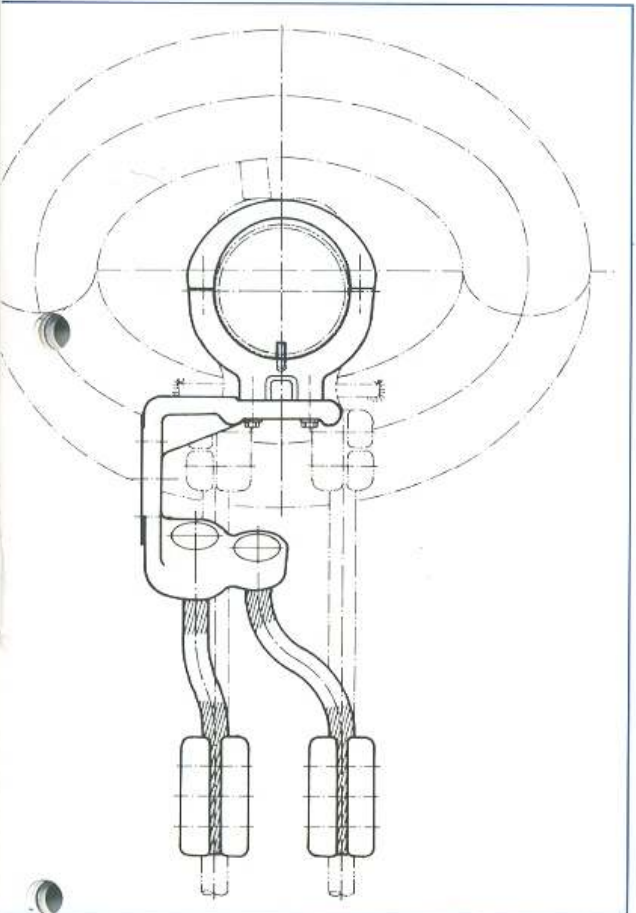


earth cooperative contact.



be support.

other special connectors such as tube support connectors with earth contact and rigid connectors with angle fixing were required for these connections (see fig. 26 and 28).

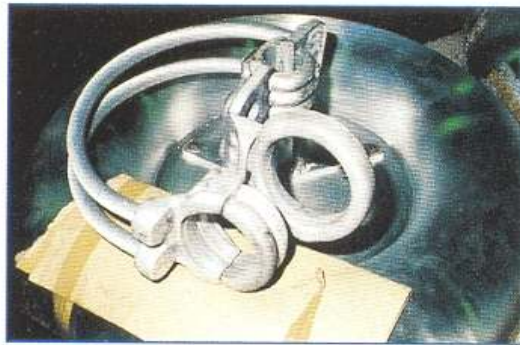


Fig. 27: Angular expansion connector for 160 mm tubes in order to connect the 80 mm feed-through pin and the horizontal 160 mm tube. The tube is supported mechanically by a suspension support with a fix point and connected electrically by means of a stud.



Fig. 28: Tube connector for rigid fastening of two tube ends to the wall insulator.

Technical data on the valve hall connector

Operational voltage: ± 500 kVDC, 525 kV/50 Hz,
— 50 kVDC

Constant current: max. 1380 A

Short-circuit current: 10 kA1s

Conductors: — 250 mm, 160 mm and 120 mm tubes

— 4 x SAI 34.4 mm strings,
80 x 80 mm apart

— 2 x SAI 39.2 mm strings, 90 mm
apart

Application: — DC feed-through, feed-through terminals and connections

— shunt conductor terminal, valve terminals, tube connection

Special features: — valve towers are allowed to swing back to their original position in case of an earthquake

— limited space determines the mounting height of the connectors

— additional terminals possible at each connector

Section C:

The ± 500 kVDC outdoor substations Gezhouba and Nan Qiao

The ± 500 kVDC outdoor substations serve as a connection between the valve halls and the long-distance transmission line. This is also where the ± 500 kV DC (this corresponds to approx. 765 kVAC with regard to corona) is led out of the valve halls, smoothed and switched to the overhead line. The substation also provides smoothing chokes and filtering circuits for the uncoupling of the high frequency arising from the phase control of the valves.

