

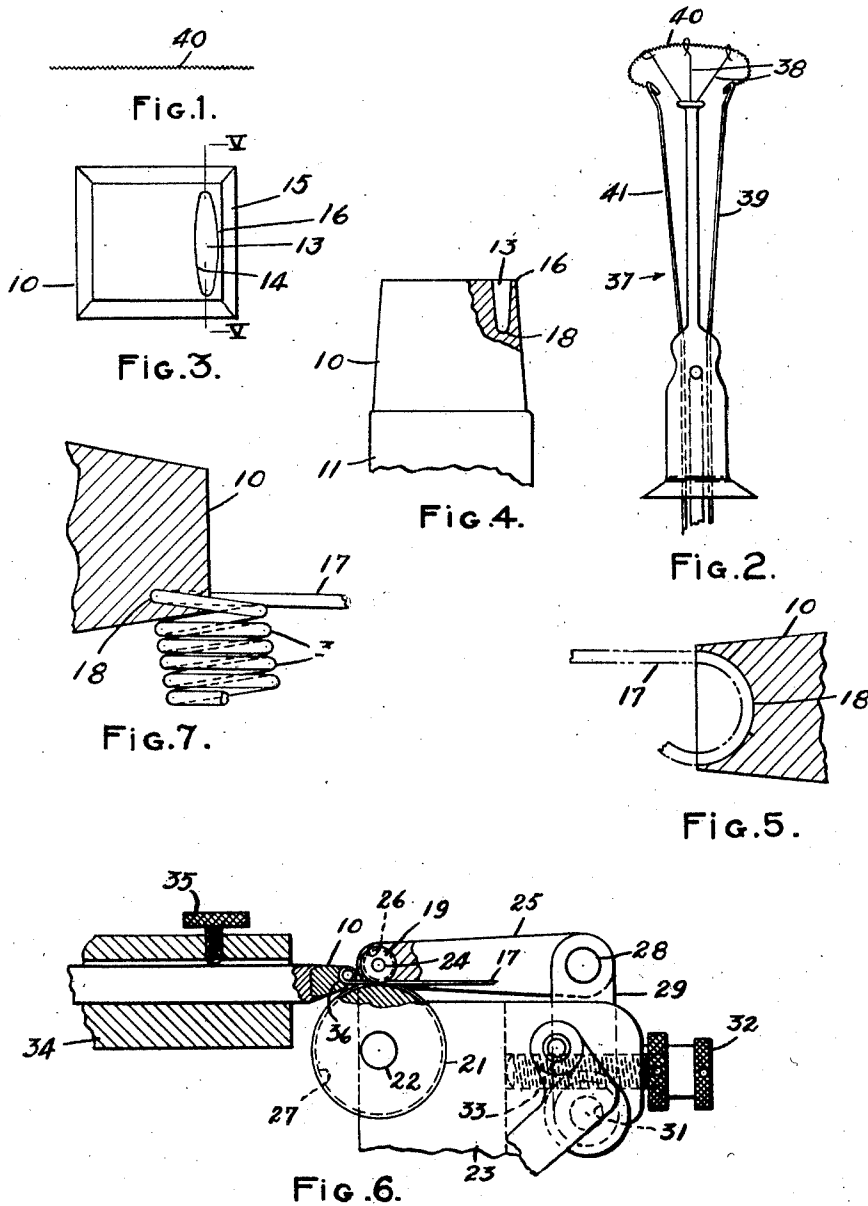
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FILAMENT FOR INCANDESCENT ELECTRIC LAMPS

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FILAMENT FOR INCANDESCENT ELECTRIC LAMPS

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This invention relates to the production of a coiled filamentary body and is a division of my application Serial No. 121,156 filed July 8, 1926, now Patent 1,670,499, issued May 22, 1928, in which a machine is set forth and described for the formation of filamentary bodies in the absence of a mandrel.

