

Service Instruction

Single-Column Pantograph Disconnectors

for Outdoor Installation

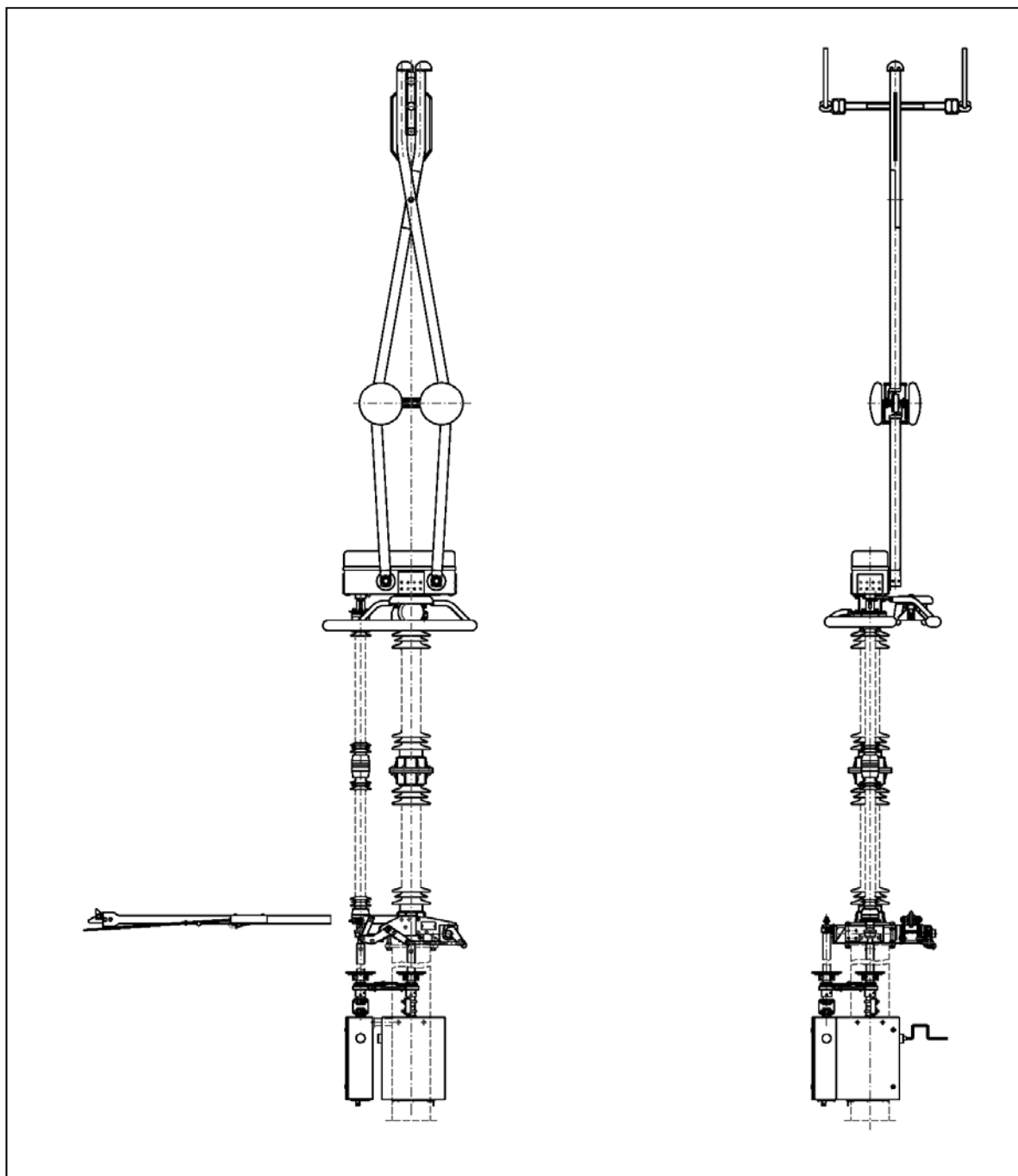
Type TFB

Additionally with Built-on Earthing Switch

Nr.
1HPL 500 655 ver. B -En

Rated Voltages
Rated Normal Current

420 kV
3150 and 4000 A



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1 General Remarks

Practical experience has shown, that strict adherence to the recommendation of this instruction manual will ensure the best possible safe performance of the equipment.

In an instruction manual it is not possible to cover every possible eventuality that might occur when using technical apparatus. It is therefore requested that all incidences, in particular those for which the instruction manual provides no plausible explanation, be reported to us directly or through our local representatives.

These instructions are based on the present technical design. We reserve the right to make any technical changes.

We cannot accept any responsibility for any damage resulting directly from incorrect handling or operation, irrespective of whether specific reference is to be found in the instructions for erection and operation or not.

With respect to this document we reserve all rights also in the event of a patent being issued and registration being made under other commercial rights. Misuse, in particular copying and handing over to third parties is prohibited and offenders can be prosecuted under civil and criminal law.

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2 Application

In open position disconnectors serve for metallic isolation of systems and form a visible isolating distance. They are designed for no-load switching and able to disconnect low charging currents. In combination with the special suspended contact for breaking commutation currents the single-column pantograph disconnector type TFB is suitable for interrupting commutation currents up to 1600 A at commutation voltages up to 330 V.

The pantograph disconnectors type TFB are designed for outdoor installation according to the Publications :

IEC 62 271-102; 2003,

IEC 62 271-1; 2007

Each disconnector pole can be equipped with an earthing switch for earthing and short-circuiting disconnected plant sections, if required.

Single-column pantograph disconnectors are appropriate for outdoor installations with conductors arranged at two different levels, one above the other. They permit modern installation design and require only a small ground space. A three-pole disconnector group consists of three identical and interchangeable disconnector poles.

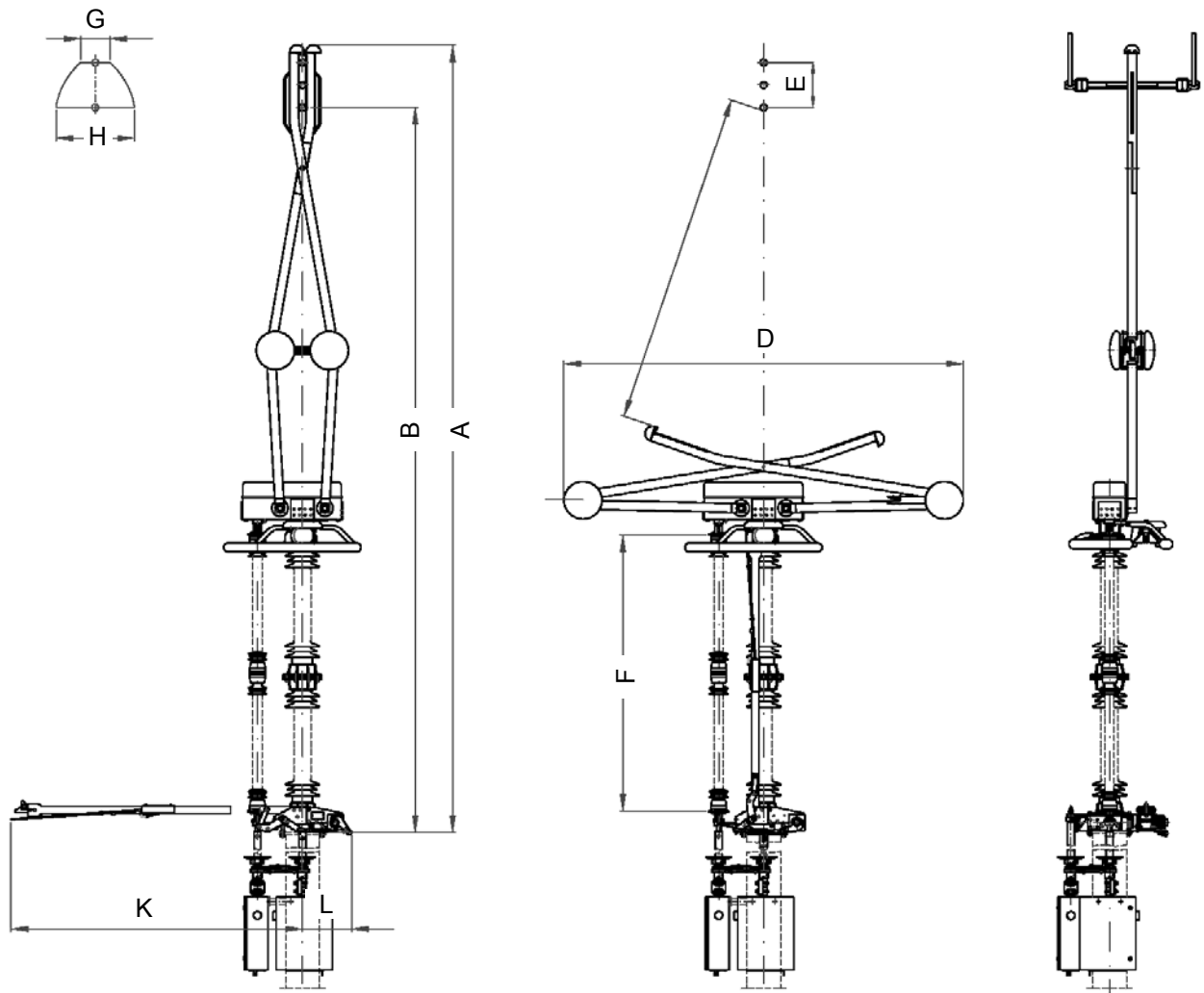
Each disconnector pole can be equipped with an earthing switch for earthing and short-circuiting disconnected plant sections, if required.

3 Technical Data

List of Types and Technical Data 420 kV

Disconnecter type: Build in earthing switch type:		TFB 420 TEB
Rated voltage	KV	420
Rated normal current	A	3150
type pc	A	4000
type q		
Rated peak withstand current for disconnecter and earthing switch	KA(pea k)	100-125-160
Rated short-time current 1 s for disconnecter and earthing switch	kA(rms)	40-50-63
Rated 1 min power-frequency withstand voltage 50Hz		
to earth and between poles	kV(rms)	520
across the isolating distance	kV(rms)	610
Rated lightning impulse withstand voltage 1,2/50 μ s		
to earth and between poles	kV(pea k)	1425
across the isolating distance	kV(pea k)	1425(+240)*
Rated switching impulse withstand voltage 250/2500 μ s		
to earth		1050
across the isolating distance	kV(pea k)	900(+345)*
Discharge inception voltage	kV(pea k)	>270
Radio interference voltage at 156 kV		<2500
Three-phase breaking capacity inductive, capacitive	kV μ V	1
Failing load of support insulator		6,0-8,0-10-12,5
Admissible mechanical terminal load***	A	
static and dynamic	kN	4,2-5,6-7,0-8,75
static portion		1,5-2,0-2,5-3,15
In combination with special suspended contact: (see Section 4.5)	kN kN	
Breaking commutation currents at commutation voltages \leq 330 V	A	1600

3.1 Main Dimensions and Weights



Main Dimensions

			TFB420
A	Height of disconnector (CLOSED)	mm	7910
B	Distance to suspended contact	mm	7350
C	Minimum isolating distance	mm	2950
D	Width of disconnector (OPEN)	mm	3560
E	Catching range	mm	400
F	Height of insulator	mm	3350
G	Envelope, top	mm	260
H	Envelope, bottom	mm	840
K	Earthing switch (OPEN)	mm	2980
L	Earthing switch counterpoise (OPEN)	mm	1030
Weights			
Disconnecter, three-pole group ¹⁾ ²⁾		kg	2000
Built-on earthing switch, three-pole group ¹⁾		kg	440

¹⁾ including operating mechanisms

²⁾ including insulators of standard design

4 Design

4.1 Disconnecter and Earthing Switch

The stable base frame 221 or 222 (in case of built-on earthing switch) is the carrying constructional element of the disconnecter. It is mounted to the foundation 1 by means of four stud bolts 13 and supports the insulator column 201 with the top intermediate piece 223, gear box 224 with the pantograph 225 as well as the pivot bearing 227 with the rotary insulator 200 and (if available) the built-on earthing switch 228 with its pivot bearing 229.

The pantograph 225 is a welded aluminium construction and together with the cast aluminium gear box 224 forms a mechanical unit. The construction guarantees the highest possible degree of mechanical stability and reliable current transfer especially in the case of the load involved in a short circuit. Bolt connections are intentionally avoided so that operating reliability is not impaired with time by bolts working loose or by corrosion in the joint. A counterbalance spring 235 is mounted in the gear box 224 for balancing the weight of the pantograph. Current is transferred in the pantograph joints and gear box by way of tapered roller contacts which are totally enclosed and protected against atmospheric influences.

The gear box is closed on all sides; thus, the installed components are protected against atmospheric influences, contamination and animals (e.g. birds, snakes) and their nests. Flat terminals 17 according to German standard DIN 46203 are provided on all 4 sides offering universal connection possibilities. Terminals according to NEMA or other standards are available, too, if required. The entire transmission system has a simple mechanical design. All gear box and pantograph bearings are permanently lubricated and thus maintenance-free.

Disconnecters for high short-circuit currents are equipped with a damper 268 (Figs. 1, 25). This damper is mounted between the pantograph joints and dampen the vibrations in the pantograph caused by the short-circuit current.

The top intermediate piece 223 is arranged between the support insulator 201 and the gear box 224 with the pantograph 225. An additionally support 320 - installed between insulator 201 and top intermediate piece 223 - can be used as mounting point for the bottom conductor; the cables or tubes can run laterally past the switch in one piece. This possibility of meeting the particular installation requirements helps to reduce the number of structural elements and thus the mounting work involved.

The suspended contact 226 or 301 is situated above the disconnecter on the overhead line and is grasped, when the pantograph is in closed position, with a high pressure, by a scissors action.

Readjustment of the nuts of the stud bolts 13 enables easy and exact adjustment of the disconnecter and/or compensation of foundation and inaccuracies caused by tensile forces.

The optionally available two-motion earthing switch 228 with its pivot bearing 229 is attached to the disconnecter frame 222.

Disconnecters for voltage 420 kV are equipped with **two-motion earthing switch type ASB**. When in closed position, the earthing blade 23 at the top of tubular contact arm lies between the contact fingers of the earthing contact 18, which is mounted on the intermediate piece 223.

4.2 Operating Mechanisms

The operating mechanisms are fastened laterally below the base frame at the foundation within easy reach. The pivot bearing 227 or 229 and the operating mechanism are connected by operating shaft 43. The disconnecters and earthing switches can be operated by way of manual or motor-operated mechanisms.

