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## (54) Improvements relating to ventilating.

(57) A louvred fire ventilator for inclusion in e.g. curtain walling or equivalent, lightweight building structures, has a lightweight, knock-together frame (100) made up of tubular side frame members (102) housing control gear (150 to 158) for operating the louvre blades (108) and top and bottom frame members having inner tubular parts (106, 104) receiving force-fitted plugging members (126, 124) (see Fig. 7) fixed to the side frame members to join the frame together. The separate outer and interchangeable frame member parts (102*d*, 130, 131) are adapted with fixing beads (130*c*, 131*c*, 114*d*) of different forms for mounting the ventilator in the cladding or glazing plane of any curtain walling or glazing system for which it is intended. The frame members and the louvre blades are formed as extrusions, cut predeterminedly to required lengths, and the louvre blades are plugged at the ends with elastomeric plugging members (140) which mount the louvre blade pivots (142) (see Fig. 21), the elastomeric plugging members (140) having sealing lips (104*c*, 104*d*, 104*g*) which make sealing engagement with the frame (100). A version having a single, bottom hung, outwardly opening fire ventilation flap (159) (see Fig. 22) is also described.

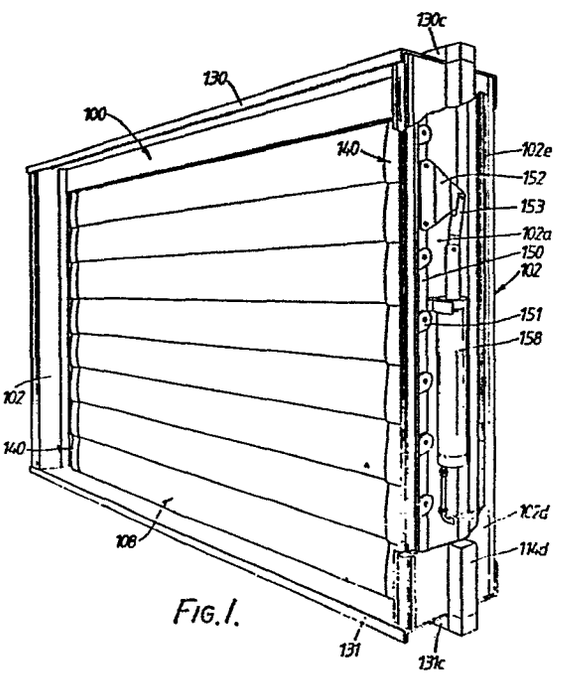


FIG. 1.

EP 0 168 195 A2

# IMPROVEMENTS RELATING TO VENTILATING

The present invention comprises improvements relating to ventilating and concerns ventilators for building structures.

In the modern trend of constructing atrium buildings and other similar lightweight building structures it is common to employ substantial areas of curtain walling and/or glazing supported by curtain walling or glazing systems extending in both vertical and inclined planes.

A current official requirement concerning smoke control for fire precautions in such building structures is a fire ventilation opening area equivalent to five percent of the largest floor served by the atrium.

There is, therefore, a need for lightweight fire ventilators which can be incorporated into curtain walling, glazing and equivalent lightweight systems, which preserve the clean building lines of the system, so as to be aesthetically pleasing, and which may readily be produced in a range of sizes and fixing modes to suit different fixing requirements of the building systems. At the same time, the usual weatherproofing requirements for such

fire ventilators persists.

The present invention provides a system ventilator for this purpose comprising a lightweight frame of tubular members surrounding and defining a fire ventilating opening, all of which members are preferably formed by extrusions, plugging members fixed to the outsides of an opposite pair of the frame members and force-fittedly plugging the ends of a further opposite pair of the frame members, thereby forming the frame, an obturating member or obturating members hinged on the frame for opening and closing movements, said obturating member or obturating members having a closed position blocking and weather-sealing the fire ventilating opening and an open position allowing the exhaustion of smoke, heat fumes and gases through said opening, and control gear for moving the obturating member or the obturating members between open and closed positions.

Preferably, the control gear is housed mainly or wholly in the hollow frame.

Preferably also, the tubular frame members are each formed with separate inner and outer parts attached together, the outer parts of the frame members being predeterminedly adapted to suit the

fixing requirements for the ventilator.

Preferably also, one opposite pair of the frame members has inner tubular parts receiving said force-fitted plugging members and the other opposite pair of said frame members has inner, channel-form parts one at least of which mounts the control gear.

The system ventilator of the present invention may have a single obturating member in the form of a ventilation flap hinged along one edge for outward opening movement.

Alternatively, a system ventilator of the present invention may comprise a plurality of obturating members formed as tubular louvre blades hinged between one opposite pair of the frame members on pivots mounted in louvre-end plugging members plugging the respective ends of the louvre blades, the louvre-end plugging members being formed with sealing lips engaging said one opposite pair of the side frame members in the closed position of the louvres.

Preferably, the louvre-end plugging members are formed of elastomeric material and preferably also, each louvre-end plugging member has an outer sealing lip exposed to the outside of the ventilator and a further sealing lip underlying the outer sealing lip, the louvre blades being hinged generally

between their leading and trailing edges and the outer sealing lips being foreshortened adjacent the leading edges of the louvre blades to expose the further sealing lips to the outside of the ventilator to be overlaid by portions of the sealing lips adjacent the trailing edge of the next adjacent louvre blade in the closed position thereof.

It is still further preferred that said one opposite pair of the frame members constitutes the side frame members of the ventilator frame and the other opposite pair of the frame members constitutes the top and bottom frame members respectively of the ventilator frame, the side frame members being formed with lengthwise extending gutters and the outer sealing lips overhanging the adjacent inner walls of the gutters in the closed position of the louvre blades.

Where the louvre-end plugging members are formed of elastomeric material, they may be provided with lip seals to seal against the outside surfaces of the louvre blades in addition.

Specific embodiments of the present invention will now be described by way of example, and not by way of limitation, with reference to the accompanying drawings in which:-

FIG. 1 illustrates a louvred ventilator of the present invention with part broken away to reveal a

control gear of the ventilator;

FIG. 2 illustrates the bottom left hand corner construction of the frame of a further louvred ventilator of the present invention and showing the ventilator fixed in a typical curtain walling system;

FIG. 3 is a vertical cross-section of the ventilator and system of Fig. 2;

FIG. 4 is a horizontal cross-section of the ventilator and system of Fig. 2;

FIGS. 5 and 6 are cross-sections of alternative outer side frame member parts;

FIG. 7 is a vertical cross-section of the ventilator of Fig. 1 showing the force-fitted plugging members;

FIG. 8 is a bottom plan view in Fig. 7;

FIGS. 9 to 12 inclusive show details of the plugging member for the bottom frame member;

FIGS. 13 and 14 show details of the plugging member for the top frame member;

FIGS. 15 to 18 inclusive are cross-sections of alternative outer frame parts of the top and bottom frame members respectively;

FIG. 19 is a cross-section of a louvre blade;

FIGS. 20 and 21 illustrate the louvre end plugging members and the pivot pins for the louvres;

FIG. 22 illustrates a ventilator of the present

invention having a single, bottom hung, outwardly hingeing ventilation flap;

FIG. 23 is a cross-section of the top frame member of the ventilator of Fig. 22;

FIG. 24 is a cross-section showing the bottom frame member of the ventilator of Fig. 2 and the hingeing arrangement for the flap;

FIG. 25 is a vertical cross-section of the ventilator of Fig. 22 showing the force-fitted plugging members; and

FIG. 26 is a bottom plan view of Fig. 25 with part removed.

In the accompanying drawings, corresponding parts are indicated by the same reference numerals throughout.

Referring now to the accompanying drawings, the louvred ventilator shown in Fig. 1 comprises a frame generally indicated at 100 made up of a pair of tubular side frame members 102 (see also Figs. 2 and 4 ) a bottom frame member having an inner tubular part 104 (see Fig. 2 ) a top frame member having an inner tubular part 106 and a single bank of eight louvre blades 108. The tubular frame members or parts 102, 104 and 106 and the louvre blades 108 are formed from lightweight aluminium extrusions. The side frame members 102 are two-part members and are

formed in two extruded parts, namely a channel-form part 102a having a cross-section as shown in Fig. 4 and an infill part 102b or 102c or 102d having a cross-section as shown in Fig.5 or Fig. 6.

