March 10, 1931.

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COIL FORMING DIE

Filed April 24, 1926

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This invention relates to machines for the production of finely coiled wire such, for example, as coiled filaments for incandescent electric lamps and more particularly to filament winding dies.

An important operation in the manufacture of certain types of incandescent lamps is the winding of the wire to helical form to provide a lamp filament and various methods are employed for thus winding the wire. I perform this operation by the use of a machine employing a cavity die, and in forcing the wire endwise into the cavity so as to produce a coil which is forced over a lip or separator portion of the die to space the turns of the wire as it emerges from the cavity.

The object of my invention is to cut a die of the aforementioned type which shall be rugged and resistant to wear and which shall be effective to produce a coil of uniform pitch and diameter, said cutting operation entailing the use of a novel machine for producing the desired configuration of the die.

Other objects and advantages will be apparent as the description proceeds.

In winding fine coils, such as coiled incandescent electric lamp filaments, from wire such as tungsten, conditions and problems are met with which do not occur with the methods of winding ordinary commercial size wire as, for example, as in the making of helical springs. The finest springs previously made are large when compared to a coiled lamp filament. When producing a coiled filament for 60 watt it is necessary, for example, to employ a wire of .0025 and to coil the wire into a helix of 566 turns so as to contain a given length of wire. Furthermore, the pitch must be maintained uniformly throughout the winding so that when the coil is cut into sections, such sections will contain a given length of wire to assure the proper resistance in the lamps in which the filament is subsequently incorporated.

From the foregoing it will be appreciated that the winding of a lamp filament presents many difficulties and in order to produce lamp filaments at a cost comparable to the manufacture of other lamp parts, it is necessary to effect the helical winding of the wire at a high rate of speed. For example, a filament for a lamp of 60 watt and 115 volts requires a given length of filament having 400 turns per inch, and in order to produce such a filament at a profitable rate, it is desirable to wind this extremely fine filament wire somewhere in the neighborhood of 10,000 turns per minute. In the winding of a filament by the use of a cavity die, it will readily be appreciated from the foregoing that in order to attain the desired accuracy of pitch at the rate of speed which the wire is wound, it is essential to have a die so formed as to give the greatest degree of accuracy and to facilitate the movement of the wire to cause its diversion from a given path which results in the bending of the wire to helical form.

The present invention, therefore, provides what may be termed a die-block formed of a suitable wear-resisting material such as a sapphire or a diamond, the latter being preferable. In producing a die in accordance with the present invention, I form a cavity of elongated concave shape having the bottom portion rounded in transverse cross-section and provided with the sides or longer walls substantially parallel. The rounded bottom portion of the die is preferably made with a radius slightly greater than that of the 50 wire to be wound. One of the walls of the cavity terminates in a lip or knife-like edge which is inclined downwardly and outwardly from the die. This edge serves as a separator to give the proper spacing to the turns of the wire when the same is wound. It has been found important to make the lip or separator edge uniform in cross-section along its length so that when the wire is passed into the die and traverses the separator edge, any variation in the position of the wire along the edge will not change the degree of spacing.

When attempting to form a cavity in a diamond, for example, great difficulty is experienced in attaining a properly shaped cavity by the grinding or lapping operation. I have found, however, that this operation is greatly facilitated by performing the lapping or cutting in the direction of the grain of the stone. I have further found that if...
the cavity is cut so that the grain of the stone runs perpendicular to the edge of the lip, that the same is sufficiently strong to withstand long use without chipping or breaking during the coil winding operation. Ordinarily it is difficult to produce a cavity with at least one straight edge; attempts in this direction giving a more or less elliptical shaped slot instead of an elongated slot or cavity with at least one edge of the mouth in a straight line desired unless certain precautions are observed. The form of cavity, as provided by the present invention, is the result of the novel method employed which includes the cutting of the stone in the proper direction, that is, with the grain, together with the manipulation of the tool to prevent lateral movement thereof and the application of diamond dust or abrasive material solely to the peripheral cutting edge of the tool. The present die, together with the method of producing the same will be more clearly understood by reference to the accompanying drawings in which:

Fig. 1 shows a perspective view of a die block with a cutting or lapping tool in position for the formation of a wire bending cavity.

Fig. 2 is an end view of the tool and die block shown in Fig. 1.

