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Bezeichnung der Erfindung: Thermistor controlled fuel heater
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement : F02M 31/12

ENTSCHEIDUNG / DECISION
vom / of / du 4 July 1990

Anmelder / Applicant / Demandeur : Technar Incorporated

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Art. 56, 83 and 111(1)

Schlagwort / Keyword / Mot clé : "Inventive step - yes";
"Disclosure of the invention - remitted to first instance"

Leitsatz / Headnote / Sommaire

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Case Number : T 269/88 - 3.2.2

D E C I S I O N
of the Technical Board of Appeal 3.2.2
of 4 July 1990

Appellant : Technar Incorporated
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Representative : Schuster T.
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Decision under appeal : Decision of Examining Division 102 of the European Patent Office dated 28 December 1987 refusing European patent application No. 83 106 976 pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : G. Szabo
Members : C. Andries
M. Schar

Summary of Facts of Submissions

I. European patent application No. 83 106 976.0, filed on 15 July 1983 (publication number 0 101 560), was refused by a decision of the Examining Division 102 dated 28 December 1987.

The decision was based on Claim 1 filed with letter dated 4 November 1987 and Claims 2 to 6 filed with letter dated 4 September 1986.

II. The reason given for the refusal was that the subject-matter of the application did not involve an inventive step in view of the prior art disclosed in the following documents.

D1: DE-A-2 919 763;
D2: US-A-3 400 252;
D3: DE-A-2 316 054; and
D4: EP-A-45 507;

and in view of the normal capacities of a skilled engineer.

III. On 7 March 1988, the Appellant lodged an appeal against this decision, paying the appeal fee on the same date. A Statement of Grounds was filed on 9 May 1988, together with new pages 11 and 12 of the description.

IV. During the oral proceedings held on 4 July 1990, the Appellant filed a new Claim 1 as well as new pages 1, 2 and 2a of the description and new Figs. 4 to 15.

Claim 1 now reads as follows:

"A fuel heater for diesel engines comprising:

conduit means (10) for transporting diesel fuel in a predetermined direction, a resistance heater (14) extending along a first portion of said conduit means (10) for heating the diesel fuel in said portion of the conduit means (10) in response to an electric current passing through the resistance heater (14),

characterised by a thermistor element (26,28) having a positive temperature coefficient being connected electrically in series with the heater element (14) and mounted in thermal contact with the diesel fuel in a second portion (24) of the conduit means (10) upstream of said first portion,

the heat transfer rate from said thermistor element (26,28) to the diesel fuel being chosen such

- that the internal temperature of the thermistor element leads to a resistance of the thermistor element being substantially less than the resistance of the resistance heater below a predetermined temperature of the diesel fuel, at which diesel fuel precipitates wax solids from solution,
- that the internal temperature of the thermistor element leads to a resistance of the thermistor element, corresponding to the resistance of the resistance heater (14), when the diesel fuel is of said predetermined temperature and
- that the internal temperature of the thermistor element substantially increases to substantially increase the resistance of the thermistor element so as to switch off the resistance heater at temperatures of the diesel fuel higher than said predetermined temperature."

V. The Appellant requested that the decision under appeal be set aside and a patent be granted on the basis of the following documents:

Claims: Claim 1 as submitted at the oral proceedings;
Claims 2 to 6 as filed with letter dated 4 September 1986;

Description: pages 1, 2 and 2a as submitted at the oral proceedings;
pages 3 to 10 as published;
pages 11 and 12 as filed with letter dated 9 May 1988;

Drawings: Sheet 1/4 as published; and
Figs. 4 to 15 as submitted at the oral proceedings.

Reasons for the Decision

1. The appeal is admissible.

2. **Amendments**

The Board is satisfied that the present application documents do not contain subject-matter extending beyond the content of the application documents as originally filed (Art. 123(2) EPC).

2.1 Present Claim 1 is supported by the originally filed Claim 1 and by that part of the originally filed description which corresponds to Figs. 4 and 6, and which relate to the heat transfer rate and to the crossing point between the temperature-resistance curves of the resistance heater on the one hand and the PTC-thermistor element on the other.

The fact that the feature "means for connecting a current source across the series connected heater and thermistor", which was explicitly present in the originally filed Claim 1, does not appear in the present wording of Claim 1, cannot be considered according to the Board's opinion as an extension in the meaning of Art. 123(2) EPC, since such a feature has to be considered as being implicitly present in each electrical heating device.

