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ARRANGEMENT FOR INDUCTION HEATING

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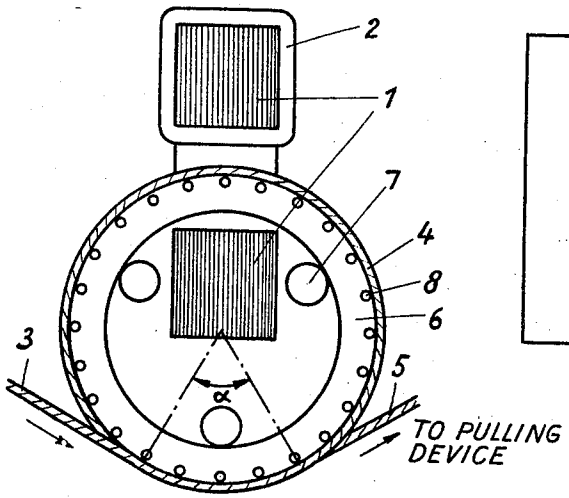


Fig. 1

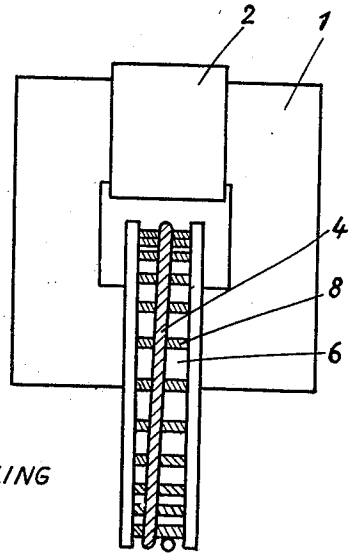


Fig. 2

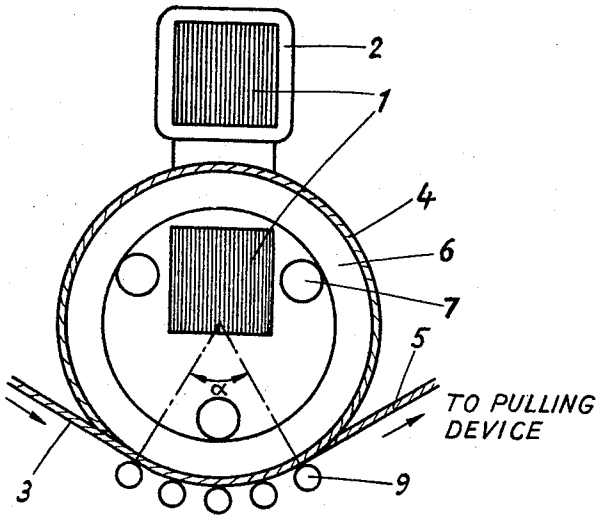


Fig. 3

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ARRANGEMENT FOR INDUCTION HEATING

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The present invention refers to an arrangement for heating of a continuously advanced metallic conductor in the form of a wire, band, strand or the like by means of electric current passage, the current required herefore being obtained by that said conductor encloses the iron core of a transformer with at least one turn, which is short-circuited by a contact arrangement, said turn forming the secondary winding of said transformer.

Within, i.a. the cable industry it is necessary to soft-anneal the cable conductor by some method at the production. The reason for this is that the conductor by cold working, e.g. drawing and forming, has experienced a change in the grain structure, which deteriorates the properties of the complete cable. This is valid both for the handling of the cable as the conductivity of the conductor material. Heating to a temperature suitable for soft-annealing can be done, i.a., by electric current of power frequency passing the conductor. The current can then be supplied to the conductor either directly through contact members or by induction. Both these processes are generally done by continuously advancing the conductor through the heating arrangement, whereupon the conductor is cooled in a water bath. According to the first-mentioned method the conductor passes over two contact arrangement situated at some distance from one another, the current being supplied to the conductor over these contact arrangements. Owing to the relatively great current, which here is the matter, and the obtained reactive potential drops, arc overs and arc marks may easily be obtained on conductor and contact members. As the use of too great currents will not be necessary, the distance between the contact arrangements must be made relatively long, for example 10–12 meters, which causes that this method requires a big space. Increased length of the heating distance makes decreased current possible at a certain conductor speed and conductor area. Great dimensions of the heating arrangement causes, however, increased reactance and therewith increased requisite transformer effect. The contact arrangements generally consist of wheels or rolls, and when the current is transmitted to them by wheel bearings or by aid of contact brushes, the wear and tear on wheel bearings respectively contact brushes will be great at high currents. Further there is a tendency of the current at conventional contact wheels to be especially concentrated in the first tangent point of the conductor on the wheel path owing to reactance phenomenon, so that arc marks easily are obtained. When a strand is to be heated by supplying current via contact wheels said tanget point between conductor and contact wheel will be successively displaced owing to the strand consisting of a number of twisted single wires so that the arc marks hereby get a bigger spreading.