4.3 Pilot Switches

The pilot switches are attached directly within the operating mechanism concerned. The mechanical control of the pilot switches by means of the operating mechanism is designed in a way that the control signal is given only after the operating mechanism has passed through the dead center position and interlocking of the disconnecter or earthing switch has occurred.

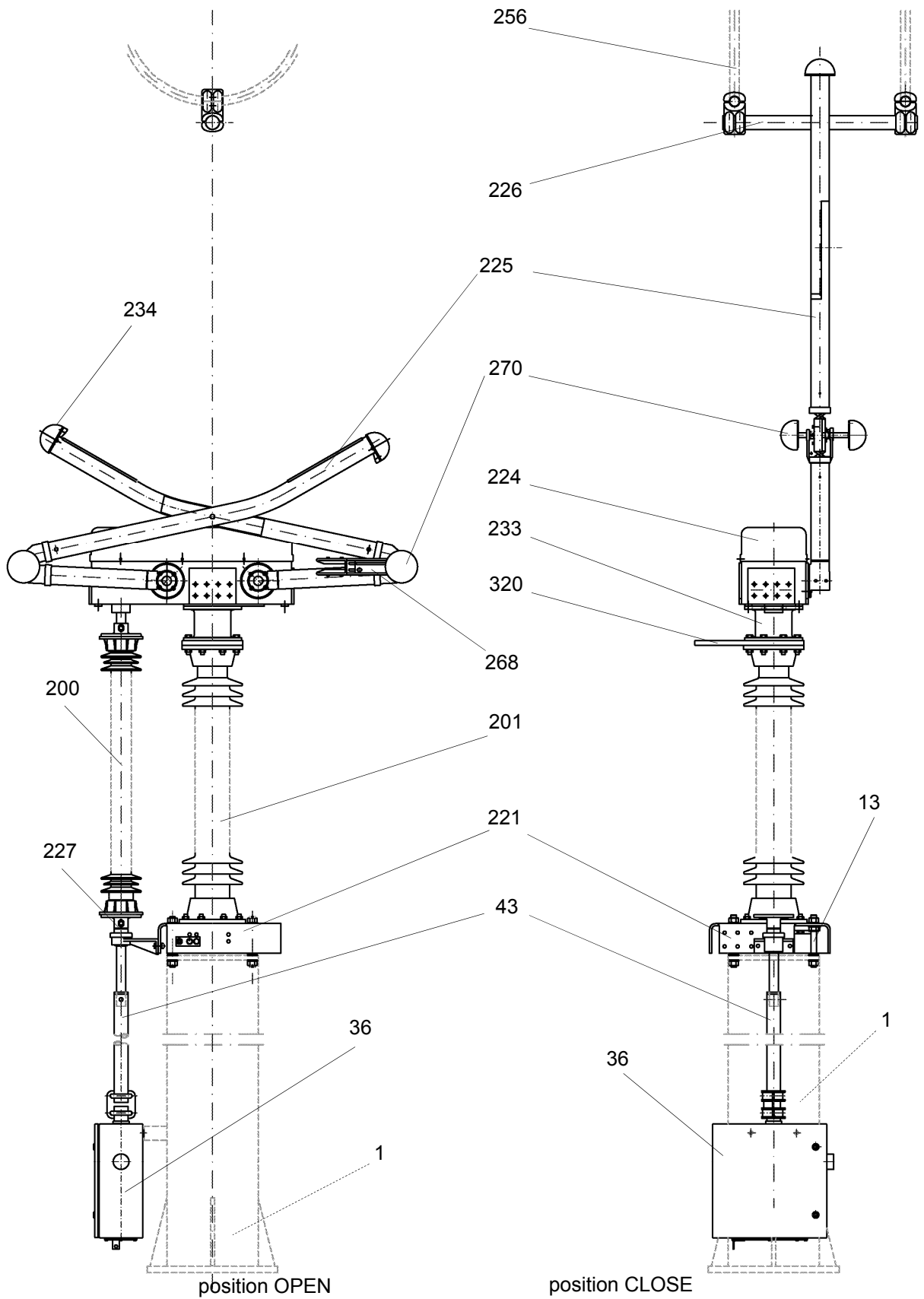


Figure 1 Pole of pantograph disconnector

4.4 Interlocking of Disconnecter with Earthing Switch

The disconnecter and earthing switch with manual operating mechanism can be interlocked with each other at the client's request so that it is only possible to operate the earthing switch with the disconnecter in open position and the disconnecter with the earthing switch in open position.

If required, manual operating mechanisms can be equipped with a blocking magnet which, when de-energized, makes any actuation of the operating mechanism impossible. In this case electrical interlocking of the manual operating mechanisms with each other is possible.

For disconnectors with motor-operated mechanism and earthing switches with manual operating mechanism, mechanic interlocking can also be provided for the earthing switch, whereas the operating mechanism of the disconnecter must be interlocked electrically

5 Mode of Operation

Each pole of the disconnectors and earthing switches is actuated by a separate operating mechanism.

5.1 Disconnecter

The energy is transmitted from operating mechanism to gear box 224 (Figs. 9, 10) via operating shaft 43, pivot bearing 227 on the base frame, rotary insulator 200 and coupling flange 230. The rotary movement is transmitted in the gear box 224 by operating lever 266 and operating rod 244 to the levers mounted together with the pantograph arms on a common shaft 267. A spring 235 is installed in the gear box 224 to counterbalance the weight of the pantograph.

The operating lever 266 in the gear box travels through a dead centre position during making and breaking before reaching its final position thus preventing the pantograph arms of the disconnecter from opening and closing automatically (e.g. due to breakage of the rotary insulator or to vibrations caused by an earthquake).

The contact strips 236 on the pantograph arms travel through a wide reach during making so that the suspended contact is reliably gripped even if its position changes considerably under the influence of adverse weather conditions. In the closed position, the contact strips 236 rest against the suspended contact with a high pressure. The high contact pressure does not only assure reliable current but also serves to reduce contact wear. The forces acting on the contacts due to the scissor action when making and breaking the disconnecter are concentrated on a single point so that even thick layers of ice can be easily broken and removed. The design of the disconnecter prevents formation of an ice block between the pantograph and gear box.

Disconnectors for high short-circuit currents are equipped with a damper 268 (Figs. 1, 25). This damper is mounted between the pantograph joints and dampen the vibrations in the pantograph caused by the short-circuit current.

5.2 Earthing Switch

The design of the operating linkage of the earthing switch is such that a dead center position is passed through shortly before the respective end position is reached. Thus, automatic opening or closing of the units is avoided.

The energy is transmitted from operating mechanism to earthing switch shaft 73 via operating shaft 43, operating lever 76, operating rod 71 and earthing switch operating lever 19. The tubular contact arm 23 swings upwards when the switch is closed. In the end position, earthing blade 88 is inserted upwards into earthing contact 18 where it is held in place.

When in closed position, the earthing blade 23 at the top of tubular contact arm lies between the contact fingers of the earthing contact, which is mounted on the intermediate piece 18.

6 Transportation and Storage

Disconnecters are delivered, on pallets, in single assemblies which have to be mounted at site. The following transportation assemblies are delivered:

1. Base frame 221 complete with stud bolts 13 or
in the case of built-on earthing switch:
Base frame 222 with built-on earthing switch complete with stud bolts 13
(however without tubular contact arm 23 and without counterpoise 92).
2. Gear box 224 with pantograph 225
3. Support insulator 201
4. Rotary insulator 200
5. Top intermediate piece 223, possibly with built-on earthing contact 18 and with built-on corona protection ring 216.
6. Corona protection fittings 231,
7. Support 320 for busbar carrier
8. Coupling flange 230
9. Suspended contact 226 or special suspended contact for switching commutation currents 301, together with clamps for stranded contactor or tube connection according to client's order
10. Operating mechanism 36 for disconnector
11. Operating shaft 43
12. Tubular contact arm 23
13. Mechanical interlocking (as loose items)
14. Small parts

As soon as the equipment arrives at the place of destination the parts should be checked for completeness. Furthermore, an inspection for damage in transit should be carried out to find out the extent of damage, the cause of damage and, if necessary, its originator. The damage report, if any, should immediately be sent to the appropriate forwarding agency to be passed on to the transportation insurance company.

The disconnector and earthing switch components and the operating mechanisms should be stored in normal mounting position to prevent damage due to ingress of water. Storage and installation should be done in a way suitable to prevent excessive contamination and any damage to the zinc coat. For this reason, the individual groups should be left on the transport pallets until installation is started.

To maintain corrosion protection provided by the special packing as long as possible the operating mechanisms should be left in this packing until installation is started.

In dry climate the duration for transportation and storage of the operating mechanisms must not exceed 6 months without heater. For longer times of storage or if there is danger of moisture condensation the heater has to be connected unless precautions were taken by appropriate packing or storage to prevent moisture condensation.

The bags with desiccative are to be removed prior to commissioning of the heater.

7 Installation

7.1 General

The disconnectors are delivered in assemblies. Since the pantograph and gear box form a unit and all mechanical adjustments have already been carried out in the factory, installation is limited to mounting of the assemblies and connection of the high-voltage leads as well as the electric connections leading to the operating mechanism.

For installation, it is advisable to use a crane or some other hoisting gear with a carrying capacity of 500 kg for TFB disconnectors ≤ 300 kV and of 1000 kg for disconnectors ≥ 362 kV. All disconnector units can readily be installed by fitting and bolting, pinning, sawing and drilling. To ensure proper installation of the disconnector poles with respect to the earthing switches, operating mechanisms and suspended contacts, the dimension drawings listed in the works orders for the respective disconnector design are required in addition to these installation instructions:

The interior parts of the operating mechanisms (e. g. pilot switches, contactors etc.) are not resistant to the atmospheric conditions prevailing out of doors; therefore, care must be taken to ensure that these parts are not exposed to humidity during installation.

With motor-operated mechanisms adjustment or manual test operations are to be carried out using the emergency crank 39 only. Do not use a power drill for this purpose.

Care has to be taken that each disconnector is properly earthed.

In any case the heaters in the operating mechanisms must be connected and commissioned immediately, even if the associated disconnectors and earthing switches have not been commissioned yet. The bags with desiccative are to be removed prior to commissioning the heating.

7.2 Designations on Rating Plates

7.2.1 Designations of Disconnectors and Earthing Switches

5xx xxxx 1 xxxx	order number and production order
yy	group number (01 do 99)
z	pole designation (for three-pole groups: a, b, c)

For example: serial number 506 920 1 1099 04 c:

Pole **c** of pantograph disconnector group, group No. **04**, order No. **506920 1 1099**.

7.2.2 Designations of Operating Mechanisms

Allocation of operating mechanisms to the individual disconnectors or earthing switches can be seen from the serial number (see rating plate of operating mechanism).

5xx xxxx 1 xxxx	order number and production order
rr	group number (01 to 99)
ss	designation of disconnector or earthing switch:
	AT for disconnector
	AE for earthing switch

For example: serial number 506920 1 1099 04 AE:

Operating mechanism number 04 for a built-on earthing switch of pantograph disconnector, order No. **506920 1 1099**.

7.3 Installation of the Disconnector

Each gear box bears a serial number on the pantograph side (machined surface, left-hand side, see Figure 7). When assembling the disconnecter, make sure that the gear boxes are matched with the corresponding frames bearing the same serial number (see nameplate).

- 7.3.1. Check the tubular steel supports (also foundations, structures) in the horizontal and vertical positions. If necessary, align with the aid of a spirit level, using adjusting screws, if any (starting position for final adjustment of the pantograph disconnecter as described in Section 7.4.12).
- 7.3.2. Make sure that all contact surfaces are bright, so as to ensure reliable earthing. Slightly grease all flange surfaces.
- 7.3.3. Mount frame 221 or 222 on the tubular steel support. Dimension $a = 140 \pm 5$ mm and the horizontal position of the frame plate can be adjusted by means of the 4 stud bolts 13.
- 7.3.4. Attach mounting bracket 233 to the gear box, using 8 screws M 12 x 25. In the open position, the pantograph must be secured against closing by means of locking screw 247. The loosely delivered corona protection fittings 270 are to be installed onto the shafts of the pantograph (screws are factory-mounted onto the shafts). Then the pantograph with gear box can be lifted with the crane, after the transportation angles 326 on the gear box are removed.
- 7.3.5. Attach intermediate piece 223 to the gear box. In the case of disconnectors with built-on earthing switch, clean contact surfaces 64 between intermediate piece and gearbox in accordance with the treatment instructions of Section 11. Make sure that earthing contact 18 is in the proper position (see Figure 7).
- 7.3.6. Loosen the counter nut 300 of locking screw 247. Turn out the screw by such an amount that carrier pin 248 can be removed. After removing the carrier pin, slide coupling flange 230 on to the gear shaft and re-install the carrier pin. Lock the disconnecter in position OPEN by turning in locking screw 247 and tightening the check nut.
- 7.3.7. Screw intermediate plate 320 or (in the absence of an intermediate plate) distance plate 320a with support insulator 201 (or the top insulator section) and - only for 362, 420 and 525 kV - corona protection fittings 231 to top intermediate piece 223. On disconnectors with earthing switch, the two corona protection fittings have different sizes. Screw the top insulator section of rotary insulator 200 to coupling flange 230. Now lift the complete assembly with the crane and attach the lower insulator sections.
- 7.3.8. Attach the insulator column to frame 221, 222. Bolt bottom fitting of rotary insulator to pivot bearing 227, using mounting material 462. Detach mounting bracket 233.
- 7.3.9. Install operating mechanism in accordance with Section 7.7.
- 7.3.10. Loosen the counter nut 300 of locking screw 247, turn out the screw by such an amount that no thread protrudes from the nut, then tighten counter nut.
- 7.3.11. Install suspended contact 226 or special suspended contact for switching commutation currents 301 as described in Section 7.5.

Please not that pantograph can be closing with installed suspended contact.