The infill part 102b or 102c or 102d is fitted to the channel-form part 102a to form the tubular frame member 102 in a manner hereinafter described, the infill part being received on the rebates 102e (see e.g. Fig. 4 ) of the channel-form part. The side frame members 102 have lengthwise running gutters 102g having inner walls 102h (see Fig.2 ) later referred to. The frame member extrusions are formed with bolt head fixing grooves 112 for use in fixing the extrusions to other frame parts and/or for fixing to the ventilator various accessories such as bird guards, insect screens, solar control equipment and so on, and the fixing grooves 112 may be used to fix bird guards and insect screens either to the inside or to the outside of the ventilators. Alternatively, the grooves 112 in the front and rear faces of the side frame members may be used to mount decorative trim strips 112a (see Fig.4 ) if desired. The bottom frame part 104 is formed with a water trap channel 104a to which a corresponding water trap channel 108a is reproduced along the leading edge of each of the louvre blades 108 (see Fig.19 ),

and the top frame part 106 is formed with a T-section slot 106a (see Fig. 3 ) at the lower edge of a depending flange part 106b to which a corresponding flange part 108b and a T-section slot 108c is reproduced along the trailing edge of each of the louvre blades 108. The leading edges of the louvre blades are the edges presented inwardly of the ventilator when the louvre blades are open and the trailing edges of the louvre blades are the edges of the louvre blades presented outwardly of the ventilator when the louvre blades are open. The infill parts 102b to 102d are formed with fixing flanges or fixing beads 114b, 114c or 114d in a lengthwise extending generally central location with respect to the longitudinal centre line of the part. Depending upon the choice of infill part 102b to 102d, the ventilator may be fitted in the cladding or glazing plane in the curtain walling or patent glazing system for which it is intended or in any prepared opening, the flanges or beads being of a shape chosen and positioned entirely as dictated by the particular fixing requirements for the ventilator. Alternatively, the infill parts of the side frame members 102 may be formed with longitudinally extending, offset flanges or beads 114b, 114c or

114d to enable the ventilator to be inset with respect to a glazing plane of a curtain walling system or proud of a glazing plane of a curtain walling system to obtain different architectural effects. Figs.2 , 3 and 4 show adjacent pairs of glazing bars 116, 117 and glazing 118 fixed thereto by fixings 120 mounting glazing bar caps 122 flush with the side frame members 102 of the ventilator frame in each case. The flanges 114b and further flanges 130b and 131b later described take the place of glazing in this example to fix the frame 100 of the ventilator in place. The glazing system then lends support to and helps in rigidifying the ventilator frame.

Fig.7 shows the construction of two vertically adjacent corners of the frame 100 of the ventilator using force-fitted plugging members 124, 126 for the ends of the bottom and top frame tubular parts 104 and 106. These plugging members are formed as aluminium castings and each has a plate part 124a, 126a shaped generally to close the open end of its side frame member part, and a plurality of tongues 124b, 126b extending from the plate part at right angles around the edge of the plate part on one side thereof, the tongues having

tapered free edge portions 124c, 126c and initial ribbed portions 124d, 126d, the ribs 128 which run perpendicular to the plate parts 124a, 126a. The plugs 124, 126 are a drive-fit in the ends of the top and bottom frame parts 106, 104. Plugging members 124, 126 are first attached to the insides of the side frame members 102 using high duty rivets 127 which may be "Monobolts" (Registered Trade Mark) marketted by Ardel Limited located in three fixing holes 128 illustrated in Fig. with an intervening water sealing gasket 130a, 130b in each case shaped to interfit with the profile of the top and bottom frame member parts 106, 104. The plugging members are then driven into the top and bottom frame member parts to compose the frame, the gaskets sealing the open ends of the top and bottom frame member parts. As illustrated in Fig. 3 , the top and bottom frame members are completed by respective header and sill plates 130 and 131 which are attached to the bolt head retaining grooves 112 of the top and bottom frame member parts 106, 104. These header and sill plates are formed with the fixing flanges 130b and 131b corresponding to the fixing flanges 114b for fixing in the place of glazing in curtain walling and glazing systems as already described above. Instead

of flanges 114b the plates 130 and 131 may be formed with fixing beads or flanges 130c, 131c or 130d, 131d as shown in Figs. 15 to 18 to suit different fixing requirements for the ventilator.

The louvre blades 108 overlap one another in the closed position thereof, and the corresponding formations on the top and bottom frame member parts 106, 104, the depending flanges 108b overlying the water trap channels 108a and lip seals 108d mounted in the T slots 108c engaging the front surfaces of the louvre blades to prevent water blowing up under the louvre trailing edges into the water trap channels 108a as far as possible. The two ends respectively of each louvre blade are plugged with handed plugging members 140, 140' the right hand one 140 of which, seen from the front of the ventilator, is shown in Figs. 20 and 21. The members 140, 140' are formed as mouldings of silicone rubber and each presents a slot 140a which matches the whole of the louvre blade profile except the formation 108c, the central portion 104b of the plugging members being divided into segments and being a force-fit in the ends of the louvre blades. The plugging members 140, 140' are lateral inversions of one another and each has a pair of sealing lips 140c and 140d to sealingly engage

the adjacent wall 102h of the adjacent side frame member 102 to seal the gaps between the ends of the louvre blades 108 and the ventilator frame 100 in the closed position of the louvre blades. The outer sealing lip 104c is shaped and positioned to engage over the free edge of the gutter wall 102h as shown in Fig. 21 while the sealing lip 104d engages against the side of the gutter wall 102h. Alternatively, the sealing lips 140c and 140d may be similarly formed both to engage with their tips against the side of the gutter wall 102h. The sealing lips 140c are exposed to the outside of the ventilator and the sealing lips 140d underlie the outer sealing lips except towards the leading edges of the louvre blades where the outer sealing lips are foreshortened to expose the further sealing lips 140d as best seen in Fig. 20 . In the closed position of the louvre blades, the trailing edge portions of the sealing lips 140c, 140d overlie the exposed leading edge portion of the sealing lip 140d of the next adjacent louvre blade proceeding down the bank of louvre blades in the mounted position of the ventilator. Still further lips 140g are provided on the plugging members 140 to obscure the gap between the ends of the louvre blades 108 and the side frame members 102 at the inside

of the ventilator. The louvre blades are hinged to the ventilator frame on hinge axes B extending generally midway between their leading and trailing edges. Metal pivot pins 142, 142' are mounted in the plugging members 140, 140', for example by being force-fitted and bonded in holes 144 therein. The pins 142, 142' may be enlarged inwardly of the holes in the plugging members 140, 140' to help in holding the pins securely in the holes. Sealing lips 140e and 140f defined by the slots 140a may be likewise bonded with the outside surfaces of the louvre blades 108.

The pivot pins 142, 142' engage with operating gear housed within the two side frame members 102. Typical gear for each side frame member is illustrated in Fig. 1 for the right hand side frame member only and comprises a control link bar 150 to which is pivoted a series of control arms 151, one for each louvre blade 108, the arms 151 being fixed on the pins 142, 142' and acting as cranks. A link bar drive bracket 152 is operated via a cylinder link bar 153 by a pneumatic ram 158 and the bar 153 has a dead-centre inline position illustrated in Fig.1 corresponding with the closed position of the louvre blades, to lock the louvre

closed. The operating gear housed in the left hand side frame member 102 corresponds.

The pneumatic rams 158 are fixedly mounted to the side frame member parts 102a and each ram houses a return spring operable to open the louvre blades. The control arms 151 are pivoted to the control link bar 150 by pivot pins mounted on adjustable sliders on the bar 150. During assembly, the sliders are fixed to the bar 150 with screws while the louvres are clamped closed so that the louvre blades close tightly against each other.

A single operating gear confined to one side frame member 102 may be employed, the pivot pins 142' simply being journalled in the other side frame member part 102a if desired.

Fig. 22 illustrates a version of the ventilator having a single, bottom hung, outwardly opening hinged ventilation flap 159, the side frame members 102 of which correspond with those already described. The top and bottom inner frame member parts 160 and 162 have cross-sections as shown in Figs. 23 and 24 respectively. The force-fitted plugging members 163, 164 for the ends of these sections are as shown in Figs. 25 and 26 and are formed generally as described for the force-fitted plugging members 124, 126 except

that they are adapted to the profile of the sections 160, 162 respectively.

The ventilation flap 159 has an aluminium glazing frame 168 of any convenient construction and the flap may be single glazed or double glazed or opaquely panelled in any desirable manner. The flap 159 is hinged to the bottom frame member part 162 as shown in Fig. 24 . Two hinge brackets 167 shown in this figure are conveniently used and are arranged so that in closing, the flap 159 passes through a vertical position to close with an inward inclination at a small angle. The flap 159 is opened and closed by control gear generally indicated at 167 in Fig. 22 housed in the side frame members 102 respectively and mounted on the side frame member parts 102a. The control gear 167 operates control lever arms 170 hinged at their two ends respectively on hinge pins 170a and 170b to the flap frame 168 and to slider carriages 171 of ball bearing linear motion sliders 172 fixed to the inside of the side frame member parts 102a and pivoted latching hooks 173 mounted on blocks 174 fixed to the parts 102a. The pins 170b pass through slots in the side frame member parts 102a and in the sliders 172 to connect with the carriages 171 and likewise,

the latching hooks 173 pass through slots in the parts 102a. The control gear 167 comprises pneumatic cylinder units 175 each including a pair of rams 176, 177 one at each end, the rams being connected respectively to the sliders 172 and to the latching hooks 173 for operating these elements in sequence by air under pressure supplied through a single supply line 178 to each unit 175. Pneumatic operation of the rams 176 to outstroke their pistons moves the slider carriages 171 downwardly to close the flap 159, whereafter pneumatic operation of the rams 177 to outstroke their pistons rotates the latching hooks 173 to engage them with latch pins 179 to secure the flap closed. The rams 176, 177 are provided with return springs (not shown) for reverse operation, the return springs of the rams 176 operating initially to pivot the flap 159 open after the return springs of the rams 177 have operated to release the latches 173, 179, the flap being moved to its fully open position by gravitational action.

As seen in Fig. 24 , the bottom frame part 162 is provided with a water trap channel 162a, a groove 162b for locating the hinge brackets 167 and a T-slot 162c for mounting a sealing strip which engages with the flap frame 168 in the open position.

