April 30, 1940. M. KADENACY 2,198,730

EXHAUST PASSAGE OF TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed June 1, 1936 3 Sheets-Sheet 1

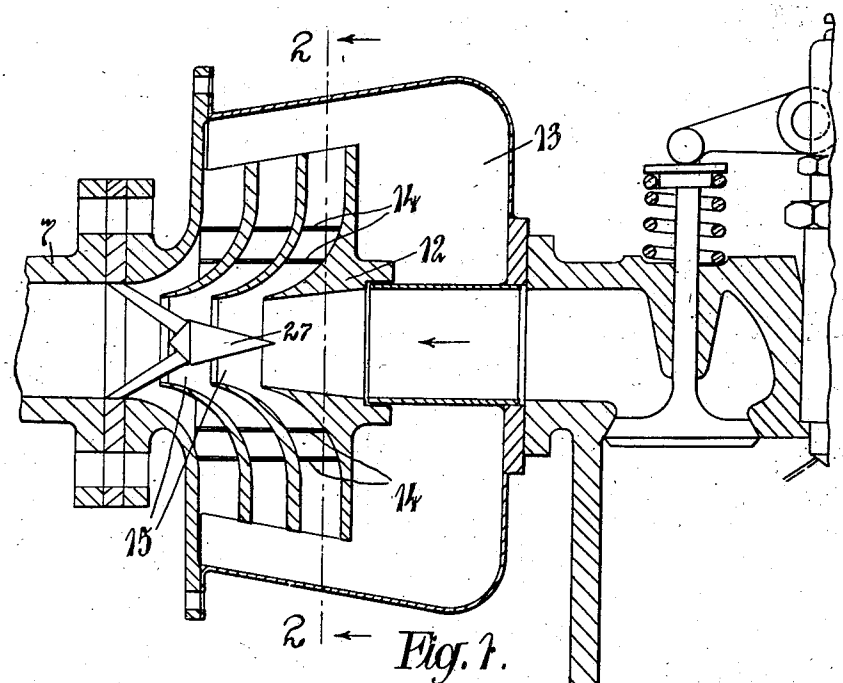

Fig. 1.

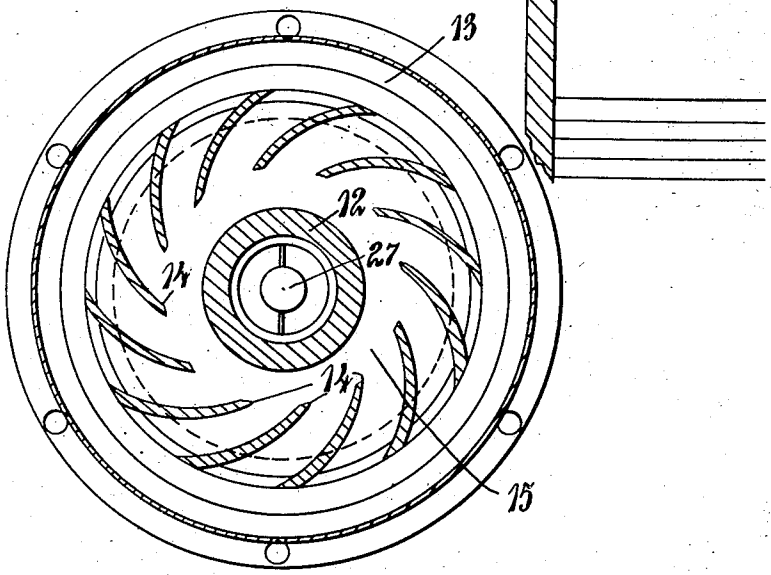

Fig. 2.

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Filed June 1, 1936 3 Sheets-Sheet 2

