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EUROPEAN PATENT APPLICATION

21 Application number: **89310607.0**

51 Int. Cl.⁵: **F23Q 7/00**

22 Date of filing: **16.10.89**

30 Priority: **19.10.88 GB 8824533**

43 Date of publication of application:
25.04.90 Bulletin 90/17

64 Designated Contracting States:
AT BE CH DE ES FR GR IT LI LU NL SE

71 Applicant: **WELLMAN AUTOMOTIVE PRODUCTS LTD**
Roberts House Cornwall Road Smethwick
Warley West Midlands B66 2LB(GB)

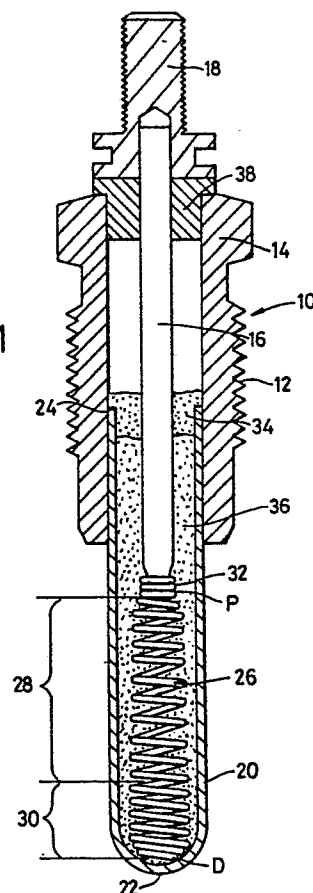
72 Inventor: **Brown, Joseph Alan**
3 Kidderminster Road
West Hagley West Midlands DY9 0PZ(GB)

74 Representative: **Spruce, George Philip et al**
Lewis W. Goold & Co. Whitehall Chambers
23 Colmore Row
Birmingham B3 BL2(GB)

54 **Glow plug.**

57 Electrically operated glow plug for facilitating start-up of diesel and other compression engines is of the sheathed element self-limiting type and incorporates resistance and heating elements (28,30) which are preferably portions of a common length of wire (26), the wire or other filament means constituting said elements being graduated in cross-sectional area along its length, the area at the effective proximal end being substantially greater than the area the effective distal end where the heating element is attached to the distal tip (22) of the sheath (20). Conveniently the wire length (26) is uniformly tapered along its length and it is also preferred that the coils constituting the heating element are more closely pitched and/or have a greater diameter than those constituting the resistance element.

Fig. 1



GLOW PLUG

This invention relates to electrically operated glow plugs as used in vehicle diesel and other compression ignition engines to facilitate speedy engine start-up.

More specifically the invention relates to glow plugs of the kind including a housing adapted to mount the plug in the wall of a cylinder or other combustion chamber of the engine in use, a tubular sheath carried by the housing to project into the combustion chamber in use, the distal extremity or tip of the sheath containing a totally enclosed heating element whereby the tip of the sheath speedily attains a high temperature when electric current is applied thereto by way of an electrode carried in the housing, and a resistance element also totally enclosed in the sheath electrically interconnecting the heating element with the electrode and formed of a material having a high positive temperature coefficient of resistance. This kind of glow plug is hereinafter referred to as "a sheathed element self-limiting glow plug".

The object of the invention is to provide a glow plug of said kind which is durable and reliable in use, which gives a quick response without risk of damage due to overheating, and which is economical to manufacture and efficient and cost-effective in use.

According to the invention a sheathed element self-limiting glow plug is characterised in that the heating and resistance elements are constituted by respective distal and proximal portions of filament means, said means being formed from coiled wire which is graduated in cross-sectional area along its length, said area at the effective proximal end of the filament means being substantially greater than said area at the effective distal end of said means i.e. at the extremity of the sheath tip.

Preferably said area at said proximal end is at least 15% greater than said area at said distal end.

The filament means may comprise interconnected wire coil heating and resistance sections formed of dissimilar materials, e.g. wire having different coefficients of resistance, as by providing two wire coils joined end to end but it is preferred that a single length of wire of uniform composition is used to form a unitary filament means i.e. the heating and resistance elements are parts of a single wire.

