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GB 1159001
GB 1041510
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(54) Method of, and apparatus for producing a composite sheet

(57) A method of and apparatus for producing a composite sheet, consisting of two parallel sheets (12), e.g. glass, which are maintained spaced apart by a profile frame (14) encircling the edges of the sheets, and engaging between the edges of the sheets, comprises arranging the sheets parallel to one another in a substantially vertical position at a distance from one another which is greater than the width of the profile frame, forming a closed profile frame from a continuous profile strand, mitre recesses (84) being provided in the profile strand in planes corresponding to the corners before the profile frame is formed, aligning the profile frame between the sheets and causing the sheets and profile frame to adhere to one another.

FIG.5

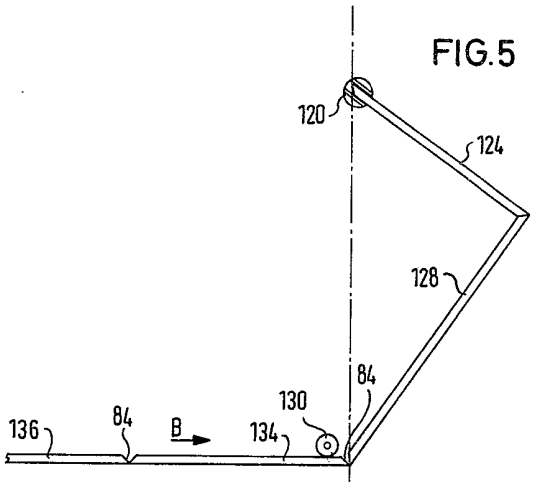

FIG.9

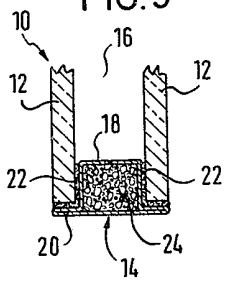

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FIG.1

FIG.1A | FIG.1B

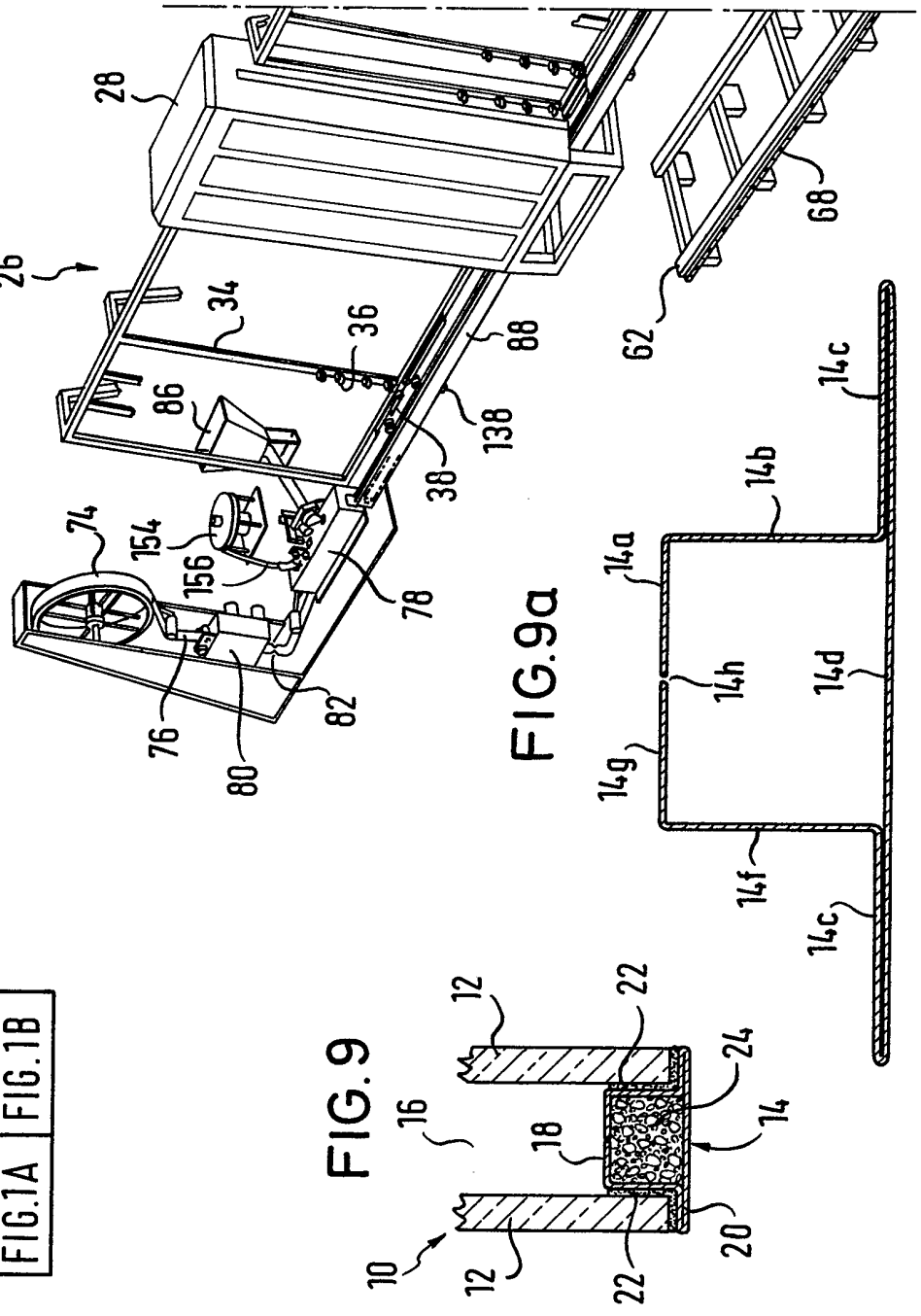

FIG.1A

FIG.9a

FIG.9

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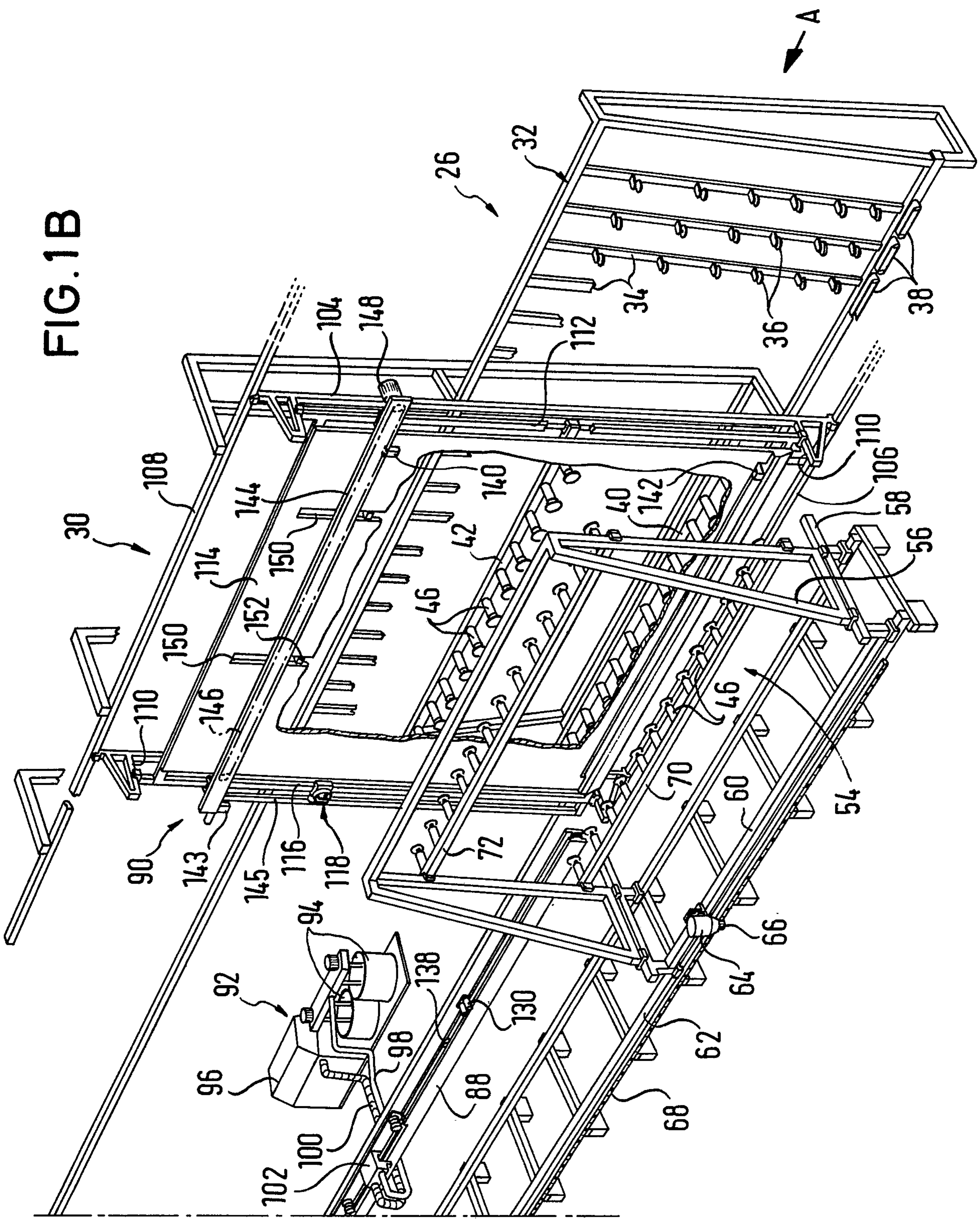

