Jan. 9, 1940. F. ZAHREN 2,186,812

INTERNAL COMBUSTION ENGINE

Filed Dec. 18, 1937 3 Sheets-Sheet 1

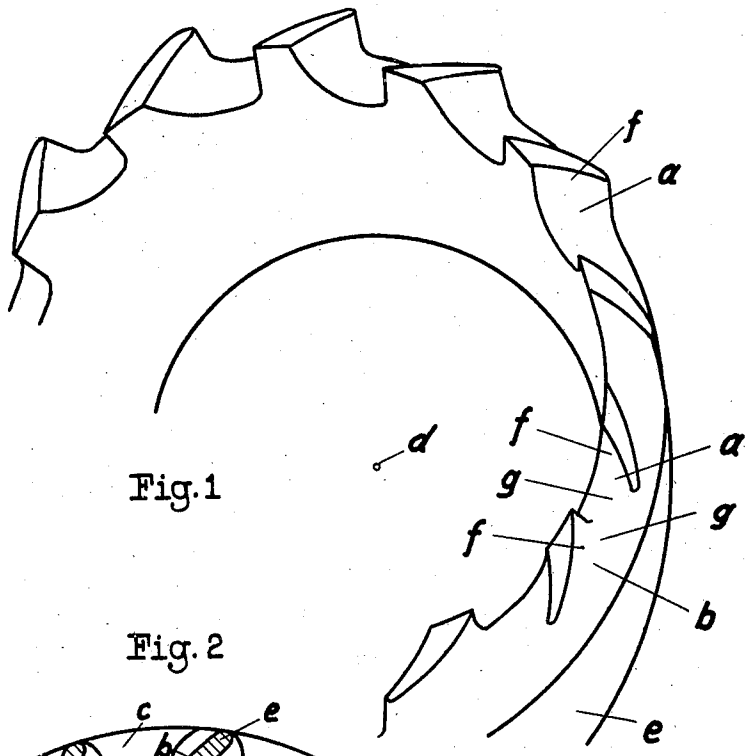


Fig. 1

Fig. 2

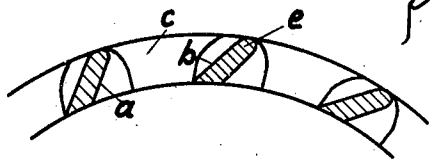


Fig. 3

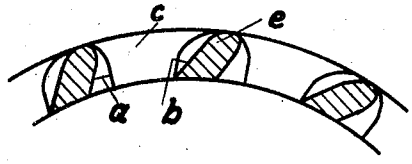
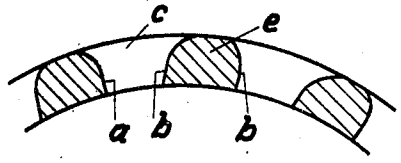


Fig. 4



Inventor:
FRANZ ZAHREN
BY
Hammond & Littell
ATTORNEYS

Jan. 9, 1940. F. ZAHREN 2,186,812

INTERNAL COMBUSTION ENGINE

Filed Dec. 18, 1937 3 Sheets-Sheet 2

Fig. 6

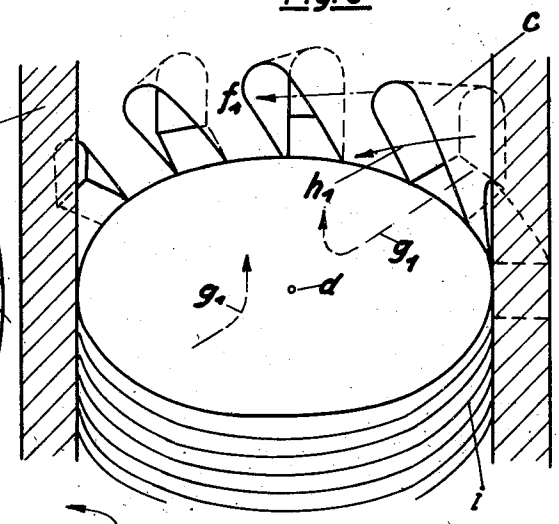


Fig. 5a

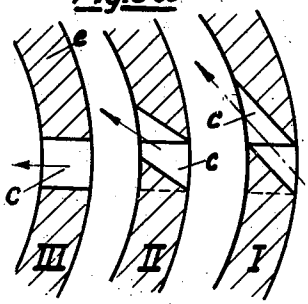


Fig. 5b. Fig. 5.