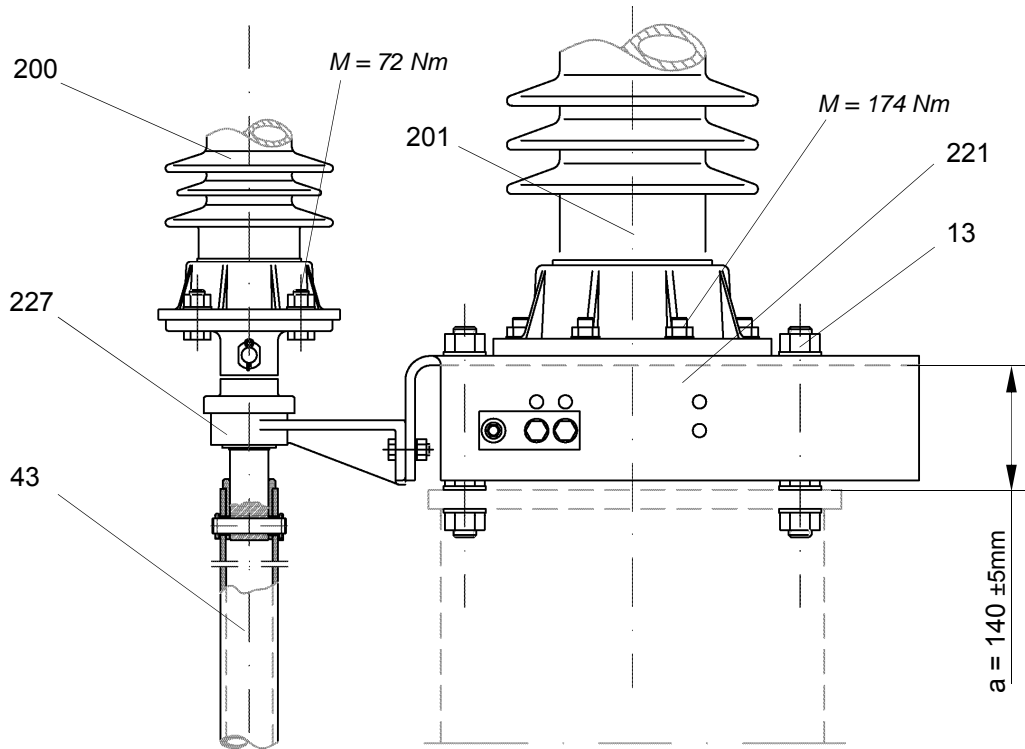


Figure 2 Mounting of base frame with insulators onto supporting structure.

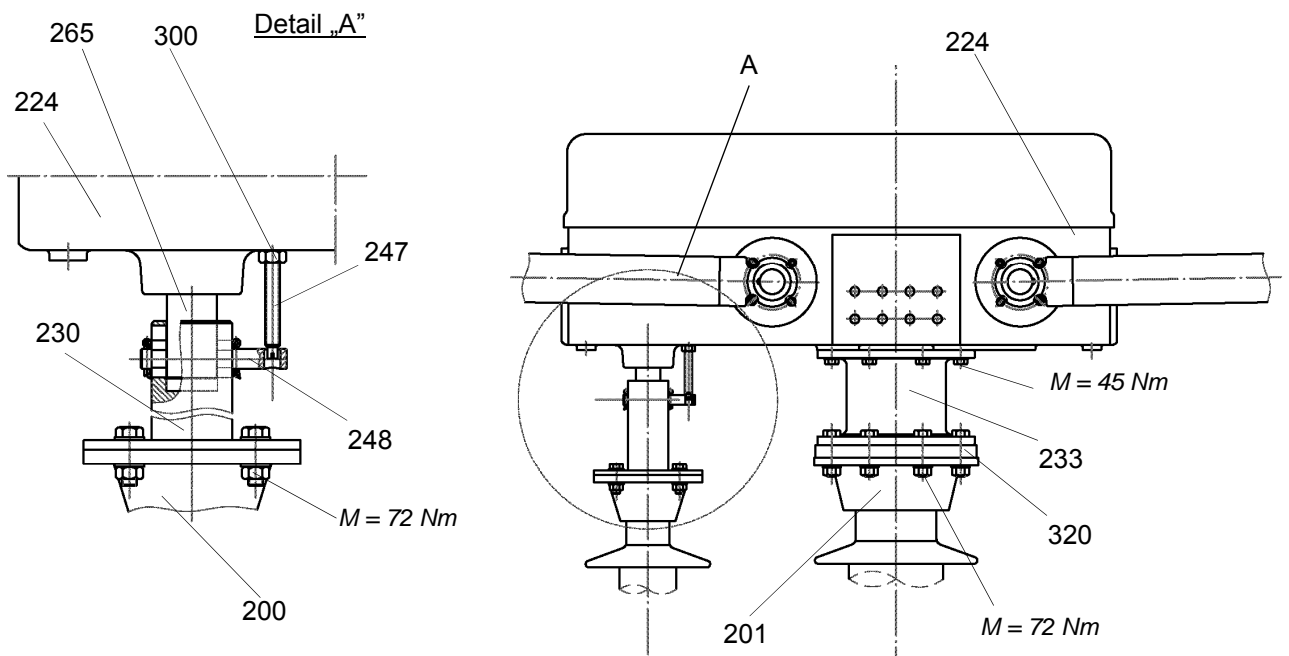


Figure 3 Installation of gearbox, top intermediate piece and insulators. Connecting of collar 320 and rotary insulator

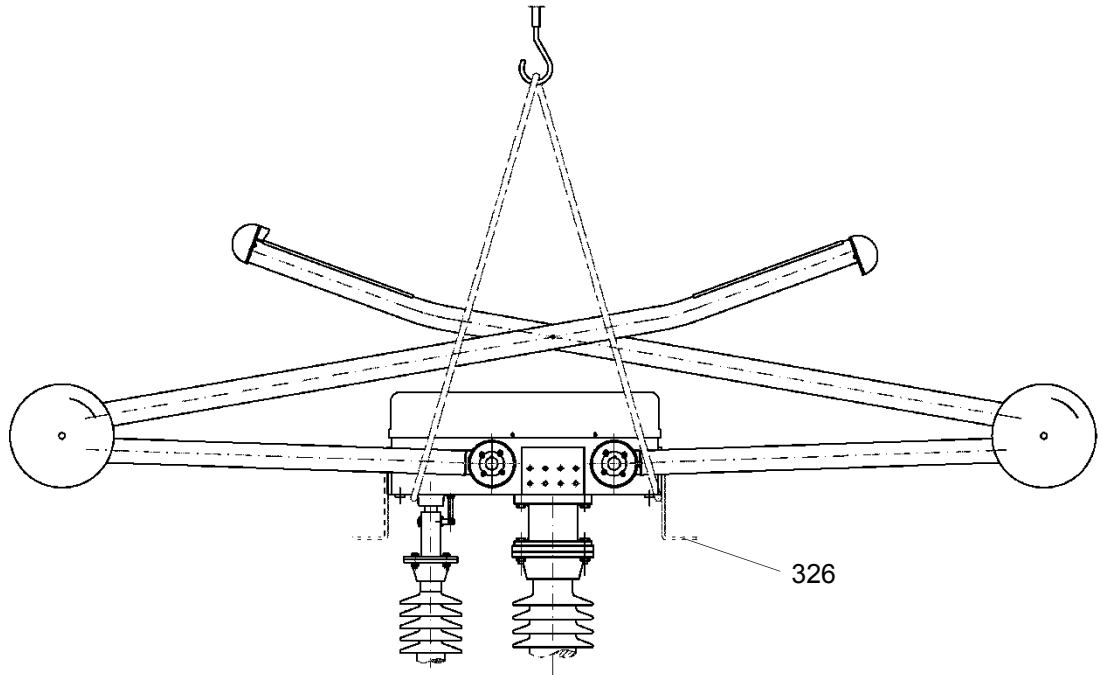


Figure 4 Lifting of pantograph.

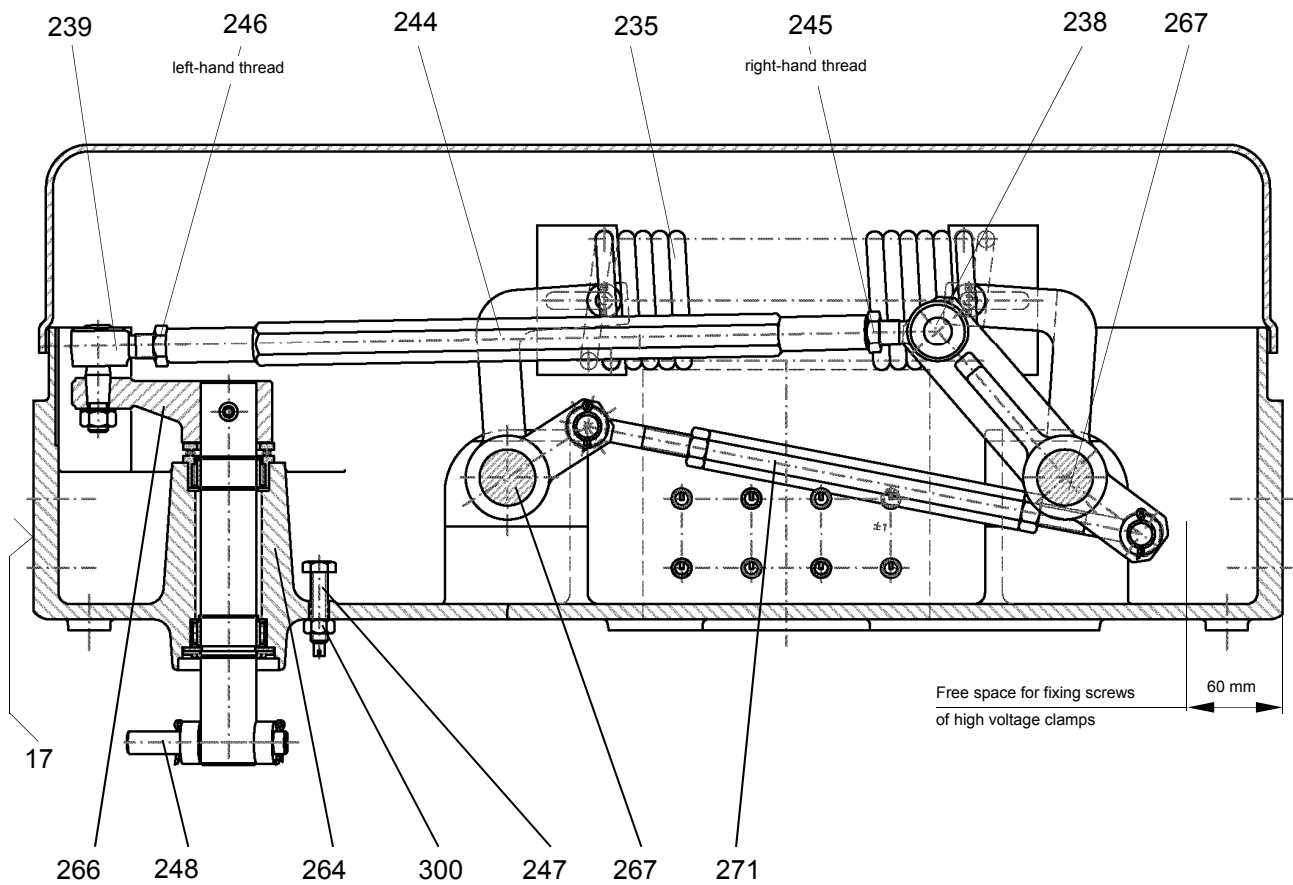


Figure 5 Gear box 224, sectional drawing: side view (switching position CLOSED)

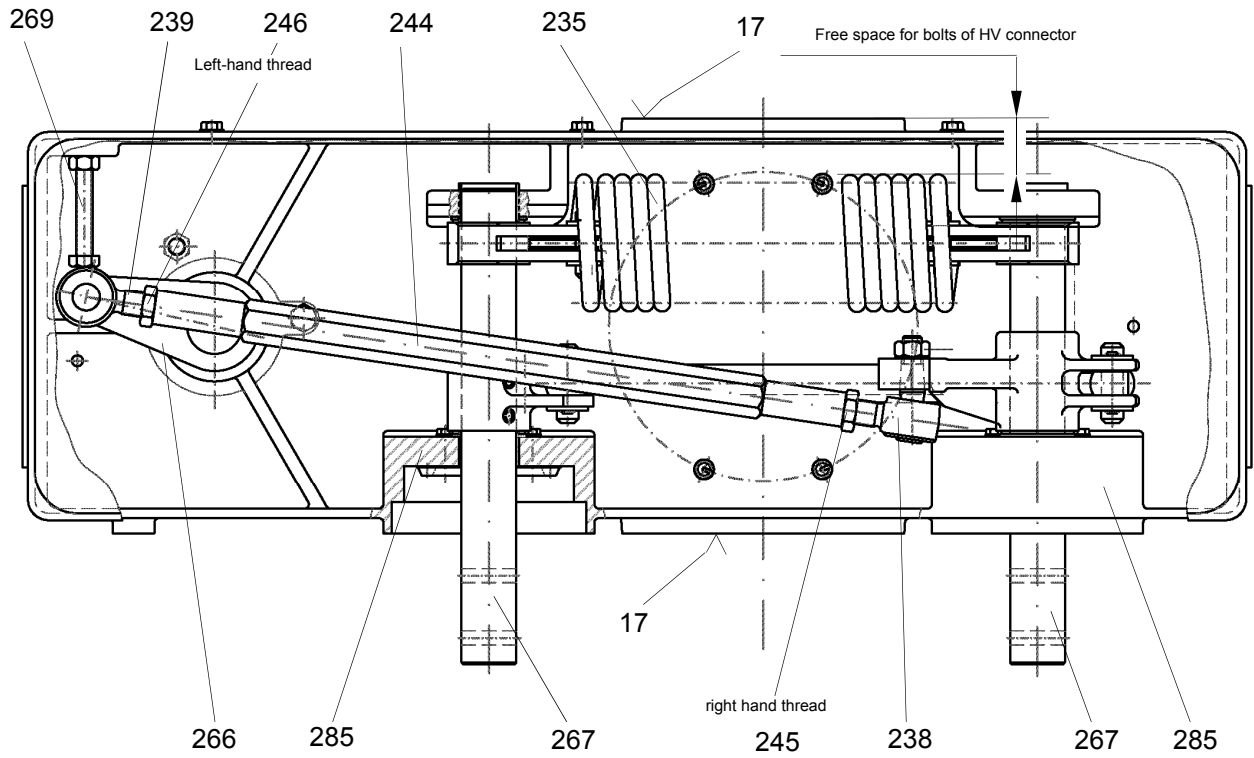


Figure 6 Gear box 224, sectional drawing: plan view (switching position CLOSED)

