

SPECIFICATION

Method and apparatus for continuously stranding electrical cable cores

This invention is concerned with a method and an apparatus for the continuous stranding, effected with alternating lay direction, of electrical cables or lines comprising cores of large cross-section, either sold or assembled from individual wires, these cores being hauled off individually from stationarily mounted supplies, concentrated into a bundle or bunch at a first stranding point, and thereafter stranded in a substantially rectilinear condition within a prescribed path whilst travelling along the prescribed path, which is limited by a second stranding point; the material being advanced in the substantially rectilinear condition, within said path, along a transition distance which is a predetermined shorter path; the bundle or bunch, after leaving the first stranding point, being peripherally frictionally gripped and retained along a length which amounts to only a fraction of the transition distance, and being stranded during the retention of a section of the bundle or bunch between the first stranding point and the retaining means, and each section thus stranded being retained in a torsion-free state in its stranded condition whilst travelling along the transition distance, before, after the stranded cores have been released from the retaining means, it is fed to the second stranding point. In this manner it is possible to apply the so-called SZ stranding technique, which has been practised for a long time in telecommunication cable and heavy-current line technology, even for stranding elements of large cross-section and hence considerably higher moments of resistance.

However, a disadvantage has been encountered in as much as cable cores produced as described in the last preceding paragraph sometimes exhibit a waviness in the bundle or bunch of cores, which, although it has no influence upon the operational reliability of the cable, nevertheless frequently gives the latter an untidy external appearance.

It is an object of the invention, in a first aspect thereof, to make it possible to produce cables which are satisfactory even externally from cores of large cross-section, without having to sacrifice an economic utilisation of the SZ stranding technique.

According to the invention, in a first aspect thereof, a method as specified in the last preceding paragraph but two is characterised in that the interval between the end of the retaining means and the second stranding point is substantially an even-number multiple of the transition distance.

The invention is based upon the discovery that a bundle or bunch of shaped strands of large cross-section stranded in the SZ mode acquires a waviness in the direction of its longitudinal axis, in a stranding method involving travel along a transition distance as mentioned above, if a stranding point (this being a fixed point) is

arranged at too short an interval from downstream end of the transition distance. The functional principle of a stranding machine involving travel along a transition distance as mentioned above, which has a periodically alternating direction of rotation in its transition-distance section, relies upon a two-fold twisting of the shaped strands, the first twisting occurring at the beginning of the transition distance, and the second occurring at the end of the transition distance. Whereas the first twisting is possible without side effects, it becomes apparent in connection with the second twisting, which is applied to an already stranded bundle or bunch, that the stranding necessary for the shortening of the length of lay, in the case of large cross-sections, no longer occurs solely internally within the stranded bundle or bunch, but also affects the bundle or bunch as a whole. The second twisting can thus generate a waviness in the bundle or bunch, and this, apart from impairing the external appearance of the product, may hinder the induction of the cable into a cable duct; also an after straightening might for instance be necessary when working with cable platforms, and winding on cable drums could be adversely affected.

However, if the second twisting occurs over a length l with a complete sequence of twists with S and Z lays, the length l corresponding to twice the transition distance, then the twisting over that distance, mathematically considered, is equal to zero, i.e. what is stranded in along e.g. an S-stranded section is stranded out again along a Z-stranded section. The waviness of the length considered is then a minimum. If the S and Z-stranded length l is an integral multiple of twice the transition distance, then the waviness in the increased length considered tends towards zero.

In applying the invention, it has therefore been found particularly advantageous if the stranded bundle or bunch, after leaving the retaining means, passes through a sheath installation before the second stranding point is reached. During the passage through the sheathing installation, at least an inner sheath producing a rounded effect may conveniently be extruded on to the stranded bunch. It will be understood that one or more other operational steps, by themselves or additionally, may be carried out (included) along said path. Thus it has sometimes been found advantageous to provide the stranded bundle or bunch, before the extrusion of the inner sheath just mentioned, with banding, which may be in the form of the familiar retaining helix. A marking of the core assembly can also be provided, in a method according to the invention, before the bundle or bunch of stranded cores reaches the second stranding point.