The channel form parts 102a of the side frame members are formed with grooves 102a' (see Fig.4) lined with silicone rubber grip seals which receive and hold ribbed flanges 102b' on the infill parts 102b.

The top and bottom frame member parts 160 and 162 are completed with header and sill plates having fixing flanges or beads to match the fixing flanges or beads on the infill parts 102a of the side frame members 102, as previously described.

There has been described, with reference to the accompanying drawings, system ventilators for use as fire ventilators which are specially adapted for incorporation into curtain walling and the like whilst preserving the clean building lines of the building. The ventilator frames are of lightweight, knock-together construction and may be readily made to any required size simply by cutting the extruded lightweight parts to the lengths required. The side frame members which house and conceal the control gear each have a readily removable and replaceable outer frame part which facilitates the fitting, adjustment and maintenance of the control gear whilst the top and bottom inner frame members are one-piece tubular members and therefore well adapted to receive the force-fitted end plugging members as required to make the ventilator frames. The

frames thus produced are sufficiently rigid for the purpose required in as far as each frame is stabilized in use, by the particular lightweight building structure into which the frame is finally assembled. The bolt-on or clip-on interchangeable outer frame parts enable the ventilators to be readily adapted to interfit with a variety of building walling systems.

The "variable size" system for the frames is extended to the louvre blades in the louvred ventilator described with reference to the accompanying drawings in as far as these are again cut from extrusions and plugged at the ends with plugging members which mount the louvre pivots, and in the ventilator described with reference to Figs. 22 to 26 the fire flap itself may be composed of a frame of extruded members cut to a required size and which is either glazed or panelled to suit the building requirements.

Whilst the ventilator described with reference to Figs. 22 to 26 having a single, outwardly opening fire flap is restricted for use in vertical walling, the louvred fire ventilator described with reference to the drawings may be utilized in curtain walling or glazing extending in an inclined plane.

CLAIMS:

1. A system ventilator comprising a light-weight frame (100) of tubular members (102; 104, 131; 106, 130) surrounding and defining a fire ventilating opening, plugging members (124, 126 or 163, 164) fixed to the outsides of an opposite pair of the frame members (102) and force-fittedly plugging the ends of a further opposite pair of the frame members (104, 131; 106, 130 or 160, 130; 162, 131), thereby forming a frame, an obturating member (159) or obturating members (108) hinged on the frame for opening and closing movements, said obturating member or obturating members having a closed position blocking and weather-sealing the fire ventilating opening and an open position allowing the exhaustion of smoke, heat fumes and gases through said opening, and control gear (167 or 152 to 158) for moving the obturating member (159) or the obturating members (108) between open and closed positions.

2. A ventilator as claimed in claim 1 in which the frame members (102a, 102b, 104, 106, 130, 131, 160, 162) are formed by extrusions predeterminedly cut to required lengths.

3. A ventilator as claimed in claim 1 or 2

in which the control gear (167 or 152 to 158) is housed mainly or wholly in the hollow frame.

4. A ventilator as claimed in any preceding claim in which the tubular frame members are each formed with separate inner and outer parts (102a, 102b; 104, 131; 106, 130; 160, 130; 162, 131) attached together, the outer parts of the frame members (102b, 130, 131) being predeterminedly adapted to suit the fixing requirements for the ventilator.

5. A ventilator as claimed in claim 4 in which one opposite pair of the frame members (104, 131; 106, 130 or 160, 130; 162, 131) has inner tubular parts (104, 106 or 160, 162) receiving said force-fitted plugging members (124, 126 or 163, 164) and the other opposite pair of said frame members (102) has inner, channel-form parts (102a) one at least of which mounts the control gear (167 or 152 to 158).

6. A ventilator as claimed in claim 5 in which said one opposite pair of the frame members (104, 131; 106, 130 or 160, 130; 162, 131) has outer parts (130, 131) which close the ends of said other opposite pair of said frame members (102).

7. A ventilator as claimed in any preceding

claim having a single obturating member (159) in the form of a ventilation flap hinged along one edge for outward opening movement, said flap being hinged to one of said frame members (162, 131) defining one side of said fire ventilation opening and said control gear (167) is housed in a further one or in two of said frame members (102) which are interconnected with said one of said frame members by said plugging members (164).

8. A ventilator as claimed in claim 7 in which the control gear (167) comprises a control lever arm (170) hinged at its two ends respectively to the flap (159) and to linearly movable slider means (171) mounted inside said hollow frame, the slider means being displaceable by the operation of air under pressure acting in a pneumatic ram (176) to move said control lever arm (170) to close the flap (157).

9. A ventilator as claimed in claim 8 in which the flap (157) is hinged along its bottom edge and is arranged to pass through a vertical position to close with an inward inclination at a small angle, when the ventilator frame is disposed in a vertical plane, and the control gear (167) comprises a return spring associated with said ram,

the return spring being operable to initiate the opening of the flap (157) to its fully open position by gravitational action.

10. A ventilator as claimed in any one of claims 1 to 6 having a plurality of obturating members (108) formed as tubular louvre blades hinged between one opposite pair of the frame members (102) on pivots (142) mounted in louvre end plugging members (140) plugging the respective ends of the louvre blades, the louvre end plugging members being formed with sealing lips (104c, 104d) engaging said one opposite pair of the side frame members (102) in the closed position of the louvres.

11. A ventilator as claimed in claim 10 in which the louvre end plugging members (140) are formed of elastomeric material and each has an outer sealing lip (104c) exposed to the outside of the ventilator and a further sealing lip (104d) underlying the outer sealing lip, the louvre blades being hinged generally between their leading and trailing edges and the outer sealing lips (104c) being foreshortened adjacent the leading edges of the louvre blades to expose the further sealing lips (104d) to the outside of the ventilator to be

overlaid by portions of the sealing lips (104c, 104d) adjacent the trailing edge of the next adjacent louvre blade in the closed position thereof.

12. A ventilator as claimed in claim 11 in which said one opposite pair of the frame members (102) constitutes the side frame members of the ventilator frame and the other opposite pair of the frame members (104, 131; 106, 130) constitutes the top and bottom frame members respectively of the ventilator frame, the side frame members (102) being formed with lengthwise extending gutters (102g) and the outer sealing lips (104c) overhanging the adjacent inner walls (102h) of the gutters in the closed position of the louvre blades.

13. A ventilator as claimed in claim 11 or 12 in which the louvre end plugging members (140) are provided with lip seals (140e, 140f) sealing against the outside surfaces of the louvre blades (108).

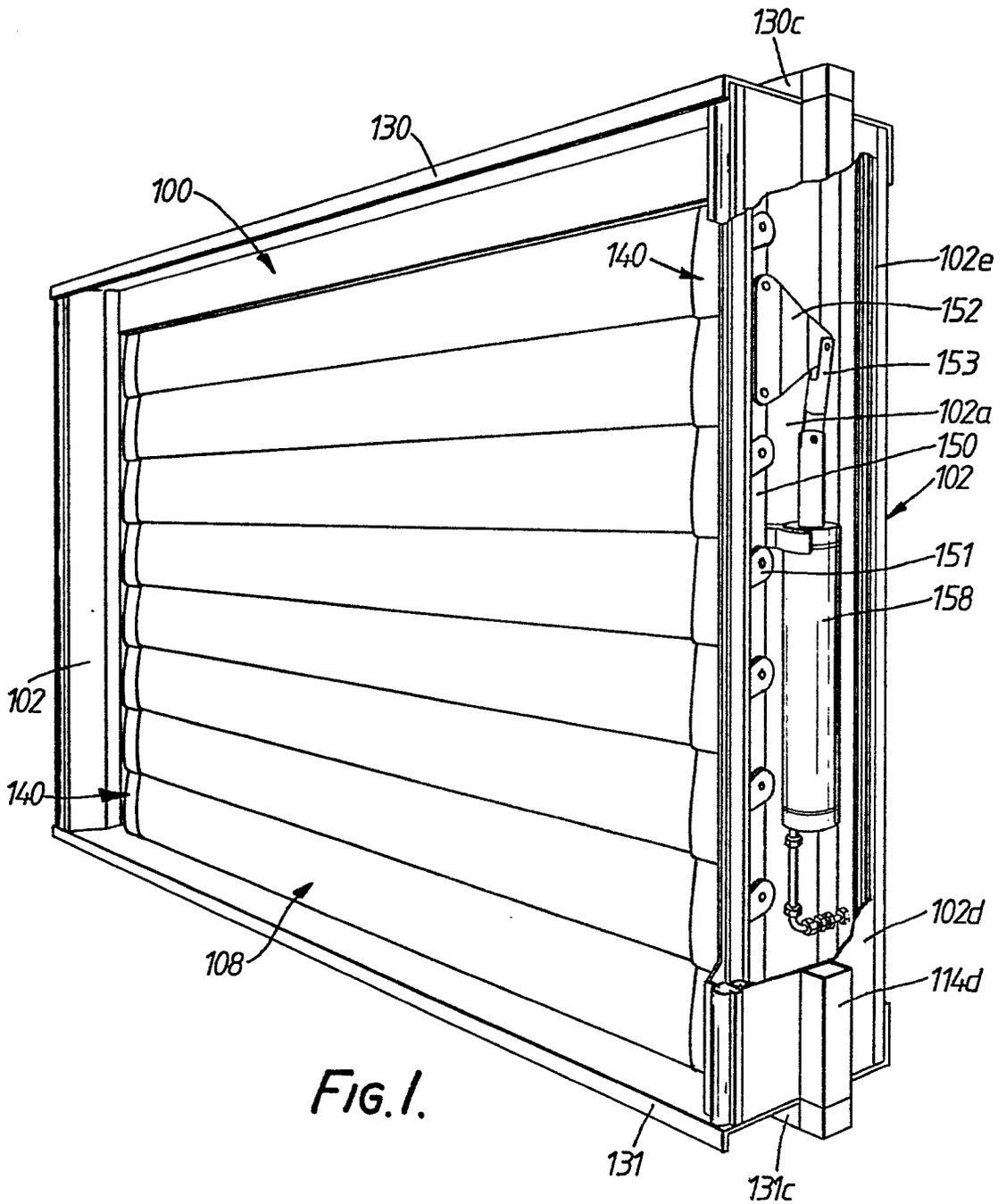
130c
130
100
140
102e
152
153
102a
150
102
151
158
102
140
108
102d
114d
131
131c

FIG. 1.