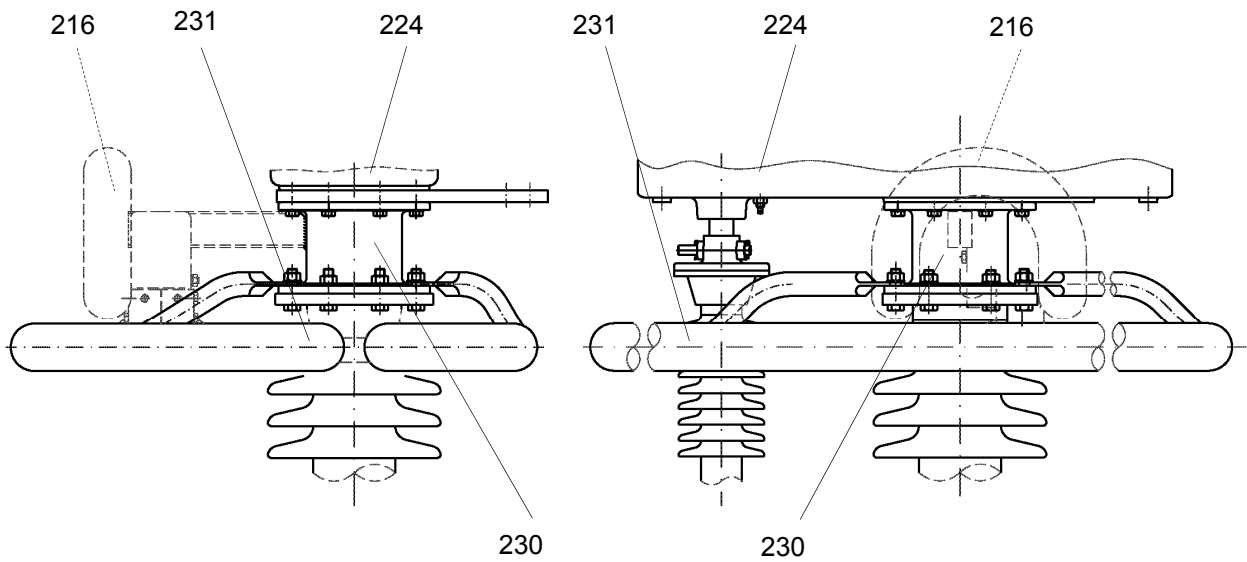


Figure 7 Installation of corona protection fittings

- 7.3.12. Adjust the centre position of the pantograph with respect to the suspended contact by means of the 4 stud bolts 13, taking care that the suspended contact touches the contact strips 236 on both sides at the same time. If contact is not made simultaneously on both sides (pantograph is not properly aligned with the suspended contact), align the pantograph by means of stud bolts 13, so that contact touch between the contact strips 236 and contact tube 237, or auxiliary contact bars 303, takes place simultaneously on both sides. With the pantograph in CLOSED position, the pantograph's centre line must be in true alignment with the suspended contact.
- 7.3.13. Bolt cable clamps to the high-tension terminals 17 on gear box. Prior to this, clean aluminium surfaces in accordance with the treatment instructions of Section 11.
- 7.3.14. After closing the disconnecter, check and, if necessary, correct the vertical adjustment of the pantograph.
- 7.3.15. The damping caoutchouc 291 of the damper 268 (Figure 25) and the stop 292 (made of caoutchouc) at the impact plate 355 (Figure 26) must not be painted or treated with a solvent or a paint thinner!
- 7.3.16. On disconnectors subject to icing, grease the pantograph tubes 242 and contact strips 236 (see Figure 8), and the suspended contacts (over their entire length between the clamps) all around with Mobil 28 Grease; thickness of grease layer: approx. 3 to 4 mm. In the case of suspended commutation contacts, the auxiliary contact bars 303 shall also be greased all around their circumference and over their entire length.
- 7.3.17. Care has to be taken that each disconnecter is properly earthed.

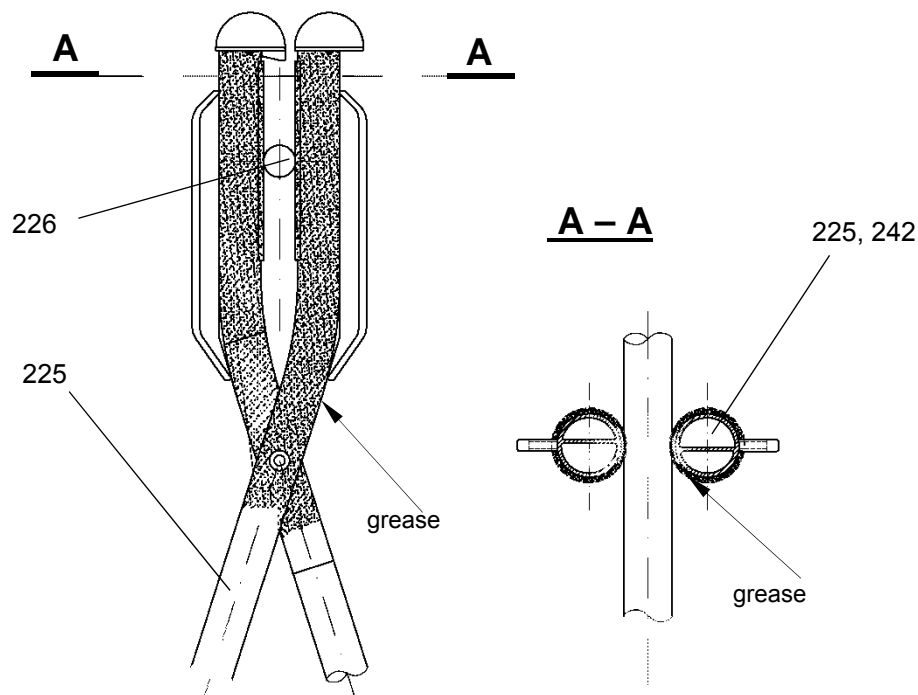


Figure 8 Treatment of pantograph for ice breaking capability

7.4 Installation of Suspended Contact

The suspended contacts are designed for connection to the line through rods or stranded conductors, depending on the layout of the installation. The design may differ significantly from one application to another. The specifications listed below refer to the configurations shown in the relevant Figures 9; 10;.

Standard design

The factory's scope of supply includes the suspended contact 226, consisting of the silver-faced contact tube 391 with two aluminium contact clamps 392 with clamping covers (factory-mounted) and corona protection fittings 393.

Special version with AgCdO inlay

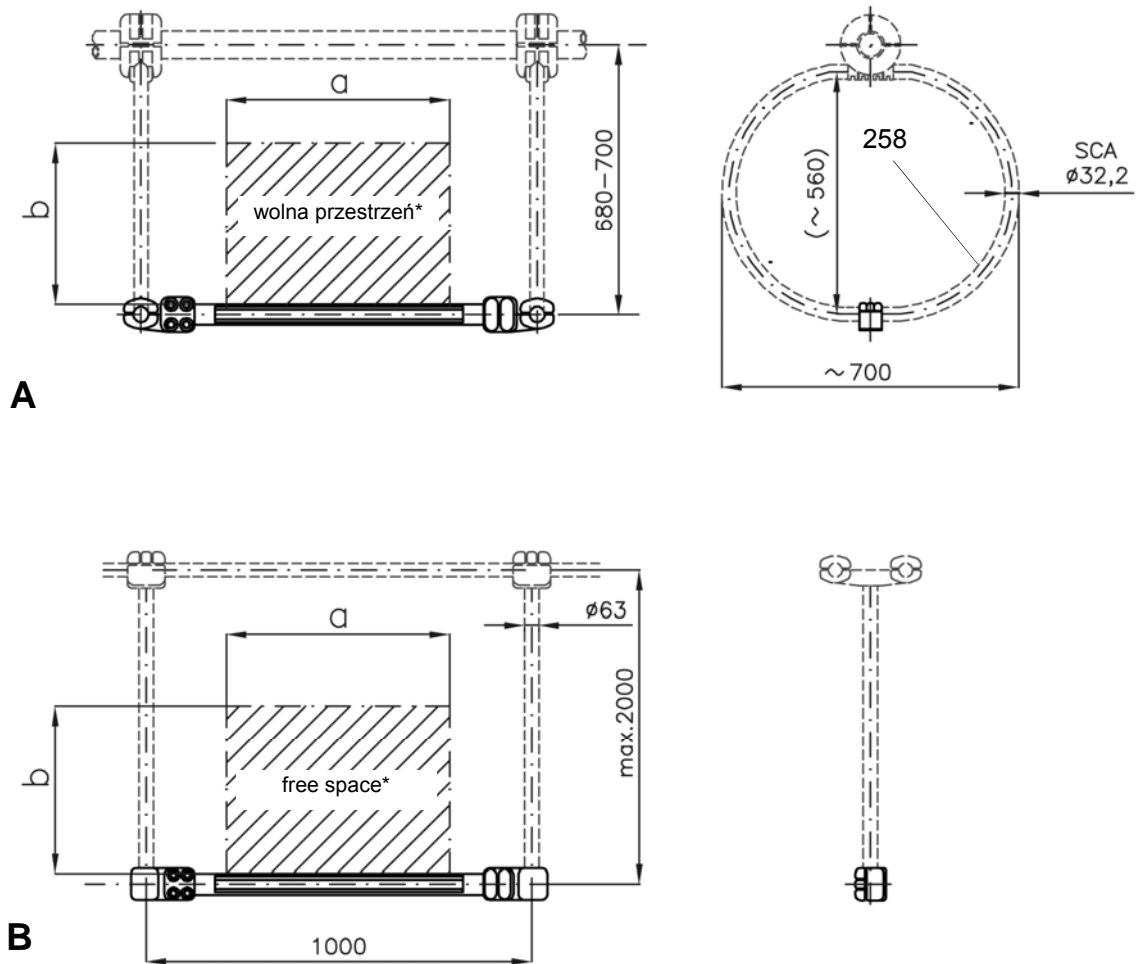
The factory's scope of supply includes the suspended contact 226, consisting of two main contact carriers 286 with contact strip 287 with AgCdO inlay, and two aluminium contact clamps 392 with clamping covers (factory-mounted) and corona protection fittings 393.

Suspended commutation contact

The factory's scope of supply includes the suspended commutation contact 301 (for construction, see Section 4.5), as well as two aluminium contact clamps 392 with clamping covers (factory-mounted) and corona protection fittings 393.

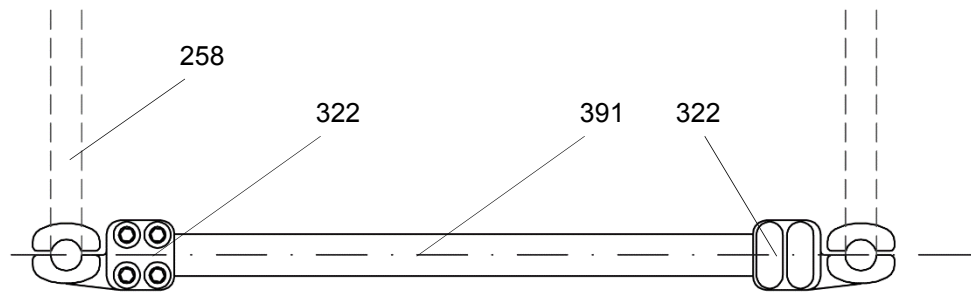
The clamps on the stranded-conductor busbar with the suspended aluminium bars 256 shall be furnished by the customer as installation material.

- 7.4.1. After treating all contact surfaces of the stranded-conductor busbar, clamps and suspended aluminum bars as specified in Section 11, mount the upper clamps with suspended aluminum bars 256 to the overhead busbar.
- 7.4.2. Remove clamping covers to install the suspended bars in clamps 392, treat the contact surfaces on clamps 392 and suspended bars 256 as specified in Section 11.1.
- 7.4.3. With the aid of the screws, attach the suspended contact to the suspended bars, adjusting the distance between the stranded conductor and the contact tube 391 as specified in the installation layout.
- 7.4.4. Install corona protection fittings 393, using the fixing material 395, 396, 397. Tighten all screws.

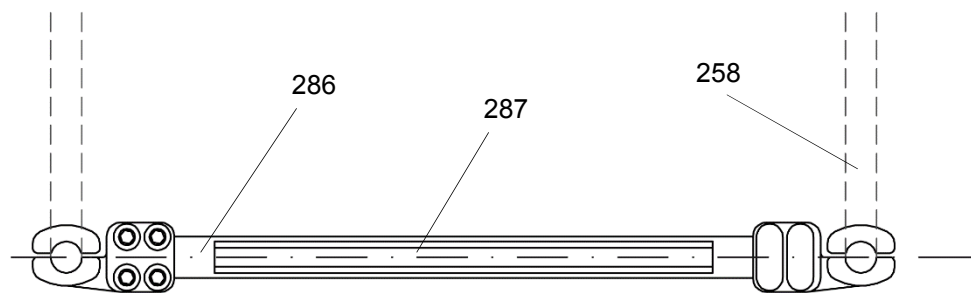


* -free space upper pantograph arm – dimensions „a” and „b” see dimension drawings

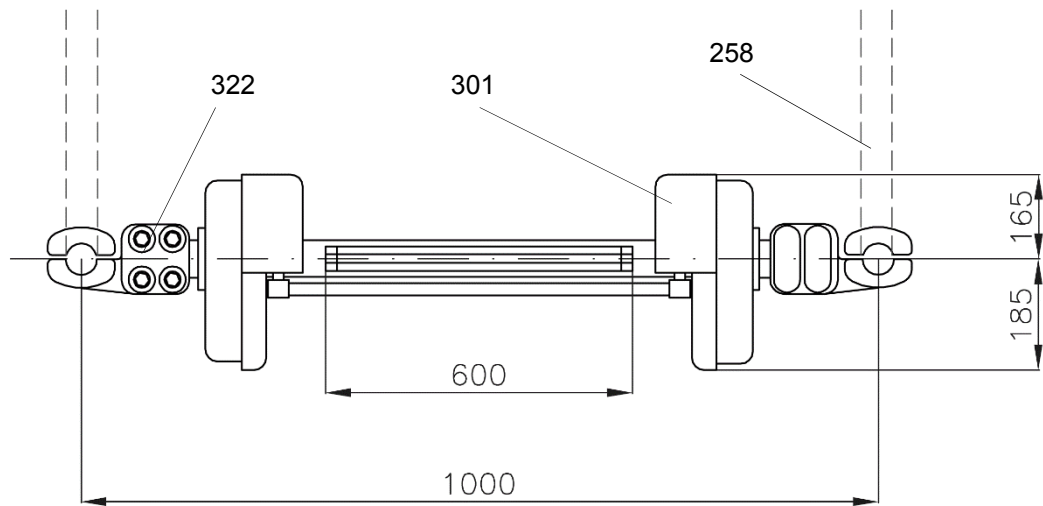
Figure 9 Suspended contact for installation
 A - onto tube conductor busbars; B - onto stranded conductors



