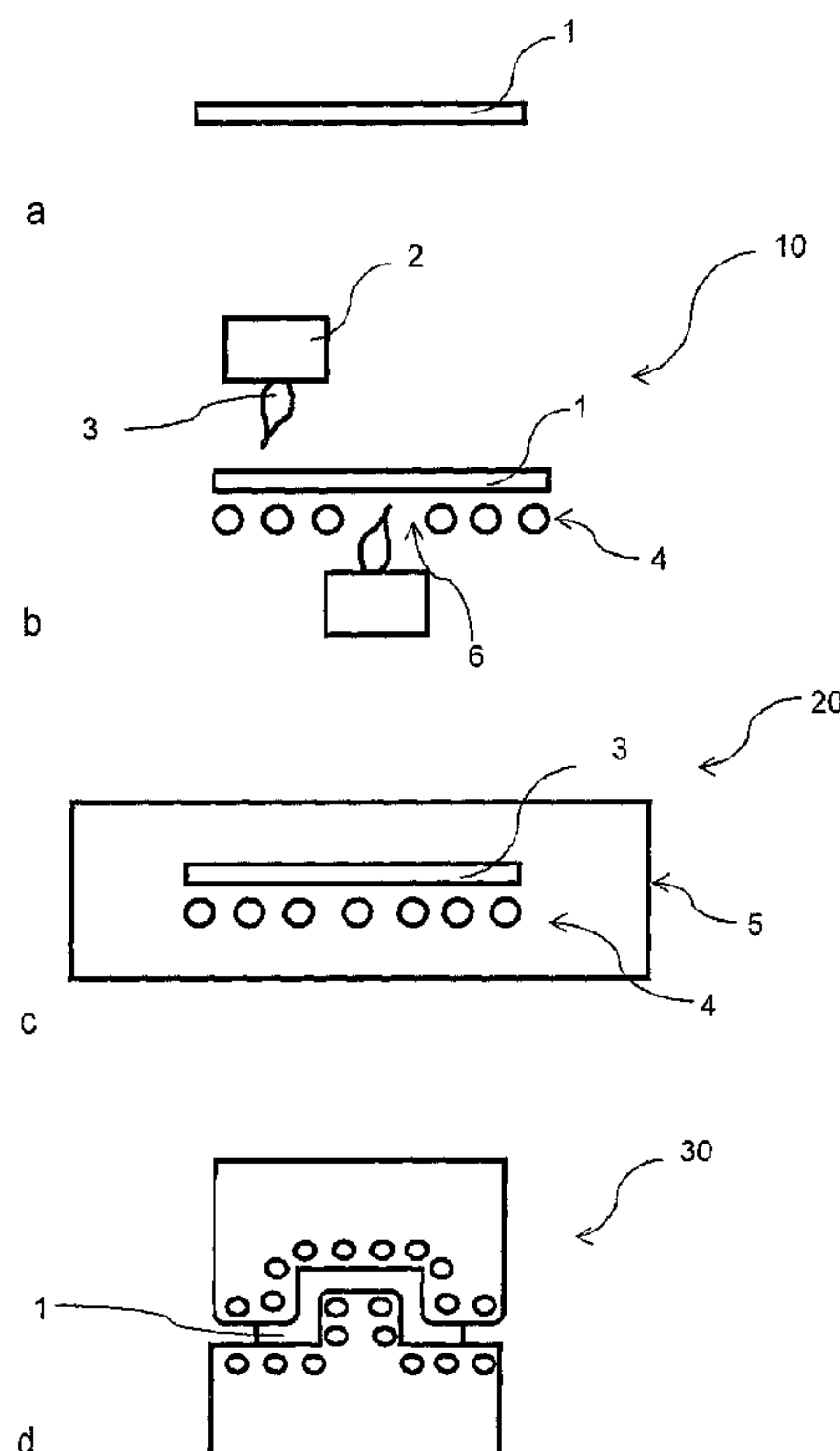




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(54) **Titre : PROCÉDE DE FORMAGE A CHAUD OU A BASSE TEMPERATURE D'UNE PIECE ET INSTALLATION DE PRODUCTION POUR LE FORMAGE A CHAUD OU A BASSE TEMPERATURE D'UNE PIECE**
(54) **Title: METHOD FOR HOT OR WARM FORMING A WORKPIECE AND PRODUCTION PLANT FOR HOT OR WARM FORMING A WORKPIECE**



(57) **Abrégé/Abstract:**

The disclosure relates to a method for hot or warm forming of a workpiece, comprising the following steps: providing of the workpiece to be formed, at least partial pretreating of the workpiece, at least partial heating of the workpiece to a target temperature and at least partial forming and/or hardening of the workpiece, wherein the workpiece is at least partially cleaned in a cleaning step between the pretreating and the heating of the workpiece.

ABSTRACT

The disclosure relates to a method for hot or warm forming of a workpiece, comprising the following steps: providing of the workpiece to be formed, at least partial pretreating of the workpiece, at least partial heating of the workpiece to a target temperature and at least partial forming and/or hardening of the workpiece, wherein the workpiece is at least partially cleaned in a cleaning step between the pretreating and the heating of the workpiece.

Method for hot or warm forming a workpiece and production plant for hot or warm forming a workpiece

Technical Field

The present disclosure concerns a method for hot or warm forming of a workpiece and a production plant for hot or warm forming of a workpiece.

Background

In hot and warm forming, uncoated or coated materials are generally used. To avoid corrosion during transport, a semifabricated piece in the form of a coil or a sheet can be provided partially, preferably entirely, with a corrosion protection oil or with lubricants. In addition, a contamination with dust or the like, especially in a coil or sheet warehouse, can likewise hardly be avoided as a rule.

Caused by thermal processes which occur upon reaching the desired temperature for the tempering process, a thermal decomposition of the substances which have been deposited on the semifabricated piece occurs. As a result of this thermal decomposition, contaminants remain on the semifabricated piece, which in turn reduce the quality of the fabricated semifabricated piece. A mechanical cleaning, such as by shot blasting, cannot always entirely remove the residues which occur, or it may in particular impair semifabricated pieces which are coated. Furthermore, large oil residues, such as those due to a large oil film, may lead to an intensified hydrogen absorption in the material during the processing of the semifinished piece. This may result in material embrittlement on account of the high strength. In the case of a micro-oiling, this behavior is not found, but then no adequate corrosion protection can be assured.

