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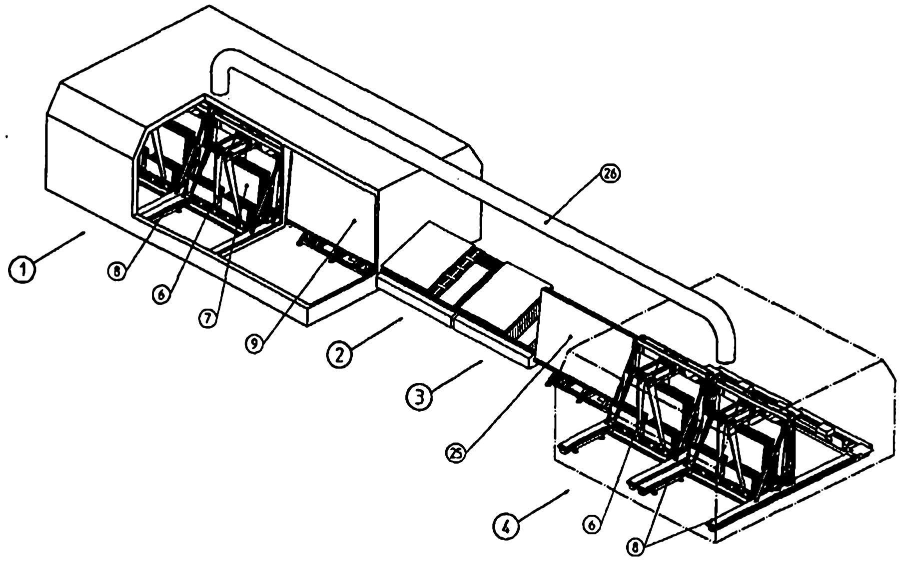
(54) Title: PROCESS AND PLANT FOR HARDENING GLASS PLATES

(54) Bezeichnung: VERFAHREN UND ANLAGE ZUM HÄRTEN VON GLASTAFELN

(57) Abstract



A plant for hardening glass plates has a pre-heating zone (1) in which several glass plates (7) stacked in a standing position in carriages (6) provided with compartments are heated together up to a temperature (for example 300 °C) below the hardening temperature of for example 650 °C. The preheated glass plates (7) are heated up to their hardening temperature in an inclined position in which they form an acute angle to the vertical and are held by air pads between two heating plates. A conveyor which at the same time supports from below the glass plates (7) is provided at the lower edge of both heating plates of the heating zone (2). The glass plates (7) heated up to the hardening temperature are moved into a cooling zone (3) with cooling plates parallel to the heating plates. The glass plates (7) are inserted between the cooling plates for toughening. The cooling plates may also be laid on both sides of the glass plate (7) to be hardened. The toughened glass plates, still at a temperature of for example 300 °C, are conveyed into an aftercooling zone (4), in which they are stored in compartment carriages (6) and slowly cooled down to room temperature. Any problems in supporting and conveying the glass plates (7) are eliminated by arranging them in an inclined position, instead of a horizontal one, in the heating zone (2) and in the cooling zone (3). Considerable energy is saved by pre-heating the glass plates (7) together and cooling the glass plates (7) together down to room temperature after their toughening, since the heating and cooling capacity in the preheating zone (1) and in the aftercooling zone (4) may be reduced.

