Nov. 23, 1943. C. V. LITTON 2,334,716

SPIRAL FILAMENT

Filed Jan. 30, 1943

Fig: 1.

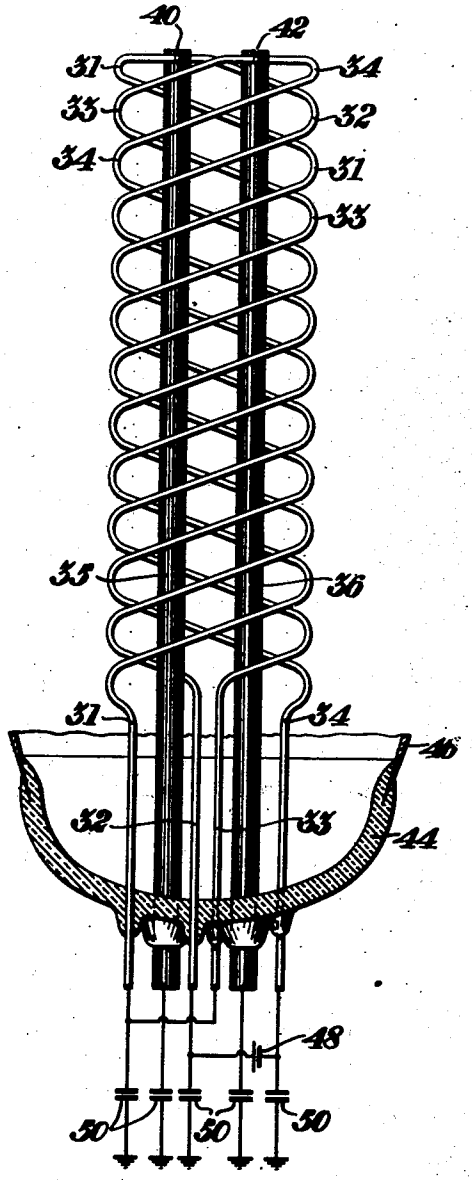
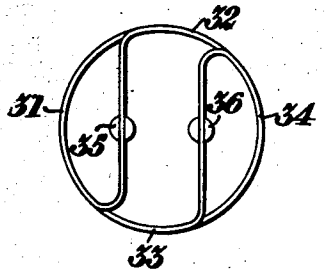


Fig: 2.



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SPIRAL FILAMENT

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12 Claims. (Cl. 250—27.5)

This invention relates to improvements in spiral filaments, and more particularly to filaments built-up from a plurality of spiral windings and adapted for use in vacuum tubes and other electron or heat-emitting devices.

An object of this invention is to provide a novel improved filament structure.

Another object of this invention is to provide a multi-spiral filament structure having relatively high longitudinal rigidity permitting small spacing between wires.

A further object of this invention is to provide a multi-spiral filament having the advantages of relatively low filament current, but high thermionic efficiency.

Other objects and advantages of the present invention will become more apparent from a study of the following description of a preferred embodiment of my invention illustrated in the accompanying drawing, in which:

Fig. 1 is a vertical plan view of a preferred form of filament structure in accordance with the present invention, showing the surrounding tube structure partially broken away and partially in section;

Fig. 2 is a top end view of the filament illustrated in Fig. 1.

In a preferred form of the present invention, such as illustrated in the drawing, the composite filament is made up of a pair of bifilar windings. One bifilar winding may consist of two wires such as **31** and **32** which are connected together at their top, with their end leads extending downward, longitudinally of the filament. The second bifilar winding is made up of separate windings **33** and **34** likewise connected together at the top. The two windings are interwound and separately supported by rods **35** and **36**. In the preferred arrangement illustrated, the rods **35** and **36** are provided at one end with slots **40** and **42** respectively which receive the end connections of the two bifilar windings, which may also be welded into the slots to secure rigidity and a good electrical connection.

The ends of the two bifilar windings as well as the lower ends of the supporting rods may pass through a glass seal **44** to which may be connected the remaining portion **46** of a tube envelope.

