June 10, 1958 A. L. PUGH, JR 2,838,427

METHOD AND APPARATUS FOR FLAME SPIRALLING

Filed Oct. 23, 1956

2 Sheets-Sheet 1

Fig. 1

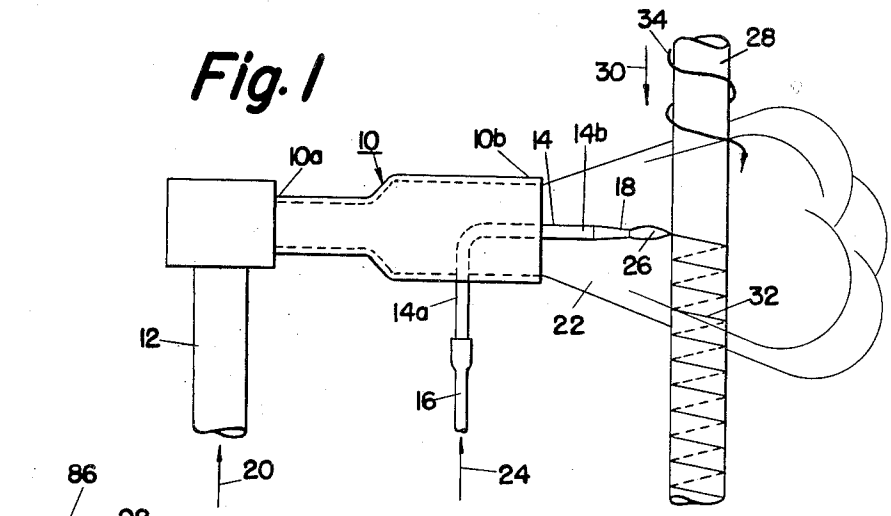
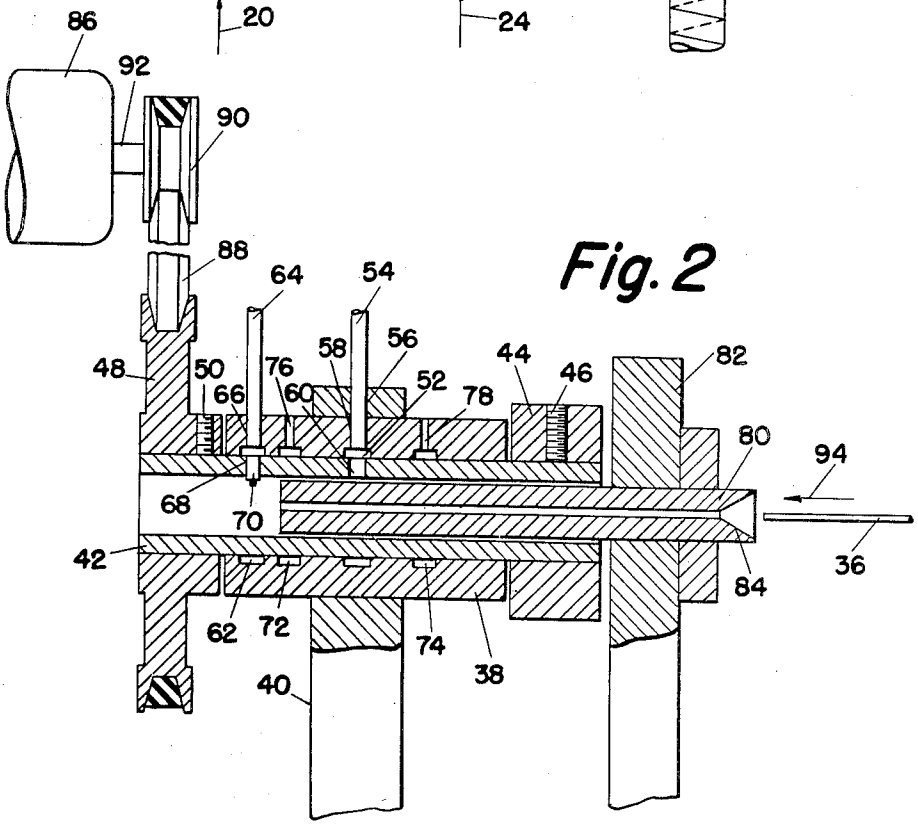


