

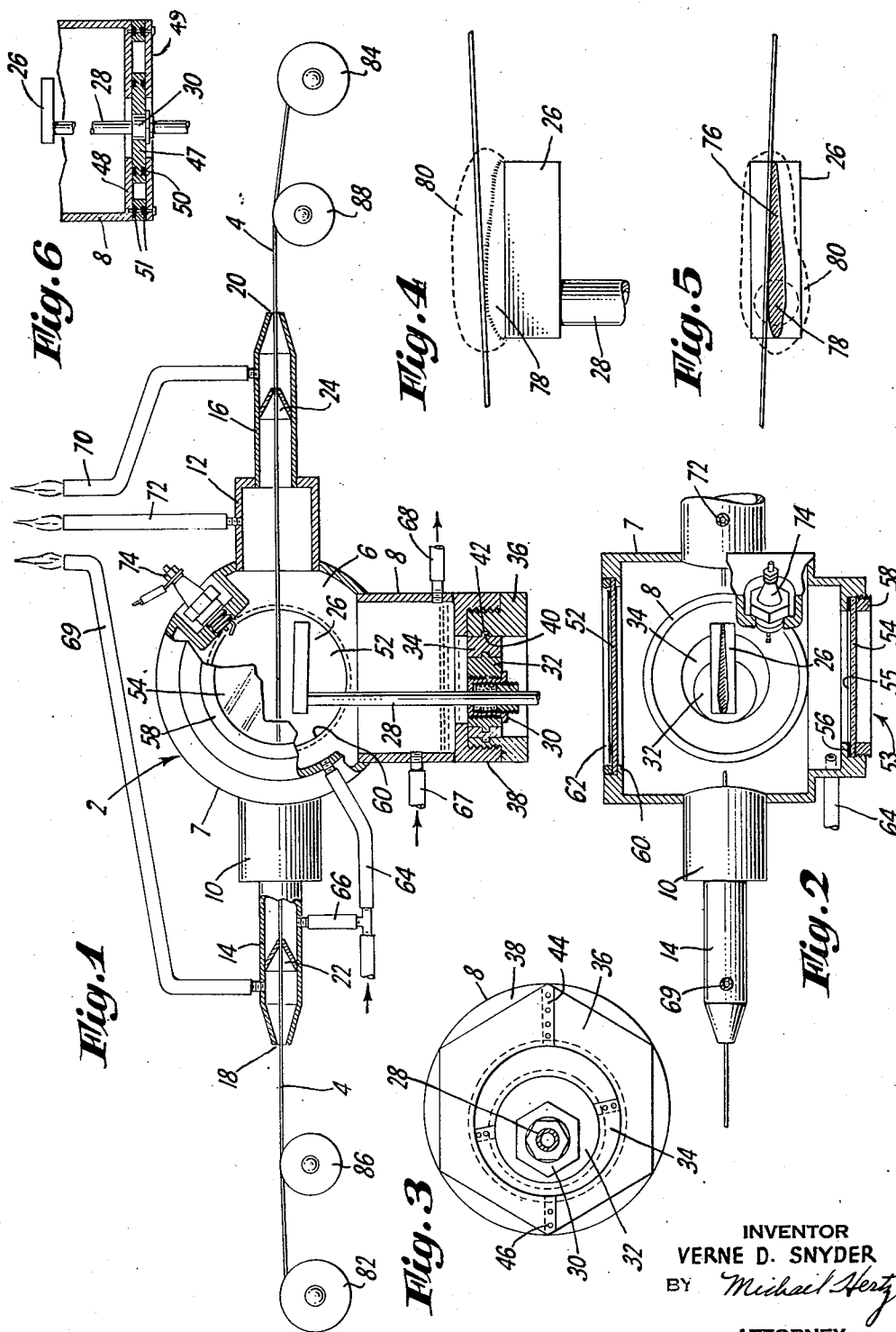
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V. D. SNYDER

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BLACK GRID WIRE COATING, AND A METHOD AND DEVICE FOR PRODUCING IT

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INVENTOR
VERNE D. SNYDER
BY *Michael Herty*
ATTORNEY

1

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BLACK GRID WIRE COATING, AND A METHOD AND DEVICE FOR PRODUCING IT

Verne D. Snyder, Emporium, Pa., assignor to Sylvania Electric Products Inc., a corporation of Massachusetts

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This invention relates to a furnace for coating wire, to the process of coating the wire and to the wire made in accordance with that process.

