

(19) **DANMARK**

(10) **DK/EP 2582901 T3**



(12) **Oversættelse af
europæisk patentskrift**

Patent- og
Varemærkestyrelsen

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- (51) Int.Cl.: **E 06 B 3/20 (2006.01)** **E 06 B 3/22 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2018-10-29**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2018-07-18**
- (86) Europæisk ansøgning nr.: **11730601.9**
- (86) Europæisk indleveringsdag: **2011-06-16**
- (87) Den europæiske ansøgnings publiceringsdag: **2013-04-24**
- (86) International ansøgning nr.: **EP2011060030**
- (87) Internationalt publikationsnr.: **WO2011161001**
- (30) Prioritet: **2010-06-21 DE 102010030310**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **Sammensat profil og fremgangsmåde til fremstilling af et forstærkningsorgan til et sammensat profil**
- (56) Fremdragne publikationer:
DE-A1- 2 061 901
DE-A1- 19 933 099
DE-A1-102005 048 992
DE-A1-102008 017 879
US-A- 3 470 598
US-A- 5 687 518

The invention relates to a composite profile with the features of Claim 1 and a method for the production of a composite profile with the features of Claim 8. Plastic profiles such as a hollow plastic profile are used as frame material for plastic windows, as floorboards, and for other applications. Plastic profiles compete in this regard with metal profiles or wooden profiles. Plastic affords good design freedom and a shapely surface in the mentioned applications, so that the plastic profile can be adapted directly to the purpose of its use in broad limits. Another advantage is the low thermal conductivity, typical of plastic, which in combination with the profile's configuration having hollow chambers and partition walls results in a very good insulating effect, which is indeed an important quality criterion for windows.

Yet the very low E modulus as compared to metals is a drawback, such that plastic profiles do not have very good bending stiffness. For applications in which a good static stability is required, a combination with a metal profile is used in many cases, where the metal profile is shoved into a hollow chamber of the plastic profile and optionally secured against sliding within the plastic profile and/or dropping out by screw fastening. In the case of plastic window profiles, this kind of reinforcement has been used since the advent of plastic window technology. For example, U-shaped reinforcing irons are commonly used. One drawback is that, due to the good thermal conductivity of the metal reinforcing profile, the particular hollow chamber makes almost no contribution to the thermal insulation, which is being increasingly felt as a shortcoming in an age of rising energy prices.

In the case of plastic window profiles, there have long been efforts to enhance the traditional U-irons by incorporating flat reinforcing bands made of stronger materials into the plastic profile, e.g., as an inner wall. If these reinforcing bands are arranged "parallel to the glass plane", regardless of the thermal conductivity of the reinforcement, the thermal insulation value which should be as high as possible "in the direction perpendicular to the glass plane" will not be negatively affected.

DE 10 2008 008343 A1 describes one such method and plastic profile in which the reinforcing bands consist of a fibreglass-reinforced thermoplastic material. But since the E-modulus of the particular plastic is far from that of metals (such as steel or aluminium), the reinforcing effect is significantly less than that of a traditional reinforcing iron. DE 199 33 099 A1 relates to the extruding of, inter alia, metallic reinforcing bands, thereby providing greater effectiveness in a static respect. The drawback to this design is the special edge configuration of the strips, which is meant to prevent a shifting of the strips with respect to the plastic profile when the plastic profile is under a bending load. Here, a punching of the two edges is proposed, while the punchings must correspond exactly to each other, in the sense that a gap on the one side will result in a tooth on the other side.

DE 2 061 901, which discloses the subject matter of the preamble of Claim 1, describes reinforcing elements which can be used in conjunction with profile sections. These reinforcing elements have profiling sections which act substantially in the longitudinal direction of the profile section.

The goal of the invention is to organize the forming of different configured reinforcing elements in the plastic profile so that the shear-resistant connection to the plastic profile can be ensured with little expense.

The problem is solved by a composite profile according to Claim 1. Moreover, the problem is solved by a method with the features of Claim 8. Advantageous embodiments are the subject matter of the dependent claims.

Various embodiments of the disclosure shall be described as examples in connection with the following drawings, which show

Fig. 1, cross sectional views of two embodiments of plastic profiles with reinforcing elements;

Fig. 2, a perspective view of a plastic profile with two reinforcing elements made of wood;

Fig. 3, a cross sectional view through a frame profile with a wooden strip as reinforcing element;

Fig. 4 a partial perspective view of an edge region of a knurled and/or embossed
5 reinforcing element;

Fig. 5 a partial perspective view of an edge region of a reinforcing element with sawtooth structure as retaining element;

10 Fig. 6 an enlarged representation of the sawtooth structure of Fig. 5;

Fig. 7 a partial perspective view of an edge region of a reinforcing element with deformed segments as retaining element;

15 Fig. 8 an enlarged representation of the structure of Fig. 7;

Fig. 9 a partial perspective view of an edge region of a reinforcing element with a corrugated structure as retaining element;

20 Fig. 10 a partial perspective view of an edge region of a reinforcing element with a lengthwise bead as retaining element;

Fig. 11 a partial perspective view of an edge region of a reinforcing element with a tooth structure as retaining element;

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Fig. 12 a partial perspective view of an edge region of a reinforcing element with a structure of set teeth as retaining element;

Fig. 13 an enlarged representation of the structure of Fig. 12;

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Fig. 14 a partial perspective view of an edge region of a fibreglass plastic reinforcing element in particular with an edge structure as retaining element;

Fig. 15 an enlarged representation of the structure of Fig. 14;

Fig. 16, a partial perspective view of an edge region of a fibreglass plastic reinforcing element in particular with an edge structure of beads and teeth as retaining element;

Fig. 17, a partial perspective view of an edge region of a wooden reinforcing element in particular with an edge structure having parallel perpendicular notches as retaining element;

Fig. 18, a partial perspective view of an edge region of a wooden reinforcing element in particular with an edge structure having set notches as retaining element;

Fig. 19, a partial perspective view of an edge region of a wooden reinforcing element in particular with an edge structure having slanted notches as retaining element;

Fig. 20, a perspective view of a plastic profile with inserted wires as reinforcing element;

Fig. 21, a cross sectional view of Fig. 20;

Fig. 22, a perspective view of a plastic profile with a reinforcing element with a composite of five layers;

Fig. 23 a side view of a reinforcing element with a composite of five layers;

Fig. 24 a side view of a plastic profile with an integrated reinforcing element with a composite of five layers;

Fig. 25 a modification of the embodiment of Fig. 24;

Fig. 26 a perspective representation of a mitre-cut plastic profile with inserted reinforcing elements;

Fig. 27 a detail view exposing the reinforcing element;

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Fig. 28 a perspective view of a plastic profile with set-back wires as reinforcing elements;

Fig. 29 a detail view of a set-back metal wire;

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Fig. 30 a perspective view of a plastic profile with a set-back metal strip as reinforcing element;

Fig. 31 a detail view of the plastic profile of Fig. 30.

15

Different embodiments are presented hereafter for a shear-resistant connection between reinforcing elements 1, 2, 4, 5 and extruded plastic profiles 10, 20 in the longitudinal and transverse direction.

20 Basically, the material suitable for the reinforcing elements 1, 2, 4, 5 is especially aluminium, steel, or high-strength fibre composites. Since these materials cannot be welded to the thermoplastic base material of the plastic profile 10, 20, which is hard PVC for window profiles, the required shear-resistant connection is to be assured primarily by a suitable positive locking design of the contact surfaces.

25 Possible embodiments are, e.g., undercuts and/or a sufficiently large contact surface.

The "displacement resistance per unit of length" need not even be extremely high and/or come close to the theoretically best achievable values, since in the case

30 of slight bending of the composite profile it is always the overall connection length which is under shear stress, i.e., the actually effective shear force is transmitted along the entire length between the participating components, and since no very large loads occur, i.e., in no way close to the breaking limits.

In a further embodiment, the reinforcement is accomplished by an insertable composite profile (see Fig. 22 to 25), which avoids the drawbacks in terms of the thermal insulating effect as compared to a traditional U-shaped reinforcing iron. In addition to the already known design of such a composite profile with a hard foam middle layer and two cover layers connected to it in shear-resistant manner, such as that of patent EP 0 153 758, a composite profile comprises additional foam cover layers. The background for this design is that it is possible to omit internal walls in the plastic window profile being reinforced, which serve primarily for accomplishing a better thermal insulating effect. A 5-layer composite profile is adapted extensively to the now larger main chamber of the plastic profile 10, e.g., by milling the outer foam layers, so that hardly any cavities remain free. Since foams with very low density have a better insulating effect than air-filled hollow chambers, the insulating effect of the plastic profile with inserted composite profile is higher, despite the lower number of chambers, than that of ordinary plastic profiles with five to seven chambers. A special benefit of this system is that window profiles with fewer internal chambers have lower weight per metre and in addition they can also be extruded more quickly on account of the faster cooling, so that these plastic profiles can be produced more cheaply.

