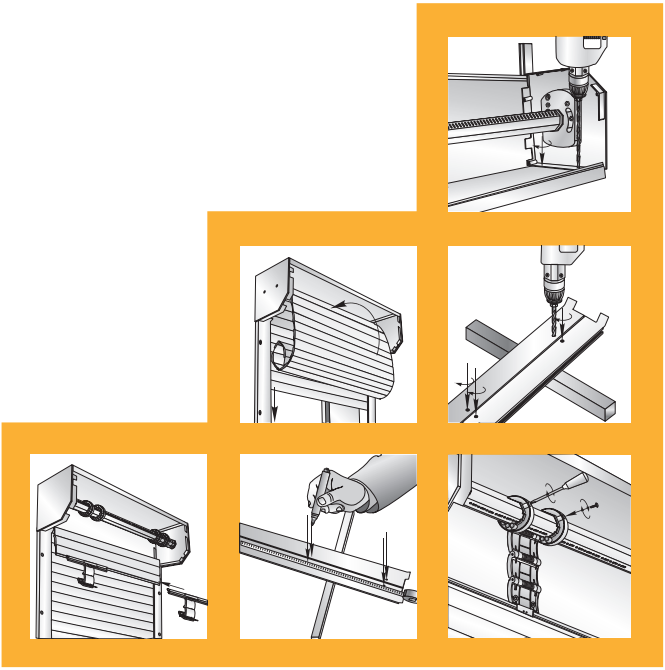
ALUTECH
ROLLER SHUTTER SYSTEMS

ROLLER SHUTTER
MOUNTING INSTRUCTIONS



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Together with high-quality production, proper mounting is a prerequisite allowing to achieve excellent consumer properties of a product.

This manual covers protective roller shutters (hereinafter referred to as roller shutters) manufactured in compliance with TU RB 37364010.001-95. The manual includes the recommended order and description of main operations of the standard roller shutter mounting process, and lists necessary equipment and tools.

This manual can be used as the training and work guidelines for operating personnel. It is recommended to use the manual together with the Technical Catalog.

This manual is based on our knowledge and experience. All existing rules and standards covering roller shutter mounting must be scrupulously fulfilled.

The content of this document cannot be the basis of legal claims. Alutech company reserves the right to modify and amend this manual.

1. GENERAL INSTRUCTIONS

1.1 Proper number of the mounting team personnel

The mounting team should consist of 3 persons. When mounting an electrically-driven roller shutter, the team must include an erection electrician fitter having the electrical installation work permit not lower than group 2. When installing roller shutters with square exceeding 4 m^2, it is recommended to include one more fitter in the team.

An average weighted productivity standard for the mounting team is mounting 3 – 4 roller shutters during 8-hours' working day, with an average square of one product being 2.5 m^2.

This standard can vary considerably depending on the mounting environment, size and configuration of roller shutters.

1.2 Recommended kit of tools and accessories requited for roller shutter mounting (per one team)

Tool name	Number
Electric punch machine	2
Electric drilling machine	1
Battery-powered screwdriver	1
Electric angle cutting machine	1
SDS adapter with a quick-lock holder	2
Riveting gun	2
1.5-m torpedo builder's level	1
Tool case	2
400 g bench hammer	2
Sledge hammer	1
Impact-type driver set (chisel, pipe drill, punch, prick punch)	1
Hack saw	1
Tin snips	1
Pliers	1
Middle side cutting pliers	1
A set of files	1
A set of hard-alloy screwdrivers	1
A set of wrenches	1
General-purpose 4-fold ladder	1
General-purpose 3-sectional ladder (more than 6 meters)	1
Silicone gun	1
Tester	1
60 W electric soldering iron	1
Electric extension cord (at least 30 meters)	1
Test electric screwdriver	1
5 m tape rule	1
125-mm caliper gage	1
Protective goggles	2
Safety helmet	3

Tool name	Number
General-purpose first-aid kit	1
A standard set of metal drills	1
Electric punch machine	2
Concrete bore Ø 6 mm L=160 – 200 mm	2
Concrete bore Ø 8 mm L=200 – 260 mm	2
Concrete bore Ø 10 mm L=550 mm	2
Concrete bore Ø 12 mm L=550 mm	2
Concrete bore Ø 14 mm L=750 mm	2
Concrete bore Ø 16 mm L=950 mm	1
Concrete bore Ø 18 mm L=550 mm	1
Concrete bore Ø 20 mm L=550 mm	1
Note: recommended personnel of the mounting team: erection electrician fitter – 1 person; assembling fitter – 2 persons.	

1.3 Recommended materials and components used during roller shutter mounting

1.3.1 Fasteners used to attach roller shutter components to frame structures of the aperture

All fasteners and fittings must be corrosion-resistant.

When mounting structural units of roller shutters, various fasteners can be used depending on the aperture material characteristics.

When mounting roller shutters to the structures made of solid materials, such as concrete, natural stone, full brick, it is recommended to use plastic dowels with thread-into screws, plastic dowels with a knocked-in component (nail screw), steel expanding anchors. The dowel or anchor must be long enough, and the hole in the frame structure must be deep enough for the anchorage to be at least 30 mm deep.

When mounting roller shutters to the structures made of hollow materials, such as economy brick (hollow clay unit), it is recommended to use steel expanding anchors. The anchor must be long enough, and the hole in the frame structure must be deep enough for the anchorage to be at least 65 mm deep.

When mounting roller shutters to the structures made of foamed concrete, gas-silicate units, it is recommended to use extended plastic nibbed dowel assemblies with thread-into screws. The dowel must be long enough, and the hole in the frame structure must be deep enough for the anchorage to be at least 65 mm deep.

When mounting roller shutters on metal structures it is necessary to use thread-cutting screws.

When mounting roller shutters on wooden structures it is necessary to use tension pins coming through the structure, or wood screws.

When mounting roller shutter controls (strap coiler, rope coiler, Cardan joint, clamp, etc), it is recommended to use plastic dowels together with a wood screw or a nail screw.

1.3.2 Materials used to seal site welds, clearances and working apertures

It is necessary to use silicone or acrylic sealants and sealing foam as sealing materials.

The materials must ensure:

- tightness in case of wind impact;
- watertightness;
- sufficient thermal insulation.

Applied sealants must be compatible with adjacent building structures and roller shutter components.

2. SAFETY MEASURES

2.1 General requirements

Only qualified personnel that know the roller shutter structure and mounting process, and that have studied the product and passed the safety training can be admitted to roller shutter mounting operations.

It is allowed to perform mounting operations only in protective clothing that doesn't restrict movements, and in the safety helmet.

Protective goggles must be used when drilling materials producing outgoing chips, and when chopping and cutting metal. A respirator must be used to protect breathing organs from construction dust.

Fitter's hammers and sledge hammers must have smooth, slightly barreled surfaces of hammer heads free of dents, chamfers, cold deformations, shears and cracks. The hammer handle must be at least 250 mm long, while the sledge hammer handle must be at least 700 mm long; hammers and sledge hammers must be securely attached to the handles and fixed with wedges.

All tools having pointed ends for handles (files, screwdrivers, etc.) must have wooden handles that are at least 150 mm long and are tightened with banding rings.

Impact-type drivers (chisels, pipe drills, punches, prick punches) must have no inclined and knocked-down heads, cracks, and wire-edges. Chisels and pipe drills must be at least 150 mm long, with the pulled-off part of the chisel being at least 60 – 70 mm long; the cutting edge must be straight or slightly prominent.

Wrenches must meet size of nuts and bolt heads, be free from cracks and dents; wrench jaws must be parallel, they must not be loose or turned up.

A special tool box or bag must be used for carrying tools to the work site. Special belts must be used for holding tools during operation. It is forbidden to put tools in protective clothing pockets.

2.2 SAFETY MEASURES WHEN WORKING AT HEIGHTS

Working at height of 1.5 m from the floor surface and more is referred to working at heights.

Operations that are performed at the height exceeding 5 m from the ground surface, floor structures or the operating platform of scaffolds and trestles are considered to be steeplejack work. Overall health of persons admitted to steeplejack work must meet medical requirements established for employees fulfilling such work.

A safety body belt must be used when working at heights.