The invention also includes an apparatus comprising means for performing a method according to the invention, characterised in that it incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores

comprising a revolving gripping jaw haul-off assembly, and means for driving the retention and stranding means in the requisite rotative mode, the interval between the end of the said assembly and the second stranding point being

substantially an even-number multiple of the transition distance specified in the first paragraph of the present description. It is to be understood that the gripping jaw haul-off assembly is

arranged along the transition distance, surrounding the stranded bundle or bunch and travelling together with the material in the axial direction. In this case the gripping jaws rotate about the longitudinal axis during the travelling

together with the stranded material, the first and last gripping element being utilised to effect stranding between itself and the stranding point, and, in a continuous cycle, surrendering this function of effecting stranding to the next, and the

latter in turn to the next, the initially first, then second etc., gripping element, by a continuing retention of the bundle or bunch, ensuring a torsion-free guidance of the latter along the transition distance. However, it has been found

particularly convenient if the retention and stranding of a bundle or bunch comprising shaped strands of large cross-section is effected by two gripping jaw haul-off assemblies arranged consecutively in the direction of passage so as to

revolve in the same direction and at the same speed. Preferably, carriages of the said assemblies are secured to chains, and form, conjointly with the latter, a chain caterpillar on both sides of the stranded bundle or bunch, and, in each pair of

these carriages, one carriage is provided with a pin position so as to travel around the operative circuit of the carriage, and the other carriage is provided with a recess so positioned and dimensioned as to cooperate with this pin, by

receiving the pin to form a positive connection between the two carriages. This measure ensures positive synchronism between the said carriages, so that the stranded bundle or bunch is always gripped on all sides simultaneously, and can be

guided in a torsion-free state during the stranding.

The invention will be explained more fully with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a side view showing equipment employed in accordance with the invention, in a first aspect thereof,

Fig. 2 is a side view, on an enlarged scale, of a haul-off assembly included therein, and

Fig. 3 is a side view showing equipment employed in accordance with the invention, in a second aspect thereof, described below.

In Fig. 1, cores 50, which may be, e.g., sector-shaped cores of a power transmission cable, which are required to be stranded, are hauled off from stationarily mounted supplies (not shown), and fed to a stranding nipple 53 through guide rollers 52, which also serve to straighten the cores 50 (the rollers 52 may thus belong to roller straightening machines). In the nipple 53, the

cores are concentrated into a bundle or bunch and

fed to a stranding device 54 disposed downstream of it in the direction of travel. The device 54 comprises at least one revoluble gripping jaw haul-off assembly and, as actually illustrated in Fig. 1, it comprises two such assemblies, consecutively connected, as shown at 55 and 56.

Fig. 2 shows details of one of these assemblies. As may be seen from this figure, its gripping jaws frictionally grip the concentrated bundle or bunch of cores peripherally, and simultaneously rotate in a direction of rotation alternating at intervals of time, so that, in each rotation, the section of the concentrated bundle or bunch which is present between the stranding nipple 53 and the first

gripping jaws of the haul-off assembly 55 undergoes a stranding. With steady revolution, in the SZ mode, the next gripping jaws of the haul-off assembly 55, and then those of the haul-off assembly 56, grip the stranded material positively

and frictionally, and guide it in a torsion-free state along the transition distance, i.e. through the two haul-off assemblies. Now in order to ensure that the products thus produced can be further processed satisfactorily, and are subject to no

waviness due to the stranding operation, a schematically indicated sheathing installation 57 is employed, this being disposed adjacently to the haul-off assembly 56. It may be constituted, e.g., by a spinner, to apply a banding, and an extruder, to apply a packing or inner sheath, and also a cooling trough.

Only downstream of the sheathing installation 57 is there a stationarily mounted haul-off device 58, which may be in the form of a caterpillar haul-off device. The haul-off device 58 also provides a second stranding point of the stranding apparatus. With an interval, 1 , between this and the haul-off assembly 56, of $2n \times 1_{sp}$, where n is a positive integer and 1_{sp} is the transition distance, the

waviness of the stranded bundle 59 will tend towards zero, i.e., in principle no waviness is present even with large cross-sections. The stranded material, provided with at least one inner sheath, is then wound via a deflector roller 60 on to a winding drum 61. It will be understood that

the caterpillar haul-off device 58 may be followed by further processing stations, in a continuous succession, so that, e.g., an armouring is applied, and immediately after this a mechanically strong outer sheath is extruded on.