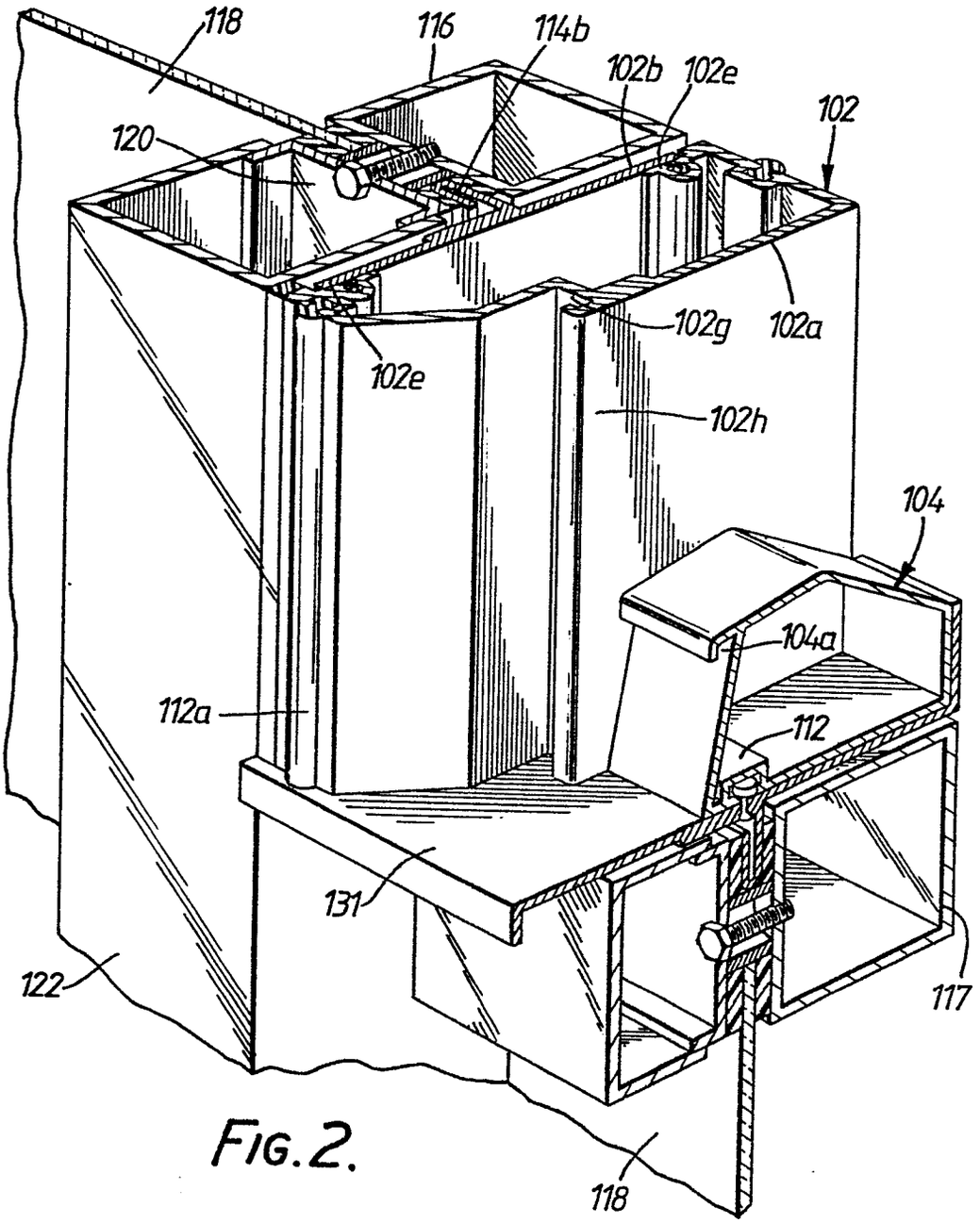
118
116
114b
102b
102e
102
120
102g
102a
102e
102h
104
104a
112a
112
131
122
117
118

FIG. 2.

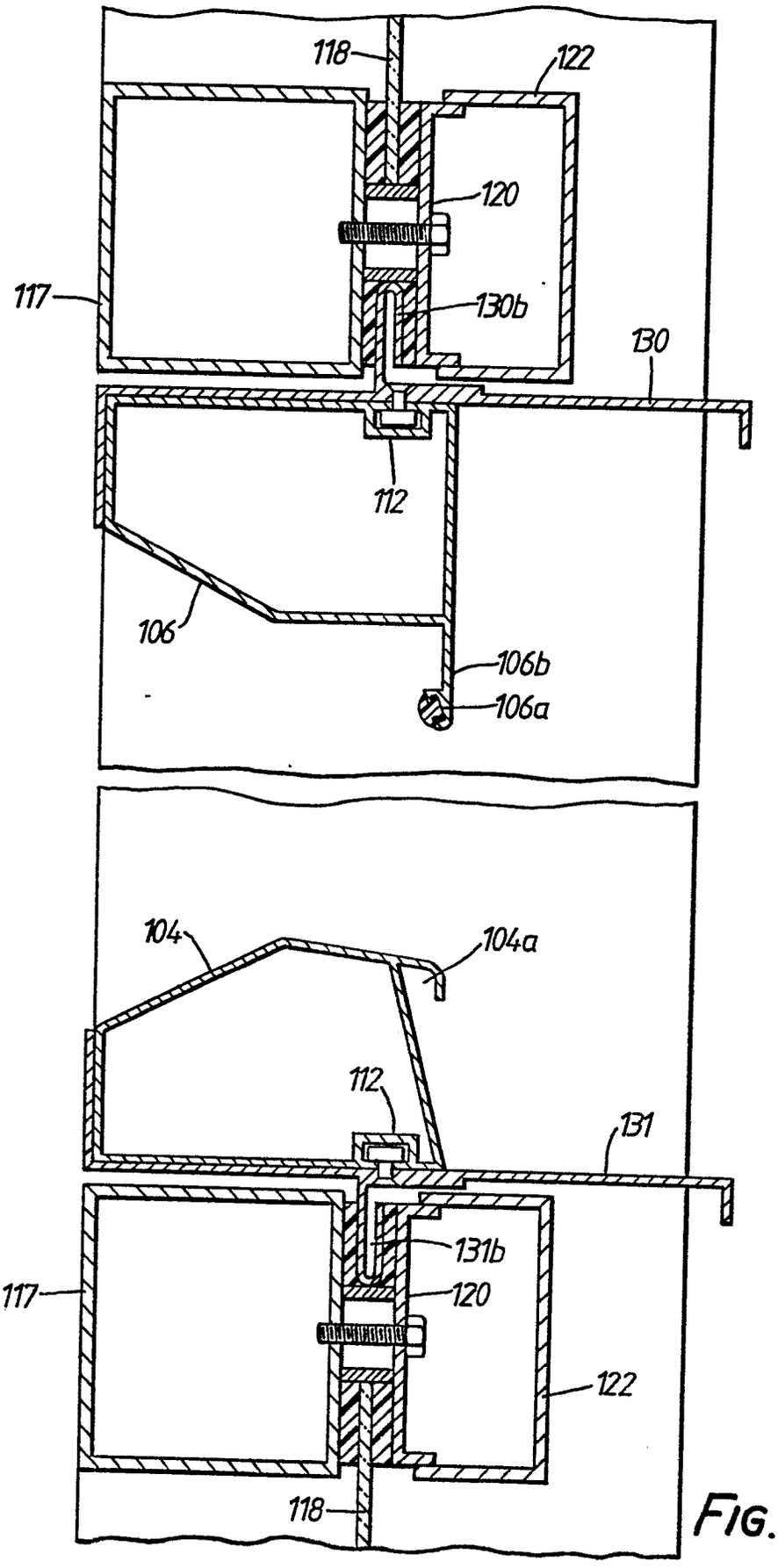
118
122
120
117
130b
130
112
106
106b
106a
104
104a
112
131
131b
117
120
122
118

FIG. 3.