In case it is impossible to attach a safety belt to the building structure components, it is necessary to use the safety strap that must be brought in behind the building structure components before the work is started. In this case the work must be performed by two fitters.

When working on structures, under which there are current-carrying conducting parts, accessories and tools must be fastened (tied) to prevent them from falling.

It is **FORBIDDEN** to use safety belts with metal-chain straps when working on structures, under which there are current-carrying conducting parts.

Roller shutter components, tools, and mounting accessories must be handed up with an endless cable. A person standing underneath must hold and restrain the cable preventing the load from swaying and approaching the conducting parts.

It is forbidden to:

- stand under the ladder, from which work is performed;
- throw up any objects to a person working above. Objects must be given with the help of strong rope.

2.3 Safety measures when working using ladders and double ladders

lean-to ladders and double ladders must be equipped with a device preventing a ladder from shifting or overturning while the ladder is in use. At the bottom ends of lean-to ladders and double ladders it is necessary to use bindings with fangs ensuring the ladder can be installed on the ground. If a ladder is used on smooth surfaces (metal, tile, concrete), fangs must be covered with pads made of rubber or other non-skid material.

It is forbidden to:

- work at the lean-to ladder standing on the step that is less than 1 m away from its top;
- work with power hand tools at the lean-to ladder;
- work standing on either of the top steps of double ladders having no banisters or guards;
- stand on steps of a lean-to or double ladder for more than one person;
- stand under the ladder, from which work is performed;
- put tools on the ladder and double ladder steps.

2.4 Safety measures when working using electric tools

Persons that have passed special training, workplace briefing, and have proper electrical safety qualification group are allowed to work with electric tools.

During mounting operations, it is necessary to use electric tools working under voltage not exceeding 380/220 V. Electric tool class must be chosen depending on the premises category in terms of shock hazard level.

A metal case of the electric tool operating under voltage exceeding 42 V AC and 110 V DC in highly hazardous premises, highly hazardous and external installations, must be earthed. The plug must be equipped with the earthing contact. Electric tools must be connected to the electric mains with earthing. Electric extension cords must have a pug and a socket with earthing contacts. Protective outfit (rubber gloves, overshoes) must be used when working with such tools. Protective outfit must be tested in compliance with the procedure established by the existing legislation.

2.4.1 Before you begin, do the following:

- check, if the supply set of parts is complete, and if the parts are attached in a reliable manner;
- visually inspect working condition of the cable (rope), its sheath and plug; integrity of insulating parts of the housing, handle and covers of brush holders; availability and working condition of bar covers; working condition of the ground circuit (between the housing and the earthing contact of the plug);
- check, if the switcher operates precisely;
- check idle operation of the electric tool. It is allowed to work only with serviceable, tested and sealed tools.

During work, electric cables must not be ruptured, bent, or laid in places, where structures and materials are stored or vehicle moves. When working in rainy (snowy) weather, the places where cables are laid and where electric tools are used must be equipped with sheds.

2.4.2 When working with electric tools, IT IS FORBIDDEN to:

- hold the electric tool cable;
- remove chips or grit particles from the cutting tool, and to replace the cutting tool before it is stopped completely. Fix the removable work tool using the tool designed for this purpose;
- connect the electric tool to the power mains with characteristics that don't correspond to those specified in the technical data sheet;
- carry the electric tool from one workplace to another one with the engine running;
- leave the unattended electric tool connected to the power mains, and the electric tool with electric motors running;
- leave unattended electric hand tool so that it can be used by unauthorized persons.

If the electric tool housing is heated, it is necessary to provide routine breaks. In case smell, smoke, loud noise or vibrations appear, it is necessary to immediately switch off the electric tool and correct the failures.

During work, it is necessary to ensure there is no immediate contact of the cable or wire used to supply power to the electric hand tool with metal objects, hot, wet surfaces or surfaces covered with oil in order to avoid electrical shock resulted from damaged insulation. Make sure places, in which cables are connected to pins of the electric hand tool, have no tension, and wires are not bent.

Electric wires (cables) must not cross electric welding cables, hoses feeding oxygen, acetylene and other gases.

2.5 Safety measures for electric installation work

electric installation work must be performed in compliance with Rules on Design of Power Electric Installations, together with meeting requirements of Consumer Power System Safety Standards.

3. GETTING READY FOR MOUNTING

3.1 Preparation of the aperture for roller shutter mounting

Please note that an important precondition of the cost-efficient mounting is high-quality treatment of the aperture frame designed for installation of the roller shutter. Exact aperture measurement specifying wall materials and thickness is of paramount importance.

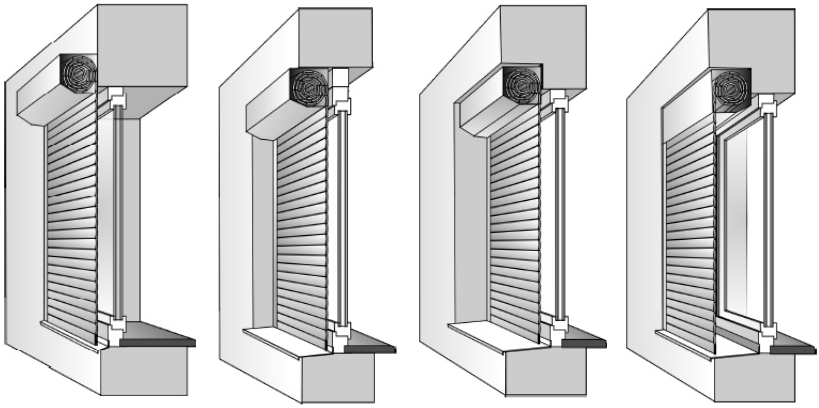
Treated apertures must meet the following requirements:

- apertures must be of rectangular form or any other form agreed by the customer and the contractor;
- surface of frame planes must be even, smooth and free of beads of finishing mortar and cracks;
- vertical and horizontal bias of working surfaces must not exceed 1.5 mm/m, and generally must not exceed 5 mm. the diagonal line difference must not exceed 5 mm. If the apertures treated by the customer have deviations from the specified requirements, the customer shall be obliged to eliminate the deviations or conclude an additional subcontractor agreement for such work.

4. PRODUCT MOUNTING

4.1 General principles

4.1.1 Main types of roller shutter mounting are shown below:

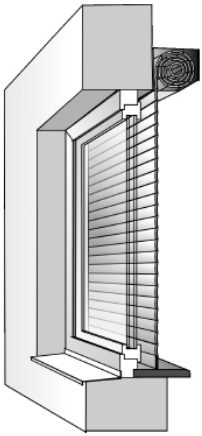


overlay outside mounting

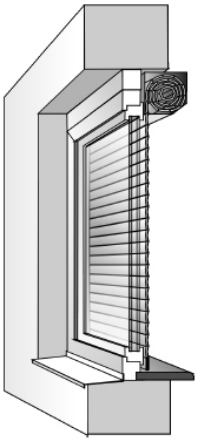
built-in outside mounting

combined mounting with the shutter box outside

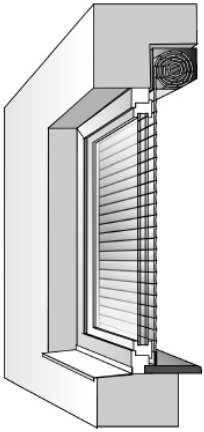
combined mounting with the shutter box inside



overlay mounting



built-in inside mounting



combined inside mounting

During mounting, it is necessary to adjust the vertical level of guide rails of the roller shutter and the horizontal level of the shutter box.

The roller shutter must be located symmetrically in relation to the aperture.

The shutter box and the guide rails must fit against the aperture frame throughout the length. Local clearances not exceeding 5 mm are allowed. Difference of diagonal line lengths measured at the end points of guide rails must not exceed 2 mm.

Before fastening, product components can be installed and adjusted with metal gaskets set up in the fastening point area. After product mounting, welds and clearances must be filled in with sealing materials.

Precision of the product installation during mounting is controlled with builder's level of US6-1 / US6-4 standard sizes of the first precision group (GOST 9416-83), and with 1 – 5 meters' tape rule of the second precision group (GOST 7502-89). It is allowed to use builder's levels and tape rules of other types provided their precision group is not lower than the specified one.

