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METHODS OF MANUFACTURING TUBULAR SHEATHED HEATING ELEMENTS

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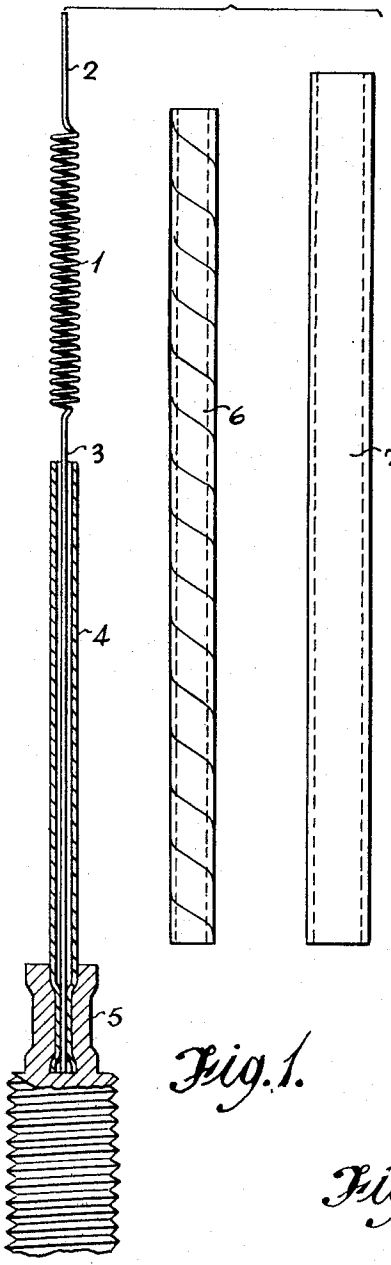

Fig. 1.

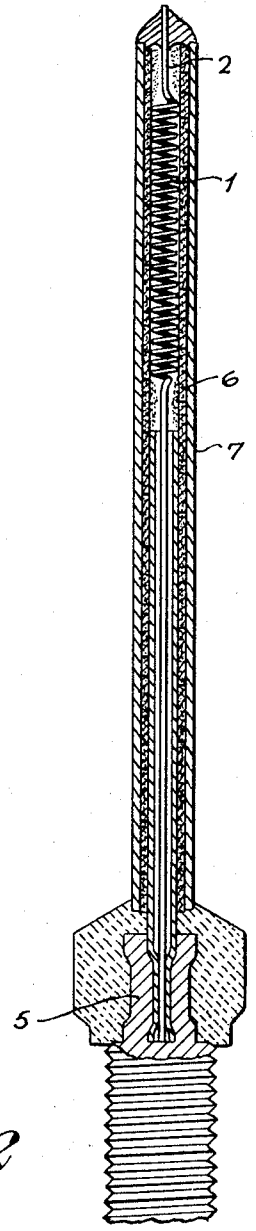

Fig. 2

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METHODS OF MANUFACTURING TUBULAR SHEATHED HEATING ELEMENTS

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2 Claims. (Cl. 338—238)

This invention relates to methods of manufacturing tubular sheathed heating elements of small diameter, and has a particular application in the manufacture of diesel glow plugs for compression ignition engines.

It is known to manufacture large heating elements, e.g. for domestic cookers, by inserting a coiled heater wire in a metal sheath which is packed with magnesium oxide to provide electrical insulation for the heater wire combined with a good thermal path between the heater wire and the sheath.

In the case of normal heater elements, i.e. of the domestic cooker type in which the external sheath diameter is of the order of 5/16 inch, the magnesium oxide insulation can be introduced by first assembling the heater in the sheath with a tube of metallic magnesium interposed, and then converting the magnesium to the oxide in situ. However, in the case of heater elements of the size with which this invention is concerned, i.e. of the order of less than 1/8 inch diameter, it is extremely difficult to manufacture magnesium tubes of the small diameter and thickness required on a commercial scale, and moreover it is difficult to assemble the elements without damaging the heater elements.

One method at present in use by which magnesium oxide lined tubular sheaths of small diameter are made consists in swaging tubes filled with magnesium oxide powder round the heater coil down to the final diameter, but the limit to which the diameter of a heating element may be reduced by this method is necessarily limited. Further, the process does not produce a heating element whose coil has a high degree of concentricity, and the thickness of the magnesium oxide wall obtained within the tube is usually rather greater than that required for electrical insulation, thereby unnecessarily decreasing the heating efficiency of the element.

According to the present invention a method of manufacturing a tubular sheathed heating element of small diameter comprises the steps of inserting a heater coil into the interior of a thin tube of metallic magnesium, inserting the tube containing the heater coil into the interior of a hollow tube forming the tubular metal sheath so that the heater coil is located in the desired part of said sheath, converting the metallic magnesium into magnesium oxide in situ and sealing both ends of the sheath to exclude moisture from the heater coil.

In carrying out the invention a flat strip of metallic magnesium may be wound into a close coiled helix to form a thin expandable tube into which the heater coil is inserted.

Preferably one tail of the heater coil is led out of one end of the tubular metal sheath and sealed to that end of the sheath to provide an electrical connection between said sheath and said heater coil. The other tail of the heater coil will be led out of the other end of the sheath through a seal of a suitable insulating material such as ceramic.

The conversion of the close coiled helix of magnesium

into magnesium oxide is performed by autoclave and dehydrating processes as are well-known to those skilled in the art.

If it is desired, the magnesium oxide may be tightly compacted about the heater coil by drawing the assembled tubular sheath through a suitable die which will also provide a means whereby the diameter of the heating element is further reduced in size. Another way of rigidly securing the heater coil within the tubular sheath is to pack the interior of the heating element with loose sand or loose magnesium oxide by any known method.

