Development of grounding kits for the world market

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Lightning strikes always represent a potential danger for antenna systems, since considerable damage and thus serious breakdowns can be caused – for example, in telecommunications – through overloads. In order to protect the feed systems from antenna installations for mobile telephony, directional radio as well as radio broadcasting against lightning and overloads, ever since the 1990s grounding sleeves have been used for coaxial cables. These solutions for the world market are "made in Germany", which means that they are backed by highly-qualified development.

More compact design, and thus considerable savings of material as well as reduced production costs, are the advantages of the latest generation of grounding kits like the QGC (Quick Grounding Clamp) from Quesy. This sleeve, which has a worldwide patent, is intended for grounding copper or aluminium coaxial cables with cable diameters of 6 mm to 62.5 mm fur use in mobile telephony on antenna masts. Produced in protection type IP68, the sleeve is ozone and UV-resistant. A salt spray test in accordance with IEC 6008-2 was also carried out. With a view to lightning current conducting capacity, the sleeve fullfils the current European standards EN 62305-1 and EN 50164-1, Figs. 1 and 2.

Special attention was given to the high-quality machining – and thus long service life – while simultaneously minimizing the use of material and simplifying installation. Thus, the grounding sleeve integrates a tin-coated ripple with a special copper alloy which guarantees a high relaxation performance. The ripple to the cable has a very low contact resistance of just 0.10 mΩ to 0.15 mΩ and thus falls below the required transfer resistance of a maximum of 1 mΩ.

For the assembly of such grounding sleeves with integrated terminal, the cable must simply be stripped, the sleeve set and secured with a single loss-secure screw. Assembly faults are practically ruled out thanks to the limited tightening of the screw. However, the road to this development was long, paved so to speak with much new knowledge gained in practice.

Fig. 1 *Modern one-piece grounding sleeve*

Fig. 2 *Grounding sleeves for various cable diameters*

From components up to the kit

The first grounding sleeves were offered in the most varied configurations. Usually the solutions consisted of a variety of components. Later the components were offered in kits, whereby all the components for the installation of a grounding sleeve were available: Round braid, flat braid; copper or brass tape; flat rubber profile, a clamp of stainless steel with two screws and a sealing mass, Fig. 3. For grounding sleeves with smaller diameters, brass clamps were used, for larger diameters copper clamps.

At a glance

The „feeder cable" e.g. for mobile telephony transmitting aerials must be effectively grounded to provide lightning protection. Over the years, the grounding sleeves used for this purpose have developed into genuine "high-tech" systems and have been optimized for safe functioning and rapid assembly.

Reduced assembly times

In particular, the assembly time on site at the antenna mast – 15 to 20 minutes per grounding sleeve – was regarded as a decisive disadvantage of the kits described, with too many and mostly unwieldy components.

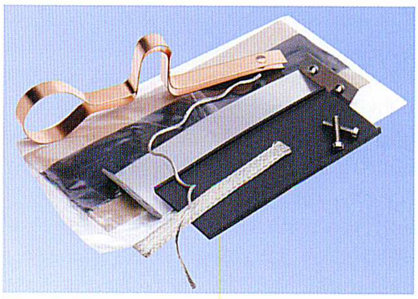

Fig. 3 *Early grounding sleeve as a set*

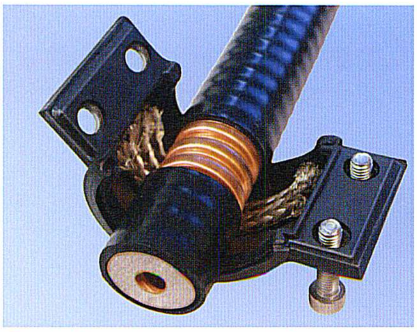

Fig. 4 *Grounding sleeve with further-developed cable cuff*

Fig. 5 *Wall bushing as a light rubber-metal construction*

Therefore, in the mid-1990s a grounding sleeve was designed in which the VA clamp fitted around the coaxial cable was provided with a seal. The insides between the clamp and the cable integrated an insert made of malleable elastic graphite. These graphite inserts served as a seal and, simultaneously, for the transmission of current in the event of an overload. As an option to this a clamp was developed with graphite as seal and a glued and tin-coated copper flat braid (Cu braid) for the transmission of electrical current.

