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[54] **METHOD OF PRODUCTION OF MULTISECTIONAL FILAMENT COILS AND CONTROL SYSTEM OF A COILING MACHINE OPERATING ACCORDING TO THIS METHOD**

[76] Inventors: **Jan Balbatun**, Szenwalda 1/22; **Antoni Makarewicz**, Gwardii Ludowej 13/3, both of Koszalin, Poland

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[51] **Int. Cl.**.....**H01b 13/00**, H01b 13/08
[58] **Field of Search**.....57/16–18, 3, 6, 57/9, 13–15, 19, 34 AT, 156, 160

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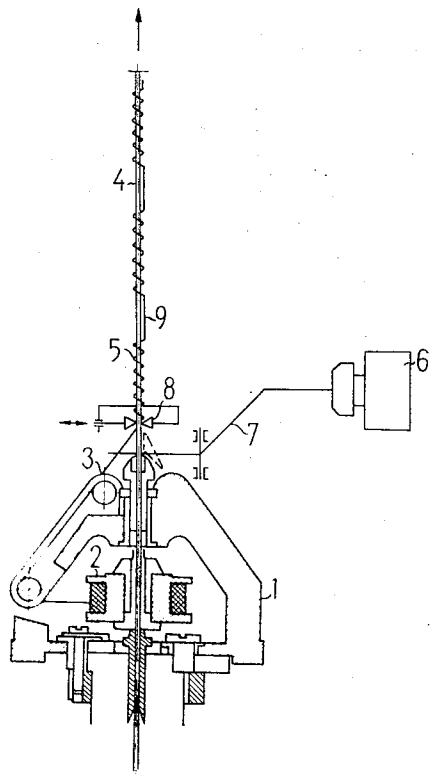
Primary Examiner—John Petrakes
Attorney—Eric H. Waters et al.

[57] **ABSTRACT**

Filament coils with coil sections and intermediate section of a straight wire are formed by winding the wire onto an advancing core to form the coil sections, halting the winding of the wire during the initial phase of formation of the intermediate sections and reversing the direction of wind of the wire through a predetermined angle during the final phase of formation of the intermediate sections. Thereby the wire will be formed straight and parallel to the core and substantially free of stress. The drive of the core and wire are controlled by an electronic control system equipped with counters regulating the number of coil turns, pitch, and length of intermediate sections.

