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(54) IMPROVEMENTS IN OR RELATING TO 2-STROKE INTERNAL COMBUSTION ENGINES

(71) We, TOYOTA JIDOSHA KOGYO KABUSHIKI KAISHA and SIGERU ONISHI, a Company organised and existing under the laws of Japan of 1, Toyota-cho, Toyota-shi, Aichi-ken, Japan and a citizen of Japan residing at 31—12, Higashiyama 3-chome, Kanazawa-shi, Ishikawa-ken, Japan, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

DESCRIPTION OF THE INVENTION.

The present invention relates to a method of firing a 2-stroke engine and to a 2-stroke engine in which said method is used.

With regard to a 2-stroke engine, it has been known that self ignition of the fresh combustible mixture can be caused in the combustion chamber of an engine without the fresh combustible mixture being ignited by the spark plug. The combustion caused by the above-mentioned self ignition is conventionally called an extraordinary combustion or a run on. When the engine is operating at a high speed under a light load, wherein the above-mentioned extraordinary combustion is caused, the amount of residual exhaust gas remaining in the cylinder of the engine is much larger than that of the fresh combustible mixture fed into the cylinder. Therefore, the fresh combustible mixture fed into the cylinder is heated until it is reformed by the residual exhaust gas, which has a high temperature, and as a result, the fresh combustible mixture produces radicals. An atmosphere wherein radicals are produced as mentioned above is hereinafter called an active thermoatmosphere. However, when an extraordinary combustion is caused, the active thermoatmosphere is extinguished at the beginning of the compression stroke, and a hot spot ignition, a mis-fire and a detonation caused by a spark plug are alternatively repeated, thus, causing a great fluctuation of torque. Since the extraordinary combustion has drawbacks in that a great fluctuation of torque occurs as mentioned above, such an extraordinary combustion is conventionally considered an undesirable combustion.

The inventor conducted research on extraordinary combustion and, as a result, has proven that, if the active thermoatmosphere which is caused in the extraordinary combustion at the beginning of the compression stroke can continue to be maintained until the end of the compression stroke, self ignition of the active thermoatmosphere is caused in the combustion chamber of an engine without the active thermoatmosphere being ignited by the spark plug and, then, the active thermoatmosphere combustion takes place. In addition, the inventor has further proven that this active thermoatmosphere combustion results in quiet engine operation and can be caused even if a lean air-fuel mixture is used. This results in a considerable improvement in fuel consumption and a considerable reduction in the amount of harmful components in the exhaust gas. An example of a 2-stroke engine capable of causing such an active thermoatmosphere is disclosed in the Japanese Patent Application No. 52—94133, filed by the same inventor.

An object of the present invention is to provide the improvements to the 2-stroke engine disclosed in the above mentioned Japanese Patent Application, and particularly to provide a combustion method and a 2-stroke engine which is suited to be operated under a partial load for a long time.

According to a first aspect of the present invention, there is provided a method of firing a 2-stroke internal combustion engine having a crank case, a combustion chamber and a combustible mixture supply passage providing communication between the interior of the crank case and the combustion chamber, the method comprising introducing a fresh combustible mixture into the crank case,

introducing the fresh combustible mixture in the crank case into said supply passage

causing the mixture to flow at a first relatively high speed in a first section of said supply passage of promoting vaporisation of liquid fuel contained in the combustible mixture,

causing the mixture to flow at a second relatively low speed in a second section of said supply passage,

introducing the combustible mixture from said supply passage into the combustion chamber without causing substantial turbulenc and flow of burned gas remaining in the combustion chamber thereby preventing dissipation of the heat of said burned gas

allowing the burned gas to heat combustible mixture introduced into the combustion chamber and thereby reform the mixture to produce radicals,

maintaining the reformed atmosphere until the end of the compression stroke, and

permitting self ignition of the atmosphere within the chamber thereby firing the engine.

According to a second aspect of the present invention, there is provided a 2-stroke internal combustion comprising

a cylinder having a cylinder bore,

a piston reciprocably movable in the bore, said piston and cylinder together defining a combustion chamber,

a crank case,

a fuel intake passage associated with mixture forming means for introducing a fresh combustible mixture into said crank case,

a combustible mixture supply passage for supplying combustible mixture from the interior of the crank case to the combustion chamber, said combustible mixture supply passage having successive first and second sections in the direction of supply of combustible mixture from the crank case to the combustion chamber, said first section being adapted for the supply therealong of combustible mixture at a relatively high speed to promote vaporisation of liquid fuel in the combustible mixture, and said second section being adapted for the supply therealong of combustible mixture at a second relatively low speed and communicating with a part opening into said chamber such that, in use of the engine combustible mixture may be supplied into said chamber without causing substantial turbulence and flow of burned gas in said chamber, and

an exhaust passage having an exhaust part opening into said combustion chamber for discharging exhaust gas to the atmosphere.

The present invention will be further described by way of example only with reference to the accompanying drawings, in which

Fig. 1 is a cross-sectional view of a first embodiment of a 2-cycle engine according to the present invention;

Fig. 2 is a cross-sectional side view of the engine shown in Fig. 1;

Fig. 3 is a plan view of a crank case;

Fig. 4 is a front view of the crank case part 1a;

Fig. 5 is a front view of the crank case part 1b;

Fig. 6 is a cross-sectional view taken along the line VI—VI in Fig. 4;

Fig. 7 is a perspective view of the bottom of the interior of the crank case;

Fig. 8 is a cross-sectional view taken along the line VIII—VIII in Fig. 7;

Fig. 9 is a cross-sectional view of another embodiment according to the present invention;

Fig. 10 is a cross-sectional side view of the engine shown in Fig. 9;

Fig. 11 is a plan view of the crank case shown in Fig. 9;

Fig. 12 is a front view of the crank case part 1a shown in Fig. 9;

Fig. 13 is a cross-sectional side view of a further embodiment according to the present invention;

Fig. 14 is a graph showing the relationship of the opening degree between the throttle valve and the exhaust control valve, and;

Fig. 15 is a cross-sectional side view of a still further embodiment according to the present invention.

