Nov. 24, 1964 F. TESTERINI 3,158,787

GLOW PLUGS EQUIPPED WITH ARMOURED RESISTANCES

Filed June 20, 1961 2 Sheets-Sheet 1

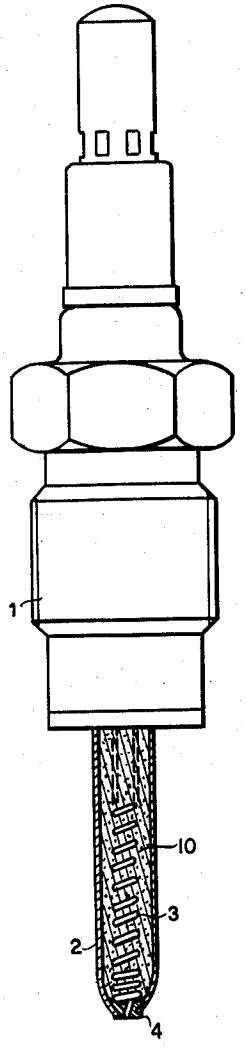


FIG.1

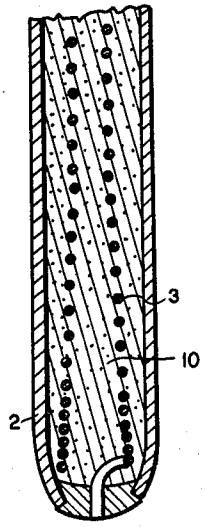


FIG.2

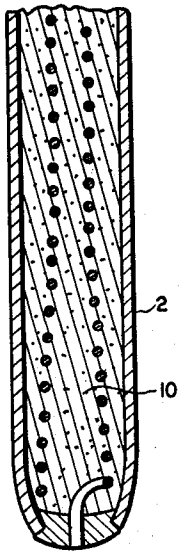


FIG.4

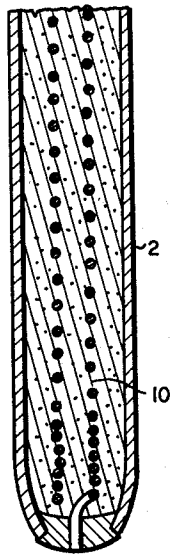


FIG.5

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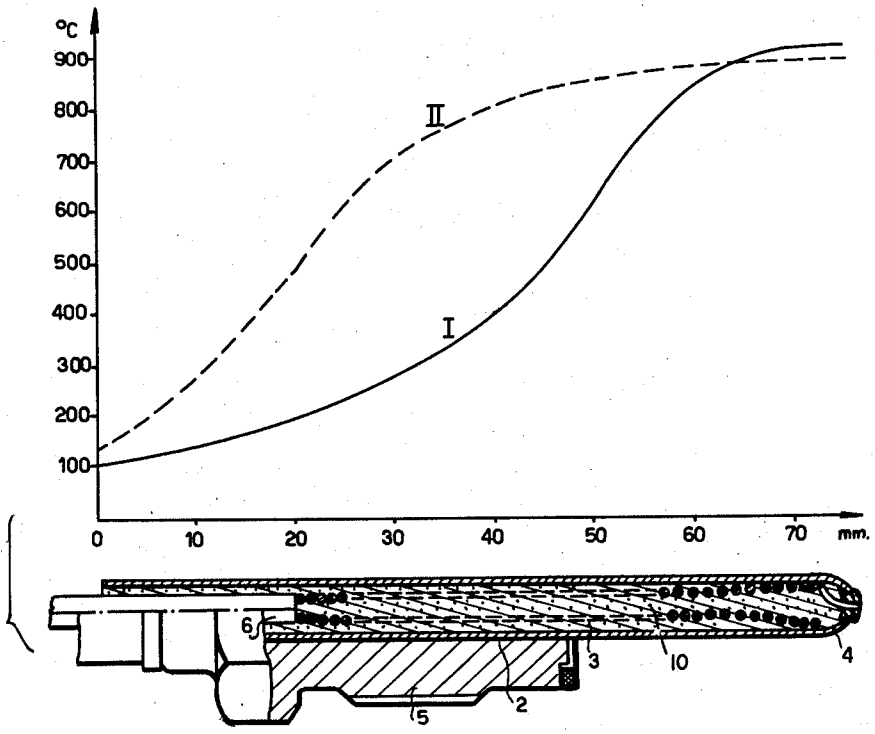


FIG. 3

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GLOW PLUGS EQUIPPED WITH ARMOURED RESISTANCES

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1 Claim. (Cl. 317—98)

The invention refers to glow plugs for internal combustion engines, comprising an electric conductor enclosed in a metal sheath, which is fixed in the longitudinal hole of the body of the plug.