8 Claims, 2 Drawing Figures



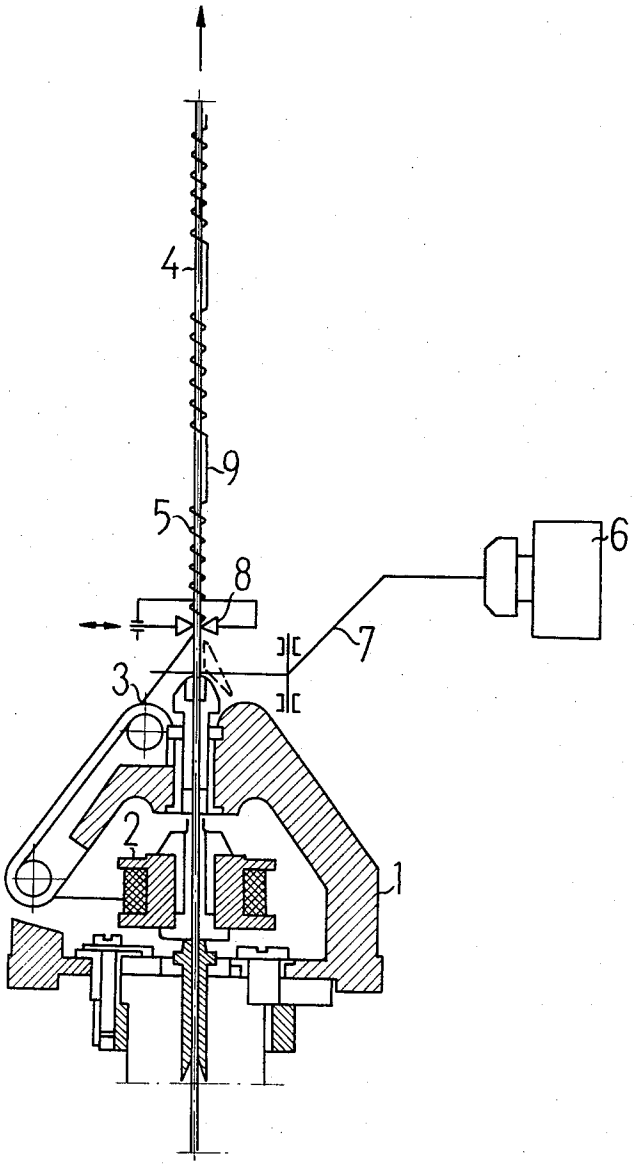


FIG. 1

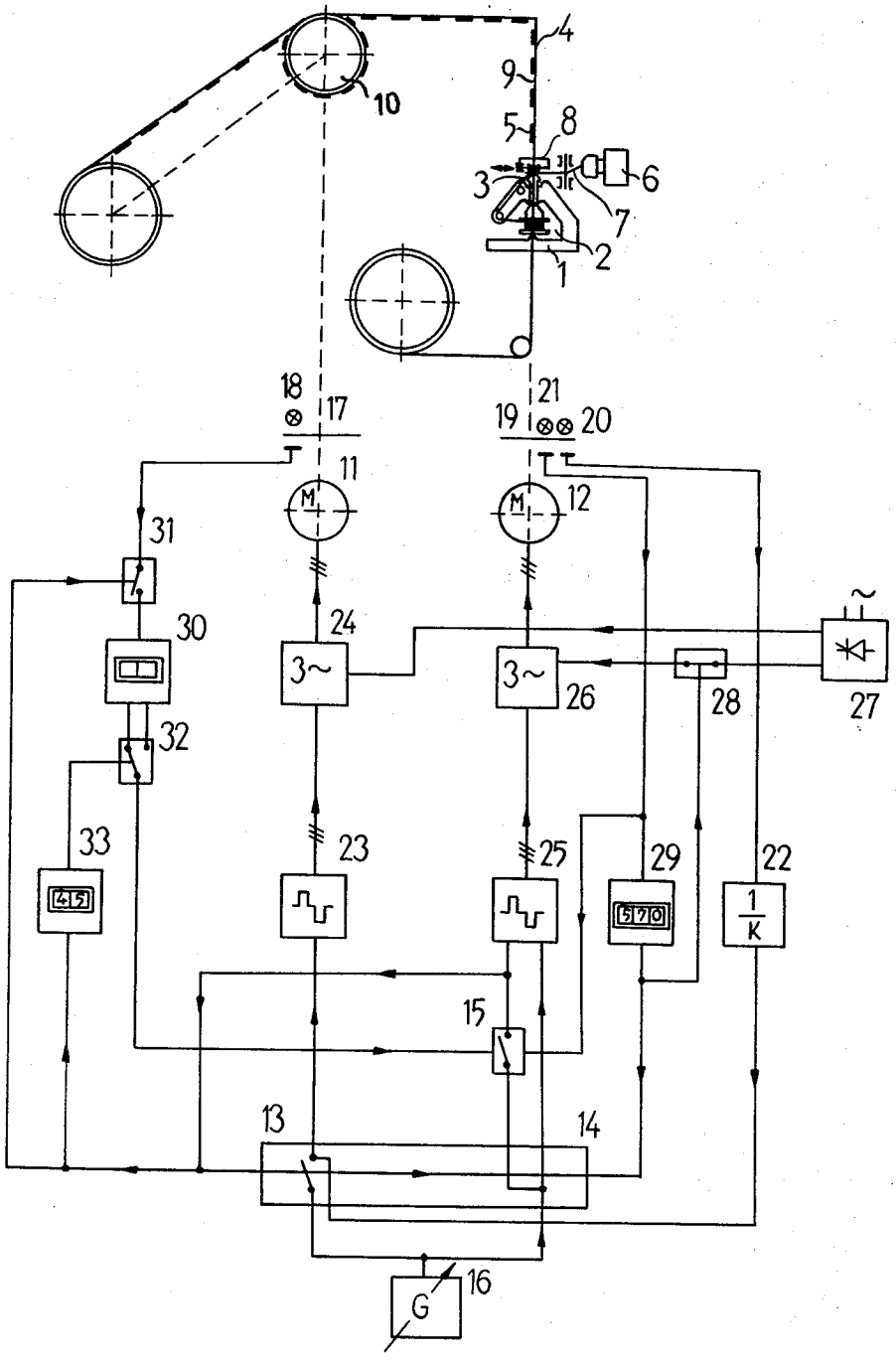

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FIG. 2

METHOD OF PRODUCTION OF MULTISECTIONAL FILAMENT COILS AND CONTROL SYSTEM OF A COILING MACHINE OPERATING ACCORDING TO THIS METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method of production of multisectional filament coils and to a control system of a coiling machine operating according to this method.

Filament coils with intermediate sections consist of sections of helical coils connected with rectilinear sections of winding wire, and are especially designed for filaments of incandescent lamps.

2. Description of the Prior Art

The manufacture of said coils by means of known devices consists in winding a winding wire on a core wire performing a translatory motion, and at the time of forming the intermediate member, the rotation of the spindle is stopped in order to form an approximately straight section of the winding wire in the intermediate section.

The control system of the coiling machine is adapted to coiling machines in which the spindle drive gear and the core wire feed gears are driven by separate motors.

In order to obtain a product which can be easily cut and the filaments automatically mounted it is necessary that the intermediate section has the form of a straight section of the winding wire parallel to the axis of the filament coil. In the known devices the intermediate section is formed by pressing the winding wire against the core wire (the spindle being stopped) by means of at least two pressing elements spaced over the length of the intermediate section. This pressing operation makes it impossible to form a coil in the intermediate section, the pressing elements effecting a strong straightening of the winding wire in the intermediate section in order to obtain a rectilinear member.

In the known machines, the process of manufacturing the multisectional filament coils is performed by means of devices in which the spindle is connected with a driving gear through an electromagnetic clutch. To control the clutch, adjustable counters are provided, one of which counts the revolutions of the drive-side part of the clutch, and