May 22, 1928. 1,670,499

J. W. EKSTEDT

MACHINE FOR MAKING FILAMENTARY BODIES

Filed July 8, 1926 4 Sheets-Sheet 1

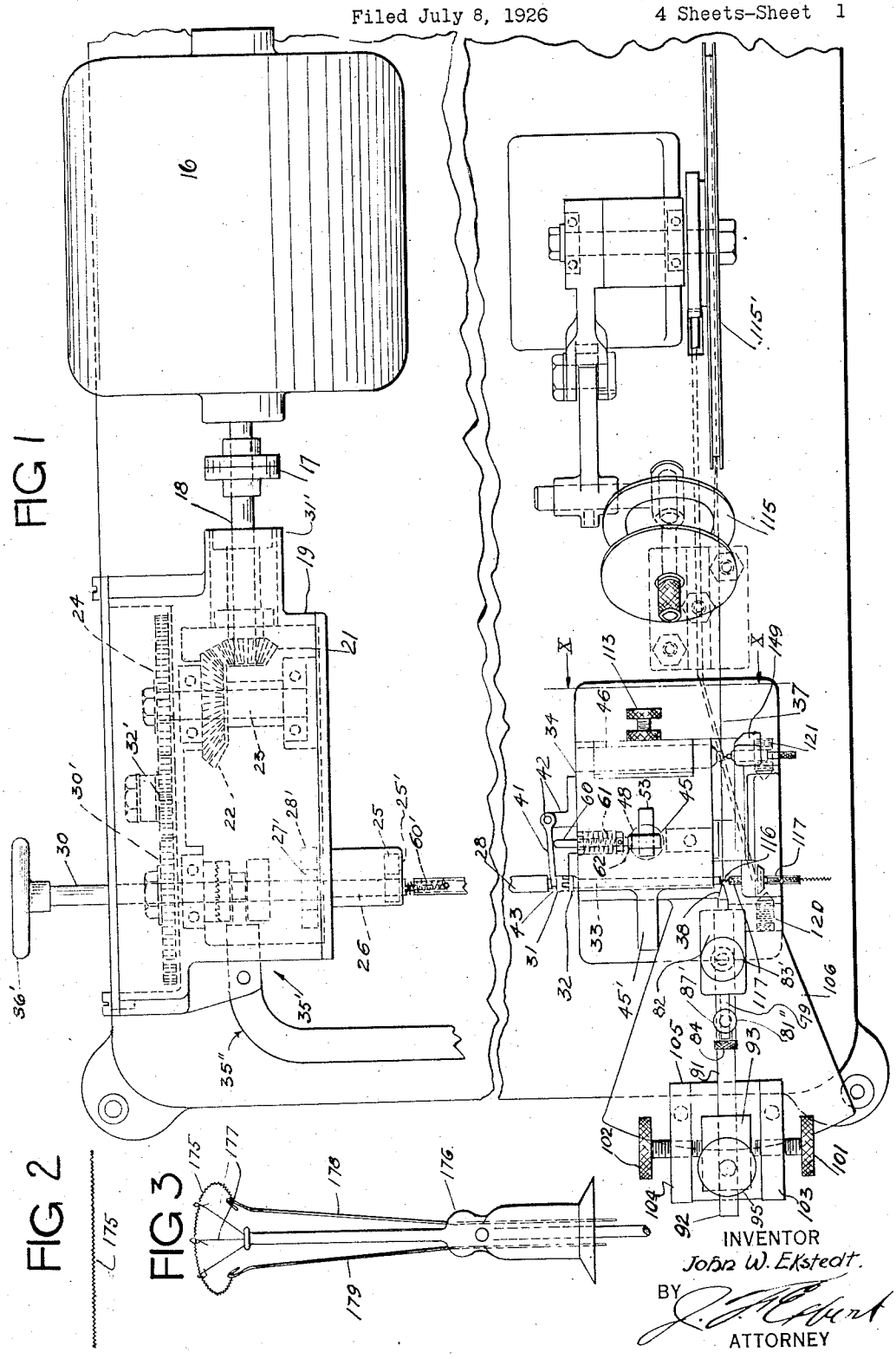


FIG 1

FIG 2

FIG 3

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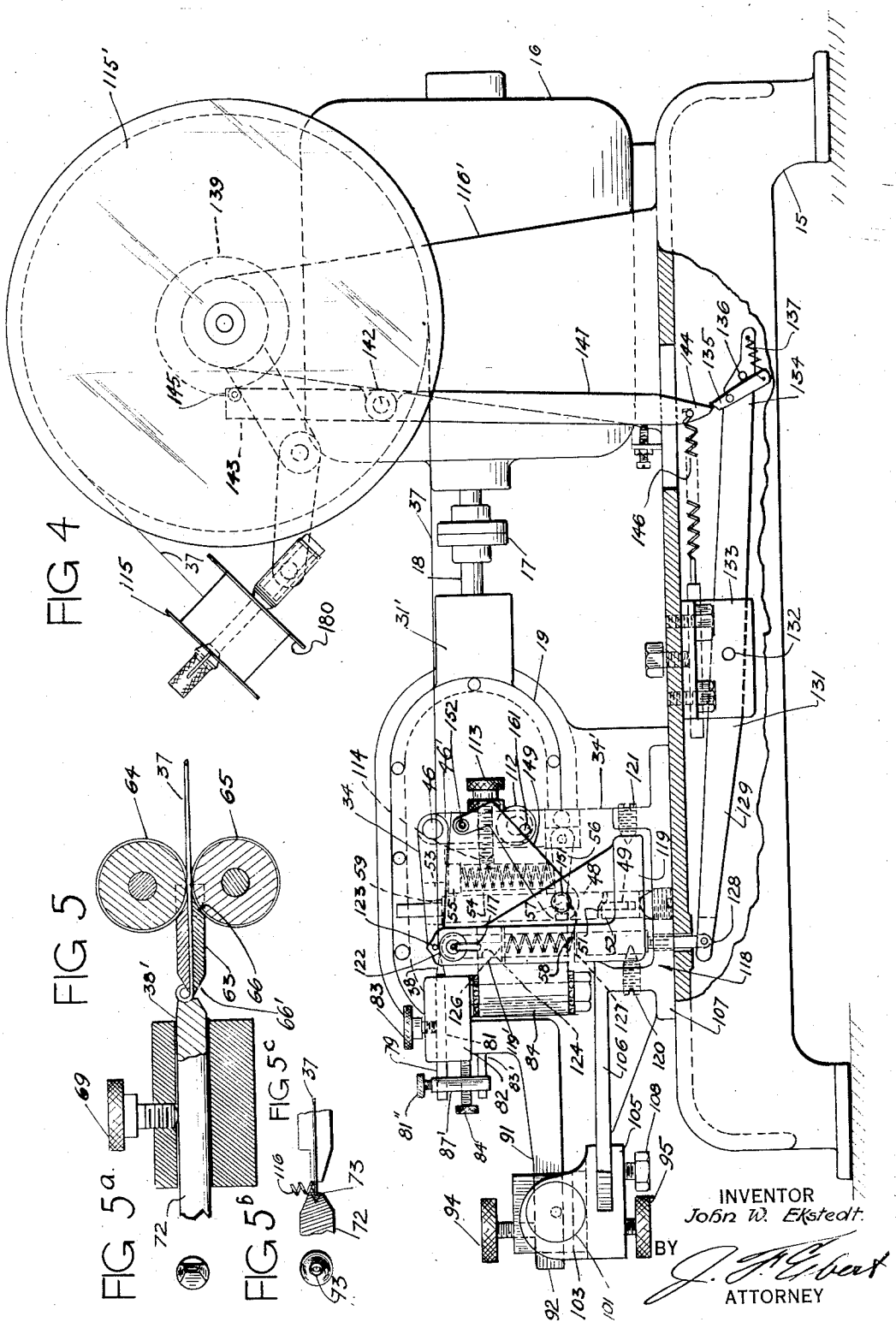


