# United States Patent

[11] 3,631,593

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[73] Assignee RCA Corporation

[54] ASSEMBLY OF FILAMENTARY DISPLAY DEVICES
6 Claims, 6 Drawing Figs.

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[51] Int. Cl. .......... H01c 17/00
[50] Field of Search .......... 29/610, 423, 25.11, 25.14, 25.13, 25.15; 313/109.5, 110, 271, 272, 278; 140/71.5, 71.6

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**ABSTRACT:** A refractory wire is wound in an elongated helix around and along a mandrel of a material different from that of the wire. A length of the wound mandrel is extended across and the helix thereof is bonded to spaced-apart legs of a fixture, and the mandrel is etched from within the helix. The helix is mounted between two spaced-apart terminals by disposing one leg of the fixture adjacent to one of the terminals, bonding the helix to the terminal, severing the helix from the one fixture leg, disposing the other leg of the fixture adjacent to the other terminal, bonding the helix to the other terminal, and severing the helix from the other fixture leg.

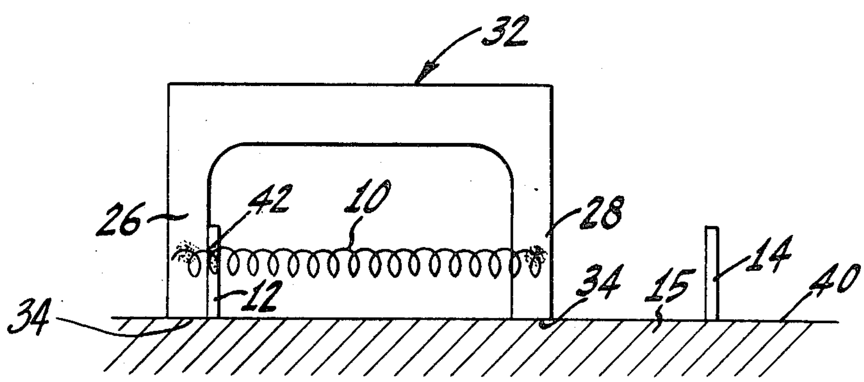

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Fig. 1.

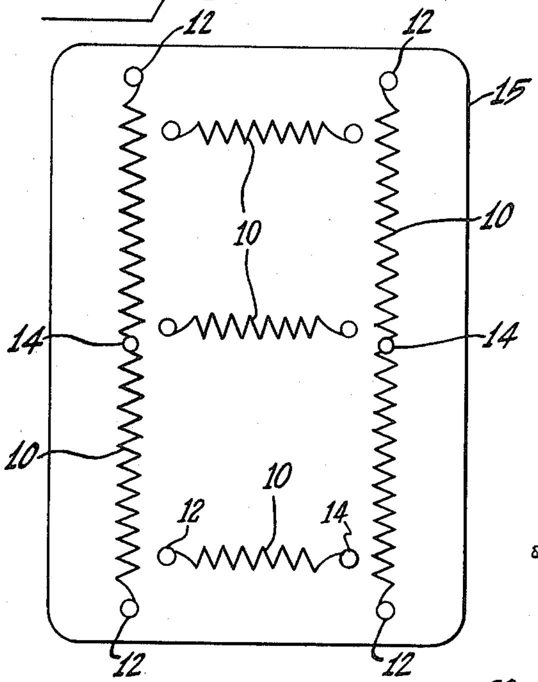



Fig. 2.

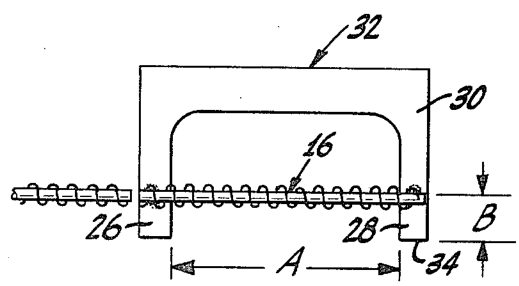




Fig. 3.

Fig. 4.