The switching and the tube and conductor connectors

The appliances of the more or less symmetrically-shaped 500 kVDC substations ("+"-pole and "-"-pole) are connected by tube conductors and quadruple bundles. As the connectors used are rather voluminous in order to avoid corona, the set constant current stress of 1,380 A/pole has no particular impact on the design. Some LORÜNSER design features of the 765 kVAC series, which have often proved successful, could be applied to the tube as well as to the conductor connectors of the 500 kVDC substation.

The peculiarity of this mega project is also reflected in the details: e.g., there was no way to use standard connectors.

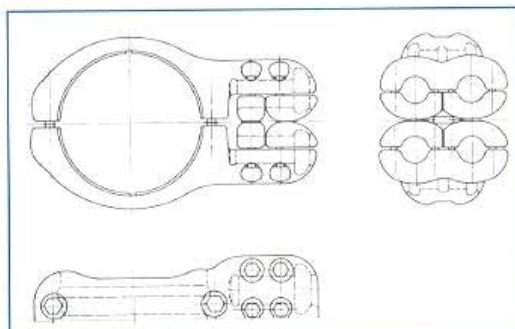


Fig. 29: T-connector for outgoing quadruple bundles.

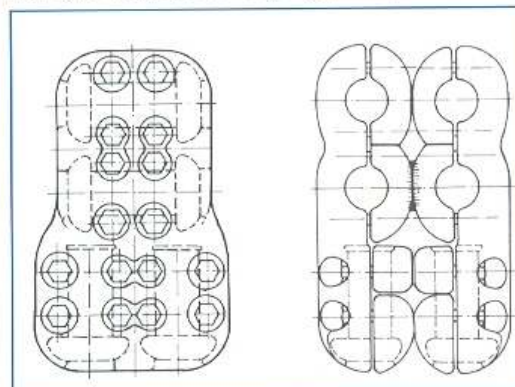


Fig. 30: T-connector for outgoing bundles.



Fig. 31: Tube conductor support for 200 mm tubes (endpoint).

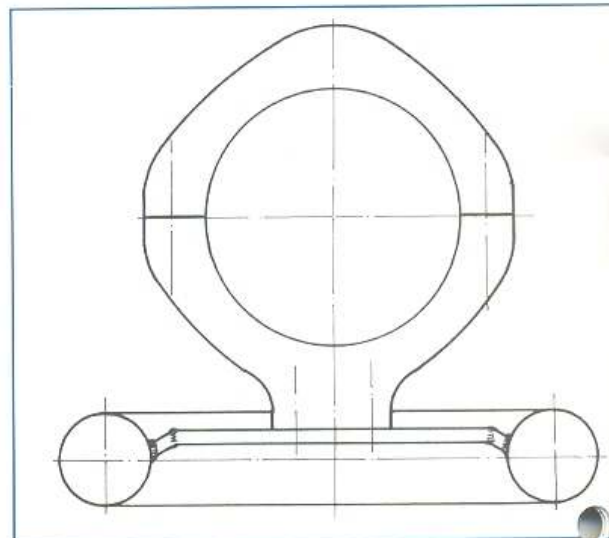


Fig. 32: Tube conductor support for 200 mm tube.