2.2 Claims 2 to 6 correspond respectively to Claims 2, 7, 3, 6 and 4 as originally filed.

2.3 The modifications of the description and the drawings only relate to a more precise definition of the object of the invention, to the description of the state of the art as well as to the correction of clerical errors. The now defined object of the invention is clearly supported by the whole content of the originally filed description, particularly by page 7, lines 19 to 24 and page 1, lines 32 to 34.

These amendments do not give rise to any objection.

3. Novelty

After examination of the cited documents the Board is satisfied that none of them discloses a fuel heater for diesel engines having all the features as defined in Claim 1.

4. Closest prior art

4.1 In the opinion of the Board the fuel heater for diesel engines according to document D4, which has been used by

the Appellant to define the pre-characterising portion of Claim 1, reveals the closest prior art.

Indeed, document D4 discloses a fuel heater for diesel engines comprising fuel conduit means and a resistance heater, as defined in the pre-characterising portion of present Claim 1. Furthermore, this document discloses a thermostatic element which includes a bimetallic thermal element and a snap-action switch, and which is mounted on the tube upstream of said resistance heater, so that a thermal contact exists with the diesel fuel and so that it is connected electrically in series with the heater element. The thermostatic element, which has also a switch function, remains closed as long as the ambient temperature of the fuel is below a critical level and will open the circuit when it senses the rise in temperature above said predetermined temperature. Thereby the precipitation of wax-like constituents out of the fuel as small wax crystals should be avoided.

4.2 On the other hand, document D1, put forward by the Examining Division as the closest state of the art, discloses an atomiser burner for oil firing plants having an electric heating apparatus for maintaining a relatively constant temperature (80° ± 10°C) for the oil supply over a range of throughputs which may vary from 0.5 to 2.5 l/h. The heating apparatus includes at least a PTC resistor mounted along the supply pipe.

According to Figs. 1 and 2 the PTC resistor is arranged in series with and upstream from a heating element which surrounds the supply pipe.

The Board is of the opinion that an atomiser burner for an oil firing plant, which is used to heat fuel up to a high temperature of about 80°C is a different device when

compared with a fuel heater for diesel engines which tries to avoid clogging of the diesel fuel filter at about 10°C, so that document D1 cannot be considered as the closest prior art, particularly since it is not obvious that such a plant as disclosed in document D1 can be used directly without any modifications in a diesel engine only to avoid the filter clogging at about 10°C. Furthermore, improving the plant according to document D1 will result in an improved burner for such a plant, and not in a fuel heater for diesel engines.

5. Problem and solution

5.1 In the view of the Appellant, the mechanical (snap-action) switch present in the fuel heater according to document D4 is relatively expensive to manufacture and to replace, and is not always reliable.

5.2 The technical problem to be solved in respect of document D4 therefore consists in providing a fuel heater which achieves a sharp switching without using a mechanical switch.

5.3 The problem is solved by the incorporation of features mentioned in the characterising part of Claim 1, particularly by the use of a specific thermistor element having a positive temperature coefficient (PTC), having a resistance-temperature curve which is specifically defined with respect to the corresponding curve of the resistance heater, and being arranged in the heater in such a manner that the heat transfer rate as defined in Claim 1 is obtained.

Indeed, during the oral proceedings the Appellant explained that the switching temperature of the thermistor, which is normally a temperature in the range

from at about 80° to 120°C (Curie-temperature), can be used to operate the heater around the critical fuel temperature of about 10°C, by carefully designing, relative to each other, all the parts of the co-operating elements which contribute to the heat transfer rate between the PTC thermistor and the fuel. It is essential for a fuel temperature of about 10°C that the fast heat build up in the PTC thermistor is such that the thermistor itself will be near to its Curie-temperature. One of the most critical features being the relation between the resistance-temperature curves of both the PTC thermistor and the resistance heater. Only by satisfying the defined relations can a sharp switching at about 10°C be reliably obtained.

6. **Inventive step**

6.1 Document D4 does not give any suggestion of the use of a PTC thermistor or of its adaptation with respect to the resistance heater-resistance and to the heat transfer rate, instead of the direct mechanical switch system.

6.2 Documents D3, and EP-A-52 945 (D5) and EP-A-51 936 (D6) also raised in the proceedings, each describe fuel heaters for internal combustion engines comprising a PTC thermistor heating element.