In the manufacture of radio tubes it has been found that better electrical properties are attained, such as reduction of secondary emission, if electrodes within the tube are black or blackened. In accordance with this knowledge, in the past, wire intended to be utilized as grid wire has been blackened, as by passing the same through a furnace and heating the same in a heavy reducing atmosphere of methane, propane or natural gas so as to deposit a layer of carbon on the wire.

But even so, in the manufacture of some tubes, it has been found that the wire as made by the prior art is unsatisfactory for such tubes. This is particularly so in the case of tubes intended for gating or pulsing, as type 7AK7, frequently utilized in electronic computers. It was found that the number of unsatisfactory tubes of that type was high when made in accordance with the methods of the prior art.

With my invention, due to the new furnace and new method of applying a black surface to the wire, the loss in tubes, termed "shrinkage," has been materially reduced.

The wire utilized as the screen grid wire in the specific type of tube mentioned above is known as "D" nickel wire; it is about .003" in diameter and, in the main, is composed of nickel, cobalt and manganese with traces of copper, iron, carbon, silicon and sulphur therein. When the wire is passed through the novel furnace of my invention and when utilizing the specified gases, a black surface is formed on the wire. The nature of this surface is not known definitely, but it cannot be removed, for example, by passing the wire between the fingers pressed thereabout, since no trace of black appears on the fingers. Rather it appears, as will be seen by considering the composition in the furnace atmosphere, that the surface consists of a mixture of oxides and hydrated oxides of the several metals in the "D" nickel wire. Whatever may be the nature of the surface, the wire, made in accordance with the disclosed process, is effective in producing tubes with far less shrinkage, due to the novel surface on the wire grid, than heretofore.

While it has been possible to obtain the desired surface on the wire with a rather wide variation in the composition of the atmosphere within the furnace, a desirable production is obtained by introducing a natural gas into the furnace chamber and introducing air through the burner tube, keeping a small pool of water in a recess on the floor of the furnace. Under these conditions with the natural gas utilized, the composition is about 2% carbon dioxide, 3% carbon monoxide and about 65% methane, the rest being presumably nitrogen and water vapor. The methane content is kept as low as possible and yet keeps the flame burning, as this keeps a relatively higher proportion of carbon dioxide and water vapor in the furnace.

Although the above composition is a most suitable one, it is possible to secure a desirable blackening of the wire

2

in a furnace atmosphere where the carbon dioxide content is brought up to 40%, by injection of the dioxide into the furnace, and the nitrogen content is 25%, with the remainder of the atmosphere principally methane. But under these conditions escaping gas, which should be rendered harmless to avoid contamination of the breathing air, could not be burned. Also it has been found possible to obtain the desired blackening with a carbon dioxide content as low as 2% and a carbon monoxide content of 3%, with a nitrogen content of 15%, the rest of the furnace atmosphere being principally natural gas.

Where oxygen instead of air is used as the oxidizing medium, a satisfactory black surface was obtained with a furnace atmosphere consisting of approximately 90% nitrogen and 10% hydrogen, the atmosphere being water vapor saturated. In this example it will be noted no hydrocarbon or carbon is utilized and yet the wire has a satisfactory black surface thereon.

In order to obtain a fuller understanding of my invention, attention is directed to the following description and accompanying drawing in which:

Fig. 1 is a front view of my furnace with portions broken away to expose the burner, a portion of treated wire, and a pair of baffles.

Fig. 2 is a top plan view of the furnace partly in section to expose window portions, the burner and other interior parts.

Fig. 3 is a bottom view of a burner adjusting means.

Fig. 4 is a diagrammatic view showing in side elevation the relationship of burner, flame and wire.

Fig. 5 is a diagrammatic plan view of burner, flame and wire, and

Fig. 6 is a sectional view of an alternative burner shifting arrangement.

Referring to the drawings more in detail, the reference character 2 indicates the furnace casing and 4 the wire treated. The furnace casing is comprised of a main combustion chamber 6 which may conveniently be within a steel or cast iron cylindrical pipe 7 of a diameter and a length to give an internal content of about 30 cubic inches.

Welded or otherwise suitably secured to the cylindrical pipe is a depending circular pipe 8 of the same material as pipe 7 but of smaller diameter, and extending from diametrically opposite cylindrical surfaces of the pipe 7 are two smaller metal pipes 10 and 12. As prolongations from these last pipes are the still smaller metal ducts 14 and 16, each of the ducts terminating in an apertured conical end as 18, 20, the apertures being just a little larger in diameter than the diameter of the wire used for threading the wire to be treated through the furnace, as will be explained hereinafter.