Before the advent of the invention set forth in the above mentioned application, the winding of a coiled filament required the use of a mandrel which was subsequently removed from the coil by immersion in an acid bath. This winding of a filamentary wire on a mandrel resulted in an article, that is, a coiled body, possessing certain detrimental characteristics imparted thereto by reason of this form of winding. In the winding of a filamentary body without the aid of a mandrel, it has been found that the resultant coiled body possesses certain advantageous characteristics which are particularly desirable when employing the coiled body as a filament for an incandescent electric lamp.

An object of the present invention is, therefore, to produce an article such as a coiled filamentary body free from the detrimental effects accompanying coils as produced heretofore and in production of a filamentary body of exceedingly small diameter, coiled in the absence of a mandrel.

When referring to a fine or filamentary wire, such wires are meant as those which range from about $\frac{1}{2}$ a mil or less to about 5 mils in diameter.

The winding of this extremely fine wire, which may herein be termed filament wire, to produce a filamentary body is necessary where a very small helix is required, such, for example, as that employed as a light source in an incandescent electric lamp and the present invention, although capable of producing fine coils for other uses, will be shown and described in connection with the production of an article such as a light source as above mentioned.

The development of the incandescent electric lamp industry has produced a lamp employing what is termed a concentrated light source. The manufacture of this element has heretofore been accomplished by the aid of a

mandrel, a fine wire being wound thereon into a continuous helix of an indefinite length and cut into sections of given lengths, depending upon the wattage desired in the lamp in which the coiled section or light source is to be incorporated.

When producing a light source or section of coiled filament for use in a lamp of a given wattage, certain conditions must be carefully observed and strictly adhered to.

The length of the selected diameter filament wire contained in the light source must be exact so that the proper resistance will be obtained for a given wattage lamp, which length must be contained in a helix of a given number of turns, the pitch of the helix must be maintained uniform and the outside diameter of the helix held constant.

In the winding of the fine filamentary wire as employed in connection with the making of lamp filaments wound upon a mandrel, it is necessary, in a determination of the rating, to consider the stretching of the wire during the winding operation.

Owing to the variation in the properties of wire such as tungsten from which coiled filaments are made, the degree of stretching varies with a consequent variation in the diameter of the filament wire and when the same is used in coiled form as a light source, a resultant variation exists in the temperature of different portions of the light source giving what is known in the lamp art as "spots", which often causes a premature termination of the useful life of the lamp.

In the winding of a filament without a mandrel in accordance with the present invention, no tensional stress is imposed upon the filament wire since the same is not pulled but guided into the die for the formation of the convolutions to produce a helix.

A coiled filament, therefore, made by the present method will contain a wire of substantially the same cross-sectional area as existed in the wire prior to winding. This is a decided advantage since no variables occur and rating data for a lamp of a given life may be arrived at and coils wound with the assurance that all coils will be alike. When winding with a mandrel the stretch-

ing of the wire made it necessary to run long tests prior to the production of coils for a given lamp in order that the amount of stretching for a given lot or spool of wire might be determined. Even with the exercise of extreme care and many tests, variations frequently prevailed since the wire often contained portions of different degrees of hardness with the result that a wire having an ununiform cross-sectional area was found in the mandrel-wound coil. Another difference between the mandrelless and mandrel-wound wire is that the mandrel-wound wire is slightly depressed on the side contacting with the mandrel thus changing its cross-sectional area from circular to that of a flattened circle. This means that the area is increased and a greater wattage is dispensed than would ordinarily be true for such wire if used without winding on a mandrel. This condition must, therefore, be taken into consideration and offers another uncertainty to be reckoned with. The absence of a mandrel obviously permits the production of a coiled wire without the above mentioned distortion to the end that an improved new and useful product is attained.

A function of a lamp is to volatilize tungsten, the larger the size of tungsten wire employed as the coiled filament, the longer the life of the lamp. Inasmuch as the cross-sectional area of a mandrel-wound filament is increased, the filament length must be shorter than the filament length of the uniform cross-sectional wire as a mandrelless wire, when taken for a given lamp. The use of a shorter wire for the mandrel-wound coils means that there is less material to be volatilized and a lamp made from said shorter filament will have shorter life.