A –standard design

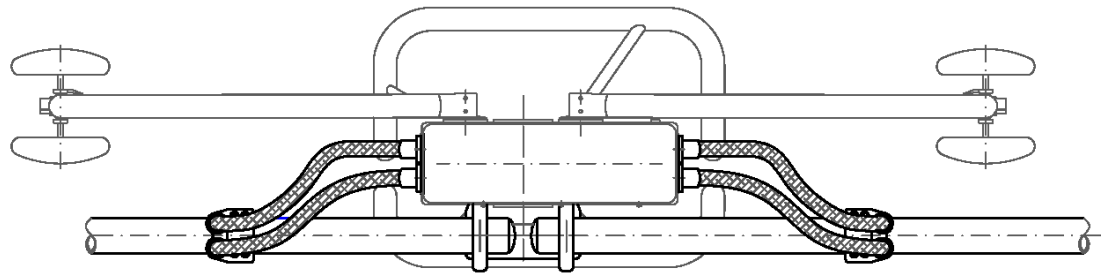
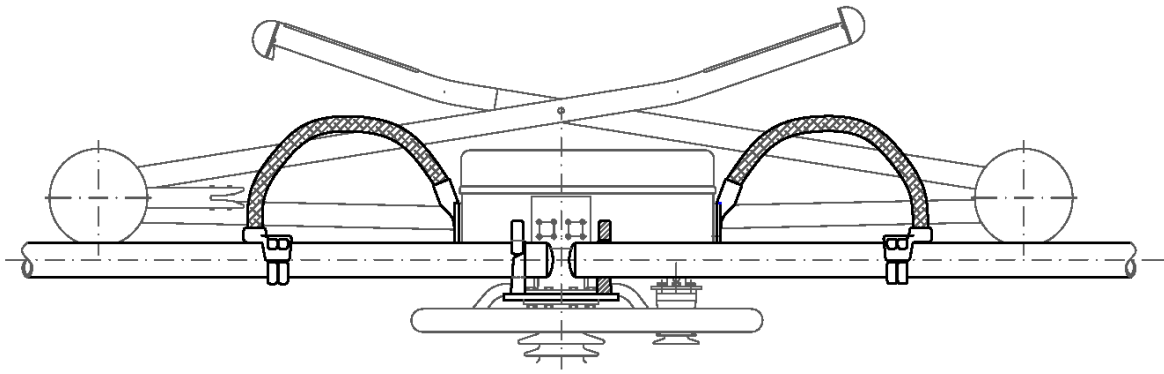


B –design with AgNI inlay

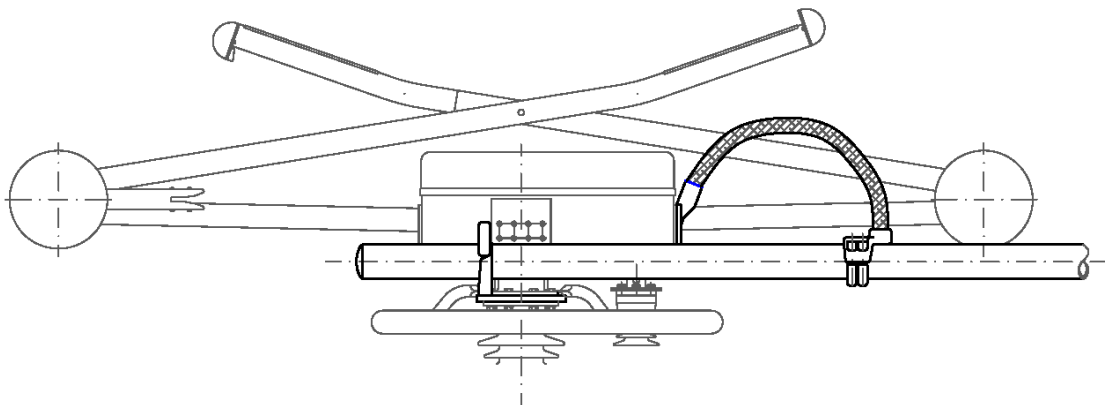


C – special design –commutation contact

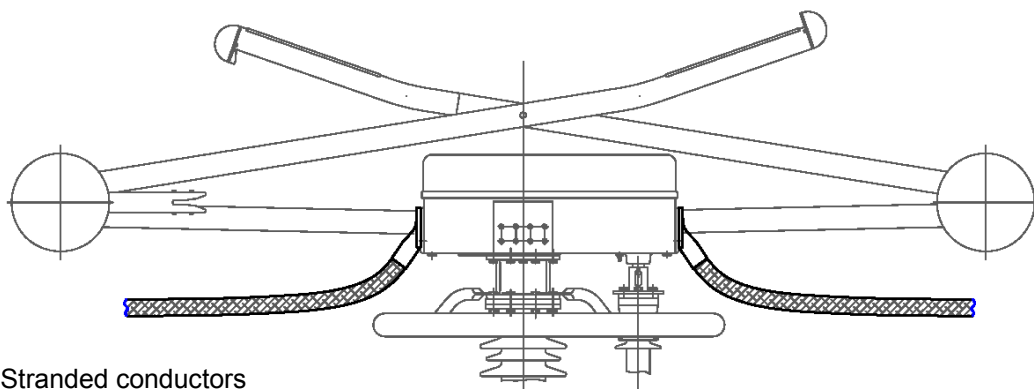
Figure 10 Types of suspended contacts for voltages



A) Rigid bus-bars from both sides



B) Rigid bus-bars from one side



C) Stranded conductors

Figure 11 Recommended connections bus-bars to gearbox

7.5 Installation of Motor-Operated Mechanism MT for Disconnecter

The motor-operated mechanism is completely adjusted in the factory. To avoid disturbances, the adjustment of the motor-operated mechanism may be changed by specialized personnel only.

Because of many different configurations of disconnectors, in every case, it is necessary to use dimension drawings supplied to individual order.

- 7.7.1 Attach motor-operated mechanism 36 to the structure. Operating mechanism and disconnecter must always have identical serial numbers (see nameplate).
- 7.7.2 Transfer the motor-operated mechanism and disconnecter to position OPEN.
(Note: When delivered, the motor-operated mechanism is in CLOSED position.)
- 7.7.3 Shorten operating shaft 43 by distance between operating pin 44 and coupling end of operating mechanism.
Paint the cut surface of the shortened operating shaft with the paint supplied to protect against corrosion. For details see Section 13.
- 7.7.4 Connect operating shaft 44 with shaft 43 by means of sleeve 414 and pin 415 (Fig 13)
- 7.7.5 Connect the shaft 43 with operating mechanism by means of coupling piece 334
- 7.7.6 Start closing the disconnecter by using hand crank 39 and check switching direction. Close disconnecter till stop 269 in the gear box 224 becomes effective. After passing the dead center position, ball joint 239 (installed on operating rod 244) will jump automatically against stop 269, clearly audible by a click.
- 7.7.7 Check that the operating mechanism has reached the end position too. If necessary, loosen clamping covers 334 and transfer operating mechanism correctly into the end position. Fix clamping covers again.
- 7.7.8 Mark position between coupling piece and operating shaft. Perform two manual switching tests with emergency crank 39. Check for perfect dead-center interlocking by the operating linkage 244 in the gear box (Figure 5; 6).
- 7.7.9 Check the marking. Tighten the fixing bolts of the clamping covers, secure coupling piece 334 in place with locking screw and lock with counter nut.
- 7.7.10 The operating mechanism is to be connected according to the plant layout. Detailed information is given in the Service Instructions for the associated operating mechanism.
- 7.7.11 To avoid condensation it is absolutely necessary to connect the heater. After installation the heater is to be commissioned immediately even if the associated disconnectors and earthing switches are not commissioned yet. The bags with desiccative serving to avoid corrosion during transport and storage are to be removed prior to commissioning of the heater.
- 7.7.12 Make sure that the filter insert of the ventilation gland in the motor housing is not plugged. If the units are painted, keep the filter insert free from paint.

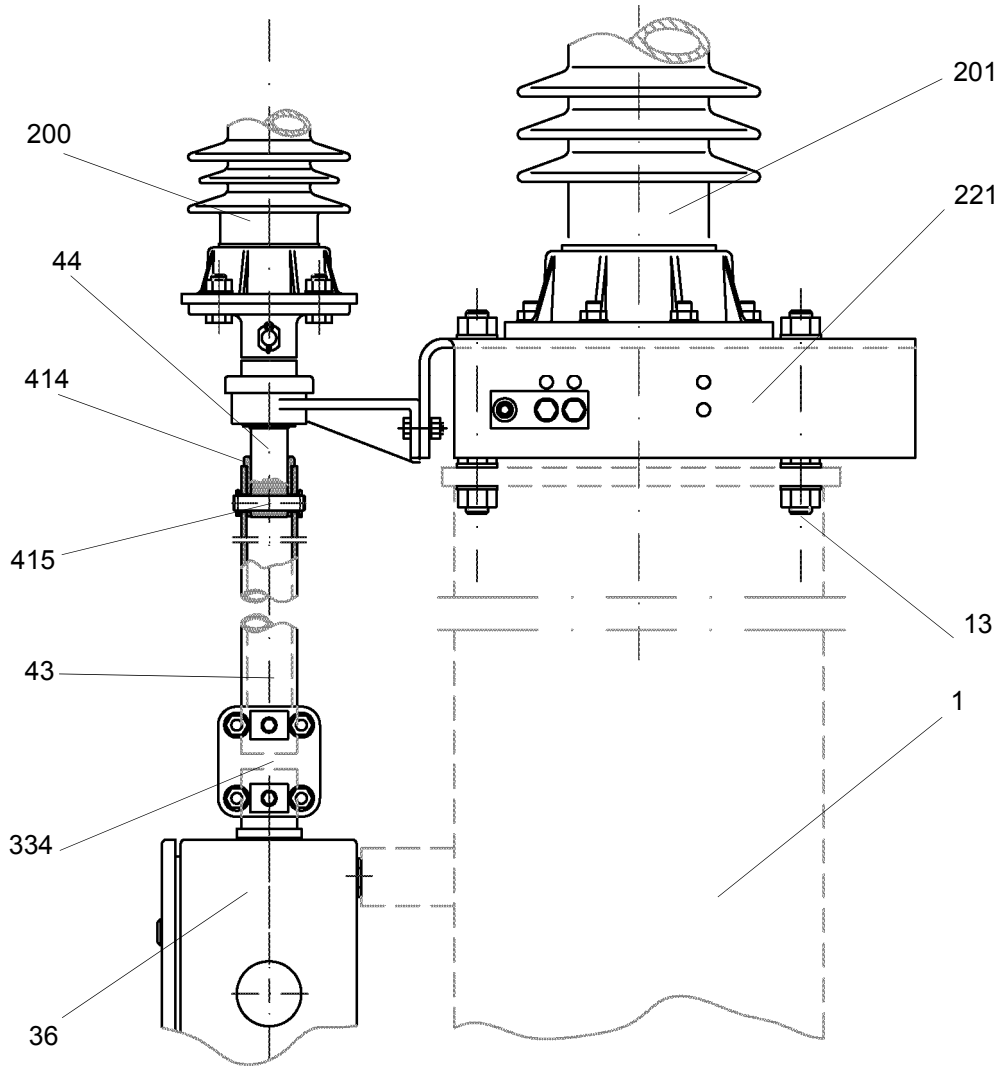


Figure 12 Installation of motor-operated mechanism for disconnector, Connecting of the operating shaft and disconnector

7.6 Installation of earthing switch type ASB

- 7.6.1 Mount the earthing switch on the base. The corresponding number is shown on the assembly drawing. Mount the mechanism so that the last meter of the earthing switch tube is horizontally (Figure 15; 16). The earthing switch is mounted with four M16 bolts. The M16 bolts are mounted on the earthing switch mechanism for shipment purposes. Unscrew and use for mounting. Tighten the fixing bolts.
- 7.6.2 Connect the earthing switch lever (77) and arm lever (80) with rod (78)
- 7.6.3 While closing the earthing switch manually, make sure the male contact of the earthing blade reaches the female contact of the earth receiving contact in the middle. If necessary adjust the position of the earthing switch by using the M16 fixing bolts. After adjustment tighten the bolts. (Figure 14). Additional adjustment is also possible by releasing the M16 fixing bolts of the receive contact and slightly rotating the earth receive contact. After adjustment tighten the bolts.

