



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
30.05.2012 Bulletin 2012/22

(51) Int Cl.:
E06B 9/165 (2006.01)

(21) Application number: **11191232.5**

(22) Date of filing: **29.11.2011**

(84) Designated Contracting States:
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
Designated Extension States:
BA ME

(71) Applicant: **KÖSTER, Helmut**
60437 Frankfurt am Main (DE)

(72) Inventor: **KÖSTER, Helmut**
60437 Frankfurt am Main (DE)

(30) Priority: **29.11.2010 DE 102010052616**
27.12.2010 DE 102010056308
07.03.2011 DE 102011005215
28.04.2011 DE 102011017662
25.06.2011 DE 102011078079
21.09.2011 DE 102011083115

(54) **Daylight roller shutter**

(57) The invention relates to roller shutters with daylight transmission. The roller shutters are installed in façades between an outer space and an inner space, comprising individual roller shutter profiles 52-55 having a sun-irradiated projection height H . The roller shutter profiles are shifted one into the other via hook- 47,48 or T-shaped profilings and/or they are kept at a distance via intermediate profiles or cords or by means of rigid or flexible bands or by means of distance holders wherein the roller shutter profiles either having punches in the area of the hook- 47,48 or T-shaped profilings or of the intermediate profiles or of the hinges, or they are held by means of distance-holders like bands or cords so that a view-out width D 42,43 results through which daylight irradiation 62 between the roller shutter profiles occurs.

The invention is characterized in that the roller shutter profiles form light reception bays with a light reception width W . The light reception bays include at least one plane, arched or bent light reflection face 56-59, 100-105 having the width B . The light reflection faces 56-59, 100-105 are disposed at an angle preferably $> 0^\circ$ relative to the horizontal, and via the light reflection faces 56-59, 100-105 at least sun irradiation 28, 60/64, 61/65 with small sun incidence angles α_1 may be reflected to inside into the upper half space of the interior, and via the light reflecting faces 56-59, 100-105 sun irradiation with higher incidence angles α_2 may be reflected to the underside of the upper roller shutter profiles.

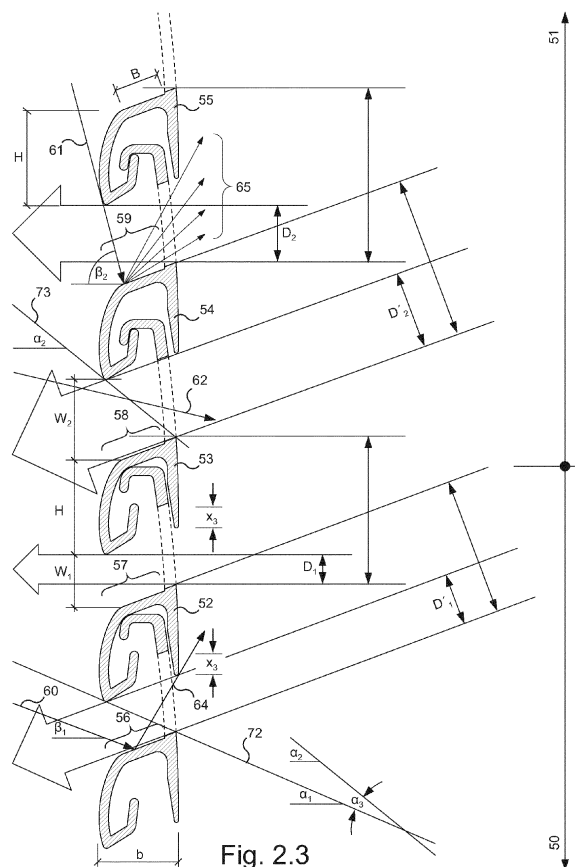


Fig. 2.3

Description

[0001] The present invention relates to daylight roller shutters as in accordance with the preamble of the main claim.

[0002] From DE 2932010, CH 345,145 A, CH 520,259 A, DE 1,804,509 U, DE 200 09 630 U1, DE 10 2004 043573 B3 it has been known to produce roller shutters with a variable light lock. If and when the roller shutter profiles move completely into each other, darkening results. If the roller shutter is rolled up, light slits are obtained in the individual roller shutter profiles generated by a punch raster. Individual profile bars will glide within a hook lock into each other and thus release the punch raster for daylight incidence when the roller shutter is rolled up.

[0003] The disadvantage of these roller shutters is that when completely lowering the roller shutters either total darkening and when pulling up the roller shutters a glaring light point raster in the roller shutter itself and, in case of sun light incidence, in the interior space will occur. It is, therefore, that the prior art roller shutters are not suited as a sun protection measure in office buildings. Neither are total darkening nor light rasters on a working level acceptable. The light raster does not provide sufficient illumination of the interior space, particularly not in the room depth. With a view to its light and dark contrasts, the light raster has, however, a rather glaring effect. The prior art roller shutters do not permit a sufficient view-out. A good view-out, however, is a precondition for shadowing systems in office buildings. All prior art roller shutters are lacking especially a means and the ability to redirect daylight to the ceiling and into the room depth. This refers also to CH 345,145 A (see Figs. 01, 02). DE 10 2004 043573 B3 shows larger punchings with slightly improved view-out instead of a point raster. But even 10 % horizontal view through the punches is not sufficient in an office building. Also this innovation is missing light redirecting properties to illuminate the interior. The inner space is darkened by the roller shutter and forces to use electric lighting while sunshine hours, and thereby wasting valuable electric energy and additionally increasing the inner cooling loads because the electric lighting is finally converted into heat.

[0004] This efficacy of LED-lighting is 70-80 lm/W while daylight behind a low-e-insulation glass brings 240 lm/W.

[0005] It has, furthermore, been known from DE 10161159 A1 to arrange miniaturized roller shutter profiles by means of a distance-holding metal tape at a fixed distance relative to each other so that in the pulled-down state, a certain view-out and diffuse light entry mainly by the albedo and horizontal irradiation into the interior space is basically secured. The disadvantage of this device is the impossibility neither to collect any direct sun nor the diffuse sky for room illumination, nor to redirect any light from outside into the depth of the room. Neither can the roller shutter react on different sun incidence angles nor can the light entry to the interior space and the daylight illumination be modelled, or varied. The light incident from the outside on the roller shutters is not reflected to the inside but is substantially reflected back to the outside as a protection against overheating with the consequence of a strong darkening effect interior. Solar gains in winter with lower angles of incidence can not be realised.

[0006] All prior art roller shutters comprise punched openings for light incidence into the interior space. Light guidance for an improved room illumination and the saving of energy for the electric illumination, however, is lacking. This refers also to JP 100 963 81 A and FR 2,941,989 which prevent any entry of direct radiation or mono-reflected radiation. FR 2,941,989 will guide at best diffuse light from the lower half space via double reflection into the interior space. Neither will a view-out nor room illumination by daylight result. The state-of-the-art does not offer any device to transport daylight into defined areas of the interior.

[0007] It is therefore the aim of the present invention to develop a roller shutter which, while considering the angle of incidence of the sun, offers the possibility to determine the direct and the indirect light transmission, the direction of the transmitted light to the ceiling and into the room depth, the shadowing and the view-out within one curtain. It is the objective of the invention to adapt the roller shutter in its functionality additionally for the supply of daylight to interior rooms in order to save electric energy for the lamps and to minimize the internal heat loads as a consequence of electric lighting as well as to reduce the external heat loads in summer and at the same time guarantee a glare free work place. Further objectives are to realise solar gains only for low angles of incidence in winter by an angle selective aperture.

[0008] This complex task of daylighting and building physics on one side and as a shutter- and profile technology on the other side is solved as in accordance with the characterizing clause of the main claim.

[0009] The decisive advantage is the adaptation of a roller shutter profile for daylight redirection by means of an integrated portion for light redirection into the upper half space of the interior room ceiling and/or into the room depth while not producing any glare on the work place.

[0010] Further advantages of the present invention include the possibility of

1. regulating the direct light transmission between the roller shutter profiles via the incidence angle of the sun and/or via the up and down function of the roller shutter,
2. regulating the indirect light transmission, i.e. the daylight redirected onto the ceiling and into the room depth by precisely redirecting the reflected rays by a specific reflector to realise a defined light distribution curve,
3. regulating the shadowing of the work place to avoid light stripes formation on the working plane,
4. regulating the view-out of the roller shutter,
5. regulating the retro-reflection of the solar energy irradiation respectively the total solar energy transmission.

[0011] These advantages are obtained by the specific design of light reception bays which have different angles α of the shadow lines. The light reception bays are defined by light guiding surfaces having a flat inclination and are determined by the width b of the roller shutter profiles. The protective function against too strong sun incidence (solar heat gain coefficient of the roller shutter) and the function of supplying daylight illumination are defined by the opening width W of the light guiding bay in relation to the height of the roller shutter profile (W/H).

[0012] For an improved room depth illumination, the curtain may be adjusted, in accordance with a further development, more open in the upper window area, and for better shading of the window-near work place, optically more dense in the lower window area. Therefore, the curtain allows within its height a variable optical adaptability to the sun incidence and to the work place conditions by generating function zones wherein the upper part serves for improved daylighting and the lower part for the required shadowing.

[0013] A further advantage is that the adjustment of the daylight- and solar transmission is obtained by the orientation of a light guidance reflector. An advanced type of shutter allows via up and down functions an additional daylight collecting and an improved visual transmission. If in case of a down function of the roller shutter the profiles pile up one upon the other, the angular inclination of the shadow line is adjusted at a base position α_2 (Figs 1, 5). If the roller shutter moves upward, the profiles suspend one in the other, a second, steeper-adjusted, shadow line at an angle α_1 will result (Figs. 3, 4). The rational of the roller shutter consists in that the individual roller shutter profiles in a down function pile up, first, in the lower area so that the window-near work place is well shadowed or even darkened (Figs. 10, 12) while the roller shutter profiles in the upper area still suspend one within the other and hence open the view-out and light entry still more so that a good room depth illumination via the upper window area is obtained.

[0014] The directional room illumination, or the light distribution relative to the interior space, is defined via a light guidance reflector having a width B . The shape and the angle of inclination of the light guidance reflector may also vary within one curtain so that the sun light in the lower roller shutter portion may be deflected, glare-free steeply upward, onto the ceiling (Fig. 9) and, in the upper roller shutter portion is deflected more flatly into the interior into the room depth (Fig. 11). The light guidance reflector is preferably shaped concave.

[0015] The essence of the invention is the integration of a light guidance reflector within the roller shutter profile. The light- and energy transmission of the roller shutter is defined by the width and the shaping of the reflector as well as its inclination. Essential of the invention, furthermore, is the shadowing of each upper profile to avoid over-illumination and overheating of the interior space relative to the high altitude of the sun in summer by the definition of the opening width W of the light guidance bay (Fig. 15). The light guidance bay is, therefore, defined as a hollow space similar to a loggia provided behind an outer line of the roller shutters. The angle selective properties of the shutters are defined by the relation W/B and W/H .

[0016] Contrary to Venetian blind-like shadowing systems or roller shutters operating like venetian blinds which execute closing or opening orders by rotating the slat tipping angle or by uniformly swinging out roller shutter profile portions over the total height of the curtain, the daylight roller shutter of the invention is characterized by a zoning into lower roller shutter areas and upper roller shutter areas, for instance above eye level. The shadow lines S or the light and energy transmission values of the roller shutter between upper and lower roller shutter zones may freely be varied within one roller shutter. The open and the closed portions of a roller shutter, particularly with a view to the height and the areal extension, may freely be selected by up and down movement and in this way may glare-free be adapted to the sun incidence angle and the shadowing requirement at the window-near work place, on one hand, and the eye level of a person standing in the interior space and looking into the curtain, on the other.

[0017] By the width B and the shaping of the light guidance reflector, the direction and the light distribution relative to the interior space are defined. By the opening width W in relation to the opaque retro-reflecting partial faces H , the quantitative light transmission, on one hand, and the protective function against overheating (total energy transmission) of the roller shutter, on the other, is defined.

[0018] The light bays are so shaped that the light guidance or the flat-disposed light redirection faces or mirrors can endure rain from the outside and are, therefore, self-cleaning as well. Rain impinging on the light guidance faces runs outwardly off dragging along any dust deposited.

[0019] Further advantages will be explained based on the figures, wherein

Figs. 01 and 02 show a roller shutter profile representing the state of the art,

Figs. 1 and 1 a show the cross section of a window zone with the optical, visual and thermal base functions of the roller shutter of the invention,

Figs. 2 and 3 show the individual roller shutter profiles, suspended one within the other or piled one upon the other,

Fig. 2.1 shows the same as in Figs 2 and 3 at an enlarged scale,

Fig. 2.2 shows the same as in Fig. 2 in the original size,

Fig. 2.3 shows the same as in Fig. 2.1 with the different optical and visual functions,

Figs. 2.4/3.1 includes a variant of the profile embodiment for rolling up including the rolling-up shaft disposed within,

Fig. 4 shows the way of rolling up the curtain with the rolling-up shaft disposed outside,

Fig. 5 shows profile variants according to Figs. 2.4 and 3.1 with the rolling-up shaft disposed inside,
 Figs. 6 and 7 show roller shutter profiles of various hook sizes of a curtain,
 Fig. 8 shows the cross section of a transparent plastic profile with incorporated reflectors,
 Figs. 9 and 11 show the cross section of roller shutter profiles having different angles of incidence of the light
 5 guidance portions
 Figs. 10 and 12 show the profiles of Figs. 9 and 11 in the completely closed state as darkening.
 Figs. 13 to 16 show the ray tracing on the profiles of Figs. 9 and 11 for different sun incidence angles
 Figs. 13.1 to 16.1 show the light distribution curves caused by the light guidance surfaces for reflected irradiation
 of the profiles of Figs 13 to 16,
 10 Fig. 13.1.1 and Fig. 13.1.2 as well as Fig. 15.1.1 and Fig. 15.1.2 show diagrams of the direct light transmission
 between roller shutter profiles and the total energy transmission of the roller shutters for sun incidence angles
 between 0° and 85°,
 Figs. 18 to 20 show a further variant of roller shutter profiles with an elastic coupling of individual profile portions.
 Fig. 21 shows the rolling up of roller shutter profiles of Figs. 18 to 21,
 15 Fig. 22 shows the rolling up of roller shutter profiles of Figs. 9 to 11 with elastic profile portions of the kind of rubber lips.
 Figs. 23 and 24 show the cross section through further types of shutter profiles.
 Figs. 25 and 26 show a special 'pullout' shutter.
 Figs. 27, 27.1 and 28 show a further type of daylight shutter with a daylight reflector on the upper and lower side of
 the profiles.
 20 Figs. 29.1 to 29.5 and 30.1 to 30.5 show ray tracings between two profiles.
 Figs. 31, 32 and 32.1 show an assembling of the shutter profiles.

