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METHOD OF PRODUCING ANNEALED STRANDED CABLE

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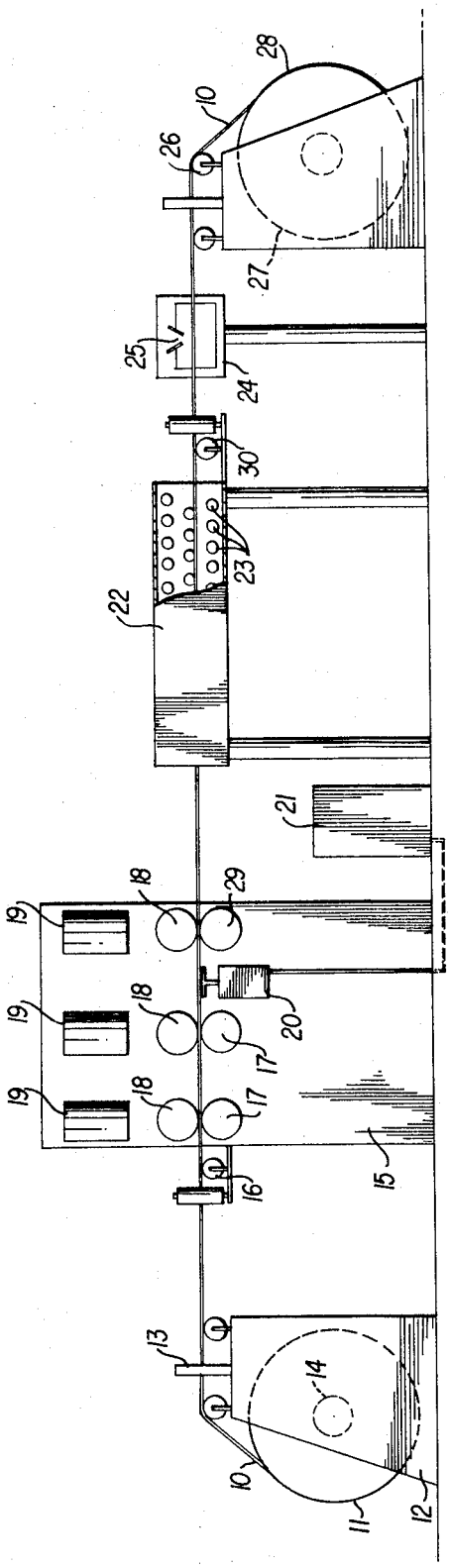

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METHOD OF PRODUCING ANNEALED STRANDED CABLE

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ABSTRACT OF THE DISCLOSURE

A method of continuously annealing stranded electrically conductive cable comprising the steps of passing unannealed stranded cable into an electrical resistance annealer, annealing the stranded cable, cooling the stranded cable and lubricating the stranded cable. Heat for annealing the cable is produced by electrical resistance between the contact rolls of the annealer and the cable. Annealing temperatures are controlled by varying the current to the contact rolls of the annealer.

SUMMARY OF THE INVENTION

This invention relates to a method whereby electrically conductive uninsulated stranded wire, or cable, is annealed, cooled, dried and lubricated in a continuous operation, thereby made ready for subsequent processing such as extrusion of insulation onto the annealed stranded wire or cable.

In prior art stranding and annealing processes, single strand uninsulated electrically conductive wire is annealed continuously or in a batch furnace before it enters the stranding apparatus. In these processes each individual strand of wire must be annealed separately, not in multi-strand form, in order to give each individual strand the required properties and temper prior to stranding. Prior art processes have been unable to successfully anneal stranded cable continuously because of their inability to control variables such as cable tension; annealing current, temperature, and time; cable temperature; varying pressure required at each electrical contact to maintain the cable in a certain posture during annealing, while at the same time preventing fraying of the cable; etc., which are necessary for the proper metallurgical and electrical properties of the cable.

Stranded wire or cable can be annealed in a batch furnace, but with certain limitations and disadvantages. In a batch annealing furnace some areas of the furnace contain more intense heat than other areas. This causes the wire or cable to be annealed at different rates of temperature, resulting in varied degrees of annealing. One spool of wire may be annealed at the correct rate of temperature, but other spools of wire in different areas of the furnace would not be annealed to the desired temper.

One object of this invention is to provide an improved method of annealing stranded cable.

Another object of this invention is to provide a method of producing stranded cable which is annealed subsequent to the stranding operation, thereby creating a more uniformly annealed stranded cable.

Other objects and advantages of this invention will be more apparent from the following specification taken in conjunction with the included drawing.

BRIEF DESCRIPTION OF THE DRAWING

The drawing is a side elevation view showing the flow of stranded cable and the payoff, resistance annealer, cooling trough, lubrication device and take-up apparatus used in the improved method of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the present invention stranded wire or cable, **10**, on spool **11** is placed on a tension pay-off, **12**, such as a Ceeco #70–554 Shaftless Pay-off. Pay-off **12** is equipped with sensor **13**, which senses the amount of tension exerted on cable **10**, and electrical and mechanical controls **14** which maintain a constant predetermined tension on stranded cable **10** by controlling the rotational speed of pay-off **12** and spool **11**. Cable **10** enters electrical resistance annealing apparatus **15** by way of guide rollers **16**, which guide the cable into a groove formed between contact rolls **17** and pressure rolls **18** of annealer **15**. Annealing of cable **10** can be accomplished by a prior art apparatus such as a #400–H4 H.P. Norling resistance annealer. Annealer **15** is equipped with electrical contact rolls **17** in series which provide the electrical energy to heat the stranded cable by means of electrical resistance between contact rolls **17**, pressure rolls **18** and cable **10**. Positive contact on the cable is maintained by a pressure roll, **18**, above each contact roll **17**.