Referring to Figs. 1 and 2, 1 designates a crank case, 2 a cylinder block fixed onto the crank case, 3 a cylinder head fixed onto the cylinder block 2, 4 a piston having an approximately flat top face and reciprocally moving in a cylinder bore 5 formed in the cylinder block 2 and 6 a combustion chamber formed between the cylinder head 3 and the piston 4; 7 designates a spark plug, 8 a chamber formed in the crank case 1 and 9 a balance weight; 10 designates a connecting rod, 11 an intake pipe, 12 an intake passage and 13 a carburetor; 14 designates a throttle valve of the carburetor 13, 15 a pair of inlet ports, 16 an exhaust port; 17 designates an exhaust pipe, 18 an exhaust passage and 19 a reed valve which permits the inflow of a fresh combustible mixture into the chamber 8 from the intake passage 12. The embodiment shown in Figs. 1 and 2 shows a Schnürle type 2-stroke engine having an effective compression ratio of 6.5 : 1. As is shown in Fig. 2, the crank case 1 comprises three crank case parts 1a, 1b and 1c. A pair of passages 20, each of which opens into the combustion chamber 6 at the inlet port 15, is formed in the cylinder block 1, and the passages 20 are connected to corresponding passages 21, each of which is formed on the upper portion of the crank case 1 aligned with the respective passage 20. The passage consisting of the passages 20 and 21 is hereinafter referred to as a second passage and constitutes a second section of a combustible mixture supply passage which is hereinafter referred to as the second supply section passage.

Fig. 4 shows the inner wall of the crank case part 1a, and Fig. 5 shows the inner wall of the crank case part 1c. Referring to Figs. 4 and 5, a pair of grooves 22a and 22b is formed on the inner wall of the crank case part 1a, 1c and arranged to extend along the circular periphery thereof. A shallow annular groove 23 having a fixed width L is formed on the inner wall of the crank case part 1a, 1c at a position located inward of the grooves 22a and 22b and, in addition, a groove 24 extending along the annular groove 23 is formed on the central portion of the bottom face of the annular groove 23. In Figs. 4 and 5, the broken line K indicates the outer contour of the crank chamber 8. Consequently, when the crank case parts 1a, 1b and 1c are assembled to form the crank case 1, all of the grooves 22a, 23b, 23 and 24 are positioned between the crank case part 1b and the crank case part 1a, 1c. As is shown in Figs. 4 and 5, the grooves 22a and 22b are joined with each other at the lowest portion 25 thereof. One end 26 of the groove 24 is in communication with the lowest portion 25 of the grooves 22a and 22b *via* a vertical short groove 27, while the other end 28 of the groove 24 is connected to a vertical short groove 29, the top of which opens into the crank chamber 8. An annular plate 30 (Fig. 6) is fitted into the annular groove 23 so that the groove 24 is covered by the annular plate 30.

Fig. 6 shows a cross-sectional view taken along the line VI—VI in Fig. 4 in the case wherein the crank case parts 1a and 1b are assembled. From Figs. 4 and 6 it will be understood that, when the crank case parts 1a, 1b and 1c are assembled, to form the crank case 1, each of the grooves 22a, 22b, 24, 27 and 29 froms a passage. As is shown in Fig. 7, a groove 31 is formed on the inner wall of the crank case part 1b, which defines the bottom of the crank chamber 8, and the top 32 of the vertical short groove 29 opens into the end of the groove 31. As is shown in Fig. 8, the bottom face of the groove 31 is formed so as to be inclined downwards from the central portion to the opposite ends thereof.

As is shown by the broken lines in Figs. 1 through 5, a pair of passages 33a, 33b and 34a, 34b opening into the corresponding passages 21 is formed in the crank case parts 1a, 1b. The lower ends of the passages 33a, 33b and 34a, 34b are connected to the corresponding upper ends 35a, 35b (Figs. 4 and 5) of the grooves 22a and 22b which are formed on the inner wall of the crank case part 1a, 1c, so that a relatively smooth connection is established between the passages 33a, 33b and 34a, 34b, and the grooves 22a and 22b. The pair of passages 33a, 33b and 34a, 34b is so arranged that the axes of the passage 33a, 34a and the passage 33b, 34b intersect with each other at an angle. Thus, the passages 33a, 33b and 34a, 34b open into the opposite ends of the lowest interior portion of the passage 21 so that, as is hereinafter described in detail, the streams of the fresh combustible mixture flowing out from the passages 33a, 33b and 34a, 34b impinge upon each other and so as to come into violent contact thereby reducing the velocity of the fresh combustible mixture stream.

As it will be understood from the above description, each of the passages 21 is connected to the crank chamber 8 *via* the passages 33a, 33b and 34a, 34b, the grooves 22a, 22b, the vertical short groove 27, the groove 24 and the vertical short groove 29. The passage consisting of the passages 33a, 33b, and 34a, 34b, the grooves 22a, 22b, the vertical short groove 27, the groove 24 and the vertical short groove 29 constitutes the first section of a combustible mixture supply passage and is hereinafter referred to as a first supply section passage. Consequently, it will be understood that the crank case 8 is connected to the combustion chamber 6 via the above-mentioned first supply section passage and the second supply section passage mentioned previously.

