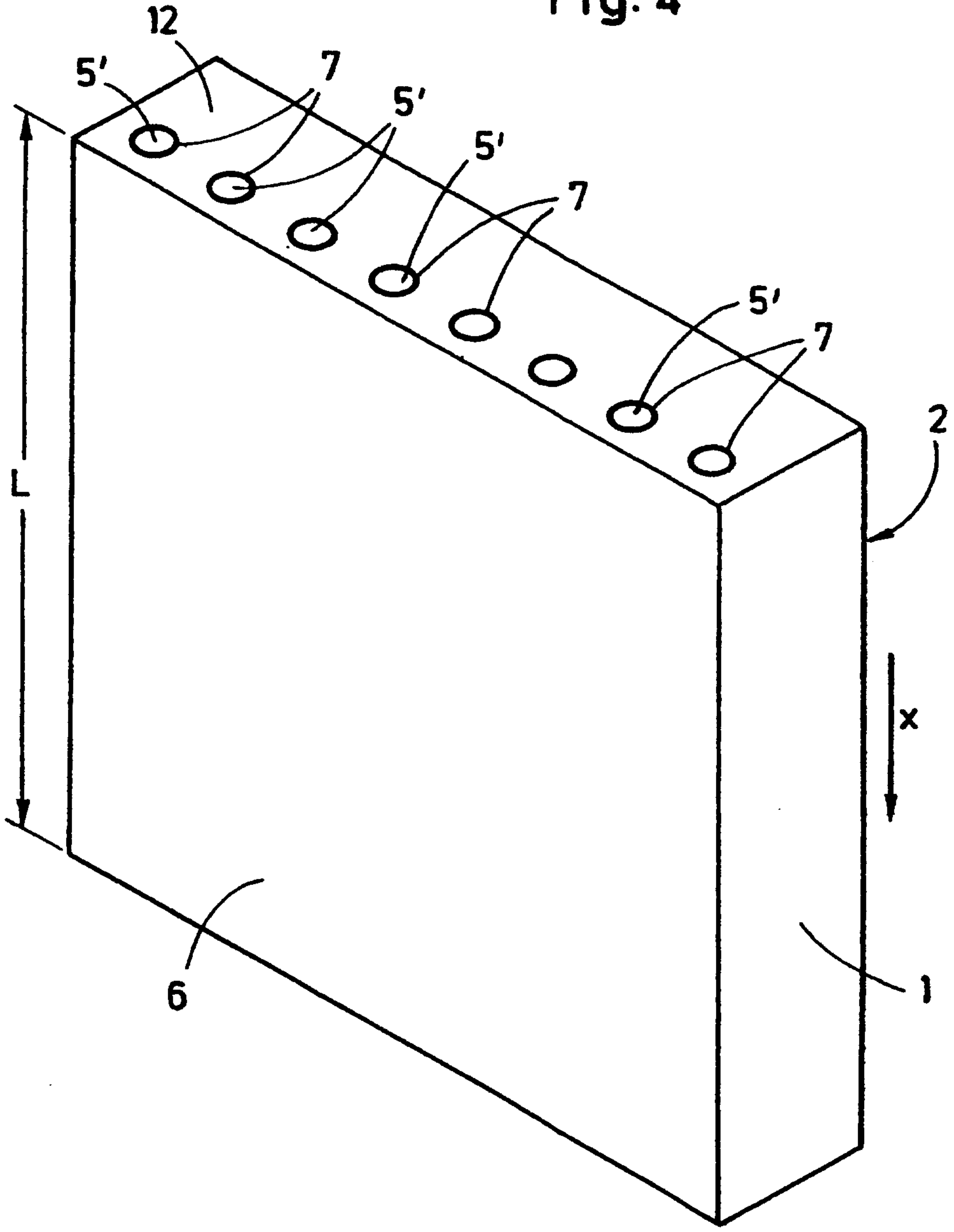
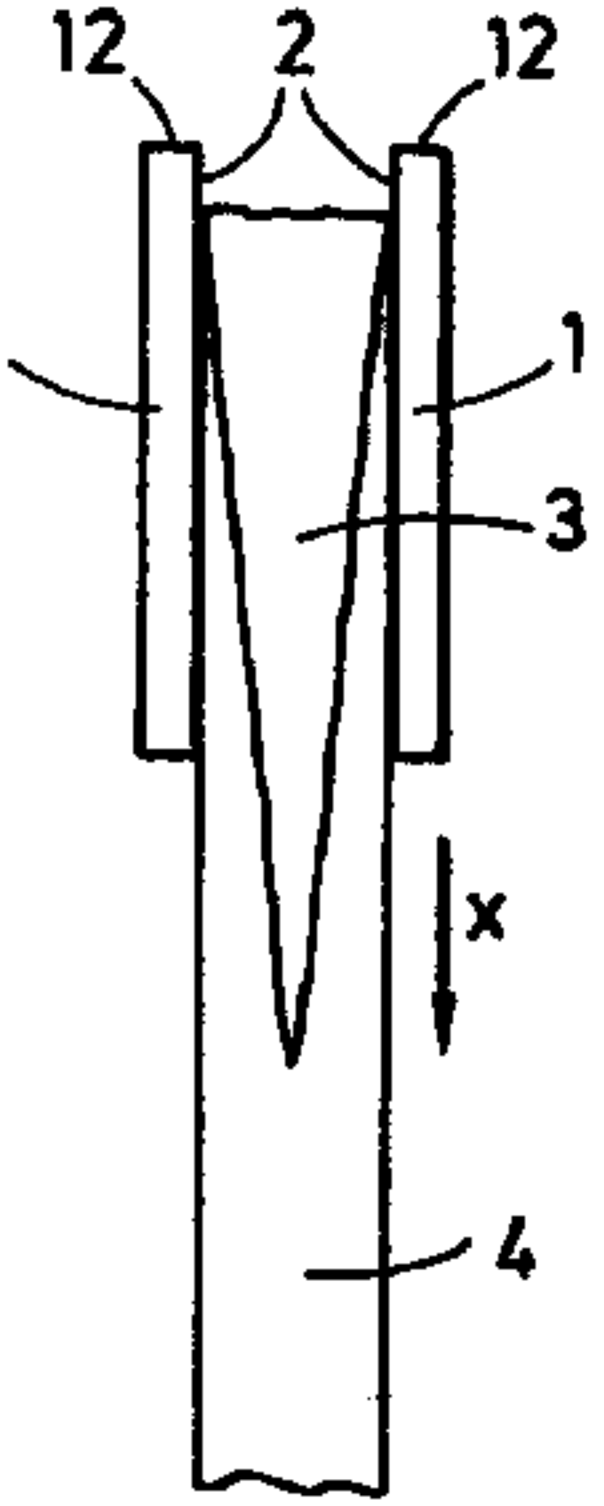


Fig. 4

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