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- (57) Claim

1. A method of improving the operation of an engine, said engine including a cylinder space, a piston movable therein, at least one inlet valve having an inlet duct associated therewith, and at least one outlet valve having an outlet duct associated therewith, said method comprising:

providing an air filling in said inlet duct, upstream of said inlet valve(s);

introducing an initial portion of said air filling into said cylinder space while said outlet valve is open whereby said initial portion of air filling flushes said cylinder space and exits into said outlet duct through the open outlet valve(s);

closing said outlet valve(s) while continuing introduction of said air filling in said cylinder space; and

introducing an air fuel mixture into said cylinder space through the inlet duct(s) and inlet valve(s) through which the air filling has passed, resulting in a fuel charge stratified on top of the air filling.

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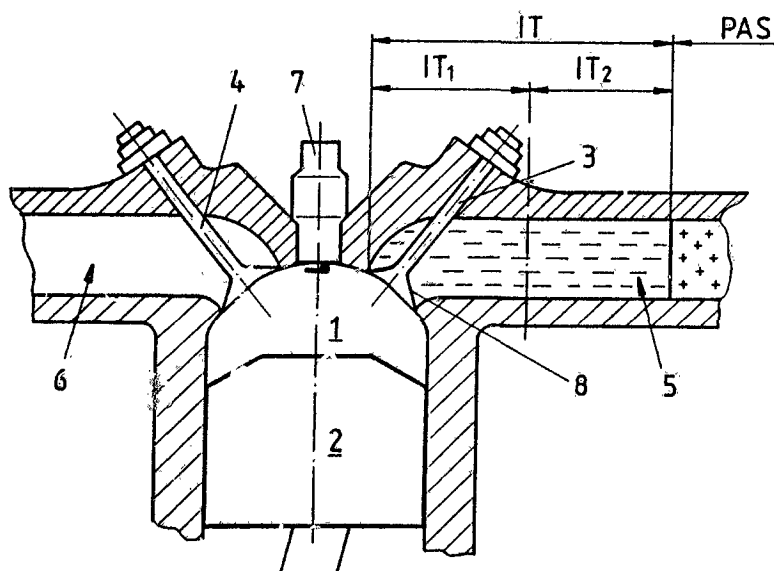
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(57) Abstract

The invention relates to a method of improving the operation of an engine. The engine includes a cylinder space (1), a piston (2) movable therein, at least one inlet valve (3), at least one outlet valve (4) as well as at least one inlet (5) and outlet (6) duct. Into inlet duct (5) or the like is introduced an air filling (IT) prior to the start of an induction stroke in a manner that said filling is first in inlet duct (5) immediately downstream of inlet valve (3). At least a portion (IT₂) of air filling (IT) or the like is introduced into cylinder space (1) while outlet valve (4) is closed. A portion (IT₁) of air filling can be reserved for flushing the cylinder space and said portion (IT₁) is intended to exit through outlet valve (4). A fuel-and-air mixture (PAS) is introduced into the cylinder space after air filling (IT). An apparatus of the invention includes means that are synchronized for filling a section of inlet duct (5) or the like starting immediately downstream of inlet valve (3) with air filling (IT) prior to the start of an induction stroke.

METHOD OF AND APPARATUS FOR IMPROVING
THE OPERATION OF AN ENGINE

The present invention relates to a method of improving the operation of an engine.

A drawback with known engines is that some of the gases already burnt during the preceding power stroke remain in the cylinder space, which is liable to impair efficiency since there is no combustion of gases already burnt. Furthermore, during the flushing of a cylinder space, some of the fuel-and-air mixture may find its way into the exhaust manifold which causes an increase in the consumption of fuel.

One solution for improving the operation of an internal combustion engine is disclosed in the publication DE-OS 19 20 751. This publication describes an apparatus for preventing the passage of fuel-and-air mixture through the outlet valve into the outlet duct during an induction stroke. The apparatus includes an air pipe, which is fitted in the intake manifold and from which branches an air duct to the base of each inlet valve. The air issuing from this air duct provides a flushing effect as the inlet valve and outlet valve are simultaneously open. However, the apparatus disclosed in the above publication is constructionally unreliable in providing a satisfactory flushing action. In addition, the cited publication does not take into consideration all possibilities for the operation of an engine achieved by means of air filling or the like.

Another known apparatus is described in USA-3,046,960. In such apparatus, a first flap fitted in an inlet duct for air and a second flap fitted in a duct for fuel-and-air mixture are opened and closed by a common actuating lever.



However, with the apparatus in accordance with the state of the art, it is not possible to quickly start closing of the first flap at a certain lever position, when such closing is required for the proper functioning of the engine.

The following is a list of some of the more essential features in terms of the operation of an engine for the passage of fuel-and-air mixture:

- The burned gases should preferably be removed as thoroughly as possible from the cylinder space prior to passing a fuel-and-air mixture into the cylinder space,
- during the flushing it is desirable that no fuel-and-air mixture is allowed to pass into the exhaust pipe,
- filling of the cylinder space should preferably be as complete as possible regardless of the running speed,
- the simultaneous open condition or overlap results in increased filling and thus increased power,
- cooling of the valves and cylinders by means of air increases the filling. In theory, this can be derived from the equation

$$\Delta V = \gamma \cdot V_0 \cdot \Delta t$$

In the equation, V_0 is the volume of gas at 0°C and the magnitude of coefficient γ is $1/273^\circ\text{C}^{-1}$. This leads to a conclusion that, when heated to 273°C , the volume of gas expands to double, and



- the complete combustion of fuel with excess air produces cleaner exhaust gases. This decreases especially the amount of the oxides of nitrogen.

The present invention attempts to achieve one or more of the above advantageous features.

According to the present invention there is provided a method of improving the operation of an engine, said engine including a cylinder space, a piston movable therein, at least one inlet valve having an inlet duct associated therewith, and at least one outlet valve having an outlet duct associated therewith, said method comprising:

providing an air filling in said inlet duct, upstream of said inlet valve(s);

introducing an initial portion of said air filling into said cylinder space while said outlet valve is open whereby said initial portion of air filling flushes said cylinder space and exits into said outlet duct through the open outlet valve(s);

closing said outlet valve(s) while continuing introduction of said air filling in said cylinder space; and

introducing an air fuel mixture into said cylinder space through the inlet duct(s) and inlet valve(s) through which the air filling has passed, resulting in a fuel charge stratified on top of the air filling.

The present invention further provides a method of improving the operation of an engine, said engine including a cylinder space, a piston movable therein, at least one inlet valve having an inlet duct associated therewith, and at least one outlet valve having an outlet duct associated therewith, said method comprising:

providing an air filling entirely in said inlet duct upstream of said inlet valve(s);



providing an air filling into said cylinder space, a portion of said air filling being introduced while said outlet valve is closed;

retaining said at least portion of said air filling in said cylinder space prior to introduction of an air-fuel mixture; and

introducing an air fuel mixture into said cylinder space through the same inlet duct(s) and inlet valve(s) through which the air filling has passed, resulting in a fuel charge stratified on top of the air filling.

Thus, it is possible, although not necessary, that a method disclosed in the publication DE-OS 19 20 751 may be applied in addition to the method of the invention in the sense that, at the start of an induction stroke, the inlet valve and outlet valve are simultaneously open for a while. Thus, a portion of the air filling or the like can be reserved for flushing the cylinder space and this portion is intended to discharge through at least one outlet valve. The at least one outlet valve may be closed before the entire air filling is discharged, some of the air filling remaining in the cylinder space into which a fuel-and-air mixture is passed after the air filling. The air filling or a portion thereof is sucked to above a piston in the cylinder space and thus the explosive fuel-and-air mixture lies on top of this layer of air. At the moment of explosion, the layer of air on top of a piston in the cylinder space assists in producing a complete combustion and, hence, cleaner exhaust gases.

The method of the present invention may be applicable to engines operating on either Otto, Diesel or Wankel principle.