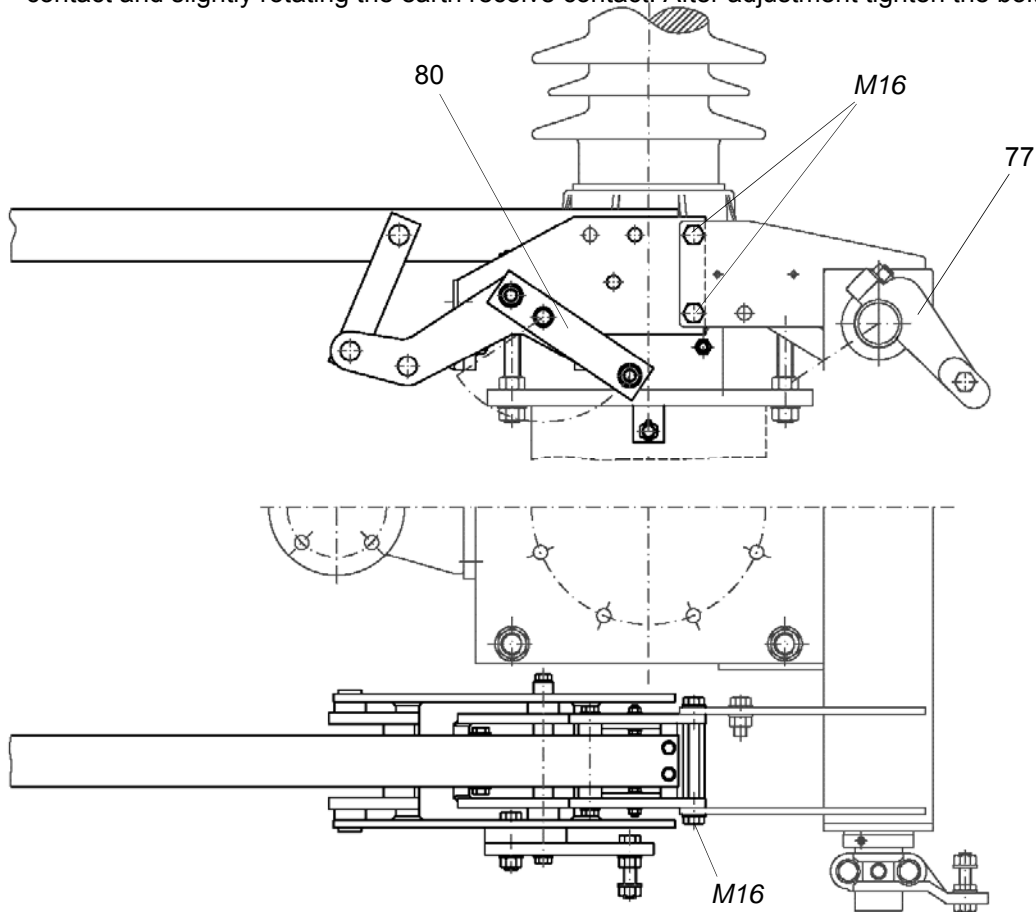


Figure 13 Assembly of earthing switch

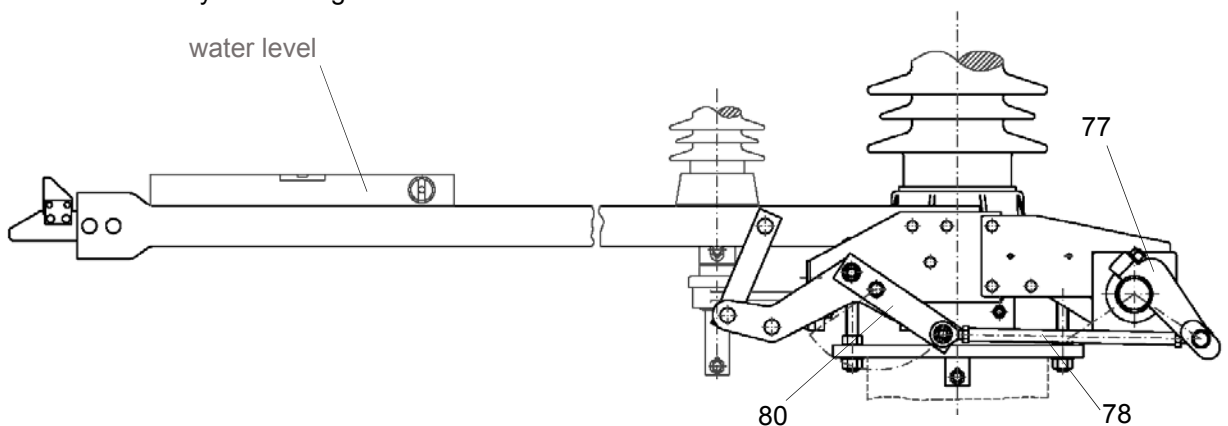


Figure 14 Regulation of earthing switch blade

- 7.6.4 Check the length of the blade before the switch makes the vertical movement. (Figure 15). The top of the male contact must be 5-7 mm below the nylon block. If necessary adjust the position of the male contact by using the M16 fixing bolts. After adjustment tighten the bolts.

Caution: When the guide is hooked in the bracket (item 4, Figure 16) release the blade by opening the bracket manually.

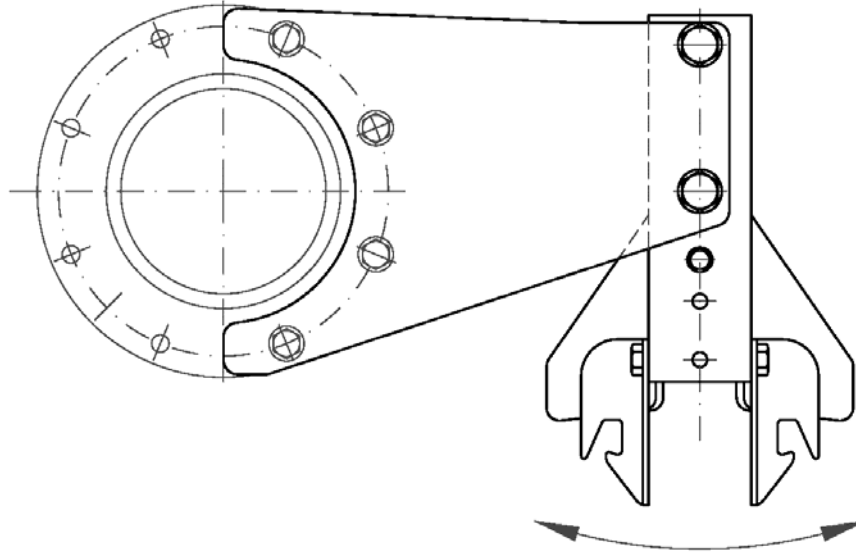


Figure 15 Regulation of earthing switch position

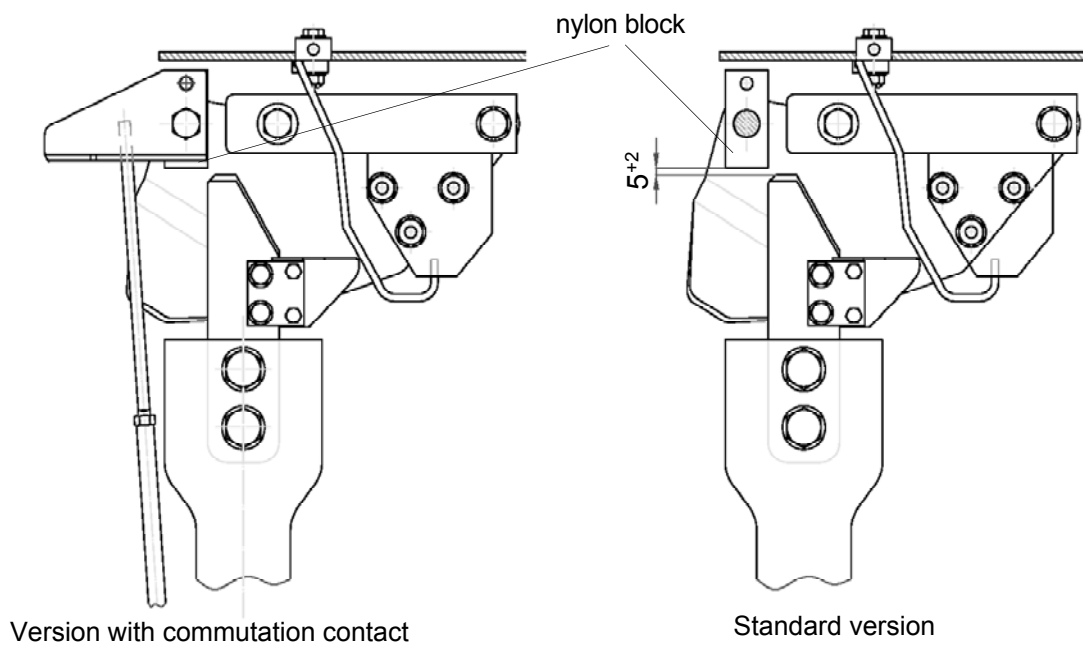


Figure 16 Regulation of earthing switch blade in close position

- 7.6.5 Put the earthing switch in the fully closed position. Check that the stopper touches the mechanism. Vertical movement of the blade is now mechanically blocked. See Figure 6.

Caution: During manually closing be careful. The stopper can crush your fingers. You can use auxiliary lever (rod) inserting between stopper and axis

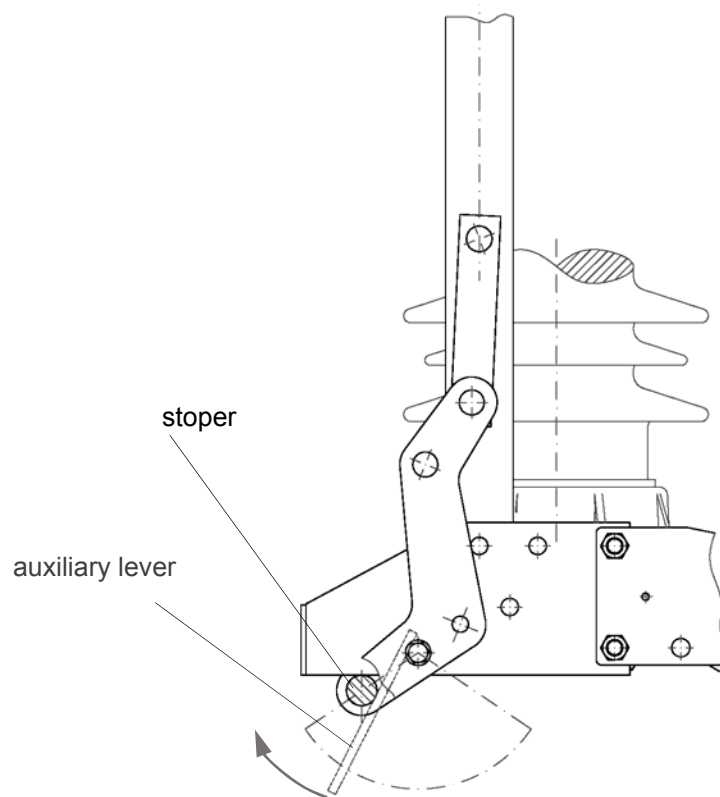


Figure 17 Regulation of earthing switch blade in close position

- 7.6.6 Mount the operating mechanism of earthing switch. Mechanism have to be in "CLOSE" position. Adjust position of operating lever (76) in position "CLOSE". Length of operating rod (71) and position of lever (19) are adjusted at factory.(Figure 18)
- 7.6.7 Check length of operating shaft (43) and if necessary shorten it. The cutting place protect with zink paint. Connect mechanism with operating shaft (43). (Figure 18)
- 7.6.8 Connect the levers (80) and (77) witch rod (78). Position of lever (77) is determined by length of rod. (Earthing switch is still COLOSED) (Figure 18)
- 7.6.9 Tight all the bolts and nuts.

Final adjustment

- 7.6.10 Open the earthing switch manually. The vertical movement of the blade is guided by the nylon block in the earth receive contact (Figure 16). During the vertical movement the roller may just touch the guide plate, a gap up to 1 mm is allowed. (Figure 18) If necessary re-adjust the guide plates according to item 7.6.9 to 7.6.12.
- 7.6.11 Loose the M8 fixing bolts of the guide plates and push the guide plates away from the rollers.
- 7.6.12 Tighten the M8 fixing bolts.
- 7.6.13 Put the earthing switch in the fully closed position and repeat item 7.6.9

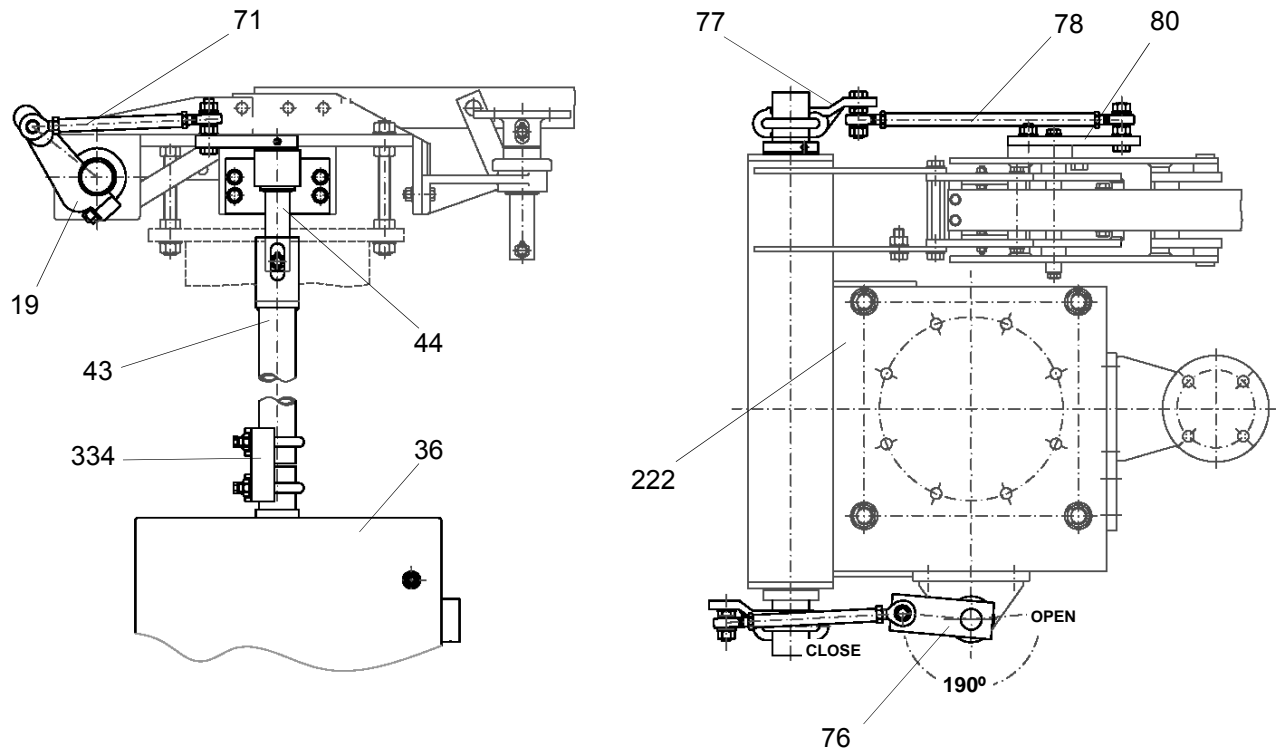


Figure 18 Installation of operating mechanism for earthing switch

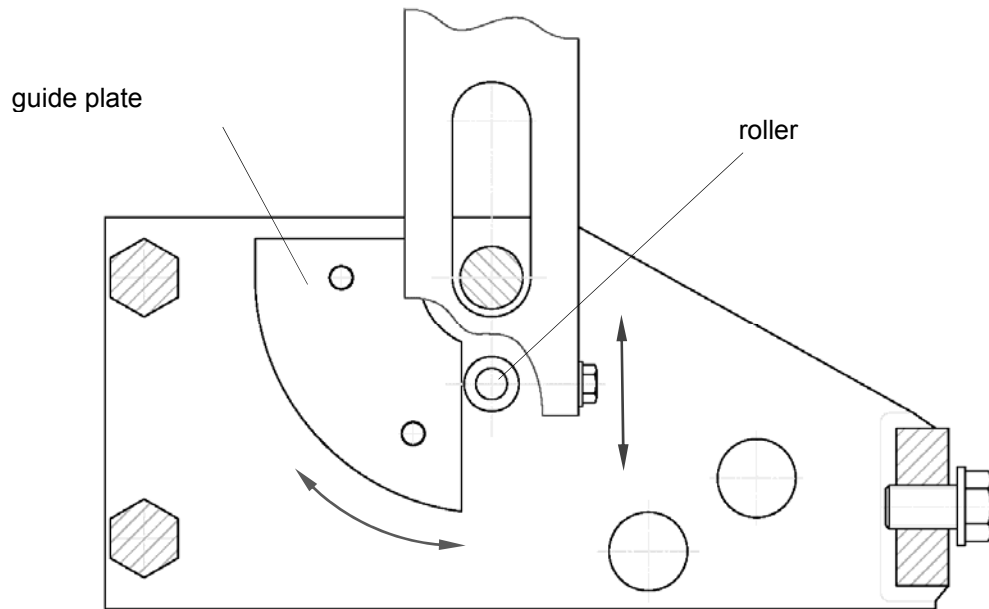


Figure 19 Adjustment of earthing switch –guide plate

7.7 Mechanical interlocking between disconnecter and built-on earthing switch

The mechanical interlocking is mainly intended to provide protection against inadvertent wrong operation by hand. In motorized operating mechanisms, electrical interlocking has to be provided to protect against maloperation.