Within the smaller ducts 14 and 16 are conical perforated baffles 22 and 24, the perforations in these baffles being substantially of the same size as the perforations 18 and 20. The baffles are necessary to throttle the flow of gas out of the chamber, and the conical form of the baffles assists in threading the wire through the furnace.

Within the furnace is a burner 26. This burner is at the upper end of a vertical tube 28, which tube, see Figs. 1 and 3, is rotatable and slidable in a packing gland 30 carried by a circular metal disc 32. This disc 32 is rotatable within a circular cut out portion in a second circular metal disc 34 but is mounted eccentric thereof. In turn the disc 34 is similarly eccentrically mounted in a plug 36 which is screw threaded into a thick bottom planar face plate 38 welded or otherwise suitably secured to the bottom of pipe 8, the plug being concentric with the axis of pipe 8. The disc 32 has a peripheral tongue fitting within a channel in disc 34 and the disc 34 has a similar tongue 40 fitting into a channel 42 in plug 36. The disc 34 and plug 36 may be made in halves to permit of assembly of parts and these halves may be

3

joined as at 44, see Fig. 3, by tongue and groove construction, the parts being secured together in any desirable fashion, as by pins 46. Further, if desired, the pins in the disc 34 may be made longer than necessary to traverse the tongue and groove construction and may be made to extend below the disc to enable manual shifting of the disc with respect to the plug. If not so extended, other projecting means could be provided on the disc to facilitate its rotation in the plug. The disc 32 may be rotated by manually grasping the pipe 28 and orbitally moving it around the center of disc 32. The burner 26 is fixedly mounted on top of tube 28 and makes with it substantially an L-shaped figure. It is to be noted, however, see Fig. 1, that the burner is slightly inclined downwardly away from the wire and forms an angle with the tube of slightly less than 90°. By reason of the construction of the burner mounting, the position of the burner can be adjusted rotatably, vertically and universally, in all directions, in a horizontal plane. This enables the burner to be adjusted with respect to the wire treated to obtain optimum blackening thereof. In lieu of the disc arrangement shown, other means may be utilized to secure universal adjustment of the burner as, see Fig. 6, by vertically and rotatably mounting the burner tube 28 in a gland mounted in a plate 47 slidable in all lateral directions in the space between two parallel plates 48 and 49 sealed at their outer peripheries to one another. These parallel plates replace bottom plate 38 in the form of invention shown in Fig. 1. Suitable packing material 50 and gaskets 51 may be employed to prevent gas leakage.

The furnace is further provided with an observation window 53 at the front of the cylinder 7 and a safety blow out disc 52 at the rear of the cylinder. The window may comprise a pane of clear glass 54 resting on a cork gasket 55 seated on a ledge 56 around the window, the glass being retained in place by a bezel ring 58 threaded into the front face of the cylinder 7. The safety blow out disc 52 may be a large disc of aluminum foil and conveniently held in place on a ledge 60 surrounding the rear cylinder opening by means of a split spring ring 62. The front portion of the cylinder adjacent the window pane 54 is made of smaller diameter than the rest of the cylinder to create a pocket to which the moist gases from the furnace proper will not readily flow. This is done to maintain the interior of the glass clear of deposits. To aid in this result, the gas mixture admitted to the furnace, in part, enters through an induction pipe 64, this pipe terminating within the furnace chamber 6 at a point close to the plane of the glass pane to maintain the inner surface clear.

Another branch 66 of the induction pipe leads to the duct 14 near the wire inlet opening 18 and its outlet is between the baffle 22 and the pipe 10. A trickle of water is fed into vertical pipe 8 through a tube 67 to maintain a pool of water in the pipe, the height of the pool being determined by the location of the overflow pipe 68. The gas is fed in close to where the wire enters the furnace and flows through the combustion chamber, with the excess flowing beyond the combustion chamber in order to maintain a general reducing atmosphere within the furnace.

The gas escaping through the baffles 22 and 24 is led by conduits 69 and 70 to a point adjacent the end of a conduit 72 passing through the pipe 12 at a point close to the combustion chamber 6. Due to the location of this conduit 72, enough gas is fed to its tip to enable a flame to be maintained constantly thereat so that any gas escaping through the perforated baffles can be ignited at the tips of conduits 69 and 70 and be prevented from being dissipated as a combustible gas into the air surrounding the furnace.

Mounted in the wall of pipe 7 and close to the window is a sparkplug 74, the electrodes of the plug being close above the burner 26 only when the same is swung about

4

the axis of pipe 28 so that the right hand end of the burner lies beneath the spark plug. Since the wire being treated is very thin, the same would be burnt and parted by the igniting burner or the spark from the electrodes were an attempt made to ignite the same when in position substantially parallel to the wire.