In its turn, this solution proved to be too unwieldy in assembly. Therefore, a system was conceived in which the components of the sleeve were securely pre-assembled or integrated: a grounding sleeve with VA clamp as the base body, to which the flat braid (braided band) was securely attached on the inside, as well as a cable for the leak conductance, which was attached, pre-assembled, to the gummed clamp, **Fig. 4**.

Optimization of the wall bushing

The wall bushings served for the entry of the coaxial cables from the outside to the inside of a building. These solutions consisted of very complex special constructions which were initially replaced by a simpler cast construction and subsequently by a lighter rubber-metal construction, **Fig. 5**.

Rubber coating in the test bed

Practical applications of the new grounding sleeve showed that the rubber coating between the clamp and coaxial cable becomes brittle and in some cases even developed cracks. In laboratory tests at the German Rubber Institute in Hanover the problem was identified: as the coating proved to be neither ozone nor UV-resistant, a new rubber compound had to be selected with the required qualities for the production of the clamp. Later, the tightness of the cable (water resistance) was also tested. With the introduction of the aluminium cable, the grounding sleeves were also subjected to a salt spray test in order to prove the corrosion resistance. All tests were completed successfully.

Improvements in the Cu braid

Usually the problem lies in the details. Particularly on small clamps, the fixated Cu braid could separate and thus reduce the contact areas for the coaxial cable. So there was a danger that when closing the sleeve the braid turned slightly towards the cable axis and, as a result, a gap was created between the clamp body and the Cu braid. This was also confirmed by trials, in which jumping lightning currents caused an arc which damaged the cable. A further problem occurred in the splicing of the braid ends, whereby fine wires in the braid laid on the rubber seal and thus led to leaks in the sleeve and to explosions in the lightning protection capacity test.

The solution was a pocket-shaped socket for fixing the conducting braid. In addition to the larger contact areas and, associated with this, a larger conductive area, this grounding sleeve provided a significant advantage in the extremely short assembly time averaging just 3 minutes – a time saving of around 80 % in comparison with the previous version.

Putting an end to leaks

The leaks caused by deposits on the sealing lips and the rubber coating, through which moisture is able to penetrate to the contacting areas, could also be avoided. The main cause here lay in what was often a too high starting torque of the seal screw. In addition, major temperature changes had a negative effect on the Shore hardness of the rubber. Dependent on the temperature, high tightening torques could thus deform and twist the gummed sealing lips. Therefore, tightening limits were built into the sleeve for a defined mechanical stop. As a result, the seals, which merely had to provide the seal strength were largely protected.

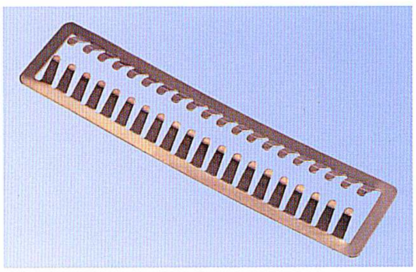

Fig. 6 *Ripple for better contact*

Terminal instead of VA sleeve

A further optimization of the grounding sleeve consisted in the omission of the VA sleeve dotted stiffening plate. The improvement consisted of a stiffening plate which could be simultaneously used as a terminal. Besides cost savings, the first electrical optimization was thus achieved with a lower contact resistance and better contacting as well as shorter assembly times.

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Production tolerances with cables

A decisive step towards the forms of today's grounding sleeves was achieved with the follow-up version. Here, in particular, high production tolerances in coaxial cables were compensated for. For this a ripple which replaced the Cu braid, **Fig. 6**, is ideal.

The ripples not only bridge high tolerances, but also make better length compensation and simultaneously uniform and lower contact pressures possible. The bent ripple sheet consists of a special copper alloy, which offers good relaxation performance as well as high conductivity and low material fatigue.

These latter optimizations subsequently led to the grounding sleeves which are preferred today. ■