(57) Zusammenfassung

Eine Anlage zum Härten von Glastafeln besitzt eine Vorwärmzone (1), in der mehrere in Fächerwagen (6) stehend gestapelte Glastafeln (7) gemeinsam auf eine Temperatur unter der Härtungstemperatur von beispielsweise 650 °C liegende Temperatur (z.B. 300 °C) aufgewärmt werden. Aus der Vorwärmzone (1) werden die vorgewärmten Glastafeln (7) einzeln in eine Heizzone (2) bewegt. In der Heizzone (2) werden die Glastafeln (7) auf die Härtungstemperatur aufgeheizt, wobei sie zur Lotrechten unter einem spitzen Winkel geneigt angeordnet und von Luftkissen zwischen zwei Heizplatten gehalten werden. Am unteren Rand der beiden Heizplatten der Heizzone (2) ist eine Transportvorrichtung vorgesehen, welche die Glasplatten (7) gleichzeitig nach unten hin abstützt. Die auf die Härtungstemperatur aufgeheizten Glastafeln (7) werden in eine Kühlzone (3) gebracht, die parallel zu den Heizplatten ausgerichtete Kühlplatten besitzt, zwischen welchen die Glastafel (7) zum Abschrecken eingeschoben wird. Die Kühlplatten können zum Abschrecken auch an die beiden Seiten der zu härtenden Glastafel (7) angelegt werden. Die abgeschreckten Glasplatten, die noch eine Temperatur von beispielsweise 300 °C aufweisen, werden in eine Nachkühlzone (4) transportiert, in der sie in Fächerwagen (6) abgestellt langsam auf Raumtemperatur abgekühlt werden. Dadurch, daß die Glastafeln (7) in der Heizzone (2) und der Kühlzone (3) nicht horizontal, sondern schräggestellt sind, ergeben sich keine Probleme mit dem Abstützen und Transportieren der Glastafeln (7). Durch das gemeinsame Vorwärmen der Glastafeln (7) und das gemeinsame Abkühlen der Glastafeln (7) auf Raumtemperatur nach dem Abschrecken derselben wird erheblich an Energie gespart, da die Heiz- bzw. Kühlleistung in der Vorwärmzone (1) und der Nachkühlzone (4) gering sein kann.

ABSTRACT

A glass plate hardening system has a pre-heating zone (1), where several glass plates (7) stacked in compartment trolleys (6) are pre-heated together to a temperature lying below the hardening temperature of for example 650°C (eg. 300°C). From the pre-heating zone (1) the pre-heated glass plates (7) are moved individually into the heating zone (2). In heating zone (2) the glass plates (7) are heated to hardening temperature, where the glass plates (7) are arranged at an acute angle to the vertical and held by air cushions between two heating panels. On the bottom edge of the two heating panels of the heating zone (2) a transport device is provided which also supports the glass plates at the bottom. The glass plates (7), heated to hardening temperature, are moved to a cooling zone, which has cooling panels arranged parallel to the heating panels and between which the glass plate (7) is inserted for quenching. The cooling panels can be touched to both sides of glass plate (7) to be hardened. The quenched glass plates, at a temperature of still 300°C, are transported to a post-cooling zone (4), where, stacked in compartment trolleys, they are slowly cooled to room temperature.

Because the glass plates (7) are not stored horizontally but at an angle when in heating zone (2) and in cooling zone (3), there are no problems with support and transport of the glass plates (7). As the glass plates (7) are pre-heated and cooled off together, considerable energy savings are achieved, as the heating, respectively cooling effort, in the pre-heating zone (1) and post-cooling zone (4) need only be low.

Method and Device for Hardening Glass Plates

The invention relates to a method with the feature of the introductory part of the preamble of claim 1.

Further, the invention relates to a system (device) with the features of the introductory part of the independent claim for the device.

Glass plates are hardened by heating them to a temperature (hardening temperature) above 650° and then quenching them to a temperature below critical temperature, eg. 300°, thus generating hardening tensions by shock-cooling the glass.

With the devices known up to date, the expenditure for heating and quenching the glass was very high. In particular, the known devices require considerable amounts of energy for the operation of the fans delivering the heated gasses for heating the glass plates.

The object of the invention is to improve the glass hardening process and the device provided for it in such a manner that time and energy expenditure is reduced while good glass hardening is still achieved.

According to the invention, this object is achieved by means of the features of the main claim of the method. With regards to the suggested plant (device), the object is achieved by means of the features of the independent claim for the device.