FIG.1B

FIG.2

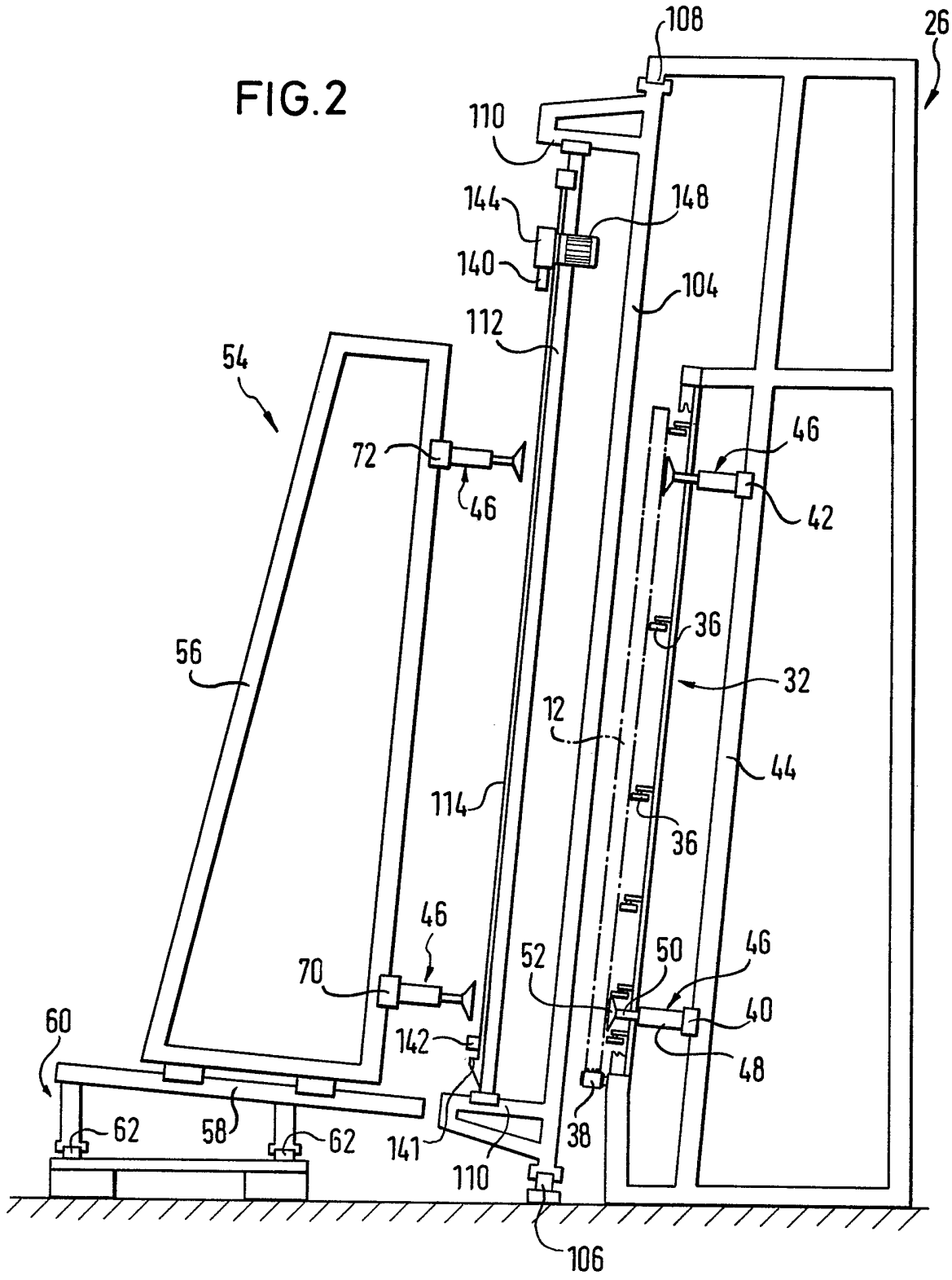
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FIG. 3

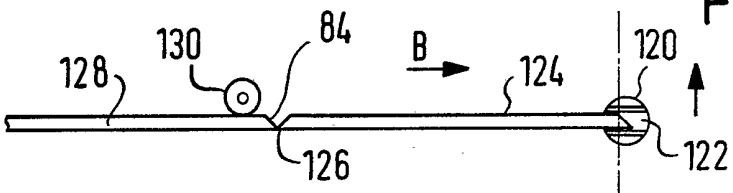


FIG. 4

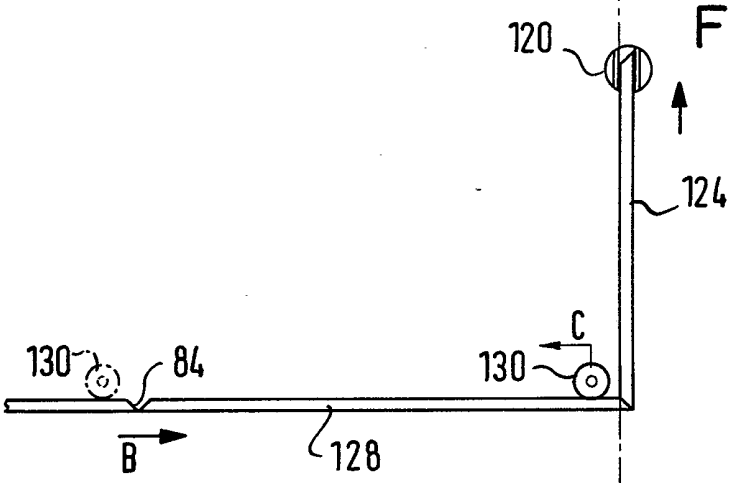
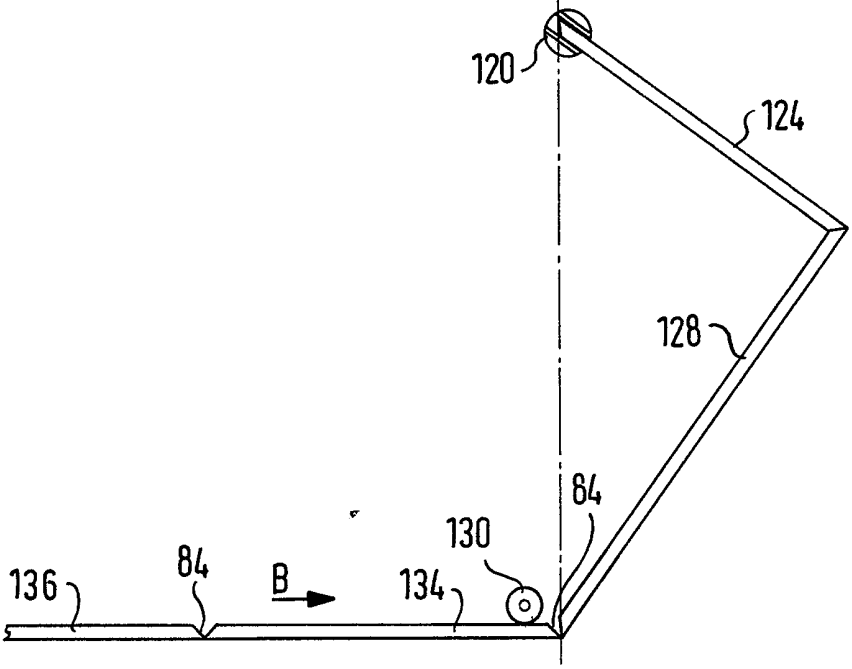