According to the second method of heating the current is transmitted inductively to the conductor. At this method a transformer is used, the iron core of which is provided with a primary winding. The conductor to be heated passes at least one turn around the core and by means of a contact arrangement the turn is short-circuited so that it forms a secondary winding to the transformer. With this method the advantage is obtained that the high secondary current only appears in the conductor. Present known embodiments have, however, several disadvantages,

especially if a strand shall be heated too. The previously mentioned problems with arc marks can also be found here at the contact arrangement, which short-circuits the conductor part which passes in and out. Furthermore the mechanical embodiment of the arrangements is relatively complicated and difficult to handle. Besides, the strands and then especially such strands with great areas have been exposed to too sharp bendings along the heating length. These mechanical strains in connection to the heating result in the soft-annealed strand showing different properties in different parts of the strand.

The purpose of the present invention is to avoid the difficulties described above. According to the invention this can be done by that the contact arrangement is so formed that the conductor passes one or several turns around a ring or drum rotatably supported on rollers and enclosing the transformer core, which has a high electric resistance per se, said contact arrangement comprising electrically conductive objects which are parallel with the axis of the ring or drum, which objects rest against said conductor so that electric current transport between the conductor parts lying side by side is possible only in a direction mainly parallel with the axis of the ring or drum and in a layer concentrically cylindrical with the ring or drum along at least a part of the length where the conductor parts lie along one another.

The invention will be further described in connection to the accompanying drawing, where FIG. 1 shows a section through a contact arrangement according to the invention seen in a direction perpendicular to the motion direction of the conductor. FIG. 2 shows the same contact arrangement seen in the direction of motion of the conductor, and FIG. 3 shows a section through another embodiment of the contact arrangement seen in a direction perpendicular to the motion direction of the conductor.

The arrangement shown in FIG. 1 and FIG. 2 comprises a transformer core 1, provided with a primary winding 2. The transformer core is enclosed by a ring or drum 6, which is rotatably supported on rolls 7 so that it can freely rotate around the transformer core. The ring or drum is made of metal or insulating material and is so formed that it per se does not not form a closed electric circuit around the core. A great number of bar-formed metal segments 8, preferably of copper or copper alloy, are placed on the same distance from one another in the outer cylindrical surface of the ring. The segments are so arranged that their axis are mainly parallel with the axis of the ring. The segments are further electrically insulated from one another and from the ring. On top of the cylindrical surface formed by the segments the conductor 4 to be heated passes. The part of the conductor going towards the ring is indicated 3 in FIG. 1 and the conductor part leaving the ring is indicated 5. The conductor is extended on the ring in one or several turns. At small conductor areas the conductor passes several turns around the ring to make better use of the transformer effect in this way. At great conductor areas it is, however, sufficient to let the conductor pass only a whole turn round the ring and further a certain length of a second turn. This length, which is represented by the arc along which the incoming and leaving conductor parts lie side by side corresponding to a certain centre angle, in FIG. 1 indicated α, forms the contact place. The turn formed by the conductor is short-circuited by the segments, which are in contact with both conductor parts in this contact place, which corresponds to an angle of the magnitude 30°–120°. The optimum value of this angle will be about 70°. To suppress the arcing, which can appear in the contact place at very high currents, the contact place has been placed under the surface of the cooling water in which the conductor is cooled after being

heated. The diameter of the segment path of the ring is of the magnitude 0.5–1.5 meters. The big diameter makes passing also of strands with very great areas through the arrangement possible without damaging them through the bending. Strand areas of the magnitude 240–300 millimeters may be possible.