Roller shutters must be securely fixed to exclude potential threat to life and health of people. Product fastening points must ensure even distribution of forces impacting the product, and reliable flow of forces to the building structure components.

During mounting, it is necessary to ensure correct and even tightening of fasteners to avoid product misalignments and ensure proper product operability.

When fastening guide rails of roller shutters, maximum allowable distance of 500 mm between fasteners must not be exceeded, while the distance from the guide rail edge to the fastening point must not exceed 150 mm.

Fasteners are chosen depending on the load distribution, and strength of adjacent building units (brickwork, concrete, gas-silicate units, etc.). If expanding dowels are used, building units must withstand pressure of the released dowel.

It is forbidden to use wooden blank plugs, sealing foam, and silicone as fasteners.

If products are fastened with dowels, it is necessary to use long drills to avoid damaging the surface of roller shutter components with a drill holder. The drilled hole must be of the same size as or slightly smaller than the dowel diameter.

When filling in mounting welds and clearances, it is necessary to use sealants packed in tubes (silicone, polyurethane foam, acryl). When filling in certain welds and clearances larger than 3 mm, it is necessary to use finishing mortars (except for mounting unpainted aluminium guide rails) compatible with the material the aperture is made of and approved by the customer.

After hardening, sealants that extend above the planes of guide rails and the shutter box must be removed, and if necessary, final weld sealing must be performed. If polyurethane foam is used, make sure deformation of the shutter box components of the roller shutter has not occurred.

After mounting operations and the building façade finishing are completed, remove protective film from the shutter box of the roller shutter. Contaminated areas must be cleaned and wiped.

4.2 Standard (step-by-step) procedure of protective roller shutter mounting

on arrival to the mounting location, unpack the product and check the supply set. Every supply set must include: shutter box assembly – 1 unit; roller shutter curtain – 1 piece; guide rails – 2 pcs., listed of equipment – 1 set.

Check the quality of the aperture frame treatment.

Mark and drill 8-mm Ø holes in the guide rails through two walls. The lower and the upper holes must be made at the distance of 100...150 mm from the rail edges. Other holes must be located evenly along the length of the guide rail with 450...500 mm stroke (Fig. 1, 2) – overlay mounting, (Fig. 3, 4) – built-in mounting.

Note: if roller shutters are mounted on metal structures, holes drilled in the guide rails must have the diameter depending on the size of used screws and self-drilling screws.

In case of overlay mounting, counterdrill holes on the front surface of the guide rail for 11.8-mm Ø blank plugs (Fig. 5). In case of built-in mounting, counterdrill 11.8-mm Ø hole in the internal rail wall (Fig. 6).

Mark and drill 4.2-mm Ø holes in the front flanged edges of the end caps and the shutter box cover (two holes from each side of the shutter box) for the following installation of rivets (Fig. 7).

Mark and drill 8-mm Ø holes in the flanged edges of the end caps and the rear panel of the shutter box to attach the shutter box to the aperture frame:

- for overlay mounting – drill two holes in the rear flanged edge of each cover (Fig. 8);
- for built-in mounting – drill two holes in the upper flanged edge of each cover (Fig. 9);
- for combined mounting – drill two holes in the rear and upper flanged edges of each cover.

Note: if roller shutters are mounted on metal structures, holes drilled in the caps must have the diameter depending on the size of used screws and self-drilling screws.

Mark and drill a hole of the required size in the rear flanged edge of the end cap and the shutter box to lead the drive components (Fig. 10).

Note: tthis operation is performed for outside mounting to draw the motor cable, Cardan joint cable, rope or cord through the wall in case the hole has not been made when the shutter box of the roller shutter was assembled.

Cut the flanged edge of the rear panel of the shutter box in places, where guide rails adjoin (Fig. 11).

Note: this operation is performed for overlay mounting.

Assemble the case frame of the roller shutter (shutter box assembly with end caps and guide rails) (Fig. 12). If the guide rails have no bent flanged edge, install two entry guides in the caps (Fig. 13).

Install the case frame of the roller shutter at the mounting location:

- for overlay mounting – adjoin the case frame on the aperture frame (Fig. 14);
- for built-in and combined mounting – install the case frame in the aperture (Fig. 15).

The guide rails must be installed straight up; the shutter box must be installed horizontally, while the entire structure must be installed symmetrically to the aperture (Fig. 16).

Mark the location of the hole in the wall to draw the controls (Fig. 17, 18).

Note: this operation is performed for outside mounting.

Remove the case frame of the roller shutter from the mounting location (Fig. 19, 20).

Drill the hole in the wall to draw the controls (Fig. 21):

- 12-mm Ø hole – to draw the motor cable, the rope;
- 16-mm Ø hole – to draw the strap;
- 14-mm Ø hole – to draw the Cardan joint, the cord. Counterdrill 20-mm Ø hole for the required depth for the spigot of the Cardan joint.

Note: these operations are performed for outside mounting.

Install the safety spring or tube in the rope or cord outlet (Fig. 22).

If the roller shutter has the lower frame, make slots in the guide rails to install gates of the locking devices (Fig. 23 – 25). In other cases, slots are made locally after installing the roller shutter curtain.

Note: this operation is performed in roller shutters with the strap drive, the rope drive, the cord drive or assistance and push-up drive to prevent unauthorized lift of the roller shutter curtain.

Install the case frame of the roller shutter in the mounting location; before that, remove the protective film from the rear panel of the shutter box (Fig. 26, 27).

Drill holes to install 8-mm Ø dowels in the aperture frame according to the ready-made holes in rails and in the shutter box. To avoid damaging the roller shutter components with a drill holder, use extended drills or concrete bores (Fig. 29, 30).

If roller shutters are mounted on metal structures, drilled holes must have the diameter depending on the size of used screws and self-drilling screws.

Attach the case frame of the roller shutter with fasteners; use the builder's level to regularly control, if it is installed correctly (Fig. 28, 31).

Connect the motor cable with switcher terminals in accordance with the motor mounting instructions (the motor manufacturer's manual).

If necessary, the motor cable can be extended by soldering cable wires and extending cable. Soldering locations must be electrically isolated in a reliable manner.

Insert the strap, the cord or the rope in respective guides (Fig. 43, 45).

For outside mounting, the strap or the motor cable must be inserted through the hole in the wall. The cord or the rope, having been fastened, must be inserted in the safety elements and drawn through the wall.

- mark and drill 6-mm Ø holes to install dowels to fasten the guide for the strap or the guide for the rope, a clamp for the crank;
- mark and drill 8-mm Ø holes to install dowels to fasten the strap coiler or the rope coiler, the cord coiler, Cardan joint for the crank drive, the guide for the cord;
- mark and drill 6-mm Ø holes to install dowels to fasten the electrical switch, and the automation unit;
- install and fasten the drive controls (Fig. 32 – 45).

Note: if roller shutters are mounted on metal structures, drilled holes must have the diameter depending on the size of used screws and self-drilling screws.

For inside mounting:

- mark and drill 8-mm Ø holes to install dowels to fasten the strap coiler, the rope coiler, or the cord coiler;
- mark and drill 6-mm Ø holes to install dowels to fasten the electrical switch, the automation unit, a clamp for the crank;
- install and fasten the drive controls.

Note: a guide for the strap / rope / cord, Cardan joint of the crank drive must be installed in advance, when the shutter box of the roller shutter is assembled.

In case of built-in mounting of the roller shutter, the controls must be fastened to the guide rail with rivets or self-drilling screws.

Install the roller shutter curtain in the guide rail slots. The curtain must be inserted above the drive shaft from the side of the rear panel. To avoid damaging the curtain coating, it is necessary to wrap the drive shaft in the soft gasket materials (Fig. 46, 47).

Finally fix the strap / rope / cord at the drive pulley (Fig. 48). Rotate the shaft to reel the pulling component to the pulley. The reeling length must be enough for the curtain to be able to lift completely.

Assemble the roller shutter curtain with pulling components (retainer springs or latch locks (Fig. 49, 54).

Attach the pulling components to the drive shaft:

- retainer springs must be inserted in linear perforated openings of the shaft (Fig. 52);

  Note: retainer springs are installed and number of lamels is selected so that their impact could throw the roller shutter curtain to the rear wall of the shutter box; in case of unauthorized lift attempt, the roller shutter curtain would thrust against the upper part of the shutter box.