FIG. 5



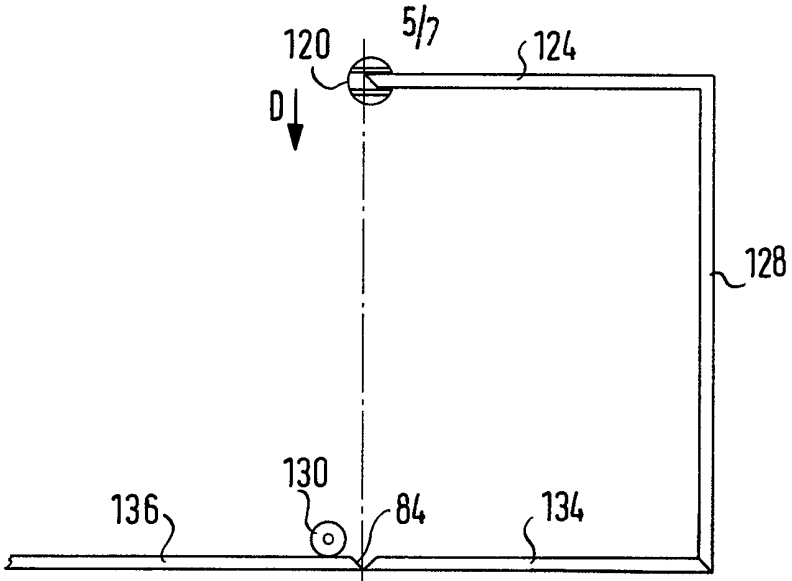
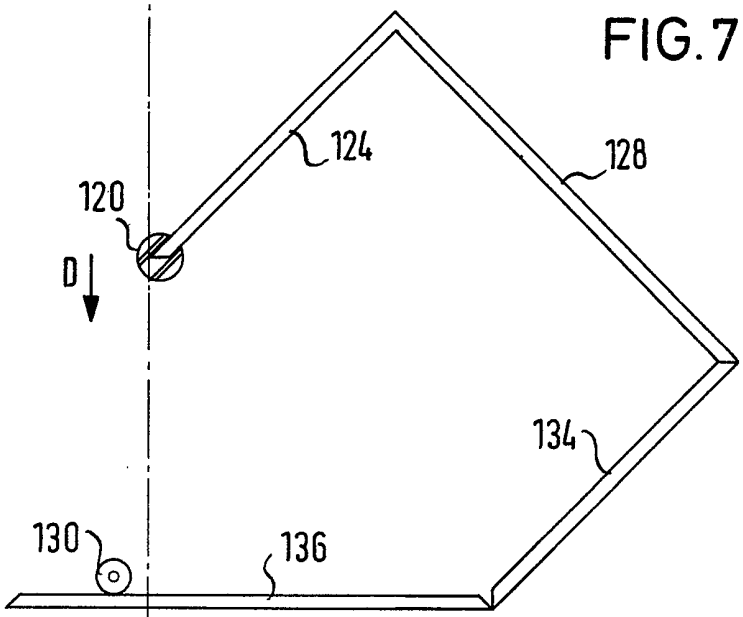


FIG.6



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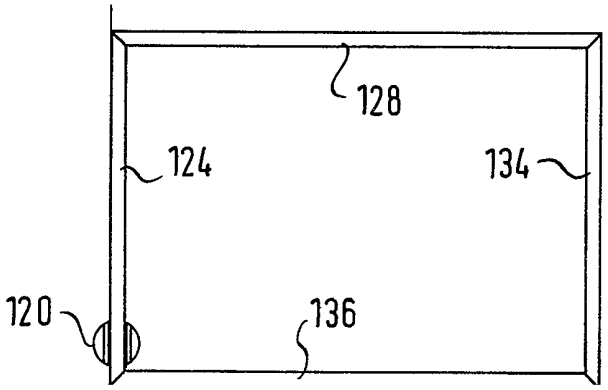


FIG.8

FIG.10

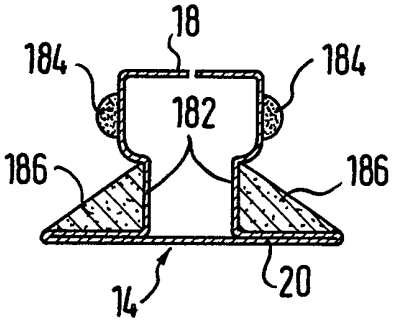
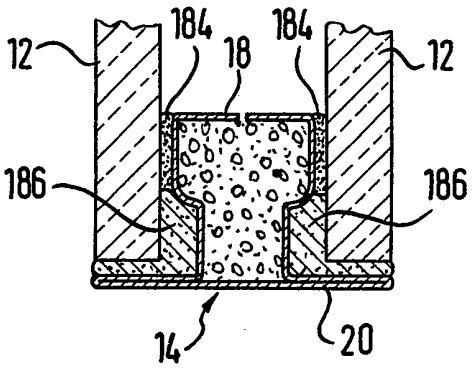


FIG.11



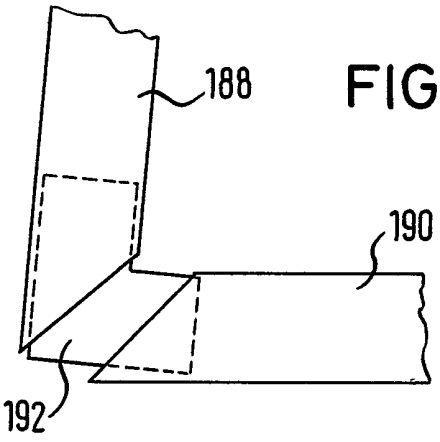
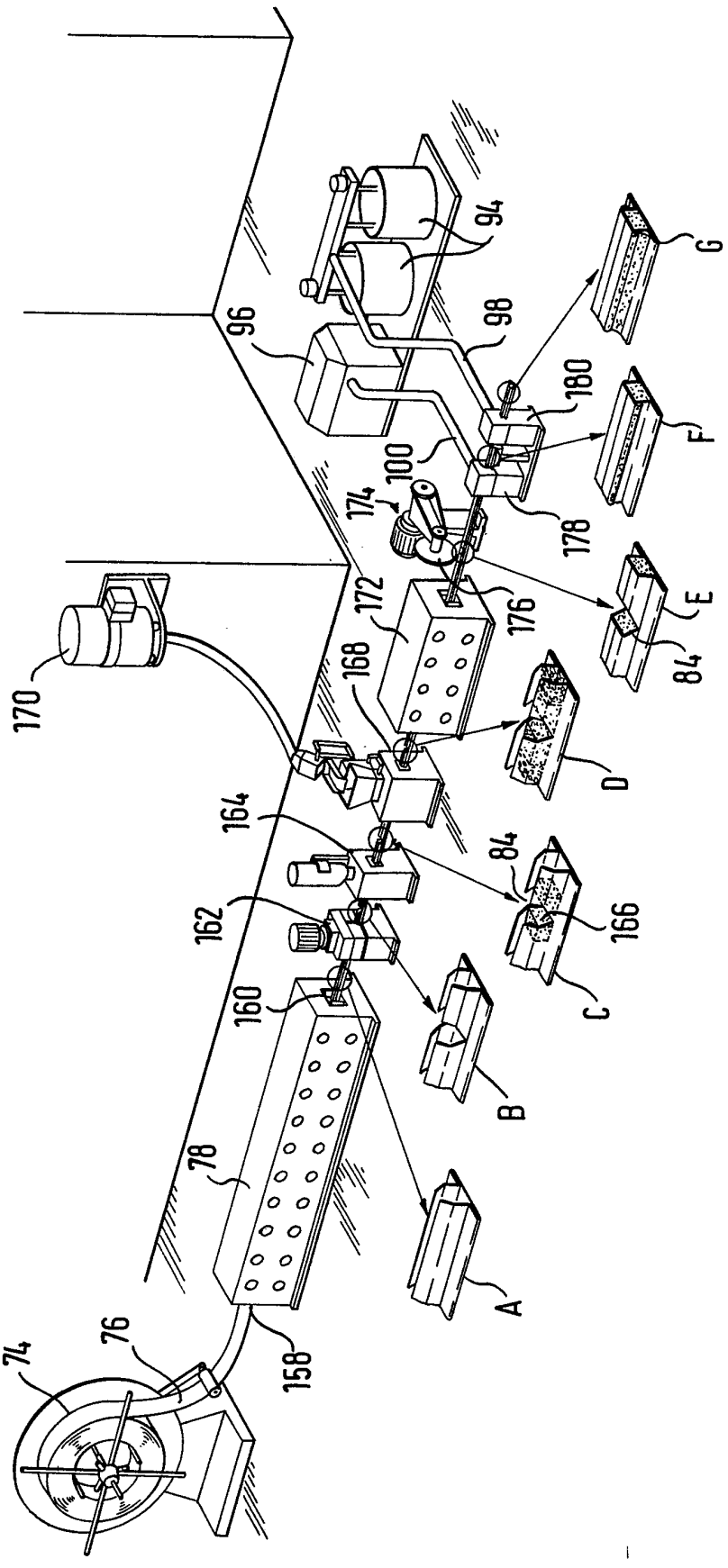


FIG.13

FIG. 12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SPECIFICATION

Method of, and apparatus for producing a composite sheet

The invention relates to methods of and apparatus for producing composite sheets, e.g composite glass sheets.