Fig. 3 is a plan view of a die block having a cavity cut therein to constitute a die in accordance with the present invention.

Fig. 4 is a fragmentary view taken on line IV—IV in Fig. 3 which shows a longitudinal cross-sectional view through a cavity in the die block; a bent filament wire being indicated in dotted lines.

Fig. 5 is a side view of the die shown in Fig. 3.

Fig. 6 is a side view of the die partly broken away to show a transverse cross-sectional view through the cavity.

Fig. 7 is a sectional view of the die showing the filament wire passing into and out from the cavity and being formed into a helix.

Fig. 8 is an end view of the die shown in Fig. 7 and also shows rollers for driving the filament wire into the die.

Fig. 9 is an end view of a modified form of the die and shows a lip portion conforming to the arcuate shape of the cavity.

Fig. 10 is a view of the die shown in Fig. 9 and partly broken away to show the cavity.

Fig. 11 is a plan view of a machine for performing a lapping operation on a diamond block to produce a die in accordance with the present invention.

Fig. 12 is a view taken substantially on line XII—XII in Fig. 11.

Fig. 13 is an enlarged view of the support for the diamond block taken on line XIII—XIII in Fig. 11 and

Fig. 14 is a fragmentary sectional view of a die as, for example, a diamond, showing the cavity and indicates by section lining, the direction of the grain of the stone.

In practicing the present invention, a die-block 10 of the proper size, preferably a diamond, is suitably secured at the end of a rod or shank 11. The block is usually embedded in the rod by soldering or brazing so that a lapping operation may be performed to cut a wire bending cavity 12. Usually the rod 11 constitutes the die holder and the die remains in the rod, and serves as a support during the bending operation in the machine employed for forming the wire into a helix. It is to be appreciated that all the drawings showing the die are exaggerated as to size and it must be kept in mind that the die block itself usually has the extremely small surface dimension of 0.021 x 0.030 inches. When the die is properly positioned in the shank or rod 11, Fig. 1, a lapping wheel 13 is moved thereagainst and the cavity 12 is cut into the block, which operation will be hereinafter more fully described.

As more clearly shown in Fig. 3, the cavity 12 is in the form of a slot having side walls 14 and 15 and an elongated mouth connected by rounded ends 16 and 17. The said ends may have a radius slightly greater than the radius of the wire to be passed into and out from the cavity. As shown in Fig. 4, the bottom 18 of the cavity when taken in longitudinal cross-section is of circular or arcuate form to receive and cause a bending action of the wire 19 when the same is thrust thereagainst as indicated in dotted lines. The bottom of the cavity is rounded in transverse cross-section, walls 14 and 15 may be continuations of the bottom. The rounded bottom of the cavity may have a diameter the same as that of the rounded ends 16 and 17. It will be appreciated that by reason of the rounded surfaces and the walls of the cavity, a wire to be bent will be properly confined and have a smooth free travel.

The cavity may be generally described as being formed by the half-revolution of a generatrix comprising two parallel straight lines joined by a curved line.

When the die 10 is positioned for the wire bending operation, the wire 19 is fed to the die by means of rollers 21 and 22. The rollers may be provided with suitable shafts connected to driving mechanism not shown, the drawing merely being illustrative of the actual wire bending operation. As will be noted, the wire which is caused to travel through a unidirectional path by reason of the rollers 21 and 22 is diverted from such path when making contact with the cavity of the die. As the wire makes such contact, it is given a bend and a continued movement of the wire against the die causes the bent end to coil and take a helical form. Initially, the free end of the wire is guided to the outside...
of an edge or lip 25 of the die which lip is in the form of a knife-edge and serves to separate the coils as they are formed during their passage out from the cavity. The lip 25 plays an important part in the proper formation of the coil to give it the desired pitch or maintain the spacing between the coils uniform. It is, therefore, evident that if the lip 25 is not of a uniform thickness along its attenuated or effective edge, a variation will occur in the winding of the wound coil. This is due to the fact that the wire may be directed to engage at slightly different points along the bottom of the cavity, thus changing the position of contact between outwardly moving portions of the wire and the lip. If, therefore, any variation existed in the thickness of the knife-edge of the lip, nonuniformity would result in the pitch or spacing between the turns of the coil produced. The sharp edge or lip 25 leads downwardly away from the wall to provide an inclined surface 26 suitably proportioned so that the coils during the winding operation are separated the proper distance to permit them to take a final spacing of a given dimension when a helix 27 is completed.

