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(54) **Curving sheets in the plastic state**

(57) Sheets in the plastic state such as hot glass sheets are curved and tempered by passage over a bed of shaping rods arranged in a path which is curved in the longitudinal direction of passage. The path of passage of the sheets is continuous without angular discontinuities. The shaping rods may themselves be curved to allow curving of the sheets in two transverse directions.

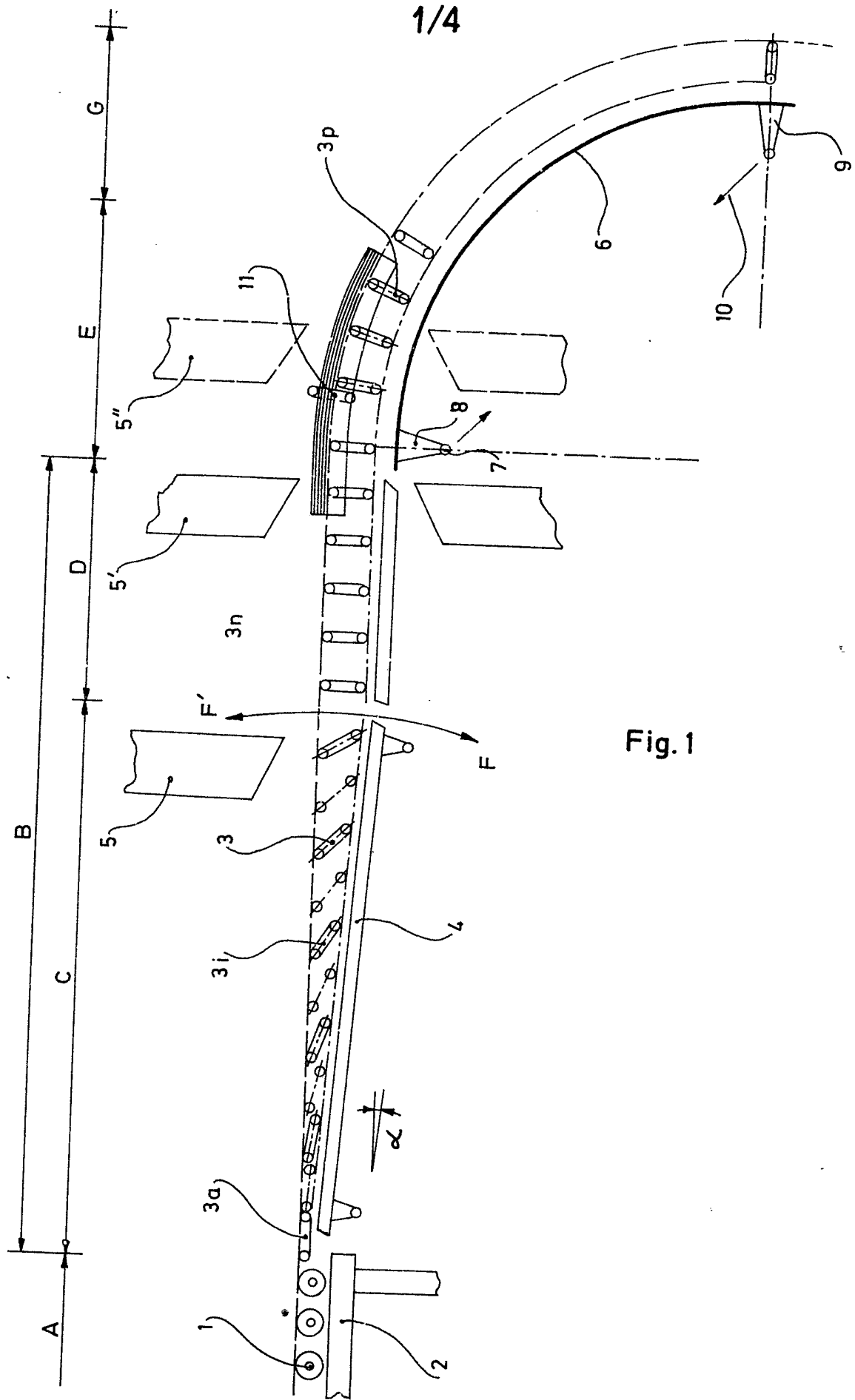


Fig. 1

Fig. 3

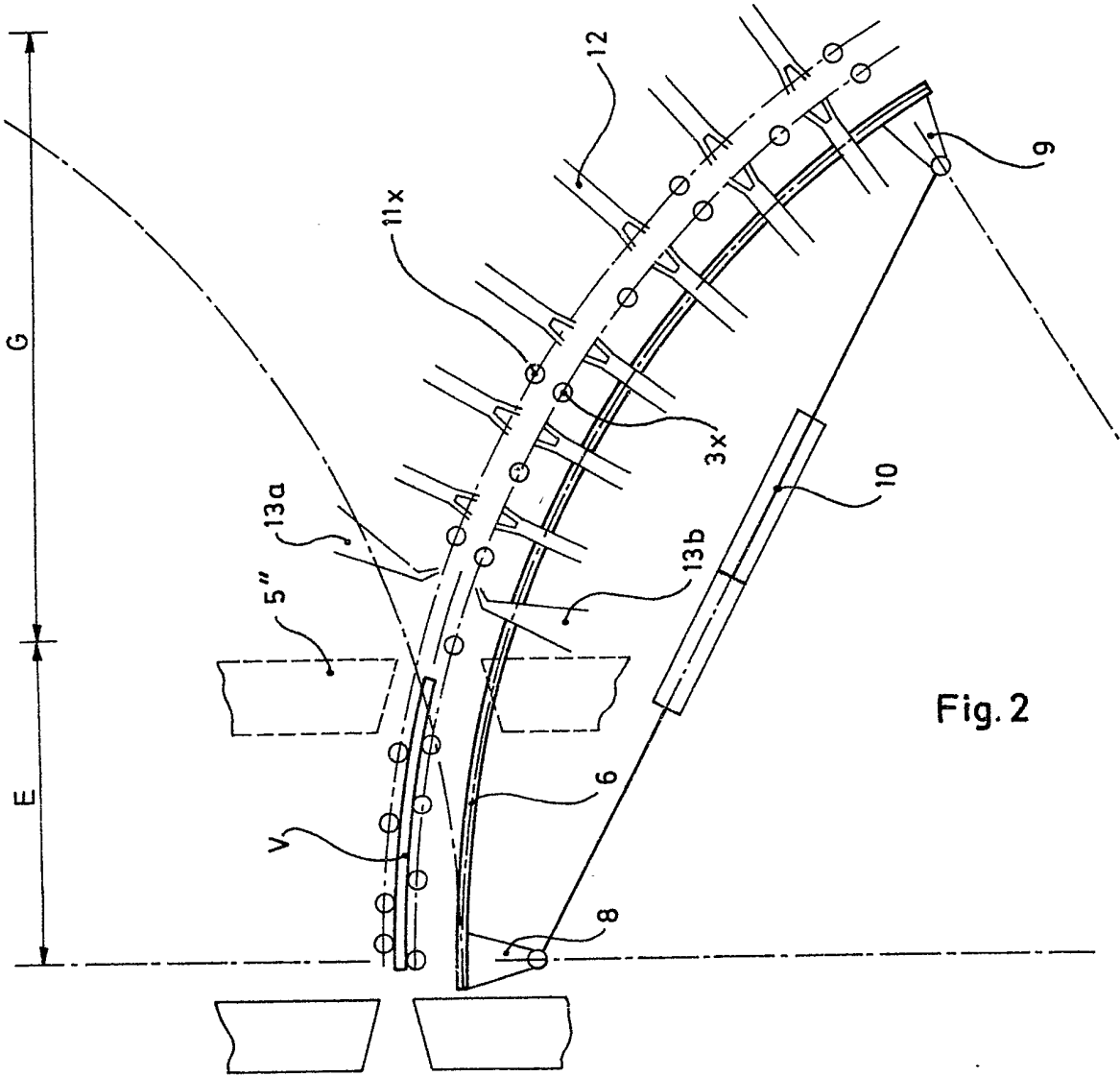
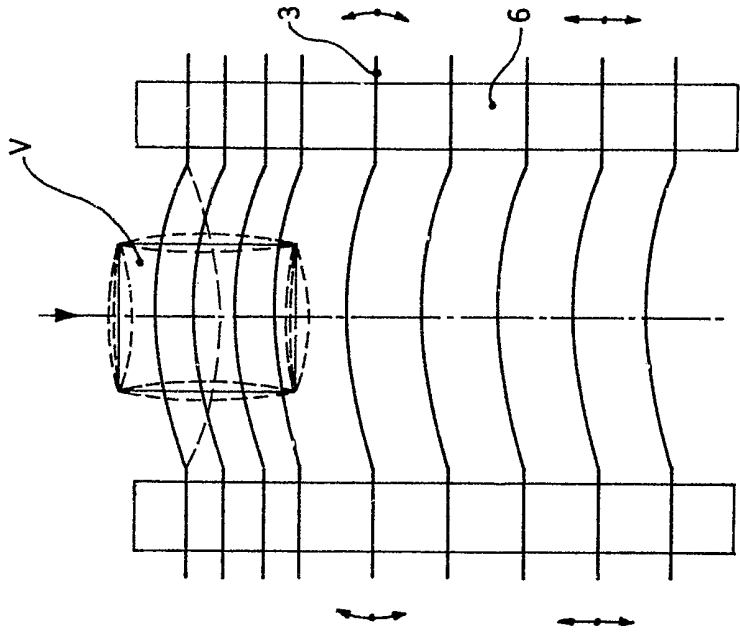