- latch lock axles must be installed in the locating holes of key lock rings that must be fixed against the stop. Ring position must be fixed with self-drilling screws. Do not drill the shaft!

Screw in the self-drilling screw in the radial hole of the key lock ring against stop to the shaft wall (Fig. 55, 56).

Note: if the crank drive is used, pulling components must be fixed after defining the maximum end position of the stopper of the reduction gear when the curtain is moving down.

Install the stoppers limiting height, for which the curtain can be lifted; before that, drill the through holes in the end slat profile of the curtain. Holes must be drilled at the distance of 50 – 100 mm of the guide rails (Fig. 58, 59).

Note: this operation should not be performed, if the roller shutter configuration includes electric motor without NHK.

If the roller shutter configuration includes assistance and push-up mechanism, the following operations must be performed after installing the curtain in the guides:

- install retainer springs (Fig. 49);
- perform pretensioning of the assistance and push-up mechanism spring by rotating the drive shaft towards spring tightening direction (clockwise if you look from the right cover). Number of shaft turns must correspond to the one specified in the technical catalog (Fig. 50);
- fix the spring with the bracket (Fig. 51);
- insert retainer springs in linear perforated openings of the shaft (Fig. 52);
- remove the bracket fixing the assistance and push-up mechanism spring (Fig. 53). Keeping the curtain with hand, check assistance and push-up mechanism operation (Fig. 57). The curtain must roll up completely; the curtain travel must be smooth. If necessary, adjust the assistance and push-up mechanism tension;
- install the stoppers limiting the height, for which the curtain can be lifted.

4.3 Product tuning, run-up and testing

If the electric motor is used, connect it to the power mains, and adjust the position of the limit switches. These operations must be performed following the electric motor manufacturer's manual.

If the electric motor with additional manual control (with the so called "manual emergency lift system", NHK) is used, it is necessary to perform two manual cycles of curtain lifting and lowering before connecting the electric motor to the power mains.

Check the operating condition of the roller shutter.

The operating condition of the roller shutter must be checked by performing ten cycles of curtain lifting and lowering with fixed stop of the roller shutter curtain in each of the following positions: the top position, the intermediate position (the roller shutter is opened halfway), and the bottom position.

Check operation of the locking devices of the roller shutter.

After checking, install the shutter box cover in the shutter box slot and fasten it with rivets (Fig. 60, 61).

To enhance protective properties of the roller shutter, splines of screw and bolt screw heads used to fasten the guide rails must be counterdrilled after mounting to prevent unauthorized unscrewing (Fig. 62).

If self-drilling screws featuring high hardness are used, splines must be filled in with silicone sealant (Fig. 63).

Working apertures are closed with fancy plugs (Fig. 64).

After the mounting operations are completed, fill in mounting clearances.

Clean contaminated areas of the product with soft rags. If necessary, use neutral detergents (Fig. 65).

4.4 Commissioning of the mounted product

4.4.1 The mounted product is accepted by the Customer in the following order:

- a representative of the Company that has mounted the product demonstrates complete functional performance of the roller shutter;
- "Certificate of Mounting" section of the product certificate is filled in, including:
  - product commissioning date;
  - signature of a person in charge of the product mounting (with print full name);
  - details (name, address, telephone number) of the Company that has performed product mounting;
  - stamp of the Company that has performed product mounting.

4.4.2 The Certificate of Mounting is signed by the customer and is sealed by the Customer's stamp, if any.

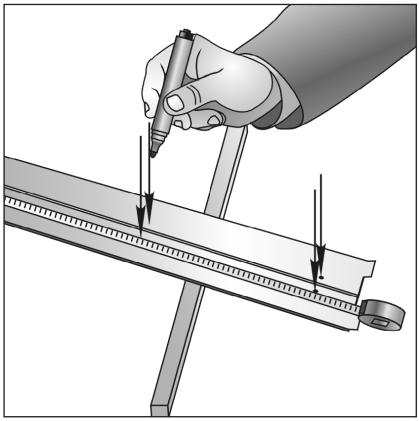


Fig. 1

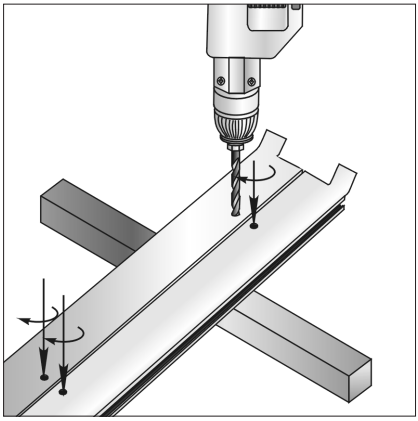


Fig. 2

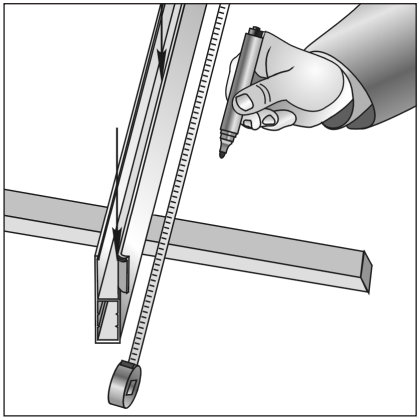


Fig. 3

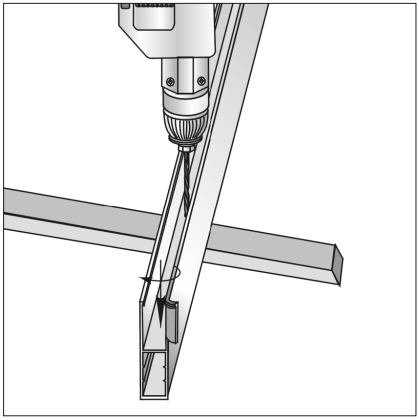


Fig. 4

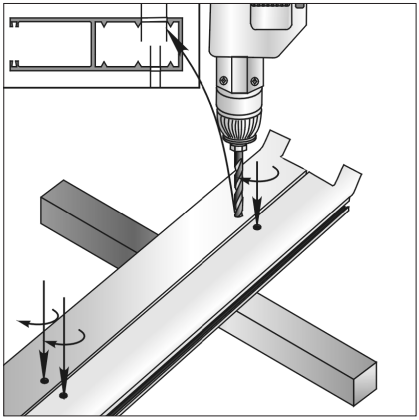


Fig. 5

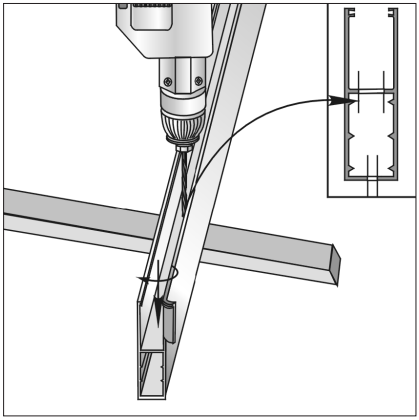
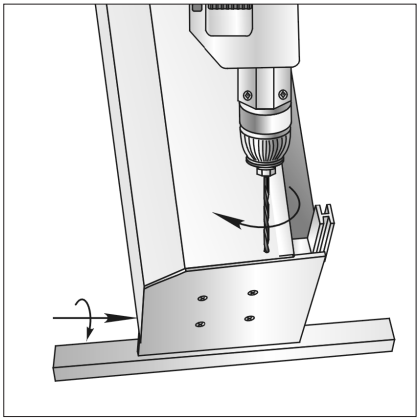


Fig. 6



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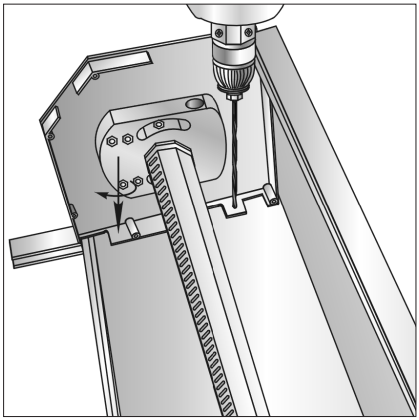