Another form of embodiment of the contact arrangement is shown in FIG. 3. Instead of using metal, segments arranged in the outer cylindrical surface of the ring, friction rollers **9** of metal, for example copper or copper alloy, are used in this arrangement to produce electric contact between the incoming conductor part **3** and the outgoing conductor part **5**. Like the segments these rollers are directed so that their longitudinal direction is mainly parallel with the axis of the ring. The rollers, which are arranged one after the other, are by means of spring force displaceable towards the drum so that their cylindrical outer surfaces can press against the two conductor parts along the length, where the conductors lie side by side. This length is formed by the arc which in FIG. 3 corresponds to the angle α.

At a contact arrangement according to the invention the current charge will be distributed equally amongst the segments or friction rollers along the whole contact length. Reactance and resistance is equal along a turn from symmetrical reasons whether a current path closes over the first, the last or one of the segments lying between them within said contact length. Hereby a concentration of the current to the first tangent point of the conducton on the wheel path is avoided, where arc marks otherwise easily are obtained.

The invention has been described primarily bearing in mind soft-annealing of a line of copper or aluminum for a heavy current cable. However, it is possible to apply the method on each continuous process, which refers to heating of metallic conductors in the form of wire, band, strand, profiles or the like to a wanted temperature without passing over the purpose of the invention.

We claim:

1. A device for electrically heating successive portions of a bendable blank metallic conductor in a continuous operation, said device comprising a transformer having an iron core and a primary winding upon said core, an annular member made of high resistance material encompassing part of said core, means supporting said member rotatable about the encompassed core part, a plurality of elongated members made of electrically conductive non-magnetic metal disposed at the outer peripheral side of said annular member circumferentially spaced and oriented substantially parallel with the rotational axis of said annular member, said elongated members being electrically insulated from each other and the annular member, whereby, upon exciting said transformer winding and winding successive turns of said conductor on and off said annular member, elongated members in contact with a conductor turn short circuit such turn by bridging conductor portions juxtaposed on the annular member, said bridges forming a current path substantially parallel to the rotational axis of the annular member and constituting a layer concentric with the periphery of said annular member.

2. A device for electrically heating successive portions of a bendable blank metallic conductor in a continuous operation, said device comprising a transformer having an iron core and a primary winding upon said core, an annular member made of high resistance material encompassing part of said core, means supporting said member rotatable about the encompassed core part, a plurality of electrically conductive, non-magnetic metal bars mounted on the periphery of the annular member parallel to the axis thereof and circumferentially spaced, said bars being insulated from each other and the annular member, whereby, upon exciting said transformer winding and winding successive turns of said conductor on and off said annular member in contact with the bars thereupon, said bars short circuit a turn of the conductor on said annular member by bridging conductor portions juxtaposed on the bars, said bridges forming a current path parallel to the rotational axis of the annular member and constituting a layer substantially concentric with the periphery of said annular member.

3. A device for electrically heating successive portions of a bendable blank metallic conductor in a continuous operation, said device comprising a transformer having an iron core and a primary winding upon said core, an annular member made of high resistance material encompassing part of said core, means supporting said member rotatable about the encompassed core part, a plurality of elongated members made of electrically conductive, non-magnetic material disposed adjacent the outer peripheral side of said annular member in peripherally spaced relationship and oriented substantially parallel to the rotational axis of said annular member, said elongated members being yieldably biased toward contact with said outer peripheral side and being electrically insulated from each other and the annular member when in contact therewith, whereby, upon exciting said transformer winding and winding successive turns of said conductor on and off said annular member, elongated members biased into contact with conductor portions juxtaposed on the annular member short circuit said portions by bridging the same, said bridges forming a current path parallel to the rotational axis of the annular member and constituting a layer substantially concentric with the periphery of said annular member.

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