[0020] Fig. 01 and Fig. 02 show a roller shutter profile from CH 345,145 A, where Fig. 01 shows the roller shutter in
 an open suspended state and Fig. 02 in a completely closed darkening state. The outer faces 212, 213 of profiles 207,
 25 208 are turned towards the interior space in order to try in an obvious way to use the inclined legs 214 and 215, or 216
 and 217, for light guidance. Tracking the light radiation 202, 209 impinging on partial faces 216 according to the law
 "angle of incidence = angle of reflection", one will find out that even if in a reverse fitting position, light deflection to the
 interior space is not possible. The reflected rays 203, 204 do not contribute to daylight illumination. Diffuse bottom
 radiation only (albedo) might penetrate between the profiles into the interior space. There will also be only a minimum
 30 view-out D between the profiles although the shadow line 201 is at 20° light incidence. In the piled-together state in Fig.
 02, a total closure will result.

[0021] The embodiment of the invention of a roller shutter now provides that a daylight reflector of the kind of a light
 shelf be integrated in the profile so that the daylight may be reflected from the upper half space (upper window area)
 into the upper half space of the interior space (interior space ceiling and room depth) while no glare will occur at a work
 35 place.

[0022] This light reflection into the interior space takes place in a specific request catalogue shown in Figs. 1 and 1.1.

[0023] Fig. 1 shows the vertical cross section of a façade-oriented room having a window-near work place, with the
 first function zone 10 in the upper window area and the second function zone 11 in the lower window area. It is the
 function of the upper window area 10 to reflect daylight 12, 13 into the room depth. It is the function of the lower window
 40 area 11 to primarily shadow the window-near work place 23 in that sun and heat are retro-reflected as shown by light
 beam 14 and 15. It is a further function of the upper light area to allow a view-out 16 from the room depth. In the lower
 window area, primarily a view-out 17 onto the street should be possible.

[0024] Further functions are shown in Fig. 1.1. In the lower window area, a shadow line 20 between two roller shutter
 profiles at a very flat angle α_1 should result in order to protect the window-near work place against direct high sun
 incidence. In the upper window area, the shadow line 22 may be provided steeper at an angle α_2 without producing a
 glare at the window-near work place. On the work plane 23, different shadow zones 18, 19 will result which are regulated
 45 by sun incidence, on one side, and actively by the moving-down position of a roller shutter, on the other.

[0025] In this way, Figs. 1 and 1.1 demonstrate the tasks and functions of a sun protection, taking into consideration

- the direct glare by regulation of the direct light irradiation
- the shading and avoidance of striation on the work plane 23 by determining the inclination of the shadow lines
- the quantitative light irradiation and the direction of the light deflection into the room depth (supply function) and
- the adaptation of the roller shutter for different sun incidence angles during various times of the day and of the year
 (visual and thermal comfort)
- and the solar heat gain (protection function).

[0026] It is now the task of an intelligent daylight roller shutter to secure the above various requests and functions.
 Figs. 2 and 3 show the roller shutter profiles of the invention in their different positions to fulfil the tasks mentioned.

[0027] Fig. 2 demonstrates how the roller shutter profiles in the upper window area suspend one in the other. In the suspended position thereof, they show a defined view-out and a defined shadow line.

[0028] Fig. 3 shows the same roller shutter profiles as they are piled up one upon the other in the lower window area. By the shifting the roller shutter profiles one into the other, the shadow line, the view-out, the light entry and the total energy transmission will change.

[0029] The figure shows a sun incidence 26 onto the roller shutter profiles at an angle α_2 . α_2 is the angle inclination of the shadow line. Sun incidence at an angle of incidence $< \alpha_2$ may partly penetrate between the profiles into the interior space. The portion 27 impinging on the light-deflecting upper side of the roller shutter profile of the invention is guided into the interior space as symbolized by the ray path 28. In spite of complete shadowing, a very good room illumination will, therefore, be obtained in the interior room depth via the upper window area. At the same time, excellent view-out 29 will be obtained between the roller shutter profiles. In order to intensify the light guidance 28, either the complete roller shutter profile, or portion 34 only, may be made reflective, for instance by applying a mirror.

[0030] In the lower window area of Fig. 3, the roller shutter profiles move into one another and reduce angle α_1 of shadow line 30. Light reflection 32 for more flat angles of incidence of the sun via the light reflecting upper sides of the roller shutter profiles, however, will remain. In spite of the flat shadow line at an angle α_1 , a very good view-out through the curtain in the horizontal line of vision 31 and to the bottom plane 23 will be retained.

[0031] The control of the curtain, the angular inclination of the shadow lines and, in particular, the size of the upper window area relative to the lower window light area, may very simply be executed by the mere up and down function of the curtain.

[0032] When moving the curtain down, the shadow line decreases continuously from below upwardly at a measure as the profiles pile up one in the other. Depending on the time of the year and/or of the time of the day, the stop point of the downward movement of the roller shutter may be programmed so that, by considering the sun incidence, the window-near work place is well shaded up to an angle of incidence $> \alpha_1$ but is nevertheless well lighted by light reflection to the ceiling.

[0033] Fig. 2.1 shows the profiles suspended one into the other when guided in a lateral U profile. The U-shaped guide shaft is schematically shown in the figure by the dotted lines 40, 41. Fig. 2.2 shows the profiles in a typical original size. The smaller the roller shutter is made, the smaller is the roll-up diameter. It is even of advantage to shape the profiles in the width thereof < 5 mm. The dotted areas 42 through 45 show the area of the punch-outs which may either be made as elongated slits or any optional hole images. In the case of residential houses, it might for instance recommendable to perforate the areas 42 through 45 with small holes only in order to assure at the same time protection against insects.

[0034] The individual roller shutter profiles consist of two portions, viz. a U-shaped hollow profile 46 with an angular reception 48 and a suspension angle 47. The reception 48 and the suspension angle 47 lay themselves into one another and in this way arrest the roller shutter in its open function. The suspension angle 47 lays itself in the base of U profile 46 and arrests the roller shutter in a closed position.

[0035] The characteristic feature of the present embodiment is that the roller shutter is never completely closed. By the moving of the individual roller shutter profiles into one another, it is only the light transmission behaviour which changes through the angle α of the shadow line. The invention thus refers to a roller shutter having defined light-technological functions adaptable to work place situation and sun incidence. If the sun is higher than the shadow lines, the curtain may be rolled up further. In case of smaller sun incidence angles, in the morning or in the evening or in winter, the curtain may be moved into a closed position and thus will shade in case of more flat sun incidence angles as well.

[0036] The dependencies between light irradiation, view-out and light retro-reflection will be explained in more detail in Fig. 2.3. The lower profiles 52, 53 have moved into one another, the upper profiles 53, 54, 55 have moved up. Insofar, the curtain area 50 constitutes the lower window zone and the curtain area 51 the upper window zone. By the moving together of the curtain in the lower window area, the vision D between the profiles will decrease by the measure $D_2 - D_1 = x_3$. Connected therewith is an angular change of the shadow line by the measure $\alpha_2 - \alpha_1 = \alpha_3$. By the moving together of the curtain, the light incidence onto the light receiver or light redirective surfaces 56, 57, 58, 59 will change as well as is shown by way of example by rays 60 and 61. Depending on the surface shape and the upper side contour, the light receiver faces 56 through 59 serve as light reflector faces adding to the light gain in the interior space. If for instance the upper side of the roller shutter profiles is made of stainless steel or aluminium with a glossy surface, a light reflection to the interior space will result as shown by ray 64. If the roller shutter profile for instance is dyed in white, diffuse light incidence will result as shown by ray bundle 65.

[0037] The present case deals with a daylight roller shutter the primary function of which should be seen in lighting design rather than in the black-out function of a classic roller shutter. By means of the light reception bay of the invention, not only the direct light transmission between the profiles but also the indirect light irradiation is controlled which is caused by the light deflection on the roller shutter profile.

[0038] In the upper roller shutter area 51, an enforced indirect light influx of zenith radiation will occur while at the same time direct sun incidence of a light influx $> \alpha_2$ is locked out. Because of the bay-shaped form of the light entry openings and the curvature of the partial faces for light reflection, the roller shutter executes differentiated functions

relative to daylight modulation which serve for improved room illumination by diffuse daylight, on one hand, but also for simultaneous shading of the interior space, on the other.

[0039] Figs. 2.4 and 3.1 each show variants of profile shapes, in a drawn-up position in Fig. 2.4 and a moved-down position in Fig. 3.1. The roller shutter profiles are characterized by the inverse hook-shaped connection of the roller shutter profiles with one another. By this turn of the hooks, different roll-up directions of the roller shutter will result, as can be taken from Figs. 4 and 5. While in case of the profiles of Fig. 2 and Fig. 3 the roll-up shaft is disposed on the outside, the roll-up shaft in case of a profile shape of Fig. 2.4 and 3.1 is provided, according to Fig. 5, on the inside.

[0040] The invention of the daylight roller shutter does not permit only two function zones, but rather further ones as well. In Figs. 6 and 7, roller shutter profiles 80, 81 for the upper roller shutter and roller shutter profiles 82, 83 for the uppermost roller shutter area below the lintel are shown. The profiles 80, 81 and 82, 83 differ from one another by an elongated hook with a larger opening 84, 85. Thereby results a shadow line $\alpha_2' > \alpha_2$ and a view-out $D_2' > D_2$ and a larger light bay $W_2' > W_2$. In Fig. 7, the roller shutter profiles of Fig. 6 are moved together. Correspondingly, the following relations will result: $\alpha_1' > \alpha_1$, $D_1' > D_1$, $W_1' > W_1$. By means of these roller shutter profiles, three function zones may be formed within one roller shutter.

[0041] Figs. 9 and 11 show a further variant of the innovation. The light guiding portions 100 through 102 of Fig. 9 are positioned steeper, the light guiding portions 103 through 105 of Fig. 11 are positioned more flat. Thereby, different shadow lines will result at an angle α_1 in Fig. 9 and α_2 in Fig. 11. The view-out D in the horizontal direction of sight varies as well. An embodiment according to Fig. 11 is arranged preferably in the upper window area, an embodiment according to Fig. 9 in the lower window area. In the upper window area, a flat light influx will result at an angle β_1 for an angle of incidence α_4 and in the lower window area, at a steep angle β_2 according to Fig. 9. Thereby, the request is met to obtain in the lower window area a glare-free illumination with light deflection to the ceiling and in the upper window area room illumination in the room depth. In case of a concave shape and different inclination of the light reflection faces 100 through 105, the shadow lines α_1 and α_2 vary as well. In the lower window area, there is a very good view-out D to the street level so that with a view to the user, a homogeneous view-out in the interior view of a roller shutter will result.

[0042] The particular feature of this roller shutter is that it may be completely closed in the upper area (Fig. 12) and in the lower area (Fig. 10) and thus is also suited as a darkening for residential houses.

[0043] The embodiment according Figs. 9 through 12 makes possible to obtain, via the light guiding faces, a very high flexibility in the application and the formation of the light-technological relations in the interior space.

[0044] It is obvious that a roller shutter having the specific light inflecting faces 100 through 105 according to Fig. 9 and 11 may also be combined with further roller profiles as similar to Figs. 2 and 3.

[0045] Figs. 13 and 4 as well as Figs. 15 and 16 demonstrate the precise light guiding optics of the roller shutter profiles of the invention.

[0046] Figs. 13, 14 refer to roller shutter profiles for the upper window area of Fig. 11, Figs. 15 and 16 refer to roller shutter profiles for the lower window area of Fig. 9. Figs. 13 and 15 show the light guidance behaviour for a sun incidence angle of 15° , and Figs. 14 and 16 for an angle of incidence of 40° . The light guidance behaviour of the roller shutter profiles may be observed by means of the assigned light distribution curves (LDC) in Figs. 13.1 through 16.1.

[0047] The profiles are organized, under optical points of view, in two partial faces having a contrary light guidance behaviour, viz.

- a light re-directive surface towards the interior and
- a solar retro-reflective surface.

[0048] By means of the relative sizes vis-à-vis to each other as well as of the opening shaft W between the profiles (light reception bay),

- the energetic behaviour (total energy transmission), passive cooling performance and
- the room illumination (daylight supply)

is defined.

[0049] By the inclination and the concave shaping of the retro-reflective outer surfaces towards the interior space, the direction of the transmitted light radiation and hence the room depth illumination are defined. By the shaping of the retro-reflective outer surfaces, the optics, i.e. the outer appearance of the roller shutter, is defined.

[0050] The mean inclination of the light re-directive surface towards the interior space amounts to between γ about 0° in the upper roller shutter area and γ about 30° in the lower roller shutter area.

[0051] The ratio between light re-directive surface B and light retro-reflective surface H of a roller shutter is preferably, but without limitation,

$$B/H > 0.3 < 1.$$

[0052] The ratio between opening width W and light reflection face H of the light reception bay is preferably, but without limitation

$$W/H > 0.3 < 1 \text{ each having a tolerance of } \pm 20 \text{ percent.}$$

[0053] In Figs. 13.1.1 through 15.1.2, the total energy transfer SHGC (continuous lines) and the direct light transmission τ_{dir} between the profiles (dotted lines) is shown in dependence on the angles of incidence of the sun between 0° and 85° sun influx. One can see that the direct transmission τ_{dir} and the total energy transmission SHGC decrease with increasing angles of incidence of the sun. The shadow line S results for a profile from Fig. 13 in $\alpha_2 = 30$, for a profile from Fig. 15 in $\alpha_1 = 15^\circ$.

[0054] As a specification for the construction, the following may apply:

Shadow line in the upper roller shutter area $\alpha_2 < 35^\circ$,
shadow line in the lower roller shutter area $\alpha_1 < 25^\circ > 10^\circ$.

[0055] In Figs. 13.1.2, or 15.1.2 is additionally shown the total light transmission τ_{tot} including diffuse light transmission τ_{diff} as dash-dotted line as well as the total energy transmission SHGC of the shutter including insulation glass insulated window as dotted line.

[0056] In Figs. 13.1.2, or 15.1.2, the opening widths W between the roller shutter profiles are selected larger so that the shadow lines for larger angles α_1 and α_2 amount to about 10° .

[0057] In connection therewith, a changed total energy transmission SHGC is obtained as well. This is shown by a comparison between the continuous SHGC-lines in Figs. 13.1.1 and 13.1.2, or 15.1.1 and 15.1.2. In the figures, characteristic numerical values are given each for the angles of incidence 0° , 30° and 60° . Based on such characteristic values, the lighting designer and the HVAC planner may determine, under consideration of the latitude of the construction site and of the orientation of the façades, the exact shape of the roller shutter profiles and decide on the passive cooling behaviour, on one hand, and the daylight illumination, on the other.

[0058] The roller shutter profiles have, in the longitudinal direction, a kind of bore 110-115 (Figs. 10 and 12) for receiving a front stopper which prevents reciprocal slipping of the profiles in their longitudinal direction.