Conveniently the single wire or other filament means is uniformly tapered along its length between the effective proximal and distal ends but it is also contemplated that the filament means may be non-uniformly tapered and/or otherwise uniformly or non-uniformly graduated in cross-sectional area between said ends including, possibly, some

increase in cross-sectional area in one or more intermediate regions as well as reduction thereof along its length in the direction of the effective distal end.

The difference in cross-sectional area of said ends may be substantially greater than 15%, for example a difference of some 37% may be employed though this figure is not to be taken as implying any upper limit.

It is also preferred that coils of the filament means are non-uniform along its length, for example those coils constituting or forming part of the heating element may have a substantially closer pitch than those constituting or forming part of the resistance element and/or may differ in diameter therefrom e.g. be of somewhat greater diameter than said coils of the resistance element.

Preferably the sheath contains a magnesium oxide filler powder having a high coefficient of thermal conductivity.

The invention further resides in a sheathed element self-limiting glow plug characterised in that its heating and resistance elements are parts of a single common length of wire of uniform composition having positive coefficient of electrical resistivity related to temperature wherein the cross-sectional area of the wire in the part constituting the heating element is substantially less than the cross-sectional area in the part constituting the resistance element.

Preferably a plug as defined in the last preceding paragraph is further characterised in that the heating and resistance elements are coiled portions of said wire, the coils constituting the resistance element differing from those constituting the heating element e.g. being more widely pitched and/or of lesser diameter than the coils of lesser cross-sectional area wire constituting the heating element.

An example of the invention is more particularly described with reference to the accompanying drawings wherein

Figure 1 is a longitudinal section of a sheathed element self-limiting glow plug embodying the invention; and

Figure 2 is a longitudinal sectional view of filament means of said plug at one stage of its manufacture.

Referring firstly to Figure 1 the body and sheath of the plug are of generally conventional construction comprising a housing 10 threaded at 12 for mounting in the engine and having a hexagon head 14 at its outer end. An insulated electrode 16 provided with a connecting terminal 18 at its outer end is sealed into and extends through

housing 10 in known manner.

A hollow cylindrical metal sheath 20 projects from the inner end of housing 10. It has a closed distal tip 22 and its proximal end part 24 is sealed within a bore of the inner end of housing 10 in known manner. Sheath 20 is conveniently formed from the metal alloy known by the Trade Mark or trade name "Inconel" e.g. "Inconel 601".

Filament means, in this example a single unitary coiled wire 26 is connected within sheath 20 between the inner end of electrode 16 and the interior of sheath 20 at the extremity of the tip 22 e.g. by welding. The wire 26 is of uniform composition throughout its length, being formed of a material having a positive coefficient of electrical resistivity related to temperature. Various metals or metal alloys could be used; nickel or an nickel alloy is preferred e.g. an alloy of nickel and chromium and/or aluminium and/or iron. Several commercially available resistance wires of such composition could be employed, another possibility is an iron and cobalt alloy.

Wire 26 is, in this example, uniformly tapered along its length so that its cross-sectional area reduces at a constant rate from its effective proximal end P where it connects to electrode 16 to its effective distal end D where it is welded to the sheath tip.

In this example the cross-sectional area at P is some 37% greater than that at D but the said difference in cross-sectional area may be lesser or greater for some applications down to at least 15% depending on the desired physical dimension of the glow plug and its required performance.

The wire 26 is formed and operates to provide a resistance element or portion 28 which occupies an intermediate zone of sheath 20 between electrode 16 (end P) and a distal or tip zone of the sheath; and a heater element or portion 30 in the latter zone and extending to the connection with the sheath tip at D.

It is to be understood that the boundary between portions 28 and 30 of the filament means between said sheath zones is not necessarily clearly defined and that the function and operation of said portions may merge into each other over a bridging region at an intermediate position along the filament means particularly, as in the present case, where said filament means is of unitary single wire construction.

As well as being graduated in cross-sectional area along its length the wire 26 is, in this example, coiled non-uniformly in forming the resistance and heating portions 28, 30. The coiled formation is best seen in Figure 2 which gives the dimensioning etc. of this particular example at one stage of its formation.

As seen from Figure 2 the coils constituting the

heating portion 30 are closely pitched so that they are adjacent to each other while the coils constituting the resistance portion 28 are at wider pitching so that they are spaced apart. Portion 30 comprises some 10 turns of wire while the effective length of portion 28 comprises some 14 turns and, due to the pitching, is about double the axial length of portion 30.

