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PLUG MOUNT STRUCTURE OF PULSE COMBUSTION APPARATUS

This invention relates to pulse combustion apparatus in which pulsating explosive combustions occur repeatedly and continuously. A pulse combustion apparatus performs repeatedly explosive combustions in a certain cycle by making use of self-ignition and natural suction of air for combustion at the time of regular combustion, at which combustion heat is used to be applied for cooking devices etc.

One example of a combustion chamber of such pulse combustion apparatus is shown in Fig. 4. A combustion chamber 1 in which explosive combustions are carried on is generally formed and sectioned by a wall 3 having a curved face of snail's, cylindrical shape etc. with a fundamental curvature owing to the characterization of combustion and so on. An ignition plug 10 is set and inserted into the curved wall 3 spirally by the screw part 13. Also, 7 denotes a tail pipe for the discharge of combustion exhaust.

As the temperature inside the combustion chamber 1 of such pulse combustion apparatus becomes, however, very high, the edge (L-shape part shown by the broken line) of the ground electrode 12 on the ignition plug 10 often becomes burnt away or damaged as shown in Fig. 4. By this reason, life span of the ignition plug 10 becomes short.

From this point, the present inventors thought it is possible to protect the ground electrode 12 if the same ground electrode 12 would be positioned near the combustion chamber wall 3, when a test result suggested a fact that temperature distribution inside the combustion chamber 1 becomes lower towards the wall 3 of the combustion chamber.

An object of the present invention is to provide a pulse combustion



apparatus in which the above problem may be resolved to extend life span of the ignition plug by a new plug mount structure for reducing heating of the ground electrode according to the above idea.

This invention is summarized as that an ignition plug mount structure of a pulse combustion apparatus, a combustion chamber wall of which is screwed into an ignition plug whose sparks start pulsating explosive combustions, which is characterized in that a ground electrode which is positioned at the side of the top of an ignition plug is set near an inner wall face of the combustion chamber by using a spacer, which decides the inserting position of the ignition plug with the selected thickness.

According to the above mount structure of the ignition plug in the pulse combustion apparatus according to the invention, the ground electrode may be positioned at a point near the inner wall of a combustion chamber by way of selecting the thickness of a spacer. That is, the prior art positions an ignition plug randomly, because there is inaccuracy in the screw-cut part of the ignition plug, the plug inserting hole in a combustion chamber and the like, or tightening torque or so on.

When a spacer is selectively used, the ground electrode may be set near the inner wall face of a combustion chamber. Therefore, temperature distribution becomes lower towards the wall of the combustion chamber, and temperature of the ground electrode becomes low so that heat collapse and undesirable effects may be lightened.

In order to clarify further the composition and function of this invention explained in the above, a suitable practical example for the ignition plug mount structure of the pulse combustion apparatus is explained below.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional front-view of a combustion chamber used in a pulse combustion apparatus as a practical example;

Fig. 2 is a schematic cross-sectional side-view of this example;

Fig. 3 is a graph of temperature characteristics at the ground electrode; and

Fig. 4 is a schematic cross-sectional front-view of the combustion chamber in a pulse combustion apparatus of a prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Fig. 1, the combustion chamber 1 is a chamber where air/fuel mixture supplied from a mixing chamber (not shown) is drawn in and at a certain cycle explosive combustions are repeated, and this chamber is formed like a snail shell with cavity of almost circular cross section with a fundamental curvature in this practical example. The entrance 2 of the combustion chamber, connected with the mixing chamber (not shown in the figure), is formed tangentially to the combustion chamber 1 in order to take in mixture well and also to prevent backfiring.

In the wall 3 defining this combustion chamber 1, a screw bore 4 for installing an ignition plug (hereinafter called plug fitting hole 4) and a screw bore 5 for fixing a flame rod are provided therewith, and an ignition plug 10 and a flame rod 20 are respectively set and inserted in the bores by screwing.

The ignition plug 10 has a central electrode 11 provided at the center of the top, a ground electrode 12 bent in the form of an L provided at the side of the central electrode, a cylindrical screw

part 13 provided on the central body thereof, and an annular stop or collar 14 with diameter larger than that of the screw part 13 provided at the end of the same screw part 13, according to a general firing device. In the conventional device, the ignition plug 10 had the screw part 13 instantly screwed into the plug fitting hole 4 formed in the combustion chamber 1. Screwing was done with use of necessary torque until the stop 14 is stopped and engaged with a peripheral outer-wall of the combustion chamber surrounding the plug fitting hole 4 (hereinafter called contact face 6). Compared with this, a spacer 30 in a ring form is inserted over the screw part 13, according to this invention. Consequently, there is a state in which the spacer 30 is set between the stop 14 and the contact face 6 of the combustion chamber 1 when the plug is screwed therein.

Four sizes, in thickness, of the spacer 30 are available in this example, which are respectively different by $1/4$ pitch in respect of the pitch of the screw part 13. In series, the four sizes are H , $H + P/4$, $H + P/2$, and $H + 3P/4$, when thickness of the thinnest spacer 30 is H and P is length of one pitch. Accordingly, the ignition plug 10 can be stopped and positioned with $1/4$ pitch difference subject to the thickness of the spacer 30.

Fig. 3 now suggests relation between temperature and position of the ground electrode 12. Data in Fig. 3 have been obtained by experiment, which presents rotating angle of the inserted ignition plug 10 in the horizontal axis and temperature of the ground electrode 12 in the vertical axis. From the figure, the temperature of the ground electrode 12 changes about 100°C in response to the rotating angle, that is, the position of the inserted ignition plug 10. From the data, as the ground electrode 12 becomes nearer the center of combustion



chamber 1 (point A in Fig. 3), the temperature becomes higher. In contrast, nearer the inner wall face of combustion chamber 1 (point B in Fig. 3), the temperature of ground electrode becomes lower. In other words, when the position of ground electrode 12 is nearest to the inner face of wall 3 in the combustion chamber 1 as shown (I) in Fig. 2, the temperature becomes lower by about 100°C than when the ground electrode 12 faces the center of combustion chamber 1 as shown (II) in Fig. 2.

From the above, the practical example uses to set one of the spacers (4 sizes) by which the ground electrode 12 is positioned nearest to the inner wall face of the combustion chamber 1. The ground electrode 12 can be set to face the inner wall face of the combustion chamber 1, in spite of any tolerance with which the ignition plug 10 and the plug fitting hole 14 of the combustion chamber 1 are respectively screw-cut.