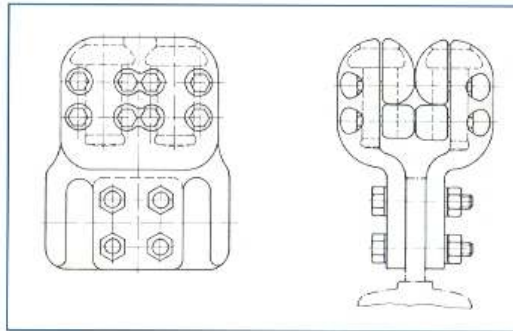
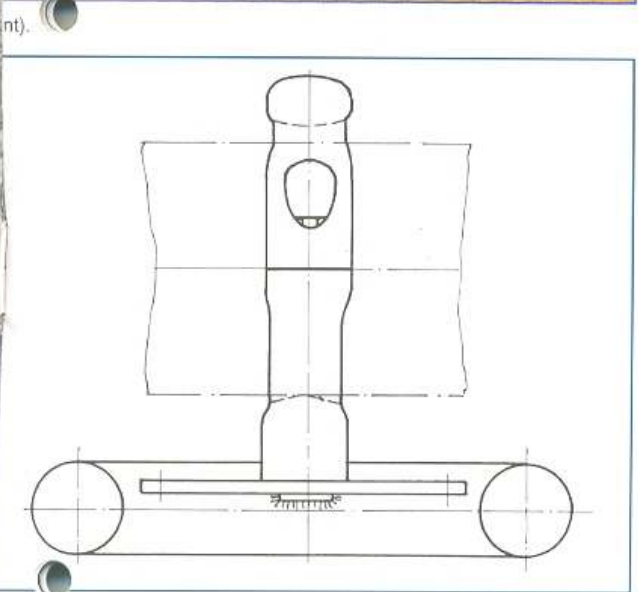


Fig. 33: Appliance terminal for flat terminal.



Fig. 34: Al tube conductor support for the endpoint of the tube (shielding rings for the insulator head and the tube end).

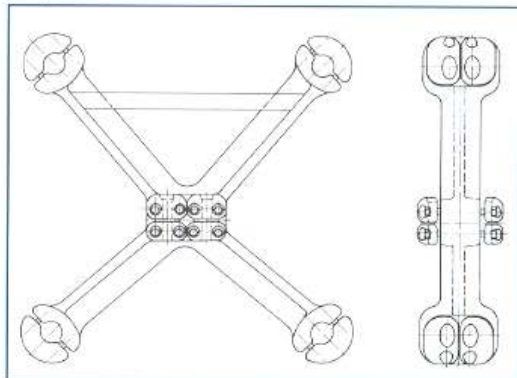


Fig. 35: T-connector for outgoing bundles forming the overhead line.

Fig. 29, 30 and 33 show the most favourable connector types. Major differences arose particularly in shielding. Fig. 31 and 34 show connectors which are mounted as a support at the endpoint of a tube busbar in the 525 kVAC and 500 kVDC substations. While the design of the 525 kVAC connectors only required two small rings in order to prevent corona discharge, in this case the mounting of a huge toroid and a small ring was necessary.

The principle of the tube bedding in the 500

All connectors used in this project are bigger and rounder than usual and special in various respects.

At least once the LORÜNSER engineers were lucky enough to find suitable connectors in their stores.

kVDC substation is similar to that of the 525 kVAC section. Due to the high voltage, however, it was necessary to provide an additional shielding for all supports and studs in those sections, e.g. by means of oval rings. The high operational voltage also required modifications in the design of other standard connectors. Fig. 35, 36 and 37 show rather unusual versions for terminals and spacers.

Apart from usual accessories, such as tube end caps, mounting clamps for damping strings, LORÜNSER also provided complete connections welded to the bundled conductors, e.g. a stud for a busbar terminal (tube with a diameter of 200 mm, 4 conductors welded in with a diameter of 32.6 mm, approx. 1300 mm long).

Technical data on 500 kVDC switchyard connectors for Gezhouba and Nan Qiao:

Operational voltage: ± 500 kVDC
Constant current: max. 1,380 A
Short-circuit current: 10 kA1s
Conductors: — 200 mm tube (appliance connections)
— 4 x Al 32.6 mm strings, 80 x 80 mm apart (appliance connection)
— 4 x ACSR 23.76 mm strings, 450 x 450 mm apart (overhead line)
Application: — DC feed-through terminals
— appliance connections and terminals
— overhead line feed-in

Section D:

The 50 kVDC substation

Due to the low voltage range, only standard connectors of the LORÜNSER series 254 kV were used for the 50 kVDC substation, which serves for the 0-bar connections and stringing.