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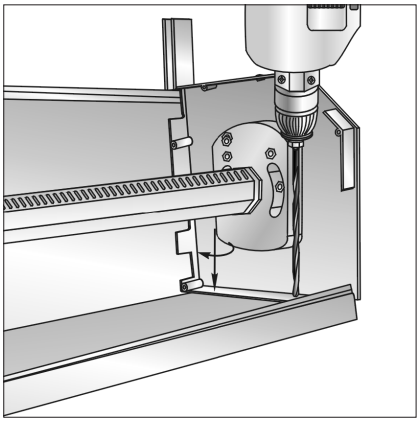

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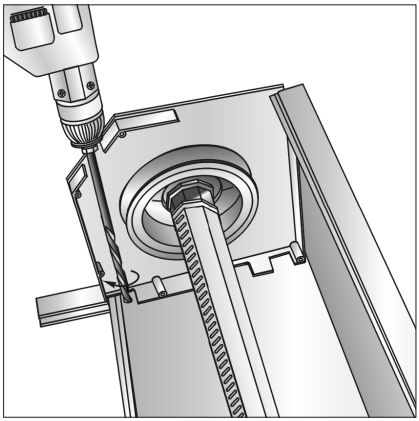

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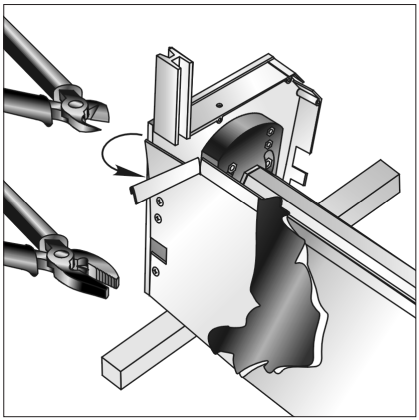

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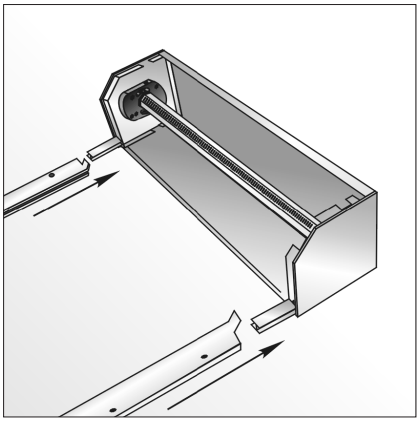

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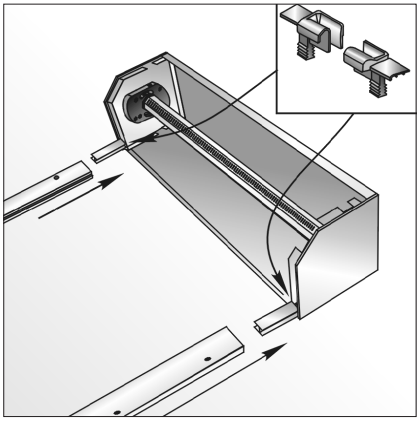

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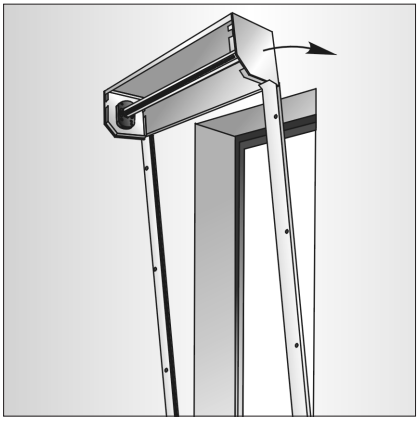
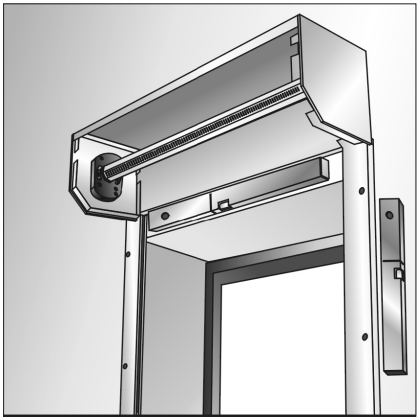


Fig. 14

Fig. 15



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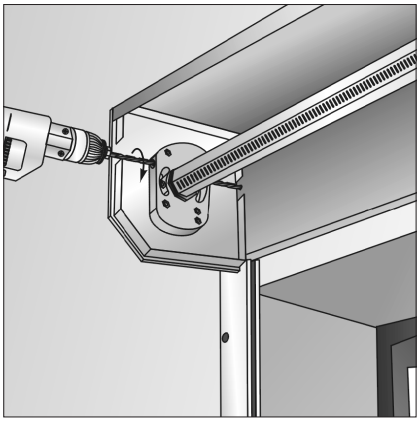

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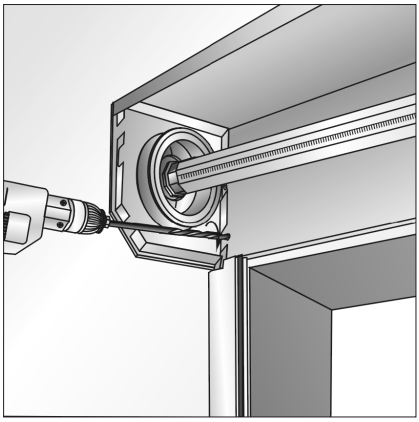

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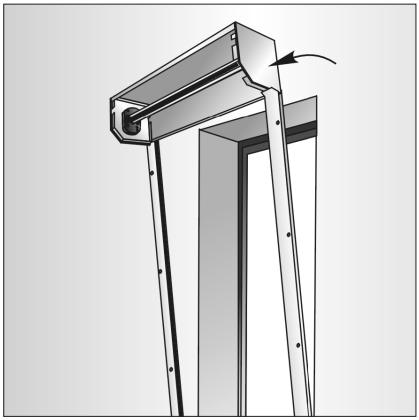

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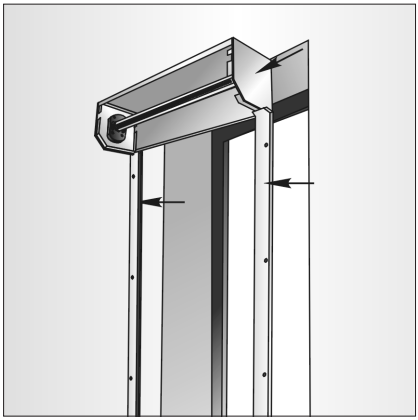

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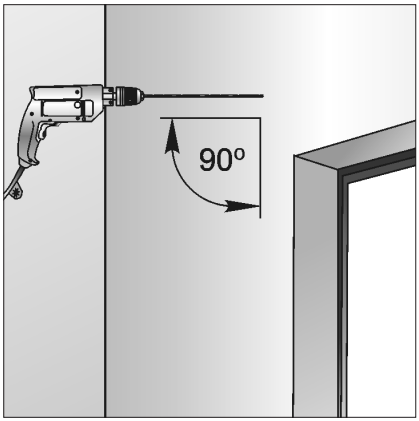

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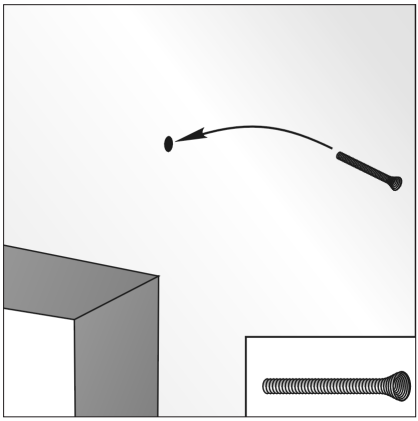

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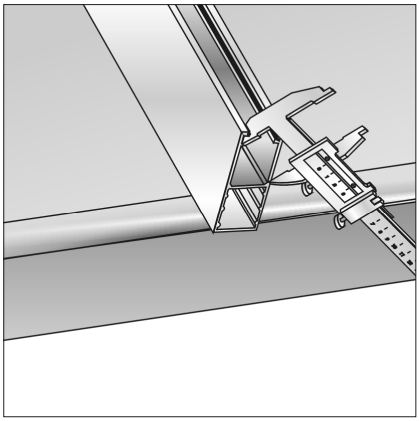

