(12) UK Patent Application (19) GB (11) 2 143 708 A

(43) Application published 13 Feb 1985

(21) Application No **8415611**

(22) Date of filing **19 Jun 1984**

(30) Priority data

(31) **58/097779** (32) **23 Jun 1983** (33) **JP**
58/119727 **29 Jul 1983**

(71) Applicant
Tokai Electric Wire Company Limited (Japan),
1-14 Nishisuehirocho, Yokkaichi-shi, Mie-ken, Japan

(72) Inventors
Tetsuo Watanabe,
Yoshitsugu Tsuji

(74) Agent and/or Address for Service
D. Young & Co.,
10 Staple Inn, London WC1V 7RD

(51) INT CL^3
H05B 3/40 F02M 31/12

(52) Domestic classification
H5H 140 144 194 213 224 231 232 250 252 AG
F1B 2F12
U1S 1953 1990 F1B H5H

(56) Documents cited
None

(58) Field of search
H5H

(54) **Heating device for heating an air-fuel mixture to be supplied to an internal combustion engine**

(57) A heating device 3 which can be mounted in the mixture intake passage 2 of an internal combustion engine, the heating device 3 consisting of a hermetic double-tube structure having a generally cylindrical outer tube 6 and a substantially polygonal metallic inner tube 7, a plurality of thermistor elements 8 having a positive temperature coefficient being placed in the space between the inner tube 7 and the outer tube 6 and held in the space between the inner tube 7 and the outer tube 6 and are held in contact with respective flat wall surfaces of the inner tube 7, an electrode member 9 having a polygonal tubular shape substantially conforming with that of the inner tube 7 surrounding the inner tube 7 while making contact with the inner surface of the outer tube 6, and a resilient member 10 disposed between the electrode member 9 and the thermistor elements 8 so as to resiliently press the thermistor elements 8 onto the flat wall surfaces of the inner tube 7 while being pressed resiliently by the reaction force against the electrode member 9.

FIG. 1

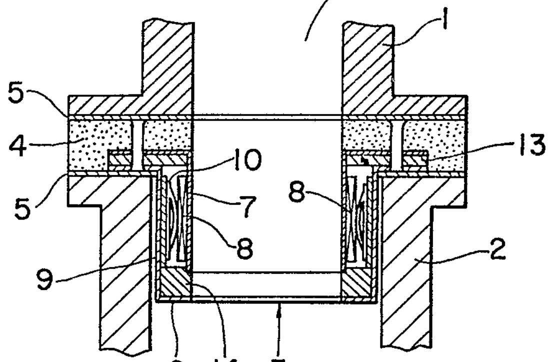
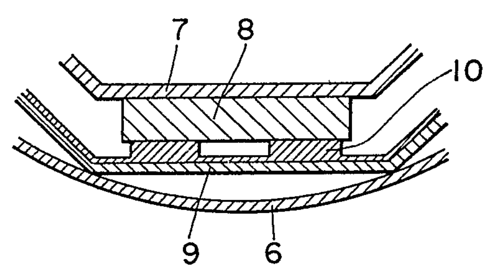