The conductor constitutes the glow resistance, and along its entire length, from the point of connection to the current inductor to the nose of the sheath, presents constant geometric and physical characteristics.

Normally the resistance consists of a cylindrical spiral, and the above mentioned characteristics are satisfied by the constant pitch of the spirals, by the cross of the wire which is also constant, and lastly by employment of wire of the same material.

It is commonly known that plugs of the above type present the defect of being subject to burning out in the inside of the connecting point of the electrical resistance with the current inductor.

Said burnings out are due to short circuits which arise in the above mentioned zone between the conductor and the sheath, and in the cases of spiral resistances, also between one spiral turn and another, due to the insufficient insulation at the maximum voltage which is present here, and which corresponds to the entire drop along the whole length of the resistance.

The object of the present invention is to eliminate the above mentioned defect with the adoption of a plug which is improved regarding the insulation at the points of maximum voltage, and at the same time has a rational distribution of the temperature along the sheath.

According to the invention, this is obtained by using a glow conductor supplied with an electrical resistance concentrated in correspondence with the nose of the sheath.

In parity with total load resistance, this improvement is achieved by varying the distribution of the resistance along the length of the conductor with variations of the geometrical characteristics by employing in the nose a piece of conductor constituted by a material having a very high resistance, or in other words varying both the geometrical and physical characteristics of the conductor.

When using a conductor of the spiral type having the cross section of the wire constant, and made of one alloy, said increase in resistance may be obtained by changing the diameter of the spiral turns and/or the pitch.

The concentration of the electrical resistance in the nose of the sheath improves the performance of the plug also from the point of view of heat distribution along the sheath, inasmuch as the temperature results as being at the extremity, and minimum in the zone of maximum voltage which corresponds to the zone where the conductor is connected to the current inductor.

The high temperature near the extremity of the sheath permits rapid heating of the nose which is the most efficient part for ignition purposes, whilst a reduced temperature in the part of the sheath corresponding to the zone of maximum voltage reduces the possibility of short circuits which can arise here due to the reduced insulating capacity of the material packed in between the hot parts.

According to another aspect of the invention, the

sheath in correspondence with the critical zone or connection of the conductor can be further cooled by surrounding it with a heat dispersing conducting body.

According to a further aspect of the invention, the performance of the plug can be still bettered, if the conductor with concentrated resistance is comprised of an alloy having a variable temperature coefficient, so that the heating at the nose is subjected to an increase due to the increased resistivity of the alloy in this zone.

Still better results are obtained if the concentrated resistance conductor is made of said alloy, and cooled by a body in contact with the sheath.

The attached drawing which is given purely as an example, illustrates an assembly arrangement of the invention and of the variations.

FIGURE 1 shows a glow plug with a cross section of the nose.

FIGURE 2 shows on an enlarged scale the section view of the nose of the plug of FIGURE 1.

FIGURE 3 shows the temperature curves along the sheath of two different plugs.

FIGURES 4 and 5 show two variations to the nose of the plug.

In FIGURE 1, **1** indicates the body, and **2** the metal sheath containing the electric conductor constituted by wire spiral **3** of constant cross section, connected at one end to the nose **4** of the plug, and the other end to the current inductor which is not shown in the figure.

The spiral terminates in nose **4** with a conical part (conical spiral) with its spiral turns very close to each other, so as to establish in this extreme part of the sheath, a concentrated electric resistance.

The remaining part of the spiral which is connected up to the current inductor, is on the other hand constituted by a cylindrical spiral with reduced diameters of the spires, and greater pitch than those of the conical spiral turns.

The shape of the spiral **3** in the sheath **2** is better shown in FIGURE 2 which represents in section the same part of sheath as shown in FIGURE 1, but on a larger scale.

With a spiral made in this manner, in parity of resistance load between the point of contact to the conductor and the nose of the sheath, it results that in the spiral connection zone, which is the part most subjected to electrical surge, the spiral turns here are more distanced away from each other, and at a greater distance from the sheath, with resulting less possibility of short circuits.

Another advantage is, that this zone of the sheath, due to reduced resistance of the spiral, does not reach high temperatures, because the calorific energy transmitted to it by the corresponding part of the conductor is reduced. Vice versa and at the nose due to the concentration of the resistance, there is an immediate and high heating phenomena, with resulting rapid and concentrated ignition.

