

Oct. 29, 1935.

F. GRUEBLER

2,018,848

INTERNAL COMBUSTION ENGINE

Filed Aug. 8, 1931

2 Sheets-Sheet 1

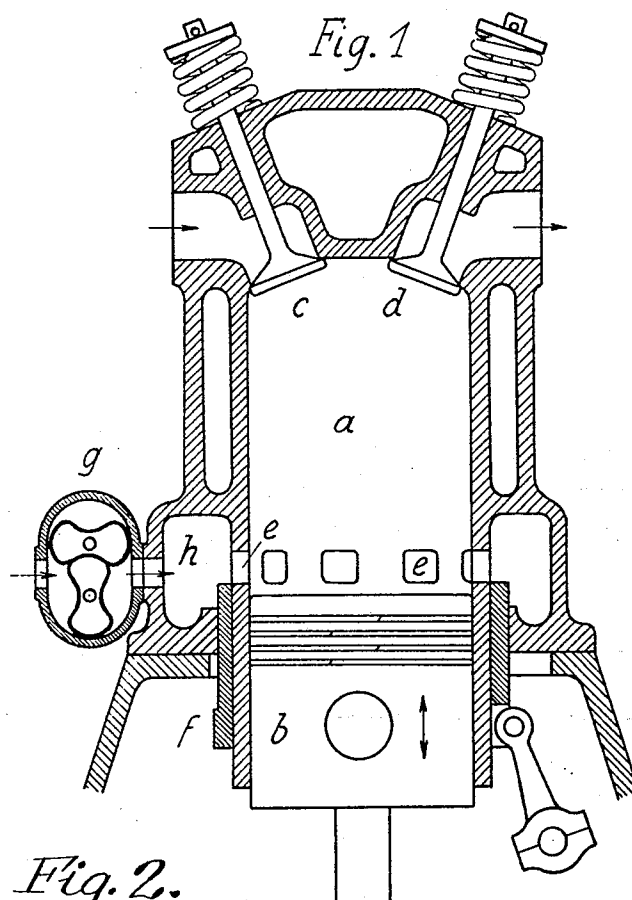
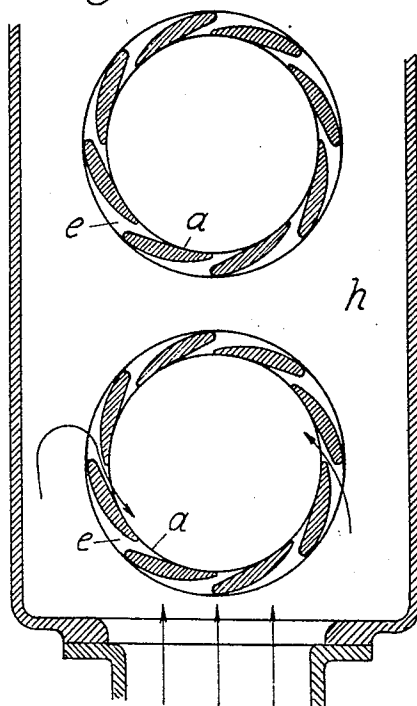
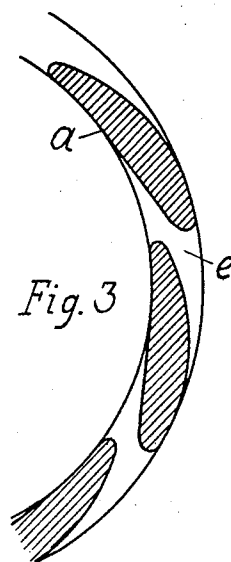


Fig. 2.