FIG. 3



GB 2 143 708 A

2143708

FIG.1

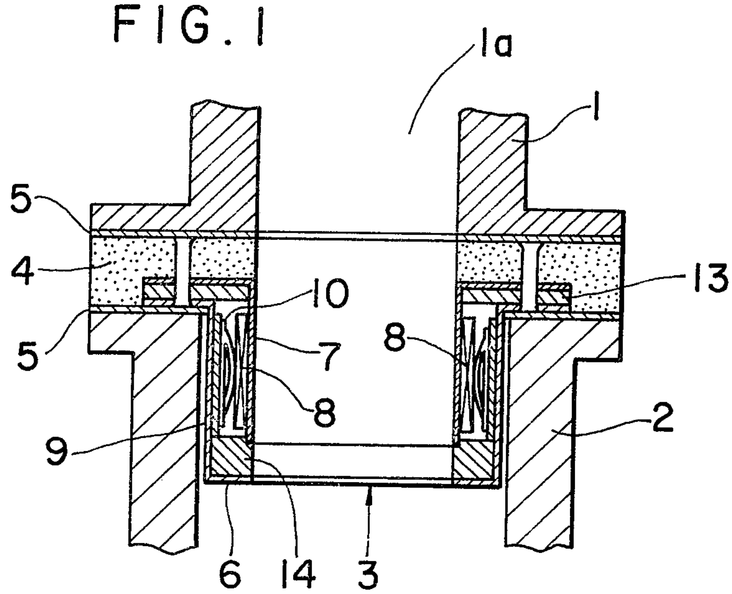


FIG.2

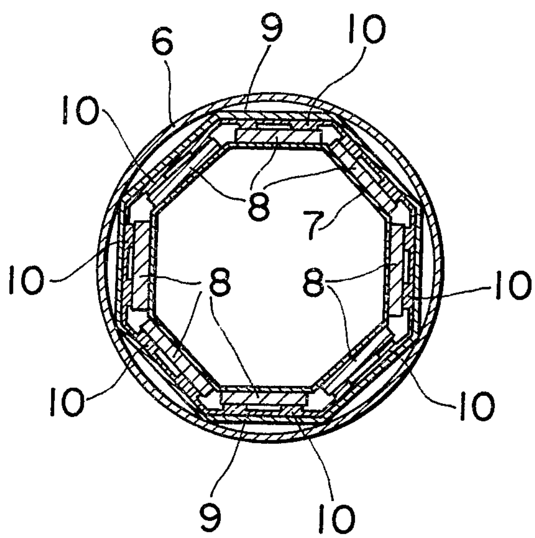


FIG.3

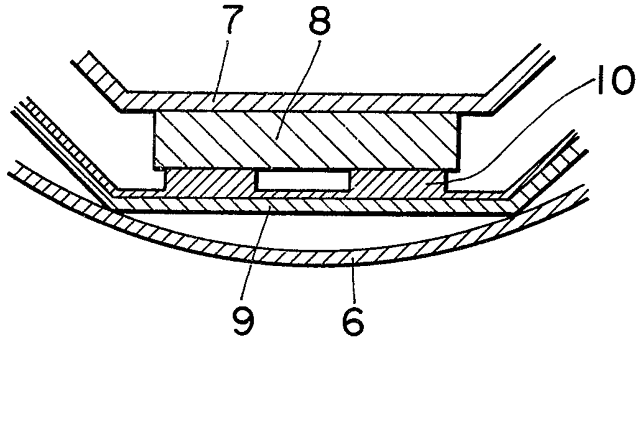


FIG. 4

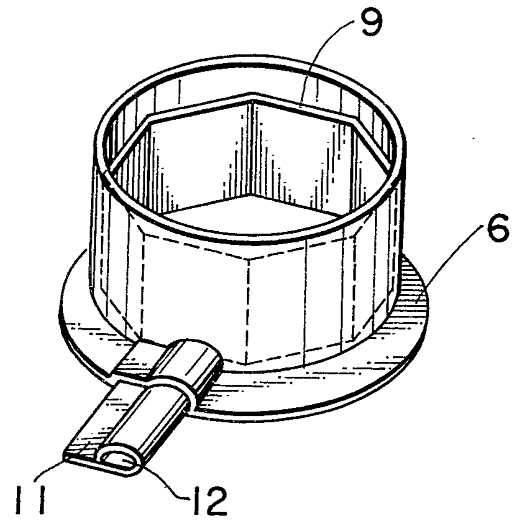


FIG. 5

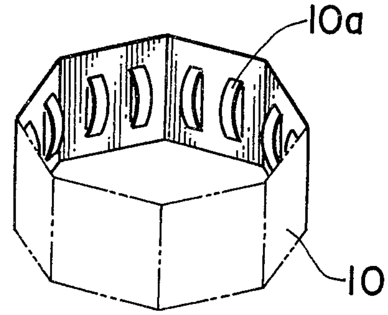


FIG. 6

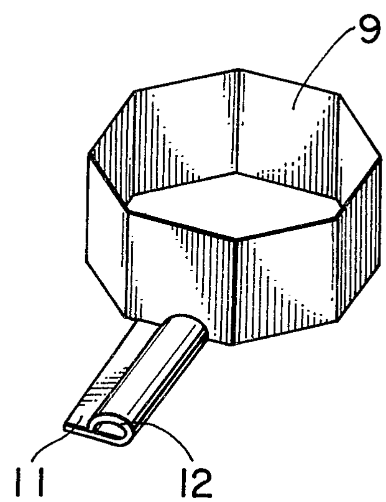


FIG. 7

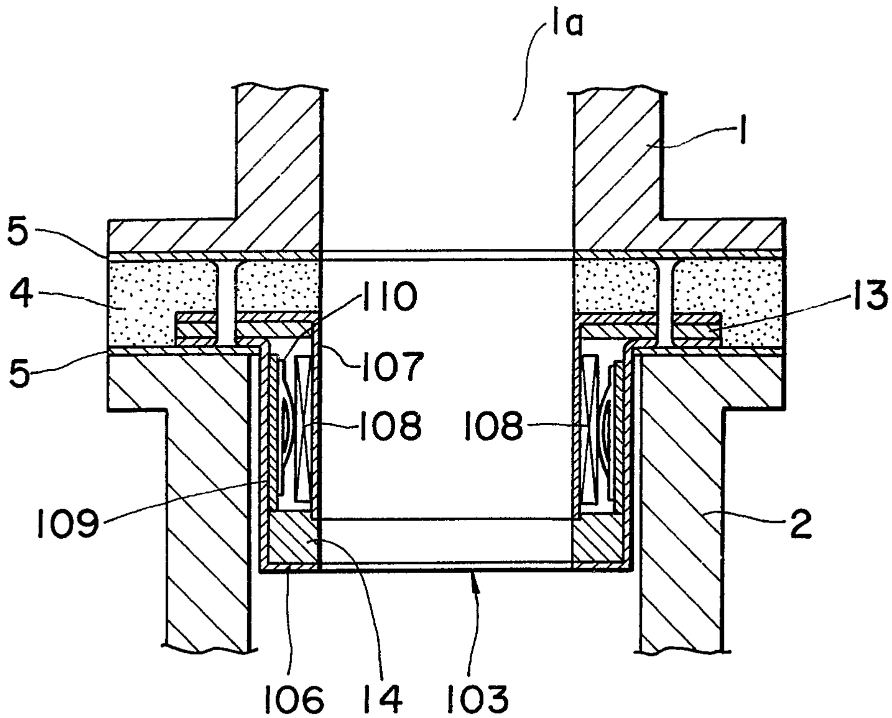