Fig. 1 shows two embodiments in which extruded plastic profiles 10, 20 (hollow plastic profile) are reinforced by reinforcing elements 1, 2, here designed as reinforcing bands. The reinforcing elements 1, 2 consist of a material (metal, fibre-glass plastic) with relatively high modulus of elasticity.

In the case of the first plastic profile 10, one of the reinforcing elements 1 is arranged a relatively small hollow chamber 11. In the second plastic profile 20, the reinforcing elements 1, 2 are each arranged in a larger chamber 12. The skilled person will recognize that different combinations are possible here.

The plastic profiles 10 are extruded, e.g., in a so-called crosshead die, wherein the reinforcing elements 1, 2 are fed through the die in the extrusion direction.

In order to accomplish the intended heightening of the bending stiffness of the

plastic profile 10, the edges of the reinforcing elements 1, 2 are joined to the plastic profiles 10 in shear-resistant manner in the longitudinal and transverse direction. This is accomplished, e.g., in that the edges of the reinforcing elements 1, 2 are embedded in positive locking manner in the plastic. That is, the edges
 5 must have retaining elements 3 acting in the longitudinal direction, e.g., undercuts, which are filled with plastic during the extrusion in the die. Undercuts are provided in the transverse direction, in the plane of the reinforcing band, so that the bond cannot become loose under long-term loading as a result of forces applied and temperature influence.

10

Various configurations of retaining elements 3 shall be presented in connection with Fig. 4 to 19.

The embodiments of Fig. 1 comprise reinforcing elements 1, 2 the shape of
 15 bands. Fig. 2 is a perspective view of a plastic profile 10 of a window sash profile in which the reinforcing elements 1, 2 are formed by wooden strips. The wooden strips have a significantly larger thickness to width ratio than the band-shaped reinforcing elements in Fig. 1.

20 **[0015]** Sufficiently effective thicknesses of the reinforcing elements 1, 2 when designed as reinforcing bands are, for example:

Steel:	0.5 to 2 mm thick
Aluminium:	1 to 3 mm thick
Fibreglass plastic:	2 to 5 mm thick
Wood:	3 to 12 mm thick

25 With the embodiment of Fig. 2, a wooden reinforcement is possible having nearly the same reinforcing effect as a reinforcement with traditional U-shaped reinforcing irons. These wooden strips 1, 2 are likewise joined in shear-resistant manner

to the plastic profile 10, in order to exhibit the optimal reinforcing effect with regard to the neutral (bending) grain.

The embodiment of a frame profile per Fig. 3 shows that even a single wooden strip can also be used as a reinforcing element 1 in a plastic profile 10. It is not necessary for the cross section of the wooden strip to be rectangular. In this case, nearly the entire main chamber of the plastic profile 10 is filled up with a wooden profile 1 adapted to the cross section. Due to the "large" wooden cross section, this reinforcement also achieves a notable stiffening effect. A shear-resistant incorporation in the plastic profile 10 can be done, but is not absolutely necessary in regard to the reinforcing effect, because the neutral grain of the wooden reinforcement and that of the plastic profile 10 run close together on account of the geometry. That is, this reinforcement could be inserted only during the window assembly, just like the U-shaped reinforcing irons, and be screwed together with the plastic profile. An encasing and/or overmoulding of the wooden reinforcement during the extrusion of the profile is likewise possible.

If wood is used as the reinforcing material, it should be protected against rot or fungal attack etc. due to moisture ingress. This is best done by proper painting or impregnation agents in conjunction with a water-tight weld seal inside the plastic profile 10 and / or the frame formed from it. In order to be able to ensure a stable condition even in the event of slight moisture ingress, e.g., due to screw fasteners or diffusion, it is recommended to make possible a certain amount of air exchange through vent boreholes.

25

The reinforcing effect against bending of the plastic profile 10 thanks to the inserted reinforcing elements 1, 2 results from the known laws of mechanics, while the main factors of influence are:

- the size of the load-bearing cross section,
- the spacing from the neutral grain, and
- the E-modulus.

30

If the geometry of the cross section of the reinforcing element 1, 2, here configured as a reinforcing band, is largely maintained and only the thickness of the reinforcing bands and their material is changed, the following thicknesses will produce roughly the same reinforcing effect, depending on the relatable E-mod-

5 ulus:

Material	E-modulus [N/mm ²]	Thickness [mm] of reinforcing band
Steel	210,000	0.67
Aluminium	70,000	2.0
Fibreglass plastic (unidirectionally reinforced)	40,000	3.5
Short fibre glass-reinforced thermoplastic	10,000	14.0
Pine wood	11,000	12.7

The values for the E-moduli are to be understood here as mean values. It is evident from the table that metallic reinforcing elements 1, 2 have the highest modulus of elasticity, followed by unidirectionally fibreglass-reinforced plastics.

If price is also considered, metals seem to be the best. Wood also looks very good here. It is striking that the required thicknesses in the case of short fibre-glass-reinforced thermoplastics, as well as wood, might at times be hard to accommodate in the plastic profile 10, so that a distinct lessening of the reinforcing effect might be expected here as compared to the metals. It is also entirely feasible to use pine wood as a reinforcement. Given the price, pine wood is far superior to the other materials, including fibreglass-reinforced plastic. Steel is still next in line.

Different configurations of retaining elements 3 are represented in Fig. 4 to 19,

being arranged on reinforcing elements 1, 2. They are supposed to produce a firmer connection between plastic profile 10 and reinforcing elements 1, 2, where forces are acting in the plane of the band both in the transverse and the longitudinal direction.

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Fig. 4 shows a partial view of an edge region of a reinforcing element 1. The retaining elements 3 here are applied by knurling and / or embossing. This is easily done, especially in the case of metal reinforcing elements 1, 2.

10 At each edge of the reinforcing element 1, 2, two embossing rolls, for example, with sharp-edged contours are pressed against each other, and the reinforcing element 1, 2 is led in between them. In this way, a plastic deformation is produced, and at the contact surfaces with the embossing rolls a sharp-edged pattern is likewise transferred to the reinforcing elements 1, 2. Many small-volume
15 depressions and raised areas subsequently make possible the desired shear-resistant embedding with the surrounding plastic in the plastic profile 10 (not shown in Fig. 4). The knurling shown produces a good positive locking and/or frictional connection resisting displacement forces in two directions: the longitudinal direction of the reinforcing element 1, 2 and transversely to it.

20

Since the reinforcing elements 1, 2 are conveniently provided in roll form in the bands, a straightening of the bands is required before feeding them to the die of the extrusion device. This is done in that the band is led between several rolls in the longitudinal direction and these rolls alternately produce a bending to the left
25 and to the right. The embossing of the edges may be incorporated in this straightening process at the start of the straightening path.

In Fig. 5 and 6 show another embodiment for retaining elements 3. Sawtooth structures as retaining elements 3 are arranged on a band-shaped reinforcing
30 element 1 (preferably made of metal) at both edges. Fig. 6 represents an enlarged view of the sawtooth structure, where sawteeth which are bent upward and downward can be seen. The sawteeth are arranged similar to the teeth of a hand saw and are also produced in this way: punching out of gaps between the

teeth and setting of the teeth, the teeth are slightly bent alternately to the left and to the right. This configuration produces a positive locking connection in two directions; in the longitudinal direction thanks to the tooth flanks and in the transverse direction thanks to the setting of the teeth.

5

Fig. 7 and 8 show an alternative embodiment, in which an edge formation of a reinforcing element 1 is present with alternating segments bent slightly to the left and to the right.

10 If larger undercuts are desired, this structure may likewise be created for a retaining element 3 by means of running wheels acting against each other. These running wheels run exactly synchronized with each other and comprise alternating gaps and projections. The edges acting against each other produce a severing of the margins of the band-shaped reinforcing element 1, 2 similar to that produced by a pair of guillotine shears and the projections produce a slight bending
15 of the resulting "teeth" alternately in either direction. Here as well, a positive locking connection is accomplished after the embedding of the edge in plastic in the two principal directions.

20 Fig. 9 shows an embodiment for a band-shaped reinforcing element 1, 2 whose edge configuration is easy to produce: there is no severing of the reinforcing element 1, 2. The edge of the reinforcing element 1, 2 is merely plastically deformed, e.g., by corrugation. This also is done between two rolls running synchronized and acting against each other, where the elevation on one roll in the running direction is "shorter" than the gap of the mating roll. This corrugated edge as a
25 retaining element 3 of the reinforcing element 1, 2 likewise results in a shear-resistant connection when it is closely encased in plastic. Advantageously, the load-bearing cross section of the stiffening profile is not weakened by separation joints and hence the entire band width contributes to the reinforcement of the
30 plastic profile.

Fig. 10 shows another embodiment for a reinforcing element 1, 2, where this em-

bodiment is not confined to band-shaped reinforcing elements. The edge is provided with additional beads, which is easy to produce especially when using aluminium by a roll machining. Thanks to these beads, the positive locking connection can be subjected to a greater loading in the transverse direction under tensile stress. For the positive locking in the longitudinal direction, a combination with the indicated tooth and corrugation configurations is recommended.