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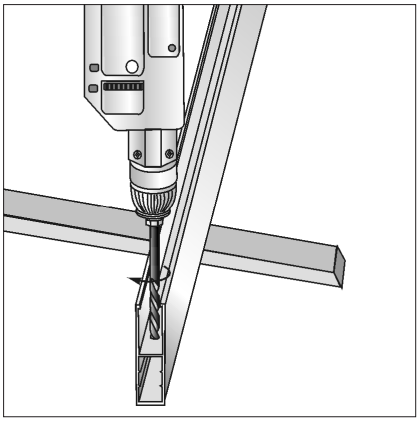

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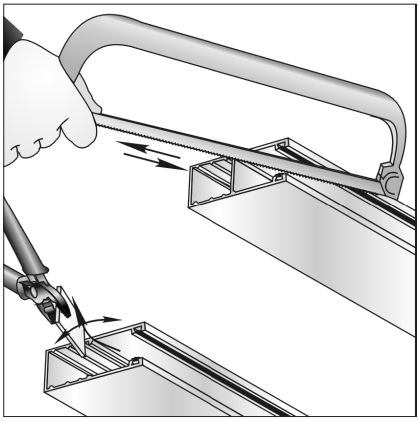

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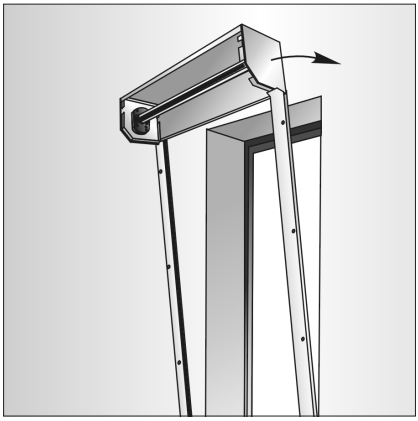

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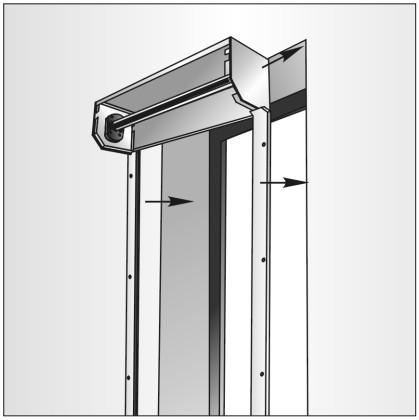

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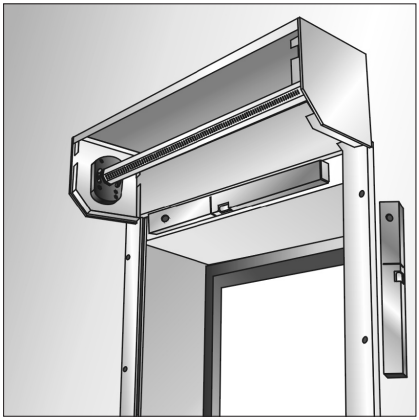

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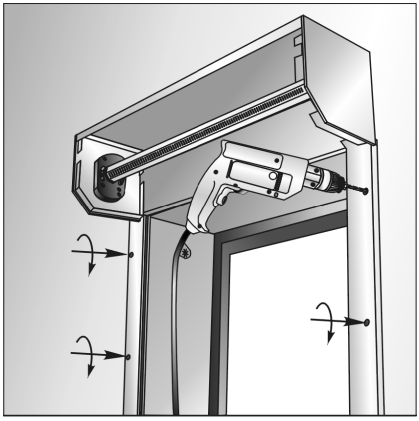

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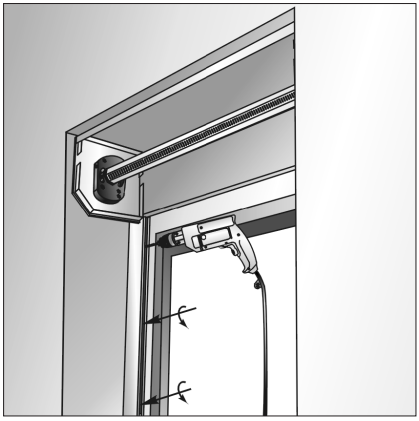

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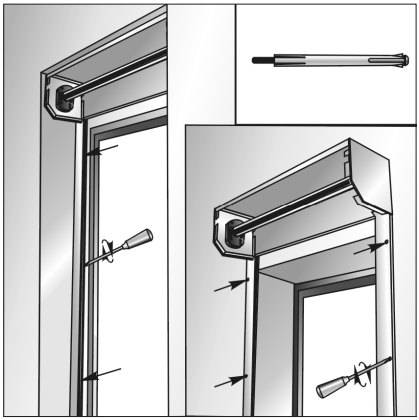

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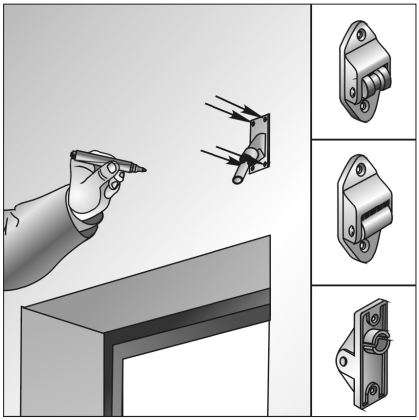

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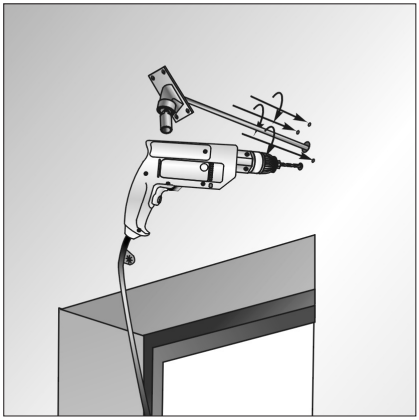

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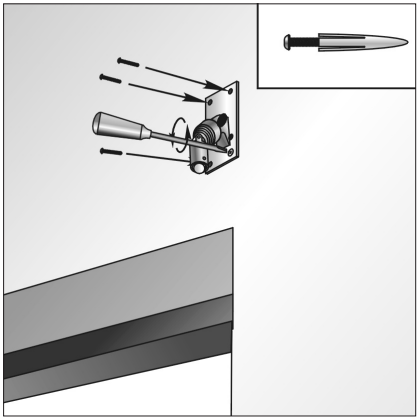

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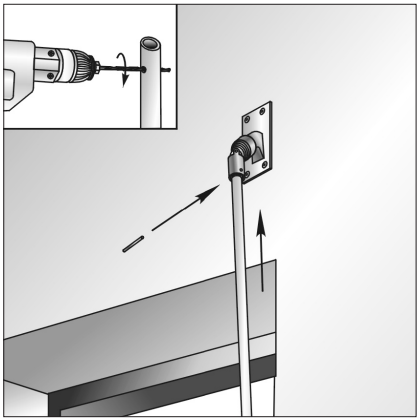

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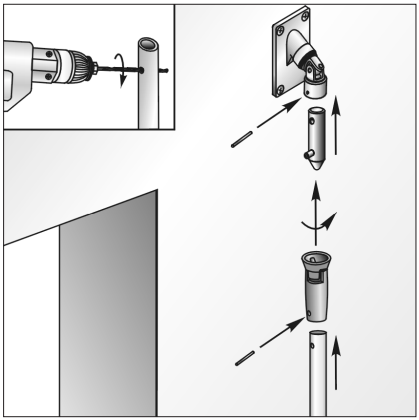

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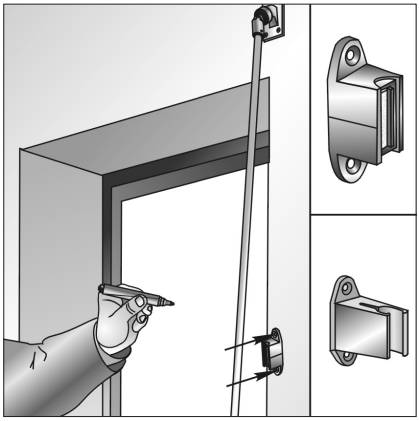