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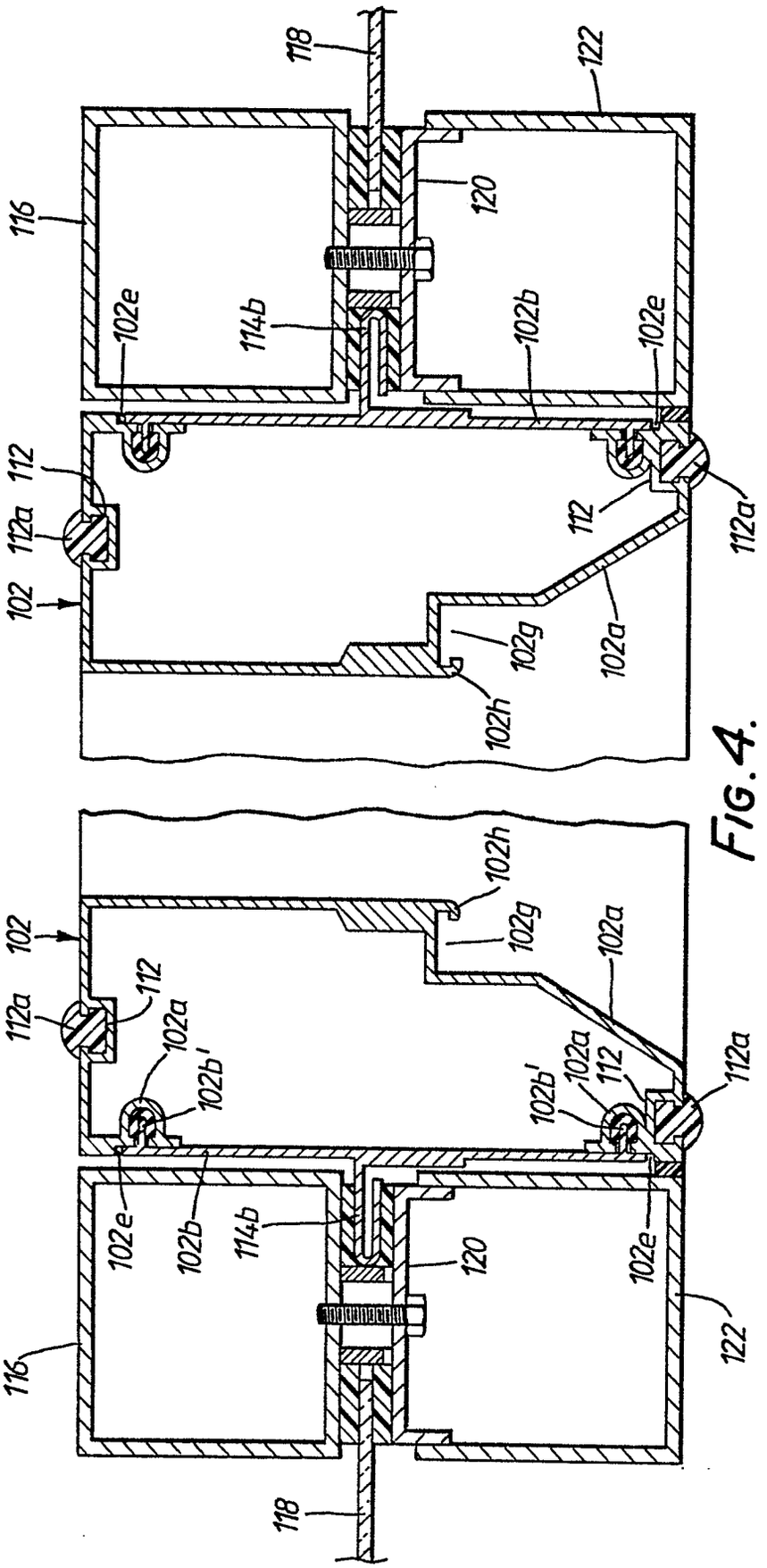


FIG. 4.

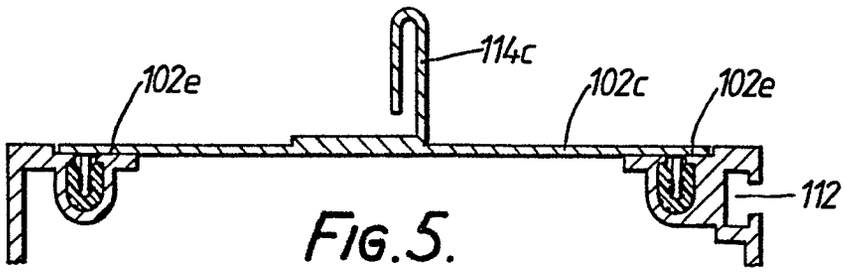


FIG.5.

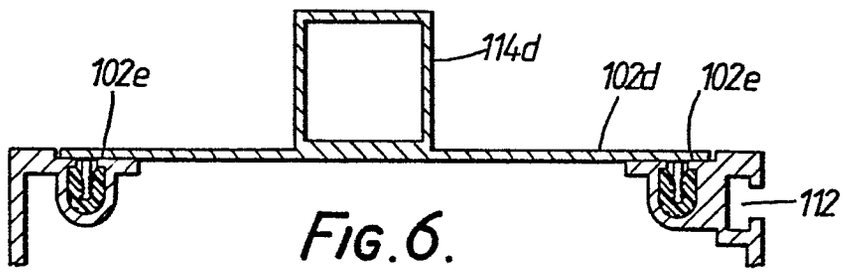


FIG.6.

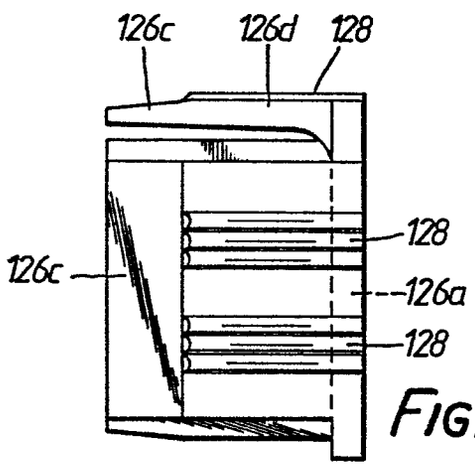


FIG.13.

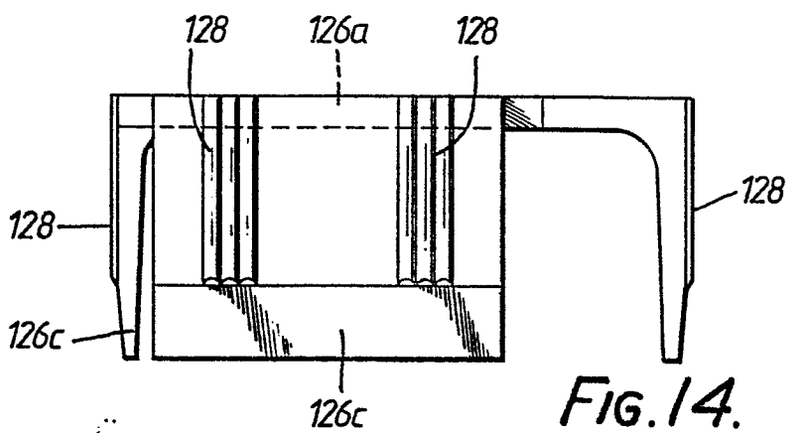


FIG.14.

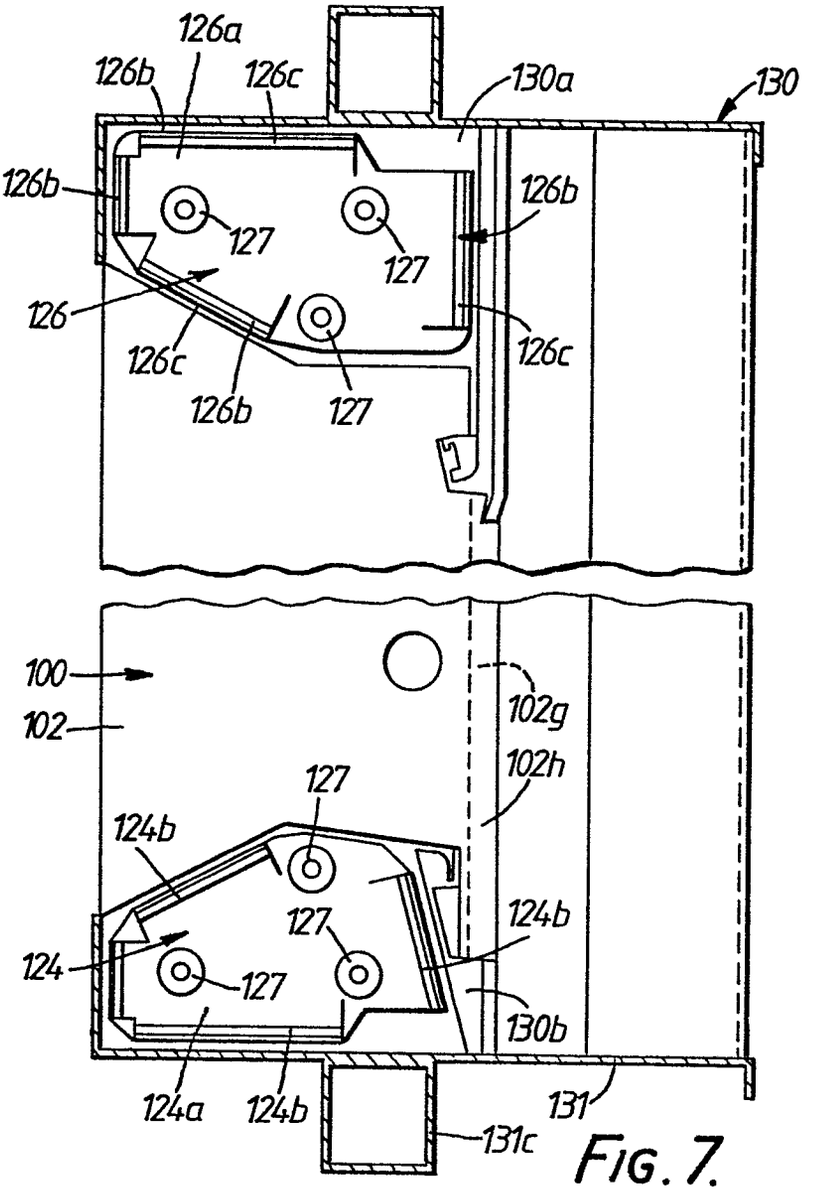
126a
126b
126c
130a
130
126b
127
127
126b
126
126c
126c
126b
127
100
102
102g
102h
127
124b
127
124b
124
127
130b
124a
124b
131
131c

FIG. 7.