Furthermore it is of great importance to produce a coiled filament with a permanent set. By this it is meant that the filament, when mounted in a lamp and flashed, retains its length and does not "droop" or sag. It has been found that a filament made in accordance with the present invention may be flashed without the attending sagging or drooping as occurs with a filament wound upon a mandrel.

The manner of driving the filament wire to the die as employed by the present machine puts a stress gradient in the wire which when the filament is heated tends to improve the crystal structure of the wire. The stress is effected by a compression upon one side of the wire by one of the driving rollers and the distortion thus results in a subsequent change in the crystalline character of the wire to promote its resistance to sag.

In order to fully recognize the conditions to be contended with, it may be pointed out that when producing a coiled filament for a 60 watt lamp, for example, it is necessary to employ a wire having a diameter of .0025 of

an inch and to coil the wire into a helix with about 563 turns so as to obtain a given length of wire affording a resistance in accordance with the wattage required.

Furthermore, the pitch of the helically wound wire must be maintained positively uniform throughout the winding so that when the helix is cut into sections, each section may contain a given length of wire and be free from zones of dissimilar temperature when the section of filament is in operation as a light source in an incandescent electric lamp. In addition to the foregoing, it is necessary that a coiled lamp filament be produced at a cost comparable with the manufacture of other lamp parts and it is, therefore, necessary to effect the helical winding of the wire at a relatively high rate of speed.

In order to produce such a filament within the permissible range of manufacturing costs, it is essential that the extremely fine filament wire be handled and wound somewhere in the neighborhood of 10,000 turns or more per minute.

A light source produced in accordance with the present invention is not only desirable from a manufacturing standpoint, insofar as a reduction in the cost is concerned, due partly to the elimination of the undesirable step of subjecting each section of filament or light source to an acid bath as heretofore necessary for the removal of a mandrel, but it has been found that greater accuracy as to uniformity of pitch, outside diameter, together with the other advantages hereinbefore set forth are attainable than with the old process.

The present article is produced by the use of a die block having an elongated cavity positioned adjacent to one edge thereof. The bottom surface of the cavity from end to end is of concave form and the wire to be wound is thrust endwise into the cavity at a point adjacent to one end thereof. The curvature of the cavity is such that the wire under a propelling force is given a reverse bend or convolution. As the wire passes out from the cavity, it is led over an edge thereof which provides a lip or separator to space each convolution of the wire and to determine the pitch of the helix thus formed. The wire may be driven by any suitable means such as a pair of force or driving rollers disposed on opposite sides of the wire so as to frictionally engage the same therebetween.

A guide may be employed to direct the wire into the cavity, but in the preferred form of the invention, as disclosed in the aforementioned application, the driving means are so positioned that the wire is driven directly into the cavity. When a pair of driving rollers are employed, they are driven in opposite directions at the same peripheral speed and one roller is preferably made slightly smaller than the opposite roller, thus by reason of the difference in contact between the

two rollers, the wire is given a slight bend in accordance with the subsequent bend it takes upon entering the die, thereby aiding in the formation of the helix.

Although a machine for producing the present coiled filamentary body is more clearly shown and described in the above mentioned co-pending application, an understanding of the method of production of such article may be had from the following description and the accompanying drawings in which:

Fig. 1 represents a coiled filamentary body such as an incandescent electric lamp filament as produced in accordance with the present invention.

Fig. 2 is a side view of an electric incandescent lamp stem and illustrates one practical use of the present article.

Fig. 3 is a plan view of the die employed for bending a wire to produce a coiled filamentary body.

Fig. 4 is a side view of the die shown in Fig. 3 and is partly broken away to show the die cavity.

Fig. 5 is a sectional view of the die, taken on line V—V in Fig. 3 and shows the application of a wire to the die cavity.

Fig. 6 is a fragmentary view of a portion of a mandrelless coil winding machine and shows the relation of the power or driving rollers to the die or wire bending member and

Fig. 7 is a sectional view of the die shown in Figs. 3 to 5 and illustrates the formation of the coil as it issues from the die cavity.