[0059] One particularity of the roller shutter profiles shown is also to be seen in the elastic profile portions 120-125. These are rubber lips which when the roller shutter is being rolled up press against the base profile thus reducing the width b of the profiles. The advantage is that, when rolling up, the cross section reduction will produce a smaller rolling up shaft, as can be taken from Fig. 22. The cross section reduction on the rolling up shaft can be recognized by the deformations of the rubber lips 272 to 278 of Fig. 22. In other words, by the possibility of the cross section reduction, the roller shutter profile may be shaped broader and thus makes broader light deflection faces 100-105 possible, even $> 5 \text{ mm}$.

[0060] It might also be conceivable to provide an elastic connection between two profile portions, for instance in a zone 140 of Fig. 18 so that the roller shutter profile may be compressed. This variant is shown in Figs. 18 to 20. In Fig. 21, the profile portions 242 to 244 press themselves against the base profiles 245 to 247 of Figs. 18 to 20.

[0061] A further advantage of this variable cross section configuration consists in that the profiles may be inserted without tolerance into a U-shaped guiding profile so that in case of a heavy wind load, the familiar rattling of roller shutters in the U-tracks is avoided. The profiles are made broader than the U-shaped side guidance and rest on both sides against U-profiles.

[0062] The roller shutter is either produced from extruded aluminium or as extruded plastic profile or as a roll shaped profile of varnished steel or stainless steel or from a compound of various materials such as plastic material in combination with steel or stainless steel or aluminium. Of particular interest is the production of the roller shutter profile 90 of Fig. 8 from highly transparent plastic material, for instance from acrylic or polycarbonate, where only the outer walls 91 and 92 irradiated by the high sun are provided with an opaque or coloured or a reflective material. This is performed by using a foil which is glued by means of a hot-melt glue onto the roller shutter profile or by using a transfer foil or by a hot embossing process for transferring a reflection layer onto the profile.

[0063] The advantages of extruding the roller shutter profiles from a highly transparent plastic material are obvious. The profile need not be punched, the view-out between the opaque portions is improved, the curtain is insulating relative to the heat absorbed at the outside of the roller shutter and moving upward. In addition, the roller shutter will also serve as a protection against insects. If aeration of the roller shutter is desired, small holes might be punched into its transparent areas.

[0064] A further possibility is the co-extrusion wherein, in the extrusion process, metal strips are either applied or even implanted so that the metal strips are covered by the plastic material.

[0065] In accordance with this method, even different strip-shaped materials having different surface characteristics may be applied. The outer sides 91 which serve as reflectors may for instance consist of stainless steel and the reflector 92 of highly reflective aluminium. The individual faces may also be made in different colour variants.

[0066] The profiles of Figs. 9 and 11 are produced either by co-extrusion or by adding the rubber lips 120-125 when extruding or roll forming. The light reflection faces 100-105, too, may be added as roll-formed parts when extruding or may be applied onto the profiles in a thermal process. For static stability of the roller shutter profiles against wind suction and wind pressure, steel strips may be inserted during the extrusion process.

[0067] The roller shutter profiles from Figs. 9 and 11 and 18 are preferably produced by material combinations of poorer and better heat conductive materials, for instance of a hard and a softer plastic material or of a metallic material and a soft rubber. The advantage of these compound materials is not only, as demonstrated, the flexibility of the profiles in their cross sectional dimensions but also the thermal separation to avoid heat conduction from the interior to the outside, or from the outside to the inside. By such material compound, the roller shutter becomes a thermal insulator and will also serve to improve the heat transfer coefficient of the window.

[0068] Fig. 23 shows roller shutter profiles 300, 301, 302 formed like a parallelogram which in the combination of a plurality of profiles shows the typical innovative properties of light reflection 303 on the light reflecting upper side 304, 305, 306. The shadow line 307 is defined by the distance between the roller shutter profiles which in the upper window area may be larger and in the lower window area may be selected smaller.

[0069] The roller shutter profiles are spaced from one another by bands which in case of a complete downward run of the roller shutter fold together as can be taken from Fig. 24. The bands are connected with the roller shutter by mechanical fastening or by gumming or by welding. To this end, polyester bars 310, 311, 312 are for instance built into the roller shutter profiles, which may for instance be connected by ultrasonic welding with a polyester band. Alternatively, a gap may be provided in the roller shutter profile into which a press-in means or an inserting means is introduced which serves to fix the bands or cords.

[0070] To provide the bands elastically deformable has the advantage to close the roller shutter completely so that it can be used as a darkening element as well. Alternatively, it might, however, be possible to also use rigid bands, for instance in the form of high-quality steel, which also in the lowered state keep the distance between the profiles and make view-out and light entry possible while the bands cannot be folded into sheets.

[0071] A further embodiment of the invention provides that the roller shutter is bent prismatically above eye level, i.e. for instance at a level of 1.7 meter, roof-shaped, to the outside. In Fig. 25, this is for instance performed by a servo motor 320 which pushes the roller shutter guide rails outwardly. At its lower point 321, the roller shutter is either held, as shown, in the façade face or, as drawn in dotted lines 323, is swung out as well.

[0072] The advantage is again seen in the daylighting, or the light technology, towards the interior space. As shown in the break of the roller shutter in Fig. 26, the roller shutter profiles in the upper window area provide, with a view to the changed positioning thereof, for a flat light redirection 330 via the daylight reflectors 331. In the lower window area, the light 332 is deflected more steeply to the ceiling. At the same time a better view to the bottom plane will result. The lateral roller shutter guide rail 333, 334 includes a hinge 335 into which a pressure crutch 336 of a servo motor 337 engages pushing the roller shutter to the outside.

[0073] Fig. 27 shows roller shutter bars 401 to 406 in the rolled down state with a shadow line of 20°. The light reflecting faces 407 to 412 have a width B on the upper side of the bars and further light reflecting faces 413 to 418 on the underside of the bars. Figs. 29.1 to 29.5 show the light reflective behaviour by raytracings between the profiles. The reflectors facing each other form a reflector system forming a horizontal funnel. The funnel is partly shaded by a small screen 440 to 445.

[0074] Fig. 29.1 shows the light reflection 420 and the direct light irradiation 421 for a sun irradiation angle of 10°. At a sun irradiation angle of 30°, the sun is reflected, in Fig. 29.2, to the underside of the upper roller shutter bar. Fig. 29.3 shows the light reflection from the underside of an upper profile back to the upper side of the lower profile as well as the back reflection 422 and 423 to the outside.

[0075] Fig. 29.4 and Fig. 29.5 show the analogue light reflection behaviour at a sun irradiation angle of 50°.

[0076] Fig. 28 shows the profiles of Fig. 27 in the pulled up state, which changes the shadow line to 35°. In this way, the view-out D and D_H (horizontal) will be improved in the manner known per se. The light reflection behaviour between the profiles can be taken from Figs. 30.1 to 30.5. In case of flat light irradiation of 10°, a larger portion of the winter sun will fall into the room. Even at an angle of incidence of 30°, the sun in Fig. 30.2 is almost completely redirected to the interior space ceiling. In case of an angle of incidence of 50°, the sun in Figs. 30.4 and 30.5 is retro-reflected for the purpose of passive cooling to the outside by two reflections only.

[0077] The raytracings show the principle of function of the light reflection between two profile bars caused by a reflective surface without any light scattering losses. It is not, however, necessary to use smooth mirrors. So-called semi-spectral surfaces with a certain light scattering, anodized surfaces or also white or aluminium-coloured, glossy or dull

surfaces are of advantage as well. All surfaces are suitable for the daylight roller shutter as long as light reflection/light scattering towards the interior will take place.

[0078] In Fig. 27, and in Fig. 28, respectively, the individual profiles in the lowered state are kept via spacer blocks 450 to 454 at a minimum distance. The individual roller shutter profiles are solidly connected via a band, not shown. In the drawn-up state a distance d opens between the spacer blocks and the lower light reflective profile. The spacer blocks may also be affixed to either the respective lower or the upper profile.

[0079] Fig. 27.1 shows the profiles of Fig. 27, however without the spacer blocks in the closed darkening position.

[0080] Fig. 31 shows the suspension of a further roller shutter. Into the individual bars 450 to 453, tube sockets 454 to 457 are inserted into which rotatable cylinders 458 to 462 are inserted. At the front sides of the roller profiles are fixed at a spacer element. A spacer element provides one longhole to enable the single profiles to be adjusted at two different distances to each other.

[0081] Fig. 32 shows the roller shutter bars of Fig. 31 with a central mounting support. A spacer support with one longhole is shown in Fig. 32.1. Into the profiles, tubes 470 to 472 are inserted which are positioned via spacers 473 to 476.

Claims

1. The invention relates to roller shutters with daylight transmission, installed in façades between an outer space and an inner space, comprising individual roller shutter profiles (52-55) having a sun-irradiated projection height H , the roller shutter profiles are shifted one into the other via hook- (47,48) or T-shaped profilings and/or are kept at a distance via intermediate profiles or cords or by means of rigid or flexible bands or by means of distance holders wherein the roller shutter profiles either have openings in the area of the hook- (47,48) or T-shaped profilings or of the intermediate profiles or of the hinges, or are held by means of distance-holding bands or cords so that a view-out width D (42,43) results through which daylight irradiation (62) between the roller blade profiles occurs, **characterized in that**

- a) the roller shutter profiles form light reception bays having a light reception width W , the light reception bays include at least one plane, arched or bent light reflection face (56-59, 100-105) having the width B , and
- b) the light reflection faces (56-59, 100-105) are disposed at an angle preferably $> 0^\circ$ relative to the horizontal, and
- c) via the light reflection faces (56-59, 100-105) at least sun irradiation (28, 60/64, 61/65) with small sun incidence angles α_1 may be reflected to inside into the upper half space of the interior, and
- d) via the light reflecting faces (56-59, 100-105) sun irradiation with higher incidence angles α_2 may be reflected to the underside of the upper roller shutter profiles.

2. Roller shutters according to claim 1, **characterized in that** the light reception bays form a ratio of width B of the light reflection faces and light reception width W (58-59, 100-105) of $B/W < 2.0 > 0.3$, and that sun irradiation on the light reflecting faces (58-59, 191-105) may be reflected at least up to a sun incidence angle $\alpha_1 > 15^\circ$ to the interior room ceiling and into the inner space depth.

3. Roller shutters according to claim 1, **characterized in that** the roller shutters may be adjusted for at least two differently large light reception widths W_1 and W_2 of the light reception bays between the roller shutter profiles (52-55) by rolling up or moving down, wherein in the lower portion of the roller shutters, the angles α_1 of the shadow lines of the light reception bays may be adjusted smaller and in the upper portion of the roller shutters, the angles α_2 of the shadow lines may be adjusted larger, and the horizontal view-out width D_H in the lower roller shutter portion may be adjusted in a smaller angle D_{1H} and in the upper roller shutter portion in a larger angle D_{2H} .

4. Roller shutters according to claim 3, **characterized in that** in the moved-down state, the angle of the shadow line $\alpha_1 < 30^\circ$ and in the suspended state the angle of the shadow line $\alpha_2 < 50^\circ$, whereby $\alpha_2 - \alpha_1 < 25^\circ$.

5. Roller shutters according to claim 1 and 2, **characterized in that** within one roller shutter, roller shutter profiles of different size are used, wherein in the upper curtain area, roller shutter profiles with light reception bays having a larger light reception width W'_1 , W'_2 and in the lower curtain area, roller shutter profiles with a smaller light reception width W_1 , W_2 are used.

6. Roller shutters according to claim 1 or a plurality of the foregoing claims, **characterized in that** the roller shutter profiles between each other form a ratio between the width W of the light reception bays and the retro-reflective projection height H of $W/H > 0.3 < 1$.

7. Roller shutters according to claim 1 and/or 3, **characterized in that** within one roller shutter at least two different roller shutter profiles are built-in which are characterized at least by different angle inclinations γ and shapes of the light reflection faces (100-102 and 100-105), and the light reflection faces are disposed at an angle $\gamma \geq 0 < 30^\circ$ relative to the horizontal, and that roller shutter profiles having a more flat angular inclination (103-105) of the high reflection faces are arranged in the upper roller shutter area (10) and roller shutter profiles having a steeper angular inclination (100-102) of the high reflection faces are arranged in the lower roller shutter area (11).
8. Roller shutters according to claim 1 and/or 3, **characterized in that** the width ratio B of light reflection faces (100-105) to retro-reflective projection faces H (130-135) of the roller shutter profile is $B/H > 0.3 < 1.8$.
9. Roller shutters according to claim 1, **characterized in that** in the rolled-down state horizontal view-out between the roller shutter profiles is blocked, and in a suspended state of the roller shutter profiles in the lower roller shutter part the shadow line $\alpha_1 < 25^\circ$ exists, and in the upper shutter part the shadow line $\alpha_2 > 20^\circ$ exists.
10. Roller shutters according to claim 1, **characterized in that** the roller shutter profiles (304-306) are provided, cross section wise, rhomboid-shaped with plane or concave/convex-arched contours at least of the light reflecting faces (304-306).
11. Roller shutters according to claim 1, **characterized in that** the roller shutters are pulled out in roof shape at least in the upper area of the roller shutter above 1.50 m.
12. Roller shutters according to claim 1, **characterized in that** two roller shutter profiles each disposed one upon the other form a funnel T, wherein the walls of the funnel form an angle of $+15^\circ \pm 4^\circ$ on the underside of an upper profile or $-20^\circ \pm 6^\circ$ on the upper side of a lower profile relative to the horizontal and the walls are provided as concave light reflecting faces and the funnels T are shaded by a screen (440-445) on the upper roller shutter profile.
13. Roller shutters according to claim 1, **characterized in that** into the roller shutter profiles shafts (458-462) are inserted into which spacer elements (464, 465, 473-476) are hung-in and which connect two roller shutter profiles with each other, the spacer elements having an oblong hole (477) for one shaft to move and one solid connection to one shaft.
14. Method for the production of roller shutter bars according to claim 1, **characterized in that** the roller shutter profiles (90) are extruded of highly transparent plastic material and the light reflecting faces (91) and the retro-reflective surface (92) are covered by an opaque and/or light reflective material.
15. Method for the production of roller shutter bars according to claim 1, **characterized in that** strip-shaped tapes (100-105, 130-135 and 91,92) having light reflective surfaces and/or metal ribbons, with or without a profiling, are added within the extrusion process for stiffening the roller shutter profiles and/or are applied on the surface and/or embedded in the plastic material.
16. Method for the production of roller shutter bars according to claim 1, **characterized in that** by means of elastic profile portions (120-125) or the roller shutter bars and/or by means of elastic couplings (140) of at least two profile portions (141,142), the width B of the roller shutter profiles or of roller shutter profile portions are made variable.