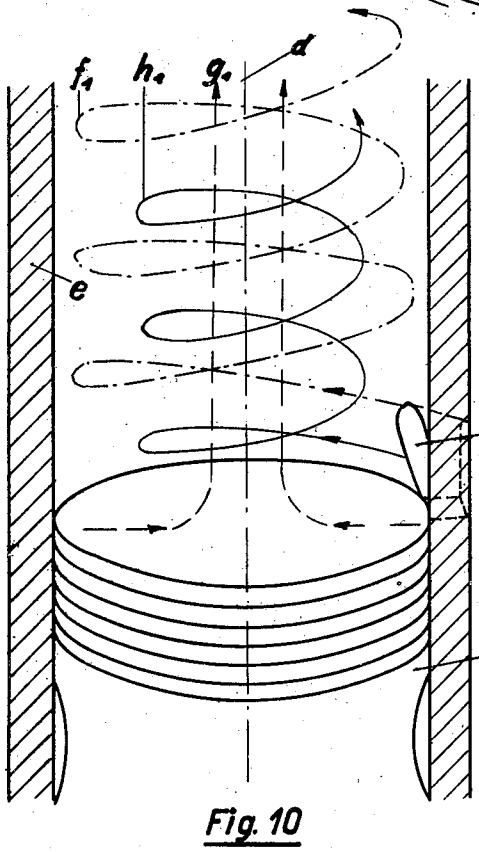


Fig. 10

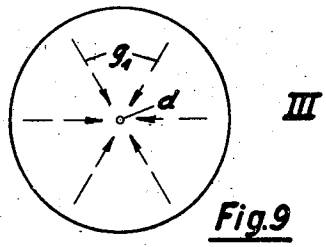


Fig. 9

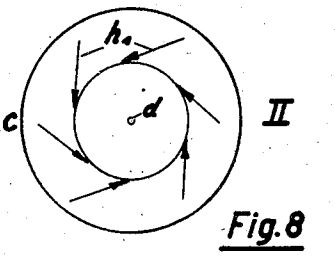


Fig. 8

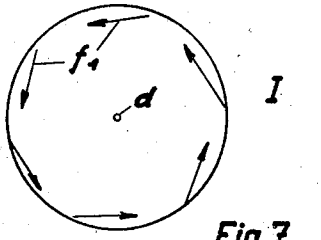


Fig. 7

Inventor:
FRANZ ZAHREN
BY Hammond & Littell
ATTORNEYS

Jan. 9, 1940. F. ZAHREN 2,186,812

INTERNAL COMBUSTION ENGINE

Filed Dec. 18, 1937 3 Sheets-Sheet 3

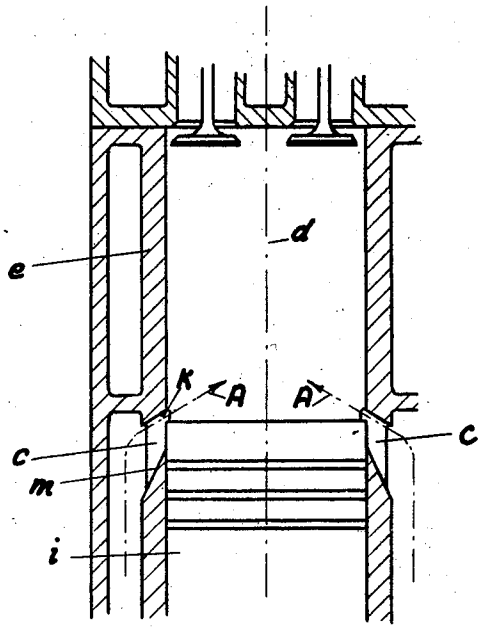


Fig. 11

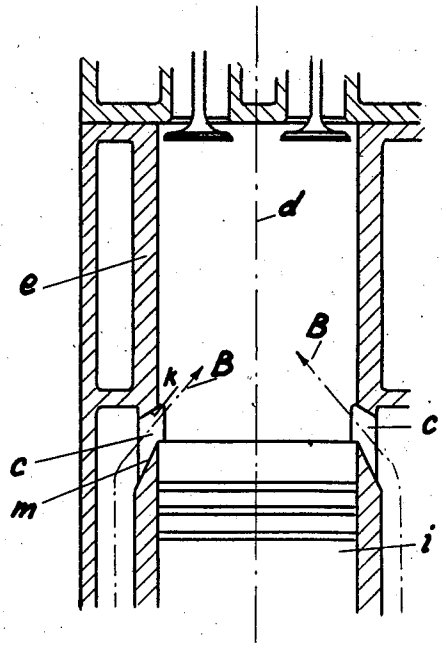


Fig. 12

Inventor:
FRANZ ZAHREN
BY
Hammond & Littell
ATTORNEYS

Patented Jan. 9, 1940 2,186,812

UNITED STATES PATENT OFFICE

2,186,812

INTERNAL COMBUSTION ENGINE

Franz Zahren, Brunswick, Germany, assignor to the firm Büssing-Nag Vereinigte Nutzkraftwagen Aktiengesellschaft, Brunswick, Germany

Application December 18, 1937, Serial No. 180,482
In Germany December 19, 1936

6 Claims. (Cl. 123—65)

This invention relates to internal combustion engines, more especially to high-speed two-stroke internal combustion engines.

Internal combustion engines are known provided with direct current scavenging means and inlet slots, controlled by the working piston, distributed over the whole periphery of the cylinder and disposed in the same zone of the cylinder. In two-stroke internal combustion engines having inlet slots distributed over the whole periphery of the cylinder it has been likewise proposed to arrange the slots in tangential direction thereby obtaining a whirling movement resulting in a better scavenging and mixing. However with these well-known arrangements the scavenging is incomplete, the waste gases being only partially pushed out of the cylinder. The object of the present invention is to avoid these drawbacks, especially to obtain, besides a satisfactory formation of the mixture, a perfect scavenging especially of the core of waste gases contained in the middle of the cylinder.

According to the invention the side faces of each of the slots pass downwards from a tangential direction into a radial one, or inversely from a radial direction into a tangential one in such a manner that when the inlet slots begin to be opened the entering partial currents are exclusively directed tangentially or radially, and the additional currents, forming on further enlarging of the opening turn, as compared with the superimposed ones, more and more towards the axis or the wall of the cylinder.

The invention will now be more fully described with reference to the annexed drawings of which

Fig. 1 is a perspective view of the slots distributed along the periphery of the cylinder;

Figs. 2 to 4 are cross-sections through the cylinder and the slots, viz.