Therefore, temperature of the ground electrode is always controlled at low, so that life span of the ignition plug 10 may be extended with effect of lightening heat stress on the ground electrode 12 subject to combustion heat. The temperature can be reduced to 750°C, further to 700°C, by controlling the direction of the ground electrode 12 towards the wall face of combustion chamber 1, but the temperature reached 900°C at the ground electrode in the prior art.

It is to be noted that the axis of the spark plug body is oblique to internal surface of the peripheral wall 3, so that mere rotation of the plug (10) alters the distance between the ground electrode 12 and the wall 3.

This invention is not limited by the practical example described above. For example, although the spacer 30 is available in four sizes



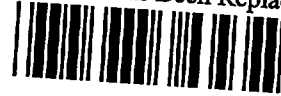
having thicknesses differing by 1/4 pitch, the number of sizes may be increased, so that the ground electrode 12 can be more accurately brought near the inner wall face, or otherwise reduced, to be simplified.

From the above, it will be appreciated that the temperature can be lowered at the ground electrode of the ignition plug, according to the ignition plug mount structure, and the life span of the ignition plug can be extended by lightening the heat load on the ground electrode.

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1. Pulse combustion apparatus comprising a combustion chamber defined by a peripheral wall (3) having a screwthreaded bore (4) accommodating a spark plug (10) for initiating pulsating explosive combustions in the combustion chamber, the plug (10) including a body which is screwed in the bore (4), a stop (14) which faces a contact face (6) provided on the wall (3), and a ground electrode (12) which is exposed in the combustion chamber, characterised in that a selectable spacer (30) is inserted between the stop (14) and the contact face (6) and determines the position of the ground electrode (12) in relation to the wall (3).

2. Apparatus as claimed in claim 1, in which the stop (14) is annular and the spacer(30) is in the form of a ring.

3. Apparatus as claimed in claim 1 or 2, in which the axis of the body of the plug (10) is oblique to the internal surface of the wall (3).

4. Apparatus as claimed in any preceding claim, in which the spacer (30) is selected from a series of spacers differing in thickness by a fraction of the axial pitch of the screwthreaded bore (4).

5. Apparatus as claimed in any preceding claim, in which the combustion chamber has an inlet (2) which is substantially tangential to the internal surface of the peripheral wall (3), the inlet (2) and



the bore (4) being arranged side-by-side and substantially parallel to each other.



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ABSTRACT

PLUG MOUNT STRUCTURE OF PULSE COMBUSTION APPARATUS

A spark plug (10) screwed into the wall (3) of the combustion chamber has a selectable spacer (30) interposed between a stop (14) and a contact face (6) to set the position of the plug (10) so that the ground electrode (12) can be arranged as close as possible to the wall (3), thereby reducing the temperature at the electrode (12) from the conventional level of 900°C, by as much as 100 to 200°C.

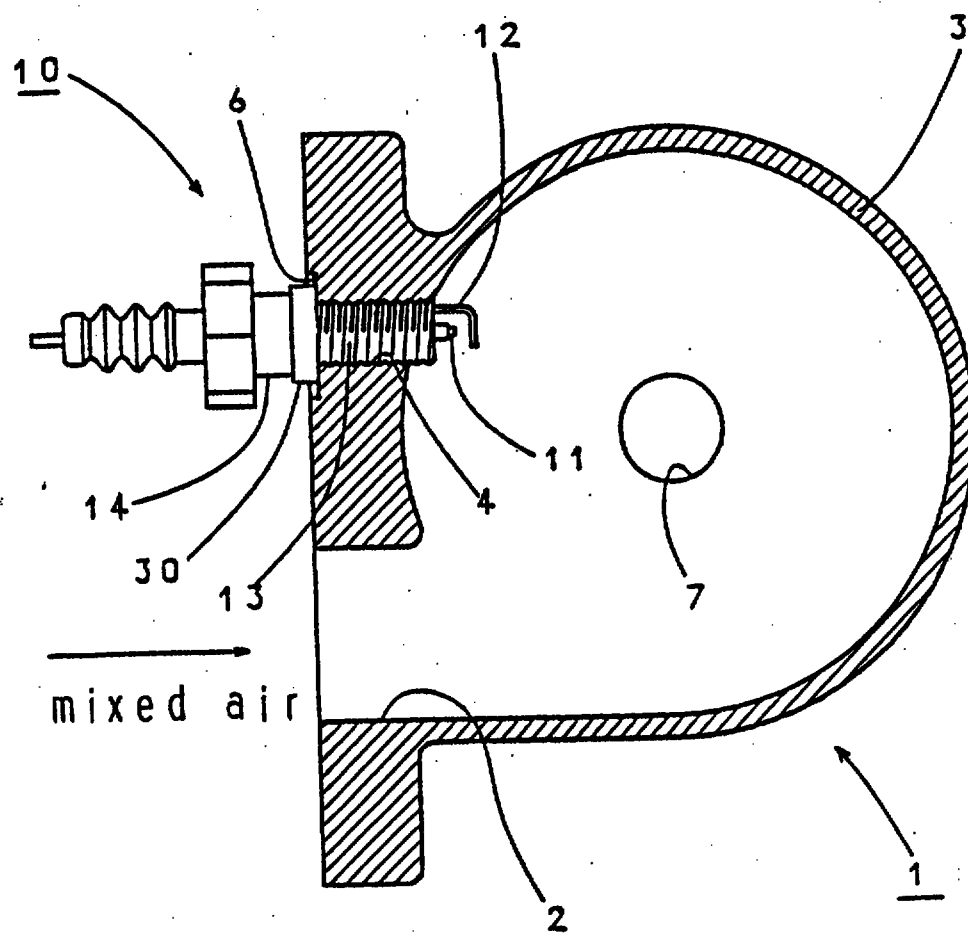
(Fig. 1)