Fig. 2



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Filed Oct. 23, 1956 2 Sheets-Sheet 2

Fig. 3

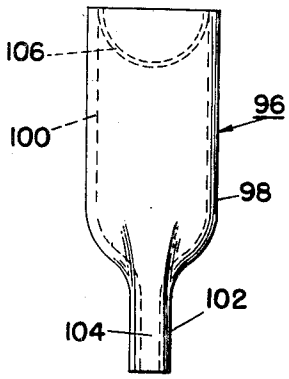


Fig. 4

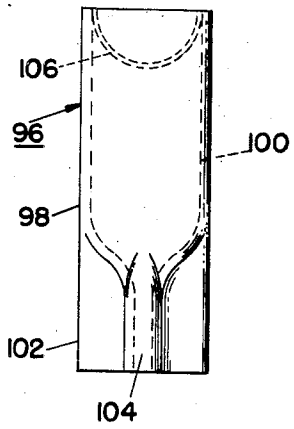


Fig. 5

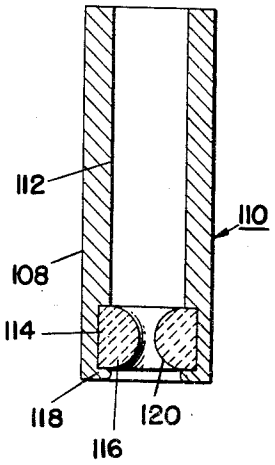


Fig. 7

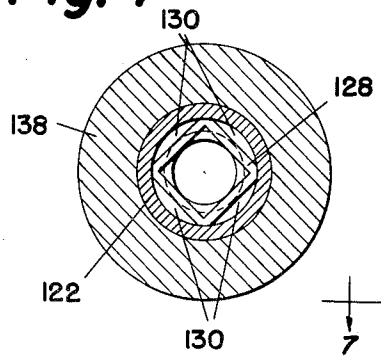


Fig. 6

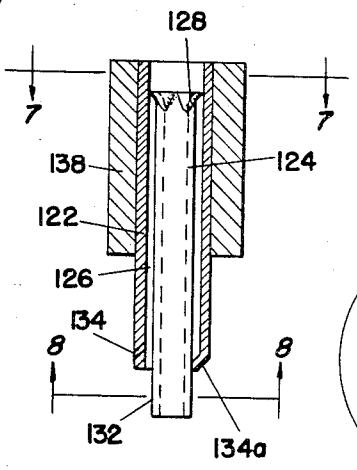
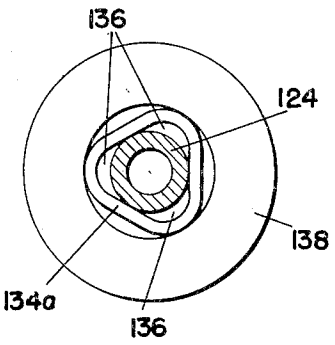


Fig. 8



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METHOD AND APPARATUS FOR FLAME SPIRALLING

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Application October 23, 1956, Serial No. 617,814

4 Claims. (Cl. 117—212)

This invention relates to a method and apparatus for burning a narrow groove in a carbon body or film. More particularly it relates to a method and apparatus for flame spiralling a carbon film electrical resistance element.

In the manufacture of electrical resistors of the type comprising a thin carbon film deposited on the surface of a cylindrical member of ceramic material, it is well known to increase the resistance value of the resistor by spiralling the resistor which comprises cutting a helical grove through the carbon film to increase the resistance path. One well known method of cutting such a groove is by rotating and translating the resistance element across a cutting or grinding wheel as shown in U. S. Patent No. 2,405,485 to E. E. Barkstrom et al. issued August 6, 1946. Another method is by sand-blasting the groove such as shown in U. S. Patent No. 2,743,554 to E. G. Dailey et al. issued May 1, 1956.