For this section, LORÜNSER did not only provide the tube and conductor connectors but also the fittings for the insulator top strings within the substations.

Technical data on the 50 kVDC substation

Operational voltage: — 50 kVDC
Short-circuit current: 10 kA1s
Conductors: — 120 mm tube
— 2 x 32.6 mm strings, 90 mm apart
Application: — 0-bar terminal (Ground Electrode)
— 0-bar switching (Ground Electrode)

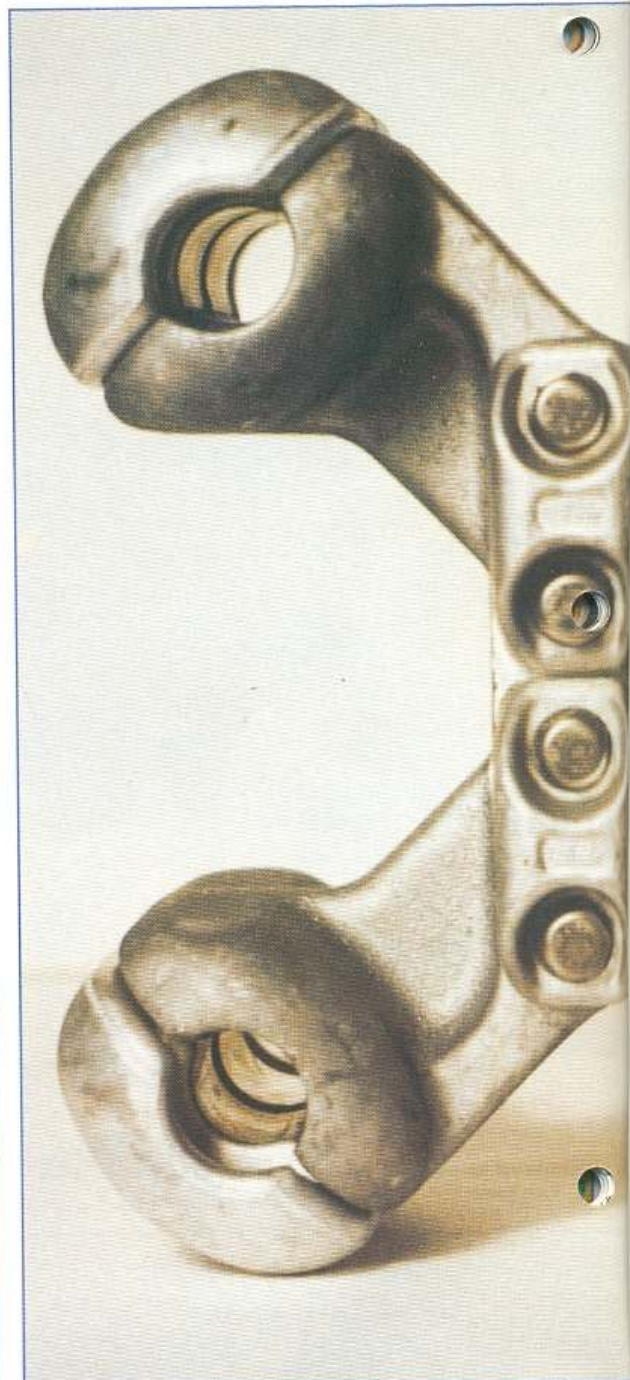


Fig. 36: T-connector for outgoing bundles.