Due to the fact that with the invention glass plates are pre-heated, for example together, and then are heated to the required hardening temperature, preferably individually, then are quenched to below critical temperature, preferably individually, and then, are cooled, for example together, to room temperature, considerable time and energy savings are achieved, because the heating and cooling zones need only be short. The invention is based on the finding that, when hardening glass plates, it is sufficient for the temperature jump from for example 650° to a temperature below critical of for example 300° C to occur quickly to obtain the desired hardening effect. Pre-heating and cooling to room temperature may then occur slowly without having a disadvantageous effect on the glass plates. The non-uniform surface stresses occurring during the known methods, resulting in undulations on the glass plates, can be avoided.

Further details and features of the invention can be seen from the subsequent description of the example device for hardening glass plates, shown in the drawings.

Figure 1 shows an oblique view of the overall system and

Figure 2 shows an enlargement of the pre-heating and cooling zone.

The system according to the invention shown in fig. 1 consists of 4 zones, ie. the pre-heating zone 1, the heating zone 2, the cooling zone 3 and the post-cooling zone 4.

In the pre-heating zone, which is located in a closed chamber 5, glass plates 7 stand upright on shelves, eg. compartment trolleys 6, and are pre-heated together to a temperature of approximately 300°. The compartment trolleys 6 used in pre-heating zone 1 may be of a construction known from EP 603 151 A or EP 704 389 A. The bottom and side rollers, respectively the cartridge-type sliding components, of the compartment trolleys 6 are made from temperature-resistant materials to withstand the high temperatures.

As shown in fig. 1, the compartment trolleys 6 run on rails 8 at a right angle to the orientation of the compartments provided on them for containing the glass plates 7, so that a selected pre-heated glass plate 7 can be conveyed to a tilting table 9, from where it can be conveyed from the pre-heating chamber 5 to the heating zone 2 in the inclined position corresponding to heating zone 2. The tilting table 9 is fitted in an advantageous manner with an air cushion support surface.

According to one embodiment, an additional heating zone may be provided between the pre-heating chamber 5, where the glass plates 7 are pre-heated together, and the heating zone 2, where the glass plates are heated, for example individually to a temperature of 650°, in which zone the glass plates 7 are heated to a temperature lying between the temperature in the pre-heating chamber 5 and the temperature in the heating zone 2. This embodiment, however, is not shown in the drawing.

One advantage of the pre-heating chamber 5 where several glass plates 7 are pre-heated together is the fact that the pre-heating can be performed slowly and thus with low energy expenditure, as sufficient pre-heating time is available. In the example of one embodiment, it can be seen that chamber 5 contains several, for example two, compartment trolleys 6 and that the trolley 6 loaded with glass plates 7 last entered into the pre- heating chamber 5 will only be moved to the unloading point adjacent to the tilting table 9 after the trolley 6 currently at the unloading point has been emptied. Then a new trolley 6 loaded with glass plates 7 will be moved to the waiting zone of the pre-heating chamber 5 where the glass plates 7 on it will slowly be pre-heated.

The heating zone 2 is shown in more detail in fig. 2. Contrary to the known heating zones for heating glass plates during their hardening, the heating zone 2 according to the invention is orientated such that the glass plates 7 are arranged not horizontally, but inclined up to almost vertically. For this purpose, the heating zone 2 (as well as the subsequent cooling zone 3) is fitted with an inclination adjustment 11, for example pneumatic or hydraulic cylinders, so that the inclination angle of the heating zone 2, respectively the glass plates 7 in it, can be adjusted according to the requirements (size and thickness of the glass plates). Thus the problems arising with heating zones with horizontally arranged glass plates during transport and support of the glass plates (deformation, deflection, etc) can be avoided.

To support the bottom edge of the glass plate 7, a transport device 12 is provided, which may consist of an infinite conveyor belt, as shown in the example, or alternatively, a transport device according to the principle described in DE 30 38 425 A, may be provided, where the horizontal support surfaces of the conveying system can grip underneath the bottom edge of the glass plate 7. For practical reasons, the support surfaces gripping underneath the glass plate 7, in particular if they grip under the entire glass plate, are arranged staggered to each other on the chains or other infinite conveying components located opposite each other.

In the example shown, the heating zone 2 has two heating panels 15 arranged opposite each other, with space in between them to accommodate the glass plate 7 to be heated, where the heating panels 15 may be heated by any manner, gas or electrical heating.