Fig. 2 illustrates a haul-off assembly 55 or 56 on a larger scale than Fig. 1. It incorporates carriages 62 for the gripping jaws, these carriages 62 being secured by means of straps 63 to chains 64 of a chain transmission 65. Two driving motors are shown at 66, and the bunch or bundle to be stranded is shown at 67.

To obtain a synchronism between associated upper and lower carriages 62, so as to ensure operational reliability, a positive coupling of paired carriages is provided for. This positive coupling results from the provision on each upper carriage of a pin 68, preferably elastic, e.g. made of hard polyethylene, which is positioned on the operational circuit 69 of the upper carriages, and

from the provision on each lower carriage of a recess 70, which is so positioned and dimensioned as to cooperate with the pin 68 of the upper carriage of the pair concerned, by receiving this pin to form a positive connection between the two carriages.

Because the carriages 62 are secured to the chains 64 by straps 63, the positive coupling must occur in a radially outward prolongation of the strap centre 71. The pin 68 and the recess 70 are then in principle part of the chain transmission, forming a toothed drive system.

The attainment of synchronism by means of this simple positive connection makes it possible to omit lateral gearing, and thereby permits an equal-sided mass disposition on the haul-off assembly concerned. Furthermore, this construction permits the parallel wiring of the armatures in the two driving motors 66, and thereby makes it possible to employ a relatively simple electronic control system. In this way two individual chain transmissions of a haul-off assembly can be brought into synchronism with the smallest possible expenditure in respect of mechanical and electronic equipment.

We now turn to a second aspect of the invention.

From the foregoing description, it will be appreciated that the invention, in its first aspect, makes it possible to avoid the waviness mentioned, by the selection of the stated interval between the end of the retaining means and the second stranding point.

However, if stranding elements of large cross-section are used, e.g., cores produced from individual wires, i.e., elements which are inherently flexible, or those which owing to some other specific construction exhibit a low rigidity compared to solid constituent strands, difficulties may sometimes arise during the formation of the stranded assembly, in that the stranding elements may not occupy, or may not always occupy, the desired position in the stranded assembly.

It is therefore an object of the invention, in a second aspect thereof, to enable the measures described earlier herein to be employed for the continuous stranding of any desired cores of large cross-section.

According to the invention, in a second aspect thereof, the cores concentrated into a bundle or bunch at the first stranding point, immediately after leaving the first stranding point, are continuously wrapped as a bundle or bunch conjointly with one or more retaining helices. The application of the one or more retaining helices and the twisting occur simultaneously, so that the one or more retaining helices are wound on to a twisted core bundle or bunch. The one or more retaining helices therefore fix the configuration of the bundle or bunch.

The "banding" or "winding" of stranded elements is known *per se*; it is resorted to after the stranding of individual elements in order to obtain secure cohesion. On the other hand, in order to improve the method according to the first aspect

of the present invention, it is intended that a bundle or bunch should be fixed with at least one retaining helix simultaneously with the twisting of the individual cores.

Insulating materials familiar in cable manufacture may be employed for wrapping the bundle or bunch with at least one retaining helix. These materials may have the shape of a band or strap, or of any desired other profile, preferably of low height. If there are particularly stringent demands in respect of tensile strength, then correspondingly tension-resistant materials will be adopted, e.g. based on polytetrafluoroethylene or polyamide. In this context a braided or woven fabric, e.g., a lattice weave, of these materials, which is cut into the form of a band and applied spirally on to the gathered bundle or bunch, has been found particularly suitable.

In order to perform a method according to this second aspect of the invention, it is convenient to make use of an apparatus which incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores, means for driving the retention and stranding means in the requisite rotative mode, and retaining helix applying means comprising a reverse winder disposed between the first stranding point and the retention and stranding means, the latter comprising a rotary gripping jaw haul-off assembly effecting the stranding, and the interval between the end of the said assembly and the second stranding point being substantially an even-number multiple of the transition distance specified in the first paragraph of the present description. A winder as just mentioned, having a very small overall length, permits a minimum interval between the first stranding point (stranding nipple) and the haul-off assembly effecting the stranding.

