

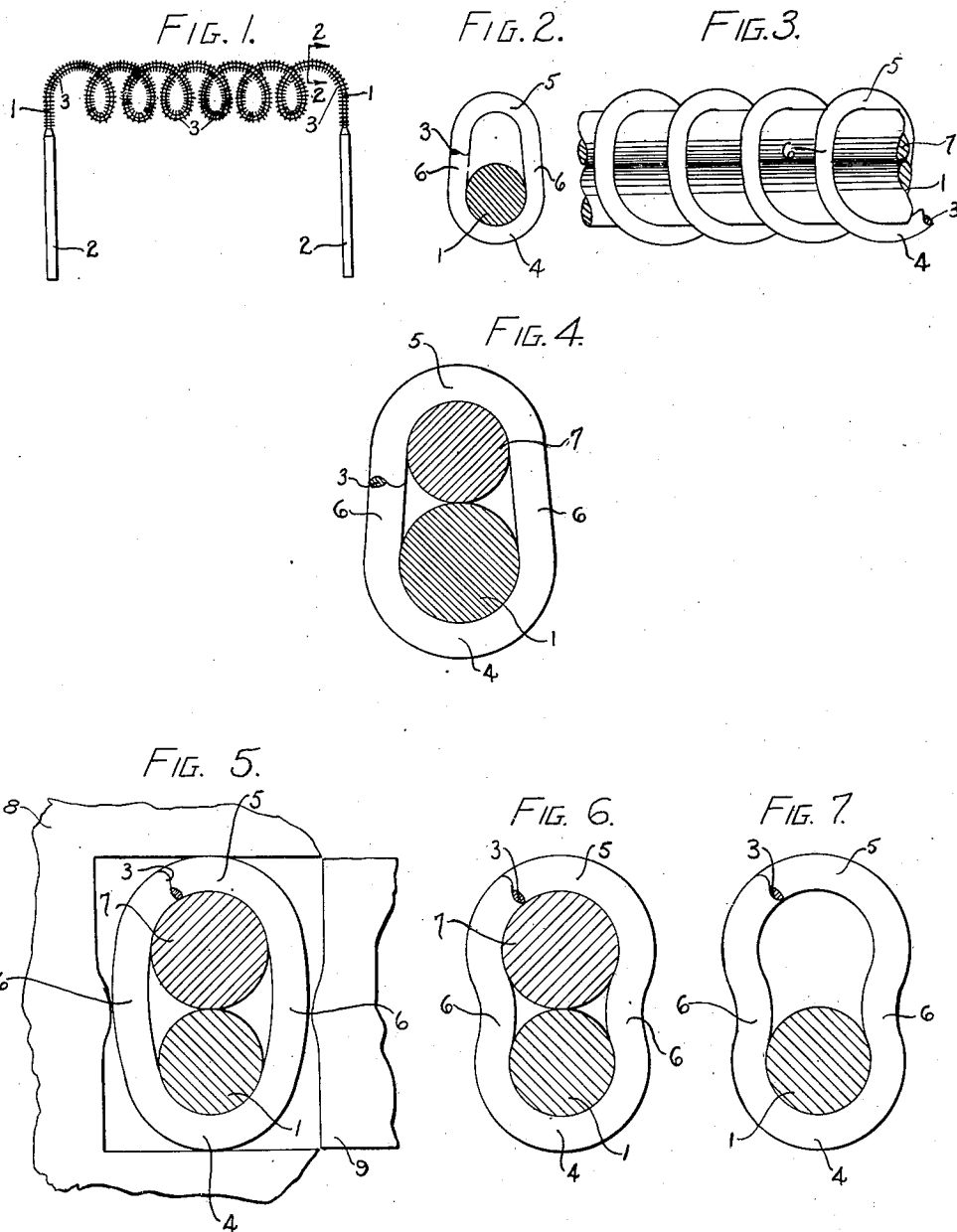
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COILED FILAMENT OR CATHODE AND ITS MANUFACTURE

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COILED FILAMENT OR CATHODE AND ITS
MANUFACTURE

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This invention relates to filamentary or wire coil structures for electric lamps and electric discharge devices, and to the construction and fabrication of such coil structures. As electrodes, coils of this character are especially useful in lamps or tubes of low pressure positive column type, which are characterized by a diffuse discharge that substantially fills the discharge envelope. The invention is hereinafter explained with reference to activated coil electrodes for ordinary tubular, positive column, fluorescent lamps, particularly the type of coil electrode shown in U. S. Patent 2,306,925 to John O. Aicher, granted December 29, 1942. But such coil structures may be found useful for any lamp coils that carry a charge or filling of fine particles, or even in incandescent electric lamps.