The heating element is provided with suitable means for obtaining electrical contact between the outer surface of the tubular sheath and the source of electrical energy to provide the supply to the heater coil by way of the seal at the end of the sheath. The heater coil itself is insulated electrically from the sheath by the magnesium oxide lining and its other tail may be connected to the source of electrical energy by an ordinary insulated lead, for instance.

The close wound helix of magnesium constructed to provide the thin tube for insertion into the hollow metal tube was, in one instance, made by winding magnesium ribbon .100" wide by .010" thick on to a mandrel of .050" diameter.

Tubular sheathed heating elements made by the invention have been produced having a wall thickness of magnesium oxide in the range .015" to .018", which thickness is adequate for effectively electrically insulating the heater coil from the tubular sheath on low voltage electrical supplies without presenting any serious hindrance to the conduction of heat to the outer surface of the tubular sheath.

According to a further feature of the present invention a glow plug of a substantially small over-all diameter for starting a compression ignition engine may be made by a method comprising the steps of closely fitting a tubular sheathed heating element made according to the invention inside an axially bored cylindrical plug body, counterboring the inner end of the axial bore, i.e. the end of the plug body adapted for insertion in an engine pre-combustion chamber, brazing the tubular sheath to the plug body in the counter-bore, and leading the inner tail of the heater coil through suitable tubular insulators, sleeving or the like to a screwed terminal insulated from the main plug body, whereby to permit a connection to be made to the heater coil from a source of electrical energy.

The invention permits of the manufacture of a glow plug for compression ignition engines of smaller diameter than hitherto. One such plug made according to the present invention has a heating element diameter of .117" and a plug body of .383" overall diameter. Such a glow plug is considerably smaller than existing types of which typical dimensions are: element diameter of approximately .19", and overall plug body diameter of about 1/2". Most of the known glow plugs have dimensions considerably in excess of even these figures.

In the construction of small size diesel engines for private motor vehicles, the amount of space available in the cylinder block for inlet ports in the pre-combustion chambers of the cylinders is very limited so that any decrease in the minimum size of glow plug that may be used is of considerable importance in facilitating the manufacture of such engines.

It will be appreciated that while the application of the invention to glow plugs has been described, it may also be applied in any other instances where small size heating elements are required.

In order that the invention may be more clearly understood reference will now be made to the accompanying

drawing which shows the invention applied to the manufacture of a glow plug suitable for starting a diesel engine and in which:

Fig. 1 shows the parts of the plug before manufacture, and

Fig. 2 shows the parts after assembly.

In Fig. 1 the reference **1** indicates the coiled heater wire which is formed at the upper end with a short tail **2** and at the lower end with a long tail **3** which extends through a tube **4** to a terminal plug **5** which is externally screw threaded. **6** is a helically coiled strip of metallic magnesium whilst **7** represents the sheath of the element. In manufacturing the plug the magnesioum tube **6** will first be placed over the heater element and then the sheath **7** will be placed over the magnesium tube **6**. The element will then be subjected to heat treatment to convert the metallic magnesium to magnesium oxide in which the heater element will be firmly embedded, as shown in Fig. 2. The upper end of the sheath **7** will be pressed inwardly around the tail **2** of the heater element and an electrically conductive connection will be made by brazing or welding. The reference **8** indicates a screwed terminal to which electrical connection may be made.

While we have shown and described particular embodiments of our invention, it will be apparent to those skilled in the art that modifications may be made without departing from our invention and we, therefore, aim by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

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

1. In a glow plug assembly for starting a compression ignition engine having an engine precombustion chamber, a cylindrical plug body adapted to be secured to said engine to project into said precombustion chamber, said plug body having a through axial bore adapted to communicate with said precombustion chamber, a tubular sheathed heater of small diameter for providing a starting ignition for said engine and comprising a metallic tubular sheathing closely fitted in said bore and secured to said plug body, an electrical conductive seal closing off the inwardly projecting end of said sheathing, a terminal plug attachment having an electrical terminal and electrical insulation means securing said terminal to the outwardly projecting end of said sheathing so that said terminal is electrically insulated from said sheathing, a

spacing tube having one end secured in said terminal to establish electrical contact therewith and projecting into said sheathing in concentric spaced apart relation thereto, a heater coil concentrically disposed in spaced relation in said sheathing near the inwardly projecting end of said sheathing facing said precombustion chamber and having substantially straight inner and outer tails projecting beyond respective ends of said sheathing; said inner tail being surrounded by said seal in contacting relation thereto for establishing electrical continuity between said coil and said sheathing, said outer tail projecting into said spacing tube to make electrical contact therewith, and a packing of magnesium oxide forming a tube within said sheathing and completely surrounding said coil and said spacing tube, said packing extending substantially the length of said sheathing.

2. The method of manufacturing a tubular sheathed heating element comprising the steps of forming a thin metallic magnesium tube from a flat strip of metallic magnesium substantially 0.10 inch wide by .010 inch thick by winding said strip in a closed helix on a mandrel to produce a wall thickness of magnesium oxide of 0.15 inch–0.18 inch upon oxidation, inserting a heater coil into said metallic magnesium tube, inserting the metallic magnesium tube containing the heater coil into a tubular metallic sheath of a diameter of less than ⅛ inch, converting said metallic magnesium into magnesium oxide in situ whereby the oxide so formed is tightly compacted about said heater coil, bringing out one end of the heater coil through a seal at one end of said tubular sheath so as to make an electrical contact with said sheath at that end, and bringing out the other end of said heater coil at the other end of said tubular sheath to make electrical contact with a suitable terminal insulated from said sheath.

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