The production of composite sheets, e.g., composite glass sheets, is at present relatively expensive and complicated. Customarily a first sheet is first of all laid horizontally upon a support. Then a profile frame assembled from individual profile sections, coated with an adhesive and sealing medium, is laid upon the first sheet. Then the second sheet is laid upon the profile frame and the entire arrangement is pressed together.

This has a number of disadvantages. First of all, a degree of rationalisation can only be achieved if a large number of composite glass sheets with the same dimensions are to be produced, since otherwise the profile sections for the production of the profile frames would have to be measured and cut to length individually for each sheet. But this means that it might conceivably be impossible to deal immediately with incoming orders because it is necessary to wait until an appropriate number of equal-sized composite glass sheets can be produced.

Particularly in the production of extremely large composite glass sheets with an edge length of several metres, the handling of the individual sheets in the horizontal position is difficult and necessitates considerable outlay and space. For example, it is necessary to ensure that the lower of the two individual sheets is supported in such a way that no scratches are made on the sheet.

According to one aspect of the present invention there is provided a method of producing a composite sheet consisting of at least two parallel sheets which are maintained spaced apart by a profile frame encircling the edges of the sheets and engaging between the sheets, the method comprising the steps of arranging the sheets parallel to one another in a substantially vertical position at a distance from one another which is greater than the width of the profile frame, forming a closed profile frame from a continuous profile strand, mitre recesses being provided in the profile strand in the places corresponding to corners before the profile frame is formed, aligning the profile frame between the sheets, and causing the sheets and the profile frame to adhere to one another.

The handling of the sheets and of the profile frame in the vertical position is considerably simpler and more economical of space than in the horizonatl position. The vertical arrangement of the two sheets and of the profile frame between the sheets creates the possibility of joining the sheets and the profile frame together in one work stage. The production of the profile frame from a continuous profile strand permits a rational production of the profile frame for composite sheets of any desired size.

The profile frame is preferably bent from a continuous metal band, the mitre recesses being formed in the metal band before or during the shaping of the profile frame. The mitre recesses are therefore punched from the metal band at intervals which correspond to the edge lengths of the sheets to be processed.

The profile frame, for example, has a substantially T-shaped cross-section, the leg of which has a substantially rectangular cross-section engaged between the sheets and a crossbar which abuts against the edge surfaces of the sheets. The leg constitutes the distance piece between the sheets, whereas the crossbar provides a frame enclosed in the individual plates.

It is necessary to achieve good adhesion of the sheets to the profile frame and also good sealing of the space enclosed by the profile frame and the sheets.

In order to achieve this, preferably the leg of the profile frame has, in a section adjoining the crossbar, a constriction consisting of depressions extending in the longitudinal direction of the profile frame on both sides of the leg, a sealing compound being applied to the lateral surfaces of the leg and adhesive being applied in the region of the constriction.

The combined adhesive and sealing media currently available commercially do not fulfil all desiderata. Either their adhesive action or their sealing action is defective. The method according to the invention takes this fact into consideration by using a sealing compound and an adhesive. Of these the adhesive is arranged at a place on the profile frame where two surfaces standing mutually at right angles are available as adhesion surfaces, so that a particularly good bond is obtained between the edges of the sheets and the profile frame. The sealing compound is located between surfaces which – referred to the adhesion surfaces – are displaced towards the interior of the space enclosed by the sheets and the profile frame. The sealing compound is therefore only exposed in a small degree to mechanical stresses or to the effects of the atmosphere, and can therefore perform its sealing function without restriction even over long periods.

The sealing compound is preferably applied in the form of a string, for example, to the lateral surfaces of the leg of the profile frame. This has the result that when the sheets are pressed with the profile frame the sealing compound is squeezed flat. Consequently the sealing compound firmly contacts the surfaces adjoining the sealing joint and no holes or gaps in the sealing joint result.

The adhesive is preferably applied in a triangular configuration which is triangular in cross-section, with a side thereof declining from the end of the constriction remote from the crossbar to the outer edge of the crossbar. Now when one of the sheets is placed upon the crossbar and urged against the leg, the adhesive is crushed so that it fills the constriction and becomes distributed over the entire available adhesion surfaces. The constriction here provides the possibility to keep the adhesive and the previously applied sealing compound mutually separate and to apply a greater quantity of adhesive.

For the production of the mitre recesses in the places of the profile strand corresponding to the

corners of the profile frame to be formed the procedure may be adopted that the appropriate mitre recesses are punched out either in the still unshaped metal band or else in the shaped profile strand. The mitre recesses are preferably formed during bending of the profile frame after the bending of the crossbar and the side walls of the leg, but before the bending in of the free end of the leg. The mitre recesses may be formed by means of a first tool engaging into the profile frame and a second tool arranged outside the profile frame and cooperating with the first tool. The first tool may be an internal die and the second tool may be a punch reciprocating transversely to the longitudinal direction of the profile frame.

Where the profile frame is used for producing a composite glass sheet, a moisture-absorbant material, e.g. silica gel, is packed into the hollow leg before the latter is bent together. This material has the function to absorb the moisture contained in the airtight space between the sheets of the composite glass sheet and thus to prevent misting of the sheets.

In the preferred embodiment, the profile strand is fed continuously to a bending station in which the leading end of the profile strand is gripped by a driver and moved along a stationary guideway during feeding of the profile strand at right angles to its feed direction so that a first profile section lying between the leading end and a mitre recess is bent about an axis oriented through an apex of the mitre recess until the edge surfaces of the profile sections adjoining the mitre recess abut mutually, the feed movement of the profile strand and the movement of the driver are continued until the leading end of the first profile section strikes against the rear end of a profile section separated from the first profile section by at least a second profile section. Therefore if e.g. a rectangular profile frame is produced, then in the first bending step the first profile section becomes bent through 90° with reference to the profile strand. Any further bending is prevented by the mutually abutting edge surfaces of the mitre recess. However if the feed movement of the profile strand is continued, then the second profile section, maintaining the right-angle between itself and the first profile section, becomes bent above an axis which lies in the apex of the mitre recess between the second and the third profile sections. When the mitre recess between the second and the third profile sections is closed, the third profile section conjointly with the first and the second ones becomes bent above an axis which is located in the apex of the mitre recess between the third and the fourth profile sections. When this mitre recess is closed, the leading end of the first profile section strikes against the rear end of the fourth profile section and the profile frame is closed.

In principle it is unnecessary for the profile frame to be particularly joined at the corner where the two free ends of the profile strand converge, because after the pressing of the sheets and of the profile frame the latter can no longer change its shape. Preferably however, the free ends of the profile strand constituting the profile frame are joined together mechanically. The joint may be effected e.g., by laser welding by means of a CO_2 laser, by ultrasonic soldering or by fitting in a corner angle which is introduced into the two free ends by means of an auxiliary device.

After the separation of the rear end of the fourth profile section from the profile strand, the profile frame can then be inserted between the sheets. By this bending method, in conjunction with the punching out of the mitre recesses, the production of the profile frames can be performed fully automatically and considerably more rationally than hitherto. It should be emphasised that this method may also be applied to the production of profile frames which do not serve for the production of composite plates or composite glass sheets.

The adhesive and sealing materials are preferably applied to the profile strand before the shaping of the profile frame, because in this case the profile strand need only travel past a stationary adhesive applicator device.