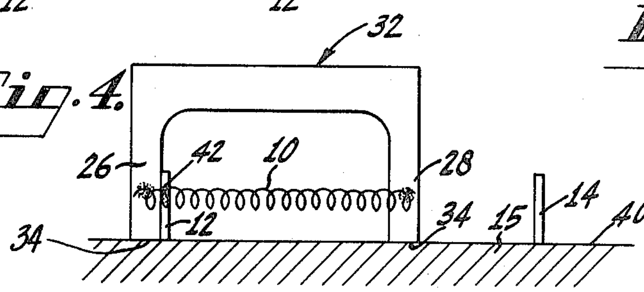



Fig. 5.

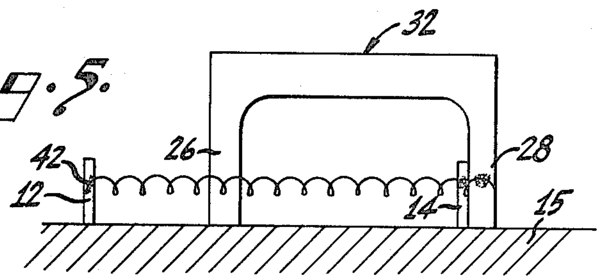
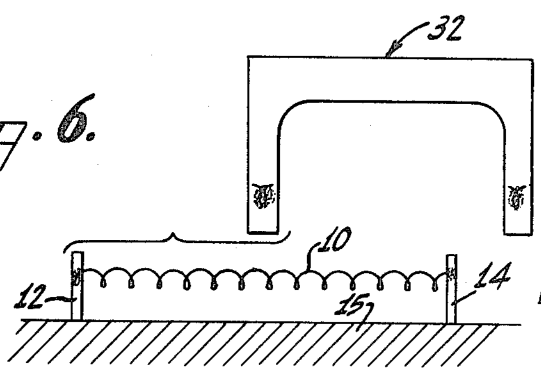



Fig. 6.

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## ASSEMBLY OF FILAMENTARY DISPLAY DEVICES

### BACKGROUND OF THE INVENTION

This invention relates to filamentary-type display devices, and particularly to the process of fabricating and mounting the filaments of such devices.

One type of display device comprises an array of electrical resistance filaments individually mounted between pairs of support terminals. By passing an electrical current through various selected ones of the filaments, to heat the filaments to incandescence, various images, e.g., numerals, are displayed.

Generally, it is preferred that such devices be operable at low voltages and currents. To this end, the various filaments are made of extremely small diameter wire, e.g., 0.0004 inch. Also, the filaments generally comprise coils of wire, the outer diameter of the coils being extremely small, e.g., 0.002 inch. A problem associated with such small and thus fragile filaments is that of handling the filaments without damaging them. Further, an especially difficult problem is that of mounting the filaments between the terminals in an accurate and reproducible manner without excessive loss of product.

### DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic illustration of a portion of a display device, showing a substrate, the support terminals on the substrate, and an array of filaments mounted between pairs of the support terminals;

FIG. 2 shows, on an enlarged scale, a workpiece used in accordance with the instant invention;

FIG. 3 shows a further workpiece, incorporating a portion of the workpiece shown in FIG. 2, used in accordance with the instant invention;

FIG. 4 shows one step of the use of the workpiece shown in FIG. 3; and

FIGS. 5 and 6 show subsequent steps in the use of the workpiece shown in FIG. 3.

### DESCRIPTION OF PREFERRED EMBODIMENTS

Filamentary display devices of the type with which this invention has utility are known. An example of such devices is described in U.S. Pat. No. 3,416,020, to J. A. Carley, issued Dec. 10, 1968.

In such display devices, as shown in FIG. 1, a plurality of filamentary coils 10 are mounted between pairs of support and terminal posts 12 and 14, the posts being mounted on a substrate 15. In the illustrative embodiment, two of the posts 14 are each common to two different filaments 10.