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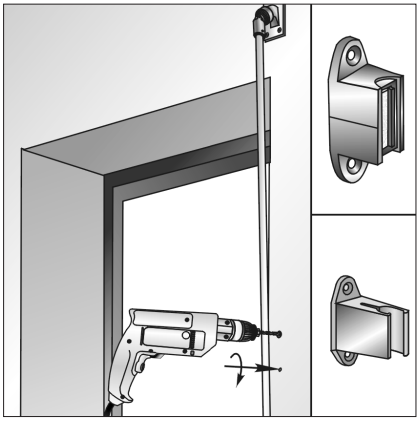

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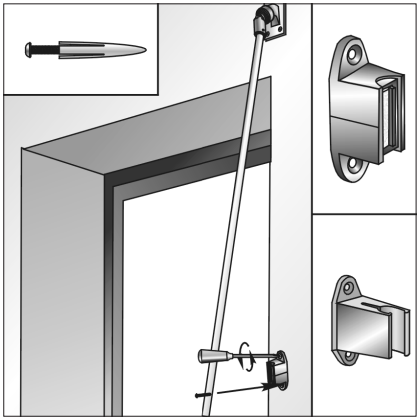

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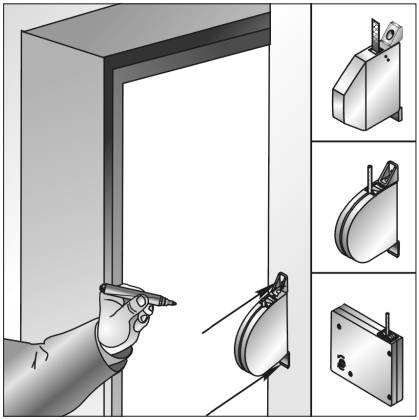

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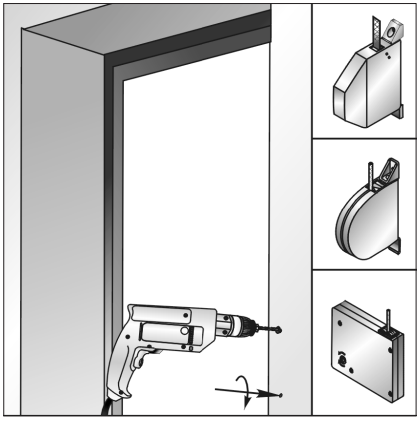

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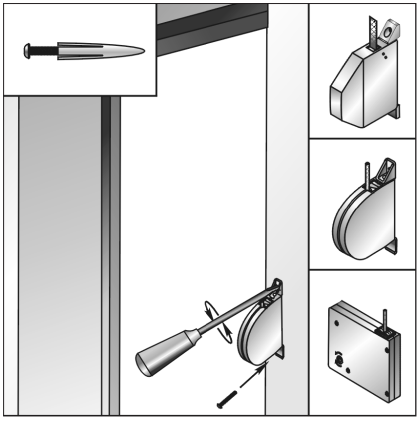

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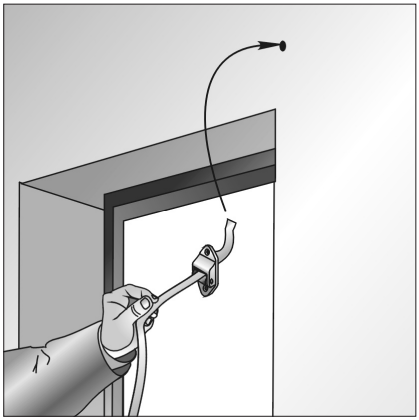

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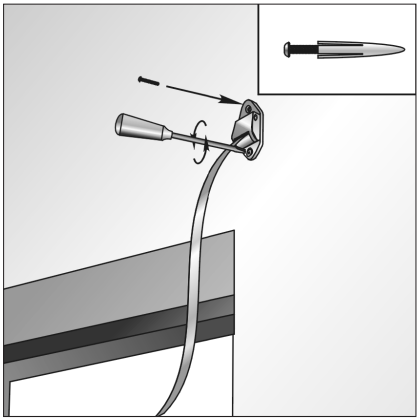

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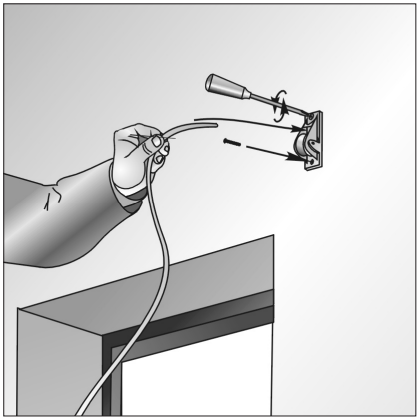

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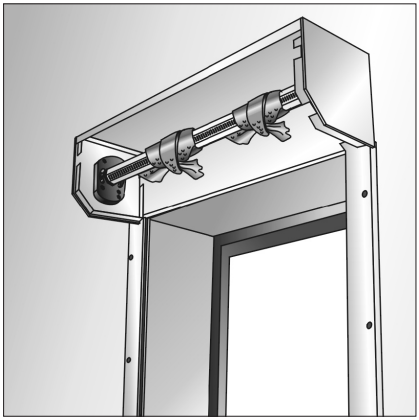

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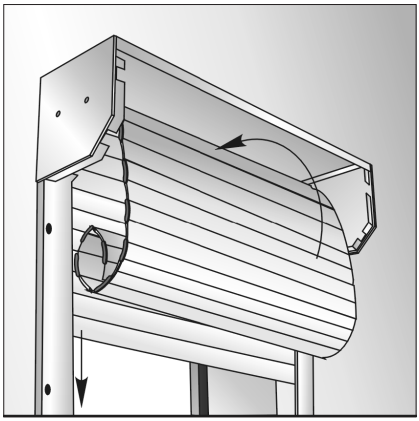

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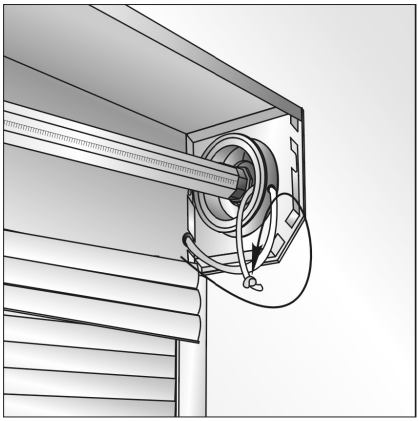

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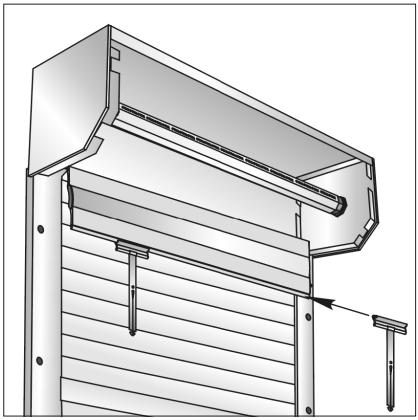

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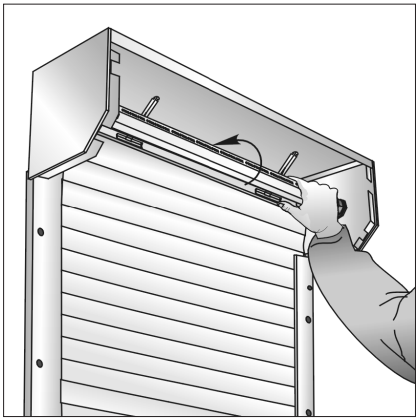

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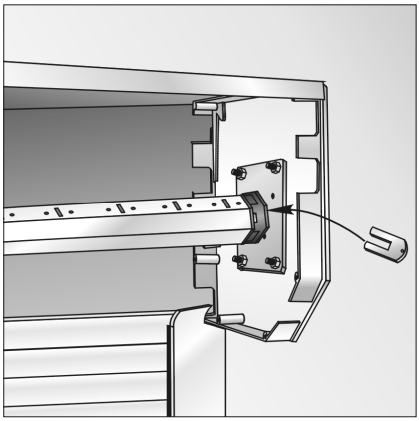