The knife-edged lip 25 must necessarily be made with the greatest possible strength without being brittle since by reason of wear, minute particles may break off, causing the lip to quickly lose its knife-edge and fail in its function of properly guiding the wire into a properly spaced helix. As hereinafter more fully explained, the present invention provides a die having the lip of the maximum strength of the material from which it is made.

From the foregoing, the importance of the particular form and proportions of the present die will be recognized and a die made in accordance with the present invention is relatively long wearing in the production of a lamp filament having the desired uniformity. It is evident, however, that although the preferred construction is to have the walls parallel, the wall opposite to a lip 25 may be made otherwise. If desirable, the die may be made as shown in Figs. 9 and 10. In this construction, a die block 10 is provided with a curved aperture 11 at the edge of one side or face thereof, thus providing what may be termed a concave ledge. This ledge is provided with a groove 12 to serve as a track for the passage of the wire and to provide a lip 23. It will be noted that whereas the lip 25 of the previously described die extends to about the center of a coil; the lip 23 is relatively short and serves as a spacer member with a minimum amount of frictional engagement with the wire.

The cutting or forming of a diamond die such as above described presents problems and difficulties which are unsurmountable by the usual die cutting operations. I have, therefore, developed a method not only for efficiently and effectively forming the cavity in the die but also of obtaining by cutting the material in a certain direction the maximum strength of the lip 25 of the die. In practicing my method, I may provide a machine comprising a frame 30 having a spindle 31 mounted in bearings 32 and 33 thereon. The spindle may be provided with a cone pulley 34, connected to a suitable source of power (not shown) and a lapping tool or wheel 13 may be suitably secured to an end of the spindle so as to be rotated at high speed for the lapping operation. Although a cone pulley 34 is shown, I have found that to properly cut the slot in a diamond block, it is essential to rotate the lapping wheel edge or the cutting portion thereof at a peripheral speed above 35,000 feet per minute. For this purpose I provide the spindle 31 with a turbine wheel 36 having blades 37 positioned to propel the wheel under a discharge of air or other fluid from an expanding nozzle 38 connected to any suitable pressure line. By means of the air driven wheel, I not only attain a high speed of the wheel but provide a rotation of the lapping wheel which is substantially free from vibration as would be caused where direct connection is employed with certain driving mechanisms.

For the purpose of performing the lapping operations, I mount the shank 11 of the die in a carrier 41, permitting the die to extend from the carrier for engagement with the lapping wheel. The carrier 41 is then placed on a carriage comprising two sets of conical rollers 42 and 43, the carrier 41 having beveled surfaces 44 and 45 for engagement with the rollers. The rollers may be mounted in suitable bearings 46 and 47 fastened to the stationary structure of the machine. When the carrier is positioned upon the rollers, it is movable to and from engagement with the lapping wheel and it has been found that a more effective cutting operation is performed by producing an intermittent contact between the lapping tool and the diamond. Means are, therefore, provided to automatically reciprocate the carrier to automatically effect such intermittent contact, which means may comprise a cam member 48 mounted in a bearing 49 integral with the frame of the machine. The cam may be engageable with a roller 51 disposed at the end of a depending arm 52 secured to the carrier 41. A rotation of the cam will, therefore, cause a movement of the carrier and consequently move the die away from the lapping wheel. A return movement of the carrier may be produced by a spring member 53 having one end secured to an adjustable plate 54 and the opposite end engageable with a notched lug 55 upon the upper surface of the carrier 41. By reason of the spring 53, a firm but resilient engagement is had
between the lapping tool and the work. As shown, the cam 48 is mounted on a shaft 56 having a pulley 57 secured thereto. An endless belt 58 leading over a groove 59 in the spindle 31 serves to impart a rotary motion to the cam. It will be understood that any suitable means may be disposed intermediate the shaft 56 and the spindle 31 so as to cause a given speed of rotation of the cam 48.

