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D E C I S I O N
of 23 March 1999

Case Number: T 0729/96 - 3.2.3

Application Number: 91100365.5

Publication Number: 0438097

IPC: F23Q 7/00

Language of the proceedings: EN

Title of invention:
Glow plug for diesel engines particularly of motor vehicles, with a tubular sheath having a diameter reduction at the closed end

Patentee:
B 80 S.r.l.

Opponent:
Robert Bosch GmbH

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no"

Decisions cited:
-

Catchword:
-

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Beschwerdekammern | Boards of Appeal | Chambres de recours

Case Number: T 0729/96 - 3.2.3

D E C I S I O N
of the Technical Board of Appeal 3.2.3
of 23 March 1999

Appellant: (Opponent)
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Representative:
-

Respondent: (Proprietor of the patent)
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Decision under appeal:
Decision of the Opposition Division of the European Patent Office dated 29 April 1996, posted on 24 June 1996, rejecting the opposition filed against European patent No. 0 438 097 pursuant to Article 102(2) EPC.

Composition of the Board:

Chairman: C. T. Wilson
Members: H. Andrä
J. P. B. Seitz

Summary of Facts and Submissions

I. European patent application No. 91 100 365.5, filed on 14 January 1991 and published on 24 July 1991 under publication No. 0 438 097, was granted on 23 March 1994.

II. The patent was opposed by the Appellant on the ground that its subject-matter was not patentable due to lack of novelty or inventive step with respect to the prior art disclosed by the following documents:

(D1): GB-A-986 947

(D2): GB-A-2 058 216

(D3): US-A-4 112 577

(D4): JP-A-61 225 517

(D5): DE-A-2 744 624

(D6): DE-C-3 003 799.

III. The opposition was rejected by the Opposition Division with a decision dated 29 April 1996, issued in writing on 24 June 1996.

IV. The Appellant filed an appeal against this decision on 7 August 1996, paying the appeal fee on the same day. The Statement of Grounds of Appeal was filed on 25 October 1996.

The Appellant requested that the decision under appeal be set aside and that the patent be revoked.

V. In the Statement of Grounds of Appeal the Appellant referred to

(D7): DE-A-3 502 525

In a letter received on 15 November 1996 he cited

(D8): "BERU catalogue 11, Glühkerzen" carrying the imprint "Valid from September 1985" referring to a glow plug of the type "141 MJ" listed and schematically depicted on page 4 of (D8)

and submitted

(D9): Photomicrograph "Schliffbild 1060/141 MJ"

which allegedly shows the above-cited BERU glow plug which according to the coded production date engraved in the glow plug had been produced in 1980. Further according to the Appellant, glow plugs of this type were still available to the public in 1985 as shown by (D8). As evidence for the facts presented the Appellant offered the testimony of Mr Werner Teschner.

VI. In a communication according to Article 11(2) RPBA dated 15 May 1998 the Board pointed out that, according to its provisional opinion, (D7) although cited outside the period of giving notice of opposition appeared to be so relevant that it should be introduced into the proceedings. Further according to the communication, the Respondent appeared not to dispute that the BERU

glow plug of the type "141 MJ" as shown in (D9) had been made available to the public before the date of priority of the patent in suit so that hearing the witness offered with regard to this issue did not seem to be necessary. The Board considered that also the citations (D8) and (D9) were so relevant to the claimed subject-matter as to justify their introduction into the proceedings.

VII. With a letter dated 23 February 1999 the Appellant submitted an X-ray photograph (D10) of a BERU glow plug of the type "141 MJ" and set out that it can be clearly recognised from the photograph that the thickness of the tapering wall of the glow plug increases in the forward direction and that the spacing between the resistance element and the tapering wall decreases in the forward direction.

VIII. At the oral proceedings of 23 March 1999 the Respondent submitted two sets of claims according to the main request and the auxiliary request, respectively.