FIG. 9
PRIOR ART

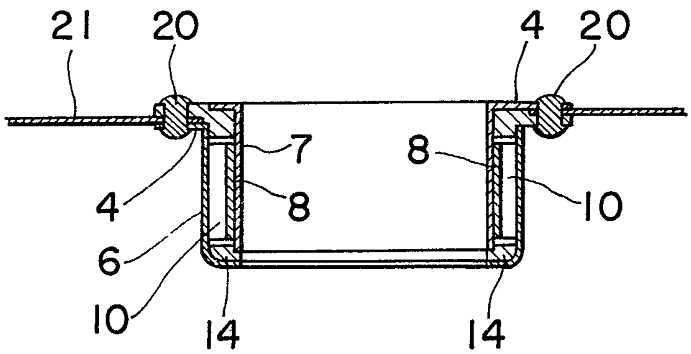


FIG. 10
PRIOR ART

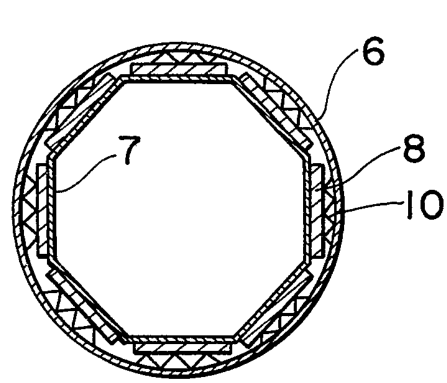
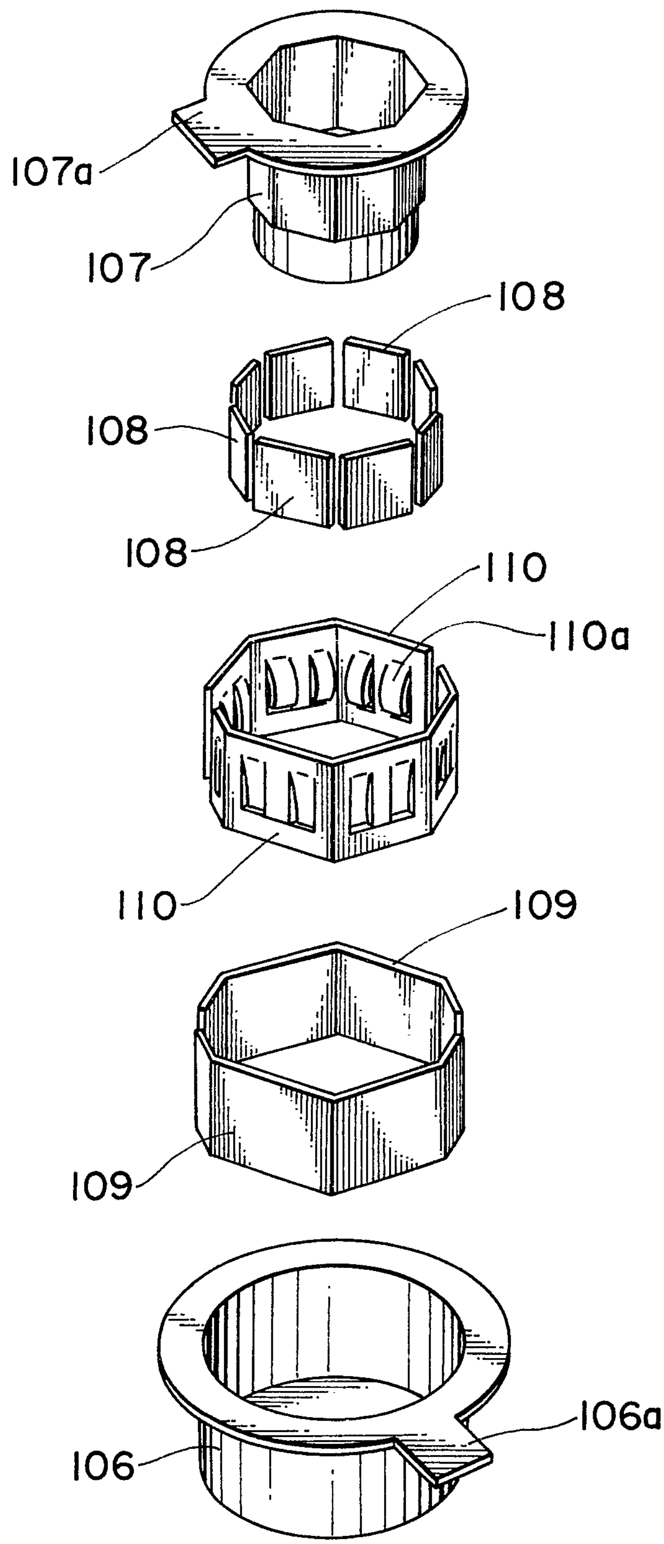


FIG. 8



SPECIFICATION

Heating device for heating an air-fuel mixture to be supplied to an internal combustion engine

The present invention relates to a heating device for heating an air-fuel mixture which is to be fed to an internal combustion engine.

Hitherto, various types of devices have been proposed for heating an air-fuel mixture to be fed to an internal combustion engine so as to promote the evaporation of the fuel as shown, for example, in Japanese Publication No. 141392/1981, and some of these devices have been put into practical use.