Fig. 11 to 13 show various edge structures as retaining elements 3 for reinforcing elements 1, 2. Fig. 11 shows teeth with notched teeth for an undercutting in the longitudinal and transverse direction according to the invention. Fig. 12 (and Fig. 13 in enlargement) shows teeth with set teeth for undercutting in the longitudinal and transverse direction according to the invention. By contrast with the embodiment shown in Fig. 7, according to the invention the cutting direction for the teeth here is not perpendicular to the edge of the reinforcing element 1, 2, but slanted. The tooth shapes per Fig. 11 to 13 are recommended for metals, which can be easily punched out and/or severed, such as aluminium. During the moulding of the reinforcing elements 1, 2 inside the plastic, the tooth gaps and/or the clearances which are present must be largely filled with plastic by pressing the plastic at high pressure into the die. This tooth shape produces an especially good positive locking connection in both principal directions, so that large forces can also be transmitted in the transverse direction. Fig. 14 shows a reinforcing element 1, 2 made of fibreglass plastic. Fibreglass-reinforced plastic is also well suited as a material for reinforcing elements 1, 2. However, for short fibreglass-reinforced thermoplastics, an E-modulus only of the order of around 10,000 N/mm² can be achieved. Better suited are endless fibreglass-reinforced plastics, while the highest rigidities are achieved here with the use of thermosetting plastics as the binding agent as compared to thermoplastic materials. Moduli of elasticity up to 40,000 N/mm² are feasible. By contrast with metals, hardly any plastic deformation is possible in this case for the forming of an edge as a retaining element 3 with undercuts. In the embodiment of Fig. 14 (and enlarged in Fig. 15), the desired notchings are produced in the edges of the reinforcing element 1 for example by milling or grinding with diamond-studded grinding discs. There is no

particular coordination of the respective notches with each other or the exact geometry thereof, so that the controlling of the different grinding discs is likewise easy to accomplish. Basically, such an edge structure as a retaining element 3 is also possible for reinforcing elements 1, 2 made of other materials.

5

Fig. 16 shows another alternative, especially for connection elements 1, 2 made of fibreglass plastic. In order to form an undercut also in the transverse direction, grooves are ground in the longitudinal direction in addition to the teeth.

- 10 Fig. 17 to 19 show reinforcing elements 1 made of wood, especially pine wood, each having a notched edge. For wooden strips as reinforcing elements 1, 2, an edge formation by notching with the aid of a saw or a milling cutter is advisable. Cuts perpendicular to the edge (Fig. 17) result in a good anchoring against displacement in the longitudinal direction. If these cuts are made at a slant to the longitudinal axis (Fig. 19) or alternately slanting forward and backward (Fig. 18),
15 a very good connection against pulling in the transverse direction is also achieved.

In the embodiments shown thus far, the reinforcing elements 1, 2 were configured
20 as bands or strips.

A further alternative is to incorporate wires with a relatively high modulus of elasticity in the plastic profile.

- 25 Fig. 20 and 21 show a plastic profile in which four wires 1, 2, 4, 5 are arranged as reinforcing elements in the plastic profile 10.

The wires 1, 2, 4, 5 can be made of steel or aluminium, for example. Alternatively, endless spars of unidirectionally fibreglass-reinforced plastics can also be arranged in the plastic profile 10. The reinforcing elements 1, 2, 4, 5 are preferably
30 arranged at the greatest possible distance from the neutral grain. It can be seen in Fig. 20 and 21 that the arrangement of the wires as reinforcing elements 1, 2, 4, 5 is done substantially in the corners of the plastic profile 10.

In a usual window profile, such as is represented in Fig. 20 and 21, four steel wires each of 3 mm diameter bring about the same bending stiffness as a typical U-shaped reinforcing iron made of sheet metal 1.5 mm thick. The shear-resistant embedding of the steel wires in the plastic profile is important for this. By knurling
5 of the wires 1, 2, 4, 5 along the entire circumference, once again the necessary undercuts are produced as retaining elements 3. If aluminium is used in place of steel, because then a cutting and/or sawing on the usual machines is possible, the diameter of the wires would have to be around 1.7 to 2.0 times as large as for the steel wires shown, in order to achieve the same reinforcing effect. Moderate
10 sacrifices in terms of reinforcing effect are entirely manageable, so that aluminium wires with diameter of around 3 to 4 mm can also be used quite feasibly.

The incorporating in the plastic profile can be done in two ways, for example:

- Extruding in a crosshead die, similar to the above for reinforcing bands.
15 When being encased in plastic, the plastic melt fills up the undercuts (retaining elements 3) of the wire 1, 2, 4, 5.
- Press fitting into grooves accessible from the outside. The wire with the embossed surface is oversized in the range of a tenth of a millimetre with respect to the groove.

20

The plastic profile 10 for a window represented in Fig. 20 and 21 allows the reinforcements to be press-fitted into the finished plastic profile 10. The wires 1, 2, 4, 5 may advisedly be press-fitted in the course of the profile extrusion, e.g., after the cooldown, but before the plastic profile 10 enters the caterpillar pull-off. But
25 they may also be press-fitted into the profile strands already cut to length or even in the mitre-cut frame pieces cut to length for the assembly of the window.

It is advisable for the wire 1, 2, 4, 5 in addition to the embossing of the surface also to be heated to around 120 to 200° C. After being press fitted, the heat is
30 introduced into the neighbouring plastic, which is softened and becomes flowable and then largely fills up the undercuts in the wire. After the cooldown, wire 1, 2, 4, 5 and plastic are optimally bonded and can transmit large shear forces with no problem.

A press fitting into the joined frame during the assembly process is even conceivable: the four frame pieces are mitre cut to length, the mitre surfaces are painted with an adhesive and joined exactly to make the frame. The adhesive needs some time to harden, so that the neighbouring parts must in no way shift relative to each other. If the wires 1, 2, 4, 5 are inserted into the grooves accessible from the outside in this layout and also bent exactly around the corners, the wires 1, 2, 4, 5 will at once take on a high load-bearing function and result in a substantial corner firmness. The frame may then be clamped at once and the hardening of the adhesive may then occur slowly over a lengthy period of time, which then has no negative influence on the cycle time. In addition to ensuring the requisite long-term rigidity and the contribution to the corner strength, a major benefit of this production method is that it eliminates the corner cleaning step. Corner cleaning is a relatively costly production process, which furthermore often results in an impairment of the surface in an aesthetic sense (e.g., shadow gaps, burrs and notches).

Thus far forms of reinforcement with reinforcing elements 1, 2, 4, 5 have been described, in which the reinforcing effect is accomplished by virtue of a shear-resistant connection by means of retaining elements 3 of inserted reinforcing elements (bands, strips, wires) with the plastic profile 10.

In the following it will be shown that a good compromise between large reinforcing effect and simultaneous significant improvement in the thermal insulation can be achieved by the installing of composite profiles as reinforcing elements 1, 2. These are created by combining high-strength bands and good thermal insulating foam materials and they are installed in the plastic profiles mitre cut to length during the assembly of the plastic window in place of the typically used U-shaped reinforcing iron.

The use of 3-layer composites for this purpose has already been known for a long time (e.g., EP 0 153 758 A2). In the embodiments described here, an additional foam layer (cover layers) 33, 34 is glued on in addition to the force-effective tension/compression reinforcing straps. When U-shaped reinforcing irons are used,

these are 1-2 mm smaller than the chambers in hollow profiles, so that they need to be screwed in place. Thanks to the use of at least one cover layer 33, 34, a certain oversized dimension can easily be adjusted, so that the reinforcing element can then be shoved free of play into the plastic profile 10.

5

With a 5-layer composite (see Fig. 22), the thermal insulating effect of the overall system can be further improved and at the same time the extrusion of the plastic profiles is easier. As regards the rigidity, there is no change as compared to the 3-layer design.

10

The individual layers of the composite profiles have the following role:

- Core layer 30: high thermal insulating effect and adequate shear strength. Since reinforced window profiles should only be under modest loading anyway, and have only a few millimetres of bending per 1 metre of length, only a modest shear force needs to be transmitted within the foam core of the core layer 30.
- Two reinforcing layers 31, 32, which produce the desired bending stiffness in the two principal directions. Advisable materials are: steel with thickness of 0.5 to 2.0mm, aluminium with thickness of 1.5 to 4 mm or fibreglass plastic with thickness of 2.0 to 6.0 mm.
- Additional cover layers 33, 34. These cover layers are formed of foam and are selected for the lowest possible thermal conductivity.

20

Three inner walls of the plastic profile have been removed from the basic 5-chamber profile, which originally formed the main chamber in which the U-shaped reinforcing iron could be inserted, and additional chambers.

25

The composite profile as reinforcing element 1, 2 in Fig. 22 to 25 has five layers 30, 31, 32, 33, 34.