According to another aspect of the present invention there is provided an apparatus for improving the operation of an



engine, said engine including at least two cylinder spaces, each cylinder space comprising a piston, at least one inlet valve, at least one outlet valve, an inlet duct for fuel-and-air mixture associated with said inlet valve, and an outlet duct for burnt gases associated with said outlet valve, said apparatus including an air introducing means for filling a section of said inlet duct immediately upstream of said inlet valve with an air filling prior to the start of an induction stroke, said air introducing means comprising:

a filling duct for each said cylinder space each respective filling duct being connectable to said respective inlet duct at said respective inlet valve;

said filling ducts being in communication with a distributor adapted for introducing said air filling into said filling ducts in a manner synchronized with the operation of said engine;

adjusting means for controlling the amount of the air filling said adjusting means being operatively connected with said distributor, and including a first regulating member fitted in a duct communicating with an inlet connection of said distributor, a second regulating member fitted in an upstream portion of said inlet duct, and means operatively interconnecting said first and second regulating members, said interconnecting means being adapted for transmitting movement of said second regulating member to said first regulating member, whereby adjusting effect imparted upon said second regulating member is transferred as a corresponding adjusting effect to said first regulating member.

The present invention also provides an apparatus for improving the operation of an engine, said engine including at least two cylinder spaces each cylinder space comprising a piston, at least one inlet valve, at least one outlet valve, an inlet duct for fuel-and-air mixture associated



with said inlet valve and an outlet duct for burnt gases associated with said outlet valve, said apparatus including an air introducing means for filling a section of said inlet duct immediately upstream of said inlet valve with an air filling prior to the start of an induction stroke, said air introducing means comprising:

a filling duct for each said cylinder space, each respective filling duct being connectable to said respective inlet duct for fuel-and-air mixture at said respective inlet valve;

said filling ducts being in communication with a distributor adapted for introducing said air filling into said filling ducts in a manner synchronized with the operation of said engine;

means for adjusting the amount of the air filling operatively connected with said distributor, said adjusting means including a first regulating member fitted in a duct communicating with an inlet connection of said distributor; a second regulating member fitted in an upstream portion of said inlet duct; and means for connecting said first and second regulating member and adapted for controlling movement of said first regulating member according to the movements of said second regulating member;

said connecting means including an intermediate spring for linking the axis of said first and second regulating member and an operating lever, said operating lever being acted upon by means of a cable or the like for imparting the adjusting effect to said second regulating member, a substantially parallel effect or action being transmitted to the first regulating member by means of said intermediate spring;

wherein in a certain operating lever position, a member of said operating lever is adapted to shift said first regulating member quickly back to a closing position against the force of said intermediate spring.



Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

- Fig. 1 shows schematically the basic idea of a preferred embodiment of the invention,
- Figs. 2a-c show the most essential stages of the most present method in a piston engine operating on four-stroke principle,
- Figs. 3-5 illustrate views of several preferred embodiments of air filling distributor means applicable in connection with an engine comprising two or more cylinder spaces,
- Fig. 6 is a perspective view of an engine which is equipped with two cylinder spaces and fitted with a distributor means and an adjustment mechanism (Fig. 6a) for adjusting the air filling in proportion to the speed of rotation of an engine and
- Fig. 7 is a view of the adaptation of a method of the invention to a two-stroke engine.

An engine shown in Fig. 1 comprises a cylinder space 1, a piston 2 movable therein, an inlet valve 3, an outlet valve 4, an inlet duct 5 as well as an outlet duct 6. It is obvious that the engine includes normal mechanical elements for controlling the movement of valves and piston as well as an ignition system with a spark plug 7 as part of it. This overall aspect is not described in detail as it is not a part of the present invention and is well known technology to a person skilled in the art.

According to the basic idea of the invention, the inlet duct 5 is filled with an air filling IT, indicated in



fig. 1 by - signs. This air filling starts at the back face 8 of the inlet valve clack and continues through a certain adjustable distance in inlet duct 5. This air filling is followed by a fuel-and-air mixture PAS, indicated by + signs. According to one aspect of the invention, the forward portion of air filling or a ^{first} ~~certain~~ portion IT₁ of air filling IT issuing from inlet valve 3 can be used for flushing the cylinder space, as described later in more detail. The second portion IT₂ of air filling IT further down in inlet duct 5 is adapted to be introduced into cylinder space 1 only after the outlet valve 4 has closed at the start of an induction stroke. In any case, the provision of through-flushing is optional in terms of the invention. Thus, the entire air filling IT can be introduced into the cylinder space while the outlet valve is closed.

It should be appreciated that the term "air filling" is intended to cover other corresponding gases or gas mixtures suitable for the same purpose. All gas mixtures capable of achieving the characterizing features set forth in the preamble section of this specification can be employed. It is naturally obvious that such a gas mixture must contain oxygen in a certain proportion.

Fig. 2a illustrates the formation of air filling IT in inlet duct 5 during a power stroke. Thus, air is supplied from a filling duct 9 connected with inlet duct 5 through a port 10 between inlet duct 5 and filling duct 9, which port can be located near inlet valve 3 as shown in figs. 2a-c. The air filling IT displaces the fuel-and-air mixture PAS away from the inlet valve further down inlet duct 5, said fuel-and-air mixture having extended all the way to inlet valve 3 after the



preceding induction stroke. Following a power stroke, and especially in four-stroke engines, at the end of an exhaust stroke, whereby the piston is at or near the top dead centre, there will be the situation shown in fig. 2b. This situation is an overlap situation with inlet valve 3 and outlet valve 4 simultaneously open for a while, whereby the burned gases, indicated by circles, discharge into outlet duct 6 as indicated by an arrow 11. At the same time, while the inlet valve is open, a portion IT_1 of air filling IT discharges from inlet duct 5 into cylinder space 1 so that this portion exits together with the burned gases into outlet duct 6.

The situation shown in fig. 2c is the starting stage of an induction stroke, said outlet valve 4 having closed and a portion IT_2 of air filling IT lying on the top surface of piston 2 and, after that, the fuel mixture having filled the rest of cylinder space 1. After the closing of inlet valve 3 and following a compression stroke, there is again the situation shown in fig. 2a after the fuel mixture extending to inlet valve has been displaced to the position shown in fig. 2a.

At the moment of explosion, in cylinder space 1 on top of piston 2 there is an air filling IT, either the entire air filling or a portion thereof, as long as the simultaneous opening of inlet valve 3 and outlet valve 4 is employed during an exhaust stroke as indicated in fig. 2.

It is obvious that in single-piston engines the delivery of air filling is simple, e.g. a control acquired from the rotation of a crankshaft or from the rotation of

a member carried thereby can be used to open a valve communicating with filling duct 9. In addition to the normal vacuum of an intake manifold, the air filling can in some cases be obtained by using an air pump or a supercharger.

Fig. 3 shows one way of applying an engine provided with two, four, six etc. cylinder spaces for practicing the method. Thus, those two (e.g. ST_1 and ST_4) of the cylinder spaces of an engine are always selected, which are simultaneously doing an induction stroke (ST) and a power stroke (ST_4). A distributor means 14 provided with two outlets 12 and 13 is connected to filling ducts 9_1 and 9_4 communicating with respective cylinder spaces. The distributor means 14 comprises an elongated chamber space 15, preferably of a circular cross-section, said outlet connections 12 and 13 as well as an air filling inlet connection 16 being in communication therewith. In chamber space 15 a longitudinally movable clack member 17 is fitted for always closing that outlet connection (outlet connection 12 in Fig. 3), whose corresponding cylinder space is in induction stroke. This is due to the fact that at this point there is a vacuum in the inlet duct that carries clack member 17 into alignment with the corresponding outlet connection 12, the clack member being carried in chamber space 15 by centering springs 17a, 17b. Thus, from inlet connection 16 there opens through chamber space 15 an access to outlet connection 13 and, hence, an air filling IT can develop in an inlet duct 5_4 . Between the movements of air filling and while the engine is not running, the clack member 17 is in alignment with inlet connection 16 and closes it.