the second of which counts the revolutions of the spindle. An adjustable counter counting the revolutions of the spindle is operative when forming the coiled section, and determines the preset number of coil turns for the coiled section, whereafter it interrupts the drive from the spindle-sided part of the clutch to form the intermediate section.

The adjustable counter counting the revolutions of the drive-side part of the clutch, performing perpetual rotations, is operative only for the time of forming the intermediate section and determines its preset length, whereafter it starts the rotations of the spindle in order to form the subsequent filament coil. The pitch of the coil depends on the ratio of the rotational speed of the spindle to the translatory speed of the core wire, and it is regulated through variations of one of said speeds, in most cases by changing the gears in the feed gear.

The described methods of forming the intermediate section produce in the winding wire internal forces which are not compensated and which when released produce deformations of the finished coil, making it impossible to obtain proper products, mainly due to the deformation of the pitch, especially of the end turns of the coiled section, and deformations of the winding wire in the intermediate section. The production of a straight intermediate section is impossible with the known methods.

Moreover, the conventional control devices are subject to considerable inertia and non-reproducible characteristics in transient states, effecting thus still greater irregularity of the coil turn pitch. It is impossible to vary the coil turn pitch, as well as other characteristics of the filament during operation of the machine.

All the mentioned disadvantages are causes of material losses and of decrease in the quality of the product. Moreover, the conventional devices are troublesome in service, do not permit a full automation of the coiling machine and thus have low capacity.

SUMMARY OF THE INVENTION

An object of the invention is to eliminate the above disadvantages. This is achieved by forming the intermediate section by means of specially selected winding motions, and through application of an electronic control system for the coiling machine.