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For the use of such 5-layer composite profiles it is advisable to simplify the plastic profiles 10, that is, to make them extrusion friendlier (see Fig. 24 and 25). These plastic profiles 10 comprise only three chambers, i.e., only two inner walls, which

are required for the stability and function of the plastic profiles 10. As compared to the original profile shape, two or three inner chambers or inner walls have been omitted, so that the profile weight per metre is reduced and a higher extrusion speed can be accomplished. Even so, the thermal insulating effect of the profile system is not lessened, because the outer foam layers of the composite profile 5 30, 31, 32, 33, 34 take over and even improve the insulating function of the original inner chambers.

The composite profiles as reinforcing elements 1, 2 for the frame profile of Fig. 10 24 or for the casement profile of Fig. 25 are produced by milling the foam portions from the composite profile of Fig. 23. It must be kept in mind that the "fit accuracy" between the main PVC profile and the foam portions of the composite profile 1 may be very tight. Slight spatial hindrances can be tolerated, because the foam can be relatively easily sheared off and/or depressed when the reinforcing profile 15 is shoved into the PVC profile along small projecting lugs. That is, the reinforcing element 1 has a very close contact with the PVC profile and supports the latter directly over a large surface or at least on a line. The screwing together of the two plastic profiles 10 can therefore become easier, i.e., fewer screws are needed with larger spacings between them. Furthermore, the thermal insulating effect is 20 increased if the foam inlay lies directly against the PVC profile along several lines, because no air exchange can occur over large distances, and the thermal transport by convection is decreased.

Besides improving the mechanical rigidity with reinforcing elements 1, 2, the improvement in the thermal insulating effect is of importance. For example, if the 25 reinforcing elements 1, 2 lie parallel to the plane of the glass, the thermal conduction of these reinforcing materials has almost no influence on the desired insulating effect, which is relevant in a direction perpendicular to the glass plane. Neither is any significant improvement in the thermal insulating effect accomplished by simply eliminating thermal bridges transversely to the glass plane, 30 because a good heat exchange continues to be ensured by air convection, which is distinctly effective in chambers with clear width greater than around 8 mm. It is therefore advisable to avoid large hollow chambers.

As a first variant, it appears to be a good idea to insert additional inner walls. But the drawbacks here are:

- an increasing of the number of chambers beyond 6 is hardly effective any more, as the cost/benefit ratio becomes very narrow.
- 5 • the weight per metre increases significantly, and
- the dissipation of heat from the inside of the profile during the extrusion becomes more costly (reduction of the extrusion speed or longer cooldown section), so that
- the production costs increase disproportionately.

10

It is possible to fill up the chambers with insulating foam. Insulating foams with very low density effectively prevents the air convection and has “little heat-conducting mass”, so that hardly any thermal conduction occurs.

- 15 Good insulating foams cannot be placed inside the profile at the same time as the profile extrusion, for economical reasons, since the desired poor thermal conduction significantly lengthens the sizing and cooldown process and a very limited foam specification can be used during the extrusion process. It is advisable to optimize separately the process for the foam production on the one hand and for
- 20 the profile extrusion on the other hand and only bring together the resulting semi-finished items.

The benefits here will be:

- no restricting of the foam production in terms of density or production rate due to the (relatively slow) extrusion process.
- 25 • that is, the material type can be largely freely selected, e.g., polystyrene or PE foam
- optimization possibility in terms of recycling: no material connection between PVC and foam. Separation afterwards is easily possible due to the
- 30 extremely different densities.
- low warehousing costs: the contours and lengths needed at the moment can be produced from relatively cheap foam blocks in very cost-efficient

manner directly at the “joining machine” by means of wire cutting, sawing or milling and then be shoved directly into the plastic profile 10.

- even the extrusion process can be organized more cost economically if inner walls of the plastic profiles 10 are removed, since their function is taken over by inserted foam profiles!

In theory, it is possible to shove the cut foam pieces into the profile bars, 6 m long, or to shove them into the cut to length and mitre-cut frame pieces only during the assembly process. A corresponding automatic production of the cut foam pieces and automatic inserting into the plastic profile 10 however is more suitable for the combining in the course of the profile production. No complications are then to be expected in the assembly process. Foams of PS or PE have lower or the same melting point as PVC with around 200° C, so that they likewise become softened when heated for the corner welding and can additionally act as a welding surfaces.

During the window assembly process, the lengths needed to form the window frames are mitre-cut at 45° from the profile bars, which usually have a length of 6 m. Then four frame profiles are welded to form a rectangular frame. The joining surfaces in this process are at first heated to the welding temperature, around 200° C, and then pressed together. A burn-off of around 3 mm is produced in this way for each profile joint surface. However, “burn-off” should not be understood literally, that is, the softened plastic mass is plastically deformed and produces a bulge, which is then removed once more from the visible surfaces.

The material of the reinforcing elements 1, 2 therefore also has an impact on the assembly process. The cutting to length, or the mitre cutting, must be adapted to the material. In the case of steel, no saw blades with hard metal teeth can be used. An economical variant available here is abrasive cutting. The other mentioned materials can continue to be cut with the hard metal circular saw blades with almost no change in the process.

During the welding process, the desired high reinforcing effect of the reinforcing

elements 1, 2, 4, 5 then produces a hindrance. The hard strips which are unchanged at the welding temperature for the plastic (PVC) then lie exactly in place and prevent the shortening of the plastic profiles 10 by the burn-off process. It is therefore advisable to set the reinforcing elements 1, 2, 4, 5 back with respect to the mitre cutting surface prior to the welding.

Fig. 26 shows a perspective view of a mitre-cut plastic profile 10 with two reinforcing elements 1, 2, for example made of aluminium or steel sheet or fibreglass plastic in band form.

10

The setting back of the hard reinforcing elements 1, 2, 4, 5 is done advantageously immediately after the mitre cutting, while still in the same clamping layout of the plastic profiles 10. At this time, the position of the plastic profile 10 and the cutting surface is exactly known and determined, so that the required surface portions can be exactly machined by means of milling or grinding processes. This may be done by an end or face mill cutter, which travels along the required contours under program control, for example. Well suited for this is a high-speed milling unit, since only slight forces are transmitted to the workpiece and a flapping or vibrating in the case of thin metal sheets is thereby prevented. Furthermore, milling cutters with a relatively small diameter are used in the case of high-speed milling.

20

Fig. 27 shows the exposed (i.e., milled free reinforcing element 1).

Inserted wires 4, 5 can be processed in similar fashion. Fig. 28 and 29 show the setting back of the wires.

25

A high-speed milling unit is also very well suited for this. The milling cutter is oriented axially parallel to the plastic profile 10, and the necessary positions are approached under a suitable programmable motion control.

30

Alternatively, a sawing or abrasive cutting method can also be used, whereby continuous slots around 2 mm in depth are formed in the mitre plane, as shown

in Fig. 30 and 31. That is, the plastic portions suitable for the actual welding process are removed in the plane of the reinforcing elements 1, 2 (fashioned here as a reinforcing band). But this is no detriment, since as the bulge is formed these "gaps" are readily filled up once more with plastic from nearby areas during the
5 welding process.

Usually the corner connection for plastic windows is made by welding of the plastic profiles 10. If the plastic profiles 10 are strengthened according to this invention with reinforcing elements 1, 2, 4, 5 (bands of metal, strips, wires, etc.), these
10 may also be used for the corner connection. In particular, since the metal components can transmit much larger forces locally than the plastic, the required corner strength can be assured in that only these metal components are joined together in durable manner. This connection can be produced either by welding them together or by gluing with an insert piece. Then the plastic itself need not
15 participate in the connection. This brings the advantage that the plastic does not form any weld bead, which consequently does not have to be removed afterwards by the tedious so-called "corner cleaning" and/or milled or taken off in a suitable form.

20 In this case, the metal bands or wires are not set back relative to the mitre surface, but rather joined together. This connection can be done either mechanically or by welding.

Mechanical: press fitting of the ends of the reinforcing elements 1, 2, 4, 5 (wire or
25 reinforcing band ends) into inlay pieces. By corresponding design of the inlay pieces with "barbs and spring action", a joining is possible with modest force expenditure. An opening then requires a very large force expenditure. Of course, an assisting of the strength by gluing is also possible.

30 Welding: for example, heat pulse welding similar to spot welding: the electrodes are placed against the reinforcing elements 1, 2, 4, 5 (wires, band, etc.) which are accessible from the outside in the groove. When the mitre surfaces are

brought into contact, an electrically conducting connection is formed at the contact surface with large resistance – an arc is formed briefly, resulting in the welding.

- 5 Laser welding for example: the mitre surfaces are joined so that the end faces of the metal reinforcing wires or bands come into contact or form only a very narrow gap. The welding laser is moved such that the metal in the joint surface is melted and welded. In connection with the figures, different embodiments have been represented for reinforcing elements 1, 2, 4, 5, each time using only a single uni-
- 10 form design in each plastic profile 10, 20. But the present invention also extends to combinations of the exemplary embodiments shown here. Thus, e.g., one edge of a band-shaped reinforcing element 1, 2 as the retaining element 3 has a corrugated structure, the other edge as the retaining element 3 has a sawtooth structure.