At the stage of formation shown in Figure 2 the coils constituting the major lengths of portions 28 and 30 are of uniform diameter. The extreme end coils taper in diameter to the effective ends D and P of the wire so that they are accommodated respectively in the domed tip end of sheath 20 and are compatible with the diameter of the electrode 16 at the proximal end P. An extra length of wire beyond end P is formed into a few close pitched reduced diameter coils 32 which are engaged around in the inner end of electrode 16 and welded thereto to form a secure connection.

After shaping as shown in Figure 2 the coiled wire 26 is subjected to a further forming process so that, when finally positioned within sheath 20 (Figure 1) the coils constituting the resistance portion 28 are somewhat reduced in diameter with respect to the coils constituting the major part of the heating portion 30.

A silicon sealing element 34 is positioned at the proximal end of sheath 20 within housing 10 in surrounding relationship to electrode 16 and the sheath is packed with magnesium oxide filler 36, this filler material having a high coefficient of thermal conductivity.

The outer end of housing 10 is closed by an insulated bush 38 which locates the outer end of the electrode 16.

The example of the filament means illustrated in Figure 2 is formed from a 380mm length of wire the effective length P-D being some 345mm and the uniform taper over that length being from 0.4445mm diameter at P to 0.3429mm diameter at D. Other particulars of the dimensioning and properties of this example are indicated on Figure 2.

The use of the single tapered or otherwise graduated thickness wire forming both the resistance and heating portions of the filament means simplifies manufacture in that there is no need to connect together two possibly dissimilar wires or coils and may provide greater reliability and consistence of performance under operating conditions.

The lesser cross-sectional area of the wire at the heating portion 30 together with the closer arrangement of the coils there ensures speedy attainment of operating temperature at the tip of the plug sheath, the reduced cross-sectional area giving the wire higher electrical resistance in this region while the greater cross-sectional area in the

resistance portion 28 coupled, in this example, with the wider spacing of the coils there gives the necessary self-limiting characteristics as heating up continues, so preventing damage or burning out of the filament means if the plug should be left switched on for an excessive period.

Trials of the invention indicate that the performance, is equal to if not better than known glow plugs of this kind particularly with regard to speed of response for fast engine starting, and the efficiency may be much greater, possibly as much as 30% less current consumption than know plugs for the same level of performance or output.

Claims

1. A glow plug including a housing (10) adapted to mount the plug in the wall of a combustion chamber of an internal combustion engine in use, a tubular sheath (20) carried by the housing to project into said chamber in use, a heating element (30) totally enclosed within a distal tip portion (22) of the sheath remote from the housing whereby said tip portion speedily attains a high temperature when electric current is operatively applied thereto by way of an electrode (16) carried in the housing, and a resistance element (28) also totally enclosed in the sheath electrically interconnecting the heating element with the electrode and formed of a material having a high positive temperature coefficient of resistance; characterised in that the heating and resistance elements (30,28) are constituted by respective distal and proximal portions of filament means (26), said means being formed from coiled wire which is graduated in cross-sectional area along its length with said area at the effective proximal end (P) of the filament means being substantially greater than said area at the effective distal end (D) of said means located at the extremity of said tip portion.

2. A glow plug as in Claim 1 characterised in that said cross-sectional area at said proximal end is at least 15% greater than said area at said distal end.

3. A glow plug as in Claim 1 or 2 characterised in that said unitary filament means is formed from a single length of wire of uniform composition to provided a unitary filament means so that the heating and resistance elements are part of a single wire.

4. A glow plug as in any preceding claim characterised in that the filament means is uniformly tapered along its length between the effective proximal and distal ends.

5. A glow plug as in Claim 1, 2 or 3 characterised in that the filament means is non-uniformly tapered or otherwise graduated in cross-sectional

area between said ends.

6. A glow plug as in Claim 5 characterised in that the filament means increases in cross-sectional area in one or more intermediate regions.

7. A glow plug as in any preceding claim characterised in that the cross-sectional area of the filament means at said proximal end is from 15% to 37% greater than said area at said distal end.

8. A glow plug as in any preceding claim characterised in that the coils of the filament means are non-uniform along its length.

9. A glow plug as in Claim 8 characterised in that those coils constituting or forming part of the heating element (30) have substantially closer pitch than those constituting or forming part of the resistance element (28).