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Fig. 1



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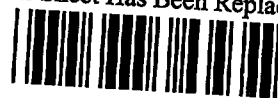
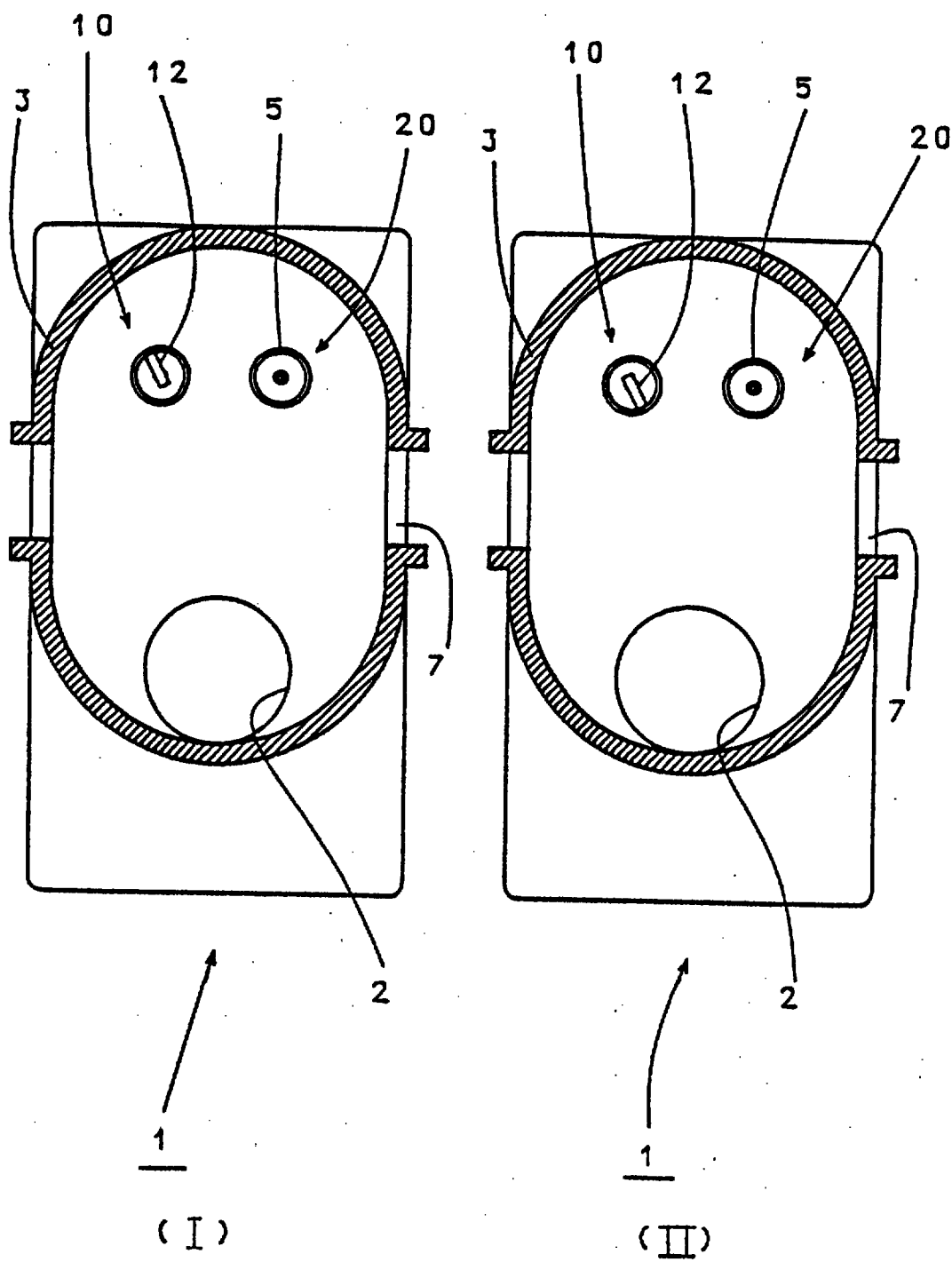
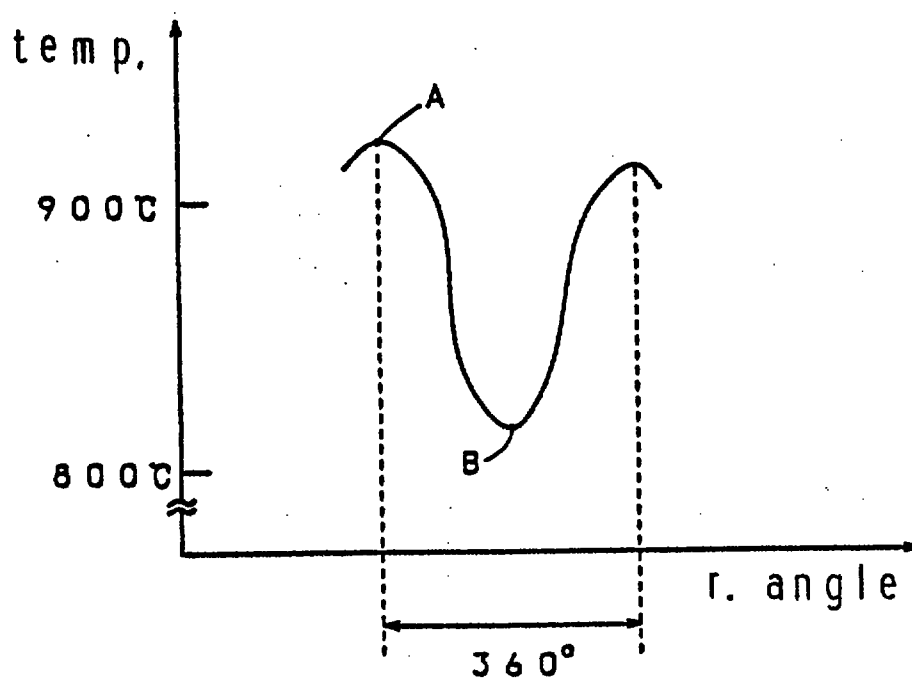