The burner 26, see Fig. 5, is provided with a slit 76 which tapers towards the end of the burner away from the pipe 28, being widest immediately above the axis of the pipe and then again tapering toward the end of the burner adjacent the axis of the pipe 28. In Fig. 5, the tapers are shown in exaggerated form. The mean slit width is of the order of $\frac{1}{16}$ " and its length is of the order of $1\frac{1}{2}$ ".

When ignited, the flame appears as indicated in Figs. 4 and 5. The oxidizing mixture introduced through pipe 28 creates an oxidizing zone at 78 with the wire being treated just skimming, for a short distance, the oxidizing zone above and to the side of the inflowing oxidizing gas. The burner 26 is at a very slight angle divergent to the wire, the angle of divergence however being shown in exaggerated form in Fig. 4. Above and to the sides of the oxidizing zone is the reducing zone 80, so that the wire in moving from left to right in Figs. 4 and 5 passes through the oxidizing zone and then through the reducing zone. It should be remembered that the flame is an upside down affair with air entering the burner and combustible gases in the atmosphere about the burner. The flow of gases is so adjusted that the wire is heated to a brilliant red heat in the oxidizing part of the flame and the wire is maintained at a visible red heat for a distance of nearly two inches to the right of the flame edge. The flame itself, when viewed through the observation windows, appears only as a blue arcuate streak between the zones 78 and 80. A suitable rate of flow of gas and air would be five cubic feet of gas per hour into the chamber and three cubic feet of air through the burner. The greater part of the reduction process probably takes place after the wire leaves the flame and while cooling as it passes through the reducing atmosphere surrounding the burner. The wire speed at which the desired type of coating can be obtained has been found to be dependent on a number of factors, such as size and shape of the flame, relative position of wire and flame, and the composition of the atmosphere in the furnace. With the factors already given, a wire speed of thirty feet per minute through the furnace has been found to be satisfactory. At that speed with the length of furnace shown about 15", the wire is permitted to cool sufficiently while in the reducing atmosphere of the furnace. For convenience, the wire may be uncoiled from a supply spool 82, drawn through the furnace and be wound up on a takeup spool 84, suitable idler rolls 86 and 88 being employed, as found necessary to properly support the wire.

In starting up the furnace, the end of the wire to be treated is suitably secured to the end of a stiff wire which is inserted into the opening 18, through the apertures in baffles 22 and 24 and through the aperture 20 at the conical end of duct 16, the curvature of the baffles and of the end of duct 16 assisting in the threading operation. The wire is now drawn through the furnace and preliminarily wound on the take-up spool ready for the same to draw the wire through the furnace. As a safety measure, before igniting the mixture in the furnace, the furnace chamber and the burner tube are flushed with nitrogen. The nitrogen may be fed in through the tubes 64, 66 and 28. Following this, hydrogen, or dissociated ammonia, which by volume is 25% nitrogen and 75% hydrogen, is introduced into the furnace chamber and the escaping gas is lighted at the burn-off tips. As an alternative method, the wire may be threaded through the furnace after igniting the combustible gas. The winding mechanism is then started at a rate of about twice operating speed. The burner tube is again flushed with nitrogen and the

5

burner 26 turned until one end is under the spark plug 74. The nitrogen is turned off and the correct amount of air (in the illustration given, three cubic feet per hour) is passed through the burner while the spark plug is operative. Natural gas at five cubic feet per hour is then fed into the furnace chamber and the hydrogen is turned off. The burner is thus ignited. Water is also permitted to flow through the inlet pipe 67 to form a pool of water at the bottom of pipe 8. The burner 26 is then turned so the length of the flame is nearly parallel to and encloses the wire. The speed of the winding mechanism is then reduced to about 30 feet per minute and the speed slightly adjusted until the color of the coated wire is correct.

Having described my invention, what I claim as new is:

1. A furnace for use in blackening wire comprising a combustion chamber, a burner in said combustion chamber, means providing for adjustment of said burner universally in a horizontal plane, a gas igniter in said chamber, ports axially alined in said furnace to permit of passage of wire through the chamber, said igniter being located to one side of said axially alined ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports.

2. A furnace for use in blackening wire comprising a combustion chamber, a burner in said combustion chamber, means providing for adjustment of said burner vertically, rotatably about its vertical axis, and universally in a horizontal plane, a gas igniter in said chamber, ports axially alined in said furnace to permit of passage of wire through the chamber, said igniter being located to one side of said axially alined ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports, and said burner being shiftable to a position close to said igniter whereby the burner may be ignited thereby.