Independent Claim 1 of the main request reads as follows:

"A glow plug for a diesel engine comprising: a tubular metal sheath (G) closed at one end by a rounded tip (K3), said tubular sheath (G) containing an electric resistance element (S) comprising at least one coil embedded into a compacted electrically insulating powder (MgO), said resistance element (S) being spaced apart from said tubular sheath (G), said resistance element (S) being electrically connected to the rounded tip (K3) of the sheath and to a current feeding wire

respectively; said tubular sheath (G) comprising a cylindrical section (G1) having an outer diameter, and an end section (G3) of reduced diameter, said end section (G3) of reduced diameter of the tubular sheath (G) comprising a conical swaging section having a wall tapering towards the rounded tip (K3), said tapering wall of the conical swaging section (G3) having a thickness increasing from a connection zone with the cylindrical portion (G1) of the sheath, towards said rounded tip (K3)
characterized in that
the swaging is provided over a length T, namely over a length TC of the initially cylindrical section and over a length TE of an initially hemispherical part K1 of length L, TE being slightly shorter than L and the angular amplitude á of the conical swaging section (G3) being included between 10° and 25°."

Independent Claim 1 of the auxiliary request reads as follows:

"A glow plug for a diesel engine comprising: a tubular metal sheath (G) closed at one end by a rounded tip (K3), said tubular sheath (G) containing an electric resistance element (S) comprising at least one coil embedded into a compacted electrically insulating powder (MgO), said resistance element (S) being spaced apart from said tubular sheath (G), said resistance element (S) being electrically connected to the rounded tip (K3) of the sheath and to a current feeding wire respectively; said tubular sheath (G) comprising a cylindrical section (G1) having an outer diameter, and an end section (G3) of reduced diameter, said end

section (G3) of reduced diameter of the tubular sheath (G) comprising a conical swaging section having a wall tapering towards the rounded tip (K3), said tapering wall of the conical swaging section (G3) having a thickness increasing from a connection zone with the cylindrical portion (G1) of the sheath, towards said rounded tip (K3)

characterised in that

the swaging is provided over a length T, namely over a length TC of the initially cylindrical section and over a length TE of an initially hemispherical part K1 of length L, T being approximately 2 L, TE being approximately 2/3 L and the angular amplitude á of the conical swaging section (G3) being included between 10° and 25°."

The Respondent (Patentee) requested that the decision under appeal be set aside and that the patent be maintained on the basis of either his main request or his auxiliary request filed during the oral proceedings.

IX. The arguments of the Appellant can be summarised as follows:

The new sets of claims submitted only at the date of the oral proceedings are too late and therefore have to be rejected.

As regards Claim 1 of the main request the distance TE must be smaller than the length L of an initially hemispherical part K1 of the sheath. The feature that TE is slightly shorter than L is therefore trivial. The

further feature according to the characterising portion of Claim 1 that the angular amplitude á of the conical swaging section is included between 10° and 25° is known from a number of citations such as (D7) to (D10). It is generally known to provide swaging sections to glow plugs as shown for example by citations (D1) to (D4). Furthermore, the feature of Claim 1 that the length TE is slightly shorter than the length of an initially hemispherical part of the sheath is in contradiction to the illustration in Figure 3 and in column 4, lines 49 and 50 of the description according to which TE is much smaller than L, namely approximately 2/3 L.

Having regard to the auxiliary request the subject-matter of Claim 1 is very close to the glow plug shown by (D9) since the citation shows a relation between the length values T and L which is approximately 80% of that claimed and an angular amplitude á in the range of 10° to 25°. As compared with (D9), Claim 1 constitutes merely a design variation of the heating range of the glow plug which, as shown by (D5), page 4, paragraph 2, is within the normal design practice of the skilled person. The subject-matter of the independent Claim 1 both of the main request and of the auxiliary request would be obvious from the prior art.

X. In reply, the Respondent argued essentially as follows:

Having regard to the main request the indication of the length TE in combination with the angle á of the conical swaging section in Claim 1 enables the skilled person to achieve a length of the conical swaging section which is greater than in the prior art

revealed.

The proof of identity of dimensions taken from the drawings of the citations is impermissible since these drawings are of a schematic nature.

Claim 1 of the main request is directed to a novel technical teaching which is not obvious from the prior art available. This applies even more to Claim 1 of the auxiliary request which in addition to the indication of the angle of the conical swaging section comprises numerical values of the lengths T and TE. The technical effect achieved by increasing the length of the conical swaging section has to be seen in an increased wall thickness of the sheath and following therefrom an increased resistance to thermochemical erosion and in improved flow conditions in the combustion chamber. Even in the case that no advantageous effect could be shown the solution proposed by the patent would constitute a useful supplement to the solutions known so far. The subject-matter of the claims according to the main and to the auxiliary request would therefore involve an inventive step.