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Fig. 5

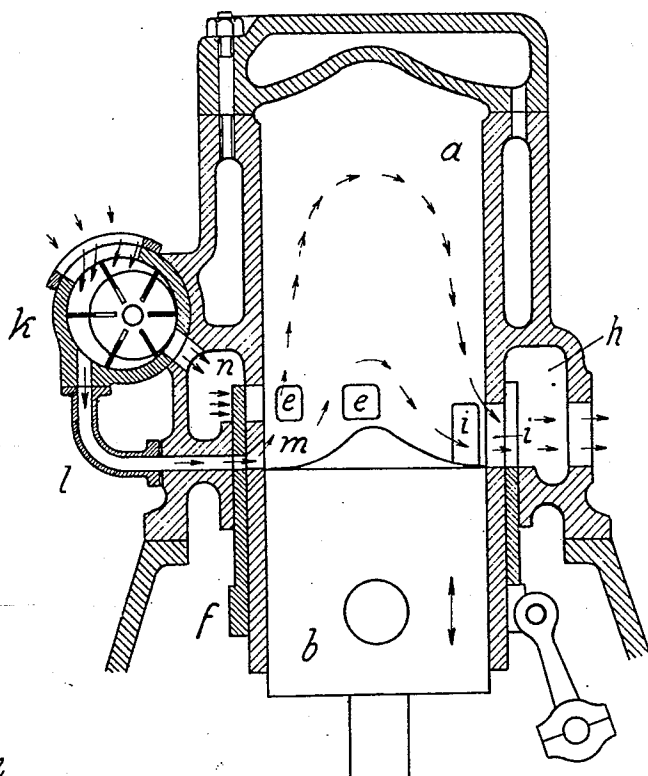


Fig. 4

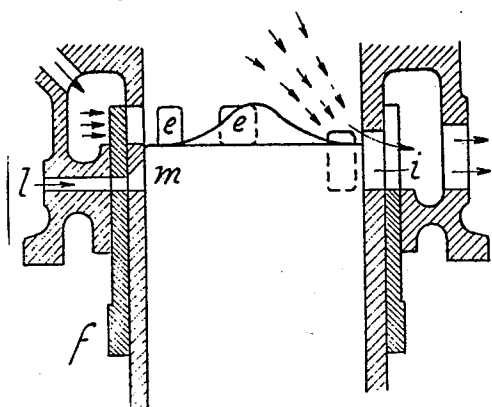


Fig. 7

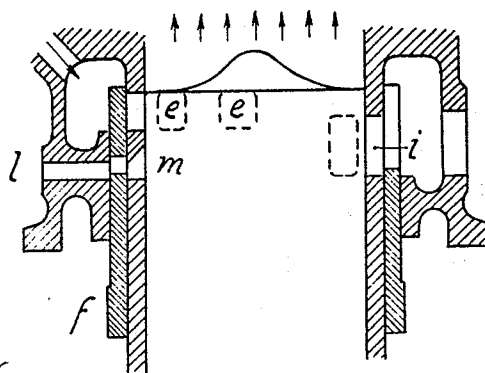
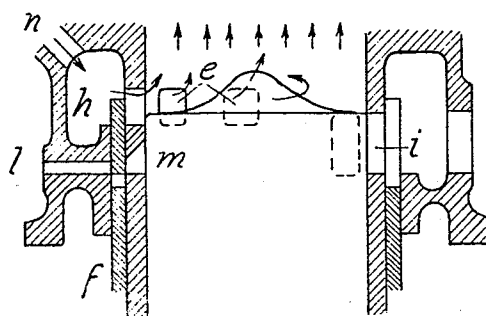


Fig. 6



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UNITED STATES PATENT OFFICE

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INTERNAL COMBUSTION ENGINE

Felix Gruebler, Basel, Switzerland

Application August 8, 1931, Serial No. 555,969
In Switzerland August 16, 1930

1 Claim. (Cl. 123—65)

This invention relates to internal combustion engines, more particularly for use on aircraft, which operate with an air compressor.

There are two fundamentally different types of compressor engines, the so-called supercharger in which the whole cylinder charge is supplied by a charging pump, and the motor operating on the replenishing method according to which the cylinder charge drawn from the atmosphere is augmented to the desired pressure by an auxiliary compressor. The object of both systems is high compression at altitude.

A serious drawback of the motor with charging pump is the excessive fuel consumption and high flame temperature common to all motors in which a homogeneous charge is burned.

According to the present invention the supplementary air is supplied to the working cylinder through nozzle-shaped inlet ports tangentially arranged in the cylinder wall and lying in a plane normal to the cylinder axis so as to effect a regular stratification. The air ports being somewhat rounded at the inlet and slightly expanding at the outlet the supplementary air follows the walls of the nozzles without breaking off, so that at the beginning of the compression stroke the charge is stratified into a rotating layer of air adjacent the piston and the turbulent initial charge above.

It has been established by tests that stable circular air motions maintain themselves into the process of combustion, and consequently the charge is gradually burned, and unlike a homogeneous charge, if the mixture is separated from the supercharge of fresh air. Stratification affords the advantage of high thermal efficiency, since the engine is able to work with a large surplus of air, while an excess of fuel will be consumed at a sufficient rate in the air-reserve of the supercharge.

Since the mixing of the air and fuel is completed only during the process of combustion, the knocking tendency of the motor is diminished, and replenishing may be combined with considerable supercharging. If this is done with hot air to aid combustion, the gasoline consumption may be reduced to about 160 grams HP/h (fuel-saving flight) while on the other hand the power output may be increased at will by an admixture of fuel to the main charge.

The tangential air ports being shaped into a suitable form of expanding nozzles, which is an essential feature of this motor, they may be placed closely together, and little extra pressure will be required to obtain and maintain an effi-

cient stratification right into the process of combustion.

The gas from the carburetter may be so deflected that it flows into the cylinder in the opposite direction of the supercharge. If the fuel is not vaporized in a carburetter it may be injected under pressure.