A typical example of these known heating devices has a hermetic double-tube structure constituted by a generally cylindrical outer tube and a substantially polygonal inner tube, a plurality of thermistor elements having positive temperature coefficient (referred to as P.T.C. element, hereinunder) disposed in the space between the outer and inner tubes and contacting the flat surfaces of the polygonal inner tube, a resilient member loaded between the outer tube and the P.T.C. elements so as to resiliently press respective P.T.C. elements onto the flat surfaces of the inner tube and, at the same time, pressed against the outer tube by the reaction force, and a means for electrically connecting the resilient member to the outer tube. This known heating device, however, is quite difficult to assemble, particularly with regard to mounting the P.T.C. elements with the resilient member correctly held thereon, because the wall surface of the outer tube is curved while the P.T.C. element has a flat form. Consequently, the expected uniform distribution of the resilient force over the entire circumference is often not achieved, resulting in the state of surface contact between eacn P.T.C. element and the inner tube being impaired and thus an inferior heat transfer to the inner tube which undesirably lowers the heating efficiency.

According to the present invention there is provided a heating device which can be mounted in the mixture intake passage of an internal combustion engine, comprising:

a hermetic double-tube structure having a generally cylindrical outer tube and a substantially polygonal metallic inner tube;

a plurality of thermistor elements having a positive temperature coefficient and placed in the space between said inner tube and outer tube and held in contact with respective flat wall surfaces of said inner tube;

an electrode member having a polygonal tubular shape substantially conforming with that of said inner tube and surrounding said inner tube while making contact with the inner surface of said outer tube; and

a resilient member disposed between said electrode member and said thermistor elements so as to resiliently press said thermistor elements onto the flat wall surfaces of said inner tube while being pressed resiliently by the reaction force against said electrode member.

Some embodiments of the invention will now be described, by way of examples, with reference to the accompanying drawings, in which:-

Figure 1 is a vertical sectional view of an embodiment of a heating device in accordance with the present invention, in a state mounted on an internal combustion engine;

Figure 2 is a cross-sectional view of the tubular heating unit of the heating device in accordance with the invention;

Figure 3 is an enlarged view of a part of the heating unit shown in Figure 2;

Figure 4 is a perspective view of an essential portion of a tubular heating element;

Figure 5 is a partly omitted perspective view of a resilient member which is one of the constituent elements of the tubular heating unit;

Figure 6 is a perspective view of an electrode plate which is another constituent element of the tubular heating unit;

Figure 7 is a vertical section view of a second embodiment of a heating device of the present invention, in a state mounted on an internal combustion engine;

Figure 8 is an exploded perspective view of a tubular heating unit incorporated in the embodiment shown in Figure 7;

Figure 9 is a vertical sectional view of an example of a conventional heating device; and

Figure 10 is a cross-sectional view of the conventional heating device as shown in Figure 9.

Figures 9 and 10 show an example of a known heating device for use in an internal combustion engine. This heating device has a hermetic double-tube structure constituted by a generally cylindrical outer tube 6 and a substantially polygonal inner tube 7, a plurality of P.T.C. elements 8 are disposed in the space between the inner tube 7 and the outer tube 6 and held in contact with flat surfaces of the inner tube 7, and a resilient member 10 located between the outer tube 6 and the P.T.C. elements 8 to press them into resilient contact with the flat surfaces of the inner tube 7 and pressed by the reaction force against the wall of the outer tube 6, the resilient member 10 being electrically connected to the outer tube 6. The electric power supply to the outer tube 6 is made through terminals 21 fixed to a flange of the outer tube 6 by, for example, caulked rivets 20. In Figure 9, reference numerals 4 and 14 represent a heat insulating member and an electrically insulating packing, respectively.

As stated before, difficulty is encountered in the assembling of this known heating device, particularly in the mounting of the resilient member 10, due to the fact that the resilient member 10 presses at its one side a plurality of flat P.T.C. elements while acting at its other side on the arcuate wall of the outer tube 6, often failing to establish uniform distribution of the resilient pressing force in the circumferential direction. Consequently, the surface contact between each P.T.C. element 8 and the inner tube 7 is often impaired thus deteriorating the heat transfer from the P.T.C. elements 8 to the inner tube 7 which results in a low heating efficiency.

This problem would be overcome by processing and finishing the resilient member 10 to a high precision, but such a countermeasure imposes various restrictions in the production of the resilient member 10 and other parts not only impairing the yield but also raising the production cost.

The heating device of the invention is free from these problems as will be understood from the following description.