In performing the cutting or lapping operation upon a die, the diamond dust or other abrasive material is applied to the periphery 61 of the wheel 13 and is held until the engagement of the diamond forces the diamond dust into the pores of the lap by any suitable binder such as a gum. By carefully charging the periphery of the lapping wheel and avoiding the deposit of diamond dust upon the sides of the wheel and by avoiding lateral movement of the wheel during rotation, the diamond may be cut to have a cavity with the straight edge or lip 25. I have also found that by reason of the high speed of the lapping wheel, the cutting operation is not only expedited but a more effective and uniform abrasive action is attained.

During a lapping operation it is usually necessary to remove the lapping-wheel to “true” up the same or renew the surface. This requirement often resulted in failure to again line up the wheel with the partially formed cavity and caused an irregular cut. In the present machine, I provide a forming tool 63 for truing the wheel 13, and mount the tool on a shaft 64 rotatable in bearings 65 and 66. The tool 63 may be adjustable along the shaft 64 and may be moved in contact with lapping wheel and then set to a fixed position by means of a set screw 65. The forming tool being thus aligned with the lapping wheel, when it is in its operative position, may be removed therefrom until it is necessary to engage the tool with the lapping wheel to reform the wheel at which time the tool 63 may be manipulated by hand lever 68 to bring the forming surface 62 of the tool in contact with the wheel after which the tool may be removed and the diamond cutting operation resumed. For the purpose of forming or reducing the neck 70 of the lapping wheel and to cut the lap 61 to the proper diameter, a stop comprising a bracket 60 and a set screw 66 is provided.

It is to be understood that when starting to lap a cavity, the neck 70 of the lapping wheel is comparatively large in diameter; as the depth of the cavity increases, however, the neck of the lapping wheel is reduced in diameter by the forming tool 63 so that upon a complete formation of the cavity the depth thereof will be almost equal to a radius of the lapping wheel. The stop just mentioned may, therefore, be set each time so that the forming tool will reduce the neck a given amount.

As above set forth, the cutting operation is greatly facilitated by cutting the die block in the direction of the grain of the stone. The block is, therefore, so placed with respect to the lapping tool during the cutting operation that the tool rotates in a plane substantially in the direction of the grain of the block which may be a diamond. The block is usually in the form of a parallelogram and the cavity is cut on one side thereof, and adjacent to an edge so that one portion of the perimeter of the mouth of the cavity constitutes the lip 25 which is subsequently lapped to a knife-edge. By reason of the manner of cutting the die, the grain or longitudinal crystals of the stone lie perpendicular to the edge of the lip as is indicated in the sectional view in Fig. 14 thus avoiding a brittle edge as in the case of having the grain run transversely to the lip.

By reason of the present invention, it is possible to produce a wire bending die of such form as to properly guide the fine wire into helical form and maintain a constant pitch in the resultant filament. Furthermore, the production of the die is greatly facilitated since by reason of the novel form of cutting the time of such operation is greatly reduced. This is an important factor inasmuch as it is obviously necessary to provide different dies for different diameter wires. In machines of the type to which the present invention relates which contain a diamond cavity die, a great loss in the value of the machine results from the costly time-consuming operation of making the various dies for the many different diameters of wires to be wound. The production of the dies therefore plays an important part in making machines of this type practical. Ordinarily the exceptionally high cost in dies tends toward making the use of the machine prohibitive for factory use by reason of the maintenance of the dies and their initial cost. The method, therefore, which improves and facilitates the production of the formation of the die reduces the cost thereof to such a degree as to render effective and desirable the other advantages attained from the winding of a filament by the cavity die method.

The present invention has, therefore, brought about a decidedly advanced step in the art tending toward greater output of helical filaments with a reduction in manufacturing costs.

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 wherein which fall within the spirit and scope of the appended claims.

What is claimed is:

1. A diamond die comprising a body portion having a cavity with an elongated perimeter at the mouth thereof and disposed
lengthwise of and substantially parallel to an edge of the body, a portion of one of the edges of the mouth being straight, said straight portion being adapted to provide a lip for the separation of the convolutions of wire when issuing from the cavity.

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

3. A coil forming die provided with a face partially bounded by a straight edge, said die being provided with a cavity in said face, the mouth of said cavity being bounded in part by a straight line immediately adjacent and parallel to said straight edge.

4. A diamond die comprising a body portion having a cavity cut in the direction of the grain of the stone, a lip adjacent to said cavity, said lip having the grain of the stone running substantially perpendicular to its operating edge.

In testimony whereof, I have hereunto subscribed my name this 23rd day of April, 1926.

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