The heating panels 15, the surface structure of which facilitate and increase heat radiation, are provided with drilled holes 16 which can be supplied with pressurised gas via chambers 17, so that gas cushions, in particular air cushions are formed on either side of a glass plate 7 located between the heating panels 15. Thus the glass plate 7 touches neither heating panel 15, but is only supported under its bottom edge and transported by the transporting device 12.

In one embodiment of the heating panels 15 it is possible for the heating panel 15 above the glass plate 7 not to have any holes/drilled holes, so that heat is radiated from the top heating panel 15 onto the glass plate 7 mostly by means of heat radiation.

With the invention, the construction of the heating zone 2 may be such, that heat is discharged to the glass plate 7 from the bottom heating panel 15 by means of radiation and convection, from the top heating panel 15 mostly by means of radiation.

To admit gas to the heating panels 15 for the purpose of air cushion formation, a pre-heated gas, eg. air, may be supplied to the chambers 17. It is, however, also possible to generate the air cushion from combustion exhaust gasses, where the combustion heat simultaneously heats the heating panels 15.

To adjust to varying glass plate sizes, the heating panels 15 may be subdivided into sections, for example parallel to the transporting device 12, ie. in conveying direction, where the sections are enabled, respectively disabled, depending on the length of the glass plate 7 as measured from the transporting devices 12. Thus further energy savings will be achieved.

The heating panels 15 are fitted such that the distance between the heating panels 15 can be adjusted according to the thickness of the glass plate to be hardened. For this purpose it is sufficient for the top heating panel 15 to be adjustable with respect to the bottom heating panel 15 by means of for example a pressure cylinder or similar control device.

Due to the construction of the heating zone 2 according to the invention, the glass plate 7 is quickly heated from the pre-heating temperature of 300° C to the hardening temperature of, for example, 650° C, mostly by way of radiation, enhanced by convection.

Immediately adjacent to the heating zone 2 is cooling zone 3 which with regards to its technical construction is identical to heating zone 2, with cooling panels 20 through which a cooling medium flows (not shown). The exit drill holes 16 in the two cooling panels 20 are supplied with a cooled gas, so that air cushions - in this case with a cooling effect - are formed as described for heating zone 2, which are arranged above or below or only below the glass plate 7 to be quenched.

The cooling panels 20, too, are adjustable with respect to each other, so that they can be positioned close to or apart from each other. This may also be utilised, with the air cushion disabled and the transporting device 12 switched off, to touch the cooling panels 20 briefly to either surface of the glass plates to increase the speed with which the quench-hardening may be performed. This method is mostly used with thin glass plates 7. For thicker glass plates 7 it will be of advantage to supply cold air to usually either side of the glass plate 7 and to stop the glass plate 7 in the cooling zone 3.

When the cooling panels 20 are touched to a glass plate 7, the transporting device 12 in cooling zone 3 is disabled to avoid undesirable relative movement between glass plate 7 and transporting device 12.

It needs to be pointed out that the transporting device 12 may also be disabled in heating zone 2, if, for example, the glass plates 7 are so big and/or thick, that it is not possible to heat them to the required hardening temperature using the continuous conveying method.

After passing through the cooling zone 3, the glass plates 7 reach the post-cooling zone 4, which may be located inside a chamber and contains a compartment trolley 6 as described above, where the glass plates 7 can be stored sorted according to batch, to then be cooled to room temperature. The cooling effect in this zone does not have to be extensive, as sufficient time is available for the cooling to take place. If the post-cooling zone 4 is located in a chamber (see dotted line in fig. 1), heated air from the post-cooling zone 4 can be supplied to the pre-heating zone 1 to save energy (pipe 26).

The surfaces of the cooling panels 20 facing the glass plates 7 may be shaped to enhance the absorption of heat radiation. For example, the surfaces of the cooling panels 20 facing each other may be ribbed or undulated to increase the surface area available for heat absorption.

