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(54) **AUTOMATIC SLIDING FIRE DOOR**

(57) The present invention belongs to the field of construction, more precisely to the field of door for special purposes, particularly for preventing fire expansion. The invention relates to automatic sliding fire door with swing leafs, which can operate in a sliding or swing manner, wherein no protruding elements such as door handles and panic bars are required for opening said door leafs.

The door comprises a longitudinal holder - door drive unit, into which at least one sliding door leaf is installed via a trolley so that the leaf may be moved in a sliding manner. The sliding door leaf comprises a leaf and a sliding doorframe, onto which the leaf is mounted with at least one hinge for allowing opening in the swing mode. The door further comprises a self-closure for self-closing of swing leaf integrated in the sliding doorframe, a flexible tube sealing in a groove between the leaf and the doorframe or between two leafs an assembly for forced closure of sliding leafs in emergency, and a recessed handle for pulling the door leaf in the swing mode. In emergency cases passage through the door is allowed by pushing the door open from one side and by pulling the recessed handle from the other side.

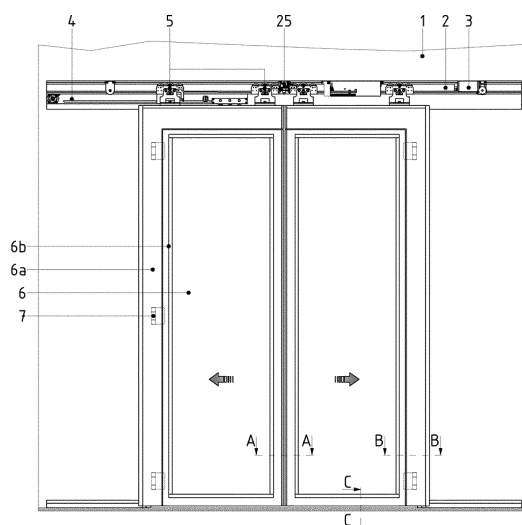


Figure 1a

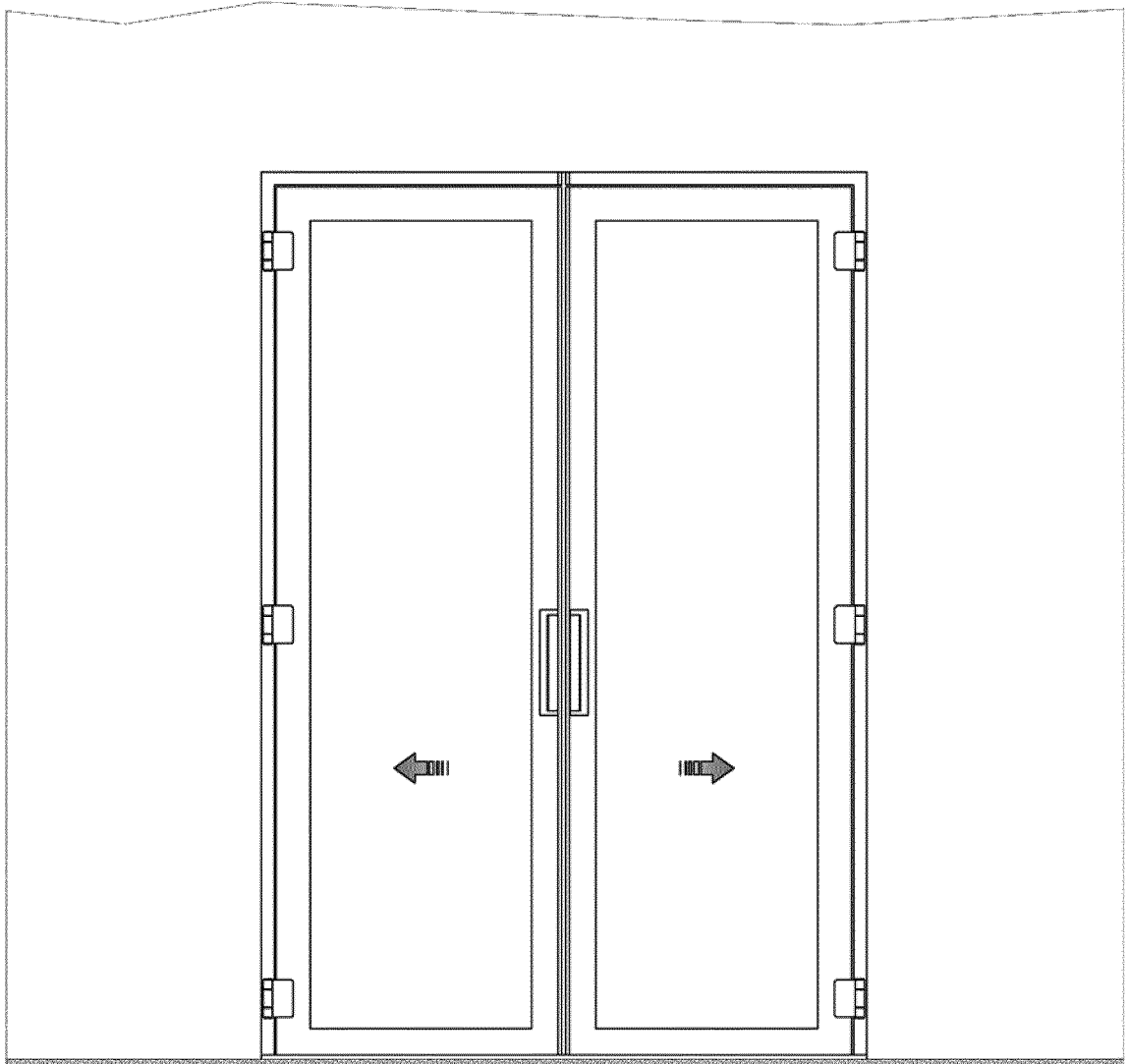


Figure 1b

Description

Field of the invention

[0001] The present invention belongs to the field of construction, more precisely to the field of door for special purposes, particularly for preventing fire expansion. The invention relates to automatic sliding fire door, which can operate in a sliding or swing operating mode, wherein no protruding components such as door handles and panic bars are required for opening said door.

Background of the invention and the technical problem

[0002] Automatic sliding fire door is intended for installation on borders of fire sectors as well as on escape routes. Most commonly such doors are used for prevention of fire expansion, wherein safe evacuation of people has to be enabled. They may be used in residential buildings, hospitals, shopping malls, industrial and business spaces, health institutions and buildings for accommodation of tourists. Existing automatic sliding fire door combine automatic sliding operation (in usual conditions) and in manual swing operation triggered by a fire alarm, electricity power failure or working error, when the doors are automatically sliding closed and switched to operation as manual swing door, which can be opened with a door handle or a panic bar.