Reasons for the Decision

1. The appeal is admissible.

2. *Admissibility of the claims*

In the communication dated 15 May 1998 the Board pointed out that claim 1 of the auxiliary request then on file contained the terms "TL" and "TE" which were

not defined in the claim and that therefore the claim was objectionable under Article 84 EPC. In the claims according to the main and the auxiliary request submitted at the oral proceedings, the Respondent took into account the above objection. In this particular situation, the Board considers these claims in spite of their submission at a very late phase of the proceedings to be admissible.

3. *Article 123 EPC*

Claim 1 of the main request is distinguished from granted Claim 1 in that it incorporates additionally the features that the swaging is provided over a length T, namely over a length TC of the initially cylindrical section and over a length TE of an initially hemispherical part K1 of length L, TE being slightly shorter than L and the angular amplitude á of the conical swaging section (G3) being included between 10° and 25°.

The features derive from page 6, paragraph 2, of the original description in combination with Figure 3 of the original drawings and from original claim 3. They lead to a narrowing of the scope of granted Claim 1.

Claim 1 of the auxiliary request is distinguished from Claim 1 of the main request in that the wording "TE being slightly shorter than L" has been replaced by the wording "TE being approximately 2/3 L" and in that the feature "T being approximately 2 L" has been added. These features are supported by page 6, paragraph 4 of the original description and further narrow the scope of granted Claim 1.

Claims 2 and 3 both of the main and the auxiliary request correspond with granted Claims 2 and 4, respectively.

The claims according to both requests comply, therefore, with the requirements of Article 123(2) and (3) EPC. There is also no objection under Article 84 EPC to the amendments made to the claims.

4. *Inventive step*

4.1 Main request

4.1.1 (D7) which can be regarded as the closest prior art discloses according to the embodiments shown in Figures 2, 3, 4 or 6 a glow plug comprising all the features of Claim 1 with the exception of the followings features:

(a) the electrically insulating material is a powder (MgO)

(b) the conical end section of reduced diameter of the tubular sheath comprises a swaging section

(c) the swaging is provided over a length T, namely over a length TC of the initially cylindrical section and over a length TE of an initially hemispherical part K1 of length L, TE being slightly shorter than L and the angular amplitude á of the conical swaging section (G3) being included between 10° and 25°.

Features (a) and (b) are part of the general knowledge

in the technical field of glow plugs and are for instance described in (D1), page 3, lines 17 to 37, or in (D6), column 2, lines 33 to 40, column 3, lines 34 to 36 and 53 to 54. These features are therefore within the design choice of the skilled person who will bring them into use whenever a recommended electrically insulating material and, respectively, a process step appropriate for shaping the glow plug sheath to its final dimensions is required.

4.1.2 According to column 1, lines 49 to 54 of the patent the inherent technical problem comprises the aspect of achieving a better reliability of the glow plug both during the preheating phase and while the motor is running. As set out in column 4, lines 39 to 44 of the patent, the swaging length is extended from the initial length L of the ogive to a cylindrical section TC of the sheath, also this section being exposed to thermochemical erosion, with the aim of increasing its thickness.

The underlying problem can, therefore, be seen in improving a glow plug such as known from (D7) in respect of its reliability in particular with regard to the detrimental effect of thermochemical erosion.

As pointed out by the Representative of the Respondent at the oral proceedings, feature (c) of Claim 1 has the effect that the length T of the conical swaging section is much bigger than the corresponding length shown in Figure 2, 3, 4 or 6 of (D7) or that shown in the photo-micrograph (D9).

It can be recognised from Figure 3 of the patent that a

particularly big conical swaging length T can be obtained above all if a value in the lower range of the angular amplitude á is chosen. There is no doubt that, by increasing the length T, the length of the range in which the wall thickness of the sheath is thickened is also increased so that the resistance to thermochemical erosion is improved. It follows that the above-cited problem has to be regarded as solved by the subject-matter of Claim 1.