The contact pressure is varied according to the specific needs of the cable passing through resistance annealer **15** by means of a variable pressure air cylinder, **19**, located above each pressure roll **18**. The final set of contact rolls, **29**, on resistance annealer **15** act as a bleed-off point for induced current thereby preventing damage to the other electrical equipment in the system. Cable temperature is determined by an infrared scanner sensor, **20**, such as a Barnes Engineering model IT–3 Infrared Sensor. Sensor **20** feeds the cable temperature information into a control panel, **21**. Control panel **21** varies the current intensity to contact rolls **17** in response to the cable temperature information from sensor **20**, thereby maintaining the predetermined temperature necessary for proper annealing of cable **10**.

After exiting the final contact rollers, **17**, of resistance annealer **15**, cable **10** travels to quench trough **22** for cooling. Quench trough **22** is equipped with a series of liquid spray heads, **23**, that may be either opened or closed independently in order to cool cable **10** to a point at which residual heat will dry the excess liquid on the cable while the cable remains sufficiently cool to prevent excessive contraction upon further cooling to ambient temperature, thereby preventing take-up spool collapse. For economic reasons the most advantageous liquid coolant for use in quench trough **22** is water. Take-up spool collapse can occur when the cable that is wound on the take-up spool has too high a temperature, i.e. the wound cable cools and contracts, thereby collapsing the center of the take-up spool.

Upon exiting cooling trough **22** by way of guide rollers **30**, cable **10** enters a lubricant application device, **24**. A liquid lubricant is sprayed through opening **25** onto cable **10** to prevent possible galling of the cable in subsequent processing. Preferably the lubricant applied to the cable is a mineral-base lubricant. An unlubricated cable is likely to gall against contact portions of apparatus during subsequent processing, such as a die for extrusion of insulation onto the cable. After exiting lubricant application device **24** cable **10** passes through guide rollers **26** onto a take-up, **27**, such as a Ceeco #70–320 traversing take-up. The cable is traversed onto a spool, **28**, at a constant linear speed to allow minimum variations of the metallurgical properties of the cable due to time and temperature fluctuations.

The method of this invention can be advantageously practiced on cables manufactured from most electrically conductive metals. The most preferred results are obtained when the method of this invention is practiced on cables manufactured from copper, aluminum and steel and alloys of these metals.

Thus through this improvement in the method of annealing stranded cable, a higher rate of production is obtained, and a stranded cable is produced having more consistent electrical conductivity and metallurgical properties.

For purposes of clarity this invention has been described herein as a method of annealing stranded cable which has been removed from a spool prior to annealing and collected on a spool after annealing, however it is not limited thereto. The method of this invention may be practiced in a continuous line of processing cable, i.e. such as receiving cable continuously from a stranding apparatus, annealing the cable by the method of this invention, and passing the annealed cable without a pause in motion to an apparatus which applies insulation to the cable.

The following terminology used in this application is explained as follows:

Stranded wire or cable—a product composed of two or more strands of wire, that is long in relation to its cross-section, and is twisted or intertwined such that the respective strands of wire at successive cross-sections along the length of the cable form a symmetrical geometric pattern. Cable normally has a cross-section greater than 0.050 inch.

What is claimed is:

1. A method of continuously annealing stranded electrically conductive cable which comprises:

(a) passing unannealed stranded cable into an electrical resistance annealer;

(b) annealing the stranded cable;

(c) cooling the stranded cable; and

(d) lubricating the stranded cable.

2. The method of claim **1** including the steps of paying off the unannealed stranded cable from a spool into the electrical resistance annealer; and collecting the annealed, cooled and lubricated stranded cable on a take up spool.

3. The method of claim **2** including the steps of

(a) sensing the tension exerted on said cable;

(b) controlling the amount of rotation of the pay off spool by a tension pay off apparatus responsive to signals from a tension sensing means; and

(c) maintaining a predetermined tension on said cable.

4. The method of claim **2** wherein said cable is collected traversely at a constant linear speed onto the take up spool.

5. The method of claim **1** including the step of guiding said cable into the electrical resistance annealer by means of guide rollers.

6. The method of claim **1** including the step of annealing said cable by heat produced from electrical resistance between electrical contact rolls and pressure rolls of said annealer and said cable, said contact rolls arranged in series and relative to said pressure rolls such that a groove is formed therebetween of sufficient size to retain said cable therein.

7. The method of claim **6** including the step of controlling the pressure exerted by each of said pressure rolls individually by means of a variable pressure air cylinder attached to each pressure roll.

8. The method of claim **6** including the step of removing induced current from said cable by the last contact roll of the series.

9. The method of claim **6** including the steps of:

(a) sensing the temperature of said cable during the annealing step; and

(b) controlling the temperature of said cable by varying the current intensity to the contact rolls in response to signals from a temperature sensing means.

10. The method of claim **1** wherein said cable is cooled by application of liquid to said cable.

11. The method of claim **10** wherein said cable is cooled to a temperature at which the residual heat will dry excess liquid thereon while said cable remains sufficiently cool to prevent excessive contraction upon further cooling to ambient temperature.

12. The method of claim **1** wherein said cable is lubricated with a liquid lubricant.

13. The method of claim **1** wherein the electrically conductive cable is manufactured of copper.

14. The method of claim **1** wherein the electrically conductive cable is manufactured of aluminum.

15. The method of claim **1** wherein the electrically conductive cable is manufactured of steel.

16. The method of claim **1** wherein the electrically conductive cable is manufactured from an alloy selected from the group consisting of copper alloys, aluminum alloys and steel alloys.

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