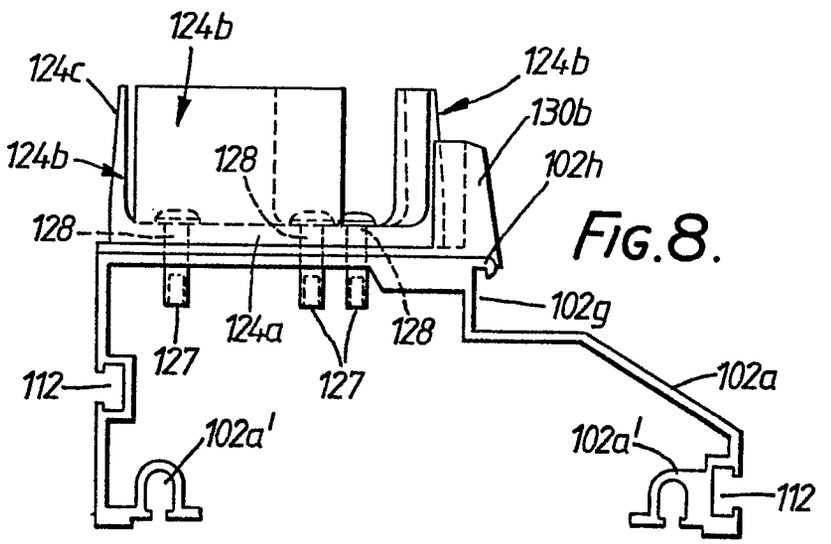
124b
124c
124b
124b
130b
128
102h
128
102g
127
124a
128
127
112
127
102a
102a'
102a'
112

FIG. 8.

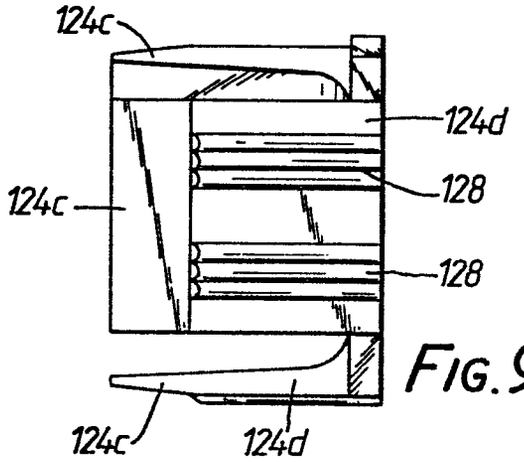


FIG. 9.

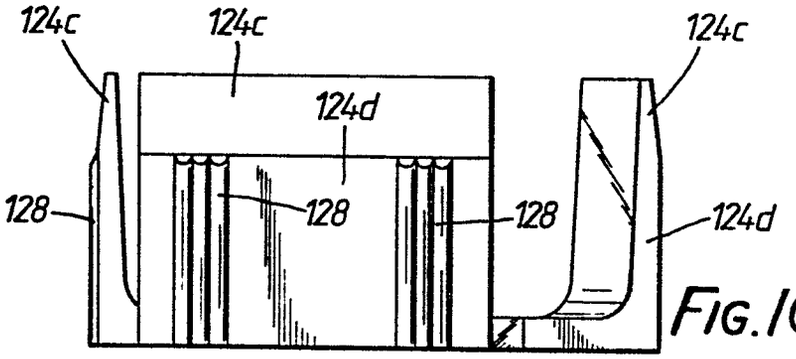


FIG. 10.

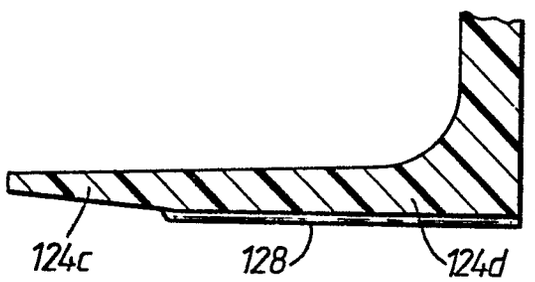


FIG. 11.

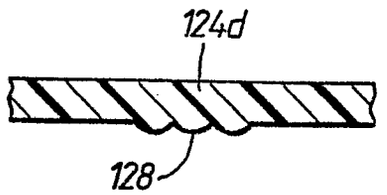


FIG. 12.

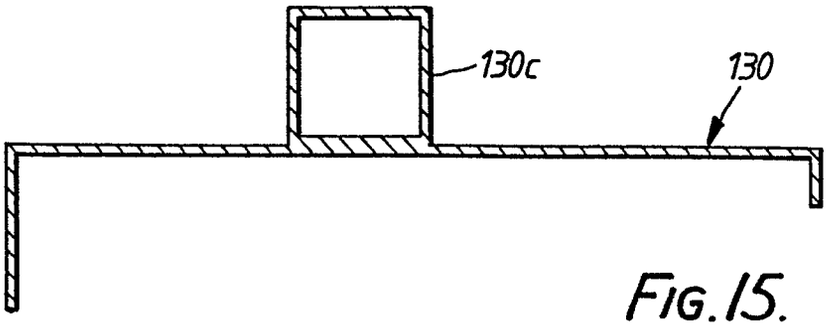


FIG. 15.

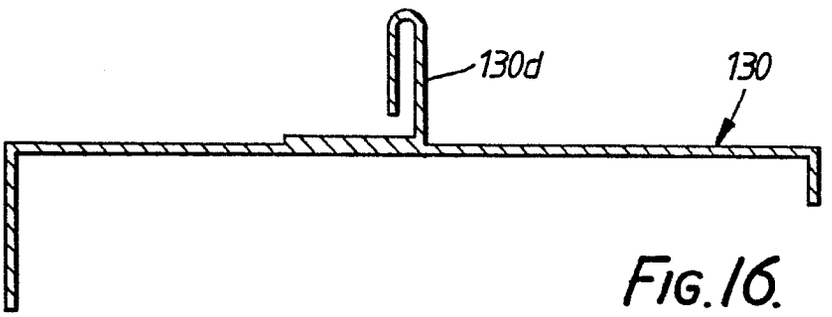


FIG. 16.

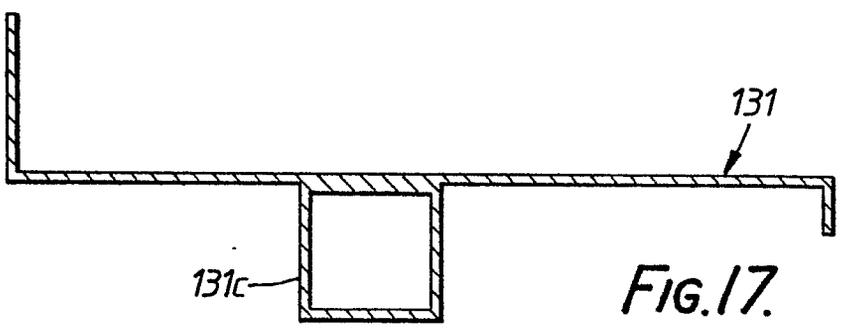


FIG. 17.

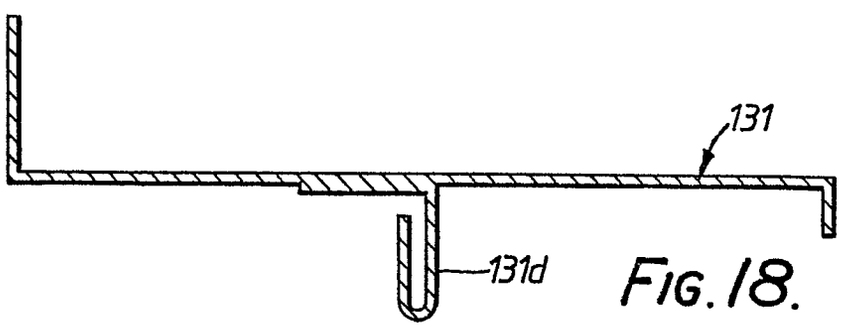


FIG. 18.