6.2.1 Document D3 relates however to the construction of that heating element and its location in a fuel conduit, so that neither is information given with respect to its resistance-temperature-curve, nor to a relevant heat transfer rate (heat build up). The problem of sharp switching around about 10°C is not mentioned either. On the contrary, although heating during the cold running of the engine is described, a man skilled in the art finds in this document only the teaching that a peculiarly

constructed thermistor is used for heating in general. Neither are special features suggested for controlling the heat transfer rate, nor is an appropriate heat build up envisaged in the PTC element.

6.2.2 Document D5 describes a heated fuel line for preventing the solidification of the fuel in the engine fuel line, and teaches to improve the efficiency of the heating of a fuel line by incorporating a special type (PTC) of electrical heating element (e.g. a Thermo-Limit-Tape) directly within the line. Document D5 does not even imply that the heating element can be used for any kind of switching. On the contrary, the device according to Fig. 4 shows a switching relay (20) as well as a circuit breaker (22) for the purpose.

6.2.3 Document D6 discloses the heating of diesel fuel within the filter means with the help of a self-regulating electrical resistance (e.g. a PTC element), particularly when the engine is started at low ambient temperatures, in order to avoid cold weather filter-clogging. Apart from the fact that the PTC element is used for heating as such, there is no indication and no suggestion in this document that the PTC element should be used for switching at all. On the contrary, this document clearly teaches that in order to avoid unnecessary power consumption by the PTC heater, and unnecessary fuel heating, an additional thermally responsive switch has to be mounted in the system for interrupting the operation of the PTC heater, when the temperature of the switch is above a selected temperature.

The statement in this document that a sharply increasing resistivity exists as the heating elements are heated, is common knowledge for a skilled person and does not give him a hint towards the solution according to the present

application, particularly since it is furthermore stated that the heater temperature is stabilised at a level generally corresponding to the Curie temperature (approximately 120°C) of the resistor material (page 15, lines 3 to 9). According to the Board, this statement does not imply that the use of a PTC element would provide sharp switching at about 10°C as required.

6.3 Documents D1 and EP-A-17 057 (D7), on the other hand, describe the use of PTC elements as heating devices (up to about 80°C) for fuel for oil firing plants, in order to improve fuel atomisation.

The fact that these PTC elements are used for heating implies for a skilled person that the heat transfer between these elements and the fuel should be as good as possible, so that no suggestion towards a controlled heat transfer rate and a **heat build up** can be found in these documents.

6.3.1 The heating device according to document D1 maintains a relatively constant fuel temperature (80° ± 10°C) over a range of throughputs which may vary from 0.5 to 2.5 l/h. According to the embodiment as defined in Claim 10 and as shown in Figs. 1 and 2, a PTC resistor (which is substantially unresponsive to temperature) is arranged in series with and upstream from a heating element which surrounds the supply pipe. The resistance of the heating element is of the same order (between 50 and 200%) as the cold resistance of the PTC resistor.

It is revealed that PTC resistors with a Curie point of about 100 to 110°C are suitable to give the fuel the required temperature and to avoid coking when the fuel is at standstill. This teaching implies that the Curie-point temperature is used as a safety or switching temperature.

The Board is, however, of the opinion that the use of a PTC element at its own high (100°-110°C) Curie-point temperature to control a threshold value for the fuel which corresponds with that Curie-point temperature, is obvious for a skilled design engineer and that such a use cannot be compared with the use of a PTC element with the same high Curie-point temperature, but at a much lower safety or switching point (about 10°C) according to the present application.

In any case, the specific relation between the resistance-temperature curves of both the heat resistance and the PTC element, as well as the heat transfer rate according to the present Claim 1 are not disclosed in the document. The broadly defined value of the resistance of the heating element (50 to 200%) with respect to the PTC element cold resistance cannot, according to the Board, imply or suggest the specific relation between these resistance curves in the meaning of the invention. Since Fig. 6 clearly shows that the PTC element itself contributes much to the fuel heating (cf. line III if the PTC element is used alone, or line II) and since there is in document D1 no mention of a sharp switching even at the high temperature, a skilled person does not find in document D1 a hint to use, in addition to the resistance heater, a PTC element solely as a switch to obtain a sharp switching at about 10°C.

Actually, it appears that with the present invention this is achieved by the other characteristics enabling a sudden and quick increase of the PTC temperature far above the low temperature limit, which through its own dynamic, rises, in the absence of heat loss, to a very high resistance point without delay.