The method of manufacturing filaments with intermediate sections, according to the invention, consists in that in the final phase of forming the intermediate section a reverse rotation of the spindle is effected, through a preset angle. This provides conditions to position the winding wire along one generating line of the core wire, parallel to the filament axis, and without stressing the winding wire.

After performing the reversal, the spindle rotates in the normal winding direction while the pressing element, actuated by an electromagnet, is pressed against the core-wire, the winding movement of the spindle forming a straight coil-free intermediate section, between the pressing element and a clamp spaced from it by the length of the intermediate section.

The control system of the coiling machine is characterized by periodic operation electronic switches controlling connection of drive motors and a generator.

The motor driving the feed of the core wire is upon forming the coiled section controlled with impulses from a spindle rotation converter over a frequency divider, which performs the preset division of impulses to obtain the required pitch of the coil turns. During forming of the intermediate section, the feed motor is controlled from the generator via an electronic switch to obtain an increased feed speed.

The spindle motor is started by means of an electronic switch of periodic action and an electronic switch controlling the reversal of the spindle rotation.

The spindle rotation converter with an impulse output is connected with a counter of the number of coil turns, which actuates the switches switching over the arrangement on forming the intermediate section. This system also comprises a converter of motor rotor rotation of the feed motor into impulses. Over an electronic periodic action switch it is connected with a counter of the length of the intermediate section, which actuates the electronic switches switching over the arrangement on winding the coiled section. The intermediate section length counter can be also controlled directly with changes of the voltage supplying the synchronous feed

motor. The intermediate section length counter has two outputs, for long and short intermediate sections, switched over by an electronic switch controlled by a counter of the number of intermediate sections.

As a result of the method according to the invention there is ensured the obtaining of a product with required characteristics, i.e., with an intermediate section of winding wire which is straight, not deformed, and with coils of proper coil turn pitch. This makes it easy to cut the filaments and to mount them automatically.

By application of a coiling machine with an electronic control system it is also possible to adjust the coil turn pitch during operation of the device, as well adjust other quantities such as the length of the intermediate section; thus the operation can be completely automated. Material losses are eliminated and the quality of product is increased.

The coiling machine with the electronic control system is easy in operation and has high capacity, due to reduction of the inertia of rotary masses and to application of an increased feed in the phase of forming the intermediate section.

The method of production of coils with straight intermediate sections according to the present invention, as well as the control system of the coiling machine will be now described more particularly by way of an exemplary embodiment with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a fragmentary side elevation view partly in section of a coiling machine according to the invention; and

FIG. 2 is a diagrammatic illustration of the coiling machine and the control system thereof.

DETAILED DESCRIPTION

Referring to FIG. 1 therein is shown a coiling machine to form filaments composed of a core wire 4 with coiled sections 5 wound thereon and intermediate sections 9 between the coiled sections 5.

The coiled sections 5 are formed by winding wire 3 from reel 2, by means of rotating spindle 1, onto core wire 4 which is being axially fed through the spindle 1.

On completion of winding of the coiled section 5 the rotary motion of the spindle 1 is stopped. The winding wire 3 is pressed against the core wire 4 with a pressing element 7 actuated by an electromagnet 6 and by clamps 8. The clamp 8 can perform translatory motion together with the core wire 4 and clamps the winding wire 3 at the guide, at the beginning of forming the intermediate section 9. The element 7 is then released from the wire 4. Further translatory motion of the wire core 4 causes forming a triangle composed of the core wire 4, the winding wire 3 and the spindle radius 1. When the preset length of the intermediate section 9 is achieved, the spindle is rotated in a direction opposite to that of winding coiled section 5.

This reversal of the spindle 1 provides conditions adequate for laying the winding wire 3 along a generating line of the core wire 4, without developing any straightening stresses. Then the pressing element 7 is pressed against the core wire 4 by the electromagnet 6 and the intermediate section is formed between pressing element 7 and clamp 8.