[0003] The technical problem, which is solved by the present invention, is construction of such automatic sliding fire door for escape routes that on their outer visible surfaces do not have any functional fittings, such as locks, door handles and/or panic bars or similar elements, as in sliding mode of operation these elements represent possible sources of injuries of users, while at the same time their installation on the door means more complicated design and a larger number of components, as well as increase the opening force. The aim of the invention is thus to ensure simplified automatic sliding fire door for escape routes without any functional or safety elements, i.e. without any protruding components. This simplification results in lower number of components and assemblies, which consequently improves door reliability, leads to lower pricing, simplified use in emergency cases, and additionally improves architectural aesthetic.

State of the art

[0004] Automatic sliding fire door with a swing leaf as described in patent SI 21048 are equipped with a mechanical forced closing system, which in emergency cases ensures unconditional sliding closure, latching of the sliding leafs and unlatching swing leaf, which are a component of the sliding leafs or are attached to the sliding doorframe with hinges. In emergency cases such as a fire alarm or electricity power failure, the sliding leaf are closed and latched, while the swing leaf may be opened with a lever handle, a panic bar or similar. The mechanical

system for closing and latching the sliding leaf and unlatching the swing leaf is based on stored potential energy of lifted weights or compressed pressure springs. The components enabling opening and closing the swing leafs such as locks, door handles, panic bars, elements for self-closing swing leafs and systems for synchronized closure of swing leafs, are installed on the surface of the leaf. Such design is potentially dangerous for users, as in normal operation of doors (sliding); the said components protrude out of the leaf surface.

If they were not present, the doors could not be opened, hence they are essential.

[0005] Patent SI 22012A discloses automatic fire door with the same mode of operation and transformation from sliding operation to an emergency operation as described in patent SI 21048. The difference is in the construction of components that ensure the transformation from the normal sliding operation into the fire mode of operation. The energy for closing the sliding leaf during transformation into fire mode, is provided with the potential energy of tensed spiral springs, wherein the systems for latching the sliding leafs and unlatching the swing leafs are managed with electromagnetic actuators. The components for closing and self-closure of swing leafs are installed on the outer surface of the leafs.

[0006] All known solutions disclose doors with functional elements as they cannot be opened in any other way. The invention differs from these known solutions in that the said functional elements are not needed, because door opening is enabled in a different manner.

Description of the solution of the technical problem

[0007] The object of the present invention is automatic sliding fire door for escape routes with one or more sliding leafs. The sliding leaf comprises a sliding doorframe and a swing leaf, which is with hinges mounted on the sliding doorframe, wherein in case of a fire, the sliding leafs are unconditionally closed in the first step, and thereafter swing leaf may be opened in the second step, for 90 or more degrees, allowing passage through the door in emergency. Said automatic sliding fire door thus have two operation modes:

- sliding mode, when in normal conditions the sliding leafs translationally move between open and closed positions;
- fire mode initiated for example with a fire alarm or electricity power failure, when a mechanical system using stored potential energy in tensed springs unconditionally closes the sliding leaf(s) and unlatch the swing leafs, so that passage through the door is enabled. The swing leaf is unlatched in the same manner as described in patent SI 22012.

[0008] The above described technical problem is solved with a construction of automatic sliding fire door, which enables that surfaces of sliding leafs are without

protruding components, hence without door fittings (locks, panic bars, door handles).

The essence of the automatic sliding fire door is in that passage in case of a fire is from one side enabled by pushing the swing door with a push and from the other side with pulling a recessed handle. In order to allow such opening, the automatic sliding fire door comprises:

- a longitudinal holder (door drive unit) with at least one sliding door leaf mounted via a trolley, so that the said sliding leaf can move in the sliding mode;
- the sliding door leaf comprises a swing leaf and a sliding doorframe, wherein the leaf is attached with at least one hinge to the mentioned doorframe for allowing swing mode of operation;
- a closure element for self-closing of the swing leaf is integrated in the profile of the sliding doorframe;
- a flexible seal tube placed in a groove between the leaf and the doorframe or between two leaves that allow pushing or pulling the leaves around the hinge in the swing door mode of operation;
- an assembly for forced closure of sliding door in case of fire alarm, electricity power failure or any other emergency, wherein the assembly comprises:
 - Spiral springs attached to a housing of the assembly for forced closing and attached to the trolley with door leaf, guided on the guide, wherein a pulling rope is attached to the trolley, the pulling rope being wound on a drum,
 - Said drum is mounted directly on a shaft of a gearbox, attached to the housing, wherein the said drum is mounted in a flange, which is attached to the housing;
- a recessed handle for pulling the door leaf in the swing mode, installed on at least one door leaf.

[0009] The longitudinal holder (door drive unit) has a guide, on which trolleys with guide wheels are moved, wherein at least one sliding leaf is mounted on the trolleys. The sliding leaf comprises the sliding doorframe and the swing leaf, which is attached to the sliding doorframe with hinges. The drive assembly moves, opens and closes, respectively, at least one sliding leaf. The assembly for forced closure in case of emergency closes at least one sliding leaf with use of stored kinetic energy in tensed springs. The closure for automatic closing of the swing leaf is preferably the same as described in document SI 22012, with a difference that it is integrated only in the sliding doorframe. An automatic closure of the swing leaf is important for prevention of swing opening during normal sliding mode of operation. In case of an alarm, the sliding leaf is forced to close, the said closure is released and the door leaf may open in the swing mode.

[0010] The sliding doorframe is preferably pre-tensed, which solves the problem of doorframe sagging in case of swing operation. In known solutions, the doorframe

sagged or touched the floor due to weight of the leaf, leading to impaired operation. Therefore, these solutions integrated a latch for blocking the bottom side for sliding frame in case the door is operating in swing. The sliding doorframe is pre-tensed in the following manner: the sliding doorframe has through an empty space of the vertical profile, through a hole in the horizontal frame and through a hollow attachment of the carrier horizontal profile inserted two tension rods, which are fixed into an attachment plate on the bottom part of the vertical profile. On hollow attachments the rods are screwed with a nut, which is at the same time also a regulation element for setting the pre-tension of the sliding doorframe.