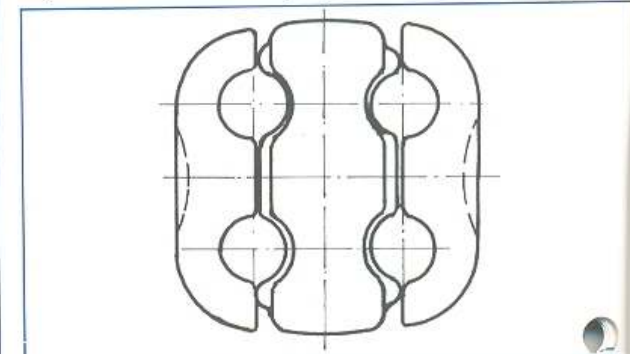


Fig. 37: 500 kVDC spacer for quadruple bundle 80°.

Section E:

The ± 500 kVDC outdoor repeater station

Because of the enormous length of transmission of more than 1,000 km, the HF-transmitted protection data would be distorted without the right preventive measures. Therefore, a HF repeater station was built in the middle of the line, in order to prevent such distortions. At the 500 kVDC outdoor repeater station, the conductors are stepped down and fed through coupling condensers and chokes.

Substation connectors of the L-series "765 kV" were also used for the connection of the appliance terminals, all carried out by bundled conductors. The type of connector applied here is mainly the same as the one which was applied in the 500 kVDC switchyard (cf. Section C, "500 kVDC conductor connectors").

Technical data on the connectors used in the outdoor repeater:

Operational voltage: ± 500 kVDC

Constant current: 1,380 A

Short-circuit current: 10 kA1s

Conductors: — 4 x 32.6 mm Al strings, 80 x 80 mm apart (appliance connection)

— 4 x ACSR 23.76 mm strings, 450 x 450 mm apart (overhead line feed-in)

Application: — appliance connections
— overhead line feed-out

The repeater station in the middle of the line prevents the consequences of high frequency "exhaustion".

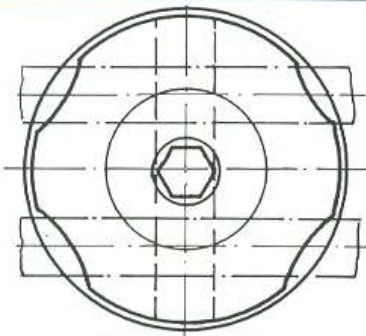
Section F:

The 230 kVAC outdoor substations Nan Qiao

At the Nan Qiao endpoint of the high-voltage line, the DC transmitted is retransformed to AC, in order to be fed into the 230 kVAC network of Shanghai.

The connector types necessary for the termination and the appliance terminals are products of the LORUNSER 245 kV standard series.

Finally Shanghai gets the energy it needs, exactly the way it wanted it, of course.



Experienced engineers take any challenge, no matter how staggering. The only thing that made them feel uneasy was the tight schedule.

The production

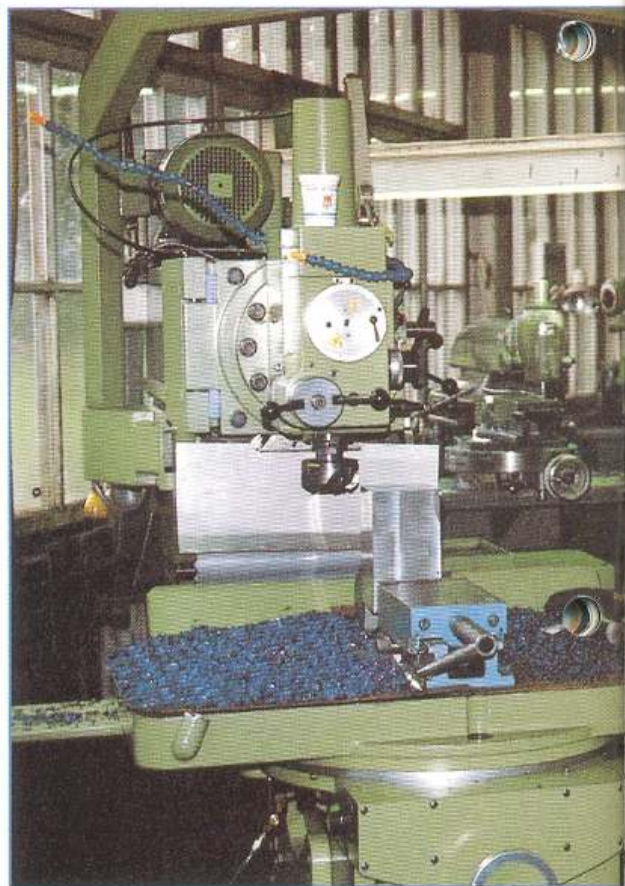
The GESHA project and its extraordinary dimensions meant a major challenge for all involved in the construction and the technical execution. For LORÜNSER, the order for the development and delivery of the substation connectors was a decisive step into the future and a possibility to prove that technical know-how, future-oriented engineering and flexibility combined with a realistic price-quality ratio are the most important prerequisites for international competitiveness.