FIG 4

FIG 5

FIG 5a.

FIG 5b

FIG 5c

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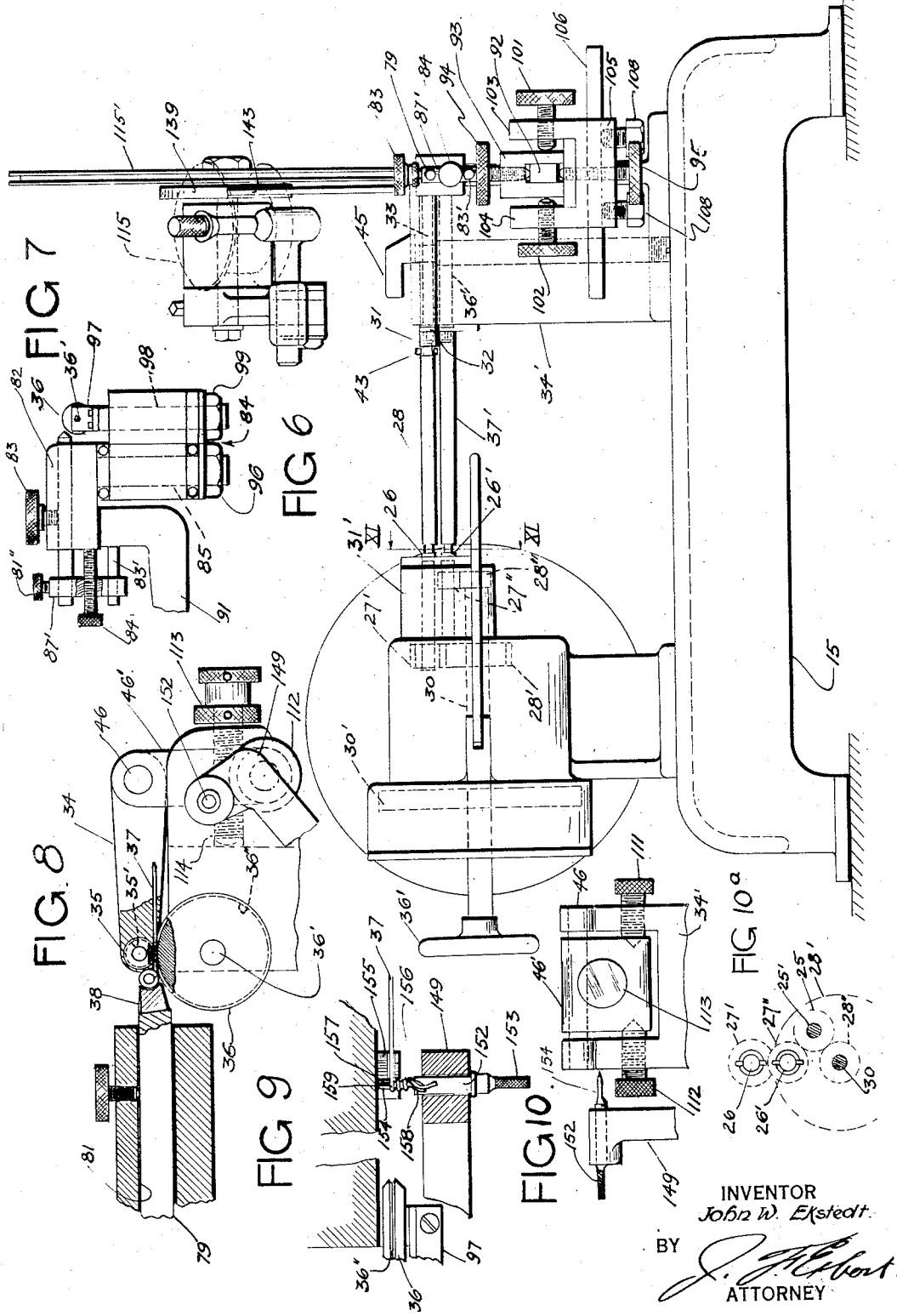


FIG 6

FIG 7

FIG 8

FIG 9

FIG 10

FIG 10a

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MACHINE FOR MAKING FILAMENTARY BODIES