10. A glow plug as in Claim 8 or 9 characterised in that coils constituting or forming part of the heating element (30) differ in diameter from coils constituting or forming part of the resistance element (28).

11. A glow plug as in Claim 10 characterised in that coils forming part of or constituting the heating element (30) are greater in diameter than coils constituting or forming part of the resistance element (28).

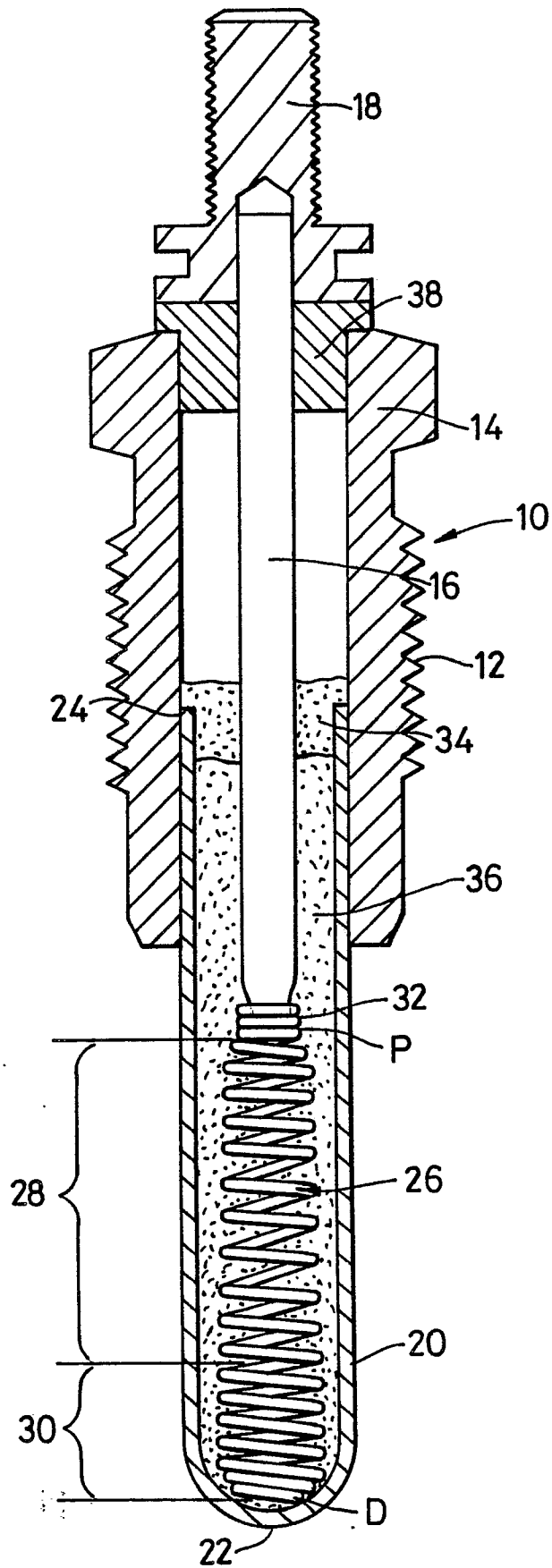
12. A sheathed element self-limiting glow plug characterised in that its heating and resistance elements (30,28) are parts of a single common length of wire (26) of uniform composition having positive coefficients of electrical resistivity relating to temperature, the cross-sectional area of the wire in the part constituting the heating element being substantially less than said area in the part constituting the resistance element.