Fig. 2 is a cross-section through the upper part, i. e. the part of the slot which is first uncovered by the piston;

Fig. 3 shows a cross-section through about the middle part, and

Fig. 4 a cross-section through the lower part of the several slots;

Figs. 5, 5*a* and 5*b* are cross-sections through a slot showing the different directions of the scavenging medium at different cross-sections of the opening dependent upon the position of the piston;

Fig. 6 shows the inlet slots in perspective view with the currents of the scavenging medium differing as to their directions;

Figs. 7 to 9 show in consecutive cross-sections the course of the individual scavenging currents, whereas

Fig. 10 is a longitudinal section of the cylinder illustrating the course of the scavenging currents;

Figs. 11 and 12 are similar longitudinal sections showing further additional modifications of the inlet slots.

The inlet slots *c*, being disposed upon the cylinder wall *e* in uniform distribution and in the same zone of the cylinder and being controlled by the piston *i* are shaped in such a manner that the side faces *a* and *b* of each of the slots *c* pass downwards from a tangential to a radial direction.

As especially seen from Fig. 1, the tangential direction of the upper part *f* of the slot continuously changes into a radial or nearly radial one in the lower part *g* of the slot. This form of the slots is also seen in Figs. 2 to 4. When the piston *i* has first uncovered the upper part of the side faces *a* and *b*, the slots *c* pass in tangential direction as shown in Fig. 2.- On further movement the piston *i* gradually uncovers the middle part of the slots, as about in Fig. 3 which shows that in this position of the piston *i* the side faces *a* and *b* of each of the slots *c* do no longer pass as strictly tangential as in Fig. 2. Finally, when the piston reaches the lower part *g* of the slots *c*, the side faces *a* and *b* pass in this part radially or nearly radially. From this formation of the slots—which of course may be inverted—it results that in the beginning of the opening of the inlet slots *c* the entering partial currents are directed tangentially or radially as the case may be, and the additional currents formed on further enlargement of the opening turn towards the axis *d* or the wall *e* of the cylinder respectively. Hereby, without the single partial currents disturbing one another, henceforth a perfect scavenging of the whole cylinder is obtained, above all the detrimental core of waste gases being surely reached, without the necessity of providing a greater amount of scavenging medium.