Fig. 2

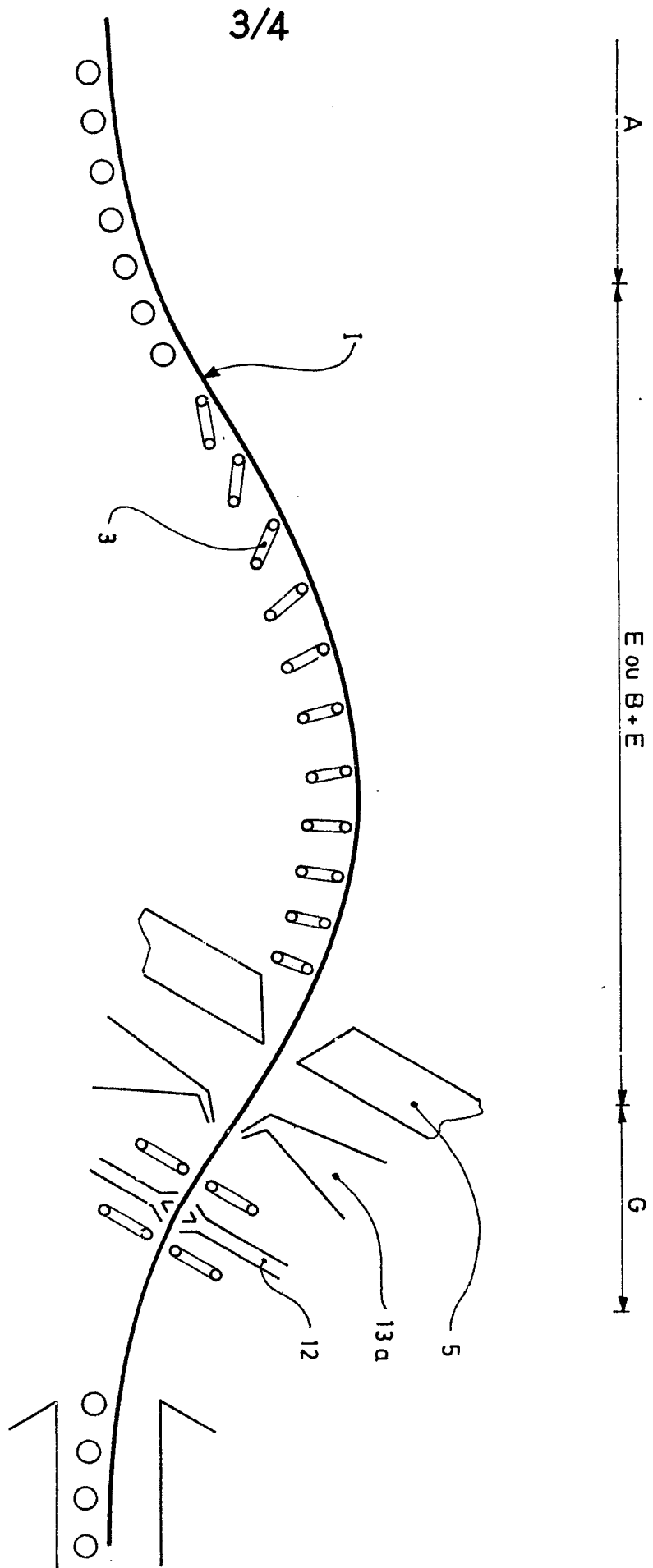


Fig. 4

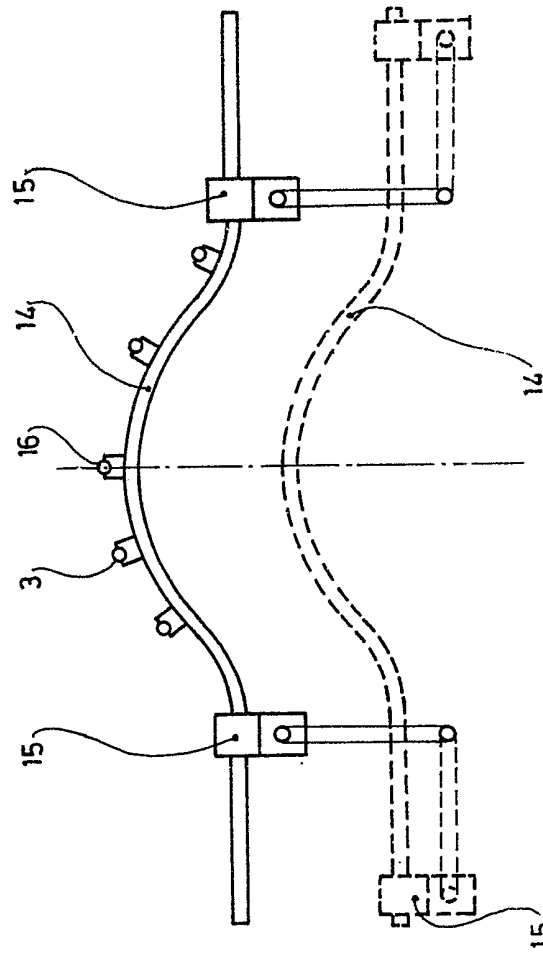


Fig. 5

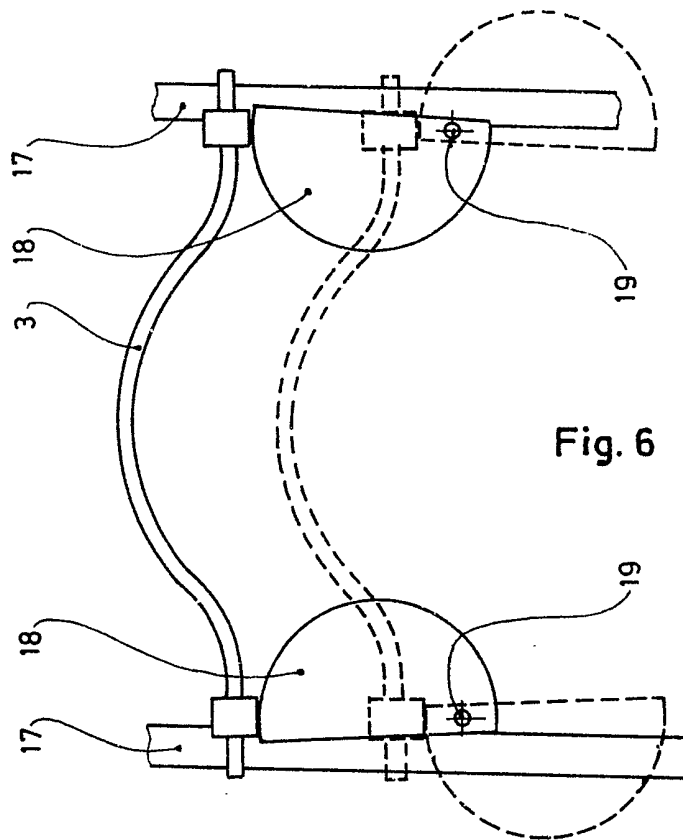


Fig. 6

SPECIFICATION

Curving sheets in the plastic state

5 The present invention relates to curving and tempering of sheets in the plastic state, such as glass sheets brought to their softening temperature. The description below refers to glass sheets, but it will be understood that the invention is applicable to sheets
10 of other materials.

It is known from French Patent 1,476,785 to use as a die for curving a plurality of curved rods which are each orientable about an axis passing through their two ends. These rods initially embedded in the same
15 plane may be adjusted outside this plane, either individually or altogether as described in particular in French Patent Application 2,312,463 to form a shaping bed in which the glass sheets take the curved shape as they are displaced thereon. Such
20 systems give satisfactory results when it is only desired to curve glass in a single direction but they do not allow manufacture of glass sheets having a double curvature especially for the automobile market.

25 There have already been suggested shaping devices using a gaseous cushion having a double curvature in U.S. Patent 3,409,422 but the modifications to be made when it is desired to change the manufacture in order to have glass sheet with
30 different radii of curvature are long and difficult.

An object of the present invention is to provide a device for curving or curving and tempering capable of making sheets with a wide range of possible curvatures; changes in the direction of curvature
35 and/or the radius of curvature being obtained by simple and rapid adjustment.

The device for curving or curving and tempering plastic sheets which may be glass sheets brought to their softening temperature uses a shaping bed
40 formed by a plurality of rods mounted to turn in bearings the shaping being obtained during passage of the glass sheets on these rods.

This device is such that it has a shaping surface on which the sheet is curved having a longitudinal
45 curvilinear profile tangent to the surface of the support means for the sheet immediately upstream thereof, which are thus prolonged without break, i.e. without discontinuities or sharp angles.

Thus to avoid or minimise the faults which affect
50 the forward edges of glass sheets when they reach an angular discontinuity when they are in a plastic state the glass sheets are made to follow initially, in a reheating zone followed by curving and tempering, a regular continuous trajectory, that is to say without
55 break, with continuous evolution of the radius of curvature of its profile in such a manner that all the glass supports, supports in the reheating furnace, shaping bed of the curving station and tempering supports have the shape that the glass sheets will