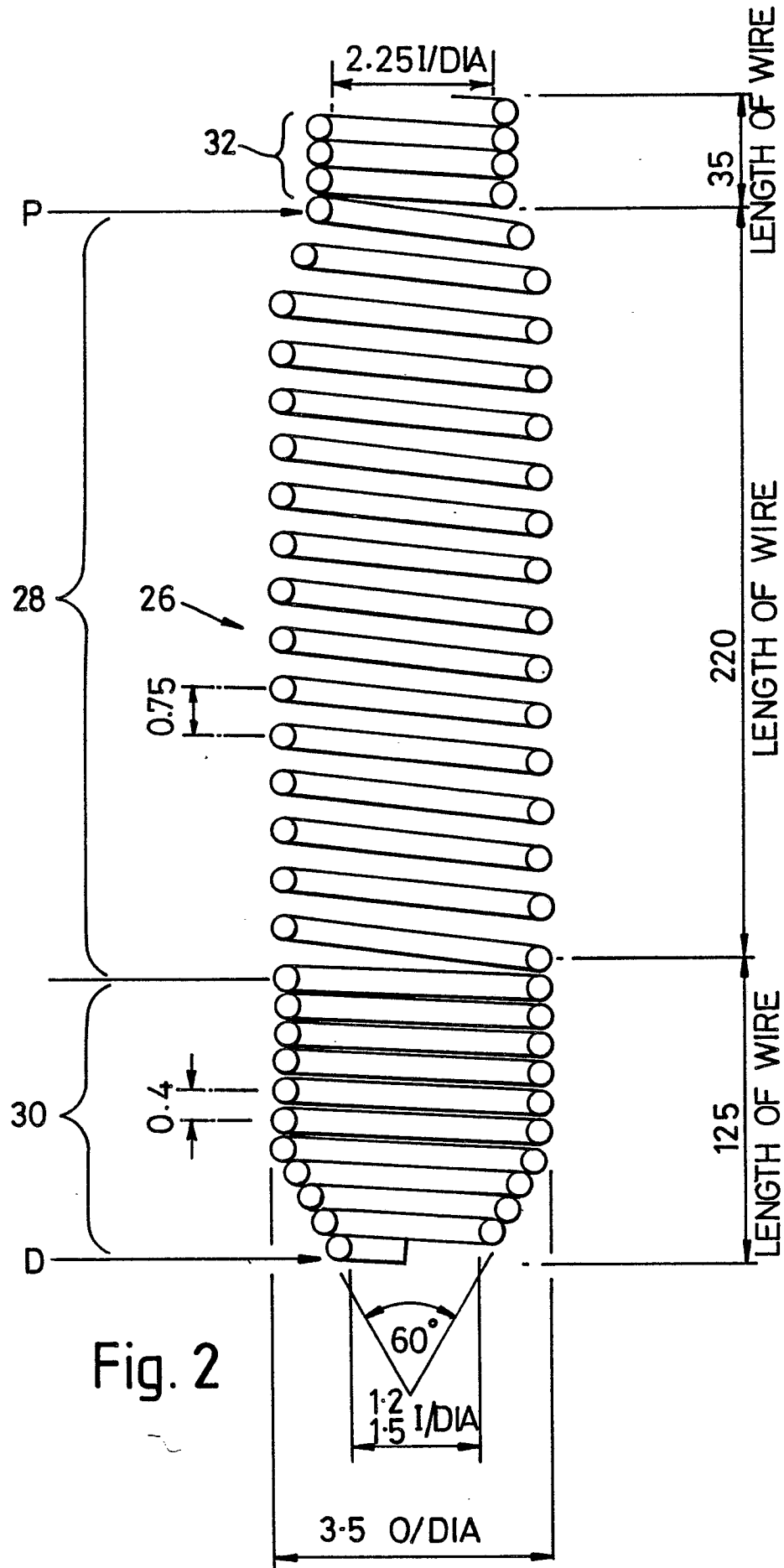
13. A glow plug as in Claim 12 characterised in that the heating and resistance elements (30,28) are coiled portions of said common length of wire (26), the coils constituting the resistance element being differently formed from those constituting the heating element.

14. A glow plug as in Claim 13 characterised in that the coils constituting the resistance element (28) are more widely pitched than those constituting the heating element (30).

15. A glow plug as in Claim 13 or 14 characterised in that the coils constituting the resistance element (28) are of lesser diameter than those constituting the heating element (30).

Fig. 1







EP 89 31 0607

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2131437 (ROBERT BOSCH) * the whole document * ---	1, 2, 3, 5, 12, 13	F23Q7/00
X	GB-A-2155543 (MARELLI) * page 3, line 20 - page 3, line 65; figures * ---	1, 2, 5, 7, 12, 13	
A	FR-A-1292098 (MARELLI) * the whole document * ---	8, 9, 10, 11, 14, 15	
A	FR-A-2105879 (ROBERT BOSCH) * claim 1; figure 1 * ---	8, 9	
A	EP-A-229677 (WELLMAN) * column 5, line 60 - column 5, line 65; figure 5 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F23Q
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 27 DECEMBER 1989	Examiner VANHEUSDEN J.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	