6.3.2 Document D7 also discloses the heating at about 80°C of fuel for an oil firing plant, wherein a PTC thermistor is used as a self-limiting heating device. It is suggested in document D7 to use an additional safety thermostat to switch off current to the heating device (PTC thermistor) in order to avoid the fuel temperature to exceed a maximum temperature. Therefore, a skilled person cannot be guided by such a teaching to use the thermistor itself as a sharp switching device.

6.4 As already indicated above, a person skilled in the art is aware of the working of PTC elements as normal heating elements and as temperature limiting elements in the range of their own Curie-point temperature, which according to the Appellant is normally situated in the range of 80° to 110°C. The use of that Curie-point temperature to stop heating at about 10°C is however, according to the Board, not obvious, particularly since in the prior art, even in technical fields distant from the invention, no such use has been suggested.

In this respect the Board wishes to point out that in document US-A-3 476 293 (D8) a PTC element with a Curie-point temperature of 120°C has been used as a control element in an aerosol dispenser heater. There exists however no heat transfer between that PTC element and the fluid passing through the heating device. The PTC element is designed so as to act only as a thermal analogue of the heater. Consequently, it heats up only as the result of its own heat generation.

Therefore, there is no control by the PTC element of a critical liquid-temperature in the meaning of the present application, let alone a control of the temperature of a moving liquid, since there is no feed-back from the liquid temperature to the PTC element.

Document D2 relates to the same problem to be solved as the present case (to avoid a switch having a contact) and suggests the use of a PTC element to control the ambient temperature of an object or material being heated within a given range of appropriate temperatures. The described temperature sensitive electric switch is controlled by the temperature of the thermistor itself, e.g. when its temperature exceeds the upper temperature limit the current flow decreases immediately whereas when the temperature drops below the lower temperature limit the current flow suddenly increases. Such a switching, keeping the temperature of the thermistor itself within a range cannot be considered as a sharp switching around one single temperature in the meaning of the application. In this heating device, the PTC element is also used to heat, so that the attention of the skilled person, searching for a simple switch in addition to a heating element is not directed towards the described solution. Furthermore, it should be kept in mind that the temperature control within a temperature range of a fluid which is additionally in a static state, cannot be compared with the method for avoiding a temperature of the flow passing fluid falling below a critical temperature.

6.5 The Board also considered the further documents cited in the examining proceedings and found them not prejudicial to the present Claim 1, either alone or in combination with the documents cited above.

6.6 The subject-matter of Claim 1 therefore involves an inventive step within the meaning of Art. 56 EPC.

7. The subject-matter of Claim 1 is therefore patentable within the meaning of Art. 52 EPC.

8. However, during the appeal proceedings, the Appellant continuously stressed the point that the functional feature "the heat transfer rate from said thermistor element to the diesel fuel being chosen such...", which is present in Claim 1, implies measures which are otherwise obvious for a person skilled in the art, and which in combination with specific features revealed in the description and influencing the heat transfer rate, allow a person skilled in the art to carry out the invention (Art. 83 EPC).

The present European patent application reveals on the one hand, that the correct heat transfer rate is critical to the proper operation of the heating device and that this rate is controlled and designed so that the effect (a sharp switching) is obtained. This implies a somewhat imperfect transfer since a very effective switching cannot be obtained if a perfect heat transfer is present (page 6, lines 2 to 23). On the other hand, some indications and suggestions are given in the application to improve that heat transfer rate (cf. originally filed application: page 2, lines 28 to 34; page 10, lines 14 to 18).

Furthermore, with respect to the embodiment according to Figs. 7 to 12 which obtains "an optimum heat transfer" by the direct thermal contact between the fuel and the thermistor the Board does not directly detect which specific features or conditions, express implicit or based on common general knowledge, do contribute to or influence the design of the heat transfer rate in such a manner that the required sharp switching can be obtained as a result of a temperature build up in the thermistor, and that even under conditions of various flow rates (dependent on the engine's load).

Since the disclosure of the invention (Art. 83 EPC) was not investigated up to now in the proceedings, and since it is important to preserve the Appellant's right to a second instance, if necessary, it is in the Board's judgment appropriate to exercise its power under Art. 111(1) EPC and to remit this case to the Examining Division for further prosecution.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to carry out further prosecution.

The Registrar: The Chairman:

S. Fabiani G. Szabo