In an electrode of this character, there may be employed a coil of tungsten or other metal wire (whether round or of angular or flattened cross-section) which may be relatively fine, or of a size adapted for rapid heating and for easy starting of an electric discharge. This coil may surround a conductor of larger cross-section that affords ample strength, distributes current throughout the electrode without an excessive voltage drop or variation of potential, and receives and redistributes heat. By thus equalizing and keeping down the temperature of the more active portions of the electrode, objectionable heat effects on its electron-emissive activating material are prevented. While the other wire may surround the main conductor or mandrel wire like an overwind, yet the conductor is considerably smaller than the internal area of the surrounding coil, which is thus largely out of contact with the conductor, so that the latter does not interfere with rapid heating of the outer wire. In this connection, it is to be remarked that the heat is not so very readily transferred from the conductor through the heavy coating or charge of refractory (and thermoinsulative) emissive oxide(s) that is accommodated and securely retained within the overwind convolutions. With the conductor wire and its surrounding coil coiled up into a larger coil, a very satisfactory cathode is provided, characterized by low resistance and easy starting of an electric discharge therefrom. If desired, such winding may be repeated one or more times: e. g., the coiled coil may be coiled once more into a triple coil.

In accordance with my invention, provision is made for interlocking engagement and contact of the outer coil wire with the inner conductor wire. This not only provides definite electrical connec-

tions between outer convolutions and conductor wire, but obviates any loosening or loss of activating material as a result of displacement of one wire relative to the other. For this purpose, outer coil convolutions are given a sort of reentrant or elongated "loop" form, with bends of the loops (or some of the loops) extending more than 180° around the conductor and conforming to or suitably engaging its periphery, so that the conductor is interlocked in these embracing or gripping bends.

To fabricate such a coil construction, I may wind the overwind wire on a composite mandrel comprising in its cross-section the main wire and associated filler material arranged alongside the latter, but leaving more than 180° of the main wire periphery exposed. The effect desired is secured by conforming the overwind to more than 180° of the main wire periphery, or, what amounts essentially to the same thing, making the overwind bear against the main wire periphery at points more than 180° apart, as well as immediately. An auxiliary wire extending alongside the main wire may serve as the filler, and these wires may even be intertwisted, which serves as a convenient means of holding them together.

Various other features and advantages of the invention will appear from the description of species and forms of embodiment, and from the drawing.

In the drawing, Fig. 1 is a side view of a coiled cathode mounted on supports and constructed according to the invention; and Fig. 2 shows a cross-section taken as indicated by the line and arrows 2-2 in Fig. 1, on a larger scale.

Fig. 3 is a fragmentary tilted side view illustrating an early stage in the fabrication of a cathode according to the invention; and Fig. 4 shows an end view from the left in Fig. 3 on a larger scale.

Figs. 5, 6, and 7 are cross-sectional views similar to Fig. 4 illustrating the fabrication of a cathode by a modified method.

As shown in Figs. 1 and 2, the electrode structure comprises a coil of main electrode conductor or mandrel wire 1 connected to lead-wire supports 2, 2 and having thereon an overwind of electrode wire 3, preferably finer than the conductor wire 1, forming a coiled coil. The overwind 3 may be connected to the leads 2, 2 directly, as well as through the main conductor 1. To avoid confusion, the activating material is omitted from these figures. For the purposes of my invention, the convolutions of the overwind coil 3, which have an internal area greater than the

cross-sectional area of the conductor 1, nevertheless bear on the periphery of the conductor 1 at points more than 180° apart around the conductor, as well as intermediately. Thus the conductor 1 is interlocked and held in definite, fixed position in one side of the convolutions 3 (whose internal area exceeds the cross-section of the conductor), and cannot be displaced in the convolutions to disturb the activating material in the basket formed by the portions of the convolutions out of contact with the conductor. As shown in Fig. 2, the convolutions 3 have the form of more or less oval elongated loops larger at their ends or bends 4 through which the conductor 1 extends than at their vacant ends or bends 5, and the bends 4 conform to and fit more than 180° of the periphery of the conductor. This may be the case even if the straighter portions 6 of the wire 3 interconnecting the bends 4, 5 should be slightly bent or bowed outward.