Figures 1 to 6 show a first embodiment of a heating device in accordance with the invention.

Referring first to Figure 1, a carburetor 1 of an internal combustion engine has an air duct 1a which extends substantially vertically, and is connected to an intake manifold 2 in which is formed a mixture intake passage having a cross-sectional area somewhat greater than that of the air duct 1a. A tubular heating unit 3 is received in the open end of the mixture intake passage of the intake manifold 2 adjacent to the carburetor 1. More specifically the tubular heating unit 3 has a flange portion embedded in a heat insulating member 4 which in turn is clamped between a flange of the carburetor 1 and a flange of the intake manifold 2 with gaskets 5 placed at the upper and lower sides therof, as will best be seen from Figure 1.

The tubular heating unit 3 is composed of a flanged outer tube 6 and a metallic flanged polygonal inner tube 7 which are assembled together with an electrically insulating plate 13 placed between both flanges, so as to form a double-tube structure. The space formed between the outer and inner tubes 6 and 7 of the double-tube structure accommodates a plurality of P.T.C. elements 8, an electrode plate 9 and a resilient member 10. An electrically insulating packing 14 is disposed at the mixture outlet end of the double-tube structure, between opposing walls of the outer and inner tubes 6 and 7, thereby attaining a hermetic structure of the tubular heating unit 3.

Each of the P.T.C. elements 8 has a flat tubular form with both sides thereof constituting electrodes one of which contacts the associated flat outer surface of the polygonal inner tube 7.

As will be clearly seen from Figures 2, 3 and 6, the electrode plate 9 has a polygonal tubular shape conforming with the inner tube 7 and contactable at its apices with the inner surface of the outer tube 6. The electrode plate 9 is provided at one axial end portion with a terminal portion 11 for connection to external lead wires so that the lead wires can be led to the outside of the tubular heating unit 3 when the unit is assembled into its final state as shown in Figure 4.

The resilient member 10 can have any desired shape and construction, provided that it can be placed between the P.T.C. elements 8 and electrode plate 9 parallel thereto so as to resiliently urge the electrode plate 9 and the P.T.C. elements 8 radially away from each other. A specific form of the resilient member 10 is shown by way of example in Figure 5. This resilient member 10 has a polygonal tubular form corresponding to the form of the inner tube 7, with pressing strips 10a cut out and raised radially inwardly from each flat wall section thereof. In the assembled state, the pressing strips 10a resiliently contact the P.T.C. elements 8 to urge these elements 8 radially inwardly, while the flat outer wall surfaces act reactionally on the flat inner surfaces of the electrode plate 9 to urge the latter radially outwardly.

The tubular heating unit 3 can be assembled quite easily in the following manner. After assembling the outer and inner tubes 6 and 7 together, the electrode plate 9 is placed between these tubes followed by the insertion of the resilient member 10. Then, the P.T.C. elements 8 are placed in a one-by-one fashion at the right positions between the inner tube 7 and the resilient member 10.

The electrode plate 9 used in the illustrated embodiment need not always be in continuous or endless form in the circumferential direction. Namely, the electrode plate 9 may be formed by bending a sheet into polygonal shape such that the opposite ends of the sheet about each other non-fixedly in the circumferential direction. Alternatively, the electrode plate 9 may be composed of two or more bent sheet segments which are assembled together with their adjacent edges abutting each other. The electrode plate 9 having one or more discontinuities in the circumferential direction considerably facilitates the mounting of the electrode plate in the inner tube structure.

It is also possible to construct the electrode plate 9 such that it springs back radially outwardly after mounting in the outer tube 6. With such a construction, it is possible to stabilize the electrode plate 9 after mounting in the outer tube 6 and to ensure a good electric contact between the electrode plate 9 and the outer tube 6.

As explained before, the terminal portion 11 is formed integrally with the electrode plate 9 at a position corresponding to the position of the flange of the outer tube 6. This construction enhances the reliability of electric connection as compared with the known heating device in which the terminals are rivet-caulked to a projection formed on the outer tube 6.