In high-speed Diesel engines the combustion may be conveniently retarded and smooth running of the engine ensured if the jet of fuel is substantially confined to the upper or initial air charge. The stratum of supplementary air participates then only, and at the same time assists by its rotation in the further process of combustion, which in this way is conformed to the motor speed.

Two forms of engine constructed in accordance with the invention are shown by way of example in the accompanying drawings in which

Figure 1 is a cross sectional elevation of a four-stroke motor,

Figure 2 is a horizontal section of Figure 1, and Figure 3 is a greatly enlarged section of the inlet channel for the supplementary air;

Figure 4 is a detail of Figure 5 representing a two-stroke engine in which the scavenging air is suitably directed and supplied at a lower pressure than the supercharge, with further details as in Figures 6 and 7.

Figure 5 is a cross section of a two-cycle motor in which the scavenging air is suitably directed and supplied at a lower pressure than the supercharge. Figures 6 and 7, which correspond to Figure 4, show parts in different positions.

The four-stroke motor as incorporated in Figure 1 comprises the cylinder *a* with piston *b*, suction valve *c* and exhaust valve *d*. The channels *e* for the supplementary air are tangentially disposed in the cylinder wall and of nozzle shape. On the inner side they are controlled by the piston and outside by the slide valve *f* which is timed to reciprocate once in two revolutions of the crank shaft, cutting the pressure conduit off after the supercharge is effected. When near the end of the suction stroke the ports *e* are uncovered, air is forced into the aspiration charge from a blower *g*, whereby the cylinder is replenished to the desired pressure. The air supply may be regulated by venting the excess of compressed air to the atmosphere, or in any other known manner.

In the two-stroke motor of Figure 5 the slide valve *f* is alternately timing the admission of scavenging and supercharging air. After the cylinder has been cleared of burnt gases through the

exhaust ports *i* from a low-pressure cell of compressor *k* by way of a conduit *l* and scavenging port *m*, higher compressed air is fed into the cylinder through the ports *e*.

5 An exact description as to how this engine is operated is given with reference to the extra drawings.

In Figure 4 the ports *e* are still cut off from the compressor by the slide *f*, but uncovered by the engine piston, which on its outstroke opens the exhaust *i*. On further descending to the dead centre (Fig. 5) the piston opens the scavenging port or ports *m* and thus establishes communication with a low-pressure cell of the compressor, 10 whence the residue of burnt gas is swept through the exhaust ports. The piston then changes into the upward stroke, and the ports *m* are closed by the slide *f* which on its downward course opens the supplementary air ports *e*.

20 In Figure 6 the piston is shown just blocking the exhaust ports *i*, but leaving the ports *e* partially open, through which at this stage fully compressed air is discharged into the cylinder from a passage *n*. The initial counter-pressure 25 is negligible and increases only with the further ascent of the piston until the ports are blocked as seen in Figure 7. When the supercharging is thus terminated, the piston proceeds on the compression stroke.

30 The supercharging being possible at moderate pressure, a two-stroke motor may be so constructed that all of the ports are controlled by the engine piston alone and the auxiliary valve gearing dispensed with.

35 With a sleeve valve engine no more would be required than extra ports low down in the sleeve.

With aero-motors it is essential that the cylinders are fed with supplementary air collectively, and not individually. If each cylinder were to have its own pressure pipe, the motor would become larger and heavier. To avoid the necessity of spacing the cylinders wider apart to make room for the extra valves and air channels, the lower parts of the cylinders, all of them or groups thereof, are enclosed in a receiver as shown in Figure 2, in which the compressed air is stored 10 for admittance at the proper periods.

Instead of an axially reciprocating or oscillating slide valve a rotary valve may be employed to control the flow of compressed air to the cylinders. The valves may then be actuated from a 15 common shaft with cams engaging on a screw gearing, the inlet ports being in any case exclusively controlled by the engine piston for at least the whole duration of the supercharging.

What I claim is:

20 In an internal combustion engine, a cylinder, an initial charge inlet port, an air pump connected to the cylinder by an annular air chamber, a plurality of inlet nozzles tangentially disposed around the lower end of the cylinder and 25 connecting the cylinder with said annular air chamber, said nozzles being rounded on the intake side and expanding at a slight angle at the other end to convert energy of pressure with the least possible loss into kinetic energy, whereby 30 at the beginning of the compression stroke the charge is stratified into a stable rotating cushion of air adjacent the piston and the turbulent initial charge above.

FELIX GRUEBLER. 35

CERTIFICATE OF CORRECTION.

Patent No. 2,018,848.

October 29, 1935

FELIX GRUEBLER.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, strike out lines 25 to 29 inclusive, comprising the following paragraph:—

"Figure 4 is a detail of Figure 5 representing a two-stroke engine in which the scavenging air is suitably directed and supplied at a lower pressure than the supercharge, with further details as in Figures 6 and 7.";

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of September, A. D. 1936.

(Seal)

Leslie Frazer

Acting Commissioner of Patents.