[0011] In comparison to known solutions the present invention does not require a mechanism for synchronized automatic closing of swing door leaves, as in one-leaf door the vertical connection between the swing leaf and the fixed doorframe in the wall or in double-leaf door the vertical connection between two swing leaves does not have a rebate, as flexible tube seals are installed in the groove, so that opening and automatic closing of leaves is possible in any sequence, even at the same time. At the same time the flexible seals on the vertical connection between the leaf and the doorframe in one-leaf door and between the left and right leaf of the double leaf door enable reliable sealing.

[0012] The described constructional design additionally allows manufacturing of swing door leaves without horizontal crossbar profiles, so that uniform glass or panels may be installed in the door leaves, which contributes to improved aesthetic appearance of the door.

[0013] Due to thermal conditions during a fire the glazing beads used for fixing and protection of glass or panels tend to fall out, the automatic sliding fire door according to the invention this problem solve with thin and narrow metal plates attached to the glazing beads. During insertion of glass into leaves and fixed walls said plates are pushed under the glass or a panel, wherein the friction force between the glass and the plate prevents the glazing beads from falling out of the leaf frame. Thus, the glass or the panel protect the glazing beads during a fire, while the glazing beads protects the groove around the glass or the panel from falling out, which are usually a weak point for leaking smoke and/or fire. This is of utmost importance for the invention, as the door may comprise large glasses or panels, which have to be reliably mounted even in cases of increased temperature during a fire.

[0014] The sliding doorframe according to the invention is comprises carrier profiles and anti-fire profiles, which are preferably connected with so called twin slot fixing, which eliminates the need for welding that causes profile deformation and lowers door quality. Essentially, along the flaps-flanges of the anti-fire profiles elongated holes are cut-out along both sides, wherein the holes are distributed in a particular raster. The carrier profile is provided with protruding tabs with the same raster as holes, but with a certain shift, so that when the tabs are inserted into the holes on the anti-fire profile and the carrier profile

is slid (pushed) in the direction of the notch on the tabs, a strong connection is achieved between both profiles.

[0015] The solution of the automatic sliding fire door for escape routes may be used for one-leaf and double-leaf door with any type and dimension of anti-fire profiles and anti-fire glass. Said doors may be installed in wall and glass openings in escape routes and allow simple and safe evacuation of people and objects in an early stage of fire, while at the same time prevent expansion of fire and smoke for at least a certain time.

[0016] The automatic sliding fire door according to the invention will be described in further detail based on embodiments and figures, which show:

- Figure 1a Double-leaf automatic sliding fire door from the inner side
- Figure 1b Double-leaf automatic sliding fire door from the outer side
- Figure 2 Cross-section A - A
- Figure 3 Cross-section B - B
- Figure 4 The sliding doorframe
- Figure 5 The assembly for forced closing
- Figure 6 Connection of carrier profiles
- Figure 7 Cross-section C - C

[0017] Figure 1a shows a double-leaf automatic sliding fire door from the inner side installed in a fire wall 1, which separates two fire sectors. Above the opening in the fire wall a longitudinal holder (door drive unit) with a guide (drive unit) 2 is mounted, wherein trolleys 5 with guide wheels arranged to move along the said guide 2, and wherein sliding leaf 6 are installed onto the trolleys 5. The sliding leaf 6 comprises a sliding doorframe 6a and a swing leaf 6b, which is attached to the said doorframe with hinges 7. A drive assembly 3 moves or opens and closes the sliding leaves 6. The assembly 4 for forced closure in case of emergency with stored kinetic energy in tensed springs closes the sliding leaves 6 in a forced manner. Figure 1b shows a possible installation of a recessed handle for opening the door from the external side.

[0018] Figure 2 shows a connection of two front profiles 8 and 11, which are a part of the frame of the swing leaves 6b, when the sliding leaves 6 are closed in normal operation or in fire operation, when the sliding leaves are closed in a forced manner. The slot 10 is sealed with tube seals 9 and 9a, which are inserted into a groove 8a of the profile 8 and into a groove 11a of the profile 11. The profile 8a may be the profile of the doorframe in single leaf system or a profile of the doorframe of the opposite swing leaf.

[0019] According to the invention the swing door leaves are without a rebate, the groove 10 between the swing leaves 6b and doorframe made of fire profile 8 or between two swing leaves are sealed with tubular seals 9 and 9a, which prevent transfer of smoke and flame. Tubular flexible seals 9 and 9a due to their shape and characteristics of the material from which they are made, prevent transfer of smoke and flames, while at the same time they allow any sequence of opening and closing of the swing leaves.

Therefore, the leaves may be opened from the inner side by pushing one of the leaf or both leaves at the same time.

[0020] Sealing of the groove between the wall 1 along the entire height of door and the inner surface 17 of the door in normal operation when the door is closed or in fire mode when the door is forcedly closed 17 is shown in figure 3, cross-section B - B. The fire profile 13 with a flange 13a is fixed to the vertical profile 18 of the sliding doorframe 6a. When the sliding leaf 6 is closed, the flange 13a is moved into the inner space of the slot 15a of the sealing profile 15 installed on the L profile 14, which is fixed on the wall 1. In order to prevent passage of flames and smoke, two membrane seals 16 and 16a are installed into channels 15b and 15c in the inner space 15a, the said seals enclose the flange 13a. When the sliding leaf is closed, the flange 13a of the fire profile 13 attached to the sliding doorframe 6a is moved into the slot (inner space), where it embraces the rebate by both seals 16 and 16a. This prevents passage of flames and smoke through the gap.

[0021] Safety rubber 12 is glued along the entire length of the vertical profile 11 of the sliding doorframe 6a. The safety rubber is a safety element, as its shape and characteristics of the material from which it is made, ensure that the push force at door closing is decreased for approximately 60%.

[0022] The sliding doorframe 6a is one of the elements of the sliding leaf 6 and it is with trolleys with wheels 5 mounted on the longitudinal holder - door drive with the guide 2 and connected with the drive assembly 3, the latter translationally moving the doorframe into closed or open position. Onto the sliding doorframe 6a the swing leaf 6b is attached with hinges 7, thus the doorframe 6a and swing leaf 6b creating the sliding leaf 6. According to the invention the sliding doorframe does not need a latch for blocking sliding doorframe, which prevents movement and sagging of the sliding doorframe in the fire mode, when swing doors are in use.