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FIG 11

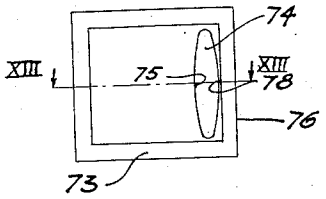


FIG 12

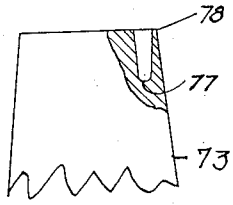


FIG 13

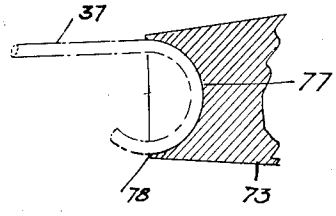


FIG 14

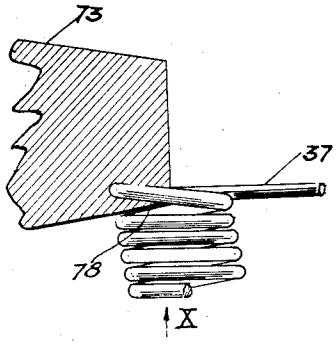


FIG 15

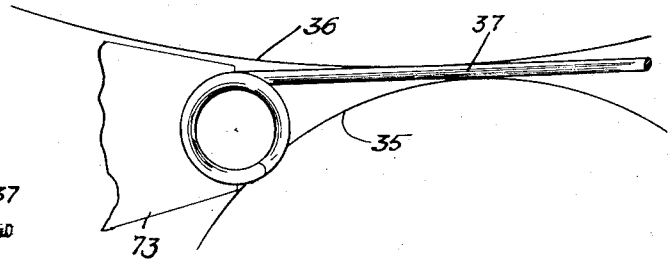
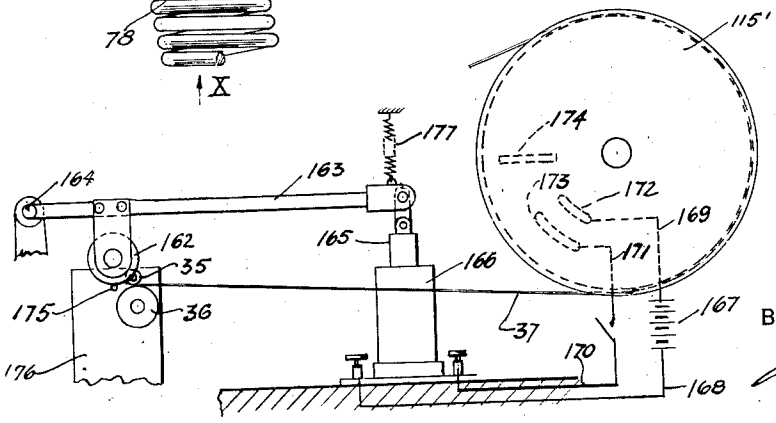


FIG 16



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UNITED STATES PATENT OFFICE.

JOHN W. EKSTEDT, OF BELLEVILLE, NEW JERSEY, ASSIGNOR TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA.

MACHINE FOR MAKING FILAMENTARY BODIES.

Application filed July 8, 1926. Serial No. 121,156.

This invention relates to the production of fine coiled filamentary bodies and is a continuation in part of my application Serial No. 651,218, filed July 13, 1923.

Great difficulty has been experienced in producing exceedingly small diameter bodies of helical form made from fine hair-like wire, particularly where it is desired to produce such bodies without the use of a mandrel during the coiling operation.

An object of the present invention is, therefore, to produce a coiled filamentary body without the use of a mandrel and in the provision of a method and apparatus for the attainment of said object.

When referring to a fine or filamentary wire, such wires are meant as those which range from about ½ 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 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 manufacture of a helical filament meeting factory requirements, it has been, as above stated, the practice to wind the fine filament wire on a mandrel. This method, of course, entailed the subsequent removal of the mandrel before the filament could be used in a lamp. Usually the mandrel is made of brass or iron and removed by immersing the mandrel wound coils in an acid such as hydrochloric acid until the mandrel has been dissolved and thus removed.

This process is both laborious and time-consuming and adds materially to the cost in the production of coiled filaments, at the same time leaves the ever present possibility of the acid treatment harming the filament material.

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 stretching 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, varia-

tions 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 wound cross-sectional wire of a mandrelless wire when taken for a given lamp. The use of a smaller 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.

Another important step is the severing operation to divide the mandrel wound filament into sections of a proper length in accordance with the rating or wattage of the lamp in which the filament is to be used. This operation is performed by accurately measuring the mandrel wound filament and then severing. The sections of mandrel wound filament are then subjected to a treatment during which the mandrel is removed. Upon a release of the mandrel from the coil, the several turns thereof change their relative positions with the result that the length of the coiled section as measured when on the mandrel, changes and if the sections are measured for 40 mm. an allowance must be made for the change in lengths after the mandrels are removed.

The present invention makes it possible to produce a filamentary body or light source avoiding the above disadvantages and to attain an accurate rating since the amount of filament to be contained in each coil constituting a light source is predetermined before the coil is actually wound. Moreover, it is obvious that by reason of the present method in which the convolutions are made by a continuous movement of the wire in the direction of its longitudinal axis, the coil is given its final set or form as it is wound which leaves it free from stresses detrimental to its usefulness as a light source for an incandescent electric lamp.

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. In an extended series of tests, 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 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.

Although the disadvantages attending the use of a mandrel in the making of coiled filaments have long been recognized, the extreme fineness of the wire to be wound, together with the exceptionally small diameter helix required has heretofore evaded all efforts to produce a coiled filament in the absence of a mandrel.

It will be appreciated that there is a decided line of demarcation between the art of winding the usual commercial wire as employed in the manufacture of helical springs and the winding of an almost invisible fine thread such, for example, as the tungsten wire from which incandescent electric lamp filaments are made. Even in the winding of this fine texture filamentary wire upon a mandrel, long experimentation and diligent effort was required and the problem was accomplished in a practical manner only by the exercise of considerable ingenuity and invention. The winding of this hair-like wire without a mandrel, as accomplished by the present invention, reaches far beyond the previous metes and bounds of the coil winding art and is a material contribution to the art of lamp making.

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 filoment 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.

In spite of the various new conditions and difficulties attending the winding of the fine filament wire without a mandrel, the present invention makes it possible to rapidly and economically produce a light source comprising an elongated filamentary body shaped to helical form containing a given length of wire and having a uniform pitch and a constant outside diameter. A light source produced in accordance with the present invention is not only desirable from a manufacturing standpoint, in so far 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.

Briefly, the invention comprises 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 aid in spacing 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, 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 coiled filament of indefinite length may be produced by a continuous operation of the machine, means are provided for severing sections of the filament after a predetermined length of wire has been wound. In accomplishing this, the action of the moving filament prior to winding has been utilized and a co-ordination of machine elements have been provided to actuate a cutter to sever the sections of the coiled filament after a given point upon the moving wire has travelled a predetermined distance. With this arrangement, it will be obvious that a machine may be set to continuously produce coiled sections of filament, each section of which contains an exact and definite predetermined amount of wire. The importance of the amount of wire contained in each coiled section of filament has hereinbefore been set forth, it being necessary that all coiled filaments of a selected diameter wire for use in lamps of a given wattage be of the same resistance.