Means, not shown, are provided for connecting the posts 12 and 14 to terminal leads of the device, whereby electrical voltages can be applied between individual pairs of posts 12 and 14 to heat the filaments mounted between the post pairs to incandescence. Thus, various images, e.g., the numerals 0 through 9, in the illustrative embodiment, can be displayed.

Each filamentary coil 10 is formed of a given length of a refractory wire, e.g., tungsten with such additives as rhenium or thorium. When heated to incandescence, the length of the wire increases. To help prevent sag of the heated coils, the coils are preferably mounted under tension. According to one technique, the coils are fabricated with a length less than the distance between the posts between which the coils are to be mounted, and the coils are stretched and tensioned in the mounting operation.

In accordance with the instant invention, the individual filamentary coils 10 are provided and mounted on the support posts as follows:

A wound mandrel assembly 16 (FIG. 2) is first formed by winding a refractory wire 18 around and along a mandrel 20 of a material different from the material of the wire 18. For example, using a refractory wire 18 of tungsten, the mandrel 20 may be molybdenum. Means for winding fine wires around and along fine mandrels are known.

In this embodiment, the wire 18 has a diameter of 0.4 mil, and is wound at 1,400 turns to the inch. The molybdenum mandrel 20 has a diameter of 1.2 mils, the coil assembly 16 having an outer diameter of 0.002 inch.

The mandrel assembly 16, from which individual coils 10 are to be provided, as described hereinafter, is significantly stronger and more rigid than an unsupported filamentary coil 10, and is relatively easy to handle with little likelihood of damage thereto.

A length of the mandrel assembly 16 is then extended between two legs 26 and 28 (FIG. 3) of a U-shaped, flat metal frame 30, bonded to the legs 26 and 28, as by welding, and cut from the remainder of the assembly 16 to provide a frame assembly 32, as shown. In the bonding operation, both the mandrel 20 and the wire 18 wound thereabout are individually bonded to the frame 30. This is necessary because the mandrel 20 will eventually be removed from within the coiled filament 18.

Using fine refractory wires for both the mandrel 20 and the refractory wire 18, these materials become embedded in the material of the frame 30, generally of a nonrefractory material, e.g., stainless steel, using a welding bonding process.

Two dimensions of the frame assembly 32 are specifically noted. One dimension is the distance A between the inside edges of the frame legs 26 and 28. This dimension determines the amount of stretching of the filament coil 10 when the coil is mounted between a pair of support posts, as described hereinafter. The other dimension is the distance B between the free ends 34 of the legs 26 and 28 and the point on the legs where the mandrel assembly 16 is bonded. This dimension determines the spacing between the filament coil 10 and the substrate 15 (FIG. 1), as described hereinafter.

The frame 30 can be provided, for example, by a stamping process, whereby frames 30 of good dimensional accuracy can be readily and inexpensively provided. The mandrel assembly 16, being relatively rigid, as noted, can be easily and accurately positioned on the frame 30, using, for example, a simple jig, not shown, whereby frame assemblies 32 can be accurately, simply, and inexpensively fabricated.

Thereafter, the mandrel 20 of the frame assembly 32 is selectively etched from within the wire 18 coiled thereabout. It is for this reason that the wire 18 and mandrel 20 should be of different materials. Using a tungsten wire 18 and a molybdenum mandrel 20, an etchant of sulfuric and nitric acids can be used which attacks molybdenum at a much faster rate than it does tungsten. The assembly is removed from the etchant before significant etching of the tungsten occurs. The frame 30, having further use, described hereinafter, is made of a material resistant to the etchant used. In the instant embodiment, for example, the frame can comprise stainless steel or an alloy of chromium and nickel, having the trade name Nichrome.

In another embodiment, the mandrel can comprise a low melting temperature material, e.g., plastic, and the mandrel removing step comprises heating and melting away the mandrel. Chemical dissolution can also be used to remove such a mandrel.

Having removed the mandrel 20, a coil 10 is left suspended between the legs 26 and 28 of the frame 30.