60 have the tendency to take naturally under their own weight.

To obtain the curvilinear profile of the shaping bed the bearings which carry the shaping rods are fixed on supports having, or capable of having, a curvi-
65 linear profile in the longitudinal direction.

In one embodiment the supports of the bearings of the rods comprise spring leaves arranged longitudinally, curvable under the action of drawing members attached to their ends in the plane of the means
70 which carry the sheet upstream of curving when they are at rest, that is to say, not curved.

Advantageously, to allow a wide range of shapes of curving of the sheets, said springs are curvable separately and their concavity may be turned up-
75 wardly or downwardly.

In another embodiment the supports for the bearings of the shaping rods are curved bars arranged longitudinally and advantageously they are mounted to be inclinable, pivoting in bearings,
80 so as to modify the longitudinal curvilinear profile of the shaping bed. In this embodiment the path of access of the sheet for the curving zone is arranged such that the path of the sheet always remains regular, that is to say without breaks or in other
85 works with a profile having a radius of curvature which is continuously variable.

Advantageously in one or the other of these embodiments with each curving rod will be associated a counter rod which will be held elastically
90 applied against the sheet, said counter rod being spaced either forwardly or backwardly from the shaping rod.

After the shaping zone the sheets may traverse a tempering zone where the sheet is brought onto
95 rods identical in their shape and their orientation at the last rod of the curving zone, said rods of the tempering zone being mounted in bearings aligned on the same lines of curvature as the bearings of the shaping rods and blowing means such as nozzles
100 being interspersed between the rods.

The shaping rods may be rectilinear in which case there is obtained a single curve. They may be curved in which case there is obtained a double curvature,
105 that is to say a transverse curvature and a longitudinal curvature.

In order, on the one hand, to avoid overheating of a glass sheet and thus improve its optical characteristics and economies in energy and on the other hand to homogenise the temperature of the glass in
110 order to achieve better tempering, the curving zone may be arranged inside a heated enclosure which may be a vault heated independently of the furnace for reheating the glass but which may also be the furnace itself for reheating the glass or in part the
115 furnace, in part an independent heating vault.