The present invention embodies other important features such, for example, as a novel support for the die whereby the same may be properly adjusted with respect to the guide or driving rollers, and a novel structure will be found in the cutting or severing mechanism and this together with other features will be more fully understood from the following description in connection with the accompanying drawings in which:

Fig. 1 is a plan view of a machine embodying the present invention for forming convolutions in a wire;

Fig. 2 represents an article produced by the present machine, the drawing being enlarged;

Fig. 3 is a side view of an incandescent lamp stem as an example of one of the uses for a fine convoluted wire made in accordance with the present invention;

Fig. 4 is a side view elevation of the machine shown in Fig. 1 and is partly broken away to more clearly show certain internal structure;

Fig. 5 is a fragmentary view of a modification of means for guiding the wire into a wire bending member;

Fig. 5[a] is an end view of wire bending die made integral with a shank as when made of metal;

Fig. 5[b] shows a die made from a diamond or other hard material and embedded in the end of a holder;

Fig. 5[c] is a sectional view of the die shown in Fig. 5[b] and shows a wire being bent to helical form;

Fig. 6 is an end view of the machine (shown in Fig. 4) viewed from the left hand side;

Fig. 7 is a detailed view of a compound or universal support for the wire bending die and a driving roll;

Fig. 8 is a fragmentary view of a portion of the machine showing the relation of a pair of driving rollers to a wire bending member;

Fig. 9 is a detailed sectional view of a threading mechanism employed for applying wire to the wire bending die;

Fig. 10 is a view taken on line X—X in Fig. 1;

Fig. 10ª is a diagrammatic representation of the driving gears for the wire propelling rollers taken on line XI—XI in Fig. 6;

Fig. 11 is a plan view of a preferred form of die employed in the present machine for performing the bending operation;

Fig. 12 is a side view of the die shown in Fig. 10 and partly broken away to show the die cavity;

Fig. 13 is a sectional view of the die taken on lines XIII—XIII in Fig. 11 and showing, in dotted lines, the application of a wire to the die;

Fig. 14 is a sectional view of the die shown in Fig. 10 and illustrates a wire being wound into helical form;

Fig. 15 is a view of the coil and die shown in Fig. 14, viewed in the direction of the arrow "X" and shows the relation of driving rollers which force the wire into the die; and

Fig. 16 is a modified form of coil cutting means electrically operated.

It will be understood that the views of the die, particularly those illustrated in Figs. 10 to 14, are greatly exaggerated as to size and that it should be kept in mind that the die block usually has the exceptionally small surface dimension of .021×.030 inches. This, of course, follows in accordance with the diameter of the extremely fine wire to be coiled.

The machine selected as illustrating an embodiment of the present invention may comprise a suitable base 15 on which various co-related machine elements are mounted. The mechanism mounted on the base may include any suitable source of power as for example, a motor 16 having the shaft thereof coupled at 17 to a driving shaft 18 mounted in a bearing provided in a gear box 19. The coupling 17 may be so constructed as to be frangible and in the event that too much resistance is imposed upon the shaft 18 by reason of the improper functioning of the coiling mechanism, the said mechanism will be released from the motor.

Suitable gear reduction mechanism may be provided in the gear box 19. This mechanism may include a pair of bevel gears 21 and 22 secured to the shaft 18 and to a stub shaft 23 respectively. The stub shaft is provided with a relatively large gear wheel 24 in mesh with other gearing to be later described, which serves to translate motion to a pair of spindles 26 and 26′ (see Fig. 6).

Spindles 26 and 26′ are journaled in a forward bearing 31′ and are provided with pinions 27′ and 27″. The pinion 27′ is disposed in mesh with a gear wheel 28′ on a shaft 30. Pinion 27″ is mounted on a shaft 26′ and is disposed in mesh with a pinion 28″ on shaft 30 through an intermediate gear 25 in a stub shaft 25′. The shaft 30 is provided with a relatively large gear wheel 30′ which meshes with an idler 32′ to transmit motion from gear wheel 24 which is driven through bevel gears 21 and 22 from driving shaft 18. The gear ratios are such that the peripheral speeds of the force rollers, to be later described, are the same. The rollers being driven in opposite directions propel the wire through a given path and into the die.

The shaft 30 may be divided and provided with any well known form of clutch 35′ so that the rotation of the rollers may be terminated at will by a movement of a hand lever 35″. A hand wheel 36′ may be provided on shaft 30 to turn the wire driving rollers when the power drive is off.

The shaft 26 is connected to an intermediate or coupling shaft 28 which is engageable by means of clutch members 31 and 32 with a shaft 33 journaled at one end of a hinged member or cover plate 34 which serves as a top piece for a housing 34′. The free end of the shaft 33 is provided with a relatively small grooved force or driving roller 35 (see Fig. 8) which in conjunction with a larger grooved force or driving roller 36 constitutes means for driving wire 37 into a die 38 to be hereinafter more fully described. The lower roller 36 is secured at one end of a shaft 36′ (see Fig. 6) and is connected to shaft 26′ by an intermediate coupling member 37′. As will be presently shown, the shaft 36′ is only slightly adjustable whereas the shaft 33 is movable away from shaft 36′ and the die 38. For this latter purpose, means are provided for effecting a disengagement of the clutch members 31 and 32 when the cover plate is to be lifted. The clutch member 31 is disposed at the end of the coupling member 28 which consists of a slidable member or sleeve. For the purpose of effecting a disengagement of the coupling member 28 with the shaft 33 a lever arm 41 pivoted at 42 is provided. The free end of this arm engages with an annular notch 43 in the member 28 and is actuated by a movement of a locking piece or member 45 which secures the cover plate in its lower position and hence the shaft 33 and roller 35 in a given operable position. The cover plate is hinged at 46 on an adjust-

able support 46′, the adjustment of which will be hereinafter fully set forth. A finger piece 45′ is provided for lifting the cover plate.

The locking member 45 comprises a spindle 48 (see Fig. 4) rotatable about a pin 49 and provided with a cam surface 51 engageable with a cam surface 52. The upper end of the locking member 45 is flattened and offset to normally project over an aperture 53 and when the cover plate is locked in closed position, the offset portion is disposed transverse to the aperture 53. The cover plate is tensionally held in its locked position by means of a spring 54 disposed between a boss 55 on the inner side of the housing 34′ and a lever arm 56 pivoted at 57. The lever arm 56 is provided with a forked end engageable in an annular notch 58 in the spindle 48, the spindle is thus held in its lower position with the cam surfaces 51 and 52 in close relation. When the offset portion of the spindle 48 is turned to coincide with the aperture 53, the spindle 48 rides upwardly on the cam surface 52.

This brings a shoulder 59 of the spindle 48 against the under side of the cover 34 slightly raising the same, thus moving the shaft 33 and lifting roller 35 away from the roller 36. By reason of the upward movement of the shaft 48 it will be evident that the cover cannot be accidentally dropped to permit the roller 35 to strike the lower roller with an injurious impact. When the cover plate is in its lower position to be locked, a rotary movement of the locking member 45 serves to permit a movement of a plunger 60 inwardly and thus permit the lever arm 41 under the action of a spring 60′ to engage the members 31 and 32 of the clutch which connects the force roller shaft 33 with the shaft 26 to rotate the upper wire driving roller 35. The inner end of the plunger 60 is urged toward and contacts with the shaft 48 under the action of a spring 61. The said shaft 48 is provided with a flattened portion 62 to allow for the inward movement of the plunger 60. When the shaft 48 is partially rotated, however, the rounded portion of the shaft causes an outward movement of the plunger with a consequent release of the shafts 33 and 26.