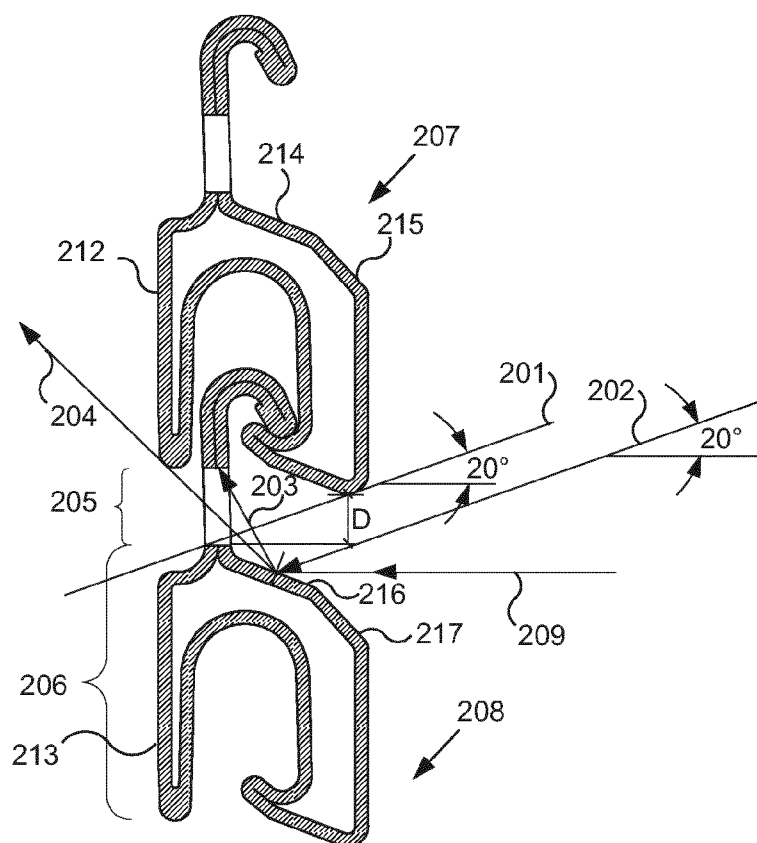


Fig. 01

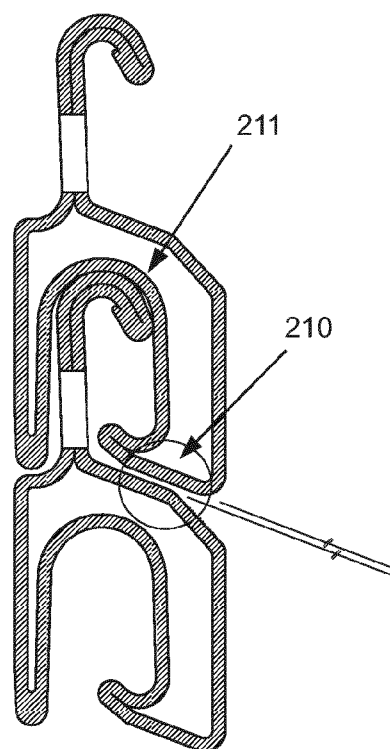


Fig. 02

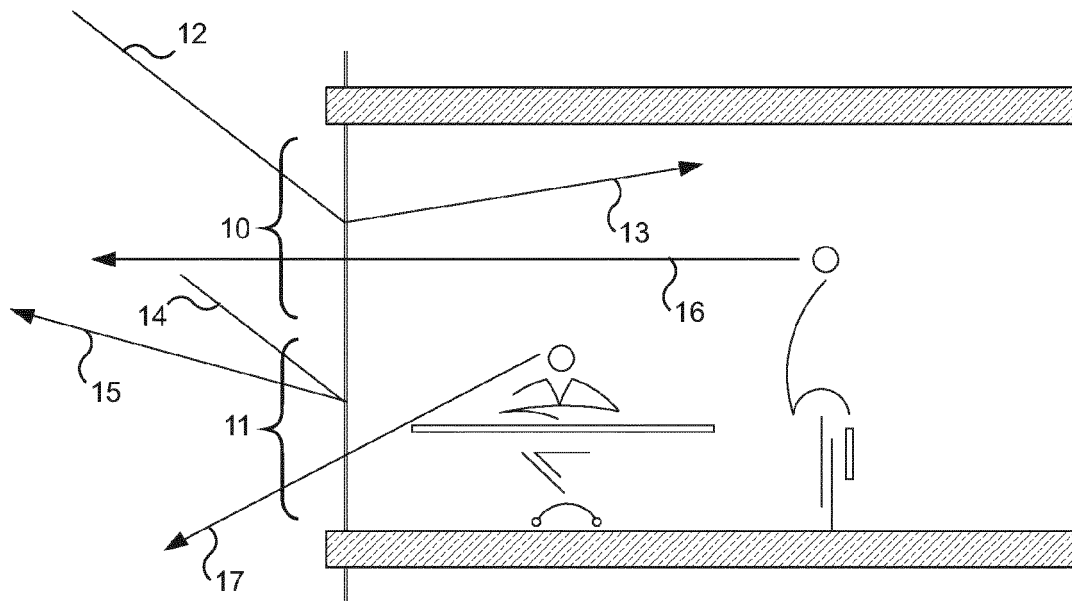


Fig. 1

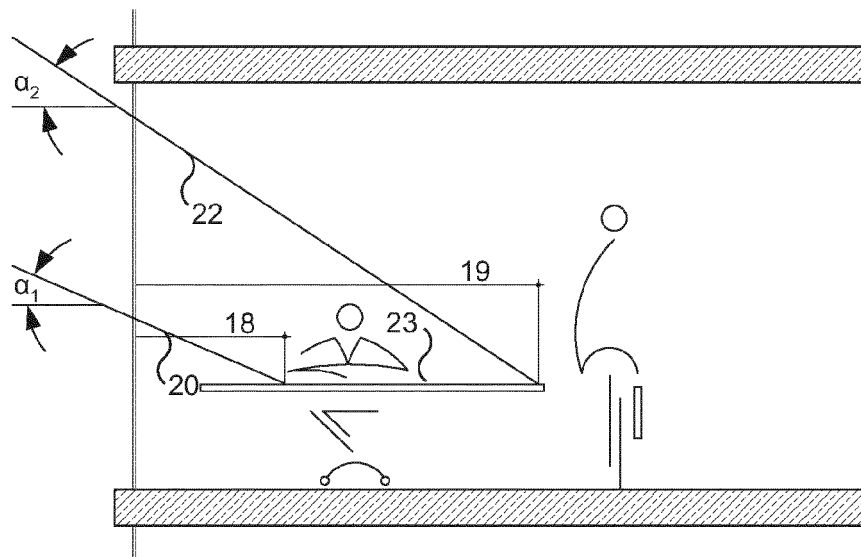
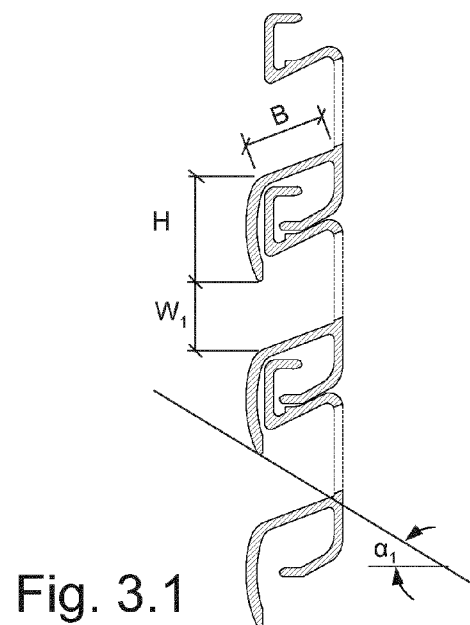
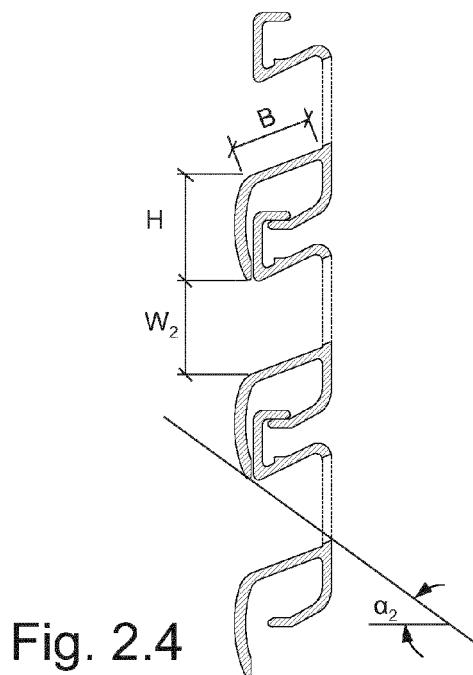
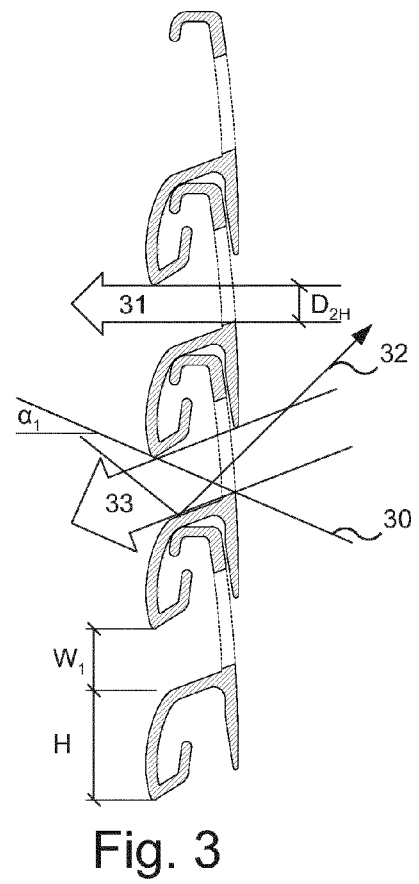
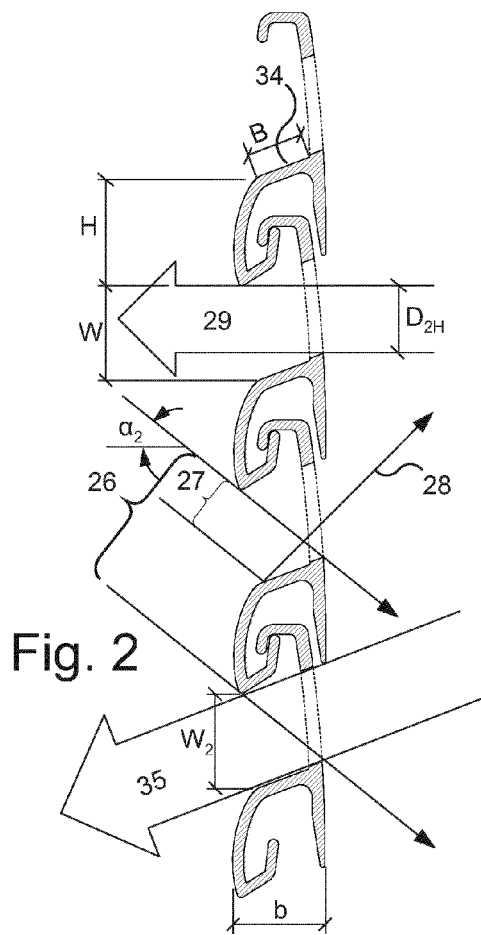


Fig. 1.1



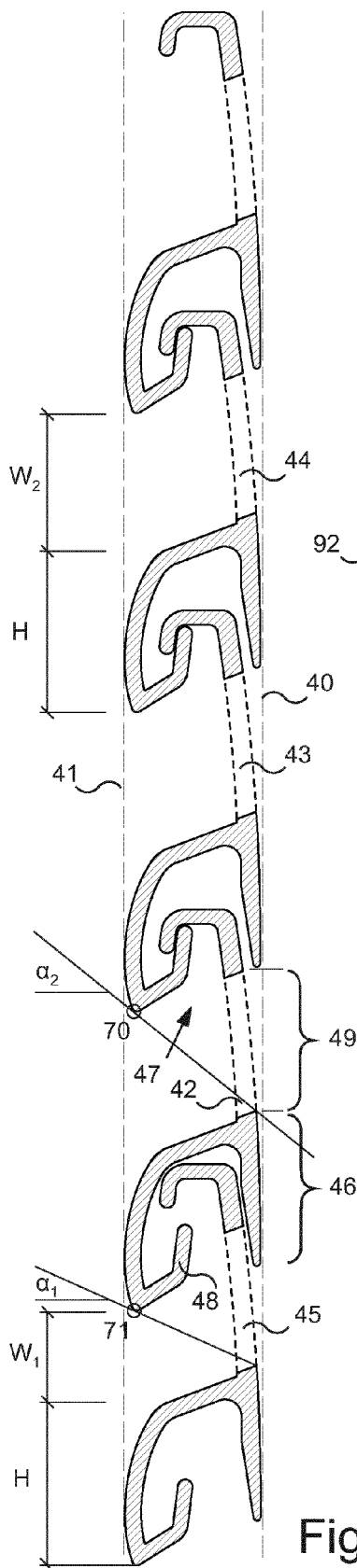


Fig. 8

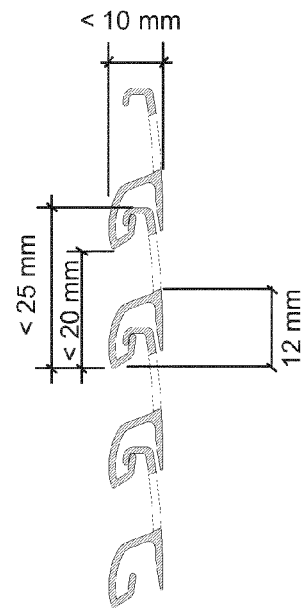
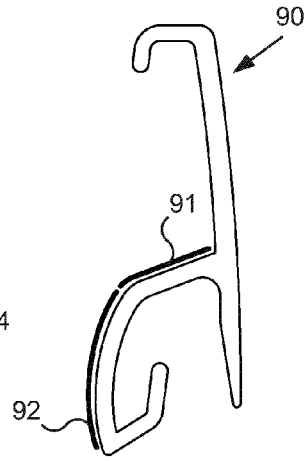