According to another aspect of the present invention there is provided an apparatus for producing a composite sheet consisting of at least two parallel sheets which are maintained spaced apart by a profile frame encircling the edges of the sheets and engaging beneath the sheets, the apparatus comprising an upright conveyor for transporting the sheets consecutively in a substantially vertical position towards an assembly station, a first manipulator to receive a first sheet from the upright conveyor and to adjust the first sheet into an assembly position, a second manipulator movable at right angles to the transport direction of the upright conveyor to receive a second sheet from the upright conveyor and to adjust the second sheet into a standby position in which the second sheet is arranged parallel and coincidently to the first sheet at a distance therefrom which is greater than the distance between the sheets of the composite sheet to be formed, a device for shaping the profile frame from a continuous profile strand and a frame bracing device for the adjustment and releasable retention of the profile frame in an assembly position in which the profile frame is located between the sheets.

When the two manipulators are holding the sheets in an assembly position and in a standby position respectively and the profile frame is occupying its assembly position, the two individual sheets are joined to the profile frame in that the second manipulator urges the second sheet against one side of the profile frame coated with adhesive on both sides, and after said profile frame is released from the frame bracing device urges the second sheet conjointly with the profile frame against the first sheet. In this manner it is unnecessary for the sheets, which may possibly be very heavy, to be touched by operatives. In addition to the economy of labour, this also has the advantage that, e.g., the risk of smearing of individual glass sheets before their assembly is reduced. Thus the apparatus may include a washing device for the sheets in the transport path of the upright conveyor upstream of the assembly station. After leaving the washing device the individual sheets need no longer be touched by operatives before their assembly into a composite sheet.

The upright conveyor may comprise a roller frame

with a plurality of rollers freely rotatable about substantially vertical axes, a substantially horizontal band conveyor being arranged at the lower end of the roller frame. The sheets edge upon the horizontal band conveyor and are supported by the roller frame. The roller frame and the band conveyor are preferably inclined with respect to the vertical and to the horizontal respectively, so that, in operation, the sheets standing on the upright conveyor are in abutment with the roller frame under the action of gravity.

To enable sheets of any desired size to be held in a vertical position, the manipulators preferably each have a plurality of controllable suction cups which are adjustable relative to each other and synchronously with each other at least in the vertical direction. For example, each manipulator may comprise two rows of suction cups which are arranged respectively on horizontal, mutually superposed and vertically adjustable brackets which are adjustable both relatively to each other and also synchronously with each other. By the relative movement of the brackets to each other the suction cups can be adjusted to different sheet sizes. In the case of a synchronous adjustment of the brackets the sheets may be raised or lowered. The suction cups themselves may be brought into contact with the sheets and made operative by means of a hydraulic or pneumatic actuating device.

The second manipulator is preferably adjustable parallel to the transport direction of the upright conveyor. The second manipulator can thus lift the second sheet from the upright conveyor and transport it into a standby position when the first sheet is already in the assembly position.

The mobility of the second manipulator vertically and parallel to the transport direction of the upright conveyor may be achieved by arranging, for example, that the second manipulator has a first frame on which the bracket for the suction cups is arranged vertically adjustably and which is arranged adjustably at right angles to the transport direction of the upright conveyor on a second frame which is, in turn, adjustable parallel to the transport direction of the upright conveyor. Each of the two frames of the second manipulator may be guided on rails and adjustable by means of an adjusting drive.

According to yet another aspect of the present invention, there is provided an apparatus for shaping a profile frame from a continuous profile strand, comprising a profile shaping unit for shaping a continuous profile strand from a metal band, a punching device controlled as a function of the dimensions of the profile frame to be formed to form mitre recesses in the metal band in the locations corresponding to the corners of the profile frame to be formed, and a bending means for bending profile sections of the profile strand mutually separated by the mitre recesses about axes oriented in the mitre recesses to form a closed profile frame.

The control of the punching device may be effected either by a measuring device which measures the edge length of sheets deposited upon an upright conveyor, or directly by feeding the already known data of the sheets into a control device.

The profile shaping unit may be constructed so that it produces a hollow profile with a substantially T-shaped cross-section, a charging device being provided for charging a moisture-adsorbant medium before the closure of the profile strand. A device for applying an adhesive and sealing compound to the profile surfaces may be arranged between the profile shaping unit and the bending means. The continuously passing profile strand can thus be coated with the adhesive and sealing compound in simple manner by means of a roller or other applicator element.

In order to prevent sagging or buckling of the profile strand between the profile shaping unit and the bending means, the apparatus may include a profile strand guideway oriented substantially parallel to the transport direction of an upright conveyor for feeding the profile strand from the profile shaping unit to the bending means is arranged between the profile shaping unit and the bending means.

The bending means may have a bracing wall which is oriented substantially vertically and parallel to the profile strand guideway and with which a bending tool is associated. In one embodiment, for example, a guideway for a driver to grip and guide the leading edge of the profile strand is arranged at a vertical edge pointing towards the profile shaping unit and directed parallel to said edge and substantially at right angles to the profile strand guideway, whilst the movement of the driver is controllable as a function of the feed velocity of the profile strand so that the profile strand is bent at the mitre recesses during the feed of the profile strand in the plane of the bracing wall to form mitre corners. The bracing wall is likewise preferably inclined slightly relative to the vertical, so that the profile frame produced by the bending process rests against the bracing wall by the action of gravity.

In order to prevent, during the bending of the relevant profile section, the next profile section from being raised concomitantly due to the rigidity of the material, a workholder movable parallel to the profile strand guideway may be provided on the latter in order to depress the profile strand immediately behind the mitre recess where bending is just proceeding.

The workholder is preferably connected to a sensor for sensing mitre recesses, which trips the return of the workholder to behind the next mitre recess when the mitre recess closes, i.e. when the prescribed final angle between two profile sections is attained.

The bracing wall has the function to maintain the profile frame in a plane until it is connected to the second sheet and adheres thereto. The bracing wall must be removed in order that the profile frame, and with it the second sheet, can be placed upon the first sheet located in its assembly position. For this purpose the bracing wall may be adjustable parallel and at right angles to the transport direction of the upright conveyor. By a slight movement at right-angles to the transport direction of the upright conveyor, the bracing wall can be separated from the profile frame and is then extracted from the assembly station parallel to the transport direction of the upright conveyor.

In order to maintain the profile at the bracing wall so that the profile sections form the prescribed mutual angles, horizontally and vertically adjustable alignment stops may be provided on the bracing wall. Preferably two upper aligning stops are arranged adjustably on a horizontal rail arranged vertically adjustable in front of the bracing wall, so that they can be adjusted in both the vertical and the horizontal and thus be adjusted to different frame sizes.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:—

Figure 1 shows a partly schematic perspective view of an apparatus according to the present invention for producing a composite sheet;

Figure 2 shows a schematic end elevation taken in the direction of the arrow A in Figure 1;

Figures 3 to 8 show the individual steps during the bending of a profile frame for a composite sheet produced by a method according to the present invention;

Figure 9 shows a schematic partial section through the marginal region of a composite glass sheet, produced by a method according to the present invention, at right-angles to the plane thereof;

Figure 9*a* shows a view on a larger scale of a profile frame shown in Figure 9;

Figure 10 shows a section corresponding to the section in Figure 9 through a further embodiment of a profile frame used according to the present invention, in which a sealing compound and an adhesive are applied to the profile frame;

Figure 11 shows a section corresponding to Figure 9, which represents the profile frame shown in Figure 10;

Figure 12 shows a perspective schematic view of part of an apparatus according to the present invention for producing a composite glass sheet;

Figure 13 shows a larger scale view of a corner of a profile frame used in a method according to the present invention for providing a composite sheet.

Throughout the drawings like parts have been designated by the same reference numerals.

An apparatus according to the present invention and illustrated in Figure 1 serves for the production of a composite glass sheet 10 consisting of two individual sheets 12 (Figure 9) which are arranged mutually parallel and are maintained a predetermined distance apart by a spacer or profile frame 14 encircling the sheet edge. The profile frame 14 seals the space 16 between the individual sheets 12 in an airtight manner. The profile frame 14 is constructed as a hollow profile with a T-shaped cross-section and is coated with an adhesive sealing compound 22 on the surfaces of a leg 18 adapted to abut against the individual sheets 12 and on the surfaces of a crossbar 20 extending from the leg 18 to left and right. The individual sheets 12 are pressed firmly with the profile frame 14 so that the required sealing of the space 16 is achieved. The leg 18 is charged with a moisture absorbant material 24, e.g. a silica gel, which absorbs the moisture present in the space 16 on assembly of the individual sheets 12 and thus prevents any subsequent misting of the adjacent surfaces of the individual sheets 12.

The apparatus according to the present invention comprises a upright conveyor 26, upon which the individual sheets, cut to size, are transported through a washing device 28 to an assembly station 30.