[0023] Figure 4 shows the sliding doorframe 6a according to the invention. It is designed in the shape of the letter L, wherein the longer part of the doorframe is the vertical profile 18 and the shorter part is the horizontal profile 24. Said profiles are made from the same anti-fire profile and are welded on the angular connection. Thus connected profiles are further reinforced from the outer side with a carrier vertical profile 17 and a carrier horizontal profile 19. The carrier profiles 17 and 19 are connected with the anti-fire profiles with the twin slot fixation as shown in figure 6. Along the flanges of anti-fire profiles in a pre-determined sequence on both sides elongated holes are cut, while the carrier profiles have specially designed protruding tabs with the same raster as holes, but with a certain shift, so that when the tabs are inserted into the holes on the anti-fire profile and the carrier profile is slid (pushed) in the direction of the notch on the tabs, a strong connection is achieved between both profiles. This connection system is used to eliminate welding, which causes profile deformation.

[0024] The sliding doorframe has through the empty space of the vertical profile 18 and through the hole in the horizontal profile 24 and through a shallow accessory 22 and 22a on the horizontal profile 19 tension rods 21 and 21a, which are fixed on the bottom part of the vertical profile 11 by attaching into the attachment plate 20, and on the upper side they are screwed with nuts 23 and 23a to the hollow accessories, wherein the rods are also functioning as regulation elements for setting the pre-tension of the sliding doorframe, the pre-tension preventing sagging of the doorframe.

[0025] Figure 5 shows the assembly for forced closing 4 comprised in the door drive according to the invention. Forced closing is necessary if sliding doors are open for closing the door in case of a fire alarm or electricity power failure. In order to allow opening in the swing manner, the door have to be closed in a sliding manner, which is ensured with the assembly 4. The latter is manufactured as a single piece, which is installed during door assembly onto the door drive with the drive unit 2. The function of the assembly for forced closing 4 is that in fire mode and or electricity cut off, with the help of potential energy of pre-tensed spiral springs, forcedly closes the sliding leafs of the automatic door. On the housing 36 made of a hollow profile a hole is provided, into which a flange 35 is inserted and fixed, to the said flange the gearbox 26a is attached, while an electromotor 26 with an electromagnetic break is mounted on the said gearbox. Onto the output axis of the gearbox 26a, drum 27 is mounted and guided through bearing on the flange 35. The flange 35 is inserted and attached to the hole in the housing 36 and screwing on. In the housing 36, guides 28 and 28a are attached, on which the trolley 30 during its translational movement is guided. A steel rope 29 is on one side wound on the drum 27, and is on the other side attached to the trolley 30, as well as to the assembly of spiral springs 31. When the door are initializing for normal sliding operation the electromotor with the electromagnetic brake is winding the steel rope onto the drum, which pulls the trolley and tenses the spiral springs. When the springs are tensed up to the triggering of a fire alarm, electricity power failure or an error, the electromagnetic brake of the electromotor continues to hold the springs and the trolleys in its initial position 32. In case of alarm, electricity power failure, an electromagnetic brake of the electromotor releases the pre-tensed springs, which have enough energy to pull the trolleys into the initial closed position 33. At the same time, a push accessory 30a hits the sliding doorframe 6a and pushes the whole sliding leaf 6 into the closed position, which is then locked with a bi-stable lock 25.

[0026] Figure 7 shows a possible manner of installation of glass into the swing doorframe 6b, which is made of antifire profiles. After installation of glass 42 into the doorframe 6b, glazing beads 39 are installed into the frame, wherein said glazing beads are provided with narrow and thin metal plates 41 distributed at certain distance. During installation of glazing beads into the frame of the swing leaf and fixed walls, the metal plates are pushed under

the glass or panel and the glazing beads are fixed by pressing and latching on the button 40. After installation of glazing beads sealing rubber 37 and 38 is installed.

[0027] The described automatic sliding fire door do not have any protruding elements as already known doors operating in a sliding or swing manner, because the present invention does not require locks, door handles, panic bars or similar elements for opening, while at the same time reliable and safe operation is ensured.

Claims

1. Automatic sliding fire door arranged to be opened in case of a fire by pushing a swing leaf from one side and by pulling a recessed handle from the other side, wherein the said door comprises:

- a longitudinal holder - door drive unit with guiders (2) with at least one sliding door leaf (6) mounted via a trolley (5), so that the said sliding leaf (6) can move in a sliding mode;
- the sliding door leaf (6) comprises a leaf (6b) and a sliding doorframe (6a), wherein the leaf (6b) is attached with at least one hinge (7) to the said doorframe (6a) for allowing a swing mode of operation;
- a closure for automatic closing of the swing leaf integrated in the profile of the sliding doorframe;
- a flexible tube seal (9a, 9b) placed in a slot (10) between the leaf and the doorframe or between two leafs that allow pushing or pulling around the hinge in the swing mode of operation;
- an assembly (4) for forced closure of sliding door in case of fire alarm, electricity power failure or any other emergency, wherein the assembly comprises:

- spiral springs (31) attached to a housing (36) of the assembly and attached to a second trolley (30), attached to the doorframe 6a, guided on guides (28 in 28a), wherein a pulling rope (29) is attached on one side to the trolley (30), on the other side the pulling rope being wound on a drum (27),
- said drum (27) is mounted directly on a shaft of a drive box (26a), attached to the housing (36), wherein the said drum (27) is mounted through bearings in a flange (35), which is attached to the housing (36);

- and a recessed handle for pulling the door leaf in the swing mode, installed on at least one door leaf.

2. Automatic sliding fire door according to claim 1, characterized in that the door have one leaf or two

leafs and any dimension or type of anti-fire profiles and antifire glass or antifire panel.

3. Automatic sliding fire door according to claim 2, **characterized in that** the door comprises two leafs and said leafs are arranged to open without any pre-defined sequence due to a movable tube seal on the connection between both leafs. 5
4. Automatic sliding fire door according to any of the preceding claims, **characterized in that**, da the seals (9 and 9a) are inserted into a first groove (8a) of a first profile (8) and into a second groove (11a) of a second profile (11), wherein the first profile (8a) may be the doorframe profile in one-leaf door or frame profile of the second swing leaf in double-leaf door. 10
5. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the door are provided with a fire profile (13) with a flap (13a) fixedly attached to a vertical profile (18) of the sliding doorframe (6a), wherein upon closure of the sliding leaf (6) the flap (13a) is arranged to be moved into an interspace (15a) of a sealing profile (15), which is mounted on an L profile (14), which is fixed on a wall (1). 20 25
6. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the groove between the wall into which the door are installed, and the sliding leaf is sealed with the fire-resistant sealing rubber (15), having an interspace (15a), inside which slots (15b and 15c) are provided for installation of sealing membranes (16 and 16a). 30 35
7. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the safety rubber (12) is glued along the whole length of the vertical profile (11) of the sliding doorframe (6a). 40
8. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the sliding doorframe is pre-tensed, which prevents sagging in the swing mode of operation. 45
9. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the sliding doorframe (6a) has through the vertical profile (18) and through a hole on the horizontal profile (24) and through a hollow attachment (22 and 22a) on the carrier horizontal profile (19) installed tension rods (21 and 21a), which are in the bottom part of the profile (18) attached into an attachment plate (20) and on the top of the hollow attachments (22 and 22a) screwed with a nut (23 and 23a), the latter at the same time being a regulation element for setting pre-tension of the sliding doorframe. 50 55

10. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the sliding doorframe is composed of carrier profiles and anti-fire profiles, which are preferably joined so that next to flanges of anti-fire profiles in a certain sequence on both sides elongated holes are cut, while the carrier profile has specially shaped tongues with the same raster as the holes but with a shift; that when the tabs are inserted into the holes on the anti-fire profile and the carrier profile is pushed in the direction of a notch on the tabs, a strong connection is achieved between both profiles.

11. Automatic sliding fire door according to any of the preceding claims, **characterized in that** the door has fire-resistant metal plates (41) in any known way attached to the bottom surface (39a) of glazing beads (39), wherein the plates (41) are stuck under the glass or panel (42).

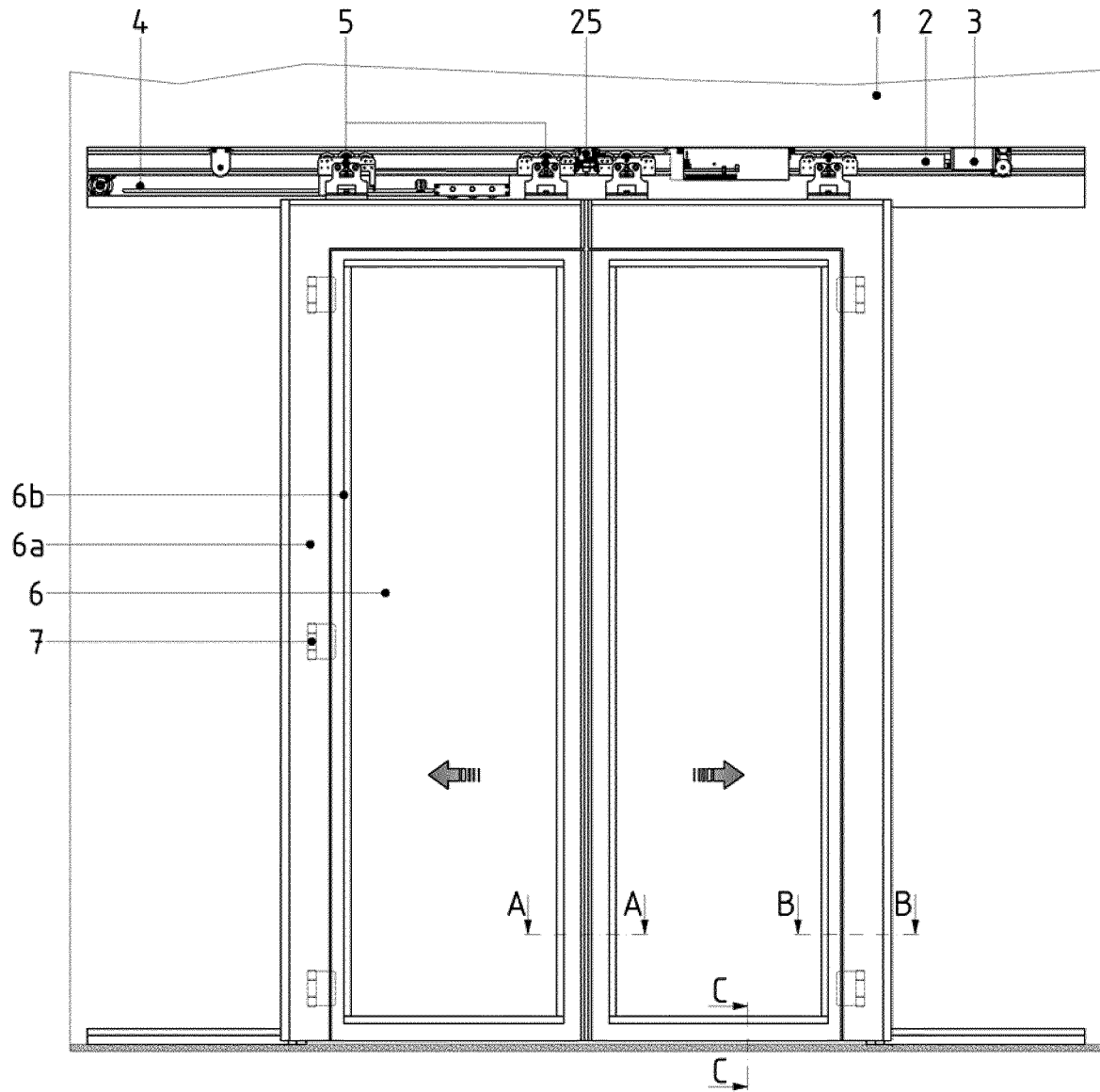


Figure 1a

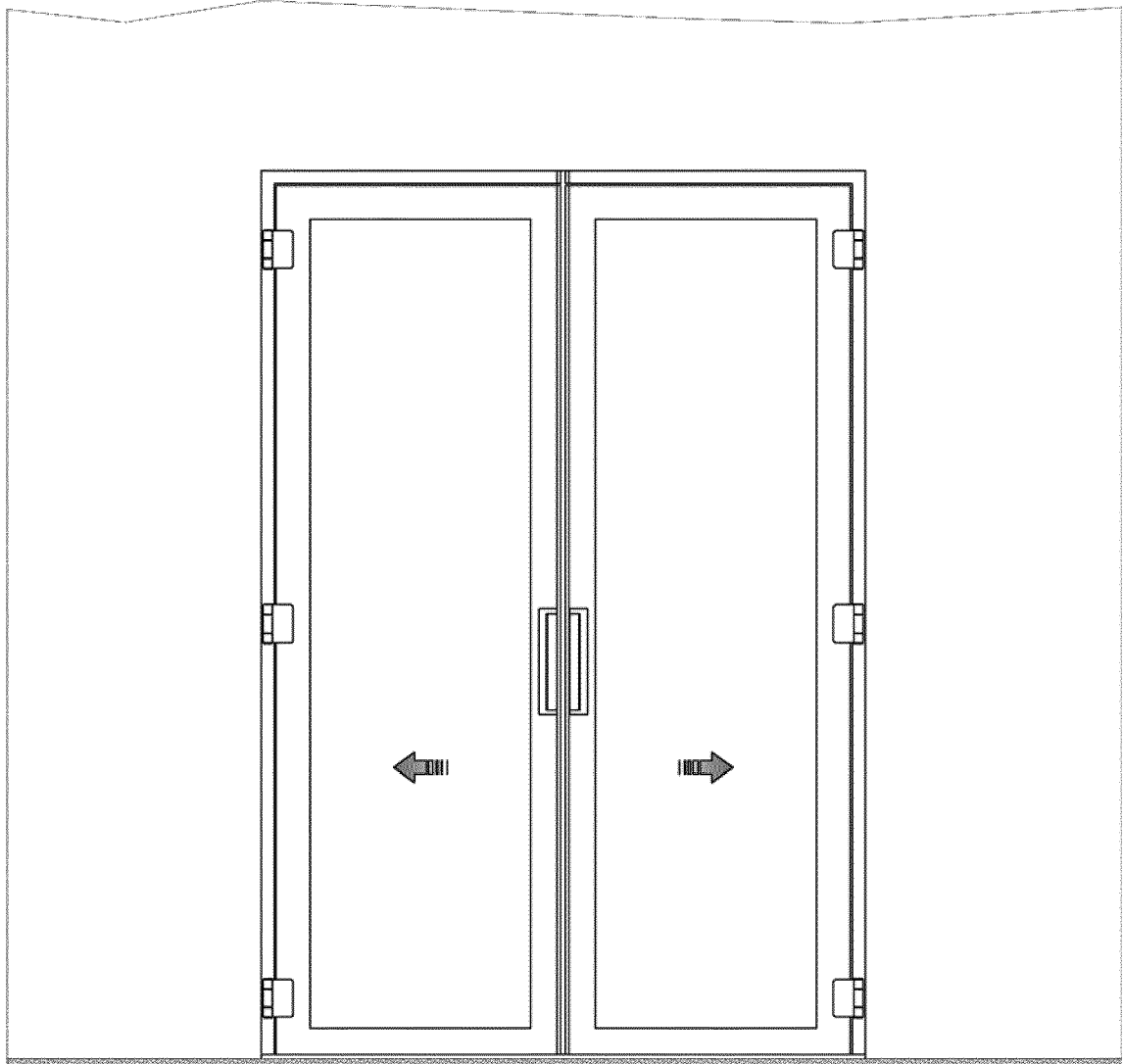


Figure 1b

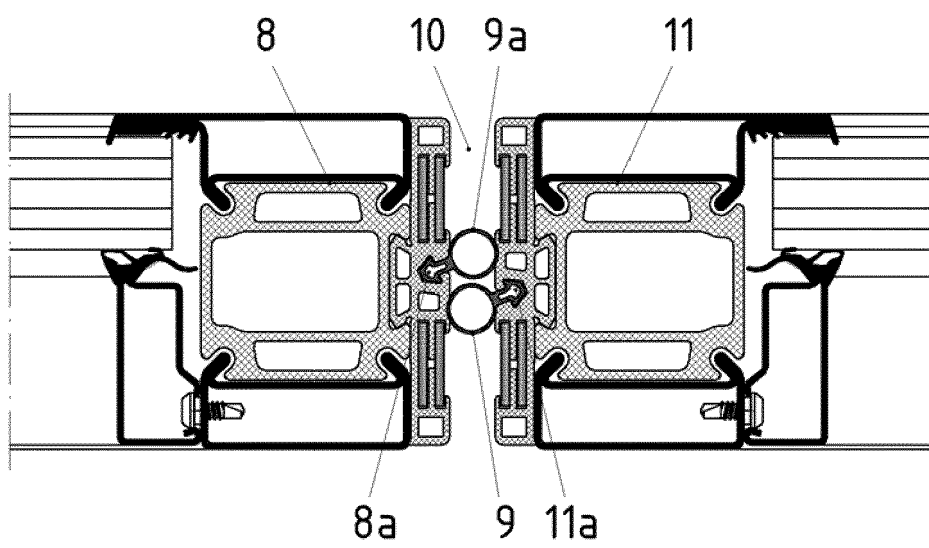


Figure 2