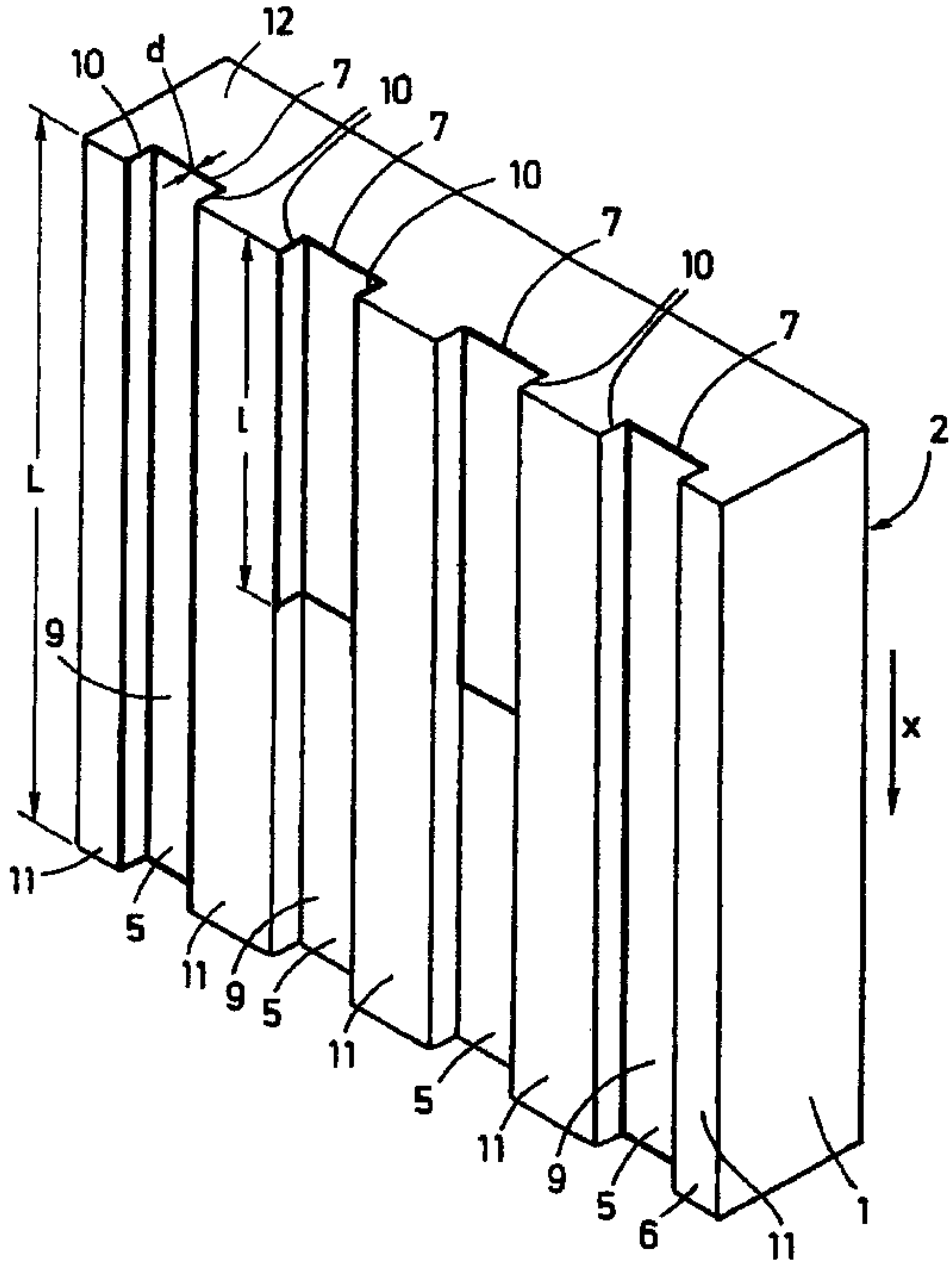
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