The spindle undergoes reversal through a preset angle and then starts to rotate in the winding sense. Thus the winding wire 3 when clamped between the element 7 and the core wire 4 forms a straight intermediate section 9 between the element 7 and the clamp 8.

The core wire 4 is advanced by a drum 10 driven by a synchronous motor 11. The spindle 1 is driven by the motor 12.

The control system of the coiling machine comprises periodically operated electronic switches 13, 14, 15, controlling the drive of motors 11 and 12 from a generator 16. Both on the shaft of the sindle 1 and on the shaft of the feed motor 11 there are mounted rotation converters in the form of conventional photoelectric pulse devices co-operating with disks. On the shaft of the feed motor there is fitted a disk 17 with a single hole in its circumference, co-operating with the photoelectric device 18. On the spindle shaft there is fitted a disk 19 having at one circumference sixty equally spaced holes co-operating with the photoelectric pulse device 20, and one hole at another radius cooperating with the photoelectric pulse device 21. During forming of the coiled section 5 the feed motor 11 is controlled from the pulse device 20 through an adjustable frequency divider 22, calibrated in units of coil turn pitch, a commutator 23 transforming single-phase current into three-phase current, and a converter 24.

During forming of the intermediate section, the feed motor 11 is controlled from the generator 16, through the electronic switch 13, the commutator 23, and the converter 24. The motor 11 speed increases then, thus the feed is also increased.

During forming of the coil, the spindle drive motor 12 is controlled from the generator 16, through the electronic switch 14 when forming the coiled sections 5, or when reversing during forming of the intermediate sections 9, through the electronic switch 15 the commutator 25, and the converter 26.

The converters 24 and 26 are supplied from a source 27 through a periodic electronic switch 28. The control system additionally comprises a counter 29 of the number of coil turns actuated by impulses from the pulse device 21, which counts the number of revolutions of the spindle 1 during forming of the coiled section 5. The counter 29 is of conventional construction and after having subtracted a preset value it switches over the arrangement for forming the intermediate section 9.

The control system also comprises an adjustable counter 30 for regulating the length of the intermediate section, controlled from the pulse device 18 through a periodic electronic switch 31. The counter 30, after having subtracted pulses equal to a preset value, switches over the electronic switch 15 for reversal. Thereafter the impulse from the pulse device 21 switches over the arrangement for forming the subsequent coiled section 5. The counter 30 of the length of the intermediate section has two outputs, for two adjustable lengths of the intermediate section. These are switched over by an electronic switch 32 controlled by a counter 33 of the number of intermediate sections. The counter 33, having subtracted the preset value of the number of short intermediate sections, switches over the switch 32 to form long intermediate sections.

In order to prepare the coiling machine for manufacturing filaments having 200 turns in its coiled section, with a pitch of 50/μm, and having a short intermediate section of 2 mm, and a long intermediate section of 6 mm, after every three short sections, the following settings must be performed:

The counter **29** of the number of turns is set to a value of **200**, the adjustable frequency divider **22** is set to **50**, the counter **30** of the length of the intermediate section, calibrated in units of the feed length, is set to values of **2** and **6**, and the counter **33** of the number of intermediate sections is set to a value of **3**.

In operation of the system, during forming of the coiled section **5**, the feed motor **11** of the core wire is controlled with impulses from the pulse device **20** of spindle rotations, through the frequency divider **22**, which divides the impulses in order to obtain the ratio of the spindle rotations to the feed speed giving a pitch to the coil of 50/μm, through the commutator **23** and the converter **24**. The spindle motor **12** is controlled from the generator **16** through the electronic switch **14**, the commutator **25**, and the converter **26**. The converters **24** and **26** are supplied from supply **27**. The counter **29** counts the number of revolutions of the spindle up to the preset value 200.

During forming of the coiled section **5** the switches **14** and **28** are closed. The switches **13**, **15** and **31** are open. The adjustable counter **29**, having subtracted the 200 revolutions of the spindle (200 coil turns in the coiled section), gives an impulse to switch off the switches **14** and **28**, and to switch on the switches **13** and **31**. The spindle stops, and the forming of the intermediate member **9** begins.