The conveyor 26 comprises a roller frame 32 with a plurality of vertical struts 34 on which a plurality of rollers 36 are arranged, each roller being rotatably about a vertical axis. At the lower end of the frame 32 a plurality of drivable conveyor bands 38 are arranged consecutively in series, the conveyor bands 38 serving as a deposit and transport device for the individual sheets deposited upon the upright conveyor 26 and for the finished composite glass sheet. The plane of the frame 32 and the deposition plane of the conveyor bands 38 are inclined slightly, e.g. at 5°, with reference to the vertical and the horizontal respectively, so that the individual sheets on the conveyor 26 about against the frame 32 under the action of gravity.

A first manipulator for gripping, for adjusting and for retaining a first individual sheet in its assembly position is arranged on a frame connected to the frame 32 in the assembly station 30. The first manipulator comprises two brackets 40, 42 directed substantially horizontally and arranged superposed. The brackets 40, 42 are guided by their longitudinal ends with vertical adjustability on vertical guideways 44 and each carries a series of juxtaposed hydraulically or pneumatically operable suction cups 46. The suction cups are each constructed with a cylinder 48 and with a piston 50, at the free end of which a suction head 52 is arranged. The suction heads 52 can be brought by the piston/cylinder arrangement 48, 50 through the frame 32 up to an individual plate 12 (see Figure 2) standing on the conveyor 26 in the assembly station 30 and rendered operative by means of a pneumatic or hydraulic operating device (not shown), so that they firmly suck the individual sheet 12. By a slight synchronous extension of the pistons 50, the individual plate can be lifted from the frame 32 and raised upwards by a synchronous adjustment of the brackets 40, 42. By an adjustment of the brackets 40, 42 relatively to each other, the first manipulator can be adjusted to different sheet sizes.

A second manipulator serves to grip, adjust and retain the second individual sheet. The second manipulator comprises a first frame 56, which is adjustable at right angles to the transport direction of the conveyor 26 on rails 58 by means of a drive device, (not shown). The rails 58 are part of a second frame 60, which is adjustable parallel to the conveyor 26 on rails 62 laid parallel to the transport direction of the conveyor 26. The adjustment is effected by means of an electric motor 64 which is arranged on the second frame 60, and which carries on its output shaft a pinion 66 which meshes with a rack 68 oriented parallel to the direction of adjustment.

Two brackets 70, 72 corresponding to the brackets 40, 42 of the first manipulator are arranged with horizontal and vertical adjustability on the first frame 56, and each carries, like the brackets 40, 42, a series of suction cups 46.

With the aid of the second manipulator 54, an individual plate standing upon the conveyor 26 in front of the assembly station 30 can be lifted from the conveyor 26 and transported into a standby position in which the plate manipulator occupies the position illustrated in Figure 1B. The individual sheets are not shown in this Figure for the sake of greater clarity.

A device for producing the profile frame 14 can also be seen in Figures 1A and 1B. This device comprises a rotatably mounted supply reel 74 for a metal band 76 from which the profile frame 14 is produced with the aid of a profile shaping device 78, e.g. is rolled through a plurality of serially arranged shaping rollers. Before the metal band 76 is shaped in the profile shaping device 78 into a profile with the cross-section visible in Figure 9, recesses 82 are punched out of the metal band 76 by a punching device 80, being shaped so that the finished profile frame 14 leaving the profile shaping device 78 exhibits in its leg recesses which correspond to mitre recesses 84 such as are illustrated in Figures 3 to 7. In the region of the mitre recesses 84 profile sections of the profile frame on the two sides of the mitre recess 84 cohere solely by the crossbar 20. The recesses 82 may also be punched out during the shaping of the profile frame by a suitable device within the profile shaping device 78.

The punching device 80 is controlled by a measuring device (not shown), which determines the edge length of the profile frame so that the intervals of the recesses 82 in the metal band 76 correspond to the edge length of the composite glass sheet to be produced.

Associated with the profile shaping device 78 is a charging device 86, by means of which silica gel 24 can be charged into the leg 18 before the latter is closed.

From the profile shaping device 78, a guide rail 88 leads through under the washing device 28 parallel to the transport direction of the conveyor 26 to a bending station 90, where the bending of the profile frame illustrated schematically in Figure 8 occurs. Between the washing device and the bending station 90 there is a device 92 for applying an adhesive and a sealing compound. The device 92 comprises two supply tanks 94 for the two components of a two-component adhesive and a supply container 96 for a sealing compound. The adhesive and the sealing compound are passed through pipes 98, 100 respectively to an applicator head 102 which engages over the profile frame 14 guided on the guide rail 88 and through which the adhesive and the sealing compound is applied to the surfaces shown in Figure 9.

The bending station 90 comprises a first frame 104, which is mounted slidably parallel to the transport direction of the conveyor 26 on a top and a bottom rail 106, 108 respectively, oriented parallel to the conveyor 26. The first frame 104 carries four bottom and top rails 110 oriented at right angles to the rails 106, 108, between which a second upright frame 112 is arranged slidably at right angles to the transport direction of the conveyor 26. The frame 112 is substantially covered by an upright bracing wall 114 which serves to brace the resulting profile frame, and the central panel of which is fragmented in Figure 1B in order to provide a view of the brackets 40, 42 of the first manipulator.

At the left-hand (in Figure 1B vertical edge of the frame 112) there is arranged a guideway 116 for a vertically reciprocatingly movable driver 118, the function of which will be explained in detail hereinbelow with reference to Figures 3 to 8.

The bending of the profile frame from the continuously produced distance profile is effected in the following manner: first of all a profile strand emerging from the profile shaping device 78 is fed upon the guide rail 88 until its leading end reaches the bending station 90, which in this case is positioned in the assembly station 30, as Figure 1B shows. The driver 118 is brought into its lowest position and a rotatable driver head 120, which has a guide channel 122 to accommodate the leading end of the profile strand, is aligned so that the leading end of the profile strand can enter the guide channel 122 (see Figure 3). Upon the further feeding of the profile strand in the direction of the arrow B in Figures 3 and 4, the driver 118 is moved simultaneously upwards on the driver guideway 116, its velocity being co-ordinated with the feed velocity of the profile strand so that the first profile section 124 becomes bent upwards above an axis which is oriented at right angles to the plane of the drawing of Figure 3 through an apex 126 of the first mitre recess 84.

In order to ensure that the bending actually occurs at the apex 126 of the mitre recess 84, and that the second profile section 128 does not likewise rise during the upward movement of the driver 118, a workholder roller 130 is arranged on the guide rail 88, is transportable along the guide rail 88 and prevents the profile strand from lifting from the guide rail 88. The workholder roller 130 is adjusted to a position just behind the first mitre recess – considered in the direction of the arrow B – and travels with the profile strand until the position shown in Figure 4 is attained, in which the first and the second profile sections 124, 128 mutually form a right angle and the mitre recess 84 is closed. The workholder roller 130 then travels out of the right hand position illustrated by solid lines in Figure 4 in the direction of the arrow C into the left-hand position, represented by chain dotted lines, behind the next mitre recess 84. The return is controlled by an appropriate control device.

During the further feed of the profile strand, the driver 118 moves further upwards until the position illustrated in Figure 5 is reached. Meanwhile the first profile section 124 and the second profile section 128, the right angle between them being maintained, are bent above an axis which is oriented at right angles to the plane of the drawing through the apex 126 of the second mitre recess 84. In Figure 5 the highest point of the driver 118 for the relevant profile frame has been attained, and during the further feed of the profile strand the driver 118 now moves back downwards in the direction of the arrow D, until the position illustrated in Figure 6 is reached. Meanwhile the workholder roller 130 remains in the position shown in Figure 5. Now during the further feed of the profile strand and further downward movement of the driver 118, the first profile section 124, the second profile section 128 and a third profile section 134

are rotated conjointly, the angles included between them being maintained, about an axis which extends at right angles to the plane of the drawing through the apex 126 of the third mitre recess 84. This process corresponds to the transistion from Figure 6 *via* Figure 7 to Figure 8, in which the finished profile frame may be seen.

Before the profile frame is closed a fourth profile section 136 is cut off from the continuous profile strand by means of a separator device (not shown) and is fed further by means of a transport finger 138 revolving on an endless chain in the guide rail 88.