Fig. 4 shows another embodiment of the distributor means.



A distributor means 18 includes a tubular element 19, coupled to be rotatable around its longitudinal axis in synchronization with the speed of rotation of an engine by means of a member 20, which is shown as reference. A person skilled in the art is well aware of how to achieve such synchronization and ^{how to construct} member 20, so this is not explained further in this context. Tube 19 is fitted inside a protective pipe 21, shown with dash-and-dot lines and provided with communicating ports into filling ducts 9_1-9_4 connected to cylinder spaces ST_1-ST_4 . Tube 19 is further provided with openings 22, corresponding to the number of cylinder spaces and arranged on the periphery of tube 19 in ^{such} a manner that always one opening can be in communication with the filling connection of one cylinder space. Furthermore, the openings are arranged at regular mutual distances on the outer periphery of tube 19. Thus, as tube 19 is rotating around its longitudinal axis, an air flow (arrow 23), produced by a vacuum prevailing in the intake manifold for developing an air filling IT in an inlet duct connected with each cylinder space, passes through a corresponding opening 22 into a corresponding filling duct 9_1-9_4 in a synchronized fashion during the compression stroke of each cylinder.

Fig. 5 illustrates a still further possible embodiment of an air distributor. This air distributor 24 comprises a ^{substantially} ~~basically~~ annular frame jacket 25, a distributing disk 26 fitted inside the jacket and provided with a distributing hole 27. Distributing disk 26 is adapted to rotate around an axle 28 which is aligned perpendicularly to the radius of the annular jacket. The ends of annular jacket 25 are closed on the one hand by an inlet gable 29 and on the other hand by a distribution gable 30. The inlet gable 29 is provided



with a filling air inlet connection 31 and the distribution gable 30 is provided with a number of outlet connections 32 corresponding to the number of cylinder spaces and communicating with filling ducts 9_1 - 9_4 and mounted co-radially relative to the centre of distribution gable 30, so that said hole 27 rotating on a circular line with a corresponding radius will be aligned with said outlet connections. When a vacuum prevailing in the intake manifold is used to supply air into the space of distributor 24 defined by frame jacket 25, distributing disk 26 and inlet gable 29 and with hole 27 rotating in alignment with inlet gable 30, the air flow always shifts to that outlet connection 32 which is in alignment with hole 27. This operation is effected in a synchronized fashion.

Fig. 6 is a perspective view of an engine 33 provided with two cylinder spaces. A distributor 24 is similar to that shown in Fig. 5 although constructed to be suitable for two cylinder spaces ST_1 and ST_2 . The filling ducts 9_1 and 9_2 are mounted in communication with respective inlet ducts 5_1 and 5_2 to provide a construction basically similar to that shown in Figs. 2a-c. Fig. 6 depicts one of the advantages gained by the present invention, namely the air filling IT creates in the distribution duct 34 of inlet ducts 5_1 and 5_2 a reciprocating motion shown by an arrow 35 for further enhancing the mixing of fuel-and-air mixture. The enlarged partial Figure 6a accompanying Fig. 6 further illustrates one embodiment of a mechanism for adjusting the amount of air filling 36. Fitted in a fuel-and-air mixture inlet duct 37 is a fuel-and-air mixture adjustment flap 38 or a similar member. This flap is used to control the speed of rotation of an engine. The adjustment flap is provided with a leverage 39 for

turning the flap around an axis KA extending in the direction of the flap diameter as shown by an arrow 40 whenever the operating lever 41 of flap 38, journalled (at 42) rotatably relative to an engine block, is acted upon through the intermediary of ~~e.g.~~ a cable 43 or the like. Similarly, a duct 31a communicating with inlet connection 31 of distributor 24 is fitted with an adjustment flap 44 or the like for adjusting the amount of ~~air in~~ air filling. The turning axle 45 of flap 44 or the like is connected by an intermediate spring 46 to the turning axle 47 of flap 38. The turning axles 45 and 47 are journalled upon sleeves 48 and 49 secured to the engine block. The turning axle 45 of flap 44 is fitted with a leverage 50. The extension 41a of an operating lever 41 is adapted to act on leverage 50 as shown by a diagram I. The flap 44 or its turning axle 45 is fitted with a cable 53 (53') or the like for keeping flap 44 closed during a cold start.

Diagram I illustrates the opening of a flap as a function of the speed of rotation of an engine. The diagram shows that flap 38 as the speed of rotation of an engine increases uniformly and the opening of flap 44 is linked with this opening movement in a manner that, with a cold start on a certain speed range of rotation, flap 44 begins to open after the detachment of cable 53 and as said intermediate spring 46 transmits the turning of axle 47 to the axle 45 of flap 44. Thus, flap 44 opens to its maximum open position as the speed range of an engine is ^{about} ~~circ~~ 40-70 % of its maximum (50 % in diagram I). After this speed range said flap 44 closes very quickly and remains closed on the top speeds of rotation of an engine. This operation is effected by means of the extension 41a of operating lever 41 and the leverage 50 of adjustment flap 44



which, upon shifting said operating lever 41 for producing top speed of rotation, encounter each other and this encounter results in the closing of flap 44.

When operating lever 41 is returned to its initial position, flap 38 closes and flap 44 remains in its closed position by the action of said intermediate spring. Diagram I depicts a corresponding operation also for flaps 38 and 44, so that the relative position of flaps 38 and 44 is sketched on respective speed ranges of an engine in alignment with dash-and-dot lines describing ducts 31a and 37. In the example, flap 44 forms with the longitudinal axis of duct 31 a 45° angle in its closed position and flap 38 is perpendicular to the longitudinal axis of duct 37 in its closed position. Thus, the turning motion of flap 44 to a maximum position is 45° (closing at half-way point of maximum speed of rotation) and the turning motion of flap 38 to a maximum position is 80°-90°. When the engine is warm, the opening of flap 44 can be synchronized by means of an intermediate spring 46 in direct proportion to the speed of rotation of an engine also on idle run and low speeds of rotation. This is effected by means of the above-mentioned adjustment mechanism 16. It is obvious that the design of such adjustment mechanism can be varied considerably within the scope of alternative constructions self-evident for a person skilled in the art. Flap 44 is fully open e.g. when the speed of rotation of an engine is half of the maximum and it closes when the speed of rotation reaches the maximum. It is clear that the operation of an adjustment flap can also be effected by a manual control which is different from the above operation. In an engine of the invention, a normal carburetor can also be replaced with continuous injection or central in-

jection. The engine can also be provided with a super-charger. It is obvious from the above that the engine can include an even or odd number of cylinders.

- 5 Fig. 7 illustrates the application of a method of the invention to a two-stroke engine. A piston 2 compresses through a crankcase 51 into an inlet duct a mixture of fuel and air. An inlet duct 5 communicates by way of a valve 52 with a filling duct, adapted to operate
10 so as to fill the forward section of said inlet duct with an air filling IT. The air filling displaces the fuel-and-air mixture which has arrived in inlet duct 5 from crankcase 51. Valve 52 can be a spring-loaded needle valve or the like allowing the flow of air filling IT from filling duct 9 into inlet duct 5 but not
15 in the opposite direction.