The feed motor **11** is now controlled from the generator **16** through the electronic switch **13**, the commutator **23** and the converter **24**. The feed motor **11** rotates with increased speed, causing an increase of the feed of the core wire.

The counter **30** counts the length of the intermediate section number of revolutions of the feed motor, and as the preset value of 2 mm is achieved it switches over the electronic switches **15** and **28** to perform the reversal, which lasts until the converter **21** gives an impulse. The converter **21** switches over the entire system on forming of the coiled section, and so it switches on the switch **14**, and switches off the switches **13** and **31**.

During manufacturing of the filament, the counter **33** counts the number of intermediate sections which are formed (number of switchings of the switch **31**) up to the preset value of 3, and then gives an impulse to switch on the switch **32**, and to switch over the counter **30** to the long intermediate section of 6 mm. The machine makes the long intermediate section and the operating cycle is then repeated.

What is claimed is:

1. A method of producing filament coils with straight intermediate sections, said method comprising winding a wire onto an axially advancing core to form a coil section, stopping the winding of the wire and clamping the wire against the advancing core to allow a straight portion of wire to advance with the core, winding the wire in the reverse direction through a preset angle to make said straight wire portion extend parallel to the core, clamping the end of the straight wire portion against the core to form a straight intermediate section and thereafter unclamping the wire and winding the wire onto the core in the original direction to form the next coil section.

2. A method as claimed in claim **1** comprising increasing the speed of axial advance of the core during the formation of said straight wire portion.

3. Apparatus for producing filament coils with straight intermediate sections, said apparatus comprising first drive means for axially advancing a core, a rotatable spindle for winding a wire onto the advancing core to form coil sections, second drive means for said spindle, a first clamp means for clamping the wire against the advancing core, a control means for stopping the second drive means and the rotation of the spindle, when the wire is clamped against the core by the first clamp means so that a straight portion of wire is advanced with the core, said second control means reversing the second drive means, to cause the spindle to rotate the straight portion of wire through a predetermined angle so that the straight wire portion extends parallel to the core, a second clamp means for clamping the end of the straight wire portion against the core to form a straight intermediate section, said first and second clamp means then being released and said control means then reversing the direction of drive of the spindle to form a subsequent coil section.

4. Apparatus as claimed in claim **3** wherein said first and second drive means each comprises a motor, a common generator being provided for the motors, said control means comprising a periodic electronic switch means selectively connecting the motors to the generator, and a second periodic electronic switch means for controlling the changes in direction of the motor of the drive means for the spindle.

5. Apparatus as claimed in claim **4** wherein said control means comprises a pulse generator for producing pulses for rotations of the spindle, and a frequency divider connected to the pulse generator and controlling operation of the first drive means during forming of said coil sections, said first drive means being connected to said generator via the first said switch means during formation of the intermediate sections.

6. Apparatus as claimed in claim **5** wherein said control means comprises a second pulse generator for producing pulses for rotations of the spindle, and first counter means connected to said second pulse generator for counting the number of coil turns of each coil section, the first counter means being connected to said first switch means to switch the state thereof upon formation of the intermediate section.

7. Apparatus as claimed in claim **6** wherein said control means further comprises a third pulse generator for producing pulses for rotations of the motor of the first drive means, a second counter means for measuring the length of the intermediate section, a third electronic switch means between said second counter means and said third pulse generator, said third electronic switch means being controlled by said first counter means to close when the coil sections are formed, said second counter means being connected to the second switch means to change the state thereof upon forming of the coil section.

8. Apparatus as claimed in claim **7** wherein said second counter means has first and second outputs for different lengths of intermediate sections, a third

counter means of the number of intermediate sections being provided and a fourth periodic electronic switching means connected to the third counter means for selectively switching over the outputs of the second counter means when a predetermined number of intermediate sections has been counted.

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