Fig. 2



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Fig. 3

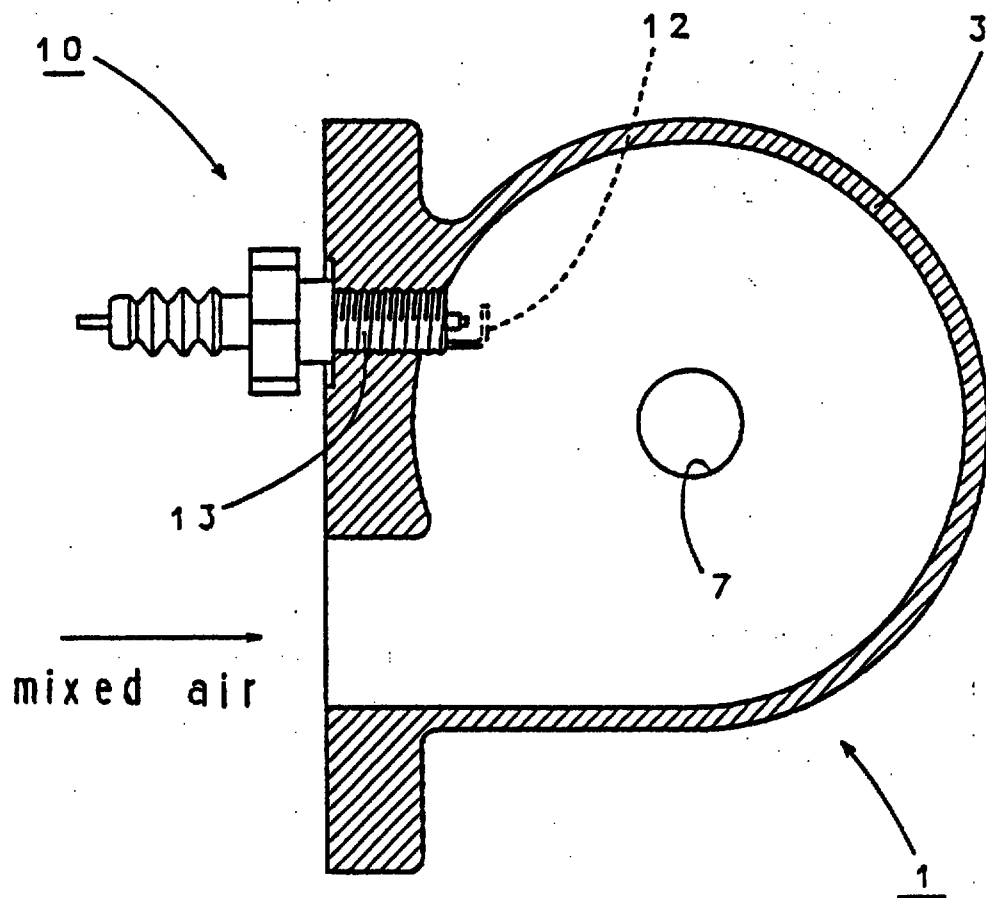


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Fig. 4



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PLUG MOUNT STRUCTURE OF PULSE COMBUSTION APPARATUS

Description

This invention relates to pulse combustion apparatus in which pulsating explosive combustions occur repeatedly and continuously. A pulse combustion apparatus performs repeatedly explosive combustions in a certain cycle by making use of self-ignition and natural suction of air for combustion at the time of regular combustion, at which combustion heat is used to be applied for cooking device etc.

US-A-5 044 928 discloses a pulse combustion apparatus in accordance with the pre-characterising part of claim 1.

A further development of such a pulse combustion apparatus is shown in Figure 4 of the accompanying drawings. A combustion chamber 1 in which explosive combustions are carried on is generally defined by a wall 3 having a curved face of snail's, cylindrical shape etc. with a fundamental curvature owing to the characterization of combustion and so on. An ignition plug 10 is set and inserted into the curved wall 3 spirally by a screw part 13. Also, 7 denotes a tail pipe for the discharge of combustion exhaust.

As the temperature inside the combustion chamber 1 of such pulse combustion apparatus becomes, however, very high, the edge (L-shape part shown by the broken line) of the ground electrode 12 on the ignition plug 10 often becomes burnt away or damaged as shown in Fig. 4. By this reason, life span of the ignition plug 10 becomes short.

From this point, the present inventors thought it is possible to protect the ground electrode 12 if the same ground electrode 12 would be positioned near the combustion chamber wall 3, when a test result suggested a fact that temperature distribution inside the combustion chamber 1 becomes lower towards the wall 3 of the combustion chamber.

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An object of the present invention is to provide a pulse combustion apparatus in which the above problem may be resolved to extend life span of the ignition plug by a new plug mount structure for reducing heating of the ground electrode according to the above idea.

Accordingly, the present invention provides pulse combustion apparatus comprising a combustion chamber defined by a peripheral wall having a curved internal surface, the wall having a screwthreaded bore accommodating a spark plug for initiating pulsating explosive combustions in the combustion chamber, the plug including a body which is screwed in the bore, a stop which faces a contact face provided on the wall, and a ground electrode which is exposed in the combustion chamber, characterised in that the axis of the body of the plug is oblique to the internal surface of the wall, a selectable spacer is inserted between the stop and the contact face and determines the position of the ground electrode in relation to the wall.

According to the above mount structure of the ignition plug in the pulse combustion apparatus according to the invention, the ground electrode may be positioned at a point near the inner wall of a combustion chamber by way of selecting the thickness of a spacer. That is, the prior art positions an ignition plug randomly, because there is inaccuracy in the screw-cut part of the ignition plug, the plug inserting hole in a combustion chamber and the like, or tightening torque or so on.

When a spacer is selectively used, the ground electrode may be set near the inner wall face of a combustion chamber. Therefore, temperature distribution becomes lower towards the wall of the combustion chamber, and temperature of the ground electrode becomes low so that heat collapse and undesirable effects may be lightened.

In order to clarify further the composition and function of this invention explained in the above, a suitable practical example for the ignition plug mount structure of the pulse combustion apparatus is explained below.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic cross-sectional front-view of a combustion chamber used in a pulse combustion apparatus as a practical example;

Fig. 2 is a schematic cross-sectional side-view of this example;

Fig. 3 is a graph of temperature characteristics at the ground electrode; and

Fig. 4 is a schematic cross-sectional front-view of the combustion chamber in a pulse combustion apparatus of a prior art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In Fig. 1, the combustion chamber 1 is a chamber where air/fuel mixture supplied from a mixing chamber (not shown) is drawn in and at a certain cycle explosive combustions are repeated, and this chamber is formed like a snail shell with a cavity of almost circular cross section with a fundamental curvature in this practical example. The entrance 2 of the combustion chamber, connected with the mixing chamber (not shown in the figure), is formed tangentially to the combustion chamber 1 in order to take in mixture well and also to prevent backfiring.

In the wall 3 defining this combustion chamber 1, a screw bore 4 for installing an ignition plug (hereinafter called plug fitting hole 4) and a screw bore 5 for fixing a flame rod are provided therewith, and an ignition plug 10 and a flame rod 20 are respectively set and inserted in the bores by screwing.