Fig. 2.2

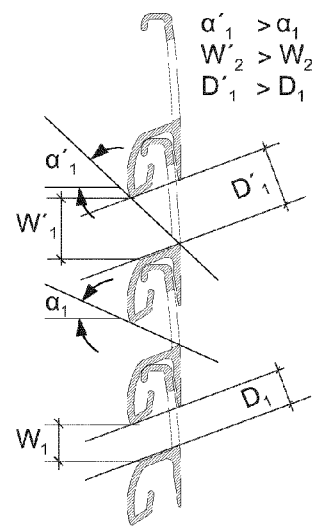
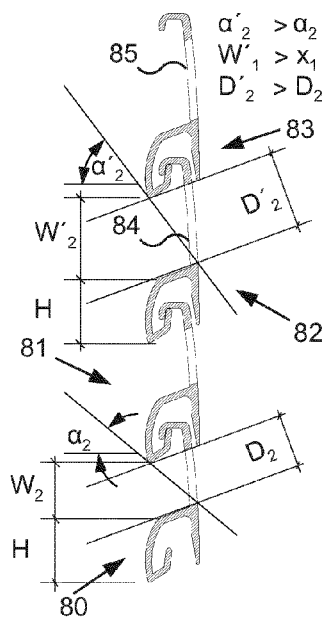
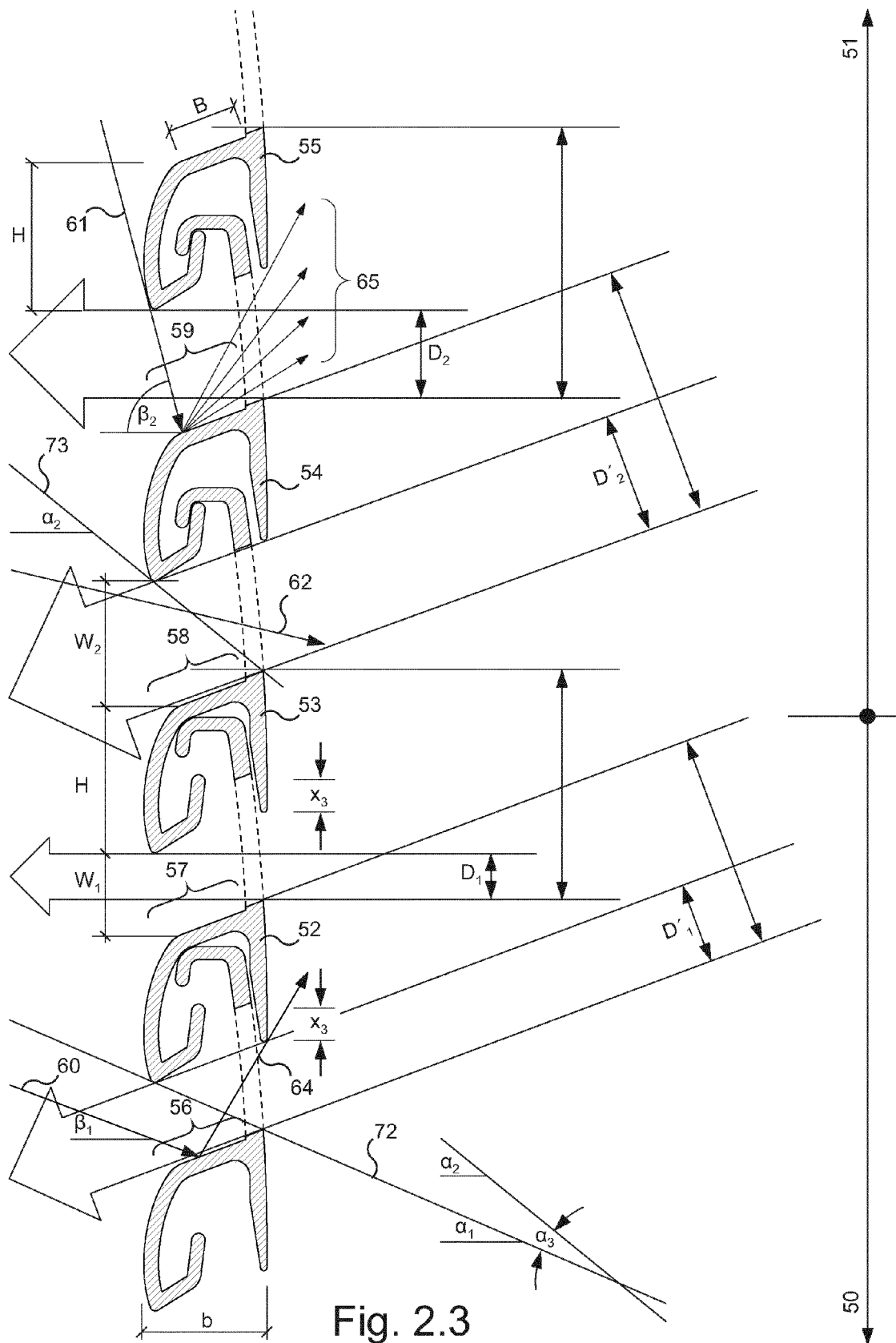


Fig. 7

Fig. 6



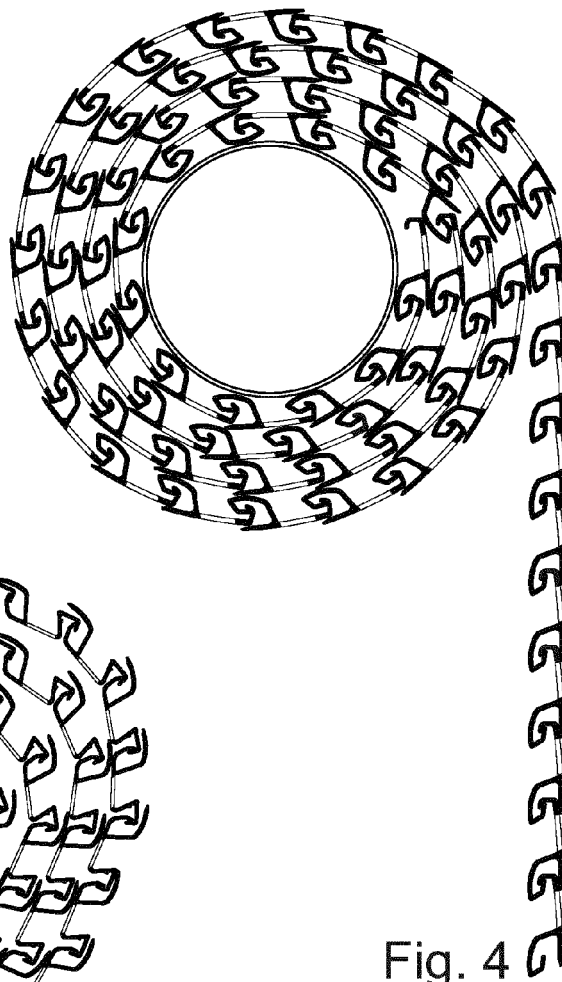


Fig. 4

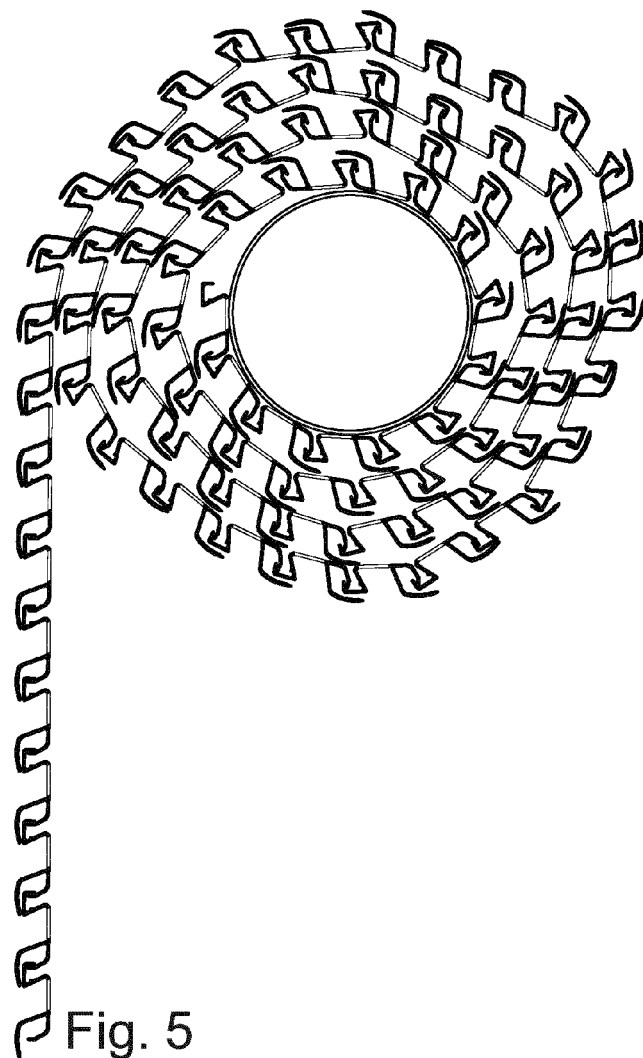
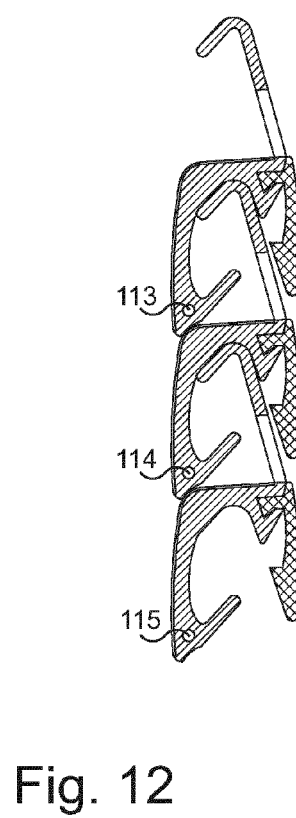
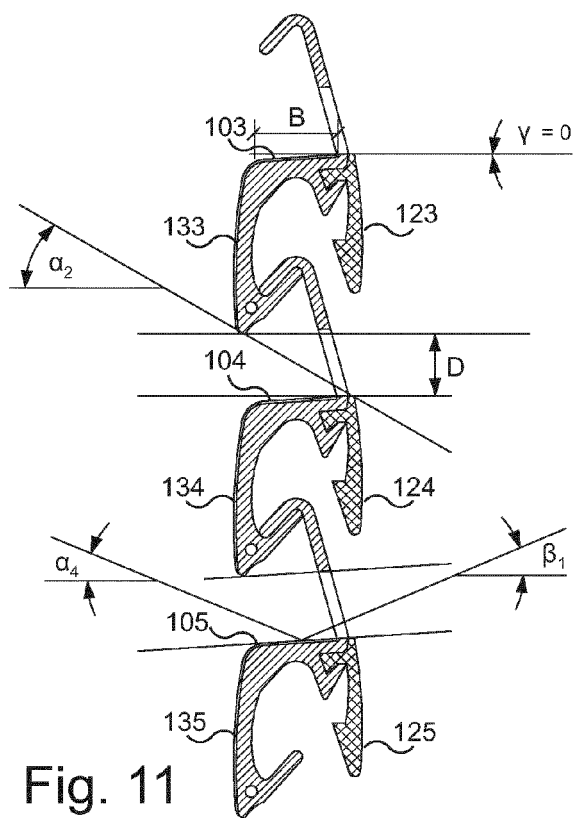
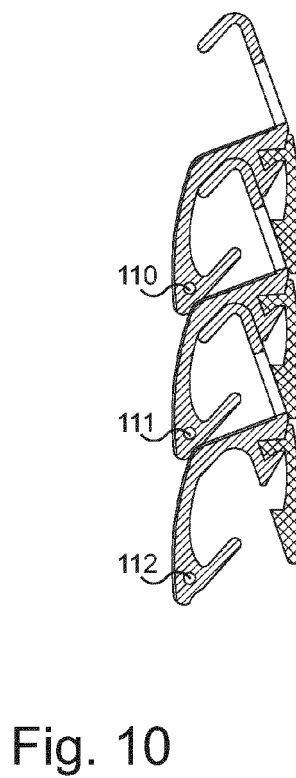
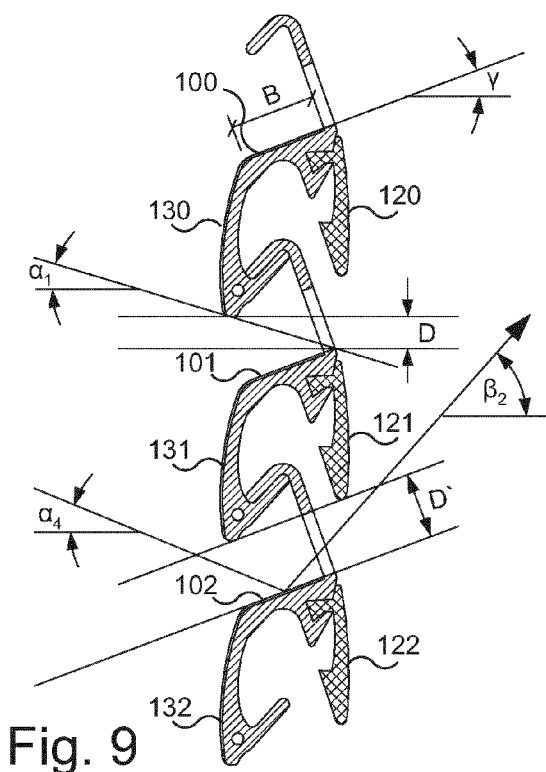