- The method and apparatus of ^{the preferred embodiments of} the invention are capable of providing an adjustable lean mixture engine. The
20 application of this method requires sufficiently long inlet ducts ⁺ an engine so as to reserve a sufficient amount of air in inlet ducts at all operating stages of an engine. The cover of an engine can be either inclined, semi-spherical, shaped as a trussed roof or a
25 vat. The outlet valve is preferably positioned higher than the inlet valve and the spark plug at the highest point of a cylinder space. A condition for these is of course that the cylinder space is adapted to extend in vertical direction. The method is capable of providing a reliably running engine which, at the moment
30 of explosion, contains a readily ignitable and lean mixture which in turn produces cleaner exhaust gases and possibly makes even the use of a catalyzer unnecessary. A fuel-and-air mixture received in the engine is
35 uniform with a reciprocating mixing motion developing



in inlet ducts 5 as well as in their distribution duct (component 35 in fig. 6). Thus, operation of the carburetor and especially a flow therethrough is smooth. In addition, it is possible to employ a higher compression ratio in the engine.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS

1. A method of improving the operation of an engine, said engine including a cylinder space, a piston movable therein, at least one inlet valve having an inlet duct associated therewith, and at least one outlet valve having an outlet duct associated therewith, said method comprising:

providing an air filling in said inlet duct, upstream of said inlet valve(s);

introducing an initial portion of said air filling into said cylinder space while said outlet valve is open whereby said initial portion of air filling flushes said cylinder space and exits into said outlet duct through the open outlet valve(s);

closing said outlet valve(s) while continuing introduction of said air filling in said cylinder space; and

introducing an air fuel mixture into said cylinder space through the inlet duct(s) and inlet valve(s) through which the air filling has passed, resulting in a fuel charge stratified on top of the air filling.

2. A method of improving the operation of an engine, said engine including a cylinder space, a piston movable therein, at least one inlet valve having an inlet duct associated therewith, and at least one outlet valve having an outlet duct associated therewith, said method comprising:

providing an air filling entirely in said inlet duct upstream of said inlet valve(s);

providing an air filling into said cylinder space, a portion of said air filling being introduced while said outlet valve is closed;

retaining said at least portion of said air filling in said cylinder space prior to introduction of an air-fuel mixture; and



introducing an air fuel mixture into said cylinder space through the same inlet duct(s) and inlet valve(s) through which the air filling has passed, resulting in a fuel charge stratified on top of the air filling.

3. A method according to claim 1 or 2, wherein said air filling is introduced into said inlet duct by displacement of said air-fuel mixture within said inlet duct in a direction away from said inlet valve.

4. A method according to claim 2, wherein air filling is introduced into the inlet duct from a filling duct which connects with said inlet duct substantially at the inlet valve.

5. A method according to claim 1 or 2, wherein said engine comprises at least two cylinder spaces and wherein said air filling is introduced into an inlet duct of each cylinder space through a communicating filling duct by means of a distributor including a control member adapted for passing air filling into each filling duct in a synchronized manner.

6. A method according to claim 5, wherein operation of said control member is controlled by means of the induction stroke of the cylinder space in such a manner that the connection of cylinder spaces coupled pairwise with the same distributor is intercepted by said control member during each induction stroke for opening a connection to the inlet duct of another cylinder space, in which prevails a compression stroke.

7. A method according to claim 5, wherein the operation of said control member is controlled by means of a transmission obtained mechanically from the speed of rotation of an engine.



8. A method according to claim 1 or 2, wherein the supply of air filling is intercepted at a certain speed of rotation of an engine, preferably at 40-70% of maximum speed of rotation.

9. A method according to claim 5, wherein the flow of air filling into said inlet duct is controlled by an adjustment means, said adjustment means including a first regulating member fitted in a duct communicating with an inlet connection of said distributor; a second regulating member fitted in an upstream portion of said inlet duct, and means operatively interconnecting said first and second regulating members and being adapted for transmitting movement of said second regulating member to said first regulating member, whereby adjusting effect imparted upon said second regulating member is transferred as a corresponding adjusting effect to said first regulating member.

10. A method according to claim 9, wherein said first regulating member is closed at a certain speed of rotation of an engine, preferably at 40-70% maximum speed of rotation.

11. A method according to claim 9 or 10 further comprising means for holding said first regulating member closed during a cold start.

12. An apparatus for improving the operation of an engine, said engine including at least two cylinder spaces, each cylinder space comprising a piston, at least one inlet valve, at least one outlet valve, an inlet duct for fuel-and-air mixture associated with said inlet valve, and an outlet duct for burnt gases associated with said outlet valve, said apparatus including an air introducing means for filling a section of said inlet duct immediately



upstream of said inlet valve with an air filling prior to the start of an induction stroke, said air introducing means comprising:

a filling duct for each said cylinder space each respective filling duct being connectable to said respective inlet duct at said respective inlet valve;

said filling ducts being in communication with a distributor adapted for introducing said air filling into said filling ducts in a manner synchronized with the operation of said engine;

adjusting means for controlling the amount of the air filling said adjusting means being operatively connected with said distributor, and including a first regulating member fitted in a duct communicating with an inlet connection of said distributor, a second regulating member fitted in an upstream portion of said inlet duct, and means operatively interconnecting said first and second regulating members, said interconnecting means being adapted for transmitting movement of said second regulating member to said first regulating member, whereby adjusting effect imparted upon said second regulating member is transferred as a corresponding adjusting effect to said first regulating member.

13. An apparatus for improving the operation of an engine, said engine including at least two cylinder spaces each cylinder space comprising a piston, at least one inlet valve, at least one outlet valve, an inlet duct for fuel-and-air mixture associated with said inlet valve, said apparatus including an air introducing means for filling a section of said inlet duct immediately upstream of said inlet valve with an air filling prior to the start of an induction stroke, said air introducing means comprising:

a filling duct for each said cylinder space, each respective filling duct being connectable to said



respective inlet duct for fuel-and-air mixture at said respective inlet valve;

said filling ducts being in communication with a distributor adapted for introducing said air filling into said filling ducts in a manner synchronized with the operation of said engine;

means for adjusting the amount of the air filling operatively connected with said distributor, said adjusting means including a first regulating member fitted in a duct communicating with an inlet connection of said distributor; a second regulating member fitted in an upstream portion of said inlet duct; and means for connecting said first and second regulating member and adapted for controlling movement of said first regulating member according to the movements of said second regulating member;

said connecting means including an intermediate spring for linking the axis of said first and second regulating member and an operating lever, said operating lever being acted upon by means of a cable or the like for imparting the adjusting effect to said second regulating member, a substantially parallel effect or action being transmitted to the first regulating member by means of said intermediate spring;

wherein in a certain operating lever position, a member of said operating lever is adapted to shift said first regulating member quickly back to a closing position against the force of said intermediate spring.

14. An apparatus according to claim 12 or 13, wherein said first regulating member is provided with a closing member for retaining said first regulating member in a closed position during a cold start.

15. An apparatus according to claim 12 or 13, wherein said cylinder spaces are pairwise coupled with a common distributor, said distributor being provided with two



outlets connected to said filling ducts, a chamber space and a control member movable therein, said control member being adapted through the vacuum resulting from the induction stroke to alternately close outlets for supplying air filling from the distributor's inlet connection through the opened outlet of said chamber space into the inlet duct of that cylinder space wherein prevails a compression stroke.

16. An apparatus according to claim 12 or 13, wherein said distributor includes a tubular member rotatable around its longitudinal axis by rotating means according to the speed of rotation of the engine, a protective pipe which is provided with connecting ports leading into said filling ducts and which surrounds said tubular member and openings whose number corresponds to that of said cylinder spaces and which are distributed in said tubular member in such a manner that at least one of said openings at a time, is in communication with a corresponding connecting portion in a manner synchronized with the operation of the engine.

17. An apparatus according to claim 12 or 13, wherein said distributor comprises a distributing disk provided with a distributing hole and adapted to rotate between an inlet end and an outlet end so as to open a communication path to each outlet connection association with the outlet end and leading to a respective filling duct, said communication path opening alternately to each outlet connection from an inlet connection at said inlet end.

18. A method of improving the operation of an engine substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

19. An apparatus for improving the operation of an engine substantially as hereinbefore described with



reference to and as illustrated in the accompanying drawings.

DATED THIS 29TH DAY OF OCTOBER 1991

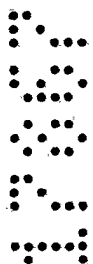
SUOMINEN L & B

By Its Patent Attorneys

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Fellows Institute of Patent

Attorneys of Australia.