Fig. 5 shows the different directions of the scavenging medium at different cross-sections of the opening of the slots *c* dependent upon the position of the piston *i*. The cross-section I, Fig. 5, shows the tangential direction of the scavenging medium, the correspondingly formed side faces *a* and *b* of the slot *c* being uncovered by the piston *i* at first.

Cross-section II, Fig. 5*a*, shows the nearly radial or less tangential course of the scavenging

medium by the formation of the side faces *a* and *b* of the slot *c* determining the course of the scavenging medium as soon as the piston *i* takes a position about in the middle of the slot *c* considering its total height.

Cross-section III, Fig. 5*b*, illustrates the radial course of the scavenging medium attained as soon as the piston *i* uncovers the whole of the slot *c*.

The single currents of the scavenging medium f_1, h_1 and g_1 corresponding to the cross-sections I, II and III of Figs. 5, 5*a* and 5*b* are shown in Figs. 7, 8 and 9. From these figures it is seen that the currents of scavenging medium f_1 flow tangentially (Fig. 7), the currents h_1 flow nearly tangentially (Fig. 8), and the currents g_1 flow radially (Fig. 9).

Fig. 6 shows the same arrangement of the inlet slots *c* in perspective view, the single currents of scavenging medium f_1, g_1 and h_1 being likewise indicated.

Fig. 10 representing a longitudinal cross-section of the cylinder makes clear the course of the single currents of scavenging medium resulting from the formation of the slots to provide such result. The single currents of scavenging medium f_1, h_1, and g_1 accomplish a perfect scavenging of the whole cylinder, the scavenging current g_1 carrying away the inner core of waste gases and the scavenging current h_1 already skimming a greater area of the cylinder, whereas the scavenging current f_1 passes along the walls of the cylinder.

Figs. 11 and 12 show by way of example an additional modification of the inlet slots *c*, where the slots *c*—besides being formed at different angles—are made in such a manner that the upper faces *k* of the slots lie at an angle nearer 90° to the longitudinal central axis *d* of the cylinder than the lower faces *m* of the slot. Hereby I attain furthermore that at the beginning of the opening of the slots *c* by the piston *i* the scavenging medium does not pass or only slightly passes to the cylinder head (see arrow A) but on further opening the slots *c* its way is distinctly directed upwards (see arrow B). For this modification Fig. 11 shows the course of the current of scavenging medium, the upper faces *k* of the slot having just been uncovered, whereas Fig. 12 shows the course of the scavenging currents in longitudinal cross-section when the slots are wholly opened. The slots *c* in each case provided in a cylinder may be of the same kind or of different kinds or only partly of different kinds with respect to one another whereby different combinations of forming the slots are rendered possible. In this case, however, it is essential to form the slots in such a manner that the single scavenging currents do not disturb one another so as to warrant a perfect scavenging of the waste gases out of all parts of the cylinder.

The side faces *a* and *b* of the slots *c* may also be formed in such a manner that in contradistinction to the modification shown the distances between corresponding points upon the side faces *a* and *b* are in each case always equal.

I claim:

1. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angle between the side faces of each slot and the tangent to the cylinder gradually varies from a value of less than 90 degrees to a total amount of about 90 degrees, and the angle between the upper faces of the slots and the axis of the cylinder differs from the angle between the lower faces of the slot and the axis of the cylinder.

2. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging, and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angle between the side faces of each slot and the tangent to the cylinder gradually varies from a value of less than 90 degrees to a total amount of about 90 degrees, the slots being differently formed with respect to one another.

3. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angle between the side faces of each slot and the tangent to the cylinder gradually varies from a value of less than 90 degrees to a total amount of about 90 degrees, part of the slots being differently formed with respect to one another.

4. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging, and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angles between the section lines formed in the side walls of each single slot by consecutive cross-sections perpendicular to the axis of the cylinder and the tangent to the cylinder gradually vary in the direction of the axis from a value less than 90 degrees to about 90 degrees.

5. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging, and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angle between the side faces of each slot and the tangent to the cylinder gradually pass in downward direction from a tangential to a radial direction.

6. An internal combustion engine, especially a high-speed two-stroke internal combustion engine provided with direct current scavenging, and inlet slots controlled by the working piston and distributed over the periphery of the cylinder in the same zone, in which engine the angle between the side faces of each slot and the tangent to the cylinder gradually pass in downward direction from a radial to a tangential direction.

FRANZ ZAHREN.