Summary

One object of selected embodiments is to provide a method for hot or warm forming of a workpiece with which the quality of the piece fabricated by the hot or warm forming is further improved beyond that of the prior art.

An exemplary embodiment provides a method for hot or warm forming of a workpiece, comprising the following method steps:

- providing of the workpiece,
- at least partial pretreating of the workpiece,
- at least partial heating of the workpiece to a target temperature in a heating station and
- at least partial forming and/or hardening of the workpiece,

wherein the workpiece is at least partially cleaned in a cleaning step between the pretreating and the heating of the workpiece.

Another exemplary embodiment provides a method for hot or warm forming of a workpiece, comprising the following steps: providing of the workpiece, at least partial pretreating of the workpiece, wherein the workpiece is coated with a protective material and/or coated with a corrosion protection oil or with a lubricant or cutting oil, at least partial heating of the workpiece to a target temperature in a heating station and at least partial forming and/or hardening of the workpiece, wherein the workpiece is at least partially cleaned in a cleaning step between the pretreating and the heating of the workpiece, characterized in that the workpiece in the cleaning step is at least partially thermally treated, wherein the workpiece in the cleaning step is heated by a burner to a cleaning temperature.

In another embodiment there is provided a production plant for hot or warm forming of a workpiece, wherein the production plant comprises a clean-ing station for cleaning a workpiece, a heating station for heating the cleaned workpiece and a forming and/or hardening die for forming and/or hardening the heated workpiece, wherein the cleaning station is suitable for a thermal treatment, wherein the cleaning station comprises a burner.

As compared to the prior art, the workpiece is cleaned after the pretreating and before the heating for the forming and/or hardening and in particular is thereby freed of residues which have become deposited due to the pretreatment on the workpiece. In this way, the quality of the part fabricated after the forming of the workpiece is improved, since the likelihood of a depositing of contaminants which form from the residues during the heating of the workpiece and thus the likelihood of a permanent impairment of the workpiece is reduced. Furthermore, other contaminations such as dust can be removed from the workpiece in the cleaning step.

Preferably, it is provided that the cleaning step is done immediately before the heating. It is furthermore preferably provided that the workpiece as a finished part after the forming and/or hardening is a structural or chassis part of a motor vehicle. In particular, the workpiece is provided as a sheet metal piece, especially a flat metal sheet (direct hot forming) or a formed part having practically its final geometry (indirect hot forming), and the pretreatment is at least part of the manufacturing process for the sheet metal piece. Furthermore, it is preferably provided that the partial region of the workpiece which is supposed to be heated during the heating to the target temperature, preferably the entire workpiece, is specifically cleaned in the cleaning step. But it is also conceivable to clean specifically those partial regions of the workpiece for which an improved surface quality is desired on the finished part.

According to a further embodiment, it is provided that the workpiece in the cleaning step is at least partially chemically, mechanically and/or thermally treated. The chosen cleaning method is thereby preferably adapted to the workpiece such that the cleaning leaves the properties of the workpiece substantially unimpaired. In this way, one can advantageously ensure that no steps are taken with the cleaning step which endanger the quality of the subsequently fabricated part.

According to a further embodiment, it is provided that the workpiece in the cleaning step is at least partially cleaned in a cleaning bath. During this chemical treatment of the workpiece, the contaminants are advantageously bound in a liquid of the cleaning bath. It is conceivable that the liquid in the cleaning bath will be exchanged by bringing the liquid into the cleaning bath and draining it out once more, for example it is pumped in a liquid circuit into the cleaning bath and again pumped out from the cleaning bath. Thanks to the binding of the contaminants to the liquid, it is advantageously prevented that the contaminants spread via the air and become deposited for example on plant parts. Furthermore, it is conceivable that the wet workpiece will be dried, for example with hot air, before the heating.

According to a further embodiment, it is provided that the workpiece is in the cleaning step brushed. For this mechanical treatment in the cleaning step, it is conceivable that the workpiece is brought into contact with the brush and the workpiece is moved in the longitudinal direction, while the brush extends substantially along the transverse direction of the workpiece. In this way, the cleaning step can be advantageously integrated in the transport of the workpiece to the heating station, without the cleaning step occasioning any significant delay in

the hot or warm forming. It is also conceivable that the brush or a system of brushes are arranged at the entrance to the heating station and in this way the cleaning of the workpiece is provided immediately before the heating. Alternatively, it is conceivable that the workpiece is cleaned manually. In manual cleaning with a brush, residues visible to the naked eye can be advantageously removed without major additional effort.

According to a further embodiment, it is provided that the workpiece in the cleaning step is heated by a burner to a cleaning temperature. Preferably the workpiece is heated by one or more burners, preferably on both sides, especially all around and uniformly. It is conceivable that the burner is moved during the heating along the transverse direction or the longitudinal direction of the workpiece, preferably in oscillating manner. Thanks to the heating already done during the cleaning of the workpiece, relatively little heating energy is required to attain the target temperature in the heating station. Preferably the cleaning station with its burner is physically separate from the heating station in order to prevent contaminants which are present in the exhaust gases occurring during the heating to the cleaning temperature from depositing on the plant parts during the heating to the target temperature. But it is also conceivable that the cleaning step is carried out in the heating station by the burner responsible for the heating first heating the workpiece to the cleaning temperature and then to the target temperature, the target temperature being greater than the cleaning temperature. It is preferably provided that the air surrounding the workpiece is drawn off during the heating of the workpiece to a cleaning temperature, for example by means of an exhaust hood, in order to carry away the contaminants.