The frame assembly 32, without the mandrel 20, is next utilized to mount the filamentary coil 10 between two support posts 12 and 14. As shown in FIG. 4, this is accomplished by first disposing one leg 26 of the frame assembly 32 against the outer side of the post 12 ("outer" with respect to the other post 14), with the filamentary coil 10 extending across the post 12. Also, as shown, the free ends 34 of the frame legs 26 and 28 are disposed in engagement with the surface 40 of the substrate 15.

Since the distance B (FIG. 3) between the leg free ends 34 and the point on the legs where the coil is bonded is controlled, as described, disposing the leg ends 34 against the substrate surface 40 determines the spacing between the coil and the substrate.

The portion of the coil 10 extending across the post 12 is then bonded to the post, as by welding or staking, or both.

Having bonded an end portion 42 of the coil 10 to the post 12, the portion of the coil between the post 12 and the frame leg 26 is broken. Owing to the fineness of the coil wire 18, the separation of the coil from the frame leg 26 can be done simply by moving the frame 30 slightly away from the post 12.

As indicated in FIG. 4, the inside distance between the frame legs 26 and 28 is preferably somewhat less than the distance between the terminal posts 12 and 14. In this embodiment, for example, the distance between the posts 12 and 14 is 275 mils, and the inside distance between the frame legs 26 and 28 is 170 mils.

The frame assembly 32 is then moved to dispose (as shown in FIG. 5) the frame leg 28 against the outer side of the post 14 with the coil 10 extending across the post 14. The movement of the frame assembly 32 to the post 14 causes stretching and tensioning of the filamentary coil 10.

The portion of the coil 10 extending across the post 14 is then bonded, at the proper height, to the post 14, and the portion of the coil 10 between the post 14 and the frame leg 28 is broken by moving the frame away, as shown in FIG. 6. This completes the coil mounting operation.

The amount of stretching of the coil 10 is determined by the difference in spacings between the posts 12 and 14 and between the frame legs 26 and 28. While not described herein, the fabrication of substrates 15 having posts 12 and 14 in accurately spaced relationship is well known.

We claim:

1. In a method of mounting a filament between a pair of spaced-apart terminals, the improvement comprising:

winding a filament of one material around and along a mandrel of another material to form an elongated mandrel assembly,

disposing said mandrel assembly between and securing the filament thereof to two spaced-apart legs of a holding means,

removing said mandrel from within said mandrel assembly to leave a filament disposed between said legs,

securing said filament between a pair of spaced-apart terminals, and thereafter

disengaging said filament from said holding means.

2. The method of claim 1 wherein said filament to said terminals securing step comprises:

disposing one of said holding means legs adjacent to one of said terminals and bonding a portion of the filament adjacent to said one leg to said one terminal, and thereafter

disposing the other holding means leg adjacent to the other of said terminals and bonding a portion of said filament adjacent to said other leg to said other terminal.

3. The method of claim 2 wherein:

said step of securing said filament to said holding means includes disposing said mandrel assembly at a predetermined distance from ends of said legs, and

each of said terminal bonding steps includes the step of disposing said leg ends in engagement with a substrate on which said terminals are mounted.

4. A method of mounting a helical filament between a pair of spaced support terminals, comprising:

bonding ends of said filament between spaced legs of a fixture;

bonding an end portion of said filament adjacent to one of said legs to one of said terminals;

breaking the bond between said filament and said one leg;

disposing the other leg of said fixture adjacent to the other of said terminals;

bonding an end portion of said filament adjacent to the other of said legs to the other of said terminals, and

breaking the bond between said filament and said other leg.

5. The method of claim 4 wherein said filament-fixture bonding step includes bonding said filament at a predetermined distance from ends of said legs, and

said filament-terminal bonding steps each includes the step of disposing said leg ends in engagement with a substrate on which said terminals are mounted.

6. The method of claim 4 wherein the spacing between said fixture legs is less than the spacing between said terminals, and including the step of stretching said filament in said process of disposing the other leg of said fixture adjacent to the other of said terminals.

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