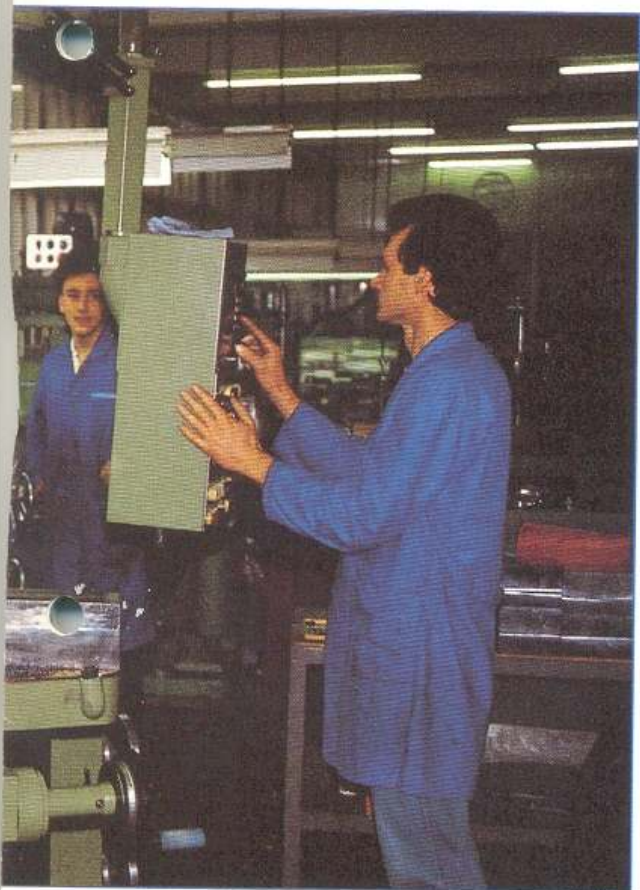
The extraordinary achievements which made it possible to meet all technical requirements and execute the GESHA orders on time become even more striking when visualizing once again the terms of the contract for this project: Less than six months lie between the awarding of the order and the delivery of approx. 5,200 connectors 65% of which had to be either purpose-built and tested or adapted considerably before being delivered. As a consequence, the design of these products required new developments and the production of new tools and mounting devices as well as the production and adaptation of construction tools, the readaptation of machines and other measures to be taken within the firm in connection with the production of the GESHA connectors. Not only experts in overhead line construction will be able to understand what all this means in view of an order volume of AS 7.7 million...

The cooperation

As a matter of fact, a large-scale project like this can never be executed single-handed. Any such attempt is certainly bound to fail. However, the outstanding cooperation of all staff members in this special case is something to be proud of.

On this occasion LORÜNSER LEICHTMETALLWERK GmbH wants to express gratitude to the ABB/Siemens consortium for their confidence and extraordinary cooperation. Moreover, we should also like thank the experimenting stations of the Elektrisches Prüfamt in Munich, and the Technical University of Graz, which allowed for the on time-execution of all tests necessary as well as all staff members and suppliers of LORÜNSER LEICHTMETALLWERK.





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