The ignition plug 10 has a central electrode 11 provided at the center of the top, a ground electrode 12 bent in the form of an L provided at the side of the central electrode, a cylindrical screw part 13 provided on the central body thereof, and an annular stop or collar 14 with diameter larger than that of the screw part 13 provided at the end of the same screw part 13, according to

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a general firing device. In the conventional device, the ignition plug 10 had the screw part 13 instantly screwed into the plug fitting hole 4 formed in the combustion chamber 1. Screwing was done with use of necessary torque until the stop 14 is stopped and engaged with a peripheral outer-wall of the combustion chamber surrounding the plug fitting hole 4 (hereinafter called contact face 6). Compared with this, a spacer 30 in a ring form is inserted over the screw part 13, according to this invention. Consequently, there is a state in which the spacer 30 is set between the stop 14 and the contact face 6 of the combustion chamber 1 when the plug is screwed therein. Four sizes, in thickness, of the spacer 30 are available in this example, which are respectively different by $1/4$ pitch in respect of the pitch of the screw part 13. In series, the four sizes are H , $H + P/4$, $H + P/2$, and $H + 3P/4$, when thickness of the thinnest spacer 30 is H and P is length of one pitch. Accordingly, the ignition plug 10 can be stopped and positioned with $1/4$ pitch difference subject to the thickness of the spacer 30.

Fig. 3 now suggests relation between temperature and position of the ground electrode 12. Data in Fig. 3 have been obtained by experiment, which presents rotating angle of the inserted ignition plug 10 in the horizontal axis and temperature of the ground electrode 12 in the vertical axis. From the figure, the temperature of the ground electrode 12 changes about 100°C in response to the rotating angle, that is, the position of the inserted ignition plug 10. From the data, as the ground electrode 12 becomes nearer the center of combustion chamber 1 (point A in Fig. 3), the temperature becomes higher. In contrast, nearer the inner wall face of combustion chamber 1 (point B in Fig. 3), the temperature of ground electrode becomes lower. In other words, when the position of ground electrode 12 is nearest to the inner face of wall 3 in the combustion chamber 1 as shown (I) in Fig. 2, the temperature becomes lower by about 100°C than when the ground electrode 12 faces the center of combustion chamber 1 as shown (II) in Fig. 2.

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From the above, the practical example uses to set one of the spacers (4 sizes) by which the ground electrode 12 is positioned nearest to the inner wall face of the combustion chamber 1. The ground electrode 12 can be set to face the inner wall face of the combustion chamber 1, in spite of any tolerance with which the ignition plug 10 and the plug fitting hole 14 of the combustion chamber 1 are respectively screw-cut.

Therefore, temperature of the ground electrode is always controlled at low, so that life span of the ignition plug 10 may be extended with effect of lightening heat stress on the ground electrode 12 subject to combustion heat. The temperature can be reduced to 750°C, further to 700°C, by controlling the direction of the ground electrode 12 towards the wall face of combustion chamber 1, but the temperature reached 900°C at the ground electrode in the prior art.

It is to be noted that the axis of the spark plug body is oblique to internal surface of the peripheral wall 3, so that mere rotation of the plug (10) alters the distance between the ground electrode 12 and the wall 3.

Although the spacer 30 is available in four sizes having thicknesses differing by 1/4 pitch, the number of sizes may be increased, so that the ground electrode 12 can be more accurately brought near the inner wall face, or otherwise reduced, to be simplified.

From the above, it will be appreciated that the temperature can be lowered at the ground electrode of the ignition plug, according to the ignition plug mount structure, and the life span of the ignition plug can be extended by lightening the heat load on the ground electrode.



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REPLACEMENT SHEET

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CLAIMS

1. Pulse combustion apparatus comprising a combustion chamber defined by a peripheral wall (3) having a curved internal surface, the wall (3) having a screwthreaded bore (4) accommodating a spark plug (10) for initiating pulsating explosive combustions in the combustion chamber, the plug (10) including a body which is screwed in the bore (4), a stop (14) which faces a contact face (6) provided on the wall (3), and a ground electrode (12) which is exposed in the combustion chamber, characterised in that the axis of the body of the plug (10) is oblique to the internal surface of the wall (3), a selectable spacer (30) is inserted between the stop (14) and the contact face (6) and determines the position of the ground electrode (12) in relation to the wall (3).
2. Apparatus as claimed in claim 1, in which the stop (14) is annular and the spacer (30) is in the form of a ring.
3. Apparatus as claimed in claim 1 or 2, in which the spacer (30) is selected from a series of spacers differing in thickness by a fraction of the axial pitch of the screwthreaded bore (4).
4. Apparatus as claimed in any preceding claim, in which the combustion chamber has an inlet (2) which is substantially tangential to the internal surface of the peripheral wall (3), the inlet (2) and the bore (4) being arranged side-by-side and substantially parallel to each other.

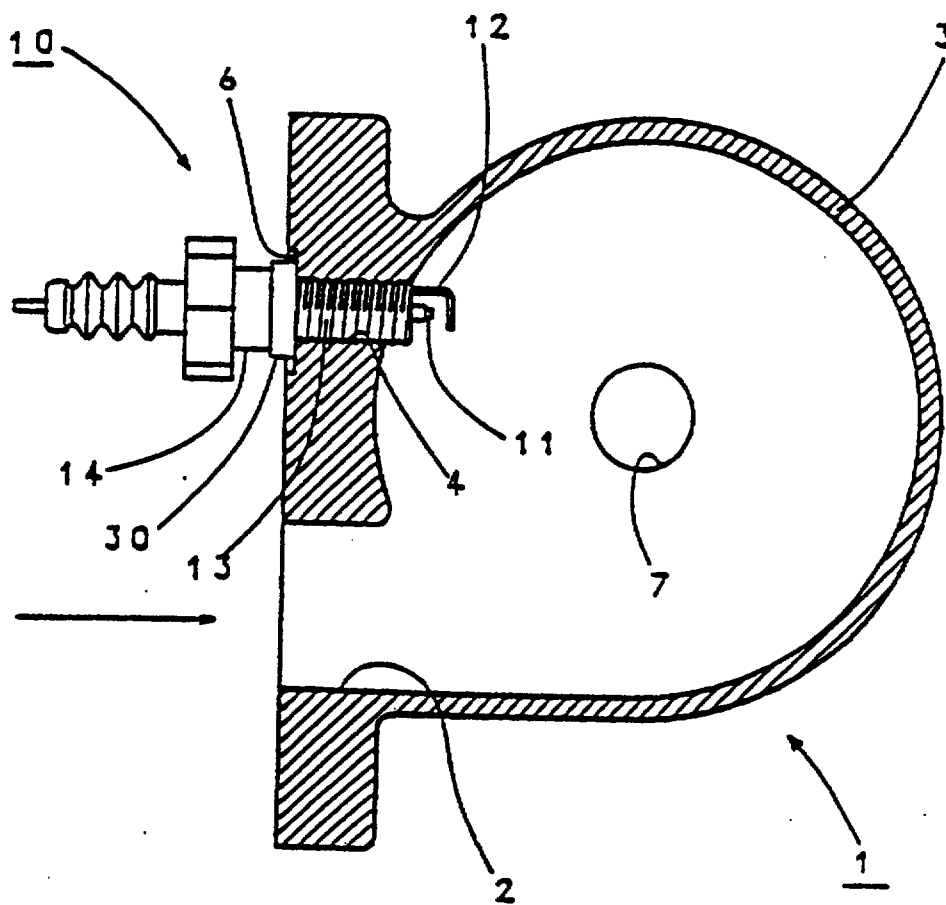
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Fig. 1