In my co-pending application for Letters Patent Serial No. 385,066 filed October 9, 1953, entitled "Apparatus For and Method of Deposition of Solids From Vapors and Products Produced Thereby," there is disclosed a method of making carbon film resistors by depositing carbon on the surface of a continuous length glass rod or tube of small diameter. It would be desirable to spiral this resistor particularly while the coated rod or tube is still of a continuous length and before it is broken apart into individual resistance elements since it would be much faster to spiral the continuous length rod or tube than to individually spiral the small resistance elements. However, the known methods of spiralling resistors previously described are not practical for use on the continuous length carbon coated glass rod or tube. Since the glass tube or rod is of a contiunous length it cannot be rotated so that to spiral it the spiralling apparatus must rotate around the tube or rod. It is highly impractical to rotate a cutting or grinding wheel around the glass tube, particularly at the high speeds necessary for fine spiralling. Another disadvantage of the use of a cutting or grinding wheel is that, if the wheel applies the slightest excess pressure on the glass tube it will cut the glass and thereby break it. Although a sand-blast nozzle can be rotated about the glass tube without too much difficulty, the problem arises in passing the particle laden blast from a stationary source to the rotating nozzle and preventing the sand from getting into the bearing surfaces for the rotating nozzle and thereby damaging the apparatus.

Another disadvantage of the sand-blast method is that the path cut by the sand-blast is too wide to obtain fine spiralling on the small diameter tubing and that the blast cuts into the glass tubing and thereby weakens it

It is therefore an object of this invention to provide a method and apparatus for spiralling a carbon coated glass rod or tube without damaging the glass. It is another object to provide a method and apparatus for spiralling a continuous length glass rod or tube coated with a carbon film. It is a further object to provide a

method and apparatus for grooving a carbon rod or film by means of a flame. It is still another object to provide a method and apparatus for flame spiralling a carbon coated glass rod or tube. Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic view of an apparatus for use in carrying out the method of this invention;

Figure 2 is a transverse sectional view of an apparatus for flame spiralling a continuous length carbon coated rod;

Figure 3 is a side view of one modification of the jet nozzle used in the apparatus of Figure 2;

Figure 4 is a front view of the jet shown in Figure 3;

Figure 5 is a sectional view of another modification of the jet;

Figure 6 is a sectional view of still another modification of the jet;

Figure 7 is an enlarged transverse sectional view taken along line 7—7 of Figure 6; and

Figure 8 is an enlarged transverse sectional view taken along line 8—8 of Figure 6.

In general, my invention relates to a method for burning a groove or path of a controlled width in a carbon rod or film by means of a flame. To merely pass a hot flame, such as provided by a blow torch or similar device, over a carbon rod or film, would not provide a groove or path of controlled width since even after the flame is removed the carbon would continue to burn. However, my invention is in a method of burning the carbon in an atmosphere which does not support combustion so that only the carbon directly under the flame will burn. In general, this method comprises passing the carbon surface in which the groove or path is to be formed through an atmosphere which does not contain oxygen and forming a hot flame within this atmosphere. Thus the portion of the carbon surface directly under the flame will be burned away to form a grove or path. However, once this portion moves past the flame, the carbon on either side of the groove or path will be in the atmosphere which does not contain oxygen so the burning is stopped to provide a groove or path of a controlled width. The carbon surface should be maintained in the oxygen free atmosphere until it cools sufficiently so that it will not begin to burn again when placed in air.

Figure 1 shows a schematic view of an apparatus for carrying out the method of my invention. This apparatus comprises a tube 10 having a gas supply duct 12 connected to its inlet end 10*a* and its outlet end 10*b* open. A second tube 14 is mounted within the open outlet end 10*b* of tube 10. A gas supply duct 16 is connected to the inlet end 14*a* of the second tube 14 and a jet nozzle 18 having a small opening is attached to the outlet end 14*b* thereof. A gas which does not contain oxygen is fed under pressure to supply duct 12 as indicated by arrow 20 to provide at the outlet end 10*b* of tube 10 a confined atmosphere 22 of the gas around the second tube 14. The gas may be either an inert gas such as nitrogen or a gas which, although it does not support combustion, will