4.1.3 The fact that (D9) forms part of the prior art has not been disputed by the Respondent (see for example the Respondent's letter dated 14 August 1997). The Appellant having indicated by submission of the prepublished BERU catalogue (D8) the type of glow plug investigated, the Board considers it proven that the glow plug depicted in the photomicrograph (D9) is part of the prior art.

(D9) shows the tubular sheath of a glow plug in which the angular amplitude á of the conical swaging section is approximately 22°, that is in the range of between 10° and 25°. Furthermore, the swaging is provided over a length T, namely over a length TC of the initially cylindrical section and over a length TE of an initially hemispherical part K1 of length L, TE being approximately 60% of L.

From the fact that according to the patent (see column 3, lines 45 to 49, and column 4, lines 49 and 50) a value of TE = 2/3 L is defined as a value TE being slightly shorter than L, a value of TE being approximately 60% of L as shown by (D9) would still be considered as a solution in the range of values claimed

(see feature (c) as defined in above section 4.1.1).

The skilled person would be induced to substitute the above-cited feature (c) known from (D9) for the conical sheath section of the plug tip shown by (D7) because he would expect some improvement as to erosion stability due to an extended portion of the conical sheath section. He would arrive thereby at the subject-matter of Claim 1 without an inventive activity being involved.

4.2 Auxiliary request

4.2.1 As expounded in section 3 above, Claim 1 of the auxiliary request differs from Claim 1 of the main request by the indication of numerical values for the lengths T and TE. By these distinguishing features, the upper and lower point of connection of the conical swaging section with the cylindrical portion and, respectively, the initially hemispherical portion of the sheath and therewith the total swaging length are defined.

4.2.2 After a given period of operation of a glow plug such as known from (D7) it may turn out that the sheath of the plug is damaged due to erosion of the sheath wall, in particular in the range of the zone connecting the cylindrical and the conical swaging section.

The skilled person being aware (see e.g. D6, Figures 1 and 2 or (D9) that deformation of the tip portion of the glow plug by swaging to a conical tip section leads to a thickened sheath wall, the thickening increasing gradually in the direction towards the tip of the plug

due to material flow caused by the swaging process, will conclude in a logically stringent way that in order to avoid or reduce damage to the sheath in the zone referred to above, the conical swaging section has to be extended into the range affected so that the length T = TC + TE forming the region of increased sheath wall thickness is extended in the direction away from the tip of the plug. Such a solution is obvious to the skilled person alone for the reason that he is aware from his basic technical knowledge of the context between the length of the conical swaging zone and therewith the range of the thickened sheath wall on the one hand and the resistance to thermochemical erosion in dependence on material thickness on the other hand.

4.2.3 Furthermore, it is pointed out in the patent (see column 4, lines 45 to 48) that in practice the length T is a compromise between the exigences of reliability of the glow plug and the optimization of the combination of the air-gas oil mixture.

In optimizing the combustion process of a Diesel engine various parameters have to be taken into account such as e.g. the size and the shape of the combustion chamber, the position of the injection nozzles with regard to the position and the dimensions of the glow plug and the injection pressure of the fuel and the air. None of these parameters is, however, comprised in the subject-matter of Claim 1. Thus, it must be concluded that the teaching of Claim 1 does not enable the skilled person to arrive at such a compromise between the required reliability of the glow plug and the optimization of the combustion process but teaches merely an improvement as to the resistance of the glow

plug to thermochemical erosion by extending the length of the conical swaging section of the sheath.

As illustrated above (see section 4.2.2), such an improvement is obvious to the skilled person from a combination of the teachings of (D7) and (D9) read in the light of the common technical knowledge in the field of manufacture and operation of glow plugs.

4.3 In the absence of any convincing argument for the existence of an inventive activity, the Board has come to the conclusion that the subject-matter of Claim 1 both according to the main request and according to the auxiliary request is not based on an inventive step (Article 56 EPC) so that these claims cannot be maintained.

5. It is unnecessary to consider the merits of Claims 2 and 3 according to both requests since these claims are dependent on the respective Claim 1. These claims must therefore fall with the independent Claims 1.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The patent is revoked.

The Registrar: The Chairman:

N. Maslin C. T. Wilson