- 7.7.1 After installing the operating shafts 43 (see chapters 7.7.4, 7.8.4 and 7.9.4), determine the required length "L" of the interlocking rod 383. To do this, measure the distance "A" between the two operating shafts 43. $L = A - 63 \text{ mm}$
- 7.7.2 Shorten the interlocking rod 383 to the appropriate length, debar it, and apply cold zinc paint. Slide on the cap 386 and locate it with threaded pin 147. Drill pin hole $\varnothing 5 \text{ mm}$ H12 and secure cap with composite sleeve 146.
- 7.7.3 Remove the upper clamping covers 334 from the coupling pieces 335 and, from below, slide the interlocking components onto the operating shafts 43 in the following order (Figure 19):
- Collar sleeves 380
 - Support plate 382 complete with interlocking rod 383 on the earthing switch operating shaft
 - Support plate 381 on the disconnecter operating shaft
 - Spacers 384
 - Interlocking sleeves 385
- 7.7.4 When mounting the operating shafts 43 to the coupling pieces 335, join the support plate 382 and the interlocking rod 383 to the support plate 381 and install the fixing material 148. Then tighten the clamping pieces 334.
- 7.7.5 Make sure that the interlocking assembly is arranged so as to form a right angle with the operating shafts, with a minimum distance of 30 mm between the assembly and the coupling pieces 335. A total clearance of 2...3 mm must be left between the interlocking rod 383 and the interlocking sleeves 385. Secure collar sleeves 380 with clamping sleeve 149.
- 7.7.6 Before the interlocking sleeves are finally secured to the operating shafts, make sure that the disconnecter and earthing switch as well as their operating mechanisms are accurately adjusted.
- 7.7.7 Put the disconnecter in "CLOSED" and the earthing switch in "OPEN" position. Using screws 151, align the interlocking sleeves as shown in Figure 18. The earthing-switch end of the interlocking rod 383 must be inside the notch provided in the interlocking sleeve of the earthing switch.
- 7.7.8 Put the disconnecter in "OPEN" and the earthing switch in "CLOSED" position. The disconnecter end of the interlocking rod 383 should now be inside the notch provided in the interlocking sleeve of the disconnecter.
- 7.7.9 After the interlocking mechanism has been properly adjusted, drill holes $\varnothing 10 \text{ mm}$ H12 through interlocking sleeves and operating shafts and secure the interlocking sleeves with compound sleeves 150.
- 7.7.10 Finally, cover all moving parts with Mobilgrease 28.

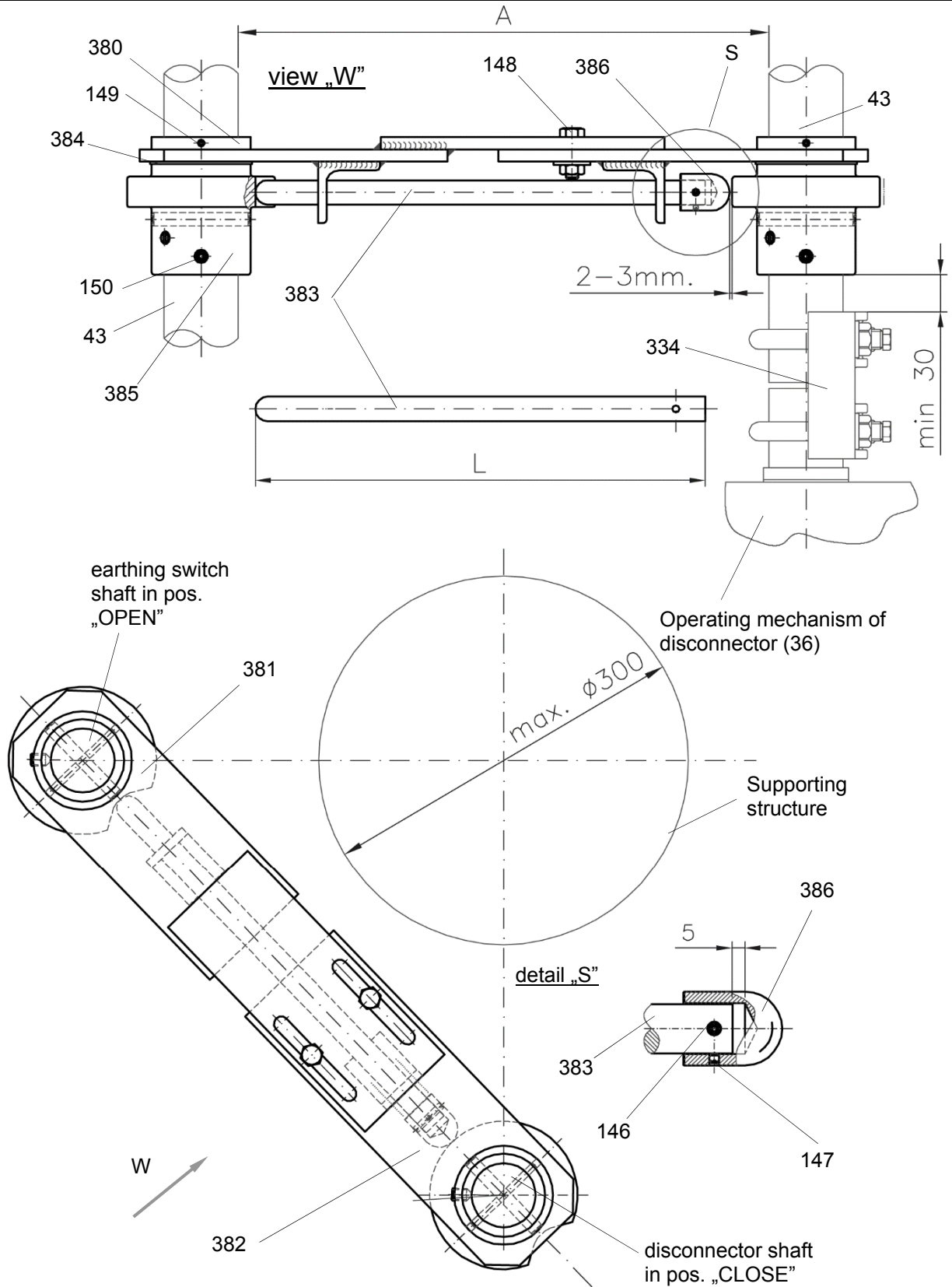


Figure 20 Mechanical interlocking between disconnector and built-on earthing switch

8 Commissioning and decommissioning

8.1 Commissioning

Prior to commissioning check whether the disconnecter and earthing switch function properly. Test and manual emergency operations on the motor-operated mechanism must be performed with the emergency crank 39 only. Do not use a power drill for this purpose.

In the case of the disconnecter check whether the operating lever 266 rests positively against stop screw 269 in switching position "CLOSED".

Important! Diagonal rod 271 as well as operating rod 244 are exactly adjusted in the factory and marked with locking varnish. Any subsequent adjustment will cause substantial changes in the unit's functioning; subsequent adjustments may only be carried out by specialized personnel.

On earthing switches, check that the contact blade 88 enters smoothly into the earthing contact 18 and that a certain amount of pretension is present after the blade's front end has been stopped within the contact.

Check the operating mechanisms as specified in the applicable operating instructions. With the mechanism in its end position, check for proper dead-centre position of the operating rods.

The switching time of the disconnecter and earthing switch may vary over a wide range according to design, operating mechanism and external influences. For proper functioning it is not necessary to maintain a certain period of time..

8.2 Decommissioning

The disconnecter type TFB is environmentally friendly product.

If the herein-described switching device is decommissioning, the materials removed should be reused. The switching device can be disposed of in an environmentally friendly manner on the basis of existing legal regulations.

Recycling is in the form of mixed scarp. The device contains the following materials:

- Steel
- Copper
- Aluminium
- Cast iron
- Synthetics
- Rubber materials in the form of sealing materials
- Ceramics
- Lubricants

There are no hazardous materials within the meaning of the regulations for handling dangerous material.

9 Maintenance

9.1 Disconnectors type TFB and earthing switches type ASB

Owing to the selection of the material used and in connection with a permanent lubrication the units are practically maintenance-free.

It is recommended to have an inspection carried out together with the inspection of the corresponding operating mechanism every 5 years of operations, at the latest, however, after 1000 make and break operations. The inspection intervals mentioned above apply to normal ambient conditions. For extraordinary conditions (e. g. use in tropical climate or at excessively low temperature or heavy pollution) these intervals should be reduced by 50 %.

The following details should be observed during inspection:

- 9.1.1 Disconnect disconnector and earthing switch; in the case of the operating mechanisms care should be taken that the heating circuit and control voltage of the blocking magnet are disconnected.
- 9.1.2 Observe IEC and the applicable national safety regulations.
- 9.1.3 Check contact strips 236 and contact tube 237, 391 or contact strip 287. Replacement is required if the silver facing of contact strips 236 or contact tubes is destroyed by pitting or mechanical wear, in the case of contact strip 287 if there are erosions of material to a depth of more than 1 mm. Details for replacement see Sections 9.4 to 9.7. In any case the clamping points of all contact elements which will be replaced by new ones have to be treated according to the instructions given in Section 11.
On disconnectors subject to icing, grease the pantograph tubes 242 and contact strips 236 (see Figure 12), and the suspended contacts (over their entire length between the clamps) all around with Mobilgrease 28; thickness of grease layer: approx. 3 to 4 mm. In the case of suspended commutation contacts, the auxiliary contact bars 303 shall also be greased all around their circumference and over their entire length. .
- 9.1.4 Check earthing blade 88 and contact fingers of the earthing contact 18 for pitting and erosion. Grease all parts with Mobilgrease 28; thickness of grease layer for equipment subject to icing: approx. 3 to 4 mm.
Replacement is required if there are traces of material erosion deeper than 1 mm. The silver facing of the earthing blades 88 and contact fingers of the earthing contact 18 is not essential for proper functioning, therefore it is not necessary to change these parts when the silver facing has been destroyed. If there are damaged contact fingers of the earthing contact, the complete earthing contact 18 (without covers) has to be changed, because the contact pressure is adjusted at the factory. For details about replacement see Section 9.8. In any case the clamping points of all contact elements which will be replaced by new ones have to be treated according to the instructions given in Section 11.
- 9.1.5 As all the bearings of the disconnector and earthing switch are supplied with a permanent lubrication, only a visual inspection of the bearings is required. If, against expectation, it is necessary to re-grease bearings of the earthing switch or joints of the operating rods use Mobilgrease 28.
- 9.1.6 Check mechanical interlocks between disconnector and earthing switch for easy movement. If necessary, clean the parts involved and spray all moving parts and contacting surfaces with lubricating varnish.
On disconnectors subject to icing, grease the interlocking sleeves 385 all around with Mobilgrease 28; thickness of grease layer: 3 to 4 mm. .
- 9.1.7 Check gear box 224 for inadmissible ingress of foreign bodies and moisture.
- 9.1.8 Check flexible connection 79 of the earthing switch (if any) for perfect condition.
- 9.1.9 Check all screwed joints for tight fit. For admissible torques see table Section 12.
- 9.1.10 Clean insulators, if necessary, when an excessive amount of dirt has accumulated.

- 9.1.11 The damping 291 of the damper 268 (Figure 25) and the stop 292 (made of rubber) at the impact plate 355 (Figure 26) must not be painted or treated with a solvent or a paint thinner!
- 9.1.12 After the inspection carry out several test switching operations, checking the switching times, and reapply voltage to the heating circuit and blocking magnet.