According to a further embodiment, it is provided that the workpiece is transported or moved during the cleaning step. In this way, the cleaning step can be advantageously integrated in the hot or warm forming of the workpiece such that potential delays due to the cleaning step are kept as short as possible. If the cleaning step involves a thermal treatment, it is conceivable that the workpiece is moved by a burner belt along the conveyance direction past a burner, with the burner heating the workpiece as it moves past it. In particular, the workpiece is moved with a conveying mechanism along a conveyance direction and in this process it passes in succession through the cleaning station, the heating station, and reaches the forming and/or hardening die.

According to a further embodiment, it is provided that the workpiece is transported from a cleaning station to a heating station between the cleaning step and the heating step. In the case of thermal cleaning, it is preferably provided that the transport path is covered in a shortest possible time in order to prevent the workpiece from cooling down again. In particular, it is conceivable that the conveying mechanism comprises heating elements which ensure that the workpiece basically maintains its cleaning temperature. Preferably, the workpiece is transported such that the workpiece does not become polluted or contaminated once more. In particular, the workpiece is moved with a conveying mechanism along a conveyance direction and thereby passes in succession through the cleaning station, the heating station, and reaches the forming and/or hardening die.

According to a further embodiment, it is provided that the workpiece is heated during the heating for the forming and/or hardening with an additional burner to the target temperature. Preferably, the target temperature chosen is a temperature between 600° C and 900° C. If a manganese-boron steel material is used preferably, it is preferably provided that the target temperature is reached above AC3, in order to transform the microstructure completely into austenite. If the target temperature lies below AC3 and above AC1, a mixed microstructure of austenite and ferrite is obtained. For example, it is provided that the speed with which the workpiece is heated to the cleaning temperature when using a burner is greater than the speed with which the workpiece is heated to the target temperature, especially when using a radiant furnace.

According to a further embodiment, it is provided that the workpiece is coated with a protective material and/or in particular it is coated at least partially with a corrosion protection oil in order to prevent corrosion during transport.

According to a further embodiment, it is provided that the burner and/or the additional burner is operated with a fuel gas and an oxygen-containing gas. Preferably, the heating power of the burner and/or the additional burner is adjusted by the mix ratio of the fuel gas and the oxygen-containing gas. In particular, an oxygen content is used to establish the maximum temperature in a burning flame of the burner and/or the additional burner. It is provided for example that a technical oxygen mixture is supplied to the additional burner wherein the oxygen content is preferably greater than 70% or especially preferably greater than 90%. Furthermore, it is provided that, in order to reach the target temperature with a desired speed at which the workpiece is heated, the distance between burner and workpiece, the oxygen content, and/or a conveying speed of the workpiece being transported along the conveyance direction are adjusted accordingly.

According to a further embodiment, it is provided that the workpiece is arranged in a forming/hardening die for the forming and/or hardening. Preferably, the forming/hardening die is at least partially cooled and thereby advantageously ensures, for example, a partial hardening of the workpiece.

According to a further embodiment, it is provided that the workpiece used is a flat metal sheet. For example, the workpiece is a workpiece fabricated substantially from a manganese-boron steel, especially 22MnB5, or it is a flat metal sheet with higher carbon content.

Another embodiment provides a production plant for hot or warm forming of a workpiece, especially for carrying out a method as described above, wherein the production plant comprises a cleaning station for cleaning a workpiece and a heating station for heating the cleaned workpiece.

As compared to the prior art, the production plant has the advantage that, as a result of the cleaning station, it can be ensured that possible residues from a pretreatment of the workpiece are removed and thus the quantity of potential contaminants which might impair the quality of the subsequently fabricated part is reduced in advantageously reduced.

According to a further embodiment, it is provided that the production plant comprises a conveying mechanism. With the conveying mechanism, the workpiece can be advantageously transported through the cleaning station and the heating station to the forming/hardening die. It is conceivable that the conveying mechanism comprises conveying rollers.

According to a further embodiment, it is provided that the cleaning station is structurally separate from the heating station. In this way, it can be advantageously ensured that the contaminants loosened by the heating of the workpiece to the cleaning temperature are distributed through the air and then become deposited on the plant parts of the heating station.

Further details, features and benefits of embodiments will emerge from the drawings as well as the following specification of preferred embodiments with the aid of the drawings. The drawings only illustrate sample embodiments which do not limit the notions of the invention.

Brief description of the figures

Figures 1a to 1d show a method for hot or warm forming of a workpiece according to a sample embodiment of the present invention.

Detailed Description

In the various figures, the same parts are always provided with the same reference number and therefore as a rule will respectively only be mentioned or designated once.

Figures 1a to 1d represent a method for hot or warm forming of a workpiece 1 according to a sample embodiment of the present invention. For example, this involves a structural or chassis part of a motor vehicle, the workpiece 1 being provided as a semifabricated part, especially in the form of a tailored rolled blank or a metal sheet as shown in Figure 1. The workpiece 1 consists, for example, of a material fabricated at least partially from a boron-manganese steel, especially 22MnB5. Thanks to the hot or warm forming, it is preferably provided that the workpiece 1 is converted into its final form as a component part. In order not to influence the properties and/or the form of the component fabricated afterwards, the workpiece 1 is subjected to a pretreatment. One example of such a pretreatment is the coating of the workpiece 1 with a corrosion protection oil or with a lubricant in order to prevent corrosion during the transport of the workpiece. Another example of the pretreatment is the application of a cutting oil to the workpiece 1 in order to facilitate a possible cutting of the sheet to size in advance of the hot or warm forming. Due to the pretreatment and other external circumstances, residues remain behind on the workpiece 1, such as those of the corrosion protection oil, the lubricant and/or the cutting oil. Upon heating of the workpiece 1 required for the hot or warm forming, these residues as contaminants would result in damage or impairment of the finished part, for example in the form of a material embrittlement. In order to avoid such impairment, it is provided that the pretreated workpiece 1 is cleaned, preferably directly before the

140419P10WO

heating of the workpiece 1 in a heating station 20, in a cleaning step. Preferably the cleaning step begins 60 seconds, preferably 20 seconds and especially preferably 5 seconds before the heating of the workpiece 1.