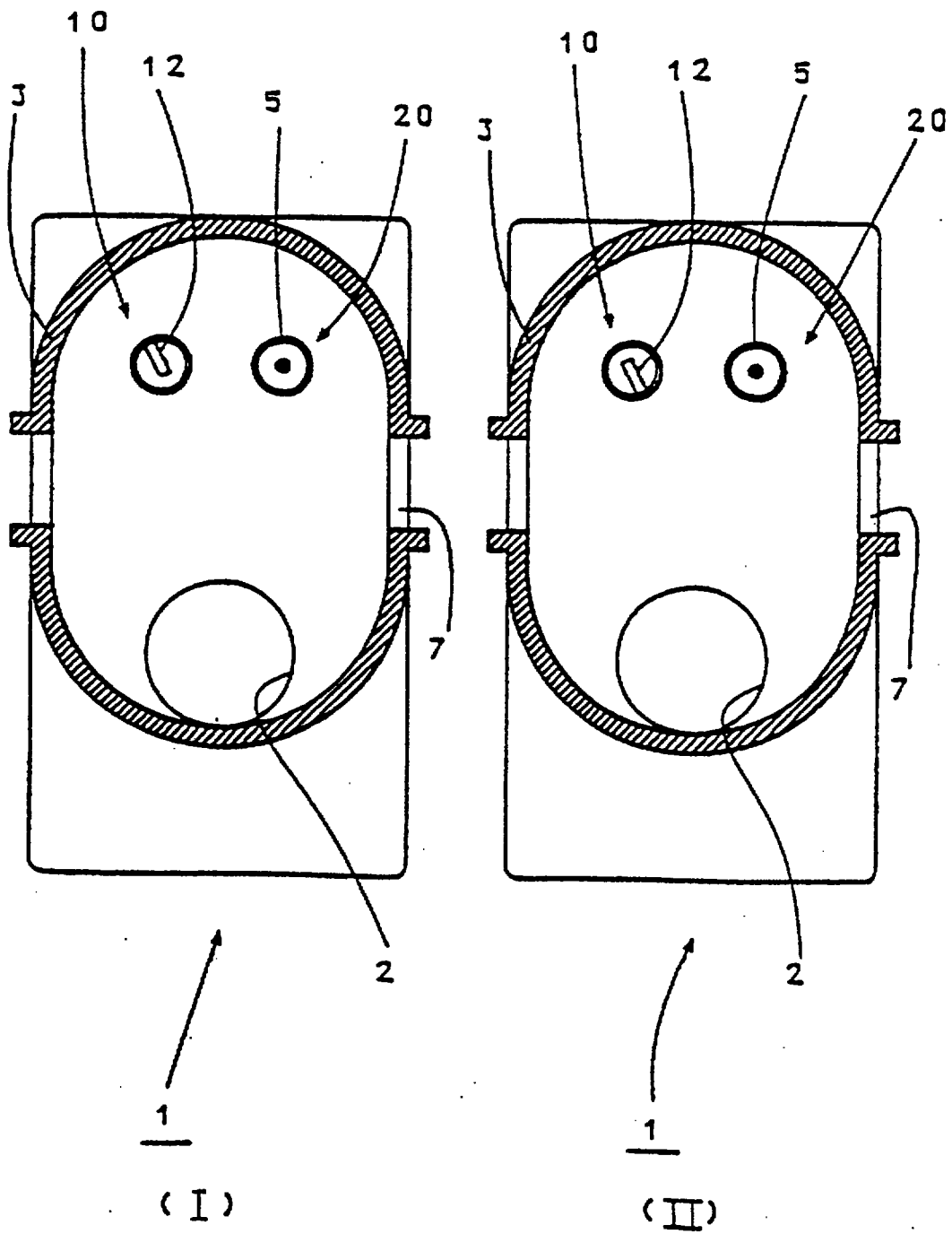
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Fig. 2



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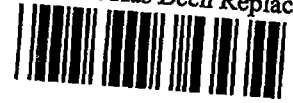
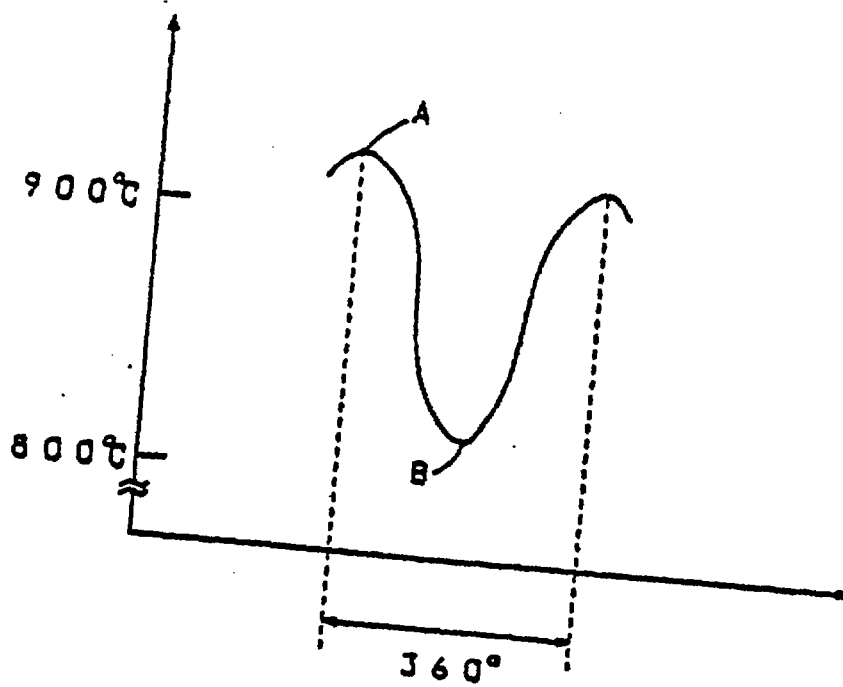