In operation, the fresh combustible mixture introduced into the crank chamber 8 from the intake passage 12 via the reed valve 19 is gradually compressed in accordance with the downward movement of the piston 4 and, thus, the fresh combustible mixture is forced into the first supply section passage from the vertical short groove 29. Then, the fresh combustible mixture introduced into the first supply section passage flows at a high speed in the first connecting passage because the first supply section passage has a small cross-sectional area. After this, the fresh combustible mixture flows into the second supply section passage. Since the fresh combustible mixture is caused to flow at a high speed in the first supply section passage, due to the fact that the first supply section passage has a small cross-sectional area as mentioned above, the flow energy is added to the fresh combustible mixture and, as a result, the vaporization of the liquid fuel continues to be promoted during this time. After the vaporization of the fresh combustible mixture is sufficiently promoted, the fresh combustible mixture in the first supply section passage flows into the second supply section passage. At this time, as mentioned previously, since the streams of the fresh combustible mixture flowing out from the passages 33a, 33b and 34a, 34b come into violent contact with each other in the passage 21 and lose kinetic energy and, in addition, the passage 21 has a cross-sectional area which is considerably larger than those of the passages 33a, 33b and 34a, 34b, the fresh combustible mixture flowing into the passage 21 from the passages 33a, 33b and 34a, 34b is abruptly decelerated. After this, the fresh combustible mixture moves upward at a low speed in the passage 21 and 20, having smooth inner walls, and then, flows into the combustion chamber 6 at a low speed when the piston 4 opens the ports 15. Even if the pressure in the crank chamber 8 is considerably higher than that in the combustion chamber 6 when the piston 4 opens the ports 15 to permit the inflow of the fresh combustible mixture into the combustion chamber 6, since the first supply section passage functions as throttling means because it has a small cross-sectional area, the fresh combustible mixture cannot flow into the combustion chamber 6 at a high speed. As a result of this, the flow velocity of the fresh combustible mixture is low throughout the inflow operation of the fresh combustible mixture. Consequently, when the fresh combustible mixture flows into the combustion chamber 6, the turbulence and flow of the residual burned gas in the combustion chamber 6 is extremely small and, as a result, the dissipation of the heat of the residual burned gas, is prevented. In addition, at the beginning of the compression stroke under a partial load of the engine, a large amount of the residual burned gas is present in the combustion chamber 6. Since the amount of the residual burned gas in the combustion chamber 6 is large and, in addition, the residual burned gas has a high temperature, the fresh combustible mixture is heated and is thereby reformed with the production of radicals. As a result, an active thermoatmosphere as referred to previously is created in the combustion chamber 6. Further, since the flow of the gas in the combustion chamber 6 is extremely small during the compression stroke, the occurence of turbulence and the loss of heat energy escaping into the inner wall of the combustion chamber 6 are restricted to the smallest possible extent. Consequently, the temperature of the gas in the combustion chamber 6 is further increased as the compressing operation progresses and, as a result, the amount of radicals produced in the combustion chamber 6 is further increased. When the radicals are produced, the combustion which is called a preflame reaction has been started. After this, when the temperature of the gas in the combustion chamber 6 becomes high at the end of the compression stroke, a hot flame generates to permit self ignition, i.e. the ignition is not effected by the spark plug 7. When the piston 4 moves downwards and opens the exhaust port 16, the burned gas in the combustion chamber 6 is discharged into the exhaust passage 18.

In order to cause the self ignition, it is necessary, firstly, to cause the high speed flow of the fresh combustible mixture in the first supply section passage so as to fully vaporize the liquid fuel, and, secondly, to cause a great deceleration of the fresh combustible mixture so as to flow the fresh combustible mixture into the combustion chamber 6 at a low speed. In order to cause the high speed flow of the fresh combustible mixture in the first supply section passage, as is shown in Figs. 4 and 5, the grooves 22a, 22b and 24 are formed by a long passage having small cross-section. In addition, while in order to cause the high speed flow of the fresh combustible mixture, it is preferable that the first supply section passage be formed as smoothly as possible. According to the experiments conducted by the inventor, it has been proven that a satisfactory high speed flow of the fresh combustible mixture can be obtained even if a sharply turning portion of the passage, such as the connecting portion of the groove 24 and the grooves 22a, 22b or the connecting portion of the groove 24 and the vertical short groove 29, is formed at a position remote from the passage 21.

When the fresh combustible mixture flows into the combustion chamber 6 from the ports 15, the radicals are produced in the vapor phase within the contact region of the fresh combustible mixture and the residual burned gas. However, in the case wherein the fresh combustible mixture comes into contact with the inner wall of the combustion chamber 6, the radicals are not produced in the contact region of the fresh combustible mixture and the inner wall of the combustion chamber 6. Consequently, as a type of a 2-cycle engine, it is preferable to adopt a Schnürle type 2-cycle engine having a pair of the ports 15 which are arranged so that the streams of the fresh combustible mixture flowing into the combustion chamber 6 from the scavenging ports 15 come into contact with each other and, as a result, the fresh combustible mixture is collected at the central portion of the combustion chamber 6 and enclosed by the residual burned gas. However, a 2-cycle engine of any other type may be used, if it has such a construction that the fresh combustible mixture is enclosed by the residual burned gas.

The fresh combustible mixture sucked into the crank chamber 8 from the intake passage

12 when the piston 4 moves upward contains a large amount of the liquid fuel. This liquid fuel is gathered on the bottom of the crank chamber 8 after it is sucked into the crank chamber 8. However, in the case wherein the open end of the first scavenging passage opens into the bottom of the crank chamber 8, as in the present invention, since the liquid fuel gathered on the bottom of the crank chamber 8 is forced into the first supply section passage together with the air-fuel mixture it is possoble to supply the combustion chamber 6 with the fuel in an amount which varies precisely in response to the load of the engine, that is, in the opening degree of the throttle valve 14.