In practice, the profile frame does not, in all probability, present the ideal shape illustrated in Figure 8, but shows some parallelogram distortion, so that it cannot yet be assembled with the individual sheets 12. The straightening of the profile frame is effected by two top aligning stops 140, 143 and a bottom aligning stop 142, which are arranged slidably on the frame 112 of the bending station 90. The bottom aligning stop 142 is simply slidable horizontally in the direction of the guide rail 88. The top aligning stops 140, 143 are arranged adjustably horizontally in the direction of the guide rail 88 on a horizontally oriented rail 144. The adjustment of the aligning stop 140 may be effected with the aid of a chain 146 indicated by chain dotted lines, which is driven by an electric motor 148. A similar adjusting device may be provided for the aligning stop 143. The rail 144 is in turn arranged vertically adjustably by both its longitudinal ends on vertical guideways of the frame 112. In this manner the aligning stops 140, 143 can be adjusted both horizontally and vertically, so that they are adjustable to any desired frame size.

In order to prevent the profile frame standing upon a support surface 141 (Figure 2) at the lower edge of the bracing wall 114, from tilting to the left in Figure 1B out of the gripping range of the aligning stop 143, a stop bar 145 oriented parallel to the guideway 116 is arranged on the frame 112.

In addition, behind the bracing wall there are arranged, with vertical adjustability, two stop fingers 152 penetrating the bracing wall in vertical slots 150, which engage beneath the top profile section of the profile frame in order to prevent the profile section 128 from sagging, particularly in the case of large profile frames.

The apparatus illustrated in Figure 1 operates in the following manner:—

To commence, a first individual sheet 12 is deposited upon the left-hand end (in Figure 1A) of the conveyor 26. The individual sheet travels through the washing plant 28 and is transported by the conveyor 26 into the assembly station 30, where it is gripped by the suction cups 46 of the first manipulator and lifted upwards from the conveyor bands 38. The first individual plate thus occupies its assembly position. Before it entered the washing plant, the individual plate was measured. The measurement data were fed to a control unit for the punching device 80, which now punches out the recesses 82 in the band 76 drawn off from the reel 74 and fed to the profile shaping device 78. Thus a profile strand is produced, the mitre recesses 84 of which are positioned so that a suitable profile frame for the composite sheet to be produced can be bent.

Simultaneously with the production of the profile frame the second individual sheet is deposited upon the upright conveyor 26, travels through the washing plant 28 and is removed from the conveyor 26, using the suctions cups 46, in an intermediate position between the washing plant 28 and the assembly station 30, by the second manipulator 54 which then likewise occupies a position between the washing plant 28 and the assembly station 30, and transported into a standby position in which it is located parallel and coincidently to the first individual sheet occupying its assembly position in the assembly station. As may be seen from Figure 2, the frame 56 of the first manipulator is for this purpose inclined relative to the vertical in the same degree as the roller frame 32. The required profile frame is now bent from the profile strand in the manner described with reference to Figures 3 to 8. The profile frame now abuts against the bracing wall 114 and is maintained after complete bending by the aligning stops 140, 143, 142 and 152, so that the angles between the profile sections correspond to the angles between the edges of the individual sheets. The frame 56 now travels on the rails 58 towards the bracing wall 114 and urges the second individual sheet into the profile frame, sufficiently firmly to obtain a temporary bond between the profile frame and the second individual sheet. The frame 112 is then adjusted towards the conveyor 26 in order to release the bracing wall 114 and the aligning stops from the profile frame. Thereupon the bending station 90 with the frame 104 is slid to the left (in Figure 1B) on the rails 106, 108 parallel to the transport direction of the conveyor 26, so that the way is clear for the second manipulator 54 to urge the second individual sheet conjointly with the profile frame onto the first individual sheet. The sheets joined in this manner are deposited back to the conveyor bands 38 by both manipulators synchronously and fed on the conveyor 26 to a station (not shown) in which the sheets are pressed together.

It should be emphasised that instead of composite glass sheets, any other type of composite sheets or plates which are correspondingly constructed may be produced with the apparatus according to the invention. The device for the production of a spacer or profile frame may also be used independently of its incorporation into the apparatus according to the invention.

The leg 18 must be closed at the mitre recesses 84 before the silica gel is charged into the profile sections between each two mitre recesses. This is performed in the profile shaping device 78 where sections of a firm plastics strip 156 fed to the profile shaping device 78 from a supply reel 154 are introduced into the ends of the hollow profile section in the region of the mitre recesses 84.

Figure 9*a* shows the profile of the profile frame on a larger scale. The profile frame is rolled from a single flat strip of material, so that all the members 14*a*, 14*b*, 14*c*, 14*d*, 14*e*, 14*f*, 14*g*, cohere and the members 14*a*, 14*g* but together at 14*h*.

The production of the profile strand from which a profile frame is then shaped will first be explained in

further detail with reference to Figure 12. The parts known from Figures 1A and 1B are again provided with the same reference numerals.

The metal band 76 running off the rotatably mounted supply reel or band creel 74 enters the profile shaping device 78 at 158. At the exit 160 of the profile shaping device 78, the profile has the shape illustrated in detail A. With this shape the profile enters a punching device 162, in which recesses are punched out of the continuous profile strand so that the mitre recesses 84 result in the finished profile. The dimensional accuracy of the profile facilitates the punching out of the recesses in the half bent profile. It may possibly present difficulties to deform by rollers the band in which the punchings have already been made. On leaving the punching device 162 the profile has e.g., the configuration illustrated at B in a position corresponding to a corner to be formed.

From the punching device 162 the profile enters a device 164 which pushes closure elements, preferably foam plastics sections 166, into the ends of the profile sections converging at a mitre recess 84 as illustrated at C. Then the profile enters a charging device 168, in which silica gel is introduced through the still open top profile sections. The silica gel is fed to the charging device 168 in a precisely metered quantity from a supply tank 170 in which the metering may be effected e.g., by a balance.

The profile leaves the charging device 168 charged with silica gel, as illustrated at D. It will be seen that the foam plastics sections 166 close the open ends of the profile sections at the mitre recesses 84 and prevents silica gel from escaping at those points.

From the charging station 168 the profile passes into a further profile shaping device 172 in which the still open profile sections are pressed down and the profile is thus closed. This is illustrated at E.

After leaving the profile shaping device 172, after a required profile length has been fed the profile is cut through in a mitre recess 84 with the aid of a separator device 174. The separator device 174 may be constituted e.g., by an upwardly and downwardly pivotable soar.

Now before the profile strand enters the bending station for the formation of the profile frame, sealing compound and adhesive are applied. As in the case of the device described in Figure 1B, the sealing compound is fed from the supply tank 96 through a heatable pipe 100 to a first applicator head 178. The latter, as will be described with reference to Figure 10, applies the sealing compound in the form of a string near the free end of the leg of the profile frame, as illustrated at F. The applicator device 178 is followed by an applicator device 180, to which a two-component adhesive is fed from the two supply tanks 94. The adhesive is applied near the transition between the leg and the crossbar, as illustrated at G. A butyl rubber is preferably used for the sealing compound, whilst Thiokol, a polysulphide, is used as adhesive.

Figure 10 shows on a larger scale a further embodiment of the profile frame in the state in which it is illustrated at G. The profile frame according to Figure 10 differs from the profile frame according to Figure 9 in that the leg 18 exhibits adjacently to the crossbar 20 a constriction which is constituted by two depressions 182, oriented parallel to the longitudinal direction of the profile frame, in the side walls of the leg 18. In the applicator head 178 the sealing compound is applied to the lateral flanks of the wider leg section as a string-shaped bead 184. As shown in Figure 10, the adhesive 186 is applied triangularly – considered in cross-section – so that it substantially fills the depression 182 and declines obliquely to the outer edge of the crossbar 20.

When the profile frame 14 is now pressed with the individual sheets 12 according to the illustration in Figure 11, the beads 184 become flattened so that the sealing compound becomes distributed across the entire lateral flank of the wider section of the leg 18. In the same manner the adhesive 186 is crushed by the individual sheets 12 so that it fills the entire cavity bounded by the depression 182 on the one hand and by the relevant individual sheets 12 on the other hand and extends without gaps over the total available adhesion surfaces. By this conformation of the profile frame and the mode of application of sealing compound and adhesive according to the invention, a secure joint between the individual sheets and the profile frame, and a reliable sealing of the cavities enclosed between profile frame and individual sheets, are ensured.

In order to ensure that the free ends of the profile strand constituting the frame which converge at a corner of the profile frame remain joined together and that no leakage can occur at that point, the convergent profile ends may be joined together mechanically at that point, which may be effected e.g., by laser welding or ultrasonic soldering. A third possibility is illustrated in Figure 13, which shows two profile ends 188, 190 which are joined by means of a corner angle 192 introduceable into the profile ends 188, 190. For this the corner angle may be introduced into one of the ends before the final closure of the profile frame, so that it enters into the other profile end when the profile frame is closed. Obviously this may be followed additionally by a welding or soldering of the joint.