The lower roller or driving member 36 is secured to an end of shaft 36′ and is disposed in such position as to tangentially engage the wire 37 at a point opposite to the point of engagement of the roller 35. The upper and lower rollers are provided with peripheral grooves 35′ and 36′ respectively of a combined depth slightly less than the diameter of the wire so as to grip and drive the same. As will be noted in the preferred construction (see Fig. 8) the rollers are in close proximity to the die 38 and the wire is driven directly from the bite of the rollers into the die. This tangential delivery of the wire avoids the use of a guide.

As shown in Fig. 5, however, a guide 63 may be employed. The guide may be made in two pieces having companion grooves to constitute a passage for directing the wire to a die 38′. In this case, chamfered force rollers 64 and 65 of equal size may be used and the guide may be tapered at 66′ so as to bring its delivery end close to the die. The die 38′ may be held in a support and secured with a set screw 69.

The guide member 63 is shown provided with socket portions 66 in order that the rollers may engage or bite the wire at a point close to the end of the guide. By reason of this, the wire is impressed by the guide before the grip of the force wheels on the wire is released, thus assuring a steady forward feed and a guiding of the wire in a uniform path free from kinks when directed to the die of the machine.

The die member may be constructed of steel and in one piece with a shank 72 as shown in Fig. 5. It is preferable, however, to form the die of a material possessing a greater degree of hardness and as shown in Figs. 5ª, 5ᶜ and Figs. 11 to 15, the die is made from a die block 73 of a substance such, for example, as a diamond or like material. The die is formed with a cavity 74 having an elongated mouth 75 and disposed adjacent to one end 76 of the die block. The bottom 77 of the cavity is rounded and concave from end to end as shown in Fig. 13. It will be noted that the cavity is so disposed with respect to an end 76 that a lip 78 is provided at one side of the die block and that at least one portion of the lip is formed into a knife edge.

The wire 37 when guided to the cavity, travels around the concave bottom 77 and is guided over the lip 78, the lip serving as a separator member to space the successive convolutions formed. This is shown more clearly in Figs. 14 and 15. As will be noted, the guide rollers 35 and 36 are disposed in close proximity to the die so that the wire is forced directly tangentially from the bight of the rollers and into the die. This avoids any frictional engagement of the wire with other machine elements and simplifies the machine as well as improving its operation.

As more clearly shown in Fig. 8, the roller 35 is of a lesser diameter than the roller 36 thus there is a difference in the degree of contact of each roller with the wire. By reason of this arrangement, the smaller roller exerts a greater pressure on the wire and thus gives it a slight initial bend prior to its application to the die and in accordance with the direction of movement for the formation of the convolutions as the wire is operated upon by the die. The unequal pres-

sures of the rollers also serve to slightly distort the wire which distortion is believed to improve the character of a coil when the same is to be used as a light source of an incandescent electric lamp.

The die member, as explained, is constituted of a die block which block may be secured to a shank 79 thus constituting a wire bending tool which may be applied to the machine by insertion into a suitable longitudinal slot 81 in a saddle member 82. The wire bending member may be supported rigidly after adjustment, by means of a set screw 83. As shown in Fig. 7, the saddle member also carries an extension bearing 84 which is pivoted on a shaft 85, depending from the saddle member. This bearing provides a mounting for shaft 36′ upon which the lower roller 36 is mounted.

The saddle member 82 is provided with an extension 91 having an end 92 disposed in a saddle block 93 and held from vertical oscillatory movement by set screws 94 and 95 which provide for a movement of the saddle member and also the bearing 84 in a vertical plane. A lateral movement of the bearing 84 and consequently the roller 35 is attained by a relaxation of a nut 96 (see Fig. 7) whereupon the bearing may be moved about the depending shaft 85. A bearing for an end of the shaft 36′ is provided at 97 on one end of a threaded rod 98 having nut 99 to permit a locking of the bearing 97. Before the shank 79 is secured by the set screw 83 it may be adjusted. Secured to the tail end of the shank is a depending arm 82 secured to the shank by a set screw 81″ and provided at its lower end with a stud or dowel 83′ which may enter a socket suitably provided in the extension 91. A stop or adjusting screw 84 is threaded through the arm 82′ and abuts the saddle 82 to permit slight adjustment of the die 38. Referring again to the saddle block 93 it will be noted that this element is disposed between two set screws 101 and 102 on ears 103 and 104 respectively, integral with a slidable retainer member 105. The retainer member is movable about an arcuate edge of a segment 106 integral with a bracket 107 suitably secured to the bed plate or base 15.

A movement of the retainer member 105 therefore results in a movement of the die and the roller 36 in a horizontal plane. When properly adjusted the retainer member may be held in a fixed position by set screws 108.

From the foregoing it will be appreciated that a compound adjustment of the die and the lower roller is made possible. The upper roller, as previously set forth, is journaled at the free end of the cover plate 34. The cover plate is pivoted at 46, the rockable member 46′ being movable about ends of set screws 111 and 112. An adjusting screw 113 is provided in a threaded aperture in the member 46′, the said screw extending through the member and into a threaded aperture 114 in a rigid portion of the structure of the machine. A rotation of the set screw 113 will therefore cause a movement of the rocker member about its fulcrum 46 and permit a horizontal adjustment of the roller 35.

Wire 37 is fed to the die from a supply spool 115 suitably supported in near relation to a measuring roller or wheel 115′ mounted in an upright bearing 116′. The wire may pass around the measuring wheel in one or more turns or in a single bight and thence to the driving rollers 35 and 36 between which it is led and engaged to be frictionally driven into the die 38. The wire enters the die endwise and is coiled first in a direction reverse to its path of movement and thence by means of the lip 78 is guided in a lateral direction so as to form a helix, the lip serving to also separate the turns of the helix thus formed. As the wire 38 emerges from the die in the form of a coil 116 it passes through a guide 117 carried at the upper end of a coil severing device 118. This device is comprised of an L-shaped member 119 supported in bracket 107 by set screws 120 and 121 so as to permit a slight movement of the member to or from the die. This adjustment causes the guide to change its angular relation to the die and as the wire 38 moves from the cavity a slight variation in pitch may be attained.

The member 119 has its vertical arm 119′ provided with a cutter wheel 122 movable across an aperture 123 through which the coiled wire passes. The edge of this aperture in conjunction with the wheel 122 functions to sever the wire after a given amount thereof has been coiled as will be presently explained.

The cutter actuating mechanism includes a slide bar 124 movable in a guide slot in the long arm 119′ of the member 119. A spring disposed between a stop 126 on the said arm and a projection 127 on the slide bar 124 normally urges the same and cutter wheel away from the aperture 122.