As an example of a cleaning step, the embodiment in Figures 1a to 1d shows in **Figure 1b** a thermal treatment in a cleaning station 10. In the present embodiment, the cleaning station 10 comprises a burner belt or roller conveyor 4, arranged underneath the workpiece 1 being delivered by the burner belt or roller conveyor 4. Furthermore, the cleaning station 10 preferably comprises a burner 2, which is arranged above and/or beneath the transportable workpiece 1. It is furthermore provided that the burner 2 heats the workpiece 1 to a cleaning temperature. For this, the burner 2 is operated in particular with a mixture of a burner gas and an oxygen-containing gas. Furthermore, when using a burner 2 for heating the workpiece 1 to the cleaning temperature, a burner flame 3 occurs which makes direct contact with the workpiece 1 in the cleaning station 10, for example, or which is held at a distance from the workpiece. In particular, the burner belt or roller conveyor 4 has a recess 6 in one position so that the burner flame 3 can heat the workpiece 1 unhindered. Furthermore, it is provided that the workpiece 1 is heated on both sides by one burner 2 apiece, in order to free as much of the surface of the workpiece 1 as possible from residues. It is conceivable that the burner 2 is moved along a direction running perpendicular to a conveyance direction of the burner belt or roller conveyor 4, preferably in oscillating manner, in order to realize by this motion the heating along a transverse dimension of the workpiece 1. In particular, it is conceivable that the cleaning temperature is adjusted or realized by the determination of a conveyance speed with which the workpiece 1 is delivered by the burner belt or roller conveyor 4, the determination of a distance of the burner 2 from the workpiece 1 and/or by the determination of an oxygen content of the oxygen-containing gas mixed in with the fuel gas. Furthermore, it is preferably provided that the burner flame 3 of the burner 2 in the cleaning station 10 heats the workpiece 1 homogeneously, i.e., uniformly along the surface. Furthermore, it is conceivable that the cleaning station 10 comprises an exhaust air system in order to carry away the pollution gases arising during the thermal treatment by the exhaust air system. In this way, it is possible to prevent the pollutants contained in the pollution gas from being deposited on the plant parts of the cleaning station 10. In order to further prevent the pollutants contained in the pollution gas from being deposited on plant parts which are situated for example in a heating station 20, the cleaning station 10 in the depicted embodiment is structurally separate from the heating station 20, as shown in Figure 1c.

Figure 1c shows a heating station 20 in the form of a furnace 5, the workpiece 1 being arranged for the heating inside the preferably enclosed furnace 5. In particular, it is provided that the target temperature is greater than the cleaning temperature. Furthermore, it is provided that the workpiece 1 is heated in the heating station 20 with an additional burner or by radiant heating, the additional burner being operated preferably with a mixture of a fuel gas and an oxygen-containing gas. In particular, the additional burner in the heating station 20 is operated with a technical-grade oxygen whose oxygen content is preferably greater than 75 %, especially preferably greater than 90%. For example, the heating in the heating station 20 can be used to adjust material properties of the component fabricated afterwards. For example, the workpiece 1 is specifically heated in at least a first region to a temperature below AC3, especially below AC1, in order to avoid a complete austenitization and/or at least in a second region to a temperature above AC3, in order to bring about an austenitization. It is also conceivable for the workpiece 1 to be precoated after the cleaning step and before the heating in order to ensure by this precoating

140419P10WO

the formation of an alloy layer on the surface of the workpiece 1. Furthermore, it is provided that the cleaning station 10 is connected to the heating station 20 via a conveying mechanism 4. In particular, the cleaned workpiece 1 is delivered by the conveying mechanism 4 to the furnace 5.

After the heating of the cleaned workpiece 1 it is provided that the workpiece 1 is placed in a preferably cooled forming and/or hardening die 30 and formed and/or hardened therein, as shown in Figure 1d. In particular, the forming and/or hardening die 30 comprises a mold which is adapted to the component to be fabricated. Furthermore, it is conceivable that the conveying mechanism delivers the workpiece 1 along the conveyance direction in a production plant through the cleaning station 10 and the heating station 20 to the forming and/or hardening die 30.

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List of reference numbers

- 1 Workpiece
- 2 Burner
- 3 Burner flame
- 4 Conveying mechanism, burner belt, roller conveyor
- 5 Furnace
- 6 Recess
- 10 Cleaning station
- 20 Heating station
- 30 Forming and/or hardening die

CLAIMS

1. A method for hot or warm forming of a workpiece, comprising the following steps:
 - providing of the workpiece,
 - at least partial pretreating of the workpiece, wherein the workpiece is coated with a protective material and/or coated with a corrosion protection oil or with a lubricant or cutting oil,
 - at least partial heating of the workpiece to a target temperature in a heating station and
 - at least partial forming and/or hardening of the workpiece,
 - wherein the workpiece is at least partially cleaned in a cleaning step between the pretreating and the heating of the workpiece,
 - characterized in that the workpiece in the cleaning step is at least partially thermally treated, wherein the workpiece in the cleaning step is heated by a burner to a cleaning temperature.
2. The method as claimed in claim 1, wherein the workpiece is transported during the cleaning step.
3. The method as claimed in claim 1 or 2, wherein the workpiece is transported from a cleaning station to a heating station between the cleaning step and the heating step.
4. The method as claimed in any one of claims 1 to 3, wherein the workpiece is heated by an additional burner to the target temperature.
5. The method as claimed in any one of claims 1 to 3, wherein the burner is operated with a fuel gas and an oxygen-containing gas.
6. The method as claimed in claim 4, wherein the burner and/or the additional burner is operated with a fuel gas and an oxygen-containing gas.
7. The method as claimed in any one of claims 1 to 6, wherein the workpiece is arranged in a forming and/or hardening die for the forming and/or hardening.
8. The method as claimed in any one of claims 1 to 7, wherein the workpiece used is a flat metal sheet.

9. A production plant for hot or warm forming of a workpiece, wherein the production plant comprises a cleaning station for cleaning a workpiece, a heating station for heating the cleaned workpiece and a forming and/or hardening die for forming and/or hardening the heated workpiece, wherein the cleaning station is suitable for a thermal treatment, wherein the cleaning station comprises a burner.