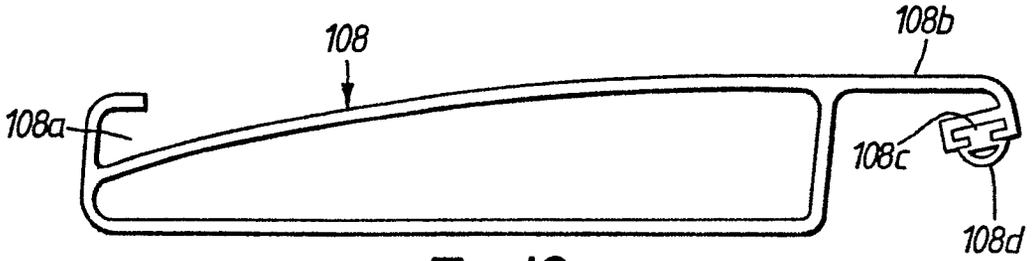


FIG.19.

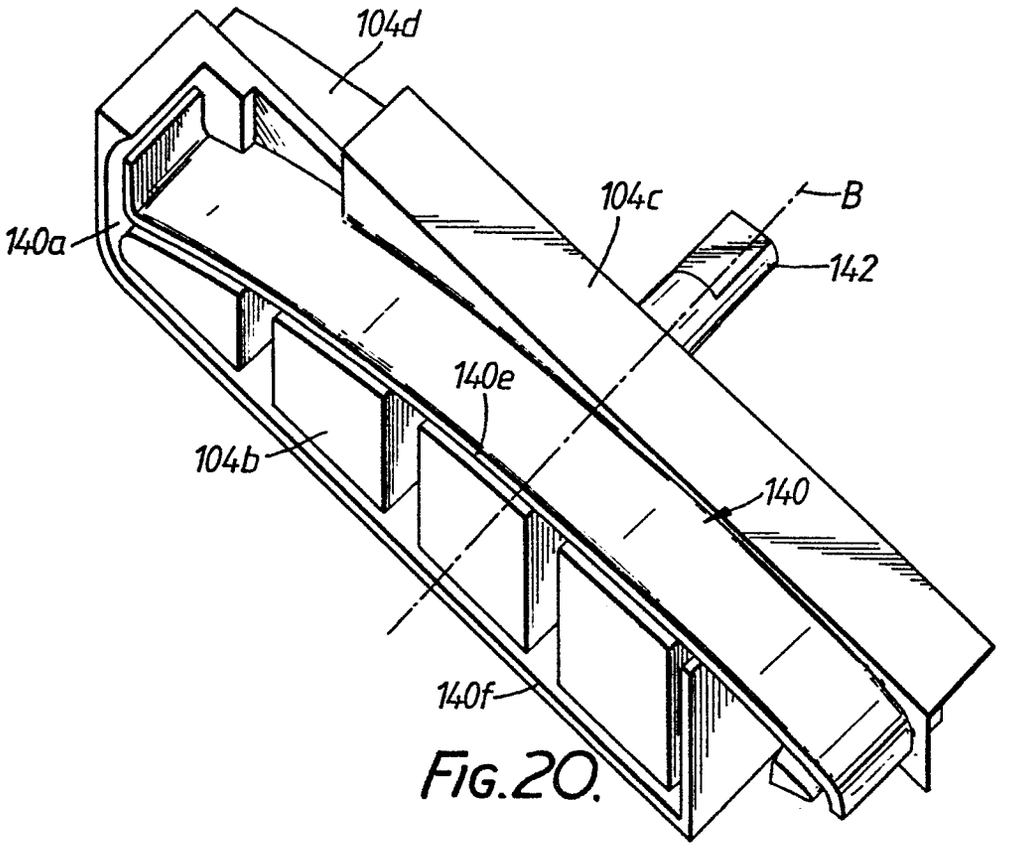


FIG.20.

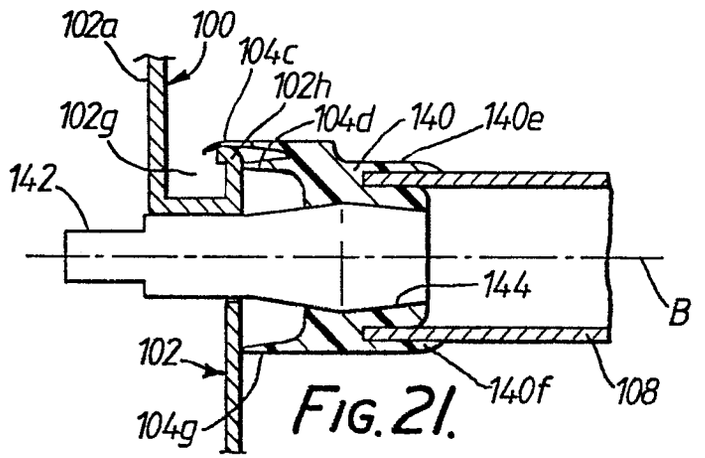


FIG.21.

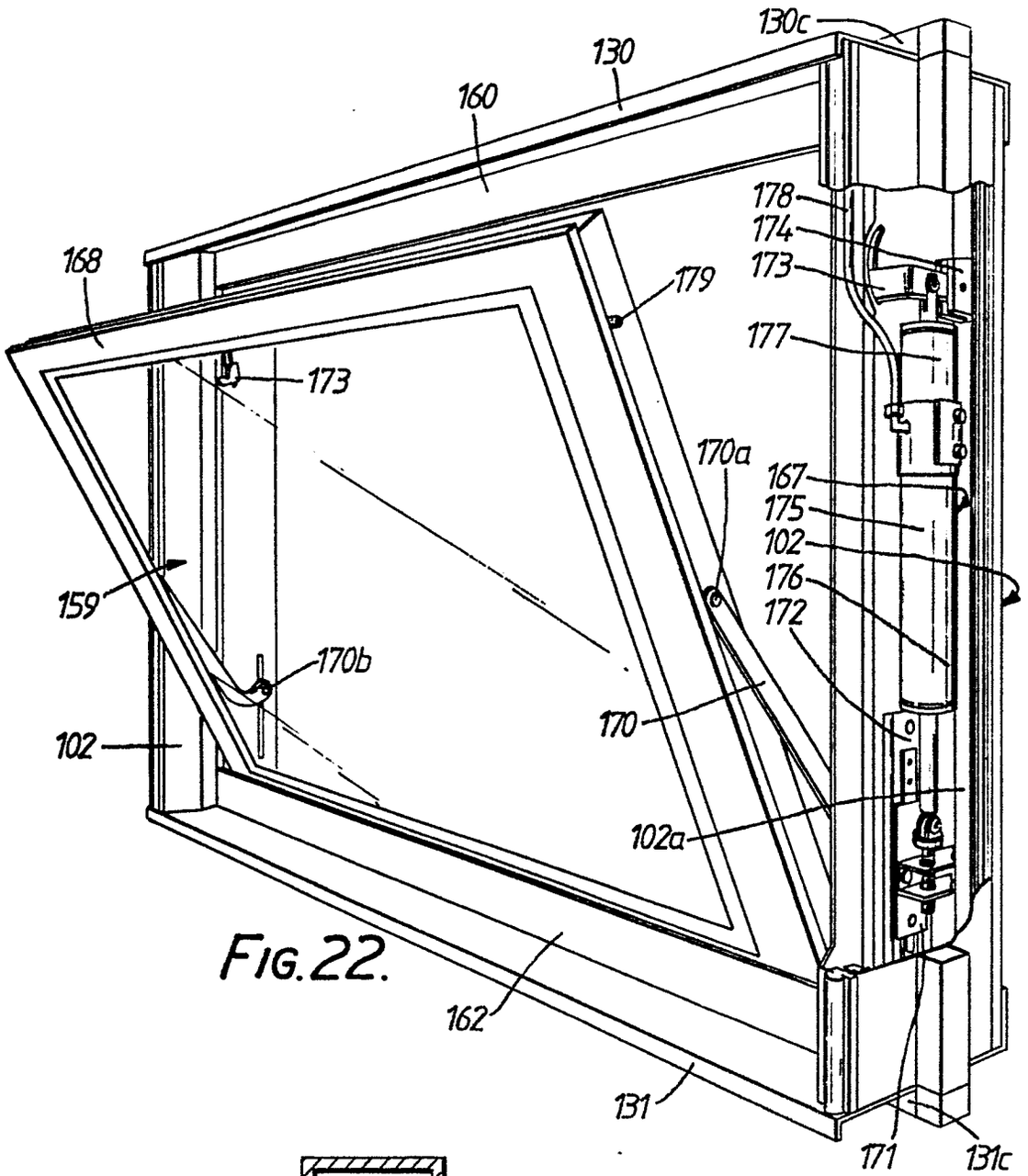
130c
130
160
178
174
173
168
179
177
173
170a
167
175
102
176
172
159
170b
170
102
102a
162
131
171
131c

FIG. 22.