Fig. 5



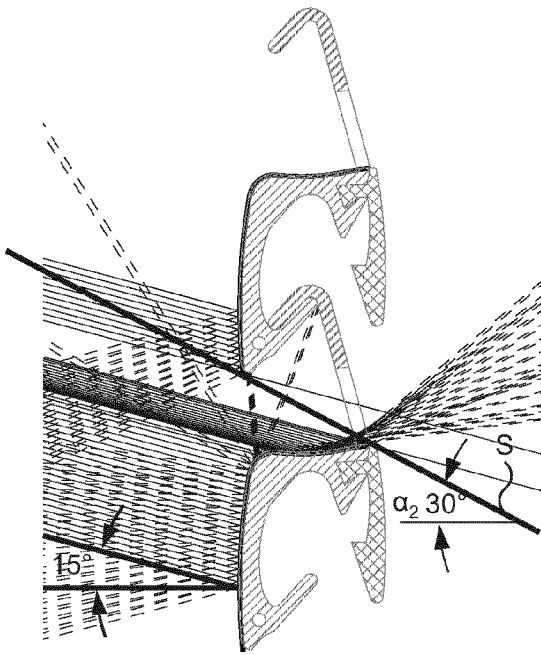


Fig. 13

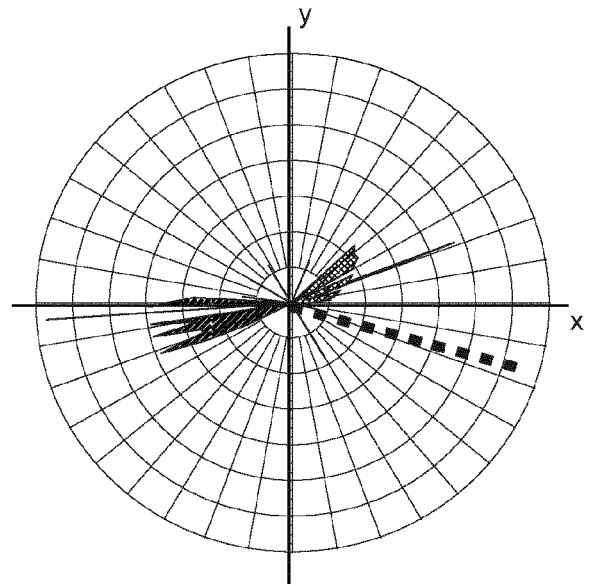


Fig. 13.1

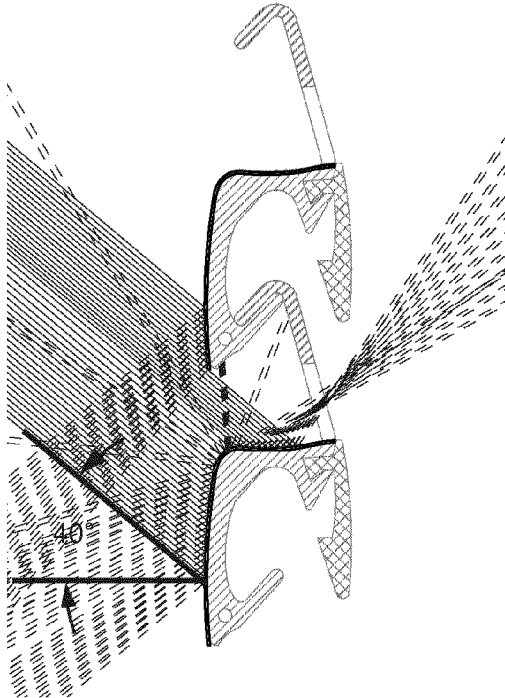


Fig. 14

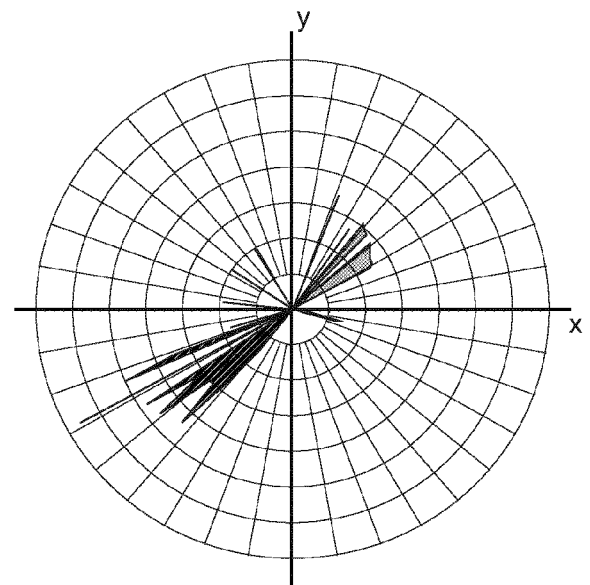


Fig. 14.1

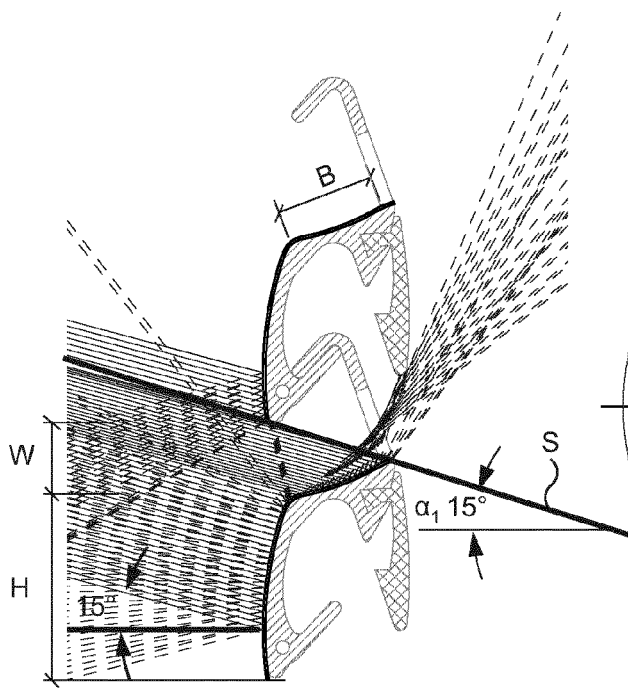


Fig. 15

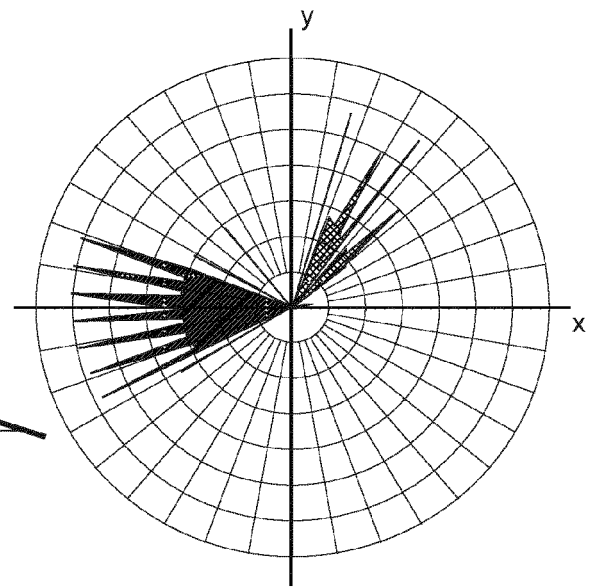


Fig. 15.1

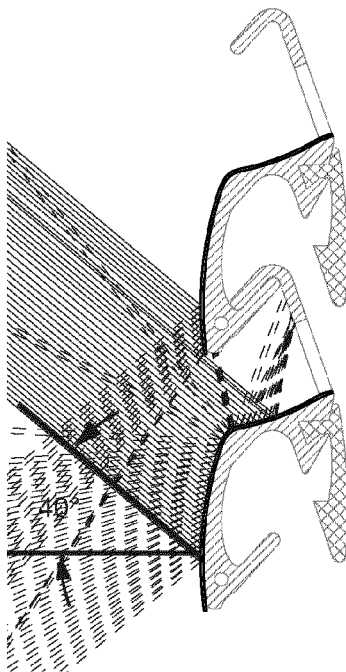


Fig. 16

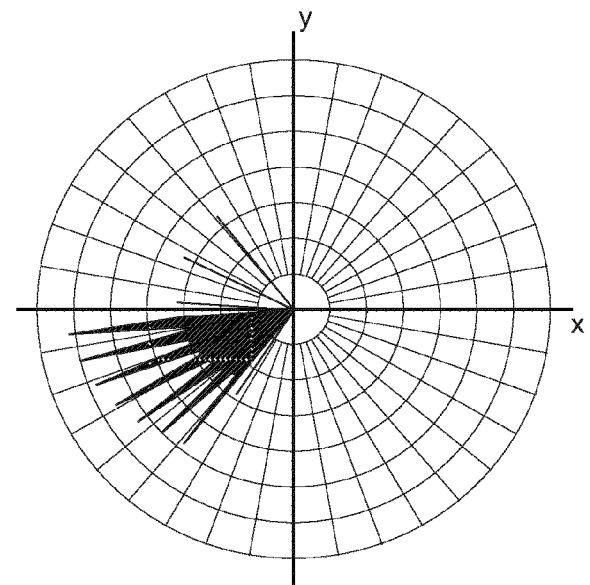


Fig. 16.1

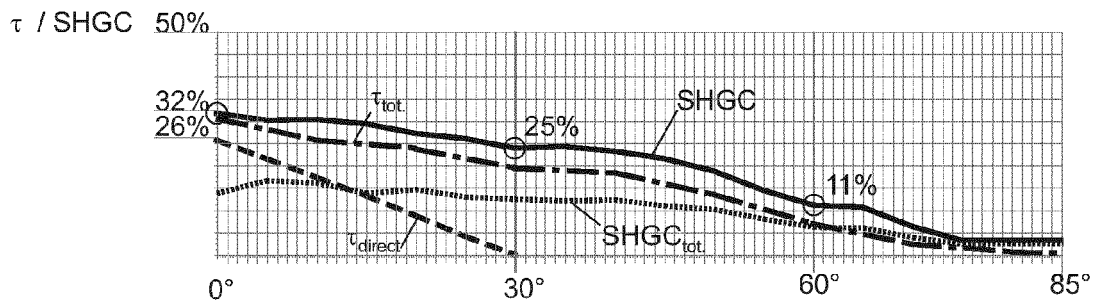


Fig. 13.1.1

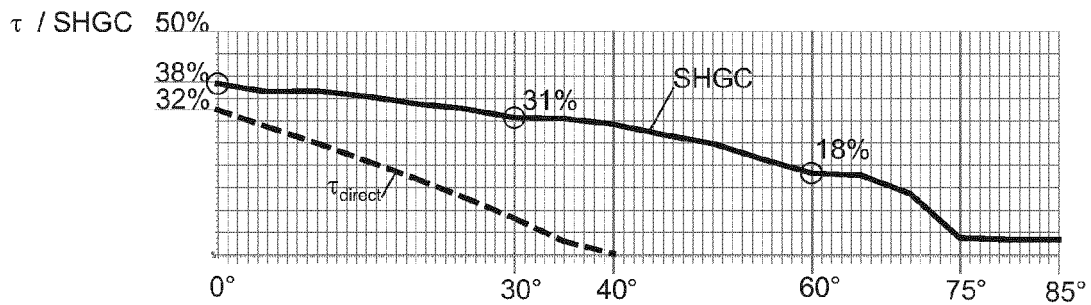


Fig. 13.1.2

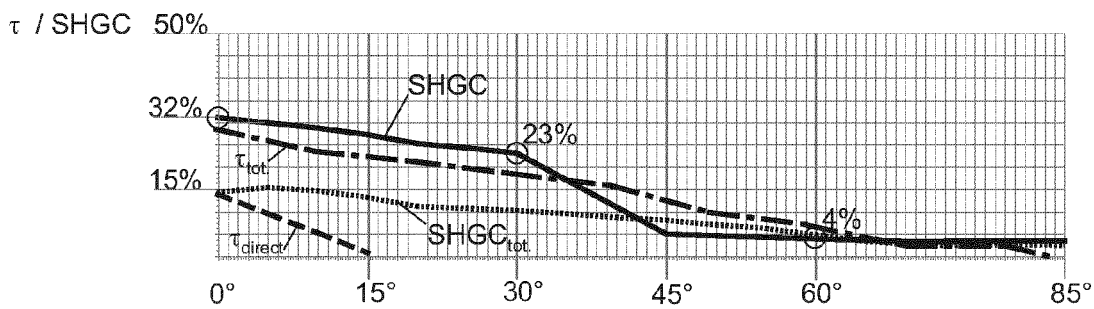


Fig. 15.1.1

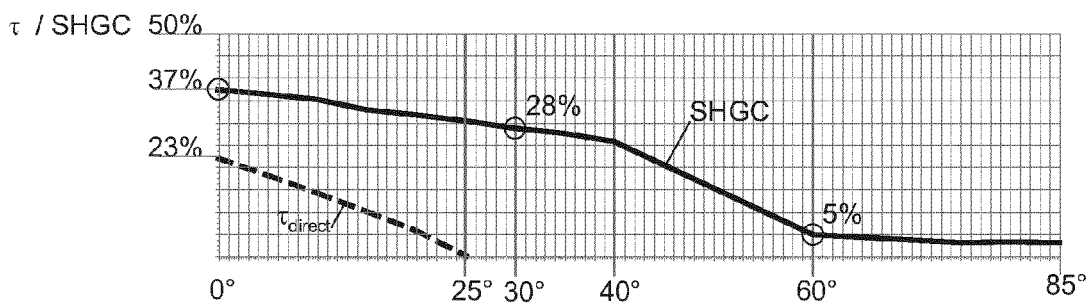


Fig. 15.1.2

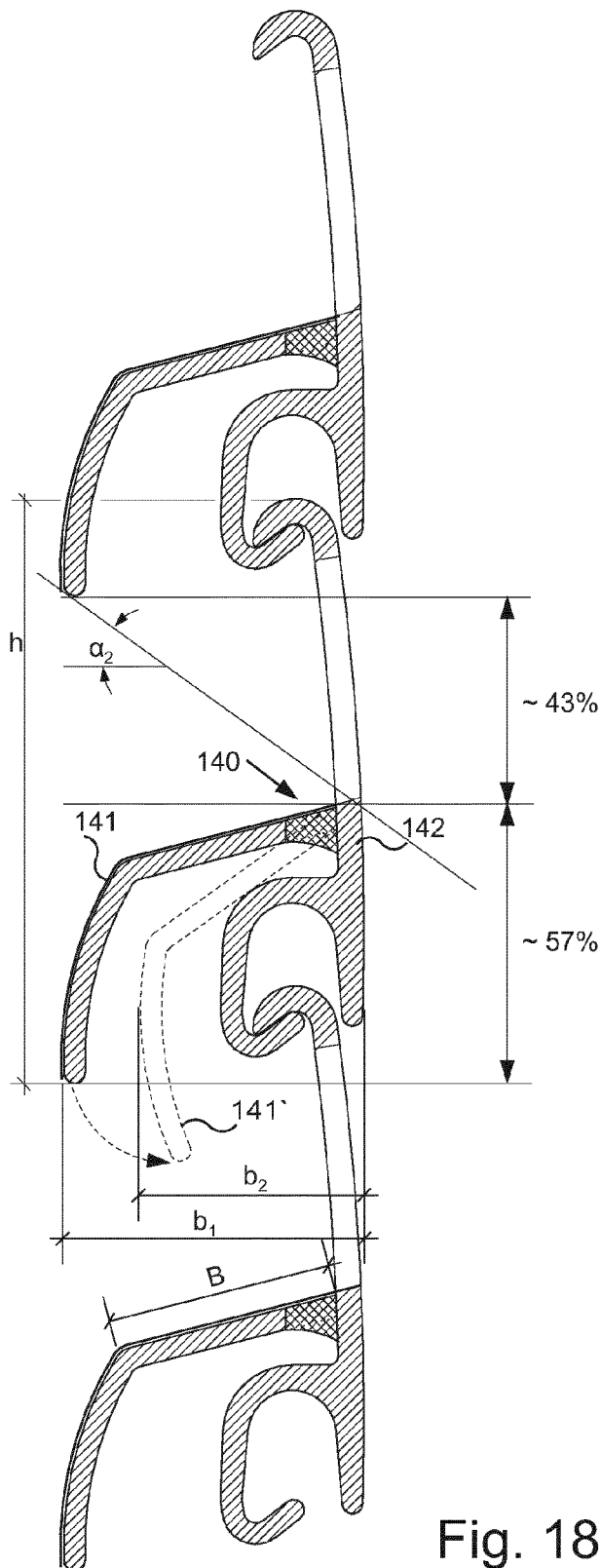


Fig. 18

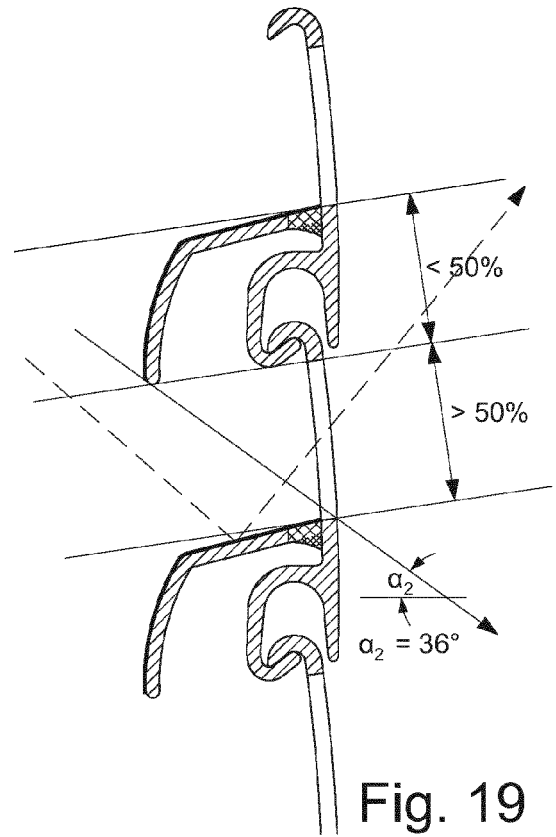