10. The production plant as claimed in claim 9, wherein the production plant comprises a conveying mechanism.

11. The production plant as claimed in claim 9 or 10, wherein the cleaning station is structurally separate from the heating station.

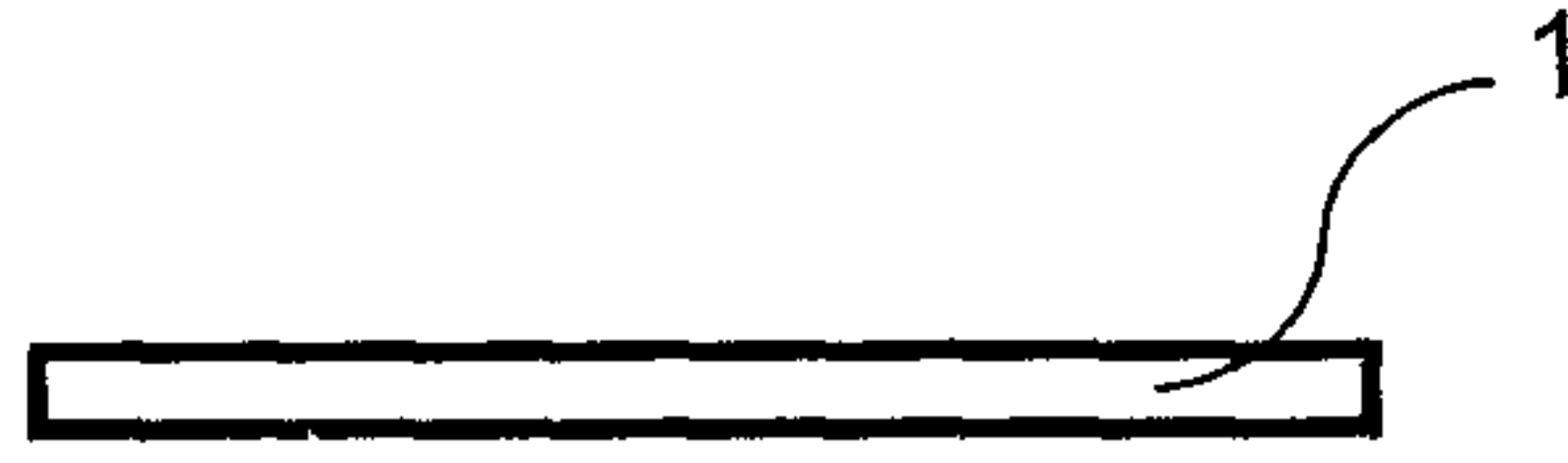


Fig. 1a

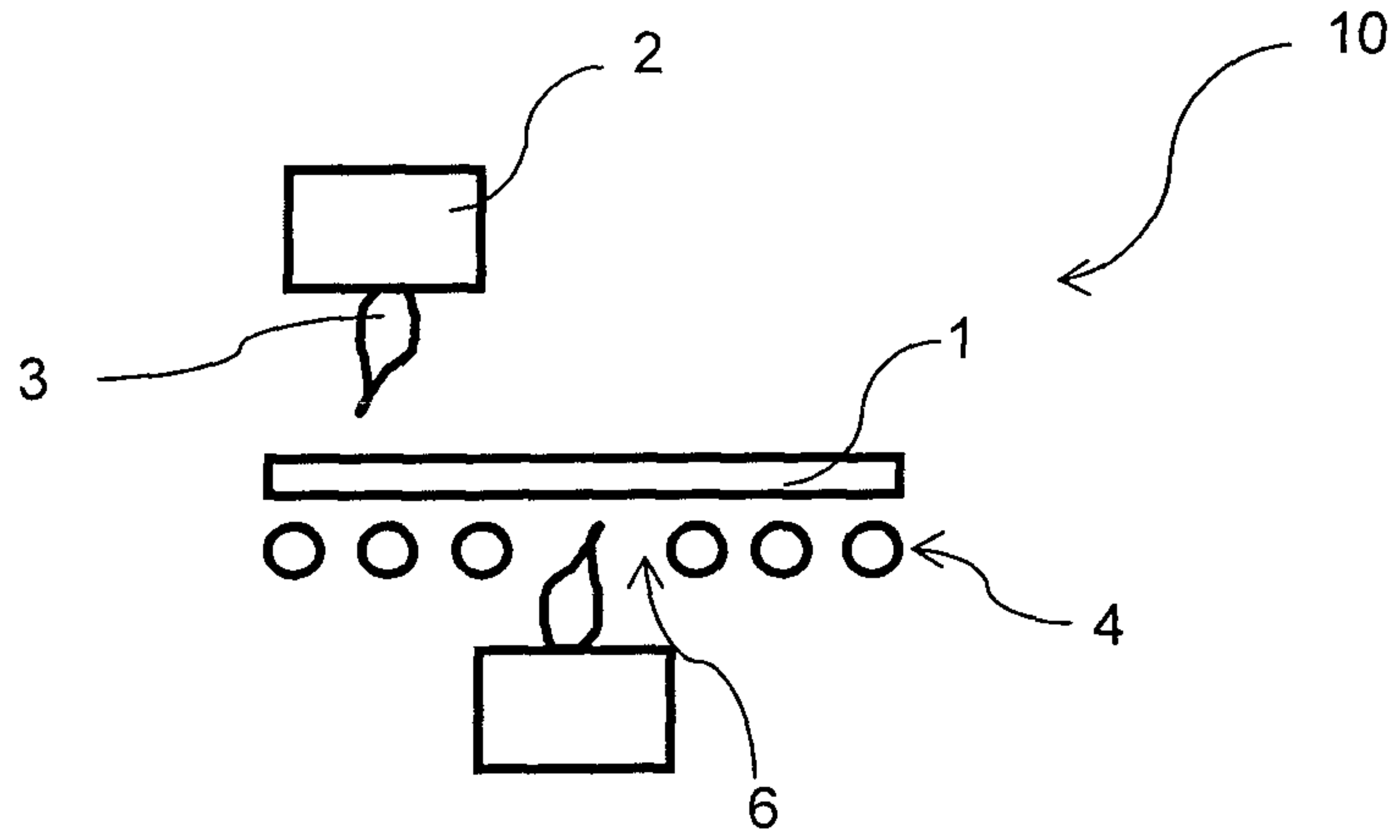