15

List of reference numbers

[0073]

- | | | |
|----|----|-----------------------------------|
| | 1 | First reinforcing element |
| 20 | 2 | Second reinforcing element |
| | 3 | Retaining elements |
| | 4 | Third reinforcing element (wire) |
| | 5 | Fourth reinforcing element (wire) |
| 25 | 10 | First plastic profile |
| | 11 | First chamber in plastic profile |
| | 12 | Second chamber in plastic profile |
| | 20 | Second plastic profile |
| 30 | | |
| | 30 | Core layer |
| | 31 | First reinforcing layer |
| | 32 | Second reinforcing layer |

- 33 First cover layer
- 34 Second cover layer

Patentkrav

1. Sammensat profil, især til vinduer og døre, og med et ekstruderet plastprofil (10, 20) og mindst et forstærkningsorgan (1, 2, 4, 5), som er forbundet hermed
5 på en i hovedsagen forskydnings-modstandsdygtig måde, og hvor der ved forstærkningsorganet (1, 2, 4, 5) er indrettet mindst et holdeorgan (3) til frembringelse af en materiel, friktionsmæssig og/eller formluttende forbindelse mellem forstærkningsorganet (1, 2, 4, 5) og plastprofilet (10), og hvor det mindst ene holdeorgan (3) virker i forstærkningsorganets (1, 2, 4, 5) plan både i forstærkningsorganets tværretning og dets længderetning,
10

kendetegnet ved,

at det har randstrukturer, der tjener som holdeorganer (3) for forstærkningsorganet (1, 2), og som har med kærve forsynede tænder i en længderetning og en tværretning eller har tænder, som omfatter underskårne tænder med en mod-
15 underskæring i længderetningen og tværretningen, og hvor snitretningen i tænderne ikke er vinkelret på randen af forstærkningsorganet, men skrå.

2. Sammensat profil ifølge krav 1, **kendetegnet ved,**

at forstærkningsorganet (1, 2, 4, 5) består af metal, fortrinsvis stål eller aluminium, af glasfiberforstærket plast, fortrinsvis i én retning forstærket Duroplast, som
20 f.eks. umættet polyester- eller epoxidharpiks, eller af træ, fortrinsvis granved.

3. Sammensat profil ifølge krav 1 eller 2, **kendetegnet ved,**

at holdeorganet (3) har en profilering, en roulettering, en ved hjælp af indsnit og/eller udstansninger frembragt struktur, en bølgestruktur, en savtakstruktur, en kærvestruktur, en klæbning og/eller et opvarmeligt sted.
25

4. Sammensat profil ifølge mindst et af kravene 1 til 3, **kendetegnet ved,** at kærvene og/eller indsnittene er udformet som holdeorganer (3) på tværs og/eller
30 på skrå i forhold til forstærkningsorganets (1, 2, 4, 5) længderetning.

5. Sammensat profil ifølge mindst et af kravene 1 til 4, **kendetegnet ved**, at forstærkningsorganet (1, 2, 4, 5) er udformet som bånd, som lister og/eller som tråd.
- 5 6. Sammensat profil ifølge mindst et af de foregående krav, **kendetegnet ved**, at dets varmeisolationsevne og/eller bøjningsstivhed er forøget ved indskydning af præfabrikerede sammensatte profilet (30, 31, 32, 33, 34) i et eller flere kamre.
7. Sammensat profil ifølge mindst et af de foregående krav, **kendetegnet ved**,
10 at forstærkningsorganet (1, 2, 4, 5) er en del af et sammensat profil med mindst fire lag, nemlig et kerneskulag (30), to med dette lag forskydningsmodstandsdygtigt forbundne dæklag (31, 32) med stor stivhed og mindst et lag (33, 34) af isolationsskum, som er klæbet på et af dæklagene (31, 32).
- 15 8. Fremgangsmåde til fremstilling af et sammensat profil ifølge mindst et af kravene 1 til 7, hvor det mindst ene holdeorgan (3) fremstilles ved en plastisk deformation, især roulettering eller prægning og/eller en omformning, især ved indrulning og/eller indpresning af riller eller bølger.
- 20 9. Fremgangsmåde ifølge krav 8, **kendetegnet ved**, at forstærkningsorganerne (1, 2, 4, 5) indlejres i løbet af plastprofilets (10, 20) ekstrusion ved hjælp af en dyse og indlejres i plastprofilet (10, 20).
10. Fremgangsmåde ifølge krav 8 eller 9, **kendetegnet ved**, at forstærkningsorganerne (1, 2, 4, 5) først presses ind i nogle udefra tilgængelige notgange i plastprofilet (10, 20) efter en vidtgående afkøling af plastprofilet (10, 20).
11. Fremgangsmåde ifølge mindst et af kravene 8 til 10, **kendetegnet ved**, at man med henblik på fremstilling af plastvinduer ved hjælp af en hjørnesvejsemetode tilbagefører indlejrede forstærkningsorganer, nemlig efter afkortning og gering-skæring i samme opspænding i en gering-sav i forbindelse med en fræse- eller saveprocedure, og dette for ikke rumligt at besværliggøre en svejseprocedure.
- 30

12. Fremgangsmåde ifølge mindst et af kravene 8 til 11, **kendetegnet ved**, at man ved fremstilling af vindues- og indfatningsrammen på afgørende måde trækker de indlejrede forstærkningsorganer (1, 2, 4, 5) hen til hjørneforbindelsen, og at disse forbindes med hinanden ved svejsning og/eller ved indpresning i en indlægningsdel.

13. Fremgangsmåde ifølge mindst et af kravene 8 til 12, **kendetegnet ved**, at forstærkningsorganerne (1, 2, 4, 5) først indpresses i udefra tilgængelige notgange i plastprofiler til vindues- eller indfatningsrammer til fremstilling af vinduer, og dette således at rammerne uden afbrydelse forløber omkring mindst et tildannet hjørne, så at der er tilvejebragt et bidrag til hjørneforbindelsen.

FIG 1

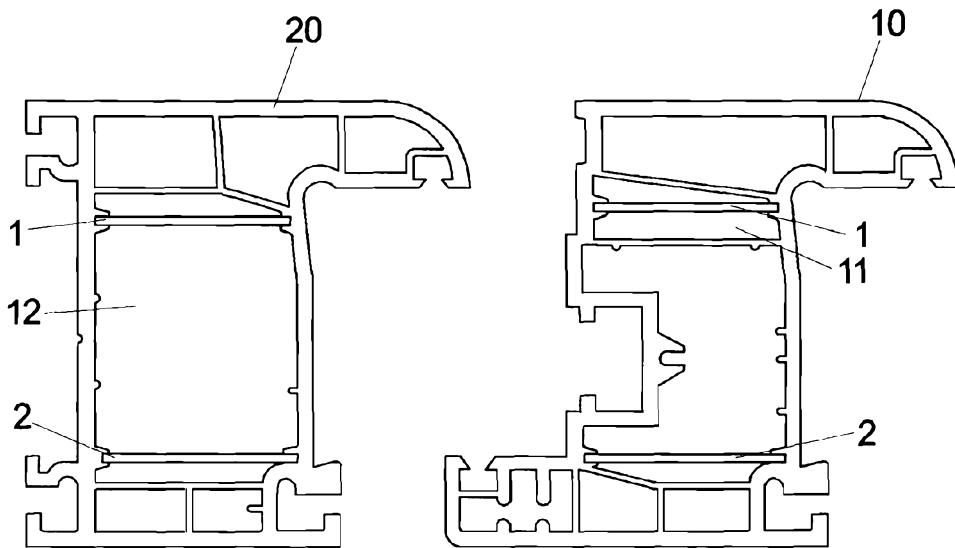


FIG 2

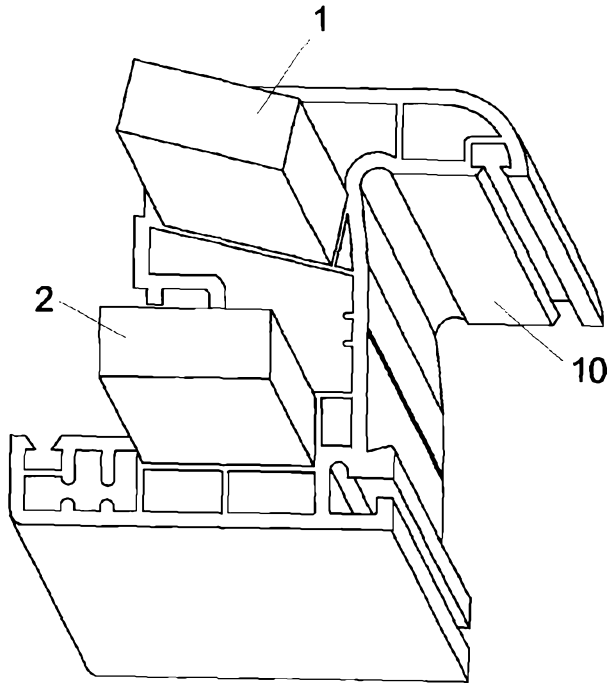
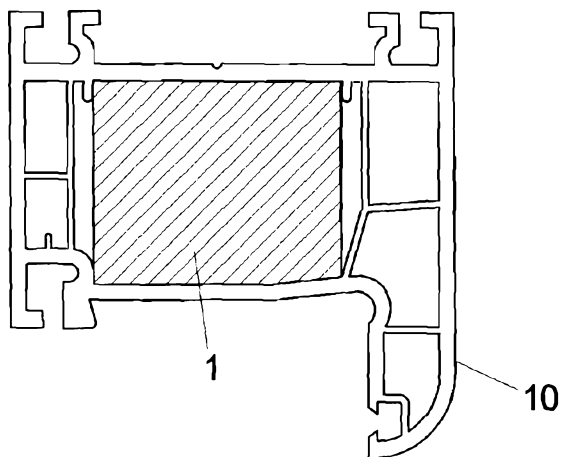