In a conventional 2-cycle engine, in order to minimize the flow resistance to which the fresh combustible mixture is subjected when the engine is operating under a heavy load, the length of the supply section passage is shortened in such a way that the supply section passage opens into the upper interior of the crank chamber. However, a conventional engine has drawbacks in that, since a large amount of liquid fuel contained in the introduced fresh combustible mixture is gathered on the bottom of the crank chamber when the engine is started, the fresh combustible mixture fed into the combustion chamber becomes excessively lean, whereby a long time is necessary to cause ignition of the fresh combustible mixture. In addition, a conventional engine has further drawbacks in that, since a great vacuum is produced in the crank chamber after ignition, the liquid fuel gathered on the bottom of the crank chamber is instantaneously vaporized and, as a result, an excessively rich mixture is fed into the combustion chamber, thus causing a misfire. However, in the present invention, the above-mentioned drawbacks are eliminated by arranging the first supply section passage so as to open into the bottom of the crank chamber. In addition, as is shown in Fig. 7, by forming the groove 31 on the inner wall of the crank case part 1b at the bottom of the crank chamber 8, the liquid fuel gathered in the groove 31 is blown away by the air stream caused by the rotating motion of the balance weight 9. As a result of this, the vaporization of the liquid fuel in the crank chamber 8 is promoted. Furthermore, as is shown in Fig. 8, by forming the bottom of the groove 31 so as to be downwardly inclined towards the grooves 29, it is possible to guide the liquid fuel gathered in the groove 31 to the grooves 29.

Figs. 9 through 12 show another embodiment according to the present invention. In Figs. 9 through 12, similar components are indicated with the same reference numerals as used in Figs. 1 through 5. As is shown in Figs. 9 and 11, in this embodiment, the passage 21 is formed in the crank case part 1b, and the upper ends 35a, 35b of the grooves 22a, 22b formed on the crank case parts 1a, 1c are connected to the bottom interior of the passages 21 via the passages 33a, 33b and 34a, 34b formed in the crank case part 1b. In the same manner as described with reference to Figs. 1 through 5, a pair of the passages 33a, 34a and 33b, 34b is so arranged that the axes of the passage 33a, 33b and the passage 34a, 34b intersect with each other at an angle and, thus, the streams of the fresh combustible mixture flowing out from the passages 33a, 34a and 33b, 34b impinge upon, and come into violent contact with, each other.

As mentioned previously, in order to continue to maintain the active thermo-atmosphere until the end of the compression stroke, it is necessary to minimize the turbulence and the flow of the residual burned gas in the combustion chamber 6. Two causes of turbulence and flow of the residual burned gas are an abrupt blowing off operation of the exhaust gas discharging from the exhaust port 16 and interference by the pulsating pressure of the exhaust gas. In order to prevent the above-mentioned abrupt blowing off operation and interference, as is shown in Fig. 13, it is preferable that an exhaust control valve 36 be disposed in the exhaust passage 18. Fig. 14 shows the relationship of the opening degree between the exhaust control valve 36 and the throttle valve 14. In Fig. 14, the ordinate X indicates a ratio of an opening area to the full opening area of the exhaust control valve 36, and the abscissa Y indicates a ratio of an opening area to the full opening area of the throttle valve 14. As is apparent from Fig. 14, the exhaust control valve 36 is gradually opened and is fully opened when the throttle valve 14 reaches a position in which its opening area ratio Y is approximately 30 percent. In addition, the exhaust control valve 36 remains fully opened when the throttle valve 14 is further opened.

In addition, in the case wherein the engine is operated only under a light load, as is shown in Fig. 15, a restricting member 37 having a fixed restricted opening area may be disposed in the exhaust passage 18. In addition, in order to appropriately prevent the exhaust gas from being abruptly discharged from the exhaust port 16, it is preferable that the volume of the exhaust passage 18 located between the exhaust port 16 and the exhaust control valve 36 be smaller than that of the combustion chamber 6 when the piston is positioned at the bottom dead center. In an engine according to the present invention, the spark plug 7 is used at the time of the warm-up of the engine and when the engine is operating under a heavy load, and it is not necessary to use the spark plug 7 when the engine is operating under a partial load wherein the active thermoatmosphere combustion is carried out.

A 2-cycle engine according to the present invention is suitable to be operated under a partial load and, according to the present invention, a quiet operation of the engine can be obtained. In addition, the active theremoatmosphere combustion causes a large reduction in the amount of harmful components in the exhaust gas, and, also causes a considerable improvement in the fuel consumption.

WHAT WE CLAIM IS:—

1. A method of firing a 2-stroke internal combustion engine having a crank case, a combustion chamber and a combustible mixture supply passage providing communication between the interior of the crank case and the combustion chamber, the method comprising

introducing a fresh combustible mixture into the crank case,

introducing the fresh combustible mixture in the crank case into said supply passage,

causing the mixture to flow at a first relatively high speed in a first section of said supply passage for promoting vaporisation of liquid fuel contained in the combustible mixture,

causing the mixture to flow at a second relatively low speed in a second section of said supply passage,

introducing the combustible mixture from said supply passage into the combustion chamber without causing substantial turbulence and flow of burned gas remaining in the combustion chamber thereby preventing dissipation of the heat of said burned gas,

allowing the burned gas to heat combustible mixture introduced into the combustion chamber and thereby reform the mixture to produce radicals,

maintaining the reformed atmosphere until the end of the compression stroke, and

permitting self ignition of the atmosphere within the chamber thereby firing the engine.