As will be seen from Figures 4 and 6, the terminal portion 11 is constituted by a flat member which is folded back partially to form an air port 12, so that the supply of a small quantity of air, which is necessary for preventing the degradation of the dielectric strength of the P.T.C. elements 8 under hermetic state of use, can be ensured without necessitating the provision of any specific air passage.

As has been described, the first embodiment of the heating device employs an electrode plate 9 having a polygonal tubular shape conforming with that of the inner tube 7 and placed in the space between the outer and inner tubes 6, 7 in contact with the inner surface of the outer tube 6. Consequently, the resilient member 10 can be placed between the parallel surfaces of the electrode plate 9 and the P.T.C. elements 8 to exert a stable and circumferentially uniform resilient force for urging the electrode plate 9 and the P.T.C. elements radially away from each other. Consequently, the P.T.C. elements 8 are held in stable surface contact with the inner surfaces of flat walls of inner tube 7, as well as with the surfaces of flat walls of the electrode plate 9.

Furthermore, the electrode plate 9, which itself exerts a resilient force, cooperates with the resilient member 10 in pressing the P.T.C. elements 8 into contact with the inner tube 7, well absorbing any dimensional or mounting error. The resilient nature of the electrode plate 9 is effective also in eliminating breakdown of the P.T.C. element 8 which may otherwise occur due to any excessive force produced by the resilient member, as well as inferior contact which may result from insufficient force produced by the resilient member. Consequently, various restrictions on the fabrication of the heating device are lessened to permit an eacy and costless production of the heating device. It is to be noted also that the use of the electrode plate 9, which can be lead out directly, can effectively improve the reliability in the electrical connection.

Figure 7 and 8 show a second embodiments of a heating device in accordance with the present invention. Referring first to Figure 7, a caburetor 1 of an internal combustion engine has an air duct 1a which extends substantially vertically, and is connected to an intake manifold 2 in which is formed a mixture intake passage having a cross-sectional area somewhat greater than that of the air duct 1a. A tubular heating unit 103 is received in the open end of the mixture intake passage of the intake manifold 2 adjacent to the carburetor 1. More specifically the tubular heating unit 103 has a flange portion embedded in the heat insulating member 4 which in turn is clamped between a flange of the carburetor 1 and a flange of the intake manifold 2 with gaskets 5 placed at the upper and lower sides thereof.

The tubular heating unit 103 is composed of a flanged outer tube 106 and a metallic flanged polygonal inner tube 107 which are assembled together with an electrically insulating plate 13 place between both flanges, so as to form a double-tube structure. The spaced formed between the outer and inner tubes of the double-tube structure accommodates a plurality of P.T.C. elements 108, an electrode plate 109 and a resilient member 110. An electrically insulating packing 14 mentioned before is disposed at the mixture outlet end of the double-tube structure, between opposing walls of the outer and inner tubes, thereby attaining a hermetic structure of the tubular heating unit 103.

Each of the P.T.C. elements 108 has a flat tubular form with both sides thereof constituting electrodes one of which contacts the associated flat outer surface of the polygonal inner tube 107.

As will be clearly seen from Figure 8, the electrode plate 109 has a polygonal tubular shape conforming with the inner tube 107. In this embodiment, the electrode plate 109 is split vertically into two segments with their opposing edges abutting each other such that its apices make contact with the inner surface of the outer tube 106.

The electrode plate 109 contacts the outer tube 106 to electrically connect the terminals of the P.T.C. elements 108, to the outer tube 106, so that the P.T.C. elements 108 can be supplied with electric power through terminals 106a and 107a which are formed integrally with the outer tube 106 and the inner tube 107, respectively.

The resilient member 110 can have any desired shape and construction, provided that it can be placed between the P.T.C. elements 108 and electrode plate 109 parallel thereto so as to resiliently urge the electrode plate 109 and the P.T.C. elements 108 radially away from each other. The resilient member 110 in this embodiment is split vertically into two segments which, when brought together, provide a polygonal tubular form corresponding to the form of the inner tube 107, with pressing strips 110a cut out and raised radially inwardly from each flat wall section thereof. In the assembled state, the pressing strips 110a resiliently contact the P.T.C. elements 108 to urge these elememts radially inwardly, while the flat outer wall surfaces act reactionally on the flat inner surfaces of the electrode plate 109 to urge the latter radially outwardly.