Fig. 19

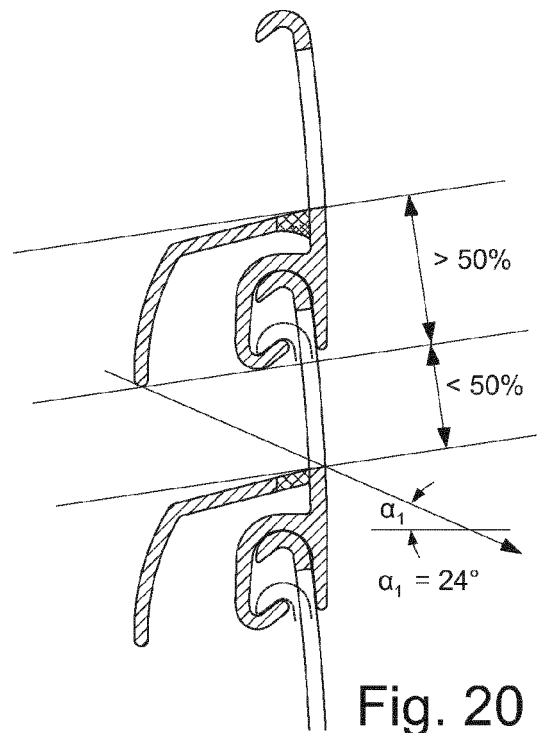


Fig. 20

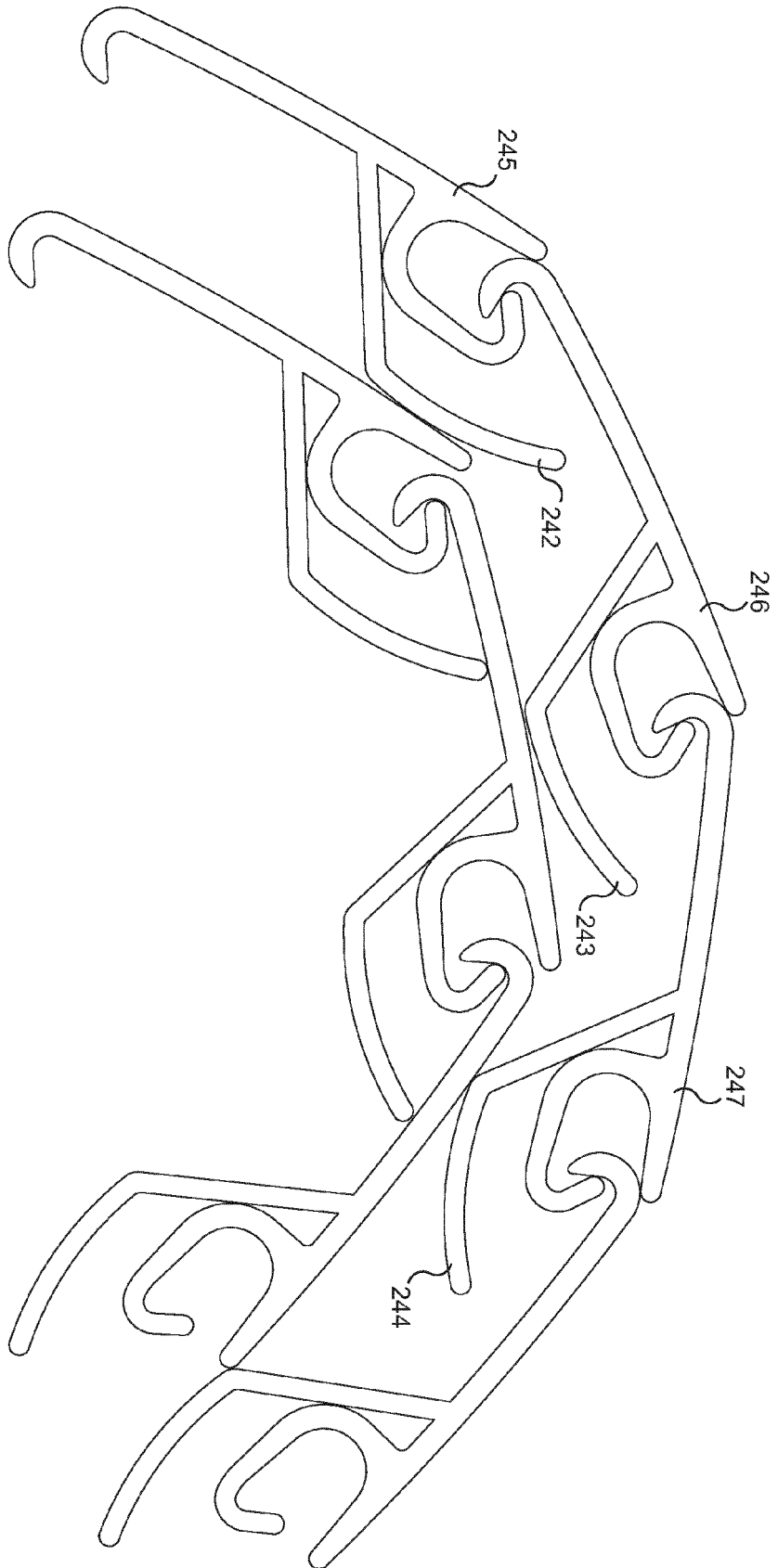


Fig. 21

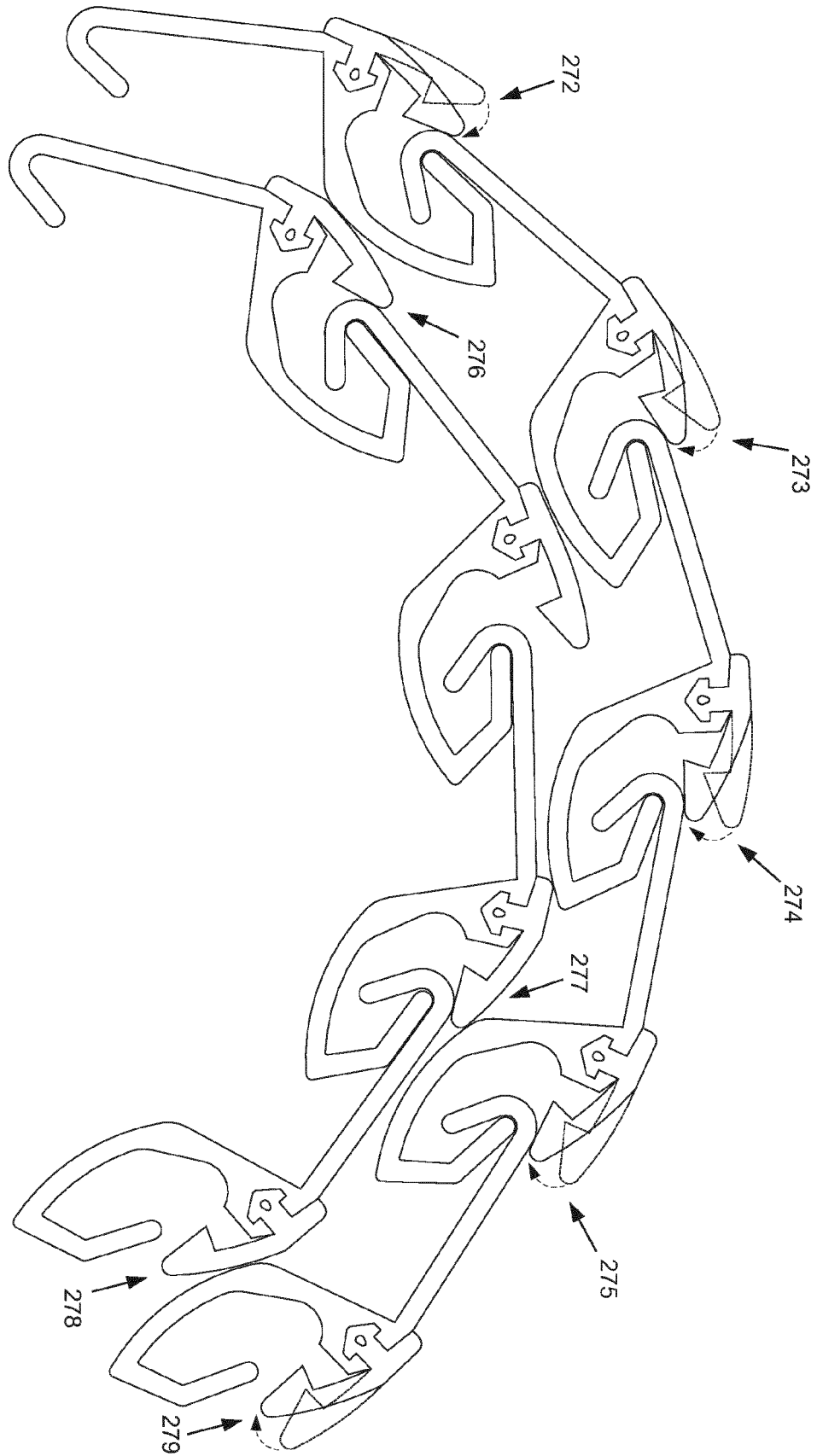


Fig. 22

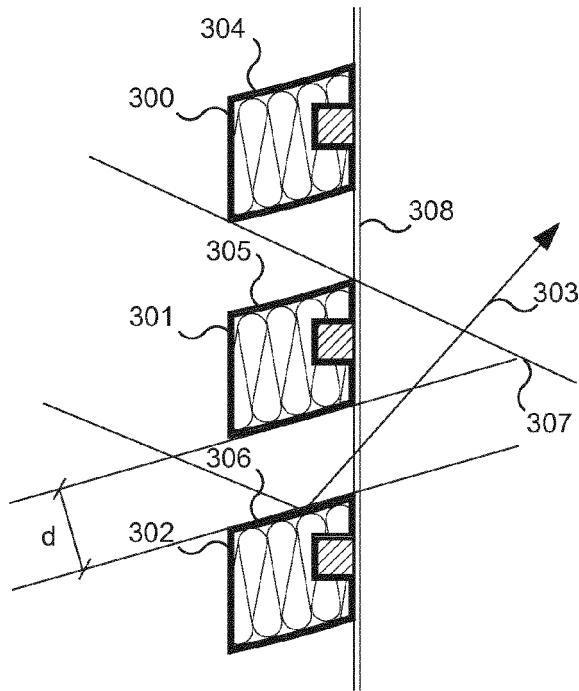


Fig. 23

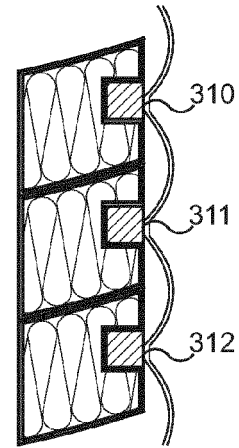


Fig. 24

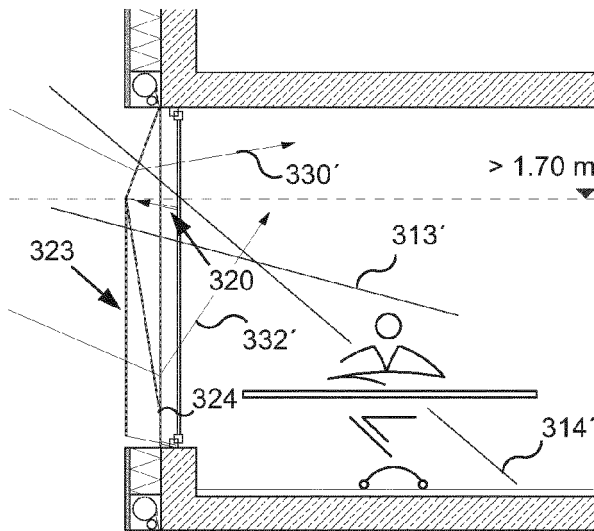


Fig. 25

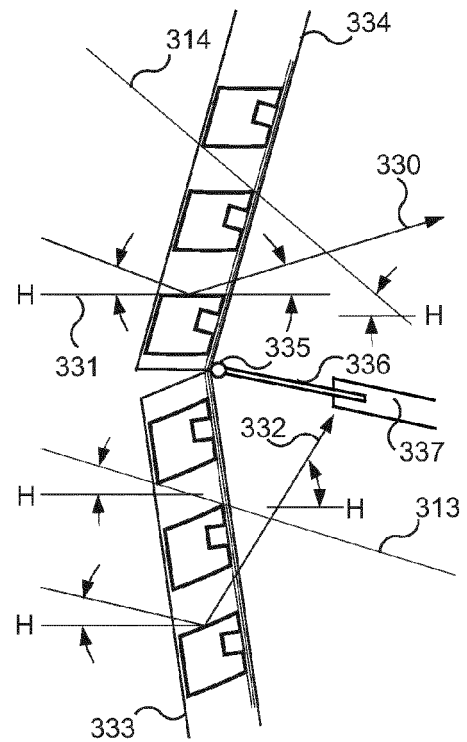


Fig. 26

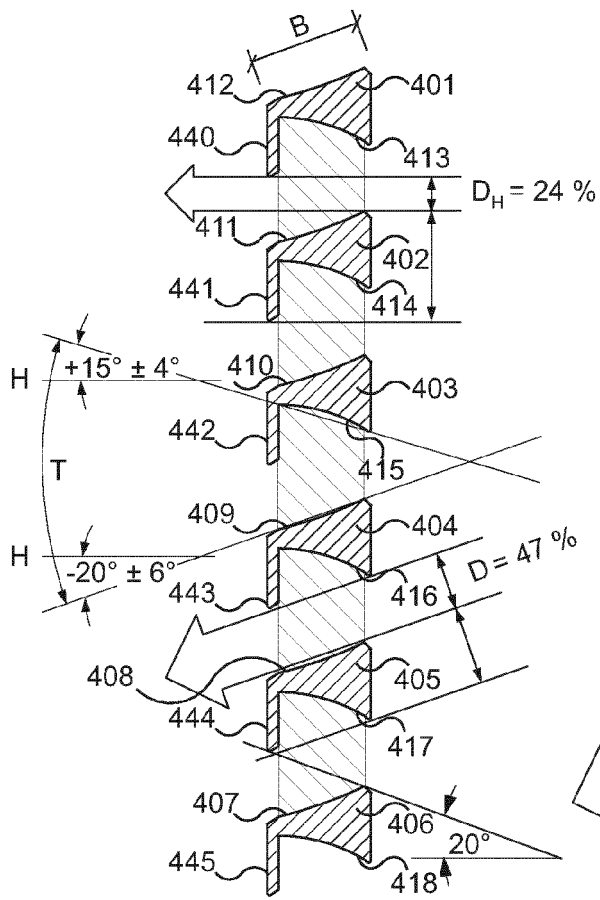


Fig. 27

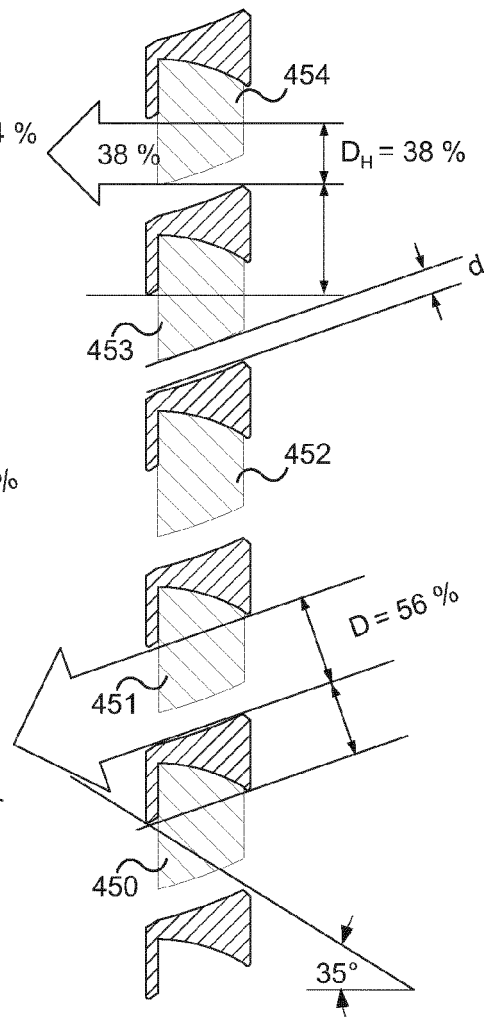


Fig. 28

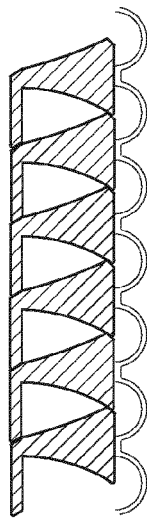


Fig. 27.1

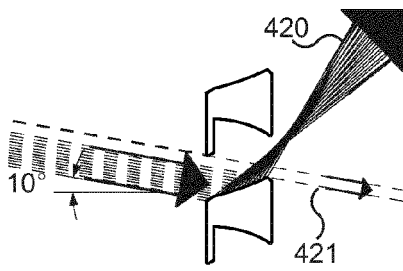


Fig. 29.1

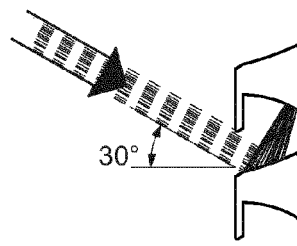


Fig. 29.2

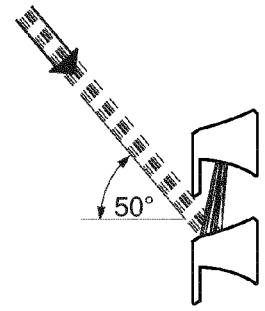


Fig. 29.4

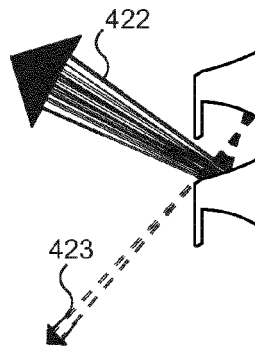


Fig. 29.3