2. A method as claimed in claim 1, wherein the fresh combustible mixture flowing in the first section of the supply passage at said relatively high speed is abruptly decelerated for reducing the flow velocity of the fresh combustible mixture so that it flows at said second relatively slow speed in said second section of the supply passage.

3. A method as claimed in claim 2, wherein the flow direction of the fresh combustible mixture is abruptly deflected to cause the abrupt deceleration of the fresh combustible mixture.

4. A method as claimed in claim 2, wherein the fresh combustible mixture is abruptly decelerated by impinging streams of said mixture flowing at said relatively high speed onto each other.

5. A method as claimed in claim 2, wherein the fresh combustible mixture flows into a space having a volume which causes said abrupt deceleration to be effected.

6. A method as claimed in claim 1, wherein the fresh combustible mixture flow at said relatively high speed in said first section over a distance which is longer than that over which the combustible mixture flows at said relatively low speed in said second section.

7. A method as claimed in claim 6, wherein the flow of the fresh combustible mixture at the relatively high speed is a smooth flow in the latter half of said first section until the fresh combustible mixture is decelerated.

8. A method as claimed in claim 7, wherein the flow of the fresh combustible mixture smoothly at the relatively high speed is a smooth flow over the entire length of said first section until the fresh combustible mixture is decelerated.

9. A method as claimed in claim 6, wherein the flow of the fresh combustible mixture in said second section and after deceleration thereof is a smooth flow.

10. A method as claimed in any one of claims 1 to 9, wherein the fresh combustible mixture in the crank case is introduced into the combustible mixture supply passage at the bottom of the interior of the crank case.

11. A method as claimed in claim 10, wherein the liquid fuel gathered on the bottom of the interior of the crank case is guided to the combustible mixture supply passage.

12. A method as claimed in any one of claims 1 to 11, wherein abrupt outflow of the exhaust gas from the combustion chamber is restricted for suppressing the flow and turbulence of burned gas in the combustion chamber so as to prevent dissipation of heat of the residual burned gas.

13. A method as claimed in claim 12, wherein the restricting operation of the outflow of the exhaust gas is carried out when an engine is operating under a partial load.

14. A method as claimed in any one of claims 1 to 13, wherein the fresh combustible mixture is introduced into the combustion chamber towards the central portion thereof.

15. A 2-stroke internal combustion comprising

a cylinder having a cylinder bore,

a piston reciprocably movable in the bore, said piston and cylinder together defining a combustion chamber,

a crank case,

a fuel intake passage associated with mixture forming means for introducing a fresh combustible mixture into said crank case,

a combustible mixture supply passage for supplying combustible mixture from the interior of the crank case to the combustion chamber, said combustible mixture supply passage having successive first and second sections in the direction of supply of combustible mixture from the crank case to the combustion chamber, said first section being adapted for the supply therealong of combustible mixture at a relatively high speed to promote vaporisation of liquid fuel in the combustible mixture, and said second section being adapted for the supply therealong of combustible mixture at a second relatively low speed and communicating with a part opening into said chamber such that, in use of the engine, combustible mixture may be supplied into said chamber without causing substantial turbulence and flow of burned gas in said chamber, and

an exhaust passage having an exhaust part opening into said combustion chamber for discharging exhaust gas into the atmosphere.

16. A 2-stroke engine as claimed in claim 15, wherein said combustible mixture supply passage comprises a first passageway having a relatively long length and relatively small cross-sectional area, and said second section of said supply passage comprises at least one second passageway having a length which is shorter than that of said first passageway and having a cross-sectional area which is larger than that of said first passageway.

17. A 2-stroke engine as claimed in claim 16, wherein said first passageway has a pair of branch portions which communicate with said second passageway.

18. A 2-stroke engine as claimed in claim 17, wherein said first passageway further comprises a single passage portion located between said branch portions and the interior of said crank case, said branch portions being branched off from said single passage portion.

19. A 2-stroke engine as claimed in claim 18, wherein said branch portions are of the same length and have no sharp turns.

20. A 2-stroke engine as claimed in any one of claims 17 to 19, wherein said branch portions have end portions which open into the bottom of said second passageway.

21. A 2-stroke engine as claimed in claim 20, wherein axes of the end portions of said branch portions intersect with each other at an angle so that the streams of the fresh combustible mixture flowing out from the end portions of said branch portions impinge upon each other.

22. A 2-stroke engine as claimed in claim 16, wherein said crank case comprises at least two crank case parts and said first passageway is a groove formed on an inner wall of one of said crank case parts.

23. A 2-stroke engine as claimed in claim 22, wherein said groove is formed between said crank case parts.

24. A 2-stroke engine as claimed in claim 22, wherein said groove extends along the circular periphery of the inner wall of said crank case part.

25. A 2-stroke engine as claimed in claim 24, wherein said groove comprises a first part extending along the circular periphery of the inner wall of said crank case part, and a second part extending along said first part.

26. A 2-stroke engine as claimed in claim 16, wherein a pair of said first passageways and a pair of said second passageways are provided.

27. A 2-stroke engine as claimed in claim 26, wherein each of said first passageways further comprises a pair of branch passages, one of the branch passages of one of said first passageways and one of the branch passages of the other first passageway being connected to one of said second passageways, the remaining branch passageways being connected to the other second passageway.

28. A 2-stroke engine as claimed in claim 16, wherein said first passageway has an opening which opens into the bottom of said second passageway, the opening of said first passageway being directed to a circumferential inner wall of said second passageway.

29. A 2-stroke engine as claimed in any one of claims 15 to 28, wherein said first section of the supply passage has at least one mixture inlet opening into the bottom interior of said crank case.

30 A 2-stroke engine as claimed in claim 29, wherein a groove is formed on an inner wall of said crank case at the bottom thereof, said mixture inlet opening into said groove.