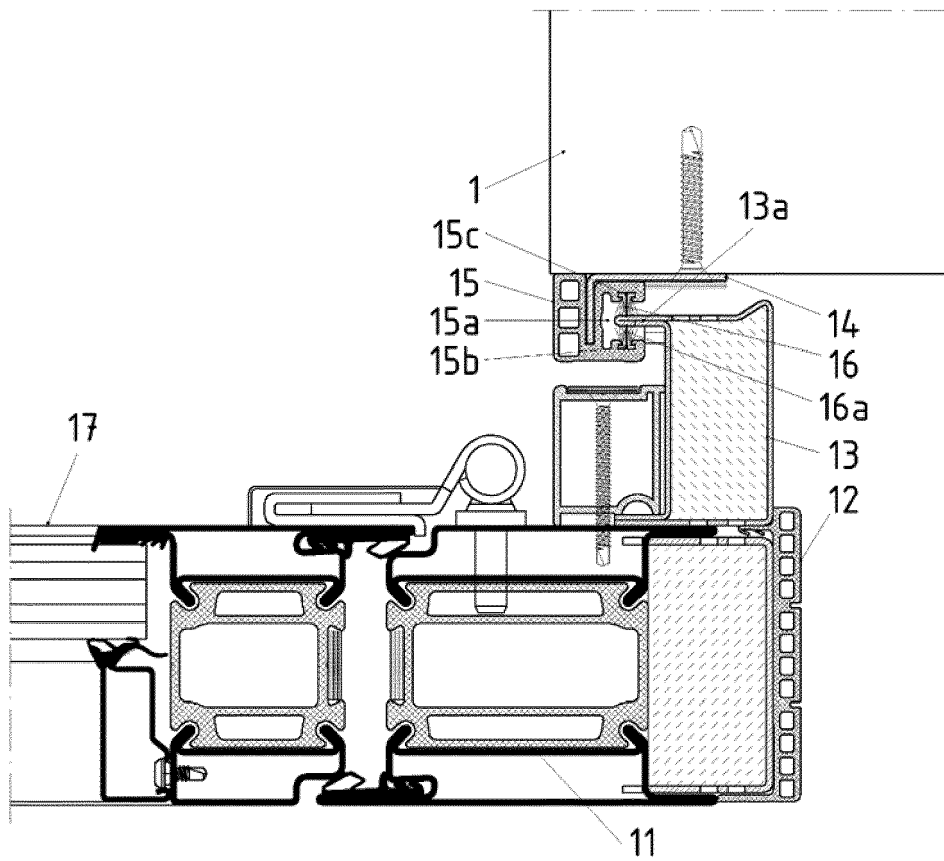


Figure 3

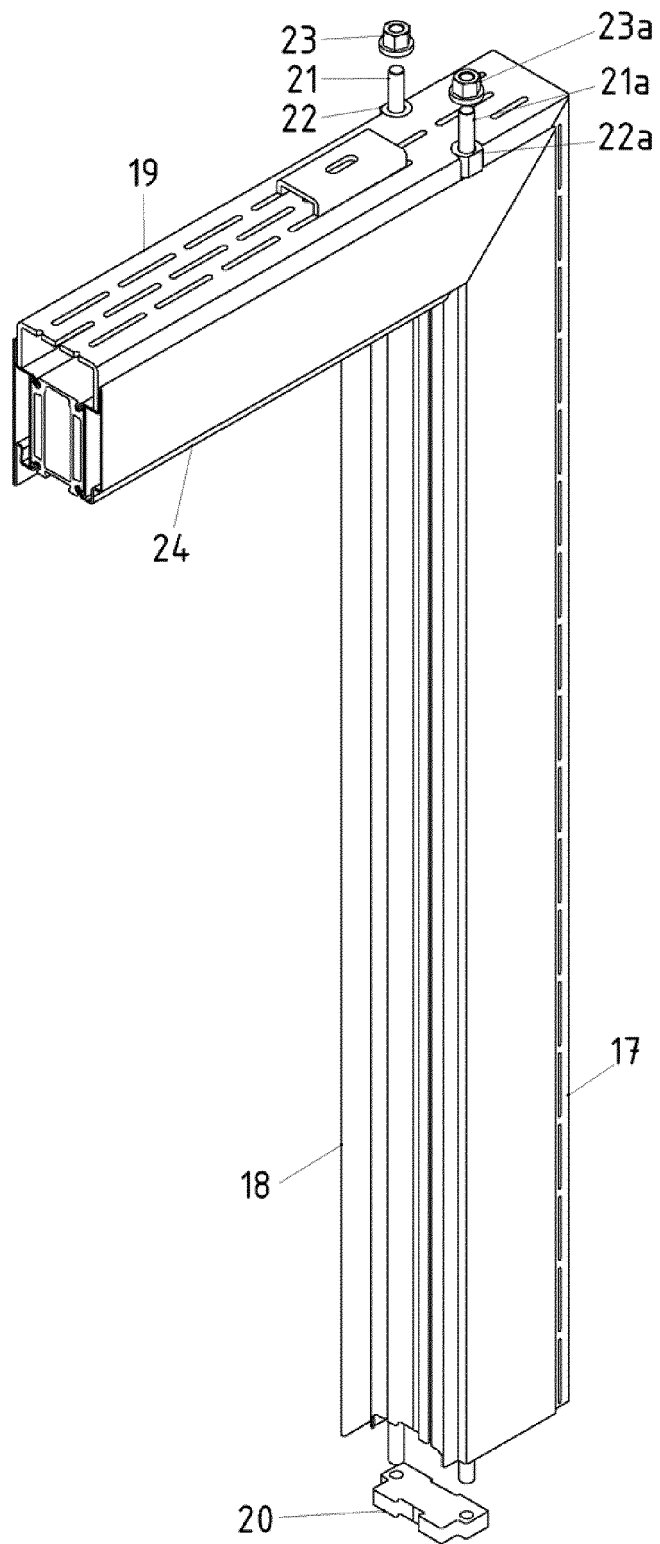


Figure 4

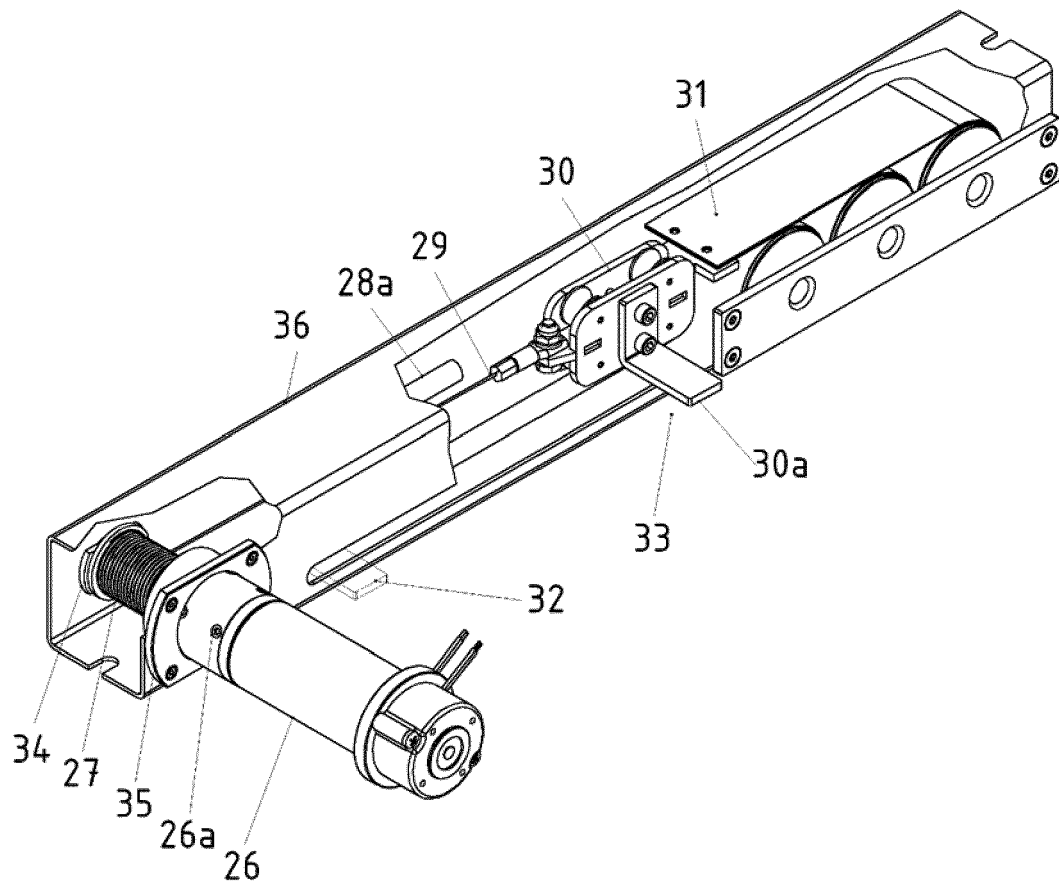


Figure 5

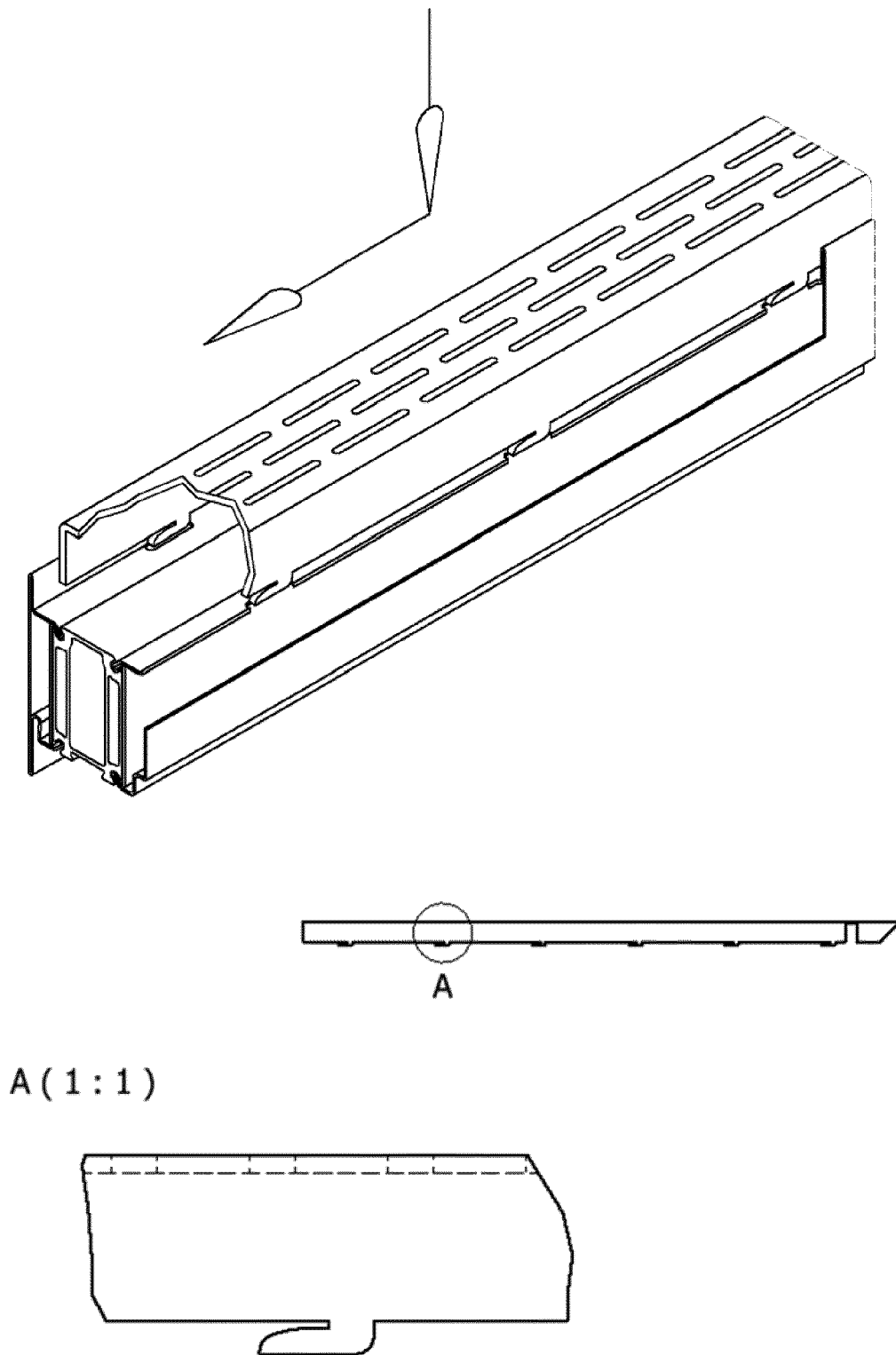


Figure 6

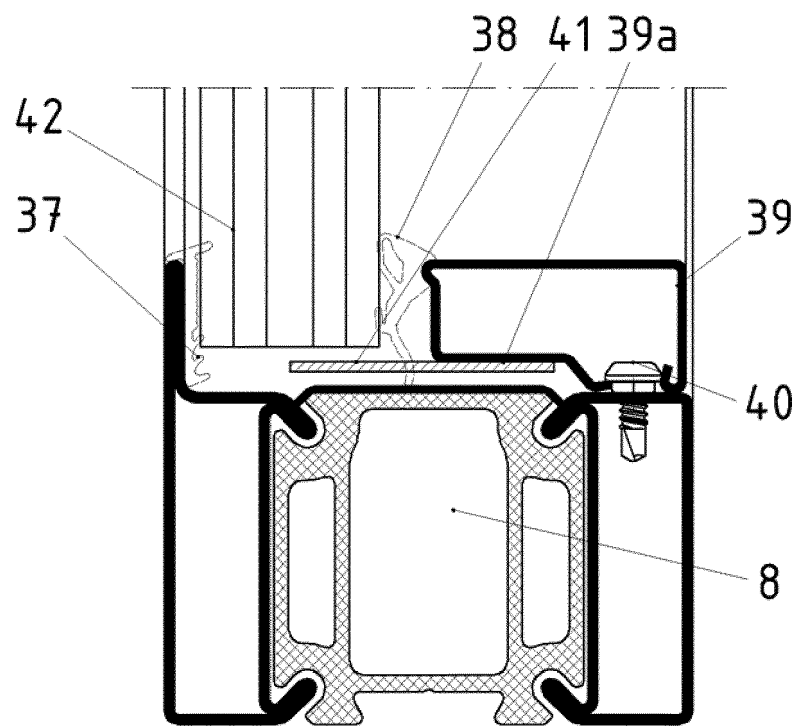


Figure 7

REFERENCES CITED IN THE DESCRIPTION

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