In fabricating such a structure as illustrated in Figs. 3 and 4, a round filler or auxiliary wire 7 is used as longitudinal "padding" alongside the main conductor wire 1 to form a composite mandrel on which relatively fine wire 3 is wound. As shown in Fig. 4, the filler wire 7 is of smaller size than the main wire 1, thus providing a composite mandrel of elongated and wedge-like cross-section. The other electrode wire 3 may be wound so tautly on this composite mandrel that the series of elongated convolutions or loops have substantially straight sides 6 interconnecting their bends 4, 5. Accordingly, the bends 4 around the larger wire 1 engage and conform to this wire 1 around more than 180° of its periphery. The wires 1, 7 are of different metals, one not affected by a reagent or solvent that does attack the other: e. g., if the wire 1 is of tungsten, the wire 7 may be of molybdenum. The composite mandrel 1, 7 with its overwind 3 may then be wound up into a larger coil on a suitable mandrel (not shown) of the same metal as the auxiliary wire 7; and this may, if desired, be repeated one or more times. After suitable heat treatment (such as heating to 1500° C. in hydrogen) to set the tungsten wire in its coiled configuration, the auxiliary wire 7 and all mandrels may be dissolved out by means of any suitable solvent therefor that does not affect the wires 1, 3 materially, such as the usual molybdenum solvent of nitric and sulphuric acids. This leaves the coil structure ready to be mounted by welding to the leads 2, 2 as shown in Fig. 1, and for coating or charging with activating material or oxides, such as a mixture of alkaline earth oxides including those of barium and strontium. Usually such activating material is applied with the aid of a carbonaceous binder like nitrocellulose, which is eliminated in exhaust-processing the completed lamp.

Figs. 5, 6, and 7 indicate a variant in which the size relations between the wires 1, 7 that are shown in Fig. 4 do not obtain: i. e., the main wire 1 need not be any larger than the auxiliary wire 7, and may even be smaller. As shown in Fig. 5, the electrode wire 3 is not wound on the composite mandrel 1, 7 very tautly, and so the sides 6 of the elongated loop convolutions are not straight, but curve outward decidedly. As diagrammatically indicated in Fig. 5, force is then applied to these loop sides 6 to force them inward reversely between the round members 1, 7. This may be done between suitable coacting dies

or rollers 8, 9 having cross-sections such as diagrammatically represented in Fig. 5. The effect of this is to make the loop convolutions conform to and engage with more than 180° of the smaller wire 1. After all the wires have been set by heat treatment and the auxiliary wire 7 has been dissolved out and removed, the coil structure shown in Fig. 7 remains, ready for mounting and for coating or charging with activating material.

In both of Figs. 2 and 7, therefore, the overwind convolutions 3 conform to more than 180° of the circumference of the main wire 1, besides engaging it at points more than 180° apart as well as intermediately. In both cases, likewise, both the wires 1, 3 are well exposed for coating with activating material, and the spacing of the wire 3 from the wire 1 provides space for an ample supply of this material, and recesses favorable for its retention. Hence it is generally unnecessary to fill the convolutions into which wires 1 and 3 together may be wound in order to provide a sufficient reservoir of material, although this may be done if desired. The relative immobility of the wires 1 and 3 due to their interengagement makes the cathode stronger and more rigid, and there is very much less likelihood that the material may be dislodged and lost than if the wires 1, 3 were not thus interlocked. In addition, the structure affords substantially all the advantages of that described in the Aicher patent aforementioned.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A composite filament structure comprising a mandrel wire and a wire coil of elongated cross section surrounding said mandrel wire, one side of the coil having its turns in tight engagement with more than 180° of the circumference of the mandrel wire whereby the coil is securely fixed in place on the mandrel.

2. A composite filament structure comprising a mandrel wire and a wire coil of oval cross section surrounding said mandrel wire, the portions of the turns of said coil at the larger end of the oval being in tight engagement with more than 180° of the circumference of the mandrel wire whereby the coil is securely fixed in place on the mandrel.

3. A filament structure as set forth in claim 1 wherein the composite mandrel and coil structure is itself helically coiled.

4. The method of making a composite filament structure which comprises arranging a pair of mandrel wires in side-by-side relation, affixing an overwind wire around said pair of mandrel wires with portions of the turns thereof in tight engagement with more than 180° of the circumference of one of the mandrel wires, and subsequently removing the other mandrel wire to leave the coil of overwind wire securely fixed in place on the said one of the mandrel wires.

5. The method of making a composite filament structure which comprises arranging a pair of mandrel wires of different size in side-by-side relation, coiling an overwind wire tightly around said pair of mandrel wires so that portions of the turns thereof are in tight engagement with more than 180° of the circumference of the larger mandrel wire, and subsequently removing the smaller mandrel wire to leave the coil of overwind wire securely fixed in place on the larger mandrel wire.

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