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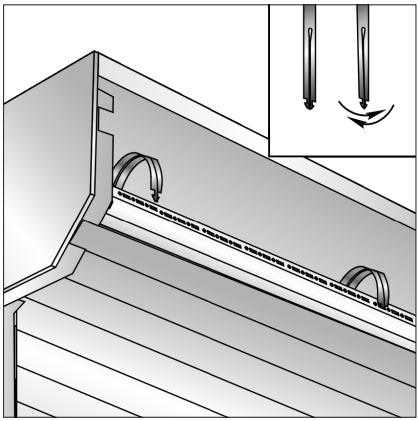

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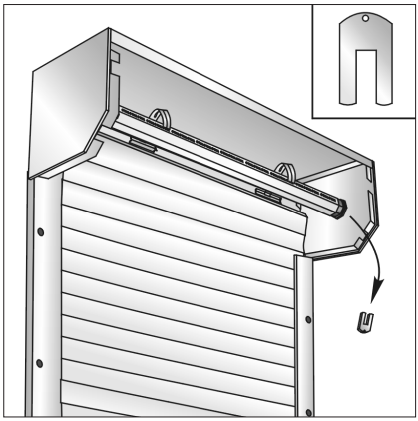

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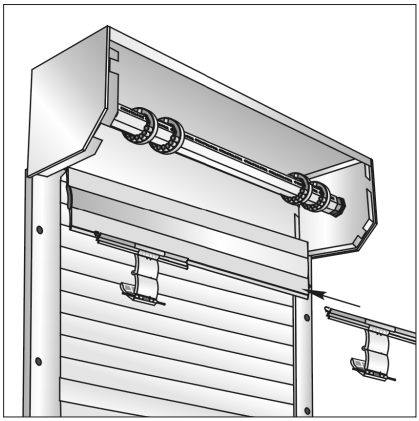

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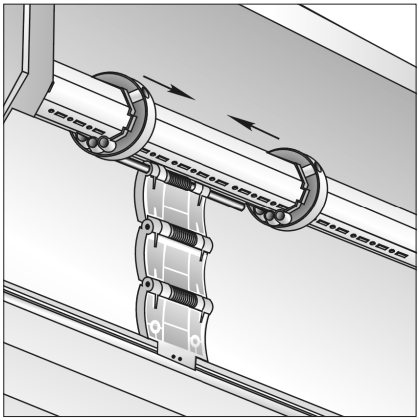

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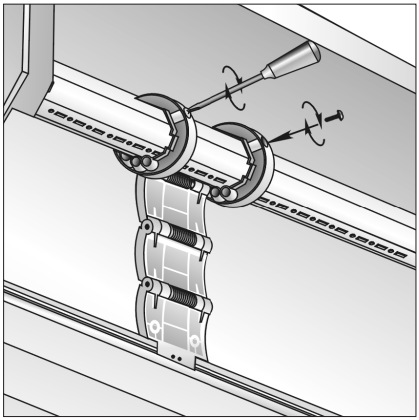

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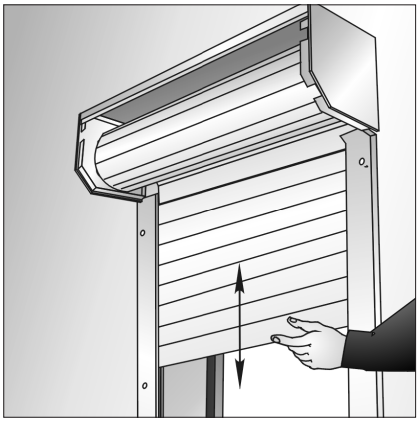

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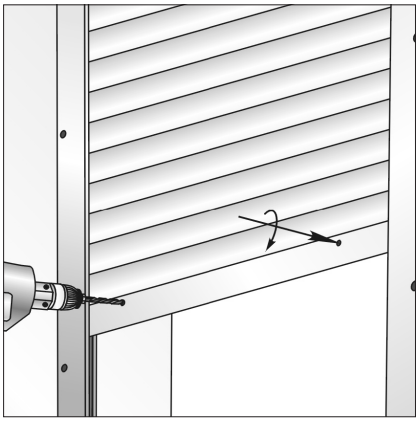

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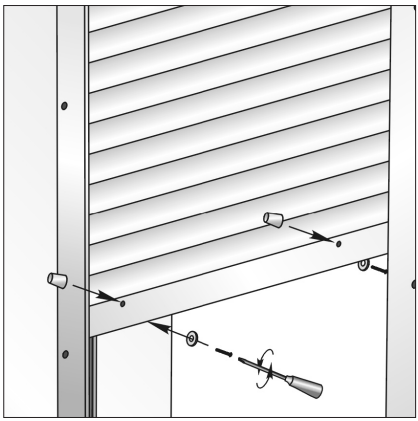

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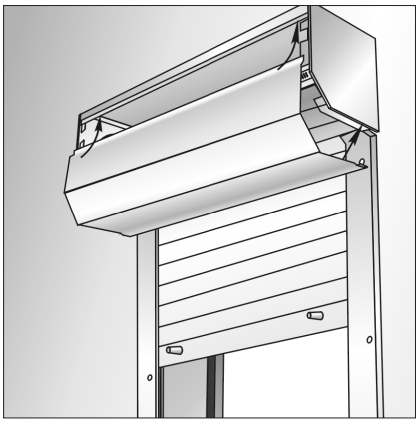

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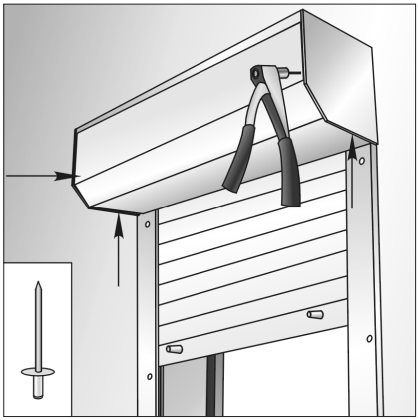

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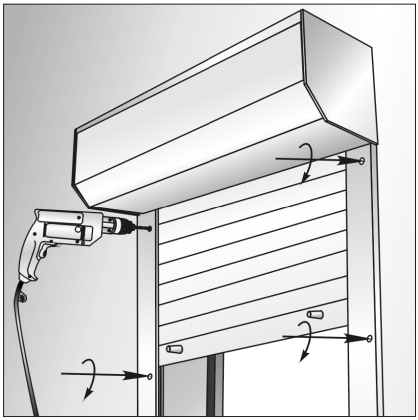
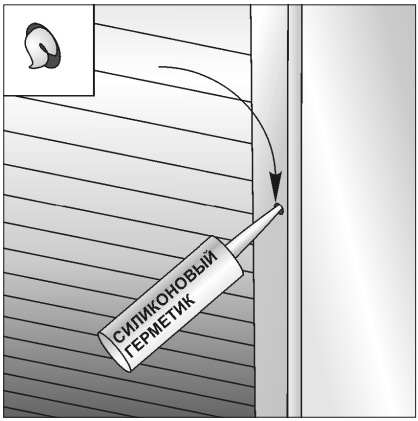


Fig. 62



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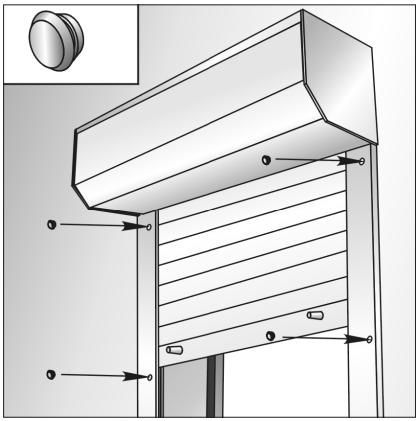

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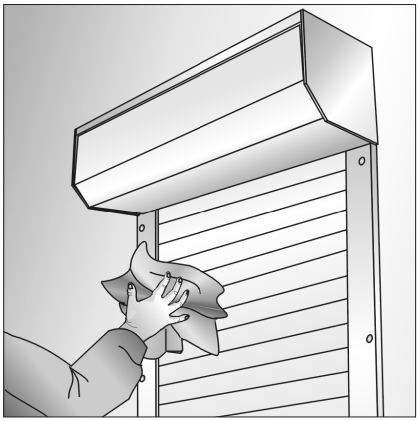

Fig. 65

Fig. 66

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