Fig. 3



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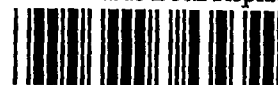
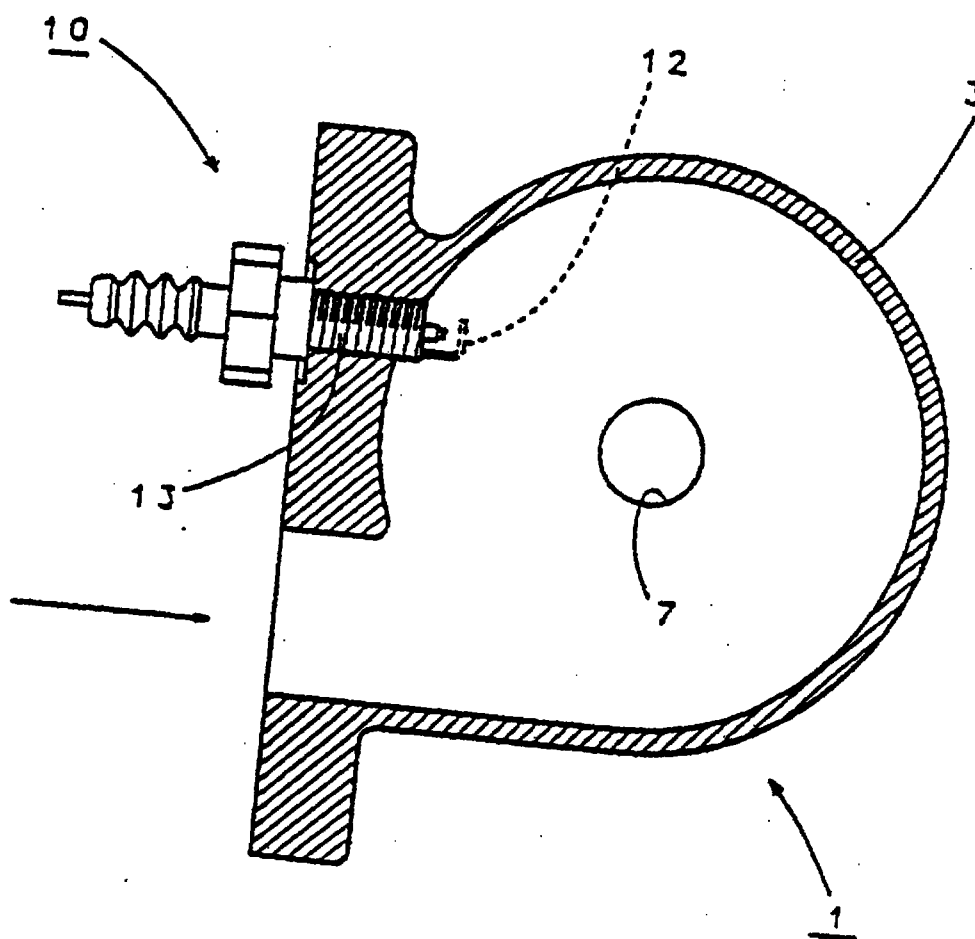


Fig. 4



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ABSTRACT

PLUG MOUNT STRUCTURE OF PULSE COMBUSTION APPARATUS

A spark plug (10) screwed into the wall (3) of the combustion chamber has a selectable spacer (30) interposed between a stop (14) and a contact face (6) to set the position of the plug (10) so that the ground electrode (12) can be arranged as close as possible to the wall (3), thereby reducing the temperature at the electrode (12) from the conventional level of 900°C, by as much as 100 to 200°C.

(Fig. 1)