The lower end of the slide bar 124 is, however, pivotally connected at 128 to an arm 129 of a lever 131 pivoted at 132 to a supporting plate 133 secured to the under side of the table 15. The opposite end 134 of the lever 131 is provided with a trigger member 135 normally held against a stop-pin 136 on the said arm by a spring 137. The lever 131 causes an actuation of the cutter when a given amount of wire has been wound. For the purpose of operating the cutter at predetermined intervals, the measuring roller is provided with a cam mem-

ber 139 which engages a trigger actuating lever 141 pivoted at 142 on the support 116' adjacent to the measuring wheel 115'. A rotation of the measuring wheel causes a rotation of the cam member which moves an end 143 of the actuating lever outwardly. This brings the lower end 144 of said lever against the trigger member 135 causing it to move and permit the end 144 to pass. When a drop portion 145 of the cam member permits the end 143 of the actuating lever to return toward the measuring wheel the end 144 of said lever engages the trigger 135 which being relatively immovable by reason of the stop pin 135, effects a downward movement of the adjacent end of the lever 131 with the result that the end 129 thereof moves upwardly and severs a coil. The actuating lever 141 is normally urged into engagement with the cam member 139 under the action of a spring 146. It will be appreciated from the foregoing that the measuring roll may be of such a diameter that upon a given movement thereof a portion of wire will have moved a given distance and since the cutter is actuated after such travel of a point in the wire, it will be obvious that the coil severed will have an amount of wire therein as determined by the measuring means.

For the purpose of facilitating the application of the fine filamentary wire to the driving rollers a mechanism termed a threading device is provided. This device is comprised of a bent arm 149 pivoted at 151 on the housing 34'. The free end of the arm 149 is provided with a rotatable pin 152 (see Fig. 9) having a knurled end 153 and an attenuated end 154.

A projecting stud 155 is disposed upon the housing and is formed with a groove 156 to receive the wire 37 and a flattened portion 157 to receive the end 154 of the pin 152. The groove 156 is arranged in alignment with the groove 36'' of driving roller 36. When the wire 37 is to be applied to the driving rollers an end of the wire is inserted in a notch 158 in the pin and the pin rotated to make several turns of the wire about the end 154 which is made the same diameter as the inner diameter of the coil to be formed. The pin, therefore, serves to make a short section of the coil with the last turn 159 in line with the groove of the roller 36. The bent arm 149 is then rocked to dispose the said turn in the groove of the roller and the upper roller 35 is moved to its operative position with relation to the cavity of the coil winding die, thus the turn 159 is engaged and the wire ready to be driven into the die. The pin is then removed by an endwise movement away from the rollers and the bent arm is returned to its initial position and rests against stop 161. The machine may then be put into operation and the driving rollers in conjunction with the die will operate to make a succession of convolutions and produce a helical filamentary body which is automatically severed into sections which in the present embodiment of the invention, are employed as lamp filaments.

The mechanism for cutting the coiled wire into sections may, as above described, be performed by mechanically operated machine elements. If, however, an electrically operated cutting device is desired the measuring wheel 115' may be used to close a circuit and operate an electromagnet or solenoid to actuate a cutter. A cutter wheel 162 may, for example, be mounted at one end of a lever 163 pivoted at 164. The opposite end of the lever may be linked to an armature 165 of a solenoid 166 the coil of which may be energized through any suitable source as battery 167 through conductors 168, 169 and 170, 171. Conductors 169 and 171 may be connected to contacts 172 and 173 respectively, disposed in the path of movement of a contact or brush 174 properly positioned on and insulated from the measuring wheel 115'.

Wire 37 may pass about the measuring wheel and between the drive rollers 35 and 36 into a die and out in coiled form through an aperture 175' in a block 176', the cutting wheel 162 moving across the aperture operates in conjunction with an edge thereof to sever the coil.

The cutter wheel 162 is normally held in an upper position by reason of a spring 177 when the solenoid is unenergized. When the measuring wheel has rotated to bring the brush 174 across the contacts 172 and 173, the armature 166 being attracted, will move the lever 163 and actuate the cutter. By this means coiled sections, all having the same predetermined amount of wire, will be produced for use in lamps of a given wattage.

The present invention provides for the feeding of the filament to the measuring roller 115' in such manner that any contact of the wire 37 with the sides or flanges 180 of the spool 115 is avoided. If a wire is delivered to the measuring roller without observing the above conditions the wire would, upon an unwinding from the spool, become mechanically abraded by the flanges of the spool with the result that possible breaks would occur. As shown in the present invention, the spool 115 is so positioned that the path of travel of the filament wire back and forth across the spool is substantially in the same plane as the groove of the measuring roller 115'. It will readily be seen that by reason of this arrangement the possibility of the wire contacting with the flanges of the spool is eliminated, thus avoiding breakage from such source. The

spool 115 is held adjustably in position and may readily be moved to its proper relation with the measuring roller. The line of travel of the wire to said roller is clearly shown in Fig. 1.

A coiled section 175 resulting from the measuring and cutting operation may, as shown in Fig. 2, constitute a resistance element commonly termed a light source which may be applied to a lamp stem 176 and supported by the support wires 177. This type of filamentary body is shaped to take the form of an open ring and the ends are clamped or welded to leading-in wires 178 and 179. It will be noted that when a filament is supported as shown, several portions thereof span the space between the supports. The droop or sagging hereinbefore referred to occurs when the filament is flashed, that is, heated to a high temperature upon an initial burning. The droop as found in the mandrel wound filament gives the filament a scalloped form with bow shaped portions between the supports. This means that the coils have stretched and an over-heating occurs in certain portions of the filament with a consequent reduction in the useful life of the lamp in which the filament is incorporated.

In operation the wire is led from the spool 115 over the measuring roll 115′. An end of the wire may then be applied to the threading device and several turns or coils produced preparatory to application to the rollers. The upper roller 35 may be lifted and the threading device moved to apply the initial coils to the lower roller 36. The upper roller may then be moved to its operative position in opposite relation to the roller 36. As the upper roller is moved to its operative position the spindle thereof is automatically caused to be connected to the driving means and the cover plate which carries the spindle is locked in position. Power may then be supplied from the motor and the driving rollers actuated to drive the wire into the die. The die as shown, has a cavity or slot to guide the wire and the width of the slot may be slightly larger than the diameter of the wire to be wound.

As the wire enters the cavity it is directed from its course of travel and if left free to coil, would produce a helix with the turns in contact. The lip 78, however, which is associated with the cavity acts to space the turns as the successive convolutions issue from the die. It has been found that when coiling wire to produce filaments for different voltage lamps the same die may be used even though a slight variation exists in the diameter of the different wires. It has also been found that the pitch for the wire of different diameter remains constant and proper for the particular wattage coil produced.