With the device according to the invention, the glass plates 7 are not moved through the heating zone 2 and the cooling zone 3 horizontally but inclined towards vertical, for example at an acute angle, so that problems with the support and transport of the glass plates 7, which have been known to occur and resulted in the deformation of the glass plates 7, are avoided in the device according to the invention.

With the transport devices 12 engaging at the bottom edge of the glass plates 7, the glass plates 7 can be transported with the desired speed through heating zone 2 and cooling zone 3, where the glass plates may be stopped briefly in the heating zone 2 and/or cooling zone 3, which is particularly of interest, when the cooling panels 20 are to be touched to either side of a glass plate 7 for quenching.

Similar to the heating panels 15, the cooling panels 20 may also be subdivided into sections, so that the cooling surface area of the cooling panels 20 can be adjusted to the size of the glass plates 7 to be quenched (their length as measured from the transporting device).

To avoid constant disabling and enabling of the various zones of the heating panels 15 and/or cooling panels 20, glass plates 7 of identical or similar height are taken from the pre-heating zone 1 and are sent through the heating zone 2 and cooling zone 3 in sequence. In the post-cooling zone 4 the hardened glass plates 7 can be sorted according to batch.

In summary an example of an embodiment of the invention can be described as follows:
A glass plate hardening system has a pre-heating zone 1, where several glass plates 7 stacked in compartment trolleys 6 are pre-heated together to a temperature lying below the hardening temperature of for example 650° C (eg. 300°C). From the pre-heating zone 1, the pre-heated glass plates 7 are moved individually into the heating zone 2. In heating zone 2, the glass plates 7 are heated to hardening temperature, where the glass plates 7 are arranged at an acute angle

to the vertical and held by air cushions between two heating panels. On the bottom edge of the two heating panels of the heating zone 2 a transport device is provided which also supports the glass plates at the bottom. The glass plates 7, heated to hardening temperature, are moved to a cooling zone, which has cooling panels arranged parallel to the heating panels and between which the glass plate 7 is inserted for quenching. The cooling panels can be touched to both sides of glass plate 7 to be hardened. The quenched glass plates, at a temperature of still 300°C, are transported to a post-cooling zone 4, where, stacked in compartment trolleys, they are slowly cooled to room temperature.

Because the glass plates 7 are not stored horizontally but at an angle when in heating zone 2 and in cooling zone 3, there are no problems with support and transport of the glass plates 7. As the glass plates 7 are pre-heated and cooled off together, considerable energy savings are achieved, as the heating, respectively cooling effort, in the pre-heating zone 1 and post-cooling zone 4 need only be low.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for hardening of glass plates wherein the glass plates are pre-heated to a temperature near to the hardening temperature, then heated to a temperature above the hardening temperature, and cooled for the purpose of hardening to a temperature below the hardening temperature wherein the pre-heating of the glass plates is carried out simultaneously for several glass plates, wherein the glass plates pre-heated thus are heated up individually to a temperature above the hardening temperature, that the glass plates are quenched to a temperature below the hardening temperature, and that the glass plates are then cooled to room temperature.

2. The method of claim 1 wherein the glass plates are pre-heated to a temperature of about 300°C.

3. The method according to claim 1 or 2, wherein the glass plates are individually quenched from a temperature above the hardening temperature to a temperature below the hardening temperature.

4. The method of any one of the preceding claims, wherein the cooling of the glass plates to room temperature is carried out simultaneously for several glass plates.

5. The method of any one of the preceding claims, wherein the glass plates during heating to a temperature above the hardening temperature and during quenching to a temperature below the hardening temperature, are aligned in an acute angle to the vertical.

6. The method of any one of the preceding claims, wherein the glass plates are supported at least from below with pressurised gas cushions and that they are supported and conveyed on their lower horizontal edge while being heated in a heating zone bound by heating panels and while being quenched in a cooling zone bound by cooling panels.

7. The method of any one of the preceding claims, wherein the hardening temperature is about 650°C.

8. The method according to any one of the claims 4 to 7, wherein the pressurised gas cushion in the heating zone area is formed by heated air or combustion exhaust gases.