Fig. 1b

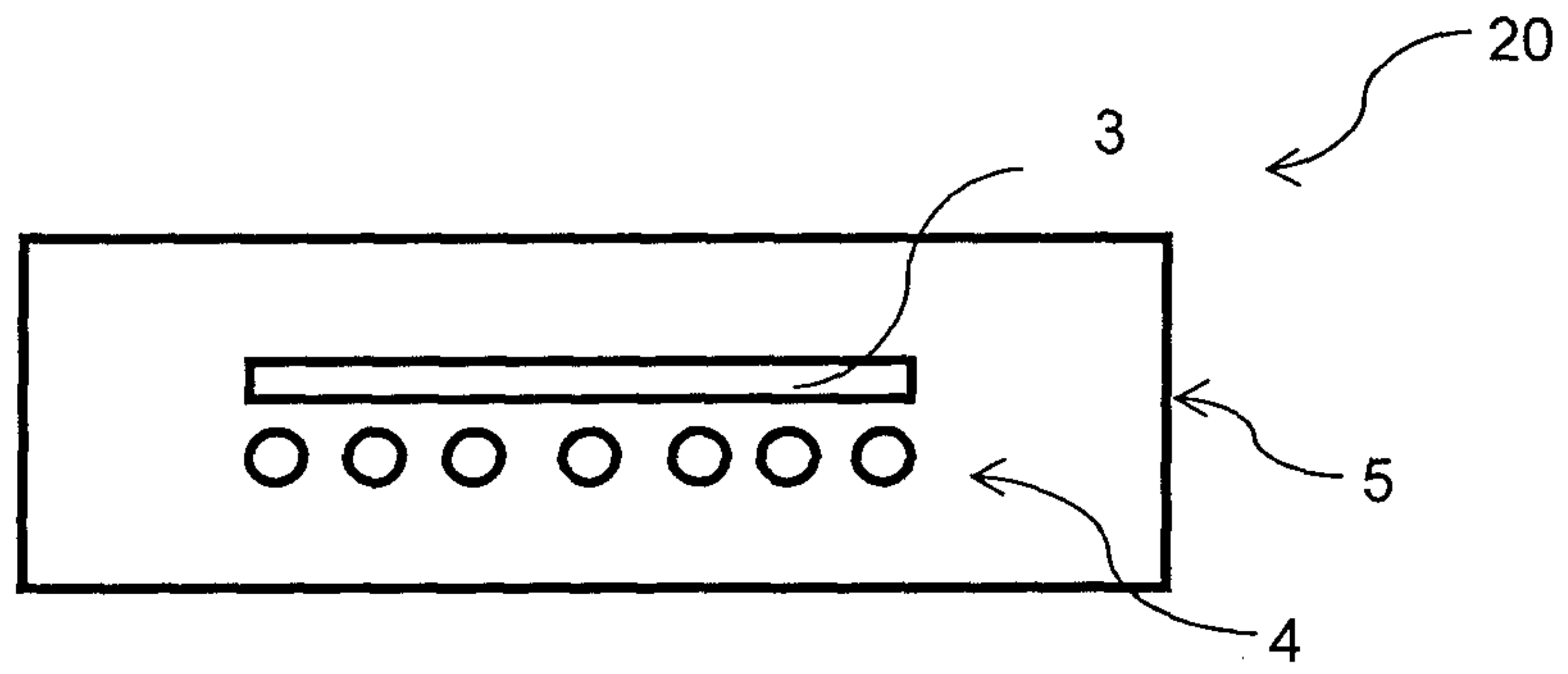


Fig. 1c

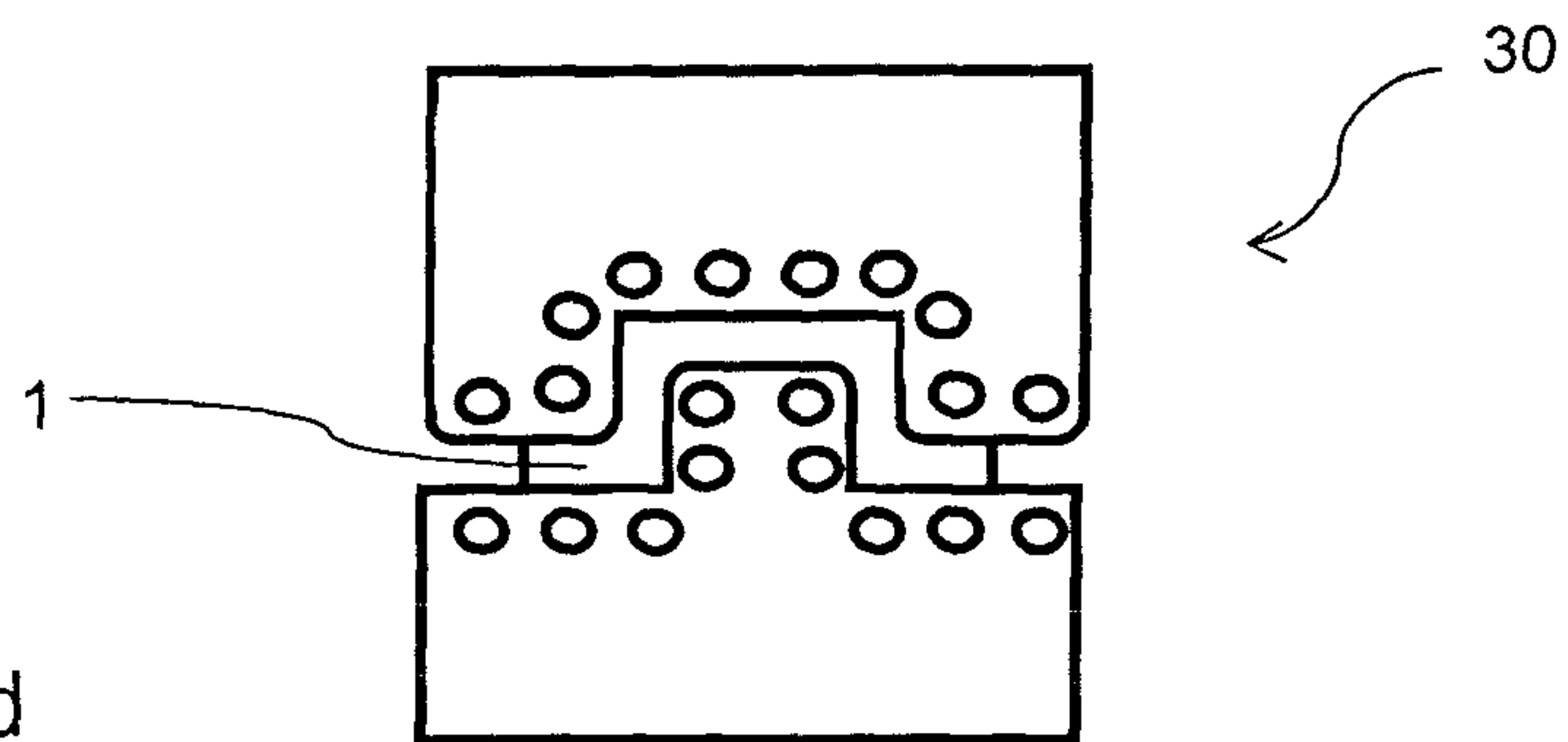
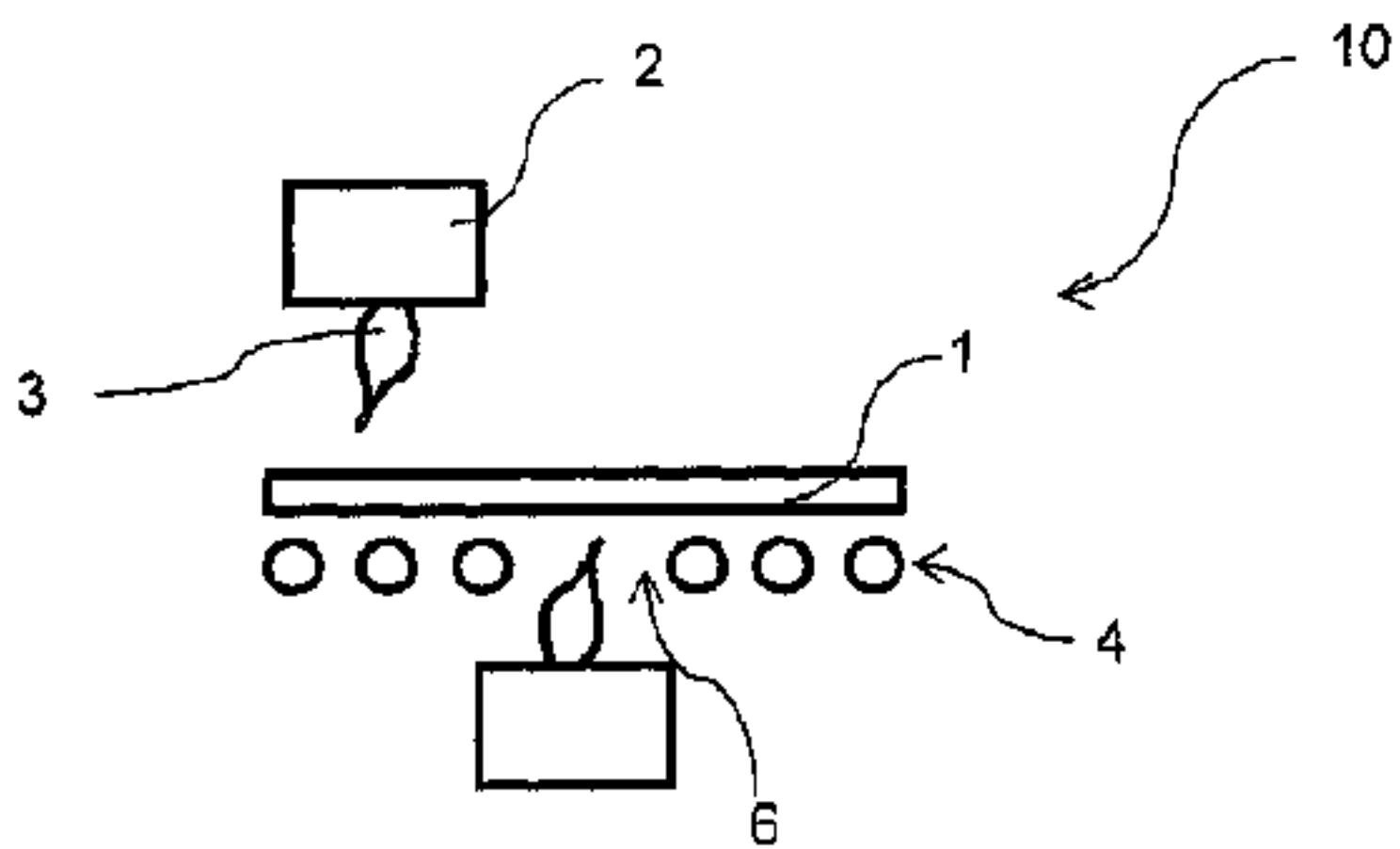