It is further advantageous, particularly to make possible a compact production installation, to accommodate a straightening device (roller straightening machine, which can be used to straighten cores hauled off from stationarily mounted core supplies), a stranding nipple providing the first stranding point, and a winder for the one or more retaining helices, in a single housing. It is also convenient to employ a straightening device having longitudinal mobility with respect to the stranding nipple. This can have a striking effect upon the stranding process in the stranding nipple. An optimum selection of the entry angle of the individual cores can be achieved by this means.

The second aspect of the invention will be explained more fully with reference to Figure 3 of the accompanying diagrammatic drawings. Figure 3 shows an installation for stranding cores of large cross-section, e.g. cores of "low tension" distribution cables in the 1 kV service voltage range.

In Figure 3, cores 101 are constituted e.g. by mutually stranded individual wires (multiple-wire sector conductors); they are therefore flexible

stranding elements in the generally accepted sense. Said cores 101 are hauled off, in the number prescribed for the finished product concerned, from stationarily mounted supplies, not shown, and fed through a roller straightening device 102, which is followed by a further device comprising "prestranding" rollers 103, to a stranding nipple 104. The core inlays (fillers) and wedge gussets often incorporated in such cables may likewise enter with them. Immediately behind the stranding nipple, i.e., whilst the stranding process of the individual cores is still proceeding the bunch is wrapped with preferably two retaining helices 106. A reverse winder 105 of the known flat construction is employed for this purpose. Next the bunched strand comprising the stranded cores provided with the wrappings enters a gripping jaw haul-off means 107 revolving in an alternating direction of rotation (SZ). The stranding bundle or bunch is twisted along the path between the stranding nipple 104 and the first gripping element of the haul-off means 107.

After leaving the haul-off means 107, the stranded bundle or bunch comprising the cores 101 travels through a sheathing line 108, in which it is given e.g., an inner and an outer protective sheath. During this stage also the stranded bundle or bunch twists from the haul-off means 107 as far as a haul-off caterpillar 109 of the sheathing line; therefore any second twisting which would give rise to waviness in the shaped strand is eliminated. Beyond the haul-off caterpillar 109, the stranded and sheathed stranded bundle or bunch (cable) 111 runs on to a cable drum 110.

It is to be understood that in the case of Figure 3, as before, the interval between the end of the retaining means (107) and the second stranding point (109) is an even-number multiple of the transition distance (distance from entrance of 107 to end of 107).

By a "stranding point," we mean, in the present description and claims, a point of transition from a non-rotating system (e.g. a non-rotating conductor supply means) to a rotating system (here a stranding device), or, conversely, a point of transition from a rotating system (stranding device) to a non-rotating system (e.g. a haul-off device or collecting drum).

50 CLAIMS

1. Method of continuous stranding, effected with alternating lay direction, of electrical cables and lines comprising cores of large cross-section, either solid or assembled from individual wires, these cores being hauled off individually from stationarily mounted supplies, concentrated into a bundle or bunch at a first stranding point, and thereafter stranded in a substantially rectilinear condition within a prescribed path whilst travelling along the prescribed path, which is limited by a second stranding point; the material being advanced in the substantially rectilinear condition, within said path, along a transition distance which is a predetermined shorter path; the bundle or

65 bunch, after leaving the first stranding point, being peripherally frictionally gripped and retained along a length which amounts to only a fraction of the transition distance, and being stranded during the retention of a section of the bundle or bunch between the first stranding point and the retaining means, and each section thus stranded being retained in a torsion-free state in its stranded condition whilst travelling along the transition distance, before, after the stranded cores have been released from the retaining means, it is fed to the second stranding point; characterised in that the interval between the end of the retaining means and the second stranding point is substantially an even-number multiple of the transition distance.

2. Method according to claim 1, characterised in that, after leaving the retaining means, the stranded bundle or bunch passes through a sheathing installation before the second stranding point is reached.

3. Method according to claim 2, characterised in that at least an inner sheath producing a rounded effect is extruded on to the stranded bundle or bunch during its passage through the sheathing installation.

4. Method according to claim 3, characterised in that the stranded bundle or bunch is provided with banding before the extrusion of the inner sheath.