Advantageously the heated enclosure for curving and the reheating furnace for the glass are contiguous thus maintaining the glass at the desired temperature without any passage of free air at a
120 temperature which is not controlled.

The present invention also proposes a method of curving and tempering sheets such as glass sheets in which said sheets are reheated up to a temperature at least equal to their temperature for the start of
125 tempering or very slightly greater than said temperature, for example about twelve degrees above, the residence of the sheets at this high temperature is prolonged, curving is carried out during this time at a high temperature and the sheets are transferred
130 immediately after curving to tempering where they

are subjected to uniform blowing.

This manner of proceeding economises energy, avoids a heating which is too high which would prejudice the good optical quality of glass panes obtained, allows a homogenisation of the temperature of the glass before tempering, which homogenisation associated with a regular blowing allows obtaining of a better state of tempering of the glass. Thus for example, with this method it is possible to avoid having, during breakage of the sheets, splinters of a length which is too great, splinters of more than 6 cm being prohibited in some applications.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings, which show:

Figure 1, a side view of a machine for curving and tempering carrying out double curving,

Figure 2, a detailed view of a zone of the machine of *Figure 1* for curving-tempering with incorporated means for blowing,

Figure 3, a view from above of the curving zone of *Figure 1*,

Figure 4, another arrangement of the shaping rods in the machine of *Figure 1*,

Figure 5, a machine for curve/tempering in which the curved lines are made by curved bars,

Figure 6, a system of cams which may vary the height of the shaping rods in a machine for curve/tempering.

Figure 1 shows a machine for curving and tempering glass sheets in which the shaping rods have bearings carried by supports having a non-rectilinear shape. The term "shaping rods" includes curved rods, curved rods covered with a rotating cover such as described in French Patent 1,476,785 and its certificate of addition 92,064, and rotating rectilinear rollers which may be covered with a coating of refractory material or any other type of rods or rollers on which the glass sheets are displaced and may be simultaneously curved.

In *Figure 1* the infrastructure of the furnace which provides the glass sheets at its softening temperature is not shown. The machine as shown in *Figure 1* comprises four zones which the glass sheets traverse successively, the zone A for heating the glass, zone B which follows it and which is the zone for progressive transverse shaping of the glass sheets such as is described in detail in French Patent Application 2,312,463 already mentioned, zone E which is the zone for longitudinal shaping and the last zone being zone G for tempering which is not described in detail. In zone A, the glass passes on rollers 1 of known type, for example of silica, supported by a framework 2. The zone B comprises two half-zones, the half-zone C and a half-zone D. At C the glass takes a transverse curvature during its travel on the curved shaping rods 3 which are more and more inclined the first rod 3a being situated in a plane which contains the upper generatrices of the rollers 1 of the furnace and the following rods such as 3i being progressively more and more displaced outside this plane owing to the action of cranks, not shown here, of which one of the arms is controlled by a beam 4 inclinable by an angle α according to one of the arrows F or F' as described more precisely

in French Patent Application 2,312,463. Preferably these tilted rods retain their summits in said plane.

Advantageously the curved transverse shaping rods 3 are situated in a heated enclosure which may be a vault heated independently or even the reheating furnace itself for the glass, the frontal wall of the furnace then being positioned at 5 and the rods being constructed as described in French Patent Application 78 11165, that is to say they are hollow and of stainless steel and swept by a reducing or neutral gas or traversed by a cooling liquid such as oil, molten salt or water.

At D the rods marked 3n all have the same orientation as described in French Patent Application 2,312,463 determined by the level of the beam 4.

In the figure they are shown in a vertical position given a maximum curvature, but they may have lesser inclinations. They may have the same inclination as the last of the rods 3 in the half-zone C or a slightly greater inclination so that the maximum transverse curvature is given by the first of the rods 3n and there is then a progressive inclination of all the rods of the zone C and the first rod 3n in the zone D. In this half-zone D the transverse curving of the glass sheet is no longer increased.

Advantageously, this half-zone D will also be inside a heated enclosure as before, which may be a vault heated independently or the furnace for heating the glass, the frontal wall of the furnace then being at 5' and the rods 3n being themselves also swept by a reducing gas or a cooling fluid as in the rods of the half-zone C.

In the following zone E, the shaping rods such as 3p retain the inclination of the rods in the half-zone D, but the bearings in which they are mounted to be inclined are arranged on two curvilinear supports 6, comprising spring leaves arranged on each side of the path of the glass sheets. These springs are fixed on the side of the downstream end of the half-zone D at an anchorage point 7, being fixed relative to said end of the half-zone D. This point 7 fixed with respect to the upstream device is situated at a level such that when the leaves 6 are at rest, that is to say non-curved, the shaping bed formed by the shaping rods 3p extends the support means for the glass situated immediately upstream without break, that is to say without angular discontinuities at junctions. Each end of the leaf 6 is provided with an anchoring means 8 or 9 allowing fixing of the device 10 for adjustment of the curvature of said leaves, which acts by traction.