In producing a coiled filamentary body, a die-member or so-called die-block 10 may be provided which may be constructed of steel and in one piece with a shank or die-holder 11. It is preferable, however, to form the die of a material possessing a high degree of hardness such as found in a sapphire or a diamond. The die may be made by forming a cavity 13 in the die-block 10, the cavity may have an elongated mouth 14 disposed adjacent to one side 15 of the block so disposed with respect to the end of the block that a lip 16 is provided, at least one portion of the lip being formed to provide a knife edge. The bottom 18 of the cavity is rounded and concave from end to end as shown in Fig. 5.

A wire 17 may be guided through a predetermined path to the cavity and caused to travel around the concave bottom portion 18 thereof and guided over the lip 16 which serves as a separator-member to space the successive convolutions formed.

As shown, a pair of force or wire propelling rollers 19 and 21 are provided to drive the wire 17 into the cavity 13 of the die-block 10, the initial contact of the wire being made at one side of the cavity. The lower roller 21 constitutes the driving roller and is secured to a shaft 22, journaled in a bracket or bearing 23. The shaft may be connected

to any suitable mechanism (not shown) to effect a rotation of the driving roller 21. The upper roller 19 is of relatively small diameter and may be rotatable upon a shaft 24 journaled at one end of a rockable bearing 25. Rollers 19 and 21 are provided with grooves 26 and 27 respectively to guide the wire 17 and of such depth that the wire is gripped or pinched between the rollers. As illustrated, the rockable bearing 25 is pivoted at 28 on an arm 29, pivoted at 31 in the bracket 23. A threaded set screw 32 extending from the arm 29 threadedly engages an aperture 33 in the bracket 23. An adjustment of the set screw makes it possible to attain an adjustment of the force roller 19 to align the same vertically with respect to the force roller 21. The shank 11 of the die-block 10 is slidable in a guide 34 and may thus be adjusted and held in place by a set screw 35. An operation of the machine to drive the wire 17 into the die 10 causes the wire to issue in a series of convolutions 36 as shown in Fig. 7.

As will be readily seen, the filament wire 17 is moved through a substantially unidirectional path and is caused to enter the die cavity at a point adjacent to an end thereof. A continued movement of the wire results in the same being diverted from its initial path and by reason of the formation of the surface of the cavity, the end of the wire is given a reverse substantially circular bend so as to produce a convolution. A continued movement of the wire from its normal path results in a repetition of the bending action giving a succession of convolutions.

For the purpose of producing a helix with the turns thereof in a given spaced relation, the lip 16 is provided and so disposed that each convolution when formed is guided from the lip so as to slightly deflect the wire from the normal path of movement which would otherwise result upon a continuous travel of the wire from the curved surface of the cavity, in which case the turns of the helix formed would be in contact. The lip, therefore, serves to space the convolutions and produce a coiled filamentary body suitable for use as a light source in an electrical incandescent lamp.

The wire may be continuously driven into the die to produce a coiled filamentary body of an indefinite length; this body may be severed into sections of the proper length to produce an article such as the filament 40 shown in Fig. 1. This article may be subsequently applied to a lamp stem 37 and may be mounted on support wires 38, leading-in-wires 39 and 41 being connected to the ends of the filament in the usual manner.

Although a continuous length of filament may be subsequently severed into the proper length sections by the usual cutting devices, it is preferable to first measure a length of

filament and then wind the same, causing an actuation of cutting mechanism when the proper length or section has been wound. Mechanism for performing this operation is
5 clearly shown and described in the above mentioned co-pending application.

As hereinbefore set forth, the production of a coiled filamentary body by means not requiring a mandrel, results in an article having
10 inherently different properties or characteristics than occur when a mandrel is employed. When winding a fine wire or filament upon a mandrel, it is necessary to either rotate the spool or source of wire about the
15 mandrel or to rotate the mandrel and at the same time, move it endwise or in the direction of its longitudinal axis.