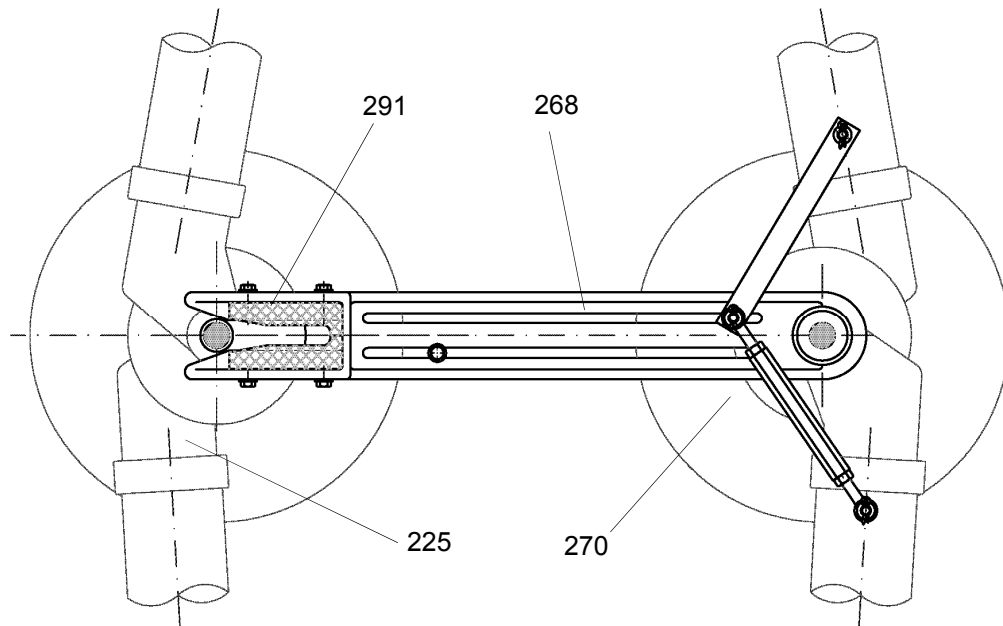


Figure 21 Damper 268 with damping rubber 291
(for $I_w = 160\text{kA}$ or $U_n = 550\text{kV}$)

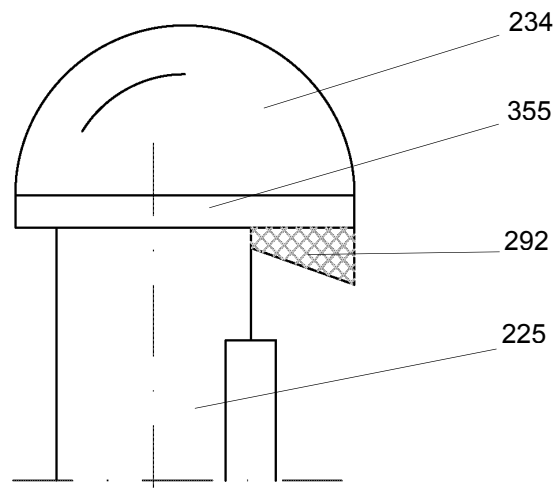


Figure 22 Stop 292 (rubber) at impact plate 355

9.2 Earthing switches

All operations described in this instruction applied to earthing switch type TEB , also concern to earthing switch type TEC with additional the following points:

- 9.2.1 Switch off electrical power supplies and control voltages and safeguard against reconnection
- 9.2.2 Clean earthing contacts (18) and contact fingers (20) (Fig. 37; 38; 39) check for erosion in area of silver layer >0,5 mm and, if necessary, replace
- 9.2.3 Grease earthing contacts (18) and contact fingers (20)
- 9.2.4 Check for damage to earthing connections between earthing switch and disconnecter base and, if necessary replace
- 9.2.5 Check maintenance-free rod ends and supporting points of all operation linkages and coupling rods
- 9.2.6 Check all bolt connections for security
- 9.2.7 Carry out some test operations manually (our recommendation: Three test operations)
- 9.2.8 Reconnect electrical power supplies and control voltages
- 9.2.9 Carry out some test operations using the motor-operated mechanism (our recommendation: Three test operations)
- 9.2.10 The maintenance of the operating mechanism for the disconnecter should be carried out according to the maintenance instructions separately supplied for the operating mechanism

9.3 Operating Mechanisms

Carry out maintenance of the operating mechanisms in accordance with the service instructions given for these units.

9.4 Replacement of Contact Strips

- 9.4.1 Switch pantograph to switching position OPEN.
- 9.4.2 Remove corona protection bowl 234.
- 9.4.3 Insert special holder 260 in tube 242 and push it onto nut 241.
- 9.4.4 Remove screw 240 and take out nut 241.
- 9.4.5 Clean zinc area on aluminium tube 242 and contact strip 236 in accordance with the treatment instructions of Section 11.
- 9.4.6 Insert special holder 260 with nut 241 into the tube and lock each fastening screw 240 with a nut. Tighten all screws equally (permissible torque: 7 Nm).

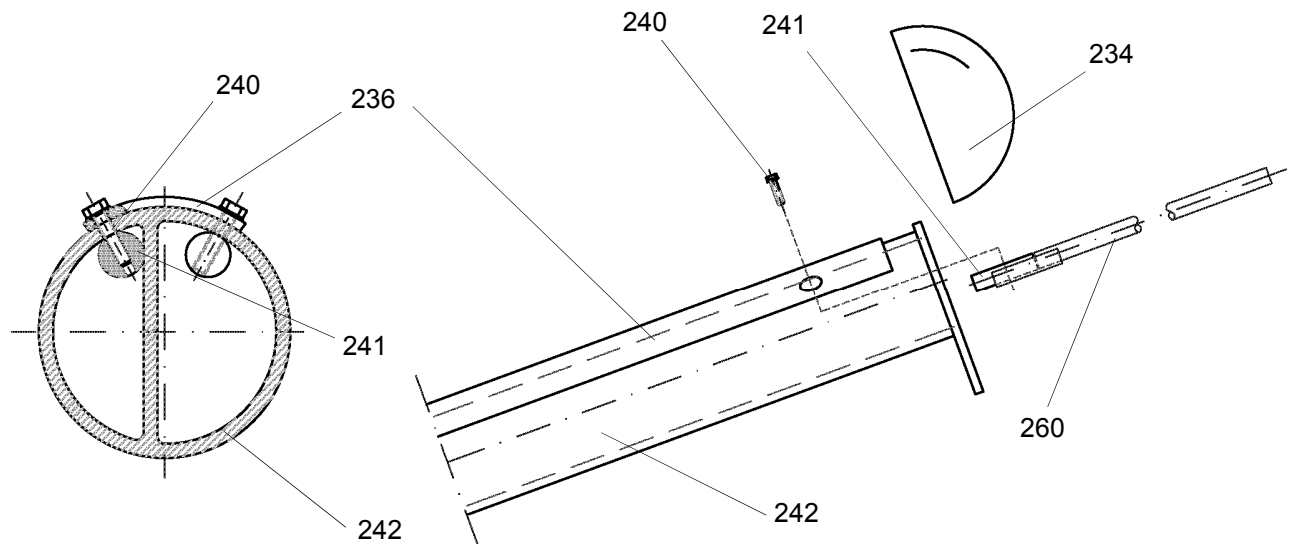


Figure 23 Replacement of contact strips

9.5 Replacement of Spare Parts for Earthing Switch

Earthing contact 18 and earthing blade 88 can be removed by simply loosening the fastening screws, and then be replaced by new ones.

When installing new earthing contacts 18 and contact blades 88, treat all aluminium contact surfaces on contact carrier, silver-faced earthing contact 18, and the surfaces of the intermediate copper-plated aluminium sheet, as well as the zinc-plated contact surfaces on the tubular contact arm 23 and contact blade 88 as specified in Section 11.

Element	Contact surface	Md
contact carrier 272 earthing contact 18	aluminium silver-faced	45 Nm
contact arm 23 contact blade 88	aluminium silver-faced	45 Nm

10 Spare Parts

It is recommended to keep a few of the following parts in stock so that in the case of any disturbance prolonged periods of interruption are avoided by rapidly replacing the defective parts.

When ordering spare parts, give the following details:

- a) Type and serial No. according to the rating plate of the specific unit,
- b) Designation of spare part, item number according to instruction

11 Instructions for Treatment of Contact Surfaces.

The surface condition of the contact surfaces has a far greater influence on the contact resistance than their size or the contact pressure. Therefore, thorough treatment of the contact surfaces is necessary prior to screwing them together.

For treatment of aluminium, copper and galvanized contact surfaces separate tools must be used by all means.

11.1 Joining of Aluminium Contact Surfaces.

Remove the oxide film with the aid of a steel wire brush (or a special tool, e.g. a slowly rotating brush, but no emery paper). It is advisable to slightly grease the contact surfaces prior to treatment. Subsequently remove the grease contaminated by the oxide film by means of a clean lint-free cloth. Immediately after the brushing operation apply another thin film of grease to the contact surface. After the brushing operation the surface must look mat grey, there must be no bright spots.

Because of the fact that a new film of oxide forms very quickly, one contact surface should be completely finished (brushed and greased) prior to treatment of the next surface. The contact surfaces thus finished should be screwed together immediately. After joining, cover the joint of the two contact surfaces with grease.

11.2 Joining of Silver-faced Contact Surfaces

Remove the grease from silver-faced contact surfaces and clean them without corroding the surface plating. Treatment with a cold cleaning agent and lint-free cloth is advisable. Apply a thin layer of grease to the contact surfaces and cover the joint of the two contact surfaces with grease

11.3 Joining of Copper (as well as Silver-faced Copper) and Aluminium Contact Surfaces

When making a joint between copper or plated copper and aluminium surfaces for current transmission, it is important to insert a bimetal (copper-aluminium) plate to prevent the contact resistance from increasing in the course of time under the influence of the atmosphere, and burning-out of the joint. When installing the copper-plated aluminium sheets, make sure that its Cu side faces the copper surface and its Al side faces the aluminium surface. Aluminium-copper clamps may also be used for this purpose.

Treatment of the aluminium surface must be carried out in accordance with item 11.1.

Furthermore, for roughening the rolling skin the copper surfaces or the copper sides of the bimetal plate should also be brushed with a brass wire brush. Subsequently apply a thin layer of grease to the contact surfaces and cover the joint of the two contact surfaces with grease. For treatment of aluminium and copper contact surfaces separate tools must be used by all means.

Treatment of the silver-faced contact surfaces must be carried out in accordance with item 11.2.

12 Admissible Torques for Screws

The specified torques are standard values unless other torques are given in the service instructions. Prior to mounting the screw thread has to be provided with a thin layer of grease.

Thread (mm)	Steel screws 8.8 (hot dip galvanized) (Nm)	Stainless steel screws A2-70, A4-70 (Nm)	Thread within aluminium (Nm)
M6	-	7	5,5
M8	-	16	14
M10	42	33	26
M12	72	56	45
M16	174	122	100
M16	140		

13 Painting Cut Surfaces

Paint steel surfaces with cold zinc primer. If a different coat of paint was originally provided, allow zinc primer to dry and apply an additional coat of the original paint on top of the zinc primer. Touch up any areas where the original coat of paint has been damaged, following the same procedure.

14 List of Components

Item	Designation	
1	Foundation (by customer)	not included in the delivery
13	Stud bolt	Base frame
17	High-tension terminal	Gear box 224
18	Earthing contact	Top intermediate piece 223
19	Earthing switch lever	Earthing switch 228
23	Tubular contact arm	Earthing switch 228
36	Motor-operated mechanism	
39	Emergency crank	Motor-operated mechanism 36
43	Operating shaft	
44	Operating pin	Pivot bearing 227, 229
46	Bolt	Operating pin 44
71	Operating rod	Earthing switch 228
73	Earthing switch shaft	Earthing switch 228
76	Operating lever	Pivot bearing 229
77	Earthing switch lever	Earthing switch
78	Earthing switch rod	Earthing switch
79	Flexible connection of earthing switch	Earthing switch 228
80	Arm lever	Earthing switch
88	Contact blade	Tubular contact arm
89	Spacer ring	
90	Tube holder	Earthing switch 228
92	Counterpoise	Earthing switch 228
93	Clamping screw	Tube holder 90
94	Clamping screw	Tube holder 95
95	Tube holder	Earthing switch mechanism
96	Fork	Earthing switch mechanism
97	Operating fork	Earthing switch mechanism
98	Eccentric	Earthing switch mechanism 99
99	Axle	Earthing switch mechanism
115	Cotter pin 4x22	Bolt 46
124	Nut M10 + Washer	Axle 99
125	Threaded pin M6x16	Axle 99
126	Clamping sleeve	Axle 99
146	Composite sleeve	Mechanical interlocking, cap 386
147	Threaded pin M4x5	Mechanical interlocking, cap 386
148	Screw M10x30 + Nut + washer	Mech. interlocking, support plate
149	Clamping sleeve 5x70	Mech. interlocking, collar sleeve
150	Composite sleeve 10x80/6x80	Interlocking sleeve 385
151	Screw M12 + washer	Interlocking sleeve 385
200	Rotary insulator	
201	Support insulator	
216	Corona protection ring	Earthing contact 18
221	Base frame	
222	Base frame with earthing switch 228	
223	Top intermediate piece	
224	Gear box with pantograph 225	

Item	Designation	
225	Pantograph	
226	Suspended contact	
227	Pivot bearing of disconnecter	Base frame 221, 222
228	Earthing switch	
229	Pivot bearing of earthing switch	Base frame 222
230	Coupling flange	Gear box, rotary insulator 200
231	Corona protection fitting	Top intermediate piece 223
234	Corona protection bowl	Pantograph 225
235	Counterbalance spring	Gear box 224
236	Contact strip	Upper pantograph arm 225
237	Contact tube	Suspended contact 226
238	Ball joint, right-hand thread	Operating rod 244
239	Ball joint, left-hand thread	Operating rod 244
240	Fastening screw	Contact strip 236
241	Special nut	Contact strip 236
242	Tube of pantograph	Pantograph
244	Operating rod	Gear box 224
245	Counter nut, right-hand thread	Operating rod 244
246	Counter nut, left-hand thread	Operating rod 244
247	Locking screw	Gear box 224
248	Carrier pin	Shaft 265
250	Corona protection fitting	Suspended contact 226
256	Suspended aluminium bar (by customer)	Suspended contact 226, 301
258	Stranded conductor ring (by customer)	Suspended contact 226, 301
260	Special holder	Change of contact strip 236
264	Top bearing	Gear box
265	Shaft	Top bearing 264
266	Operating lever	Gear box 224
267	Shaft of pantograph	Gear box 224
268	Damper	Pantograph 225
269	Stop screw	Gear box 224
270	Corona protection hood	Pantograph 225
271	Diagonal rod	Gear box 224
285	Roller bearing with tapered roller contacts	Gear box 224
286	Contact carrier	Suspended contact 226
287	Contact strip with silver/AgCdO inlay	Contact carrier
288	Screw	Contact carrier
290	Y-type clamp (by customer)	Suspended contact > 125 kA
291	Damping caoutchouc	Damper 268
292	Stop (caoutchouc)	Impact plate 255
300	Counter nut	Locking screw 247
301	Suspended commutation contact	
380	Collar sleeve	Mechanical interlocking
381	Support plate, earthing switch side	Mechanical interlocking
382	Support plate, disconnecter side	Mechanical interlocking
383	Interlocking rod	Mechanical interlocking
384	Spacer	Mechanical interlocking
385	Interlocking sleeve	Mechanical interlocking
386	Cap	Mechanical interlocking
391	Contact tube	Suspended contact

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