31. A 2-stroke engine as claimed in claim 30, wherein said groove has a bottom which is downwardly inclined towards said mixture inlet.

32. A 2-stroke engine as claimed in any one of claims 15 to 31, wherein means for restricting the outflow of the exhaust gas from said exhaust port is disposed in said exhaust passage.

33. A 2-stroke engine as claimed in claim 32, wherein said restricting means comprises an exhaust control valve which is partially closed when the engine is operating under a partial load.

34. A 2-stroke engine as claimed in claim 32, wherein said restricting means comprises a restricted opening having a fixed opening area.

35. A method of firing in a 2-stroke

engine, substantially as herein described, with reference to the accompanying drawings.

36. A 2-stroke engine, substantially as herein described with reference to and as illustrated in Figs. 1 to 8 or Figs. 9 to 12 or Fig. 13 or Fig. 14 of the accompanying drawings.

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1592268 COMPLETE SPECIFICATION

12 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

Fig. 1

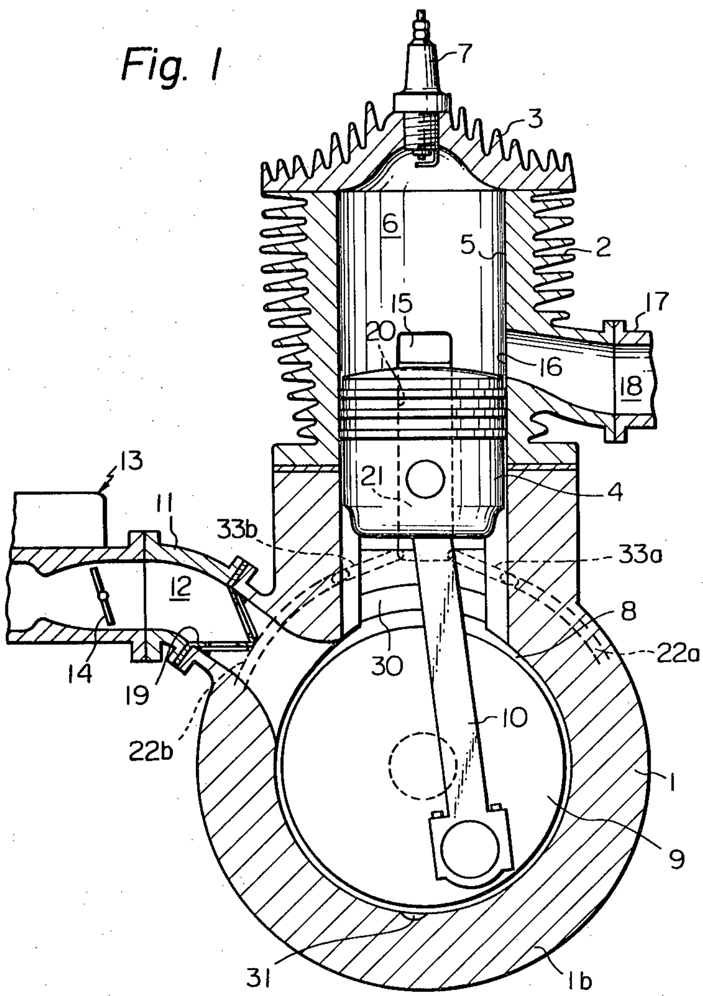
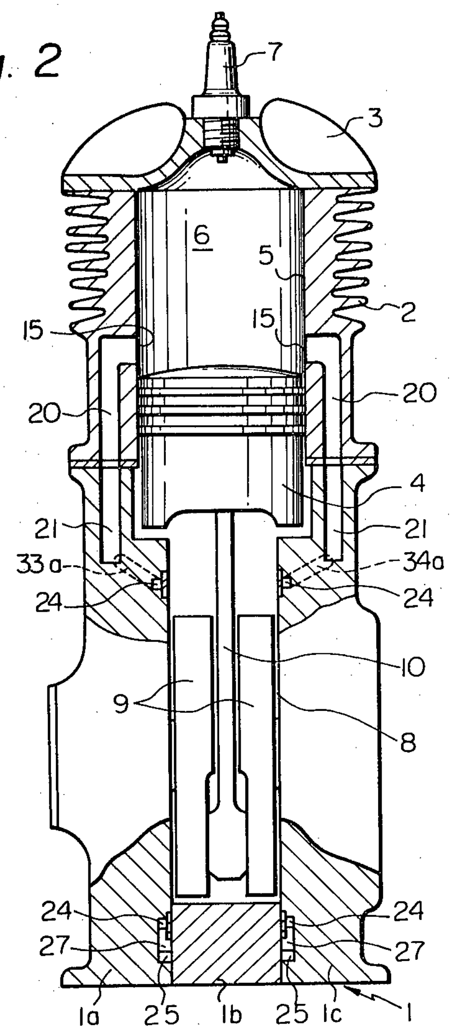