It is, of course, necessary to produce a helix of the same inside diameter as the outside diameter of the mandrel upon which it is wound, it is therefore essential to apply a wire to the mandrel while the wire is under tension. The pull necessary to properly dispose the wire upon the mandrel causes a change in the dimensions of the wire during the coiling operation. For example, the tensional stress supplied slightly stretches the wire and since the wire, such as tungsten, used for lamp filaments varies in its degree of hardness at various portions thereof, it is evident that the stretching effect will be greater in some portions than others. A coiled filamentary body when wound on a
35 mandrel will, therefore, possess variations in the diametrical dimensions of the wire from which the body is formed. Furthermore, the exceptionally close contact required between the mandrel and the filament causes a further distortion of the filament by slightly flattening the surface of the filament wire, particularly in such portions having the least degree of hardness. Ordinarily the use of a coiled body would not be effected by these minute variations in the diameter or by any internal stress which might be imparted to the coil. A coiled filamentary body to be employed as a light source must, however, be free from the above variations in order that the coils as produced may meet the rating data set down in accordance with the standard factory requirements.
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When winding a filament by the present method, that is, in the absence of a mandrel, the filament wire is not subjected to any
55 tensional stress but is merely guided through a helical path and the force supplied is in the nature of a thrusting action and avoids such distortions as the flattening of portions of the filament wire as above mentioned. It is evident that the present coil will be free from tensional stress and inasmuch as no mandrel exists about which the coil must be wound, the successive convolutions take their final set without internal tension. Since the coiled
65 filament has a permanent set, the heating

thereof when in a lamp will not result in a release of internal forces which cause an extension or contraction of the coiled section which action is opposed to the result desired in lamp making. The article produced by the present method, therefore, as practiced to provide a light source, gives a more uniform product, attaining a new and useful result. 70

As above mentioned, it is essential to produce a filamentary body formed from exceedingly fine wire. This is made possible by the use of the above described method of driving a wire endwise into a cavity die and in guiding the wire as it issues from the die into a plurality of successive spaced convolutions. It is possible by reason of the present invention to coil a wire having a diametrical dimension of a $\frac{1}{2}$ mil or less and to produce filamentary bodies of wire varying in diameter up to 5 mils. 75 80 85

In the winding of this fine diameter wire, it has been found that by the use of a large and small driving roller the difference in the contacting area of the rollers causes a slight variation in the degree of bend on opposite sides of the wire, thus aiding in the coiling operation, and when the coil is formed, the unequal stress applied serves to cause the wire when heated during use to resist the so-called "sagging effect". Furthermore, the use of the small sized roller permits the disposition of the die in close relation to the gripping surfaces of the rollers so that the method employed includes the close relation of the die to the rollers so that the thrust is applied to a relatively small section of the wire and is more effective in producing the bend to divert the wire into a series of convolutions. 90 95 100

The present invention has brought about a decided advanced step in the art of making fine coiled filamentary bodies and particularly in the art of manufacturing such bodies which must be made with accuracy as to diameter and pitch as, for example, when producing a filament or light source for an incandescent electric lamp. 105 110

Although a preferred embodiment of the present invention has been described and illustrated, it is obvious to those skilled in the art that modifications may be made therein which fall within the spirit and scope of the appended claims. 115

What is claimed is:

1. A filamentary body composed of a wire free from tensional stress having a diametrical dimension of between $\frac{1}{2}$ to 5 mils coiled to helical form by a pushing operation. 120

2. A filament for an incandescent electric lamp comprising a wire coiled to helical form by a pushing operation to avoid tensional stress in the wire and having a diametrical dimension of approximately from $\frac{1}{2}$ to 5 mils. 125

3. A filament for an incandescent electric lamp comprising a wire coiled to helical form 130

by a pushing operation thereby producing a wire without internal stresses, whereby it is not subject to twist during a flashing operation.

5 In testimony whereof, I have hereunto subscribed my name this sixteenth day of December, 1926.

JOHN WILLIAM EKSTEDT.

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