FIG 3



3

FIG 4

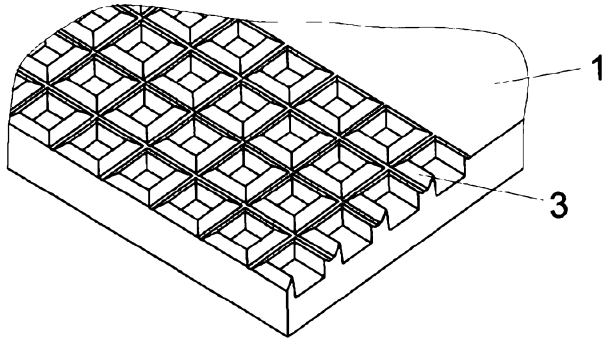


FIG 5

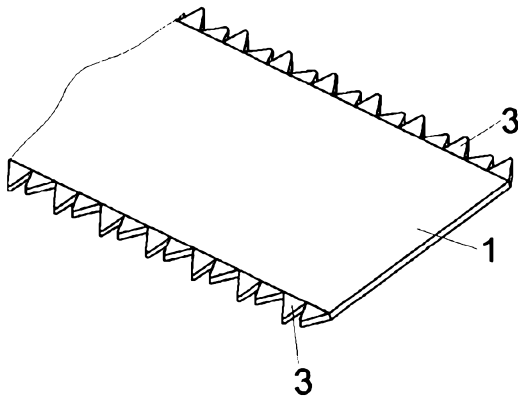


FIG 6

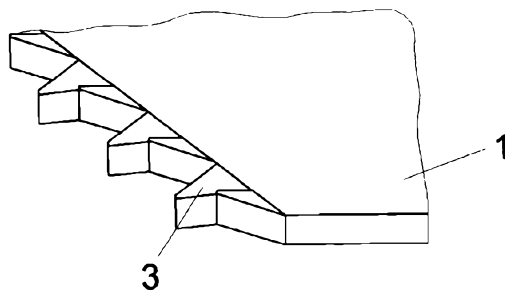


FIG 7

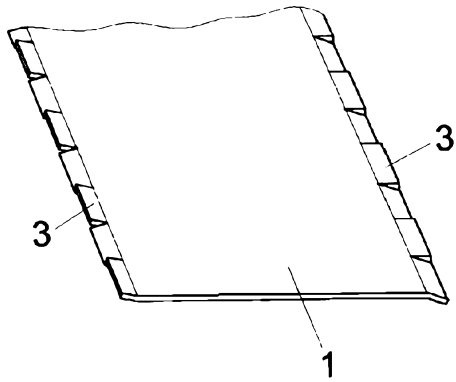
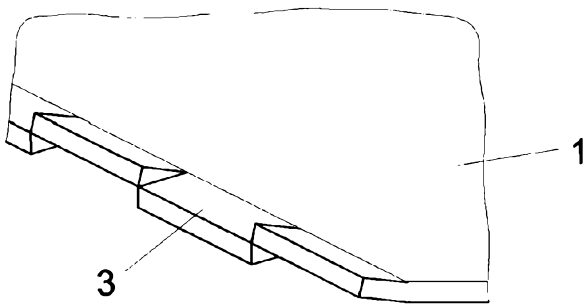


FIG 8



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FIG 9

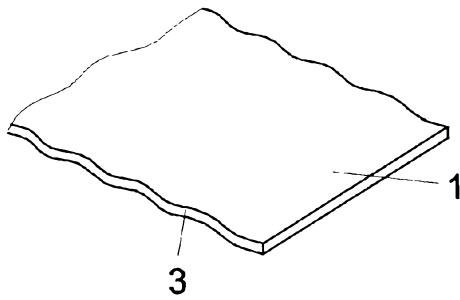


FIG 10

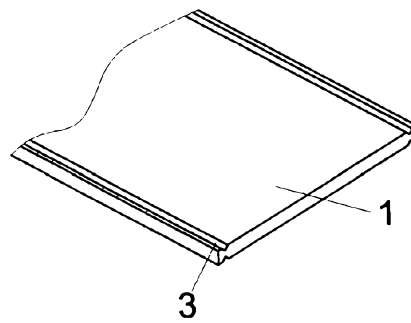
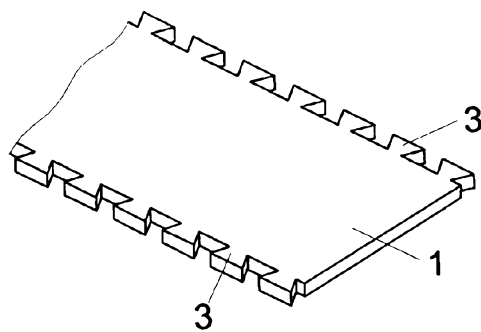