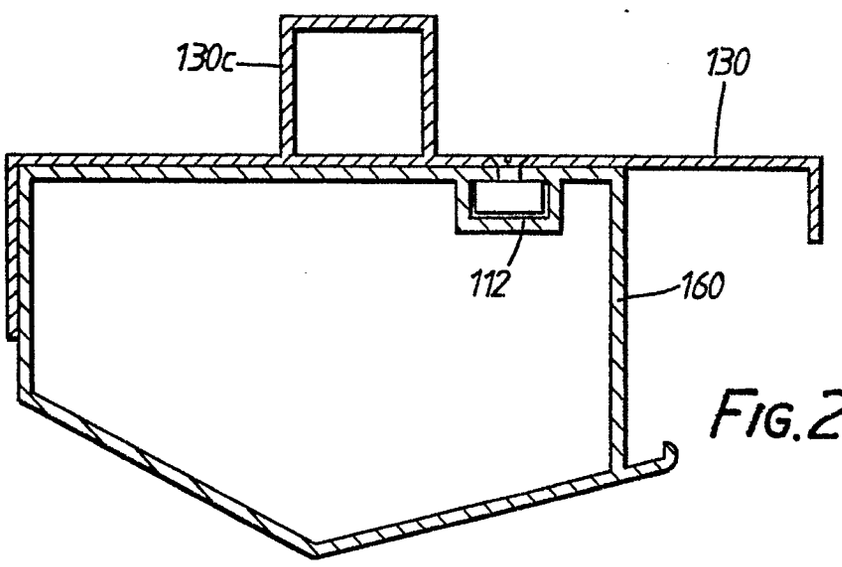
130c
130
112
160

FIG. 23.

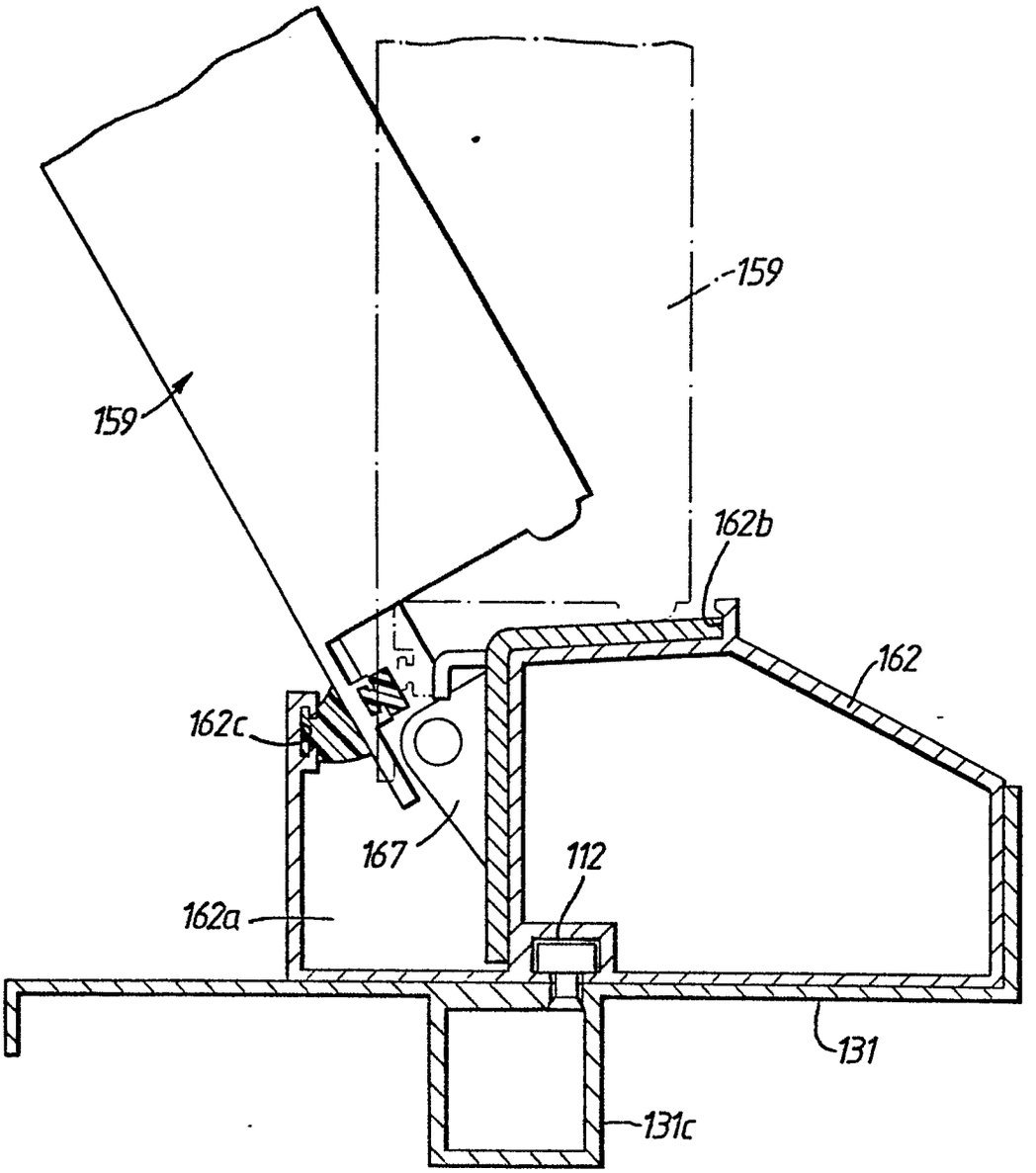


FIG. 24.

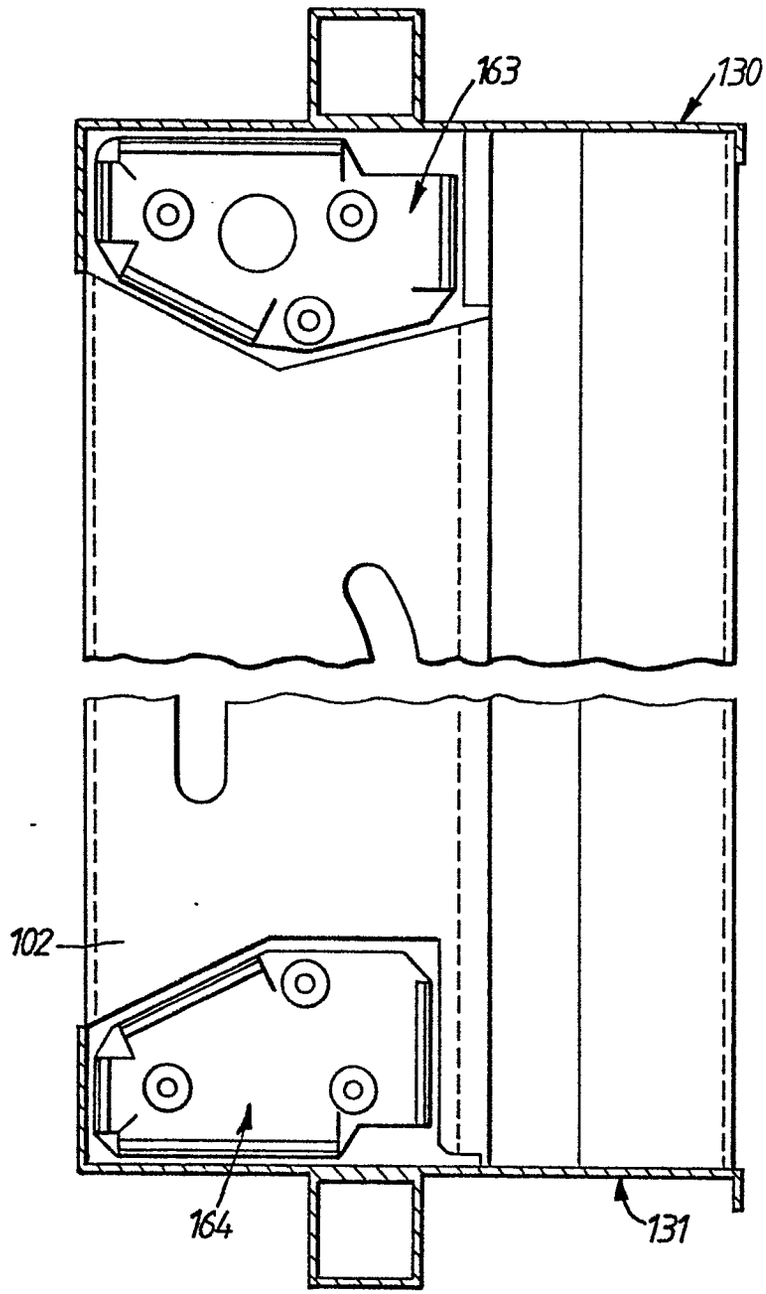


FIG. 25.

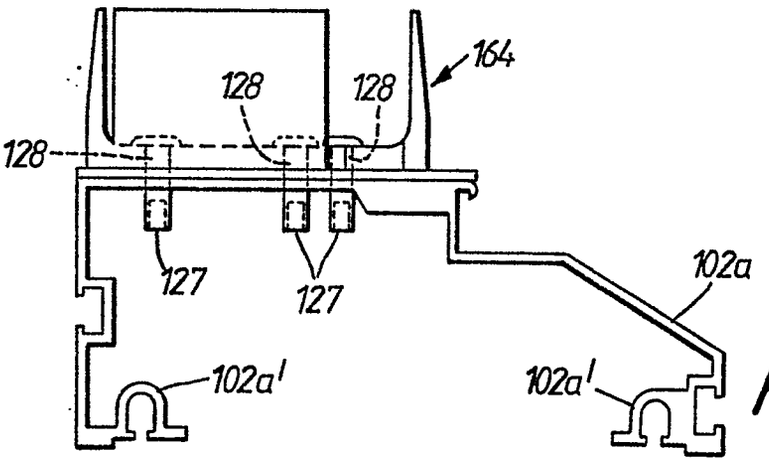


FIG. 26.