5. Apparatus comprising means for performing a method according to claim 1, characterised in that it incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores comprising a revolving gripping jaw haul-off assembly, and means for driving the retention and stranding means in the requisite rotative mode, the interval between the end of the said assembly and the second stranding point being substantially an even-number multiple of the transition distance specified in claim 1.

6. Apparatus comprising means for performing a method according to claim 1, characterised in that it incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores comprising two gripping jaw haul-off assemblies arranged consecutively in the direction of passage so as to revolve in the same direction and at the same speed, and means for driving the retention and at the same speed, and means for driving the retention and stranding means in the requisite rotative mode, the interval between the end of the second of the said assemblies and the second stranding point being substantially an even-number multiple of the transition distance specified in claim 1.

7. Apparatus according to claim 6, characterised in that carriages of the said assemblies are secured to chains, and form, conjointly with the latter, a chain caterpillar on both sides of the stranded bundle or bunch, and, in each pair of these carriages, one carriage is



stranding elements in the generally accepted sense. Said cores 101 are hauled off, in the number prescribed for the finished product concerned, from stationarily mounted supplies,

- 5 not shown, and fed through a roller straightening device 102, which is followed by a further device comprising "prestranding" rollers 103, to a stranding nipple 104. The core inlays (fillers) and wedge gussets often incorporated in such cables
- 10 may likewise enter with them. Immediately behind the stranding nipple, i.e., whilst the stranding process of the individual cores is still proceeding the bunch is wrapped with preferably two retaining helices 106. A reverse winder 105 of the
- 15 known flat construction is employed for this purpose. Next the bunched strand comprising the stranded cores provided with the wrappings enters a gripping jaw haul-off means 107 revolving in an alternating direction of rotation
- 20 (SZ). The stranding bundle or bunch is twisted along the path between the stranding nipple 104 and the first gripping element of the haul-off means 107.

- After leaving the haul-off means 107, the
- 25 stranded bundle or bunch comprising the cores 101 travels through a sheathing line 108, in which it is given e.g., an inner and an outer protective sheath. During this stage also the stranded bundle or bunch twists from the haul-off means 107 as far as a haul-off caterpillar 109 of the sheathing
- 30 line; therefore any second twisting which would give rise to waviness in the shaped strand is eliminated. Beyond the haul-off caterpillar 109, the stranded and sheathed stranded bundle or
- 35 bunch (cable) 111 runs on to a cable drum 110.

- It is to be understood that in the case of Figure 3, as before, the interval between the end of the retaining means (107) and the second stranding point (109) is an even-number multiple of the
- 40 transition distance (distance from entrance of 107 to end of 107).

- By a "stranding point," we mean, in the present description and claims, a point of transition from a non-rotating system (e.g. a non-rotating conductor
- 45 supply means) to a rotating system (here a stranding device), or, conversely, a point of transition from a rotating system (stranding device) to a non-rotating system (e.g. a haul-off device or collecting drum).

50 CLAIMS

1. Method of continuous stranding, effected with alternating lay direction, of electrical cables and lines comprising cores of large cross-section, either solid or assembled from individual wires,
- 55 these cores being hauled off individually from stationarily mounted supplies, concentrated into a bundle or bunch at a first stranding point, and thereafter stranded in a substantially rectilinear condition within a prescribed path whilst travelling
- 60 along the prescribed path, which is limited by a second stranding point; the material being advanced in the substantially rectilinear condition, within said path, along a transition distance which is a predetermined shorter path; the bundle or

- 65 bunch, after leaving the first stranding point, being peripherally frictionally gripped and retained along a length which amounts to only a fraction of the transition distance, and being stranded during the retention of a section of the bundle or bunch
- 70 between the first stranding point and the retaining means, and each section thus stranded being retained in a torsion-free state in its stranded condition whilst travelling along the transition distance, before, after the stranded cores have
- 75 been released from the retaining means, it is fed to the second stranding point; characterised in that the interval between the end of the retaining means and the second stranding point is substantially an even-number multiple of the
- 80 transition distance.

2. Method according to claim 1, characterised in that, after leaving the retaining means, the stranded bundle or bunch passes through a sheathing installation before the second stranding
- 85 point is reached.