FIG 11



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FIG 12

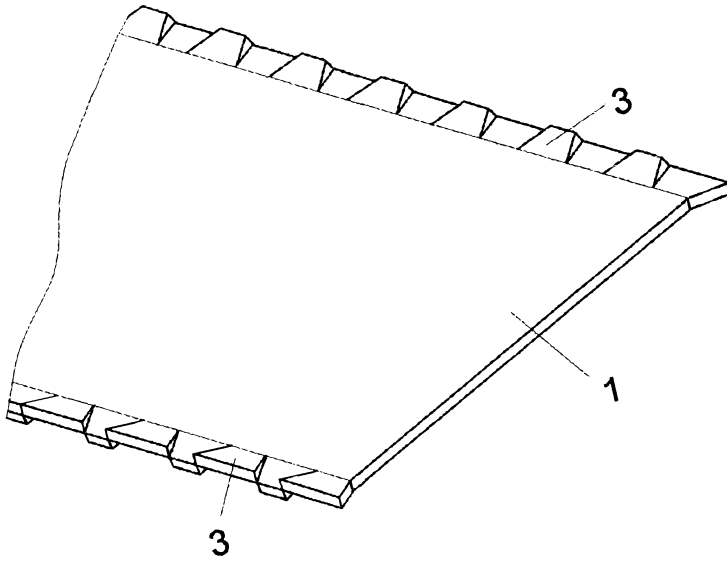


FIG 13

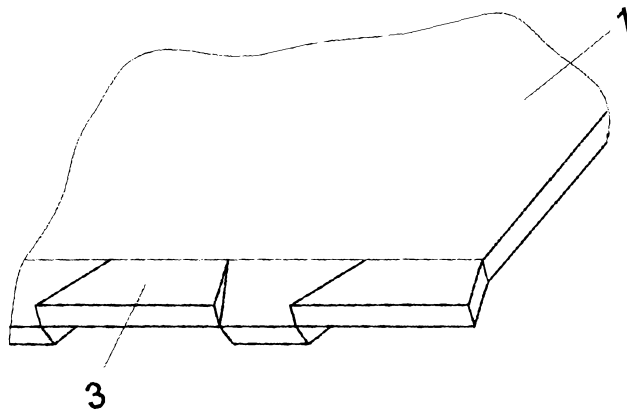


FIG 14

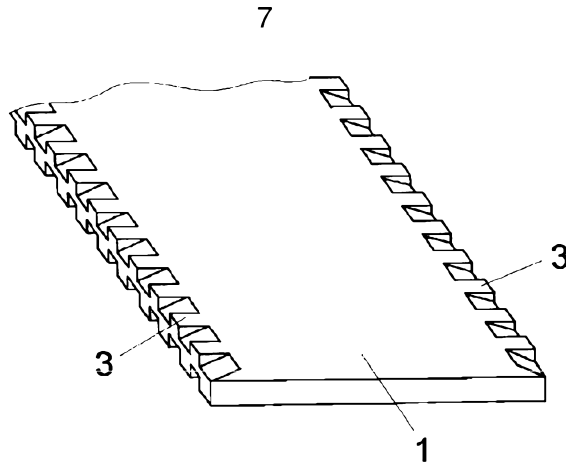


FIG 15

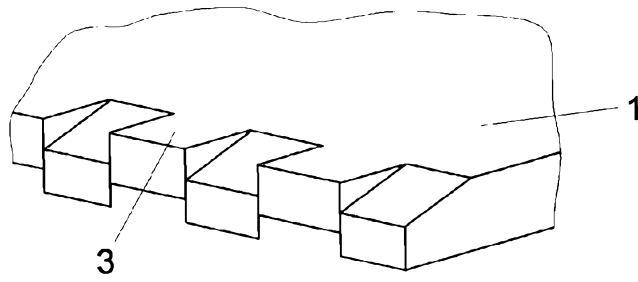
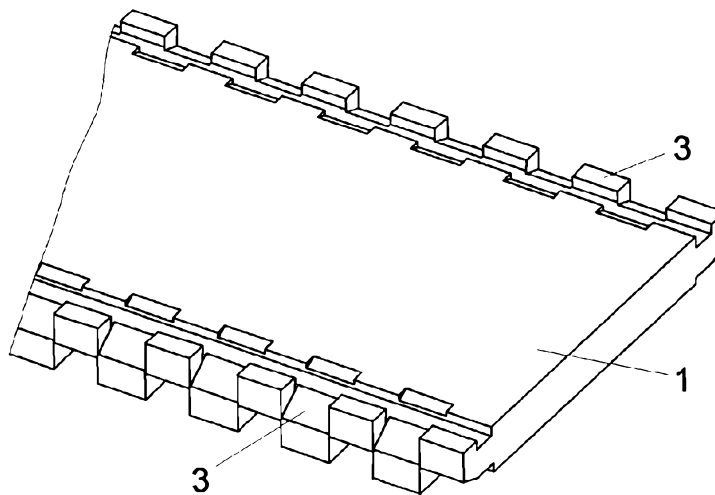