Advantageously, the downstream ends of the leaves 6 will be supported by supports which are not shown capable of being adjusted simultaneously in the direction of height and in the longitudinal direction to follow the displacements of said ends of the leaf when the curvature will be modified. Counter rods 11 are provided above the shaping rods 3p slightly displaced forwardly or rearwardly with respect to the shaping rods, having approximately the same transverse profile and arranged at a distance from the shaping rods sufficient to allow passage of the glass sheets between the shaping rods and the counter rods. These counter rods improve the shaping of forward and rear edges of the glass

5 sheets by avoiding a formation of a flat portion, and may be curved rods of the same type as rods 3p, also inclinable, and mounted in sliding bearings urged elastically towards the bearings of rods 3p in such a
 10 manner as to clamp lightly the glass sheets. These counter rods may be themselves in contact with the glass sheets or carry one or more rollers which are in contact with the glass. In another embodiment the counter rods or the counter rods carrying the rollers
 15 are replaced by independent rollers held elastically in contact with the glass.

In a preferred embodiment the zone for heating the glass or in certain cases the furnace is prolonged to the end of the zone E, the frontal wall of the
 20 furnace then being moved to 5" so as to enclose the zone E for longitudinal shaping which allows avoidance of loss of heat during curving, improvement in the optical quality of the glass and homogenisation of the temperature of the glass in order to give a
 25 better tempering. In Figure 1 the leaf spring supports 6 for the bearings of rods 3p are oriented downwardly, an arrangement which minimises wearing of the rods 3p or the sheaths which cover them; but in the same way they may be oriented upwardly. In the
 30 same way the curved rods which are transverse are concave downwardly but they may also be concave upwardly. Thus it is possible, not only to vary the radii of curvature in the two directions of curvature, but also to choose the direction of curvature. As
 35 shown in Figure 1 the path followed by the glass sheets on the rollers 1 in the reheating furnace, on the rods 3a, 3i, 3n, 3p in the curving zone and then in the tempering zone G follows a regular profile without angular discontinuities, that is without
 40 breaks, with a radius which varies so as to be continuous from infinity in the reheating furnace up to a value which may be close to 1 metre in the zones E and G.

Figure 2 shows in greater detail the tempering means not shown in zone G of Figure 1.

In zone G rods 3x identical to rods 3p and 3n and of the same inclination are arranged in the latter portion of the curvilinear profile formed by the leaf
 45 springs 6. Counter rods 11x identical with regard to their shape to counter rods 11 of the zone E, or rollers, or counter rods carrying rollers, are mounted as in zone E above and preferably facing the rods 3x, that is to say not spaced with respect to rods 3x. Between these rods and these counter rods are
 50 interspersed blowing means for example double nozzles 12 as shown in Figure 2, fed individually either directly by flexible hoses which are not shown, or by means of blowing boxes which are not shown. These nozzles are oriented so as to be
 55 normal to the glass surface which passes on the rods, except for the two first nozzles 13a and 13b of which the blowing end is curved in a direction interior to the zone G so as not to cool or disturb the zone E for longitudinal shaping which is immediately
 60 upstream. These nozzles 12 are mounted on members carried by bearings in which the rods 3x turn or are directly mounted on the leaf spring 6. Thus, whatever the curvature of said leaves 6 they will conserve their blowing direction perpendicular to
 65 the glass sheets and their blowing ends will always

be at the same distance from the glass; this allows a uniform blowing which is perfectly controlled.

Advantageously when the rods 3x are curved the blowing nozzles will be arranged in several articu-
 70 lated parts as described in French Patent Publication 2,144,523, preferably with overlap of the contiguous parts to avoid a heterogeneity of blowing at the level of the articulations.

It is also possible to have each bearing for a rod 3,
 75 in particular the bearings for rods 3x, and each nozzle support fixed individually on a screwed rod connected to an exterior framework, which thus renders each bearing and each support for a nozzle individually adjustable.

In the embodiment described above there has been provided successively transverse curving and longitudinal curving. But it is also possible to carry out the two curvings in the two directions simultane-
 80 ously avoiding the two half-zones C and D shown in Figure 1 by rendering the rods 3p of the zone E for shaping in the longitudinal direction progressively more and more curved from the curvilinear surface determined by the different axes of pivoting of the rods 3p mounted to rotate in the
 85 bearings which rest on the curved leaves 6.

The transverse curving provided in zone B may also be omitted, and the curved rods 3p will then rest embedded in the curvilinear surface already defined previously and parallel to the surface defined by the
 90 two leaves 6. When the transverse curving is omitted the curved rods 3p may be replaced by rectilinear rollers. It is thus possible to make glass sheets having only one curvature in the longitudinal direc-
 95 tion.

The system of leaf springs 6 held curved by a device 10 adjusted by traction such as one or more pulling members and carrying the conformation rods 3x, is suitable to give glass curvatures having a radius as low as about 0.90 metres and it allows
 100 attainment of any greater radii up to infinity.

Because of the anchoring of these leaves 6 to a fixed point 7 with respect to the end of the half-zone D in the case of Figure 1, or in a more general manner fixed with respect to the end of the station
 110 immediately upstream, as for example the end of the reheating zones for the glass in the case where the zone B does not exist, the glass sheet travels on supports of which the longitudinal profile is regular and varies continuously without break. There is thus
 115 obtained a perfectly regular curving, further improved by the fact that it takes place in a heated enclosure and thus with a relatively low temperature very slightly greater than the temperature at the start of tempering, that is greater by only about 12
 120 degrees.