The tubular heating unit 103 can be assembled quite easily in the following manner. After assembling the outer and inner tubes 106 and 107 together, the electrode plate 109 is placed between these tubes followed by the insertion of the resilient member 110. Then, the P.T.C. elements 108 are placed in a one-by-one fashion at the correct positions between the inner tube 107 and the resilient member 10.

It will be understood that the resilient member 110 and the electrode plate 109 can easily be brought into the outer tube 106 and correctly located in the same, because of the split-type constructions thereof.

Furthermore, since the electrode plate 109 and the resilient member 110 are constructed such that they spring back radially outwardly after mounting in the outer tube 106, it is possible to stabilize the electrode plate 109 after mounting in the outer tube 106 and to ensure a good electric contact between the electrode plate 109, resilient member 110 and the outer tube 106.

It is to be noted also that, in this embodiment, a uniform circumferential distribution of the resilient force is attained by adoption of the split-type construction of the resilient member 110.

As has been described, the second embodiment of the heating device employs an electrode plate 109 having a polygonal tubular shape conforming with that of the inner tube 107 and placed in the space between the outer and inner tubes 106, 107 in contact with the inner surface of the outer tube 106. Consequently, the resilient member 110 can be placed between the parallel surfaces of the electrode plate 109 and the P.T.C. elements 108 to exert a stable and circumferentially uniform resilient force for urging the electrode plate 109 and the P.T.C. elements radially away from each other. Therefore, the P.T.C. elements 108 are held in stable surface contact with the inner surfaces of flat walls of inner tube 107, as well as with the surfaces of flat walls of the electrode plate 109, thereby ensuring a stable and reliable electrical connection.

The second embodiment offers a further advantage in that the resilient member 110 and/or the electrode plate 109 having a split-type structure composed of two segments can easily be fabricated by an ordinary press to permit the use of a simple die, thereby allowing a reduction of the production cost and mass-production of these members to an acceptable dimensional precision.

Although the invention has been described in terms of specific examples, it is to be understood that the described embodiments are only illustrative and that various changes and modifications may be imparted thereto without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A heating device which can be mounted in the mixture intake passage of an internal combustion engine, comprising:

a hermetic double-tube structure having a generally cylindrical outer tube and a substantially polygonal metallic inner tube;

a plurality of thermistor elements having a positive temperature coefficient and placed in the space between said inner tube and outer tube and held in contact with respective flat wall surfaces of said inner tube;

an electrode member having a polygonal tubular shape substantially conforming with that of said inner tube and surrounding said inner tube while making contact with the inner surface of said outer tube; and

a resilient member disposed between said electrode member and said thermistor elements so as to resiliently press said thermistor elements onto the flat wall surfaces of said inner tube while being pressed resiliently by the reaction force against said electrode member.

2. A heating device as claimed in claim 1, in which said electrode member is made of a sheet material bent to a polygonal tubular form with its opposing edges abutting each other, so as to exhibit a radially outward expanding tendency to make resilient contact with said outer tube.

3. A heating device as claimed in claim 1, in which said electrode member is made of a plurality of segments bent from flat sheets and assembled together with their opposing edges abutting each other, so as to exhibit a radially outward expanding tendency for establishing a resilient contact with said outer tube.

4. A heating device as claimed in any one of claims 1 to 3, in which said electrode member is provided with a terminal portion for connection to lead wires, said terminal portion having an air port through which the space between said and outer tubes is communicated with the ambient air.

5. A heating device as claimed in any preceding claim, in which said resilient member has a polygonal cylindrical form contacting the inner surface of said electrode member.

6. A heating device as claimed in claim 5, in which at least one of said resilient member and said electrode member is split vertically into two segments.

7. A heating device which can be mounted in the mixture intake passage of an internal combustion engine, substantially as hereinbefore described with reference to and as illustrated in Figures 1 to 6 or Figures 7 and 8 of the accompanying drawings.

8. An internal combustion engine provided with a heating device as claimed in any preceding claim.

Printed in the UK for HMSO, D8818935, 12/84, 7102.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.