Fig. 2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1

Fig. 3

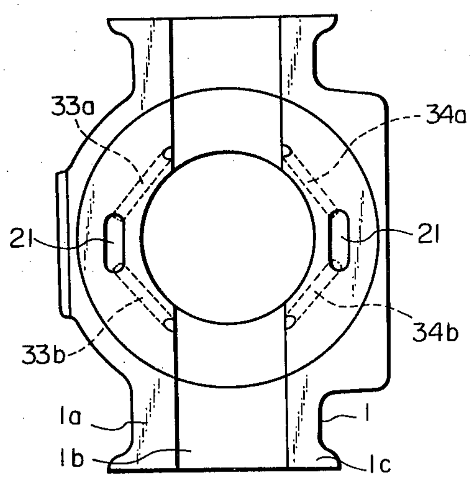

Fig. 4

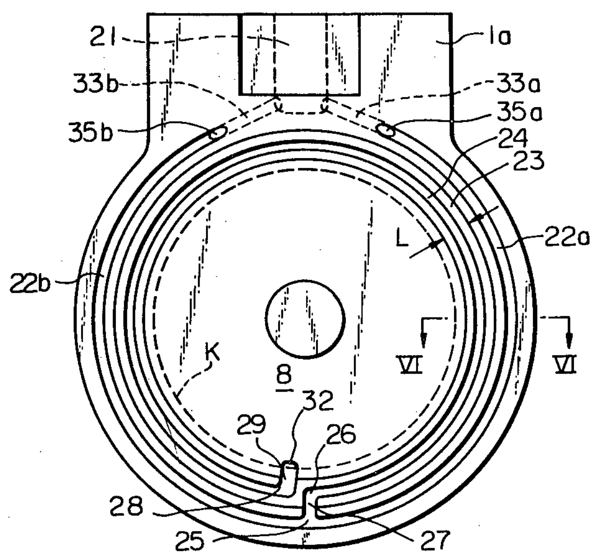

Fig. 5

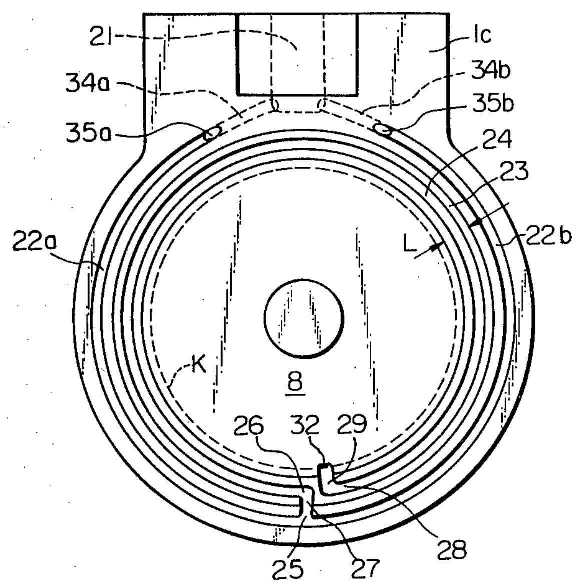

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Fig. 6

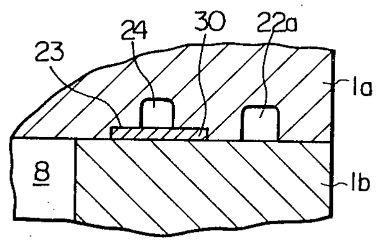

Fig. 7

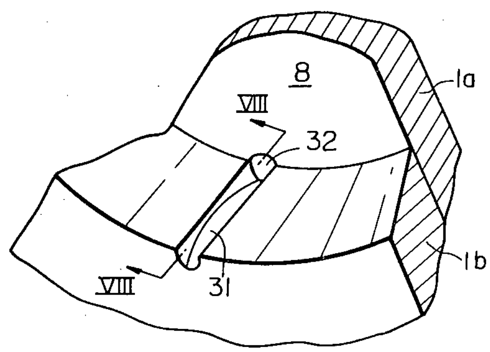

Fig. 8

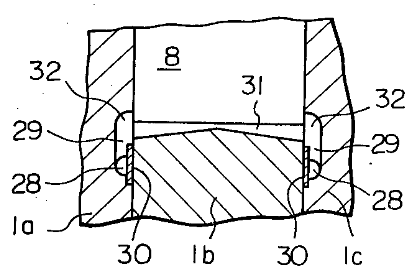

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Fig. 9