Figure 3 shows a view from above of a curving device with a glass sheet V to be curved. The contours in broken lines of the sheet of glass V indicate all the possible shapes which it may take.
 125 The rods 3 may be directed upwardly and at this stage the sheet takes a curvature of which the concavity is turned downwardly; the rods 3 may be, on the other hand, lowered in which case the concavity is oriented upwardly; the leaf-springs 6
 130 may be lowered and in this case the longitudinal

curvature has a concavity turned downwardly and inversely, if they are curved upwardly, the concavity of glass in the longitudinal direction will be turned upwards. Further, each of the leaves 6 may be

5 curved differently and can thus give to the glass an unsymmetrical shape having double curvature.

Figure 4 shows another arrangement of the curving zones. To facilitate reception of the glass sheets at the output of the curving and tempering device

10 the whole of said device is tilted upwardly. Thus it is possible to recover the curved and tempered glass sheets on a horizontal transporter close to the same level as the upstream device for transport. To avoid faults which affect the forward edges of the glass

15 sheets when they encounter an angular discontinuity, the profile of the upstream transporter is modified by giving it a slight slope so that it arrives at, tangential to the shaping surface.

The modification of the profile of the transporter in

20 the reheating furnace may start at an early stage, an essential factor being that there is no angular discontinuity in the path of the glass when it is in the plastic state. Even if it is considered necessary, to obtain a suitable profile it is possible to elongate the

25 reheating furnace or add to the output of the furnace a heated enclosure which will give more space to modify the profile of the path of the glass. Further a longer reheating furnace or a supplementary heated enclosure at the output of the furnace will allow a

30 longer time for heating the glass and thus an improved homogenisation of temperature which is beneficial for tempering.

All these measures to obtain an improved quality of curvature of the glass also contribute to the

35 obtaining of an improved state of tempering of the glass. The majority of the standards in force forbid appearance of splinters more than 6 cm long in automobile panes when they are broken. This may be obtained with the improved curving device

40 described above. An increase in the time of heating of the glass homogenises the temperature of the glass and this homogenisation associated with a regular tempering allows obtaining of a satisfactory result.

The supports for the bearings of the shaping rods are formed of one or more leaf springs in the above-described embodiment but they may also be obtained by the systems described below and shown in Figures 5 and 6. These systems comprise

50 bars 14 which are curved, arranged longitudinally on each side of the path of the glass. The two ends of each of these bars are in the extension one to the other thus allowing said bars to be inclined, pivoting in the bearings 15 about the axis passing through the

55 two ends as shown in Figure 5. Each of these bars 14 carries a sliding bearing 16 in which are mounted the ends of shaping rods 3.

Thus, when it is desired to modify the longitudinal curvature of the bed of shaping rods the inclination

60 of the curved bars 14 will be varied.

This longitudinal curvature may be zero when these bars are embedded in the same plane, it will be at maximum and the same as the curvature of the bars 14 themselves when they are raised vertically

65 with respect to the plane in which they were

previously embedded. Thus in the same way as with the leaf spring 6 it is possible to pass from flat glass to glass having one or two curvatures with different radii of curvature, the maximum curvatures being, in

70 the transverse direction, those of the curved rods 3 and said rods being vertically raised in the longitudinal direction by bars 14, said bars thus being tilted vertically. In the same way as with the leaf springs 6 the two bars 14 may be inclined differently thus

75 allowing an unsymmetrical longitudinal curvature. In the same way as before, when only a simple curvature is desired, that is to say in a single direction, it is possible to choose to carry out this curvature causing the glass to pass on a path formed

80 by rectilinear rods arranged along a curvilinear longitudinal profile.

Another means of modifying the profile of the longitudinal curvature is shown in Figure 6, the bearings of the shaping rods 3 being mounted on

85 slider 17, said bearings each resting on cams 18.

By rotating the cams 18 there is caused raising or descent of the sliders which entrain the bearings of the rods 3 and vary the positioning in height of said rods. It is possible to control all these cams from a

90 common axis 19 or to control them individually. All the cams 18 should have different profiles which are determined as a function of the range of curvatures which it is desired to be able to reproduce.

As in the preceding embodiments if a simple

95 curvature of the glass in a single direction is necessary it is possible to use rectilinear rollers as the shaping rods.

Further, it is possible to combine the leaf springs to the first embodiment or the curved bars of the

100 second embodiment with the system of sliders 17 and cams 18. It is thus possible with the sliders and the cams to modify the profile of curvature of the shaping bed, given by the springs or the curved bars without touching the adjustments of said springs or

105 said bars which are curved. It is possible for example to obtain a longitudinal curvature which is more pronounced than that allowed with the curved bars tilted to the maximum.

In the case of the arrangement as a saddle-back of

110 the shaping rods, as shown in Figure 4, the recovery of the glass sheets at the output of the curving and tempering device is particularly easy as it is carried out on a horizontal transporter practically at the same level as the upstream transporter. The length

115 of the device is not critical and following the zone G for tempering in which there is created the necessary difference in temperature between the core and the surface of the glass and in which the glass is rendered sufficiently rigid so that it does not deform

120 any more, it is possible to arrange on the extension of the curvilinear profile a cooling zone which confirms the state of tempering required, retaining this difference in temperature so as to avoid the release of the stresses.