As the coiled wire issues from the die it passes through the guide 117 and through the aperture 123 of the cutter. When the measuring wheel 115′ makes the necessary rotation the cutter is actuated, thus a coil is severed having an amount of wire exactly as measured before the cutting operation.

The severed coils may be discharged through a suitable chute and if desirable a counting device may be used to indicate how many cuts are made and thus keep track of the number of coils produced.

As previously set forth the present machine is universally adjustable but it is to be understood that the adjustments referred to are within an extremely fine range and account for any lost motion or play. The machine is in fact a precision instrument rather than an ordinary coil winding machine.

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.

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.

What is claimed is:

1. A machine for producing a coiled filamentary body comprising means for propelling a filament wire in the direction of its axis through a given path, a die having a curved surface disposed in the path of movement of said wire, said die having its surface of a curvature with a diameter substantially the same as the diameter of the helically wound wire to guide the same into a helix of a predetermined diameter and spacing means for maintaining a predetermined pitch in said helix.

2. A machine for producing a coiled filamentary body comprising means for propelling a filament wire in the direction of its axis through a given path, a die having a curved surface disposed in the path of movement of said wire to guide the same into a helix of predetermined diameter, coil separating means on said die for imparting a predetermined pitch to said helix, and means for varying said pitch.

3. A machine for producing a coiled filamentary body comprising means for propelling a filament wire in the direction of its axis through a given path, a die having a curved surface disposed in the path of movement of said wire to guide the same into a helix of predetermined diameter coil severing means and means operable after travel of a point on said wire through a predeter-

mined distance to actuate said coil severing means to sever a coiled section containing a number of turns having a total length equal to the said distance through which said wire has moved.

4. A machine for producing a coiled filamentary body comprising means for propelling a filament wire endwise through a given path, a die for diverting said wire from said path and into helical form, a coil severing means and means controlled by a movement of an uncoiled portion of said wire through a predetermined distance to actuate said severing means.

5. A machine for producing a coiled filamentary body comprising driving members for propelling a filament wire endwise through a given path, a die for diverting said wire from said path into helical form, means for producing an initial convolution in said wire and means for moving said convoluted wire in operative relation to said driving means.

6. A machine for producing a coiled filamentary body comprising rotary members for propelling a filament wire endwise through a given path, a die for receiving said wire to form the same into a helix, means for forming an initial helical bend in said wire and means for disposing said helically bent wire in operative relation to said rotary members.

7. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chambered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, and a forming die having a curved die-depression opposed to the discharge end of said guide-member.

8. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, a forming die having a curved die-depression opposed to the discharge end of said guide-member, and a supporting means for said die having means for adjusting said die both laterally and vertically relative to the discharge end of said guide member.

9. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, a forming die opposed to the discharge end of said guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electromagnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic-means, and circuit closing means associated with and actuated by said measuring reel.

10. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, a forming die opposed to the discharge end of said guide member, a supporting means for said die having means for adjusting said die both laterally and vertically relative to the discharge end of said guide member, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

11. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, a forming disc having a curved die-depression opposed to the discharge end of said guide member, a supporting means for said die having means for adjusting said die both laterally and vertically relative to the discharge end of said guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from

the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

12. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, the outer discharge end of said guide member having a conical tip at the apex of which the bore thereof terminates, a forming die having a curved die-depression in its extremity opposed to the discharge end of said guide member, one side of die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, and means for supporting said die.

13. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, the outer discharge end of said guide member having a conical tip at the apex of which the bore thereof terminates, a forming die having a curved die-depression in its extremity opposed to the discharge end of said guide member, one side of die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, a supporting means for said die having means for adjusting said die both laterally and vertically relative to the discharge end of said guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels, and said wire supplying means around which the wire is passed, means for covering the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

14. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, the outer discharge end of said guide member having a conical tip at the apex of which the bore thereof terminates, a forming die having a curved die-depression in its extremity opposed to the discharge end of said guide member, one side of die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, a laterally adjustable carrier-plate, a laterally adjustable saddle-block on said carrier-plate, and a vertically adjustable saddle-member having means for rigidly supporting said die.

15. In a wire convoluting machine, the combination with a pair of driven force wheels opposed one to the other, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, of a wire guide member having a longitudinal bore to receive the wire from said force wheels, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, the outer discharge end of said guide member having a conical tip at the apex of which the bore thereof terminates, a forming die having a curved die-depression in its extremity opposed to the discharge end of said guide member, one side of said die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, a laterally adjustable carrier-plate, a laterally adjustable saddle-block on said carrier-plate, a vertically adjustable saddle-member having means for rigidly supporting said die, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic

means, and circuit closing means associated with and actuated by said measuring reel.

16. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, a forming die having a curved die-depression in its extremity of a width corresponding to the diameter of the fed wire, said die-depression being opposed to the discharge end of said wire-guide, one side of said die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, a supporting means for said die having means for adjusting said die both laterally and vertically relative to the discharge end of said guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

17. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longtiudinal bore to receive the wire fed forward by said force wheels, a forming die having a curved die-depression in its extremity of a width corresponding to the diameter of the fed wire, said die-depression being opposed to the discharge end of said wire guide, one side of said die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, means for adjustably supporting said die comprising a laterally adjustable carrier-plate, a laterally adjustable saddle-block on said carrier plate, and a vertically adjustable saddle member having means for rigidly supporting said die.

18. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, a forming die having a curved die-depression in its extremity of a width corresponding to the diameter of the fed wire, said die-depression being opposed to the discharge end of said wire guide, one side of said die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, and means for adjustably supporting said die in desired alinement and elevation as opposed to the discharge end of said guide member.

19. In a wire convoluting machine, the combination with a pair of driven force wheels, of a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, a forming die having a curved die-depression in its extremity of a width corresponding to the diameter of the fed wire, said die-depression being opposed to the discharge end of said wire guide, one side of said die extremity being cut away adjacent to said die-depression to provide clearance for the convolutions issuing from the latter, and means for adjustably supporting said die in desired alinement and elevation as opposed to the discharge end of said guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

20. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide-member from the end of said bed-block, a forming die, and means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member.

21. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide-member from the end of said bed-block, a forming die, means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is

passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

22. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide member from the end of said bed-block, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, a forming die having a curved countersunk die-depression in its forward end, and means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member.

23. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide member from the end of said bed-block, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, a forming die having a curved counter-sunk die-depression in its forward end, means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

24. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide member from the end of said bed-block, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the biting points of said force wheels, a forming die having a curved counter-sunk die-depression in its forward end, means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member, comprising a laterally adjustable carrier plate pivoted at its inner end upon said table, a laterally adjustable saddle block pivoted at its outer end upon said carrier-plate, and a vertically adjustable saddle member pivotally mounted on said saddle-block, said saddle member having means for rigidly supporting said die.