9. The method according to any one of the claims 4 to 8, wherein the pressurised gas cushion in the cooling zone area is formed by cooled air.

10. The method according to any one of the claims 4 to 9, wherein the panels bounding the cooling zone are brought into contact with both sides of a glass plate for the purpose of quenching the glass plate.

11. The method of any one of the preceding claims, wherein the glass plates are transported through the heating zone and/or cooling zone with a speed corresponding to their thickness and, if required, are stopped briefly in the heating and/or cooling zone.

12. The method of any one of the preceding claims, wherein warm exhaust air from the post-cooling zone is used for pre-heating purposes in the pre-heating zone.

13. The method of any one of the preceding claims, wherein heating in the heating zone takes place mainly by radiation enhanced by convection caused by the pressurised gas.

14. A device for performing the method of any of the preceding claims, wherein the device has a heating zone and a subsequent cooling zone in which heating panels and cooling panels are provided at a distance from each other at an acute angle to the vertical, and wherein ahead of the heating zone a pre-heating zone, and after the cooling zone a post-cooling zone is provided.

15. Device according to claim 14, wherein the distance between the heating panels in the heating zone and the distance between the cooling panels in the cooling zone is adjustable.

16. Device according to claim 14 or 15, wherein a transport device is provided at the bottom edge of the heating panels and at the bottom edge of the cooling panels.

17. Device according to any one of the claims 14 to 16, wherein the inclination with respect to the vertical of the heating panels and the cooling panels is adjustable

18. Device according to any one of the claims 14 to 17, wherein the pre-heating zone includes a pre-heating chamber, and wherein shelves are provided in the pre-heating chamber to carry several glass plates which are to be pre-heated simultaneously.

19. Device according to any one of the claims 14 to 18, wherein the post-cooling zone includes a post-cooling chamber, and wherein shelves are provided in the post-cooling chamber to carry several glass plates which are to be cooled simultaneously.

20. Device according to any one of the claims 14 to 19, wherein at least in the heating panels below the glass plates to be heated, holes are provided for the discharge of pressurised gas for the purpose of gas cushion formation between the heating panel and the glass plate to be heated.

21. Device according to any one of the claims 14 to 20, wherein in the cooling panel below the glass plate to be quenched, but preferably in both cooling panels, holes are provided in the surfaces facing the glass plate for the discharge of pressurised gas for the purpose of air cushion formation between the cooling panel and the glass plate to be quenched.

22. Device according to any one of the claims 14 to 21, wherein the heating panels are equipped with electric heating.

23. Device according to any one of claims 14 to 22, wherein the heating panels are heated by combustion gases from at least one gas burner.

24. Device according to any one of the claims 21 to 23, wherein combustion gases exit through the holes in the heating panels.

25. Device according to any one of the claims 18 to 24, wherein between the shelves a tilting table is provided in the pre-heating chamber and the heating zone for the storage of glass plates for the purpose of pivoting said glass plates into the angle position corresponding with the heating zone.

26. Device according to any one of the claims 19 to 25, wherein a tilting table is provided behind the cooling zone to align glass plates from the angle position of the cooling zone to that position in which they are to be stored in the shelf in the post-cooling chamber.

27. Device according to claim 8 or 19, wherein the shelves in the pre-heating chamber and/or the post-cooling chamber consist of compartment trolleys moveable in a direction transverse to the conveying direction.

28. Device according to claim 18 and 19, wherein a duct is provided which connects the exhaust air opening of the post-cooling chamber with the pre-heating chamber.

29. Device according to any one of the claims 14 to 28, wherein the heating panels are divided into several sections which can be heated independently of each other.

31. Device according to claim 29 or 30, wherein the heating panels and/or the cooling panels are divided into strip-like sections running parallel to the transport device on the bottom edge of the heating zone and/or the cooling zone.

32. Device according to any one of the claims 14 to 31, wherein an additional device for further pre-heating of individual glass plates is provided between the pre-heating zone, where several glass plates are pre-heated simultaneously, and the heating zone.