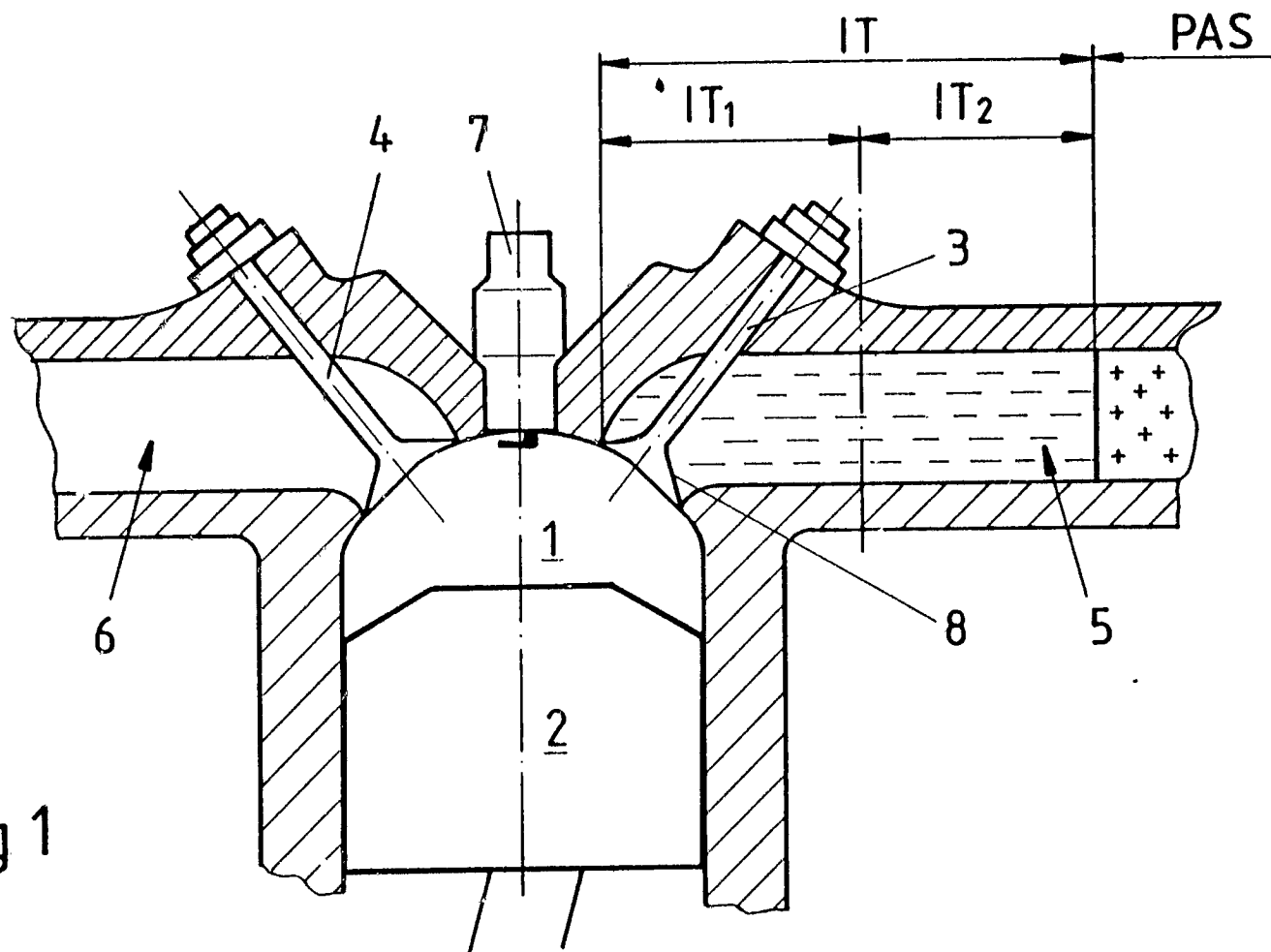
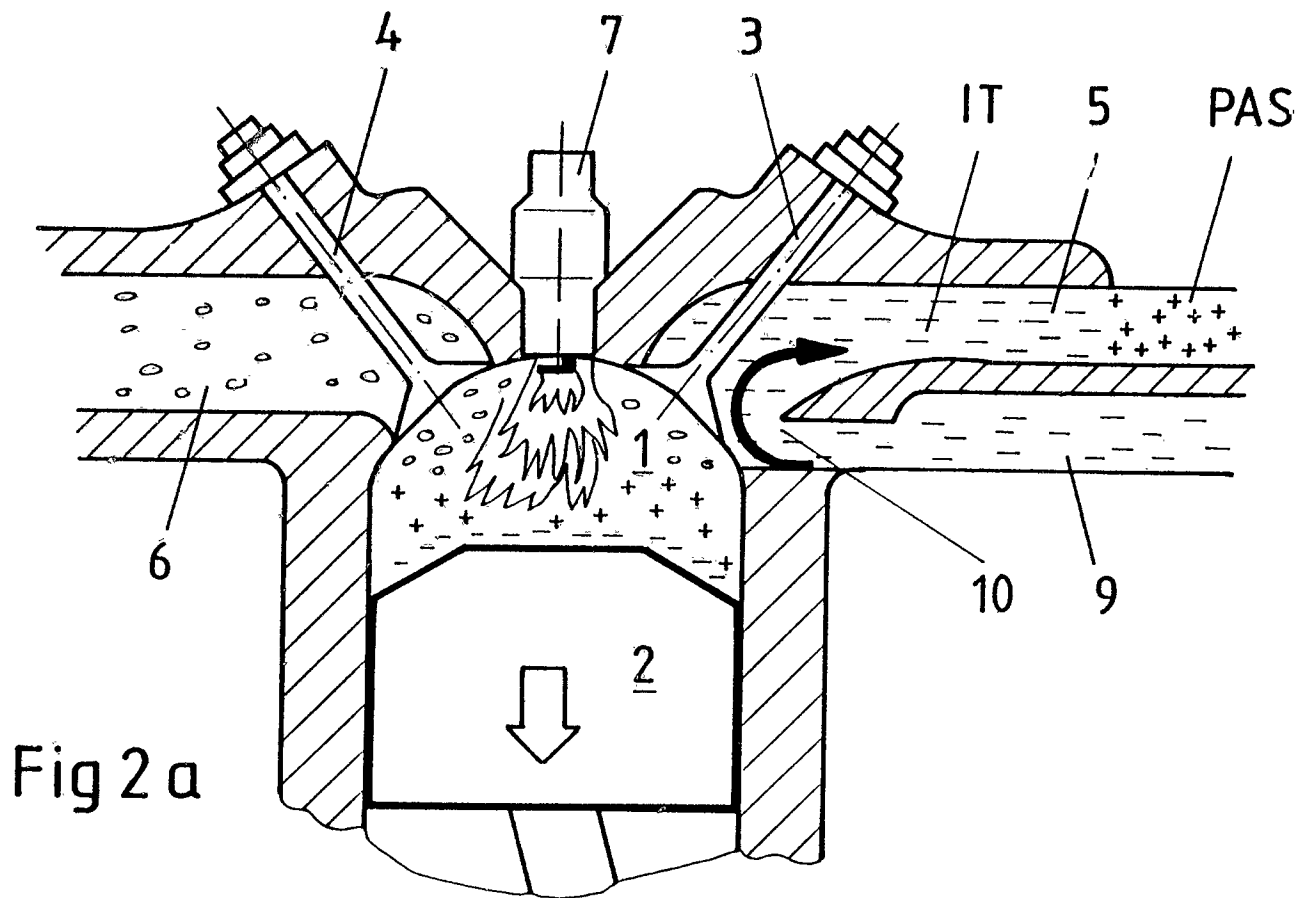