The leads of the bifilar winding are preferably interconnected with one another either inside or outside of the tube so that the current in adjacent turns of the filament as a whole flows in opposite directions. In Fig. 1, for example, the leads of the windings **31** and **33** are connected to one another while a source of power such as a battery **48** for heating the filament is connected across the wires **32** and **34**. Accordingly, it will be seen that current flowing from the positive terminal of the battery **41** will flow upwardly through the wire **32**, will return downwardly through the second half of the one bifilar winding consisting of the wire **31**, will then flow upwardly through the wire **33** of the second bifilar winding and then downwardly through the wire **34**. By providing a current flow which is in opposite directions in adjacent filament turns, the possibility of induced electromagnetic current as a result of current flow in the windings is obviated by the neutralizing action of adjacent turns. In order to place the entire filament structure at ground potential with respect to radio frequency currents, all four filament leads as well as the supporting rods may be grounded through suitable condensers **50**.

While the specific form of invention illustrated is directed to a quadrifilar filament formed from two bifilar windings, the principles of the invention are applicable to other filaments containing more than two sets of bifilar windings. In such cases additional supports will be provided for each additional bifilar winding, while the inter-connection between all the bifilar windings will still be such as to provide opposite current flow in adjacent wires. All of the windings as well as the supports may be grounded with respect to high frequency currents by the inclusion of suitable condensers.

The invention described above will satisfy the objects primarily stated. The resulting filament structure will have a more uniform emission area and greater strength and rigidity than the same length of wire in one coil, while at the same time it has less volume than a plurality of unnested parallel or series coils. The magnetic and electrostatic effects of the filament are minimized. And while I have described above the principles of my invention in connection with certain specific structure, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of my invention as set forth in the objects and the accompanying claims.

I claim:

1. A spiral filament structure for vacuum tubes and the like, comprising a plurality of substantially identical coaxial bifilar spiral windings threaded one within the other and with their respective common ends lying substantially within a single plane, and a supporting rod for each

bifilar winding mounted within the windings and each rod being connected to the common end of its respective winding.

2. A filament structure according to claim 1, in which the distance between the wires of each bifilar winding is equal to the distance between turns of the spiral filament as a whole.

3. A spiral filament structure for vacuum tubes and the like, comprising a plurality of substantially identical bifilar spiral windings, each bifilar winding consisting of a single wire wound with double, spaced turns, joined at one end and having longitudinally extending leads projecting from its other end, and means for coaxially mounting said bifilar windings, screwed one within the other and with their joined ends all substantially within a common plane, said means comprising a supporting rod for each bifilar winding extending longitudinally within the windings, each rod being connected at one end to the joined section of its respective winding.

4. A filament structure according to claim 3, in which the distance between the wires of each bifilar winding is equal to the distance between turns of the spiral filament as a whole.

5. The combination according to claim 3, in which the one end of each rod is provided with a transverse slot for receiving the joined end of its supporting winding.

6. The combination according to claim 3, in combination with means for serially connecting said bifilar windings so that the current flow in the composite spiral filament is in opposite directions in adjacent turns.

7. The combination according to claim 3, in combination with means for capacitatively coupling the ends of each bifilar winding and the other ends of each supporting rod to ground.

8. A quadrifilar spiral filament comprising a pair of substantially identical bifilar spiral windings, each bifilar winding consisting of a single wire wound with double, spaced turns joined at one end and having longitudinally extending leads projecting from its other end, and means for coaxially mounting said bifilar windings, screwed one within the other and with their joined ends both substantially within a common plane, said means comprising a pair of supporting rods extending longitudinally within the composite filament, each rod having a slot at one end adapted to receive the joined end of one of the windings.

9. The combination according to claim 8, in which the distance between the wires of each bifilar winding is equal to one-fourth the distance between the turns of that winding.

10. The combination according to claim 8, in combination with means for serially connecting said bifilar windings so that the current flow in the composite spiral filament is in opposite directions in adjacent turns.

11. The combination according to claim 8, in combination with means for capacitatively coupling the ends of each bifilar winding and the other ends of each supporting rod to ground.

12. The combination according to claim 8, in combination with means for serially connecting said bifilar windings so that the current flow in the composite spiral filament is in opposite direction in adjacent turns, and means for capacitatively coupling the ends of each bifilar winding and the other ends of each supporting rod to ground.

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