This arrangement as a saddle-back of the longitudinal curving will be all the more advantageous when the radii of curvature are greater so as to minimise the modification of the upstream transporter which has to bring the glass sheets tangentially

130 to the curving bed.

In the case of the device illustrated in Figure 1, to avoid displacements which are too big in height or in length when the longitudinal radius of curvature is altered, preferably there is arranged on the modifiable curvilinear profile as few elements as possible, that is to say only the means for shaping and the tempering means which are strictly necessary to establish the difference in temperature between the core and surface of glass and to render the glass rigid, the necessary complementary cooling being carried out in devices placed downstream and not mounted on the leaf springs.

In the case of a machine for curving and tempering of a type shown in Figures 1 and 2, the means for recovery of the glass sheets at the output of the tempering may be: a bath filled with a fluid having a good coefficient of heat exchange for example oil or molten salt in which the curved glass falls in free fall to land on the surface of an inclined conveyor which removes it or a horizontal conveyor having a flexible surface capable of receiving the glass sheet which falls in free fall from the last pair of rods 3x and counter rods 17 and transporting between two blowing boxes of known type or an extension of the leaf springs until the glass traverses a complete semi-circle, which extension is provided with rods and counter rods to transport the glass sheet through the blowing boxes, to deliver it onto a horizontal conveyor having an orientable access ramp arranged below the start of the machine for curving and tempering.

CLAIMS

1. A device for curving and tempering sheets in the plastic state (such as glass sheets brought to the softening temperature on a shaping bed) comprising a plurality of shaping rods arranged in a bed along which the sheet passes in contact with the rods, the bed comprising a portion having a curvilinear profile in the longitudinal direction of motion of the sheets tangential to a means for feeding the sheets situated immediately upstream of said portion thus making with said upstream means a path having a radius of curvature which is continuously variable.
2. A device according to Claim 1 in which the shaping rods of the portion having a curvilinear longitudinal profile are mounted on spring leaves arranged longitudinally on each side of the shaping rods.
3. A device according to Claim 2, in which the upstream end of the spring leaves is fixed with respect to the means for feeding the sheets immediately upstream of said leaves.
4. A device according to Claim 2 or 3, in which the spring leaves have their ends connected to traction means to draw them into a desired curved shape.
5. A device according to Claim 4, in which the traction means belongs to one of the following categories: drawing members adjusting separately the curvature of each leaf, drawing members arranged below the leaves so as to curve them downwardly and drawing members disposed above the leaves so as to curve them upwardly.
6. A device according to Claim 1, in which the shaping rods of the portion having a curvilinear longitudinal profile are mounted on curved bars arranged longitudinally on each side of the shaping bed.
- A device according to Claim 6, in which the path for feeding the sheets to be curved on the portion having a curvilinear longitudinal profile is arranged to arrive tangentially at said curvilinear portion.
8. A device according to Claim 6 or 7, in which each curved bar has a saddle-back profile and has its two ends aligned and mounted in bearings about which they may turn so as to vary the longitudinal curvature of shaping bed.
9. A device according to Claim 8, in which the shaping rods are mounted on the curved bars by means of sliding bearings.
10. A device according to any one of the preceding claims in which the shaping rods are mounted in moveable bearings on sliders adjustable in height.
11. A device according to any one of the preceding claims, in which the shaping rods are associated with respective complementary means for holding the sheet such as a counter rod and/or rollers spaced from the rod by a distance at least equal to a thickness of the sheet, said means being spaced longitudinally with respect to the rod with which it is associated.
12. A device according to Claim 11, in which complementary holding means is urged elastically towards the rod with which it is associated.
13. A device according to any one of the preceding claims, in which the shaping rods are rectilinear.
14. A device according to any one of the claims 1 to 12, in which the shaping rods are curved rods having their two ends aligned to form an axis about which they may be inclined to form a shaping bed having a transverse profile which may be curved.
15. A device according to Claim 14, in which a part of the shaping bed having a curvilinear profile in the transverse direction only precedes a part of the bed having a curvilinear longitudinal profile.
16. A device according to Claim 14, in which the shaping bed has a progressive curvilinear profile simultaneously in the transverse direction and in the longitudinal direction.
17. A device according to any one of the preceding claims, in which the bed is mounted at least in part inside an enclosure which is heated, associated with a reheating furnace for the sheets or forming part of it.
18. A device according to any one of the preceding claims, in which a tempering zone comprising blowing nozzles interspersed between rods identical to the shaping rods is arranged on a curvilinear profile continuing the longitudinal curvilinear profile of shaping.
19. A device according to Claim 18, in which the nozzles are fixed normal to the surface of the bed integral with the rods or with bearings or supports therefor.
20. A device according to Claim 18 or 19, in which the blowing nozzles associated with the rods are articulated with their contiguous portions overlapping.

21. A device for curving and tempering sheets, substantially as hereinbefore described with reference to the accompanying drawings.

22. A method of curving and tempering sheets in which said sheets are heated to achieve the plastic state, curved and tempered, wherein the sheet is heated to a temperature at least equal to its temperature at the start of tempering, the sheet is maintained at this temperature, there is carried out curving of the sheet while at this elevated temperature, and the sheet is immediately tempered after the curving by homogeneous blowing of cooling fluid.

23. Glass sheets, when curved and tempered by a device according to any one of claims 1 to 20.

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