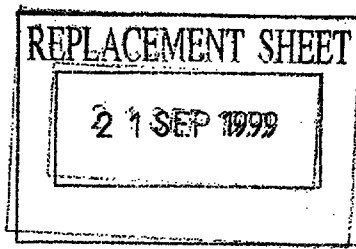


Fig. 1

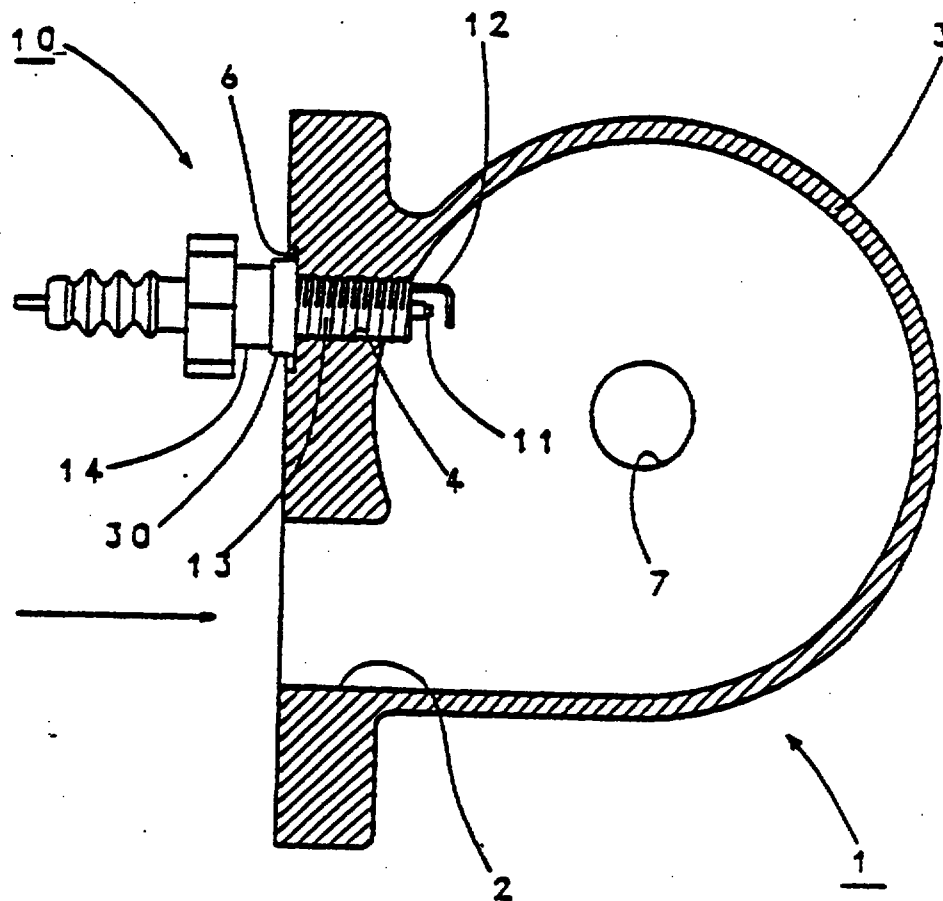
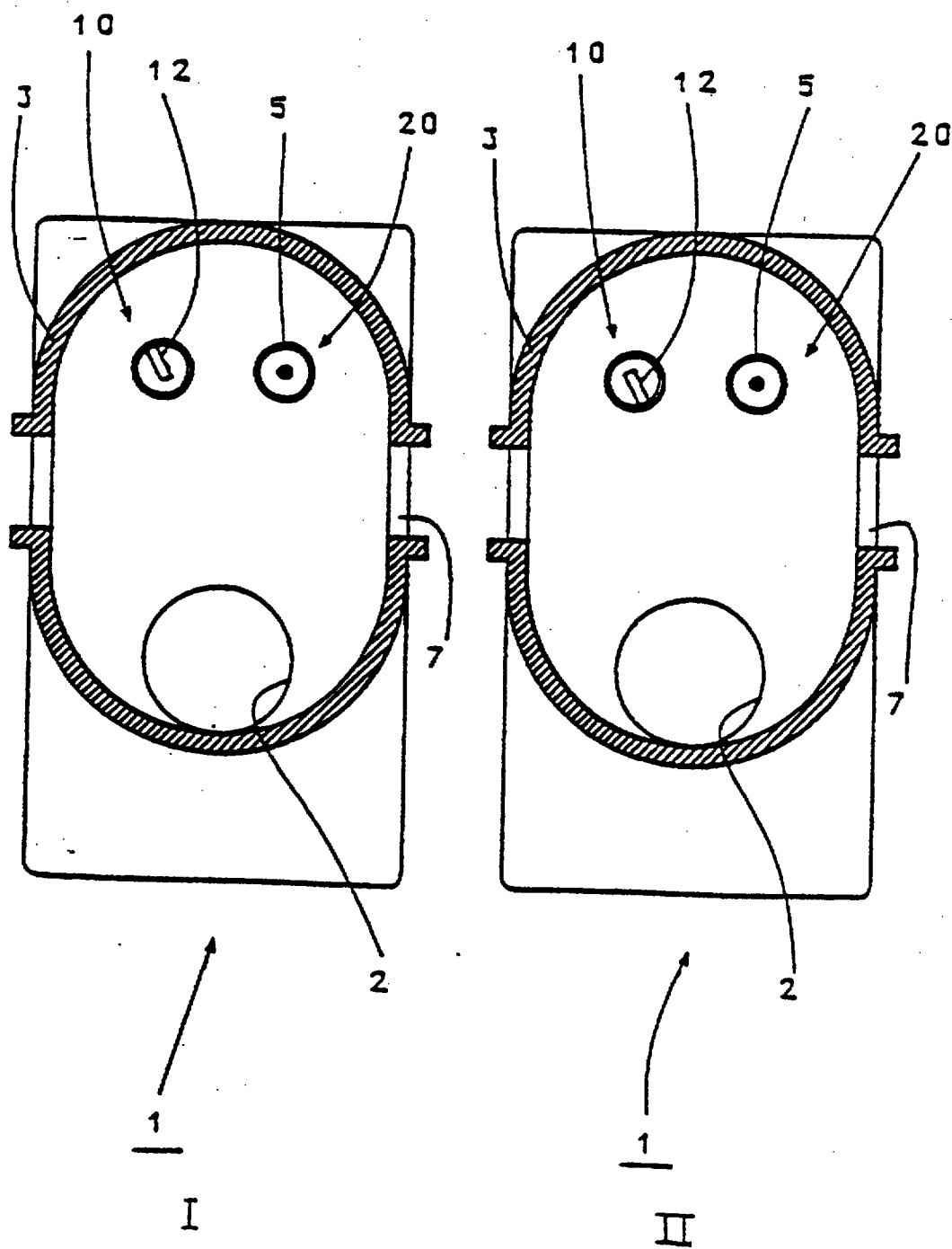


Fig. 2



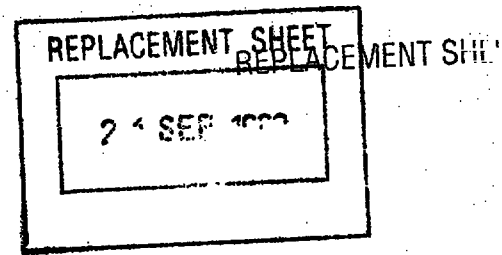


Fig. 3

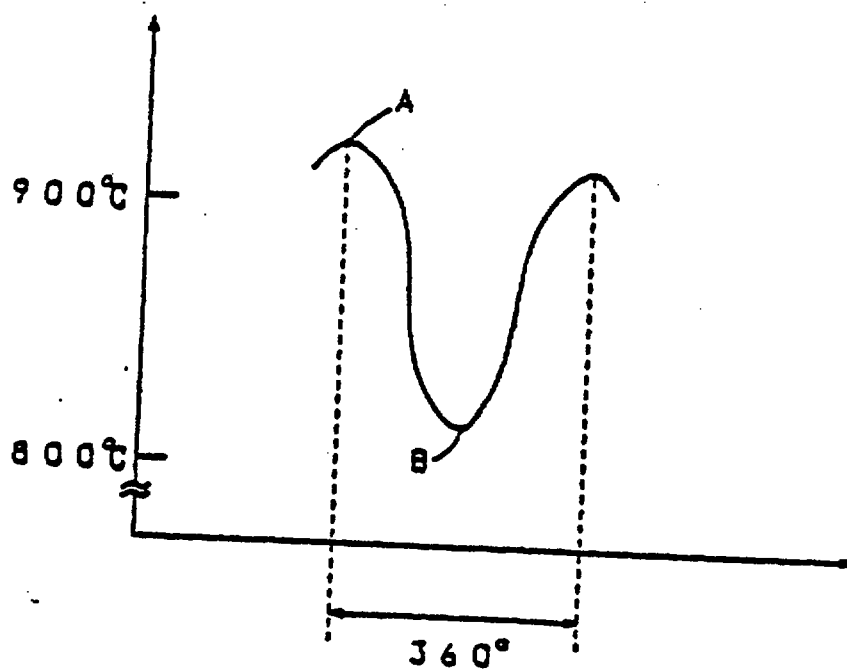


Fig. 4