itself burn, such as hydrogen or a hydrocarbon such as methane, or an illuminating gas either of the natural or manufactured type. Oxygen or a mixture of oxygen and a combustible gas is fed under pressure to supply duct 16 as indicated by arrow 24. If the gas fed into tube 10 is an inert gas such as nitrogen, tube 14 must be supplied with a mixture of oxygen and a combustible gas. However, if tube 10 is supplied with one of the previously mentioned gases which will burn, then it is only necessary to feed oxygen to tube 14. The gaseous mixture at the end of jet 18 is ignited to form a small hot flame 26. The size and type of flame formed is controlled by the type of nozzle used and the pressure and amount of gas supplied in the same manner as generally used for any oxygen torch. The carbon surfaced member 28 is translated through the atmosphere 22 in the direction indicated by arrow 30 with its surface contacting the hot tip of flame 26 to burn a path or groove in the surface. To form the spiral path 32 the member 28 is also rotated as indicated by arrow 34. Thus the portion of the carbon surface of member 28 directly contacted by the flame 26 is burnt away but as soon as this portion is moved beyond the flame further burning of this portion will be stopped by the atmosphere 22 which does not contain oxygen. The width and depth of the path so provided is determined by the size of the flame and the speed of the member thereacross. Although in Figure 1 the apparatus is shown to be stationary and the member translated, relative movement between the apparatus and member can be obtained in any desired manner such as by translating the apparatus while the member is held stationary or for the purpose of forming a spiral path by rotating one and longitudinally translating the other. Although member 28 is shown to be a continuous length rod or tube it may be a short rod or tube or even a flat sheet or disc.

Figure 2 shows an apparatus for forming a spiral path in a continuous length carbon surfaced member 36 such as the carbon coated glass filament disclosed in my previously mentioned co-pending application. This apparatus comprises a bearing sleeve 38 mounted in a stationary support 40. A hollow sleeve 42 is rotatably supported in the bearing 38 and extends beyond each end thereof. A thrust bearing ring 44 is secured on one end of sleeve 42 by a set screw 46 and a pulley 48 is held on the other end of the sleeve by a set screw 50. Bearing 38 has a first annular groove 52 in its inner surface substantially centrally between its ends. A gas supply pipe 54 for the gas which does not contain oxygen is connected to the groove 52 through aligned holes 56 and 58 in the support 40 and bearing 38 respectively. Sleeve 42 has a hole 60 therethrough in alignment with groove 52 to feed the gas from the groove into the sleeve. Bearing 38 has a second annular groove 62 in its inner surface adjacent one end thereof and a supply pipe 64 for oxygen or an oxygen, combustible gas mixture, is connected to the second groove 62 by a hole 66 in the bearing 38. Sleeve 42 has a hole 68 therethrough in alignment with second groove 62 in which a jet nozzle 70 is force fitted and extends into the sleeve 42. Additional annular grooves 72 and 74 are provided in the inner surface of bearing 38 one on each side of the first groove 52 and each of the additional grooves is vented to the atmosphere by ports 76 and 78 respectively. A tubular guide member 80 mounted on a stationary support 82 extends into the entrance end of sleeve 42 to a point adjacent the jet 70. Guide member 80 has a flared entrance end 84 to permit ease of insertion of the carbon surfaced member 36 into the guide. Sleeve 42 is rotated by means of a variable speed motor 86 through a drive belt 88 which drivingly connects pulley 48 to a drive pulley 90 on motor shaft 92.

In operation, to burn a spiral path or groove in the carbon surfaced member 36, the gas which does not contain oxygen is fed under pressure to annular groove 52 from supply pipe 54. The gas then flows through hole 60 to completely fill sleeve 42 and provide a confined atmosphere thereof. The oxygen or oxygen combustible gas mixture is fed under pressure to groove 62 from supply pipe 64 and then passes through jet 70. The gaseous mixture at the tip of nozzle 70 is ignited to provide a small hot flame within sleeve 42. Motor 86 is then turned on to rotate sleeve 42 and jet 70 and thereby rotate the flame. Since grooves 52 and 62 surround sleeve 42, they provide reservoirs of the gases for continuously feeding the gases through hole 60 and jet 70 as the sleeve rotates. The carbon surfaced member 36 is then fed in the direction of arrow 94 into the guide 80 and across the flame at the tip of nozzle 70 where a groove or path is burnt into the carbon surface in the manner as previously described. Since the flame rotates around the member 36 as the member travels longitudinally thereacross, the path formed in the carbon surface will be in the form of a helix, the pitch of which can be varied by varying either the speed of rotation of the flame or the speed of the travel of the member 36.