Fig 1

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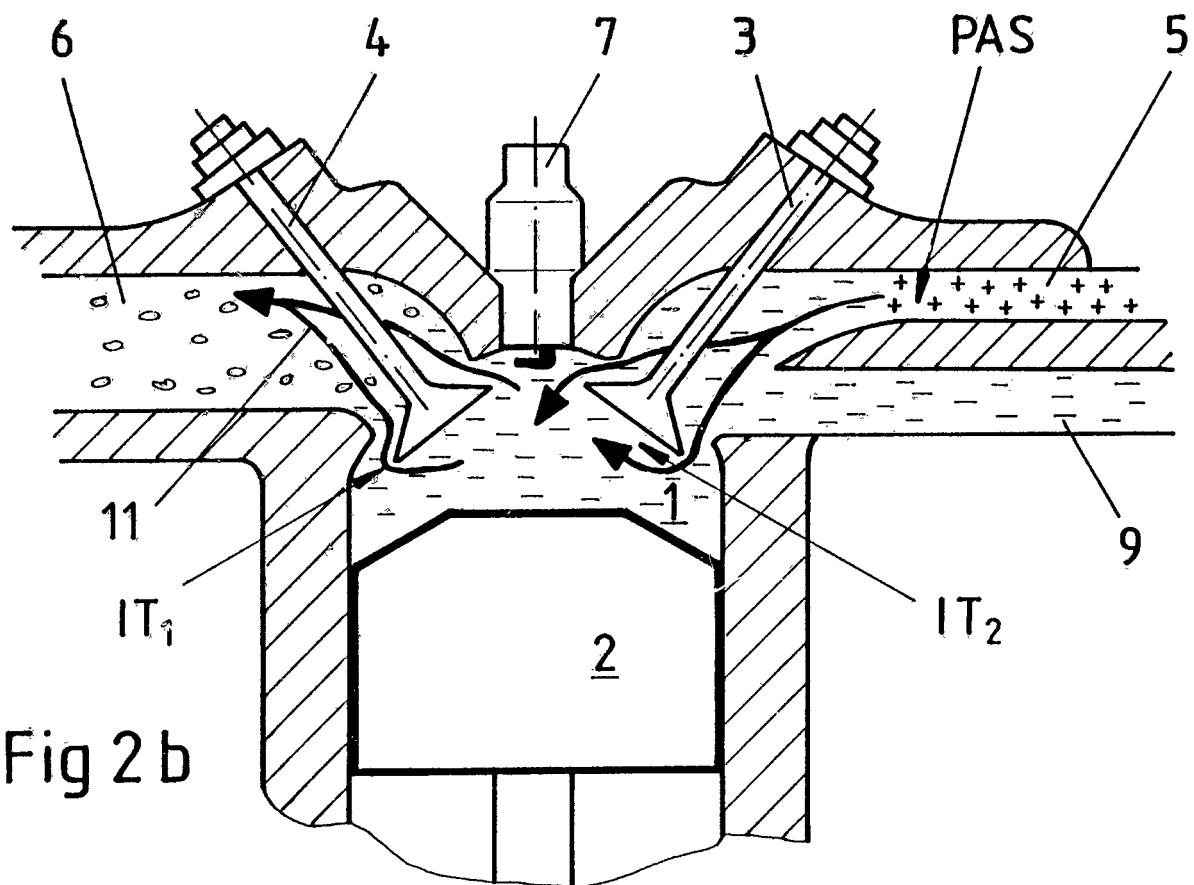
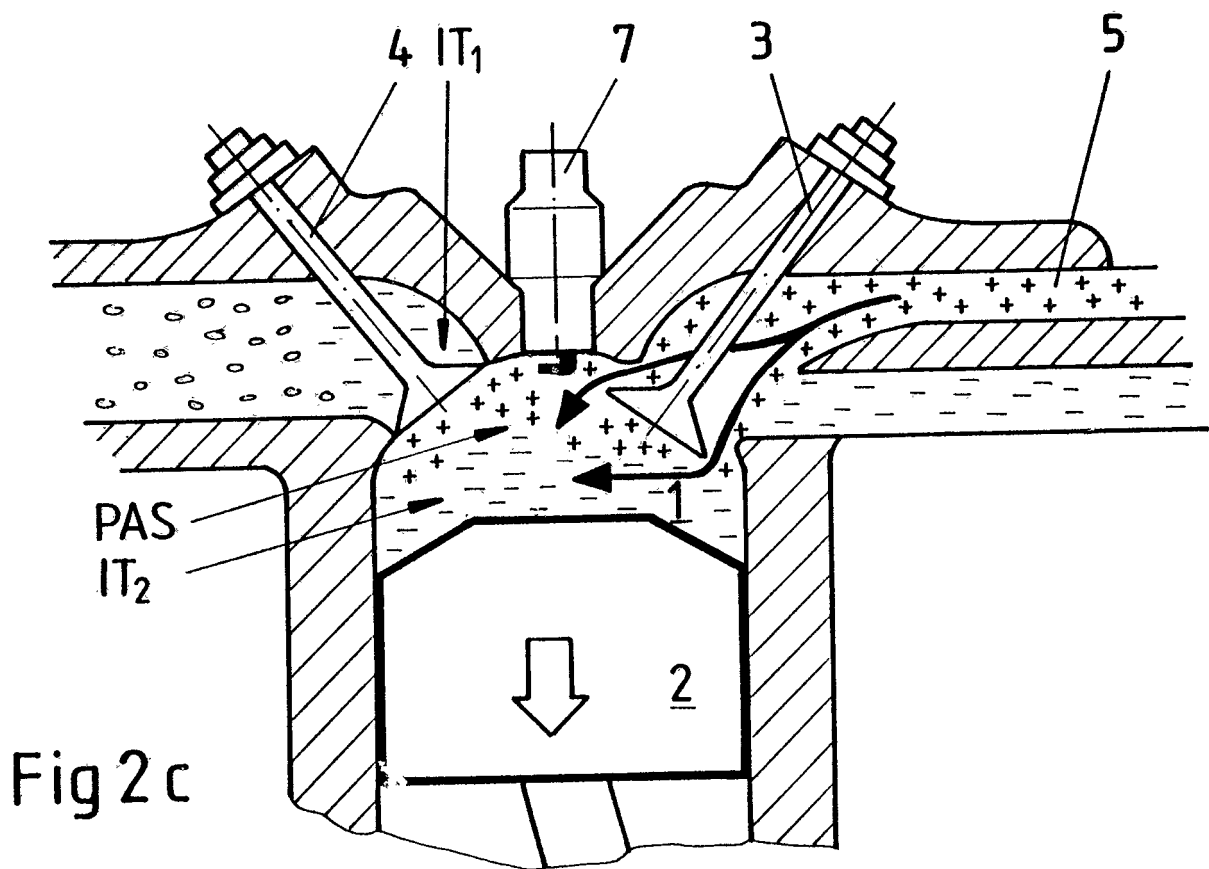