CLAIMS

1. A method of producing a composite sheet consisting of at least two parallel sheets which are maintained spaced apart by a profile frame encircling the edges of the sheets and engaging between the sheets, the method comprising the steps of arranging the sheets parallel to one another in a substantially vertical position at a distance from one another which is greater than the width of the profile frame, forming a closed profile frame from a continuous profile strand, mitre recesses being provided in the profile strand in the places corresponding to corners before the profile frame is formed, aligning the profile frame between the sheets, and causing the sheets and the profile frame to adhere to one another.

2. A method as claimed in claim 1 in which the profile frame is bent from a continuous metal band, the mitre recesses being formed in the metal band before or during the shaping of the profile frame.

3. A method as claimed in claim 2 in which the

profile frame has a substantially T-shaped cross-section, the leg of which has a substantially rectangular cross-section engaged between the sheets and a crossbar which abuts against the edge surfaces of the sheets.

4. A method as claimed in claim 3 in which the leg of the profile frame has, in a section adjoining the crossbar, a constriction consisting of depressions extending in the longitudinal direction of the profile frame on both sides of the leg, a sealing compound being applied to the lateral surfaces of the leg and adhesive being applied in the region of the constriction.

5. A method as claimed in claim 4 in which the sealing compound is applied in the form of a string.

6. A method as claimed in claim 4 or 5, in which the adhesive is applied in a configuration which is triangular in cross-section with a side thereof declining from the end of the constriction remote from the crossbar to the outer edge of the crossbar.

7. A method as claimed in any of claims 3 to 6 in which the mitre recesses are formed during bending of the profile frame after the bending of the crossbar and the side walls of the leg, but before the bending in of the free end of the leg.

8. A method as claimed in claim 7 in which the mitre recesses are formed by means of a first tool engaging into the profile frame and a second tool arranged outside the profile frame and co-operating with the first tool.

9. A method as claimed in claim 8 in which the first tool is an internal die, and the second tool is a punch reciprocating transversely to the longitudinal direction of the profile frame.

10. A method as claimed in any preceding claim in which before forming the leg of the profile frame a moisture-absorbant material is charged into the same.

11. A method as claimed in any of claims 2 to 10 in which the profile strand is fed continuously to a bending station in which the leading end of the profile strand is gripped by a driver and moved along a stationary guideway during feeding of the profile strand at right angles to its feed direction so that a first profile section lying between the leading end and a mitre recess is bent about an axis oriented through an apex of the mitre recess until the edge surfaces of the profile sections adjoining the mitre recess abut mutually, the feed movement of the profile strand and the movement of the driver are continued until the leading end of the first profile section strikes against the rear end of a profile section separated from the first profile section by at least a second profile section.

12. A method as claimed in claim 11 in which the free ends of the profile strand constituting the profile frame are joined together mechanically.

13. A method as claimed in any preceding claim in which a first sheet is picked up by a first manipulator, a second sheet is picked up by a second manipulator, a profile frame is bent and thereafter retained in abutment with a bracing surface, the second sheet is urged against the profile frame coated with adhesive and the profile frame is thereby fixed to the second sheet, the retaining connection between the bracing surface and the profile frame is released, the bracing surface is removed from the position of alignment with the profile frame, and the first sheet is urged against the remaining free side of the profile frame which is likewise coated with adhesive.

14. Apparatus for producing a composite sheet consisting of at least two parallel sheets which are maintained spaced apart by a profile frame encircling the edges of the sheets and engaging beneath the sheets, the apparatus comprising an upright conveyor for transporting the sheets consecutively in a substantially vertical position towards an assembly station, a first manipulator to receive a first sheet from the upright conveyor and to adjust the first sheet into an assembly position, a second manipulator movable at right angles to the transport direction of the upright conveyor to receive a second sheet from the upright conveyor and to adjust the second sheet into a standby position in which the second sheet is arranged parallel and coincidently to the first sheet at a distance therefrom which is greater than the distance between the sheets of the composite sheet to be formed, a device for shaping the profile frame from a continuous profile strand and a frame bracing device for the adjustment and releasable retention of the profile frame in an assembly position in which the profile frame is located between the sheets.

15. Apparatus as claimed in claim 14 including a washing device for the sheets in the transport path of the upright conveyor upstream of the assembly station.

16. Apparatus as claimed in claim 14 or 15, in which the upright conveyor comprises a roller frame with a plurality of rollers freely rotatable about substantially vertical axes, a substantially horizontal band conveyor being arranged at the lower end of the roller frame.

17. Apparatus as claimed in claim 16 in which the roller frame and the band conveyor are inclined with respect to the vertical and to the horizontal respectively, so that, in operation, the sheets standing on the upright conveyor are in abutment with the roller frame under the action of gravity.

18. Apparatus as claimed in any of claims 14 to 17 in which the manipulators each have a plurality of controllable suction cups which are adjustable relative to each other and synchronously with each other at least in the vertical direction.

19. Apparatus as claimed in claim 18, in which each manipulator comprises two rows of suction cups which are arranged respectively on horizontal, mutually superposed and vertically adjustable brackets which are adjustable both relatively to each other and also synchronously with each other.

20. Apparatus as claimed in any of claims 14 to 19, in which the second manipulator is adjustable parallel to the transport direction of the upright conveyor.

21. Apparatus as claimed in claim 19 or 20 when dependent thereon in which the second manipulator has a first frame on which the bracket for the suction cups is arranged vertically adjustably and which is arranged adjustably at right angles to the transport

direction of the upright conveyor on a second frame which is, in turn, adjustable parallel to the transport direction of the upright conveyor.

22. Apparatus as claimed in claim 21 in which each of the two frames of the second manipulator is guided on rails and adjustable by means of an adjusting drive.

23. Apparatus as claimed in any of claims 19 to 22, in which the first manipulator is arranged in the region of the upright conveyor operationally immovably parallel to the transport direction thereof and the suction cups are arranged to engage through the roller frame.

24. Apparatus for shaping a profile frame from a continuous profile strand, comprising a profile shaping unit for shaping a continuous profile strand from a metal band, a punching device controlled as a function of the dimensions of the profile frame to be formed to form mitre recesses in the metal band in the locations corresponding to the corners of the profile frame to be formed, and a bending means for bending profile sections of the profile strand mutually separated by the mitre recesses about axes oriented in the mitre recesses to form a closed profile frame.

25. Apparatus as claimed in claim 24 in which the profile shaping unit is constructed so that it produces a hollow profile with a substantially T-shaped cross-section, a charging device being provided for charging a moisture-absorbant medium before the closure of the profile strand.

26. Apparatus as claimed in claim 24 or 25, in which a device for applying an adhesive and sealing compound to the surfaces of the profile frame is arranged between the profile shaping unit and the bending means.

27. Apparatus as claimed in any of claims 24 to 26, including a profile strand guideway oriented substantially parallel to the transport direction of an upright conveyor for feeding the profile strand from the profile shaping unit to the bending means is arranged between the profile shaping unit and the bending means.

28. Apparatus as claimed in claim 27 in which the bending means has a bracing wall which is oriented substantially vertical and parallel to the profile strand guideway and with which a bending tool is associated.

29. Apparatus as claimed in claim 28 in which a guideway for a driver to grip and guide the leading edge of the profile strand is arranged at a vertical edge pointing towards the profile shaping unit and directed parallel to said edge and substantially at right angles to the profile strand guideway, whilst the movement of the driver is controllable as a function of the feed velocity of the profile strand so that the profile strand is bent at the mitre recesses during the feed of the profile strand in the plane of the bracing wall to form mitre corners.

30. Apparatus as claimed in claim 29 in which a workholder movable parallel to the profile strand guideway is provided on the latter in order to depress the profile strand immediately behind the mitre recess where bending is just proceeding.

31. Apparatus as claimed in any of claims 28 to 30 in which the bracing wall is adjustable parallel and at right angles to the transport direction of the upright conveyor.

32. Apparatus as claimed in any of claims 28 to 31 in which horizontally and vertically adjustable alignment stops are provided on the bracing wall.

33. Apparatus as claimed in claim 32 in which limiting stops are provided on the bracing wall which prevent the profile frame from escaping from the region of alignment of the aligning stops.

34. A method of producing a composite sheet substantially as herein described with reference to the accompanying drawings.

35. An apparatus for producing a composite sheet substantially as herein described with reference to and as shown in the accompanying drawings.

36. Apparatus for shaping a profile frame from a continuous profile strand substantially as herein described with reference to and as shown in the accompanying drawings.

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