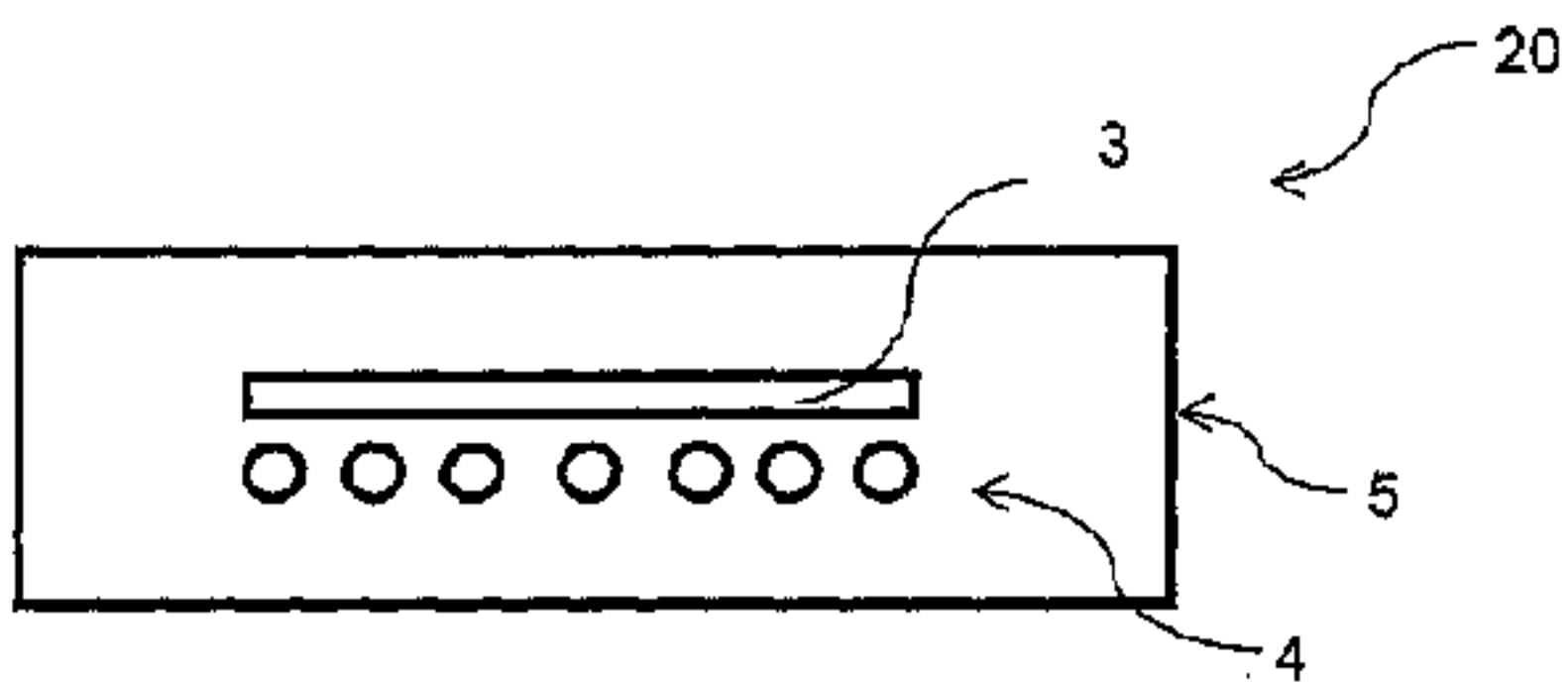
Fig. 1d



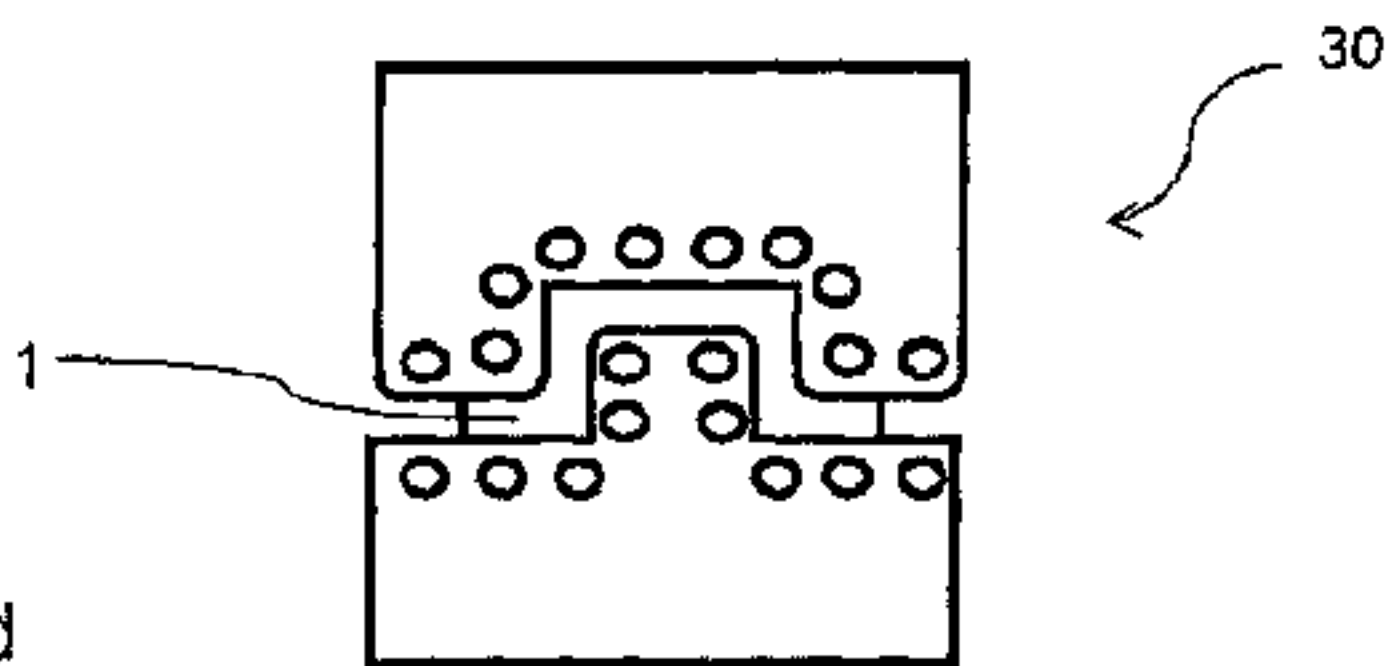
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