25. In a wire convoluting machine, a bed-block, a table of reduced height forward of said bed-block, a force wheel journaled in the forward end of said bed-block, a vertically movable frame pivotally connected with said bed-block, a second force wheel journaled in the free end of said frame so as to normally oppose said first force wheel, transmission means for rotating said force wheels in opposite directions, said force wheels having grooved peripheries to embrace and grip the wire, the marginal portions of said force wheels being chamfered on each side of said grooved peripheries, a wire guide member having a longitudinal bore to receive the wire fed forward by said force wheels, means for rigidly supporting said guide member from the end of said bed-block, the rear end of said guide member having socket portions conforming to the peripheral shape of said force wheels whereby said bore is placed in close tangential relation to the bit-

ing points of said force wheels, a forming die having a curved counter-sunk die-depression in its forward end, means on said table for adjustably supporting said die in opposition to the discharge end of said wire guide member, comprising a laterally adjustable carrier plate pivoted at its inner end upon said table, a laterally adjustable saddle block pivoted at its outer end upon said carrier-plate, a vertically adjustable saddle member pivotally mounted on said saddle-block, said saddle member having means for rigidly supporting said die, means for supplying wire to said force wheels, a rotatable measuring reel intermediate said force wheels and said wire supplying means around which the wire is passed, means for severing the convoluted wire issuing from the forming die, electro-magnetic means for actuating said severing means, an electrical circuit for activating said electro-magnetic means, and circuit closing means associated with and actuated by said measuring reel.

26. A coil forming die comprising a body portion having a cavity in one surface thereof and adjacent to one side of the body, a portion of said side of the body terminating in a coil separating lip for the spacing of convolutions in a coiled wire when passing from said cavity.

27. A coil forming die comprising a body portion having a cavity in one surface thereof and adjacent to at least one side of the body, a portion of said side of the body terminating in a coil separating edge to separate turns of coils of a coiled wire when passing from said cavity.

28. A diamond die comprising a body having a cavity with an elongated mouth, said cavity being of arcuate form from end to end, the bottom of the cavity being rounded in transverse cross-section, said rounded portion connecting said sides, and a lip along one of the edges of said mouth.

29. A machine for producing a coiled filamentary body comprising a bending die, and wire driving means in close proximity to said die for frictionally driving a wire endwise into said die, said wire driving means being so positioned with respect to said bending die as to prevent buckling of the wire between said driving means and said die.

30. A machine for producing a coiled body comprising a bending die having a cavity, means for frictionally driving a wire endwise into said die to cause the wire to make a succession of convolutions and means associated with said die for spacing said convolutions.

31. A coil winding machine comprising a die having a cavity, rotary members disposed in close proximity to said die for engaging a wire to drive the same into the cavity of said die for the formation of a series of convolutions therein, and means integral with said die for uniformly separating said convolutions.

32. A coil winding machine comprising a cavity die for bending a wire into convolute form, a pair of rotary members in close proximity to said die for frictionally driving a wire by engaging the same on a line substantially transverse to its path of travel, and means for actuating said members to drive said wire into the die for the formation of a series of convolutions therein, said rotary members being so disposed with relation to said die as to avoid buckling of the wire between said members and said die.

33. A coil winding machine comprising a cavity die for bending a wire into convolute form, a pair of rotary members in close proximity to said die for frictionally driving a wire by engaging the same on a line substantially transverse to its path of travel, means for actuating said members to drive said wire into the die for the formation of a series of convolutions therein and means integral with said die for spacing said convolutions by a predetermined amount.

34. A coil winding machine comprising means for bending a wire into convolute form and means for imparting an initial bend in said wire prior to the application thereof to said first mentioned means.

35. A coil winding machine comprising a die for bending a wire into convolute form, and means for imparting an initial bend in said wire prior to engagement with said die.

36. A coil winding machine comprising a die for bending a wire into convolute form when thrust thereagainst, means for producing an initial bend in said wire and means for moving said wire endwise into said die.

37. A coil winding machine comprising a die for bending a wire to convolute form when thrust thereagainst, and a pair of rotary members for frictionally engaging said wire to drive the same into said die, said members having different diametrical dimensions.

38. A coil winding machine comprising a wire bending means, a pair of rotary members for engaging a wire at opposite sides thereof, said rollers varying in their degree of contact area with said wire to give an initial bend to said wire prior to application to said bending means.

39. A machine for producing a helical body containing a predetermined length of wire comprising means for measuring a portion of the length of said wire, and means for coiling another portion of said wire containing an amount of wire equal to said measured portion.

40. A machine for producing a helical body containing a predetermined length of wire comprising means for measuring a portion

of the length of said wire, means for coiling a section of said wire equal to the measured portion and means for severing said coiled section.

41. A machine for producing a coiled filamentary body comprising driving means for moving a wire through a given path, wire bending means for causing the wire to take a helical path, said driving means being so disposed with relation to said wire bending means as to prevent the tendency of the wire to buckle during its movement between said driving means and said wire bending means.

42. A machine for producing a spaced coiled filamentary body comprising driving means for moving a wire through a given path, die means for receiving and bending said wire into helical form, separator means for spacing the convolutions of said helically formed wire, said driving means and said die means being so disposed as to prevent the tendency of said wire to buckle during movement between said respective means.

43. A machine for producing a coiled filamentary body comprising driving means for moving a wire through a given path, die means for opposing the movement of said wire and for causing the same to take a helical path, said driving means being so disposed with relation to said die means as to prevent the tendency of the wire to buckle during movement between the above mentioned respective means and means operable to sever coiled sections containing predetermined lengths of wire.

44. A machine for winding in the absence of a mandrel, a helical incandescent electric lamp filament of about 40 mils or less outside diameter from a wire having a diameter of about 5 mils or less, comprising means for moving a wire through a given path and wire bending means disposed in the path of movement of said wire to divert the same into a series of convolutions.

45. A machine for winding in the absence of a mandrel, a coiled incandescent electric lamp filament of about 40 mils or less outside diameter from a wire having a diameter of about 5 mils or less, comprising rotary members for moving the wire through a given path and wire bending means disposed in the path of movement of said wire to divert the same into a series of convolutions.

46. A machine for winding in the absence of a mandrel, a coiled incandescent electric lamp filament of about 40 mils or less from a wire having a diameter of about 5 mils or less, comprising rotary members for driving the wire through a given path and a wire coiling die disposed in the path of movement of said wire to drive the same into a series of convolutions.

In testimony whereof, I have hereunto subscribed my name this 7th day of July, 1926.

JOHN W. EKSTEDT.