Referring to Figures 3 and 4, one construction of a jet nozzle which can be used in the apparatus shown in Figure 2 comprises a tube 96 of copper or brass having an outer diameter 98 substantially the same as the diameter of sleeve hole 68, if not slightly larger, so that the tube will fit tightly in the hole, and a longitudinal bore 100. The tip 102 of tube 96 is flattened and provided with a small hole 104 extending from the bore 100 to the end of the tip. A screen 106 may be placed across the bore 100 to prevent any dirt in the gases from clogging up hole 104.

Figure 5 shows another modification of the jet nozzle which comprises a tube 108 having an outer surface 110 of a diameter large enough to fit tightly in hole 68 and a longitudinal bore 112. The oulet end of bore 112 is provided with a counterbore 114 in which a sapphire jewel 116 is seated. The end of tube 110 is peened over at 118 to hold jewel 116 in counterbore 114. Jewel 116 has a Venturi shaped hole 120 therethrough to provide a fine hard blast of the gas. This form of the jet has the advantages over an all metal jet that it is simple to make and the jewel is not affected either chemically or mechanically by the flow of gas or the flame.

Figures 6, 7 and 8 show a jet nozzle which provides for preheating the gas to obtain a hotter flame and which comprises a pair of concentric cylindrical tubes 122 and 124 of a metal which will withstand high temperature and oxidation such as an alloy of platinum and rhodium. Inner tube 124 has an outer diameter smaller than the inner diameter of outer tube 122 to provide a space 126 therebetween. The inlet end 128 of inner tube 124 is rectangular with its corners tightly engaging the inner surface of outer tube 122 (Figure 7) to center inner tube 124 within outer tube 122 and provide inlet ports 130 between the sides of the rectangular portion 128 and the inner surface of outer tube 122 to the space 126 between the tubes. The outlet end 132 of inner tube 124 extends beyond the outlet end 134 of outer tube 122 which is of triangular configuration (Figure 8) with its sides 134*a* bent inwardly to tightly engage inner tube 124 (Figure 6) to provide outlet ports 136 between the inner tube and the corners of the triangular portion 134 from the space 126 between the tubes. A mounting sleeve 138 of copper or bronze and having an outer diameter large enough to fit tightly in sleeve hole 68 is force fitted around the inlet end of outer tube 122. In operation, some of the gas entering the jet nozzle passes through inlet ports 130 along space 126 between the tubes and out through outlet ports 136. The gaseous mixture at the outlet ports 136 are ignited to provide a flame which surrounds the outlet end 132 of inner tube 124. This flame preheats the gas which passes through inner tube 124 so that when the gas is ignited it will provide a hotter operating flame.

It will thus been seen that the objects set forth above, among those made apparent from the preceding descrip-

tion, are efficiently attained and, since certain changes may be made in carrying out the above method and in the constructions set forth without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The method of burning a path or groove in a carbon surfaced body comprising the steps of contacting the surface of the body with a hot flame, providing relative movement between the flame and the body to pass the flame across the surface of said body and then providing a non-oxidizing atmosphere over the burnt surface of said body.

2. The method of burning a path or groove in a carbon surfaced body comprising the steps of passing a hot flame across the surface of said body and in contact therewith and surrounding the burnt surface of said body within an atmosphere which does not contain oxygen immediately after removal of the flame.

3. The method of burning a path or groove in a carbon surfaced body comprising the steps of providing a hot flame, providing an atmosphere which does not contain oxygen adjacent said flame, translate said body across and in contact with said flame and then through said atmosphere.

4. The method of burning a path or groove in a carbon surfaced body comprising the steps of forming an area of a non-oxidizing atmosphere, forming a hot flame within said area, and translating said body through said area with the surface thereof passing across and in contact with said flame.

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