3. A furnace for use in blackening wire comprising a combustion chamber, a burner in said combustion chamber, means providing for adjustment of said burner vertically, rotatably about its vertical axis, and universally in a horizontal plane, a spark plug in said chamber, ports axially alined in said furnace to permit of passage of wire through the chamber, said spark plug being located to one side of said alinement of ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports, and said burner being shiftable to a position close to the electrodes of said spark plug whereby the burner may be ignited by the spark plug.

4. A furnace for use in blackening wire comprising a combustion chamber, oppositely directed lateral ducts on opposite sides of said chamber, a burner in said combustion chamber, means providing for adjustment of said burner universally in a horizontal plane, an igniter in said chamber, ports including one at each end of the duct and one in each of the lateral ducts spaced from the corresponding end port, all of said ports being axially alined to permit of passage of wire through the chamber, means in between the inner ports for admitting a gas into the chamber, means between the inner and outer ports for bleeding excess gases away from the outer ports, to a point where the gases may be burnt out of contact with the wire, said igniter being located to one side of said axially alined ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports.

5. A furnace for use in blackening wire comprising a combustion chamber, oppositely directed lateral ducts on opposite sides of said chamber, a burner in said combustion chamber, means providing for adjustment of said burner vertically, rotatably about its vertical axis, and universally in a horizontal plane, an igniter in said chamber, ports including one at each end of the duct and like directed conical perforated baffles in each of the lateral ducts, said perforated baffles being spaced from the corre-

6

sponding end port, all of said ports being axially alined in said furnace to permit of passage of wire through the chamber, means in between the inner ports for admitting a gas into the chamber, means between the inner and outer ports for bleeding excess gases away from the outer ports, to a point where the gases may be burnt out of contact with the wire, said igniters being located to one side of said axially alined ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports, and said burner being shiftable to a position close to the electrodes of said igniter whereby the burner may be ignited thereby.

6. A furnace for use in blackening wire comprising a combustion chamber, oppositely directed lateral ducts in opposite sides of said chamber, a burner in said combustion chamber, means providing for adjustment of said burner universally in a horizontal plane, an igniter in said chamber, ports axially alined in said furnace to permit of passage of wire through the chamber, means admitting a reducing gas into one of said lateral ducts for passage through the combustion chamber, means conducting unburned gas away from said chamber, said means being located near the free end of the other of said lateral ducts to provide for a long passage of reducing gas beyond the combustion chamber, said igniter being located to one side of said alinement of ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports.

7. A furnace for use in blackening wire comprising a combustion chamber, oppositely directed lateral ducts in opposite sides of said chamber, a burner in said combustion chamber, means providing for adjustment of said burner vertically, rotatably about its vertical axis, and universally in a horizontal plane, an igniter in said chamber, ports axially alined in said furnace to permit of passage of wire through the chamber, means admitting a reducing gas into one of said lateral ducts for passage through the combustion chamber, means conducting unburned gas away from said chamber, said means being located near the free end of the other of said lateral ducts to provide for a long passage of reducing gas beyond the combustion chamber, said igniter being located to one side of said alinement of ports so that when operative the heat therefrom will not effect rupture of the wire threading the ports, and said burner being shiftable to a position close to the electrodes of said igniter whereby the burner may be ignited thereby.

8. The process of blackening a wire which comprises passing the wire through a flame having an inner oxidizing zone and an outer envelope forming a reducing zone with the wire just skimming the oxidizing zone as it enters the flame.

9. The process of blackening a wire which comprises passing the wire through a flame having an inner oxidizing zone and an outer envelope forming a reducing zone with the wire just skimming the oxidizing zone as it enters the flame and the flame, in a vertical plane, diverging away from the wire, the wire then passing through the reducing zone as it leaves the flame.

10. The process of blackening a wire which comprises passing the wire through a flame elongated in the direction of travel of the wire, said flame having an inner oxidizing zone tapering in width and height in the direction of travel of the wire and an outer envelope forming a reducing zone, the wire just skimming the oxidizing flame as it enters the flame, the upper surface of the oxidizing flame diverging away from the wire in the direction of travel of the wire, as viewed in the vertical plane of the burner.

11. A wire made in accordance with the process claimed in claim 8.

12. A wire made in accordance with the process claimed in claim 9.

13. A wire made in accordance with the process claimed in claim 10.

7

14. A wire having a surface corresponding with that of a wire treated in accordance with the process claimed in claim 8.

15. A wire having a surface corresponding with that of a wire treated in accordance with the process claimed in claim 9.

16. A wire having a surface corresponding with that of a wire treated in accordance with the process claimed in claim 10.

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