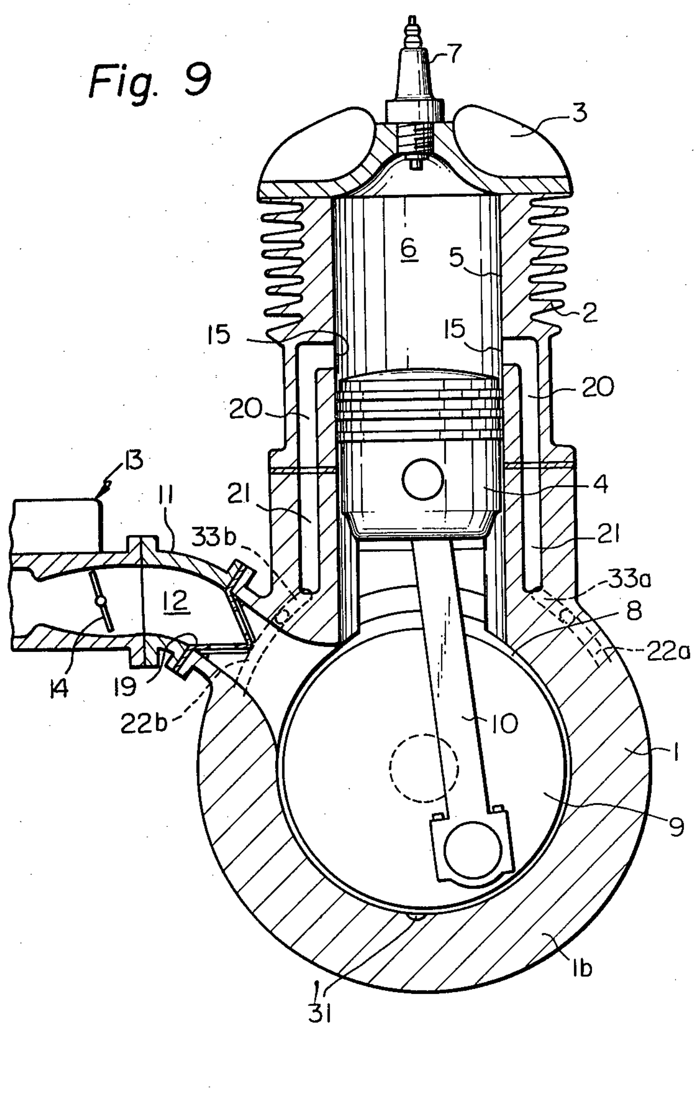

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Fig. 10

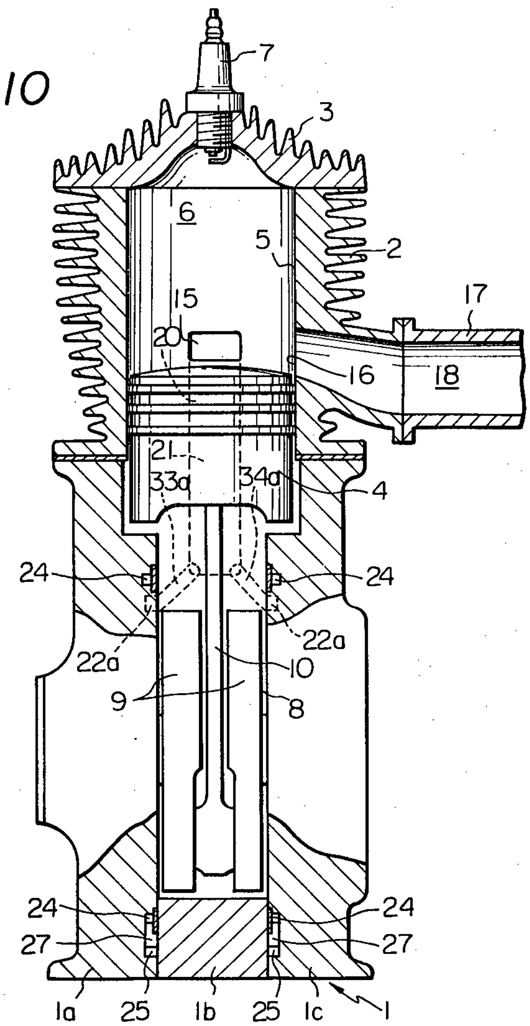

Fig. 11

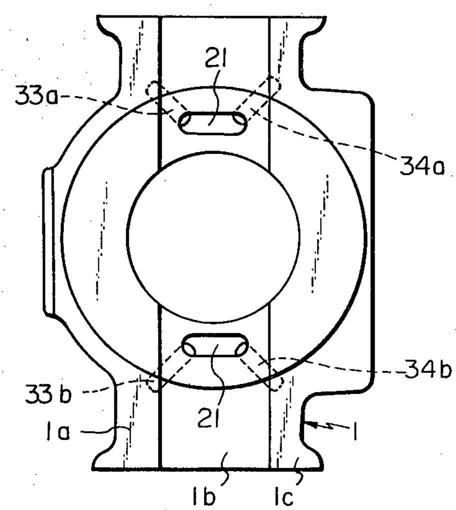

Fig. 12

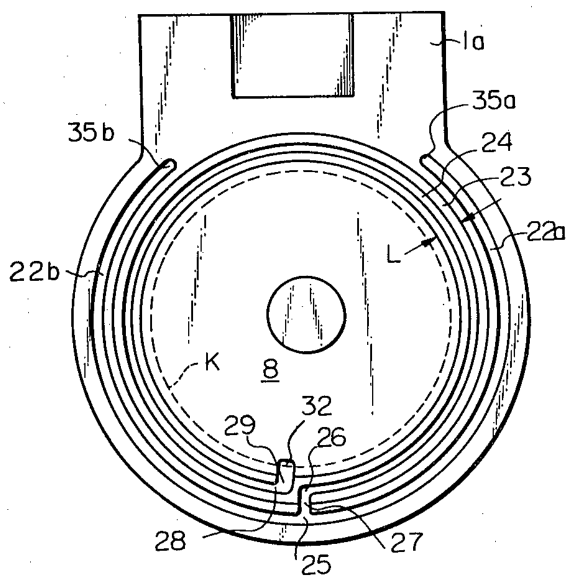

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Fig. 13

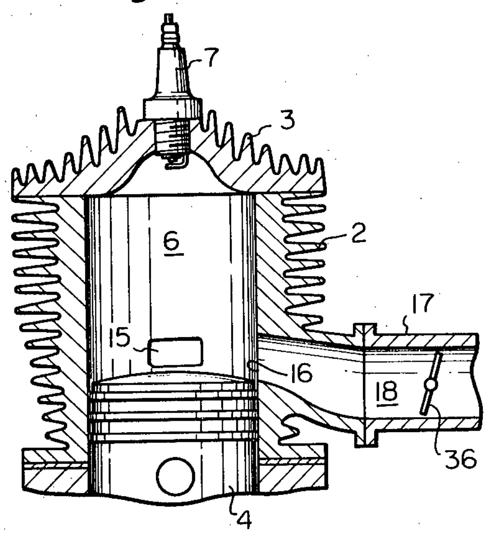

Fig. 14

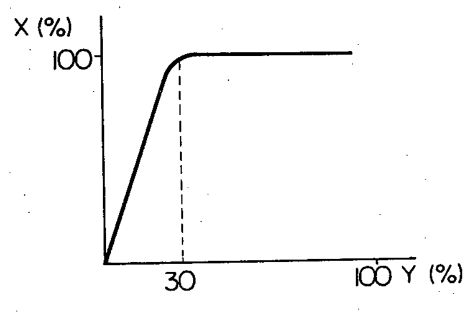

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Fig. 15