DATED this 9th day of November, 1999.

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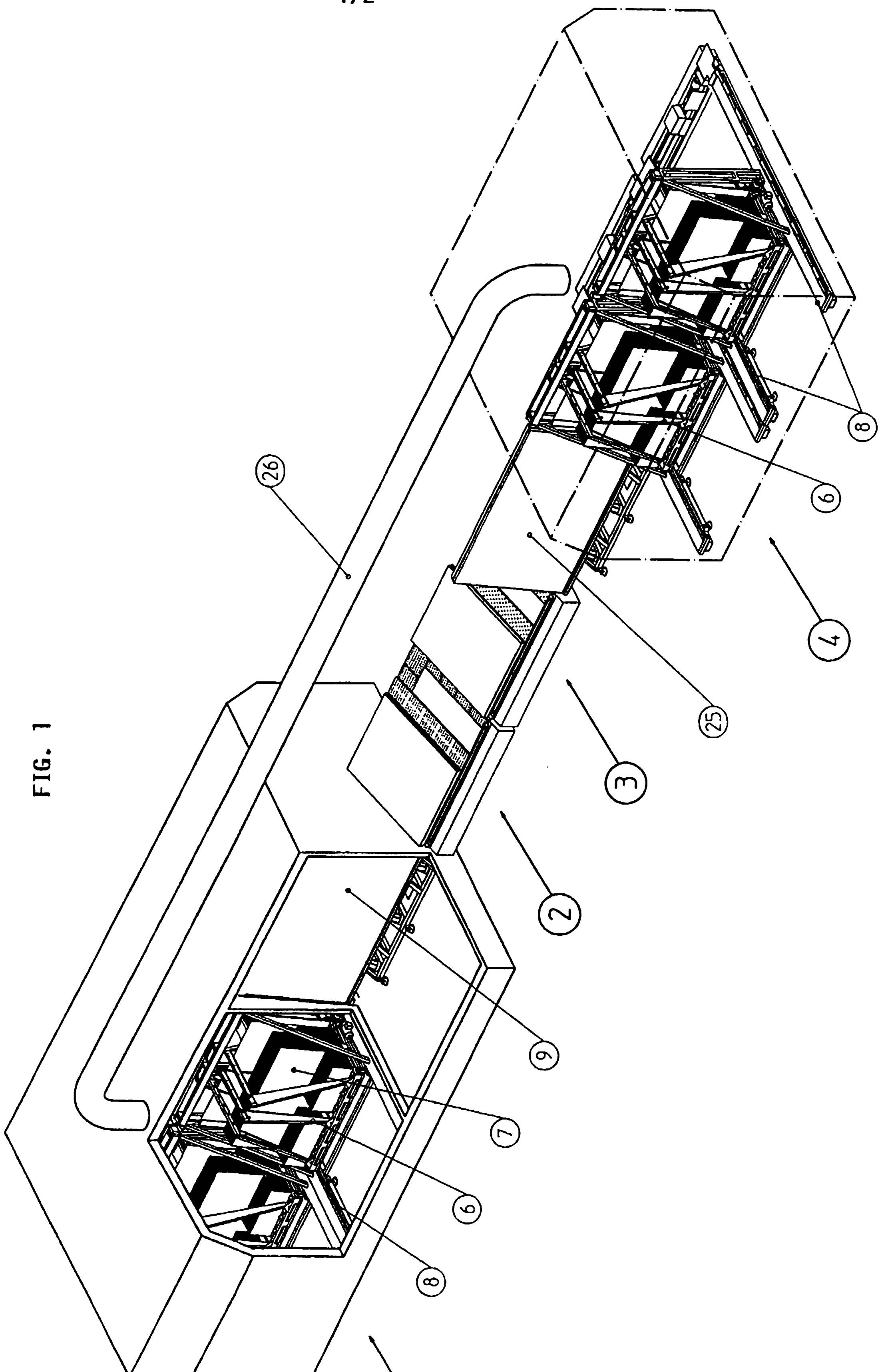

FIG. 1

FIG. 2