Fig 2 b



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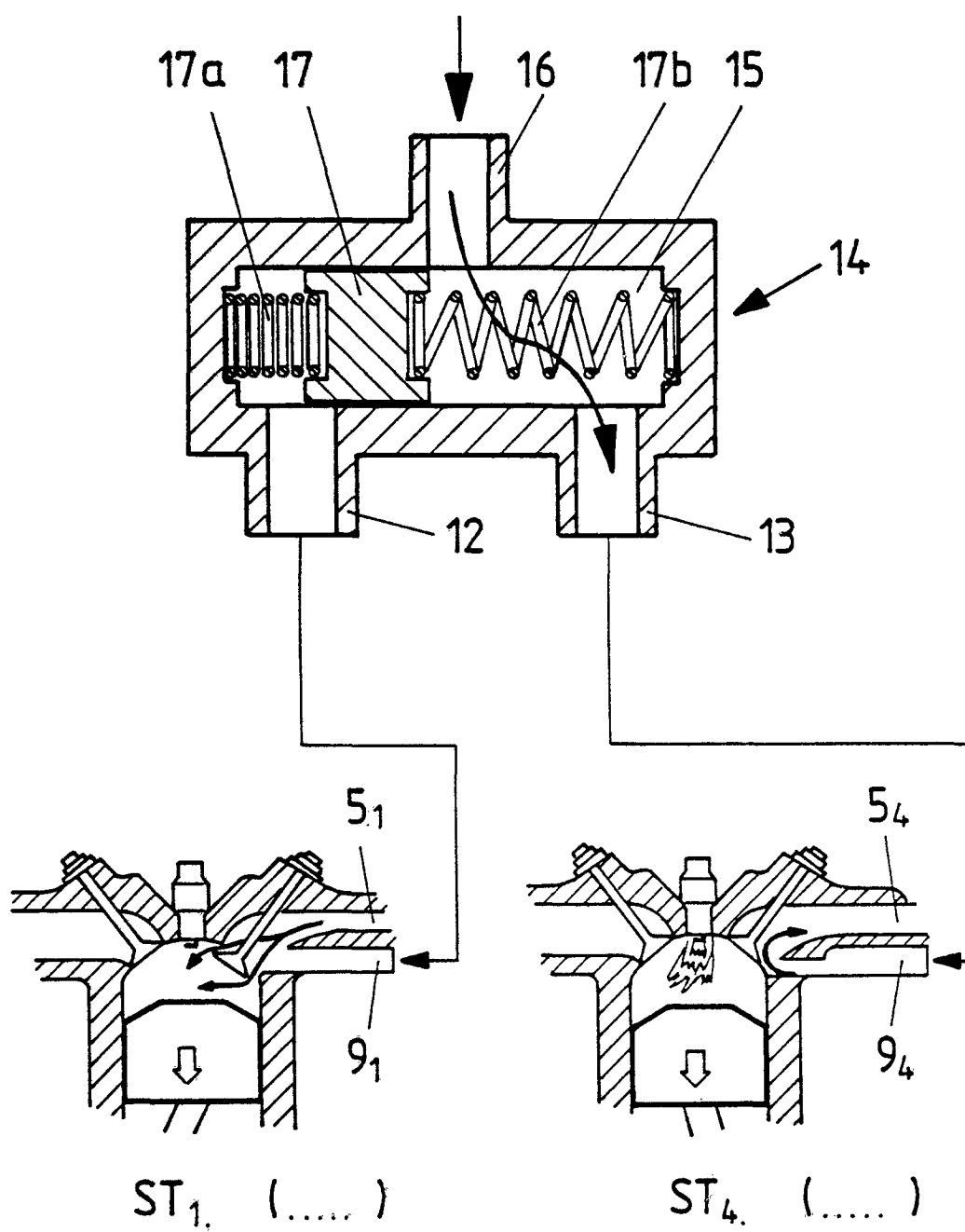
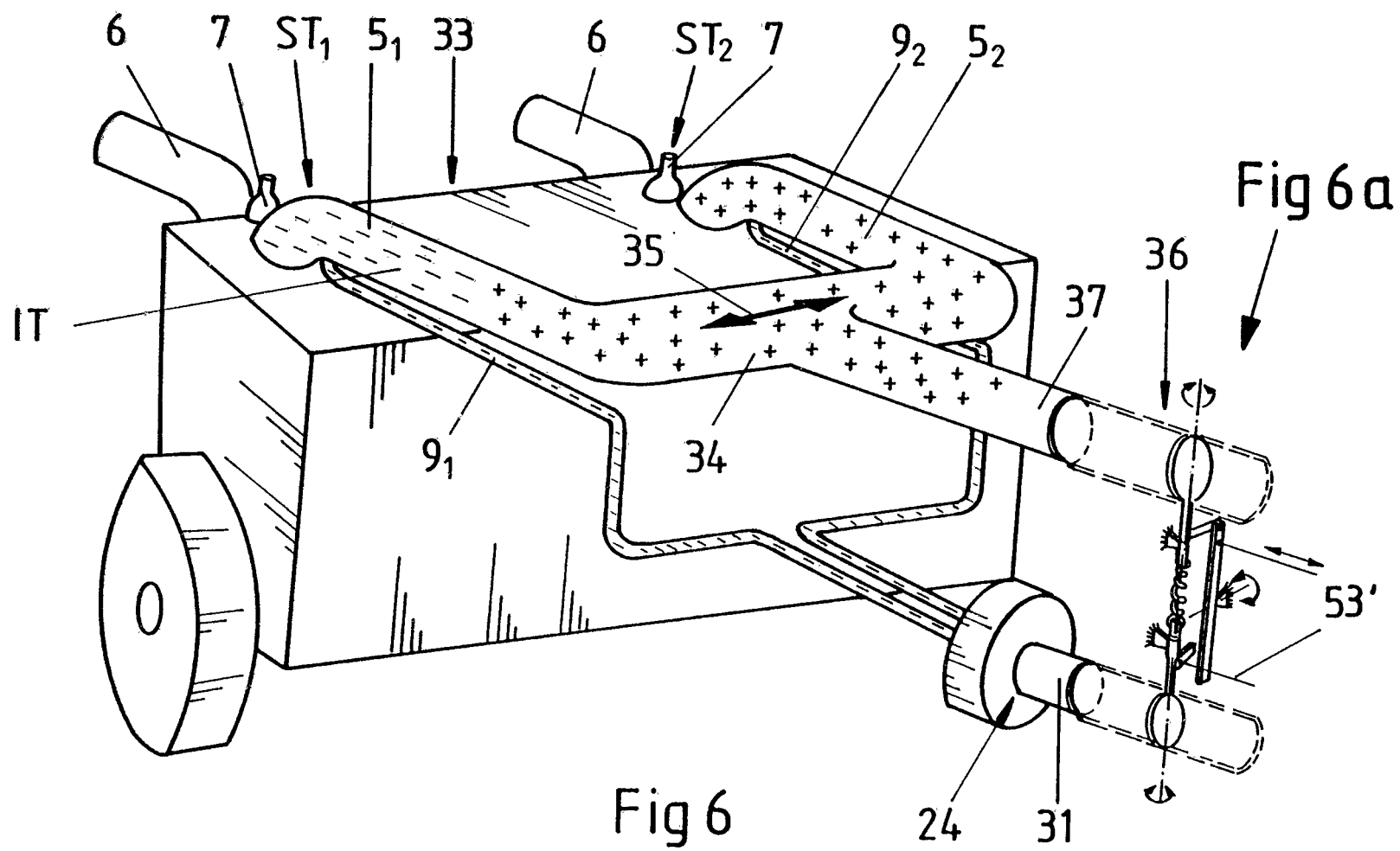