With a spiral of the above mentioned type, the heating concentration at the nose is further favoured by the fact that in this zone, because of the spiral turns being of increasing diameter, the packing material **10** is reduced in volume with a resulting increase of heat transmission towards the exterior.

The central zone of the sheath which comprises the internal point of connection of the spiral with the inductor can be further cooled by means of a body in contact with it, and which dissipates outwards the heat which is transmitted by the internal resistance.

This cooling body may be constituted by a metal sleeve connected or not to the plug or even by the body of the plug.

Further, the performance of the plug can be still improved if the spiral is made of an alloy having a resistivity which increases in relation to the temperature.

This method gives as a result, that during ignition only the noise of the plug, which is a part which is more heated, is subjected to a thermal shock due to the effect of the increase in resistivity at the extreme end of the spiral, whilst the central section which is at a reduced temperature due to the lesser internal resistance, and/or the dissipation of heat caused by the cooling body, is subjected to a lesser thermal treatment shock as the contribution given by a smaller increase in resistivity is less.

FIGURE 3 on its lower side illustrates part of a glow plug incorporating all the embodiments of the invention, and that is to say: the adoption of a part of conical spiral and reduced pitch in correspondence with nose 4 of the sheath, the employment of a wire having a variable temperature coefficient, and lastly incorporating the cooling of the sheath 2 in a central section which is sufficiently long, by means of part 5 of the body of the plug.

Curve I in continuous line (see FIG. 3) illustrates the temperature performance along the sheath of this plug and in which the spiral wire employed is a nickel chrome alloy with other correctives, and having a resistivity variable with the temperature.

Curve II shown in dotted lines on the other hand refers to the temperature performance of a normal plug, and that is to say not using the improvements included or provided for by the invention.

From a comparison of the two curves it is evident that nose 4 of curve I reaches temperature values greater than in curve II, whilst in correspondence with the connection point of spiral 3 with inductor 6, or in other words, the part of the sheath covered by part 5 of the body of the plug, said curve I is sensibly lower or below the corresponding part of curve II.

From tests it has been found that the reduction of temperature in the critical zone of an improved plug as compared to a normal plug, is around 350° C.

The invention has been described and illustrated with reference to a plug employing a conical spiral in the nose with reduced pitch of the spiral.

It is clear that the same heat concentration effect may be obtained using a conical spiral at the nose but with a constant pitch, as shown in FIGURE 4, or even with a cylindrical spiral with the pitch reduced only at the nose as shown in FIGURE 5.

Different other arrangements of the spiral are possible with which to achieve the same aim.

For example, by using a completely cylindrical spiral, the pitch of the spiral may decrease downwards commencing from the current inductor, or even only in correspondence with the nose of the plug.

The cylindrical spiral may have a final portion which is also cylindrical but with a greater pitch, the pitch of the spirals of the two portions being suitably established.

A completely conical spiral may be employed or having a variable cone shape increasing towards the nose. Also

in this case the pitch of the spirals can be established in any manner, that is to say with a constant pitch, decreasing to any given requirement, or only in the nose.

Further, the invention has been illustrated considering the geometrical variations of the conductor in order to to have a greater resistance in the nose. It is obvious that the same results can be obtained by employing at the extreme portion of the sheath, a conductor of suitable resistance, or in other words combining this solution with all the possible geometric solutions.

Naturally all the foregoing also holds good for plugs in which the sheath is cooled by a metal sleeve and not directly by the body of the plug.

I claim:

A glow plug for internal combustion engines, comprising an elongated plug body, having a central axial bore hole extending through its entire length, an elongated tubular metal sheath having a portion housed within said bore hole and engaging the inner walls of said bore hole in heat exchange therewith, and another portion extending beyond said glow plug body and terminating in a closed nose; a current feeder, extending into the first-mentioned portion of the sheath, and an electrical conductor located in said sheath and consisting of a spirally wound wire coil, said coil conductor having a terminal connected with said current feeder and located within the first-mentioned portion of the sheath, the other end of said coil conductor being conical and connected with said closed nose, said conical end being located within the second-mentioned portion of said sheath; said coil conductor having a central tubular portion connected with said terminal and said conical end, said terminal having a substantially constant spiral coil diameter from the end of the current feeder to said central tubular portion of said coil conductor, said conical end having a diameter increasing in the direction of said closed nose, the pitch of said spiral coil conductor decreasing in the direction of said closed nose; said coil conductor consisting of a material having a resistance which increases proportionately to the rise in temperature, and an insulating packing material situated within said sheath and embedding said coil conductor.

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