FIG 16



8

FIG 17

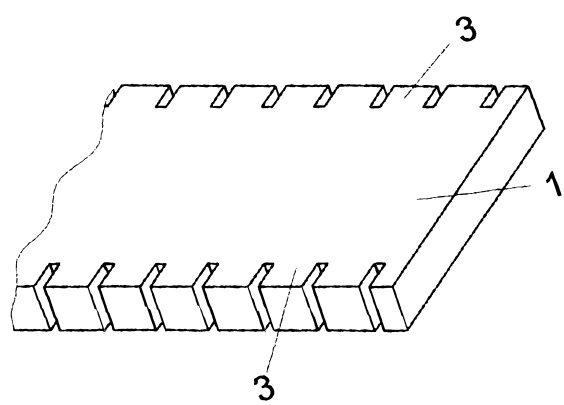


FIG 18

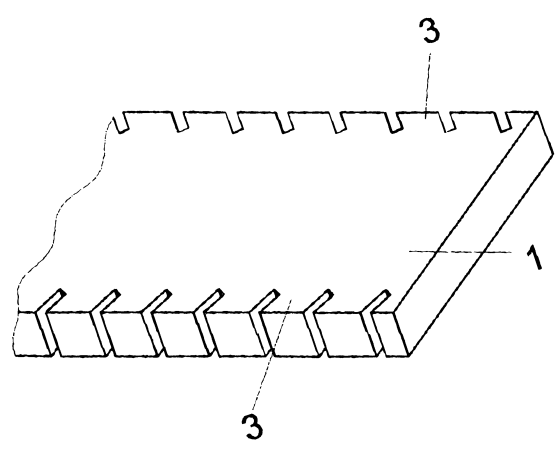


FIG 19

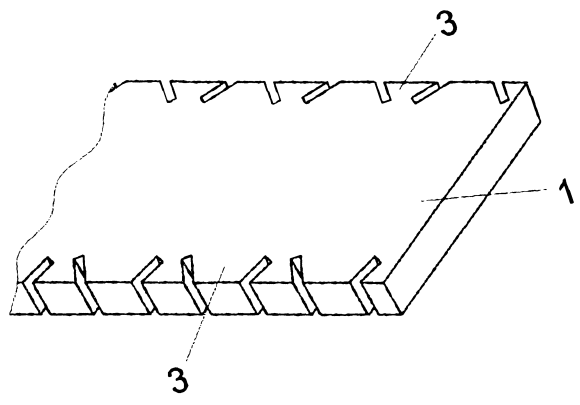


FIG 20

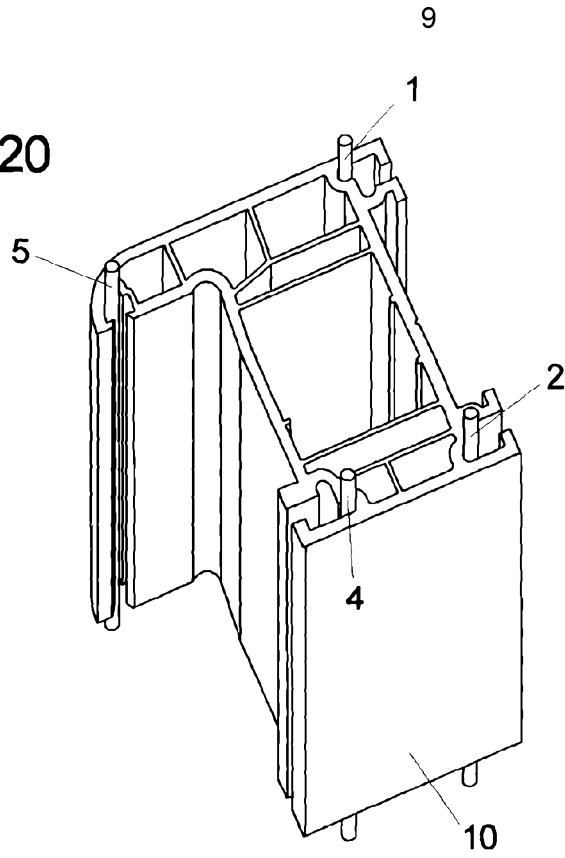


FIG 21

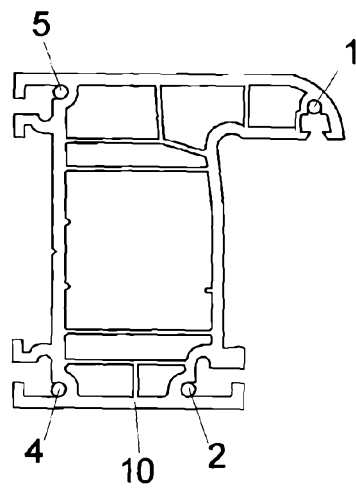


FIG 22

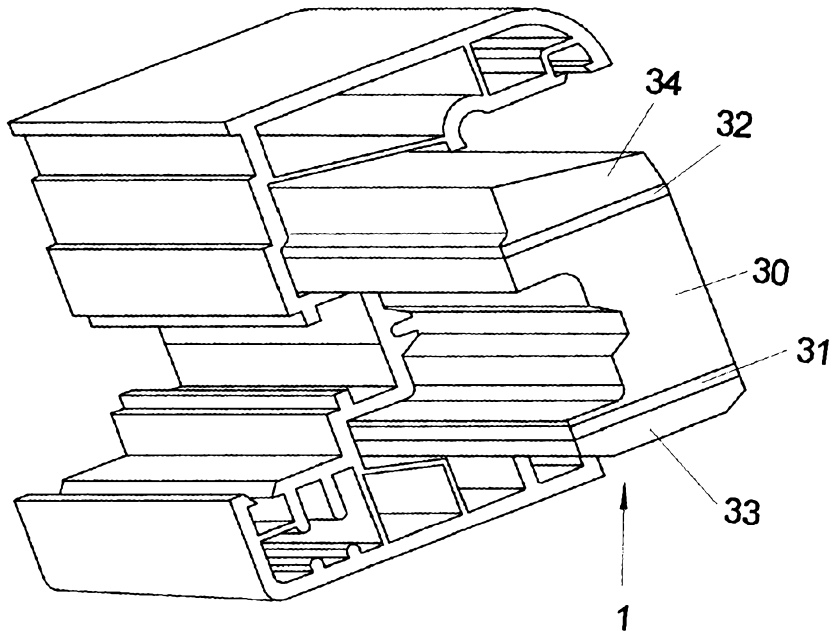


FIG 23

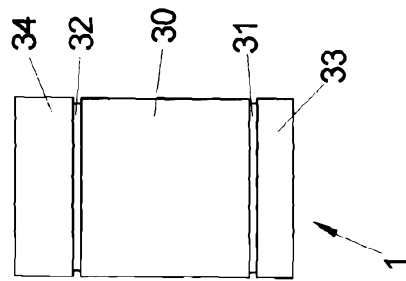


FIG 24

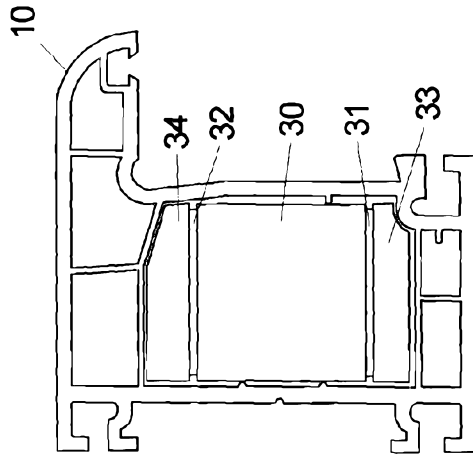
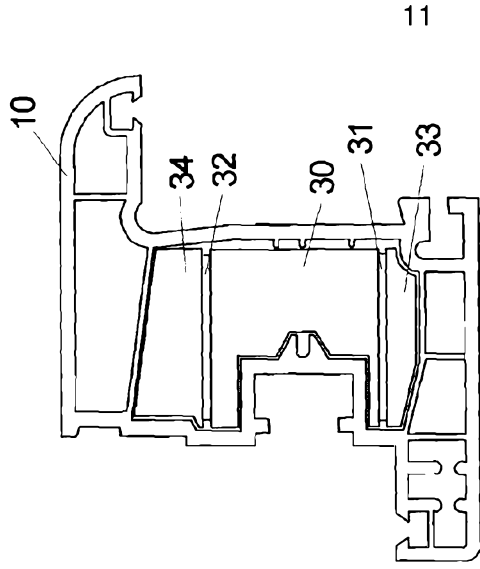


FIG 25



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FIG 26

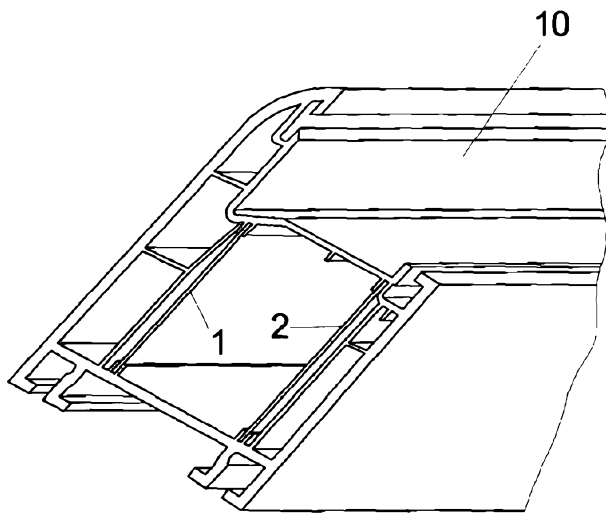


FIG 27

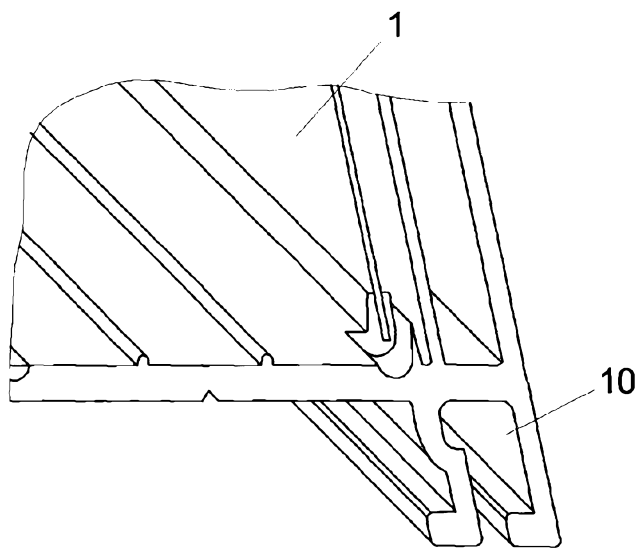


FIG 28

13

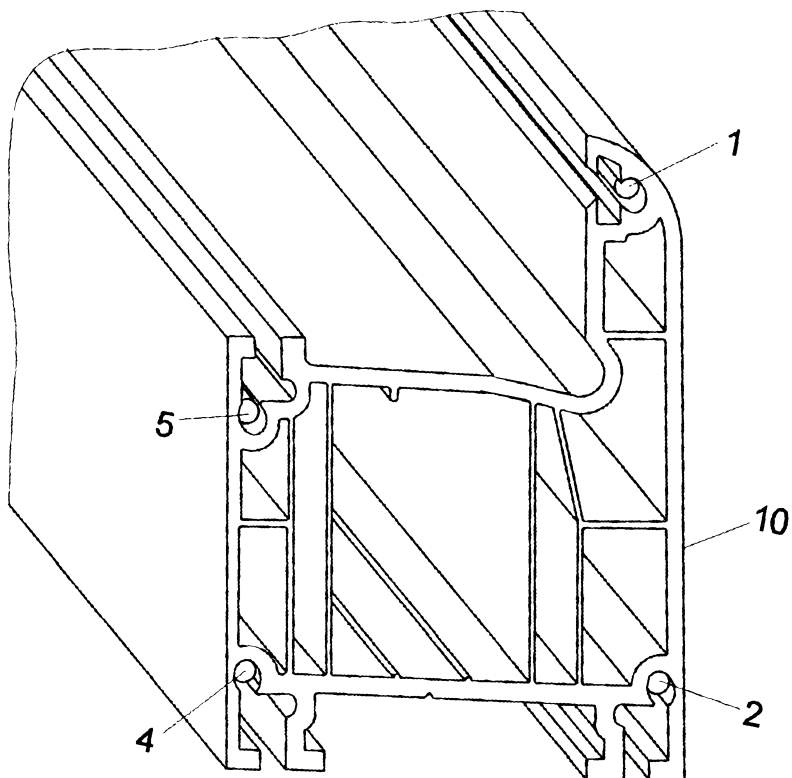


FIG 29

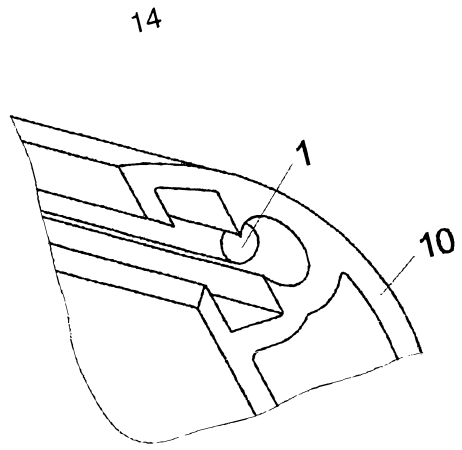


FIG 30

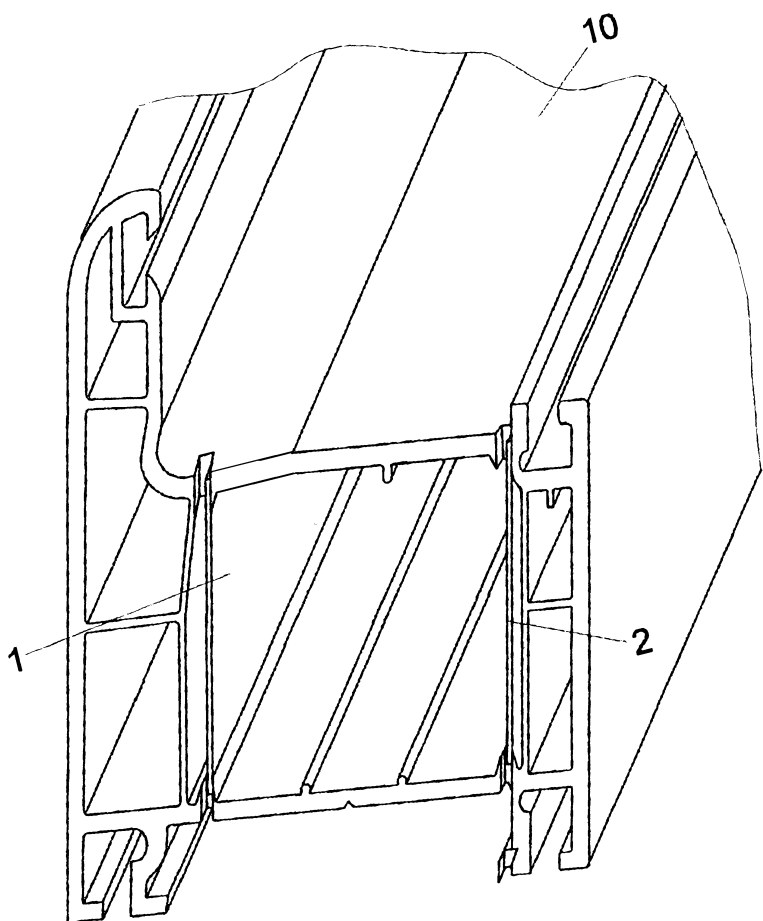


FIG 31