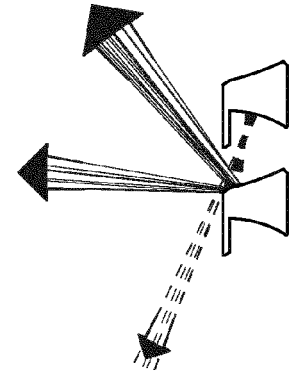


Fig. 29.5

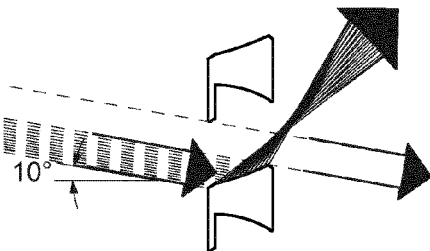


Fig. 30.1

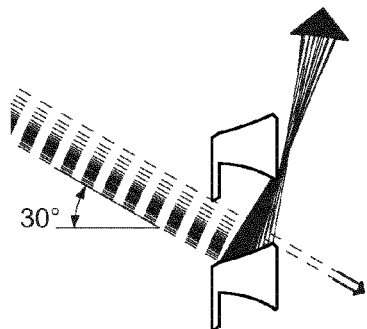


Fig. 30.2

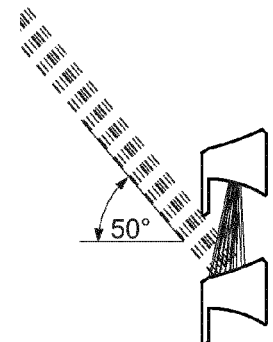


Fig. 30.4

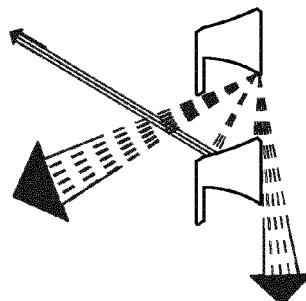


Fig. 30.3

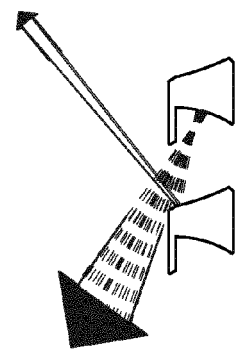


Fig. 30.5

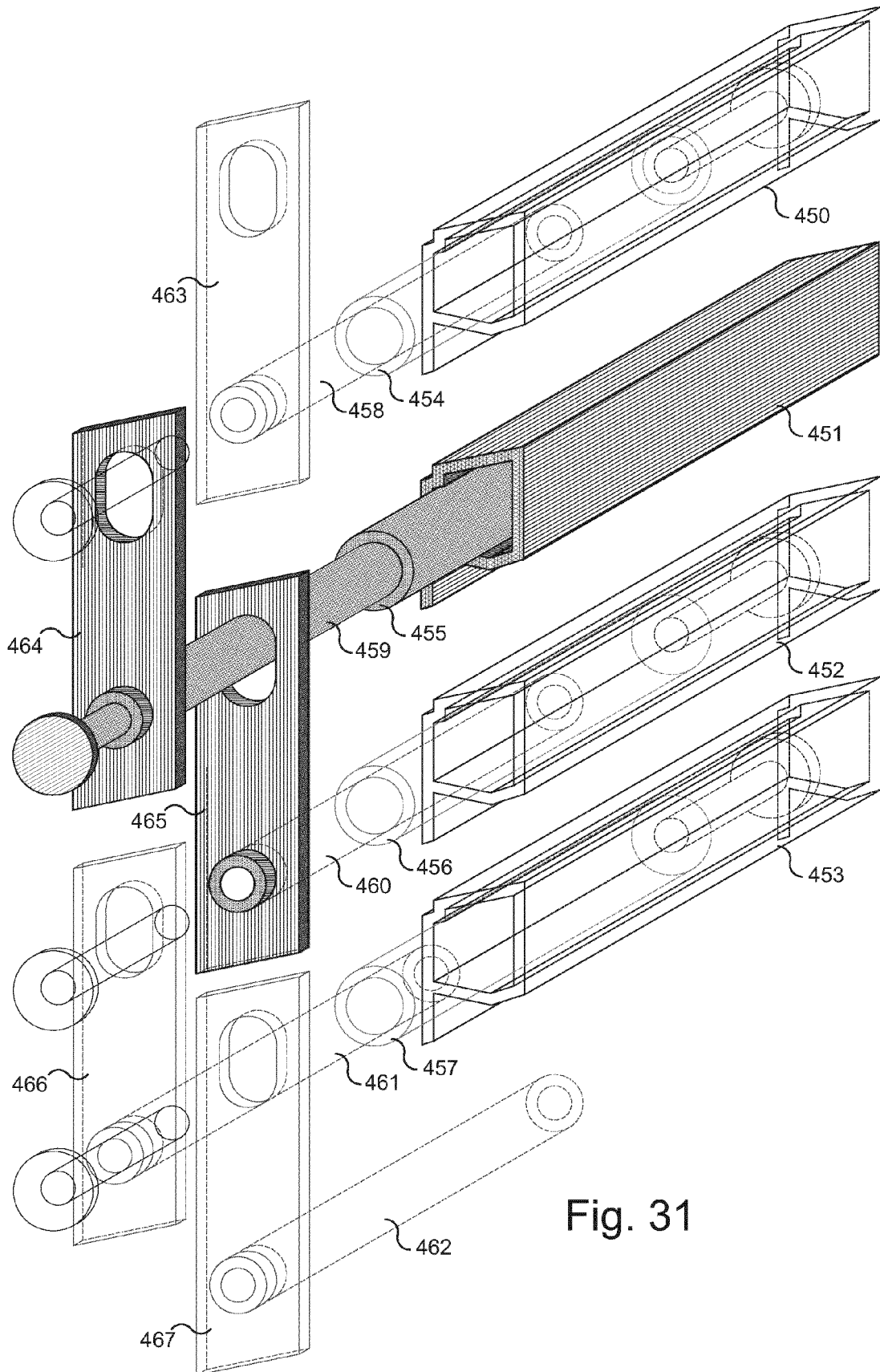


Fig. 31

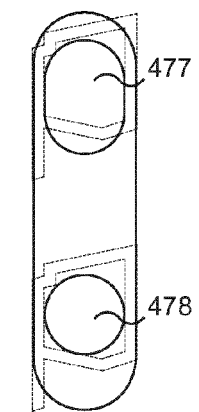
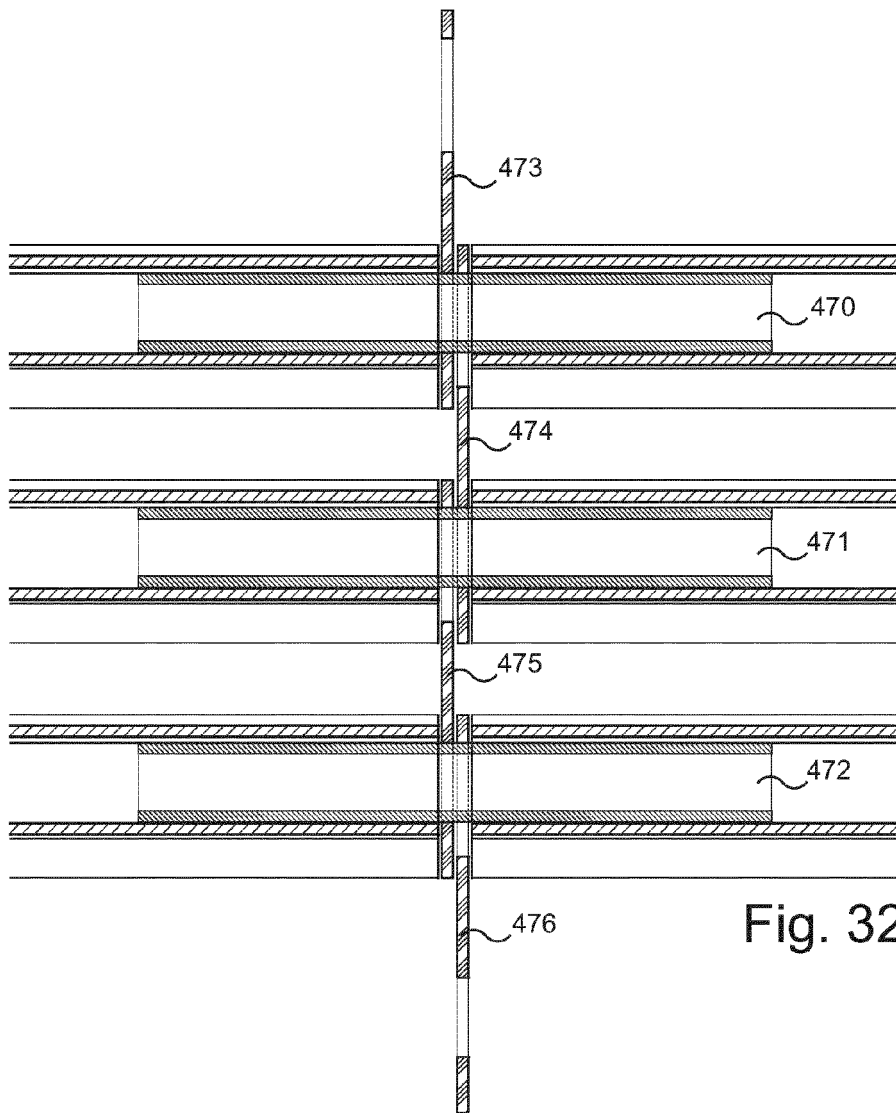


Fig. 32.1

Fig. 32

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 2932010 [0002]
- CH 345145 A [0002] [0003] [0020]
- CH 520259 A [0002]
- DE 1804509 U [0002]
- DE 20009630 U1 [0002]
- DE 102004043573 B3 [0002] [0003]
- DE 10161159 A1 [0005]
- JP 10096381 A [0006]
- FR 2941989 [0006]