Fig 3



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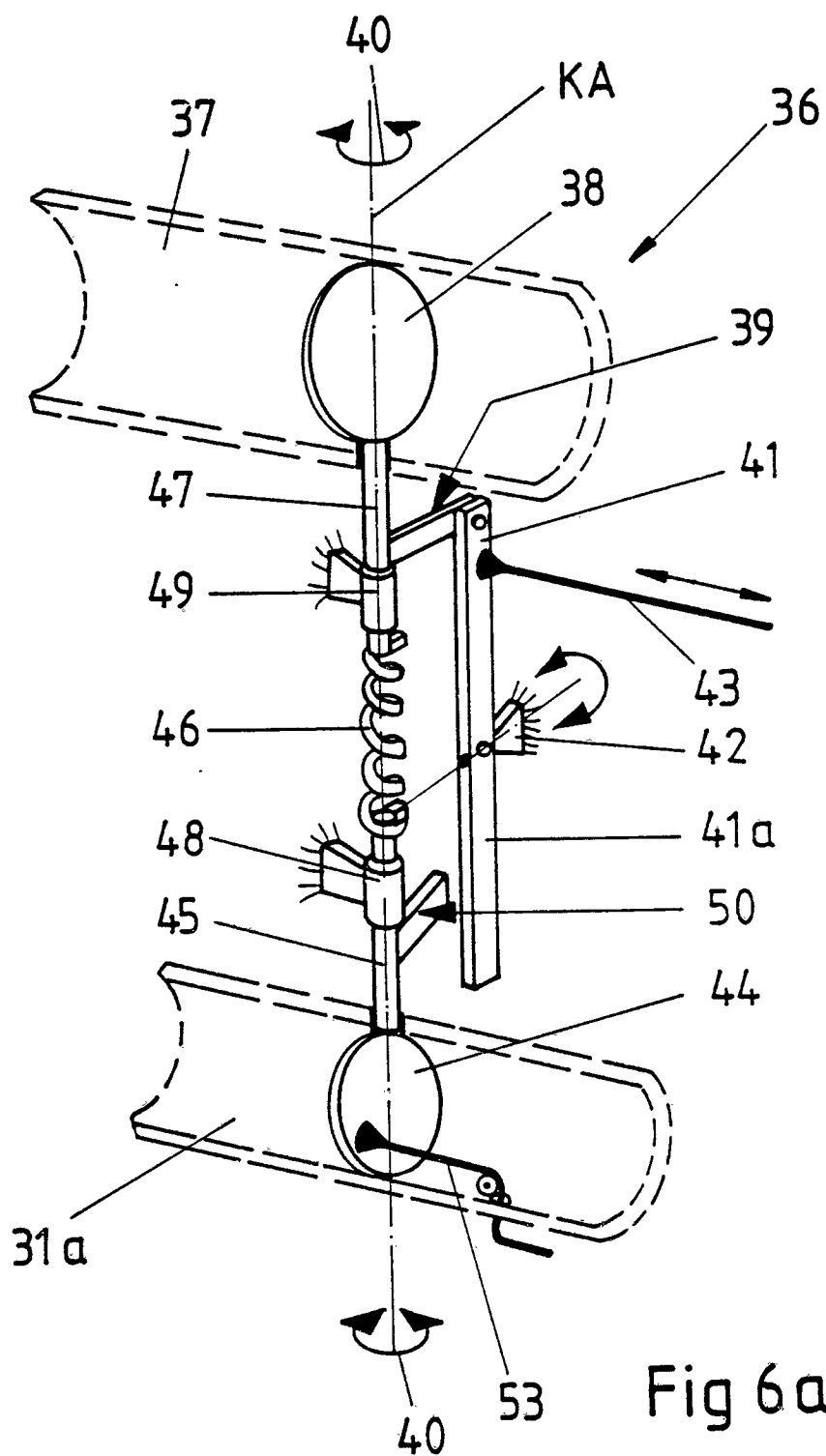


Fig 6a

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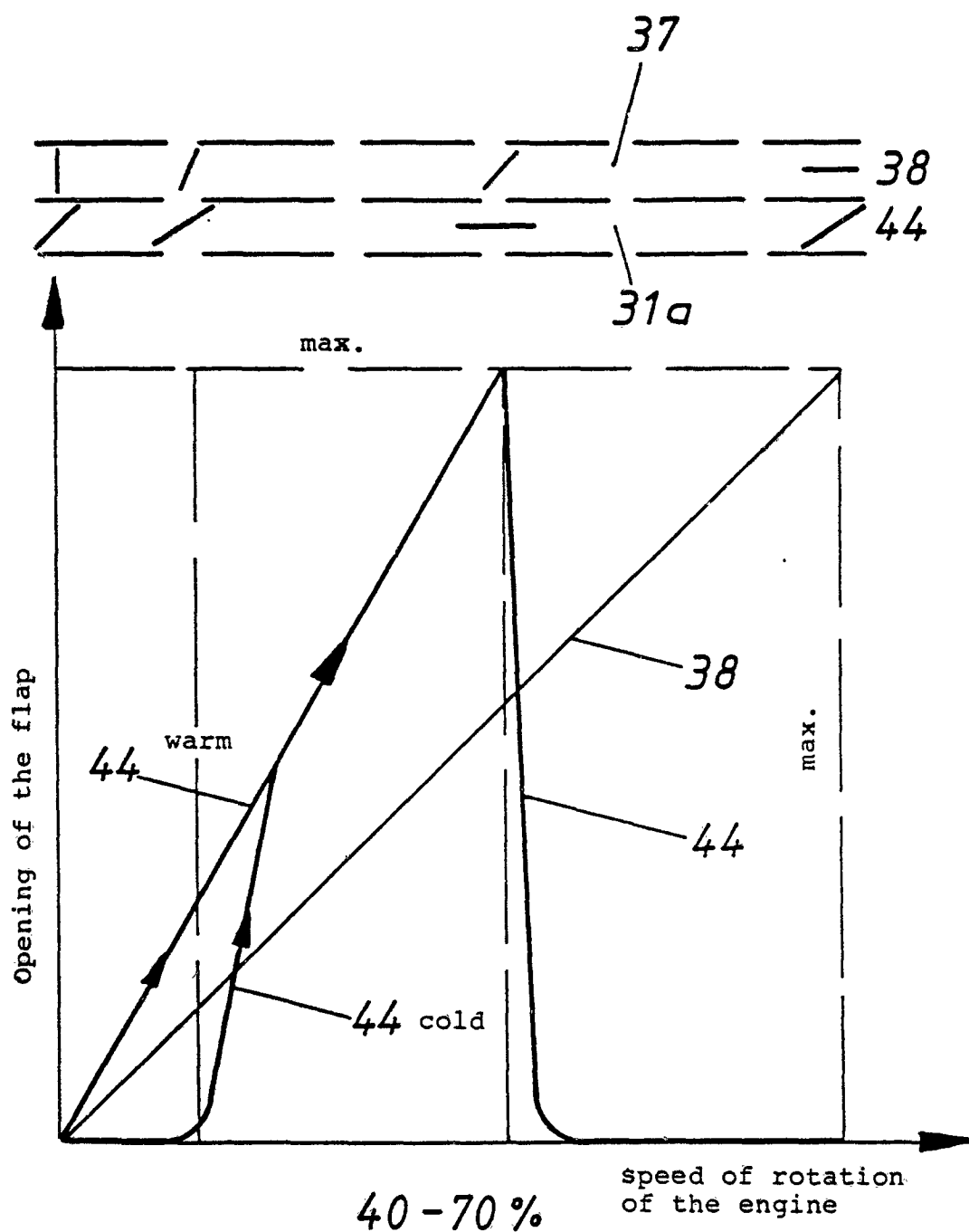


DIAGRAM I

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI88/00070

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
F 02 B 25/22		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbols	
IPC 4 F 02	B 25/00, /20, /22, 27/00; F 02 D 9/00, 21/00, 21/10; F 02 M 23/00, 35/00, 35/10	
US C1	123:76, 318, 327, 336, 434, 585 .../...	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
X	DE, A, 1 920 751 (MASCHINENFABRIK AUGSBURG-NÜRNBERG AG) 5 November 1970 & NL, 7002646	1-4, 12, 14
A	DE, A, 2 151 941 (BLUME, KURT) 26 April 1973	
A	US, A, 4 610 236 (OKINO) 9 September 1986 See fig. 1, detail 11.	13
A	US, A, 4 232 641 (CURTIL) 11 November 1980	13
X	US, A, 3 046 960 (J. DOLZA) 31 July 1962 See col. 3, lines 33-59.	12 - 14
X	US, A, 2 940 432 (C. HIJSZELER) 14 June 1960 See fig. 2, 4 A-5 and accompanying text. .../...	1-3, 12-14
* Special categories of cited documents: 10 "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
1988-12-08		1988-12-14
International Searching Authority		Signature of Authorized Officer
Swedish Patent Office		Herman Phalén

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields searched (cont.)Nat Cl 46a¹:7; 46a²:7, 51V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE ¹

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers , because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING ²

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

CORRECTED

International Application No. PCT/FI88/00070

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	Patent Abstract of Japan, Vol. 10, No. 342, M-536, abstract of JP 61-142322, Publ. 1986-06-30.	
X	Patent Abstract of Japan, Vol. 7, No. 79, M-204, abstract of JP 58-5423, publ. 1983-01-12.	1-2