3. Method according to claim 2, characterised in that at least an inner sheath producing a rounded effect is extruded on to the stranded bundle or bunch during its passage through the
- 90 sheathing installation.

4. Method according to claim 3, characterised in that the stranded bundle or bunch is provided with banding before the extrusion of the inner sheath.

5. Apparatus comprising means for performing
- 95 a method according to claim 1, characterised in that it incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores
- 100 comprising a revolving gripping jaw haul-off assembly, and means for driving the retention and stranding means in the requisite rotative mode, the interval between the end of the said assembly and the second stranding point being substantially
- 105 an even-number multiple of the transition distance specified in claim 1.

6. Apparatus comprising means for performing a method according to claim 1, characterised in that it incorporates core supply means, means
- 110 providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or bunch of cores comprising two gripping jaw haul-off assemblies arranged consecutively in the direction of passage
- 115 so as to revolve in the same direction and at the same speed, and means for driving the retention and at the same speed, and means for driving the retention and stranding means in the requisite rotative mode, the interval between the end of the
- 120 second of the said assemblies and the second stranding point being substantially an even-number multiple of the transition distance specified in claim 1.

7. Apparatus according to claim 6, characterised in that carriages of the said assemblies are secured to chains, and form, conjointly with the latter, a chain caterpillar on both sides of the stranded bundle or bunch, and, in each pair of these carriages, one carriage is



provided with a pin so positioned as to travel around the operational circuit of the carriage, and the other carriage is provided with a recess so positioned and dimensioned as to cooperate

- 5 with this pin, by receiving the pin to form a positive connection between the two carriages.

8. Method according to claim 1, substantially as described with reference to Figures 1 and 2 of the accompanying drawings.

- 10 9. Apparatus according to claim 6, substantially as described with reference to Figures 1 and 2 of the accompanying drawings.

- 15 10. Electrical cables and lines produced by a method according to claim 1, 2, 3, 4, or 8, or by means of an apparatus according to claim 5, 6, 7 or 9.

- 20 11. Method according to claim 1, characterised in that the cores concentrated into a bundle or bunch at the first stranding point, immediately after leaving the first stranding point, are continuously wrapped as a bundle or bunch conjointly with one or more retaining helices.

- 25 12. Method according to claim 11, characterised in that one or more insulating profile bands or strips are used as the one or more retaining helices.

13. Method according to claim 11, characterised in that one or more braided or woven fabrics are used as the one or more retaining helices.

- 30 14. Method according to claim 13, characterised in that one or more lattice weaves of tension-resistant insulating material are used as the one or more retaining helices.

15. Apparatus comprising means for

- 35 performing a method according to claim 11, characterised in that it incorporates core supply means, means providing a first stranding point, means providing a second stranding point, means for the retention and stranding of the bundle or

- 40 bunch of cores, means for driving the retention and stranding means in the requisite rotative mode, and retaining helix applying means comprising a reverse winder disposed between the first stranding point and the retention and stranding means, the latter comprising a rotary gripping jaw haul-off assembly effecting the stranding, and the interval between the end of the said assembly and the second stranding point being substantially an even-number multiple of the transition distance

- 50 specified in claim 1.

16. Apparatus according to claim 15, characterised in that a straightening device, a stranding nipple and a retaining helix winder are accommodated in a single housing.

- 55 17. Apparatus according to claim 16, characterised in that the straightening device is longitudinally mobile with respect to the stranding nipple.

- 60 18. Method according to claim 11, substantially as described with reference to Figure 3 of the accompanying drawings.

19. Apparatus according to claim 15, substantially as described with reference to Figure 3 of the accompanying drawings.

- 65 20. Electrical cables and lines produced by a method according to claim 11, 12, 13, 14 or 18, or by means of an apparatus according to claim 15, 16, 17 or 19.

PATENTS ACT 1977

SPECIFICATION NO 2061340B

The following corrections were allowed under Section 32 on 15 September 1983:

Front page, Heading (73) Proprietor *below* Proprietor *delete* whole lines *insert* Kabelmetal Electro
Gesellschaft Mit Beschränkter Haftung, Kabelkamp 20, Hannover, Germany

THE PATENT OFFICE

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