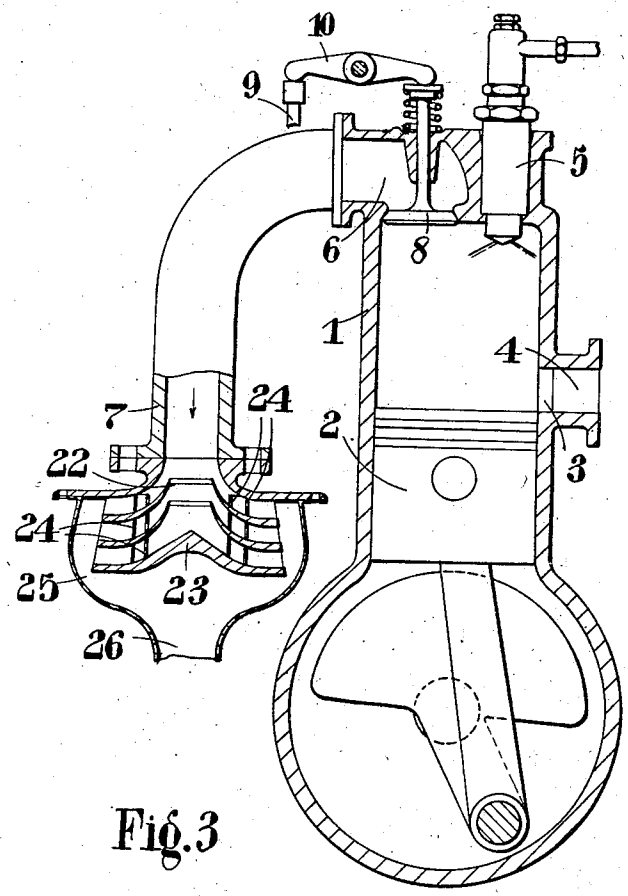

Fig.3

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EXHAUST PASSAGE OF TWO-STROKE INTERNAL COMBUSTION ENGINES

Filed June 1, 1936 3 Sheets-Sheet 3

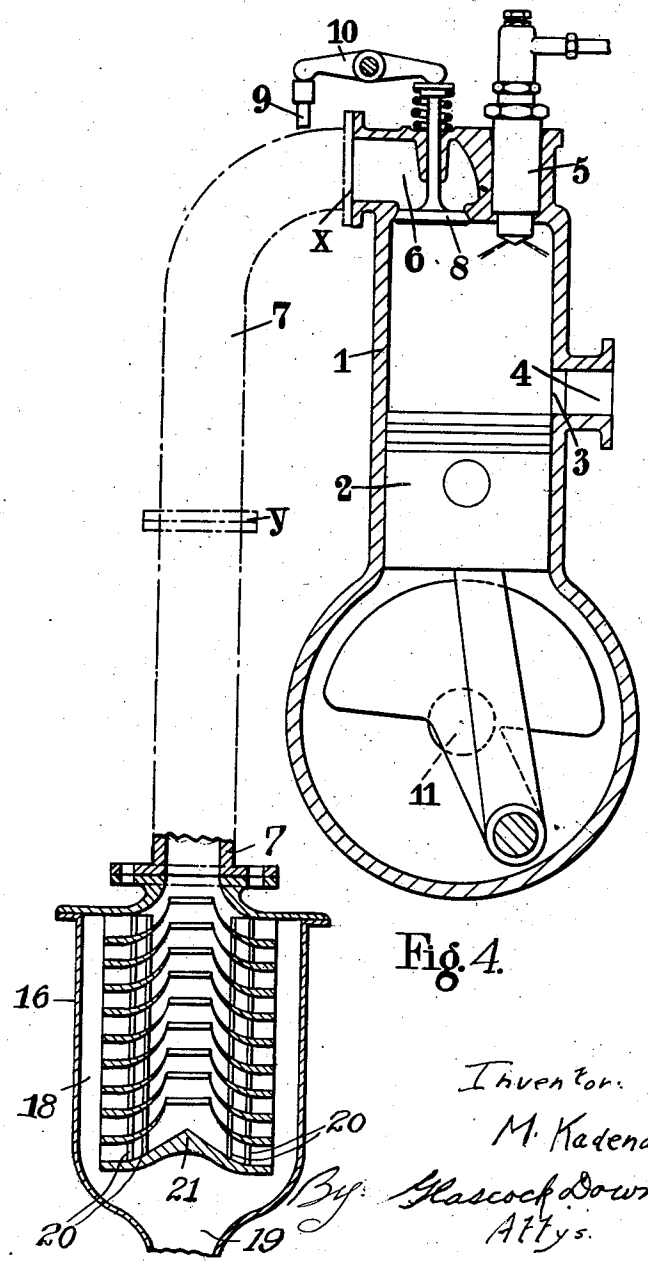

Fig. 4.

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Patented Apr. 30, 1940

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UNITED STATES PATENT OFFICE

2,198,730

EXHAUST PASSAGE OF TWO-STROKE INTERNAL COMBUSTION ENGINES

Michel Kadenacy, Paris, France, assignor to Armstrong Whitworth Securities Company, Limited, London, England

Application June 1, 1936, Serial No. 82,959
In Great Britain January 11, 1936

6 Claims. (Cl. 60—32)

This invention relates to improvements in the exhaust passage of two-stroke cycle internal combustion engines of the kind wherein at least a substantial portion of the burnt gases leaves the cylinder at a speed much higher than that obtaining when a flow resulting from an adiabatic expansion only is involved, and in such a short interval of time that it is discharged as a mass leaving a depression behind it which is utilised in introducing a fresh charge into the cylinder by opening the inlet orifice with the required delay after the opening of the exhaust orifice to ensure that the burnt gases are then moving outwardly through the exhaust orifice or duct and that a suction effect is exerted at the inlet orifice as a consequence of the exit of the said mass.

It is specified in my U. S. Patent No. 2,130,721 issued September 20, 1938, that the area of the inlet ports, and the duration of opening of these ports, in relation with the characteristics of the exhaust system, must be sufficient to permit the charge to fill the cylinder and enter the exhaust system in the time available before the return of the burnt gases occurs; provision must be made to ensure that the charge will be retained in the cylinder and will not be forced out by the return of the burnt gases towards the cylinder and that the charge will not be sucked out by a prolonged outward movement of the issuing mass of burnt gases.

The object of the present invention is to provide improved means whereby the objectionable influence of the return of the burnt gases on the contents of the cylinder may be destroyed while permitting the desired utilisation to be made of the phenomena in question in charging the engine.

A further object of the invention is to provide improved means whereby in addition any objectionable influence of a prolonged suction in the exhaust system on the contents of the cylinder may be avoided while still permitting the desired utilisation to be made of the phenomena in question in charging the engine.

The invention consists in so arranging and constructing the exhaust system of an internal combustion engine of the kind set forth that it permits the free and unrestricted outward motion of the issuing mass of burnt gases, pushing before it all the gases in its path, until it reaches a predetermined position in the exhaust system which is located not further from the cylinder than the zone from which the return of the burnt gases would occur and there imparts gyratory motion to the said gases as a whole, which all rotate substantially in said position so that any subsequent outward or return motion of the gases is prevented or reduced until the exhaust orifice is closed.

By way of example a device may be located at the zone from which the reversal in direction of motion of the mass of burnt gases would occur, and may destroy or attenuate the return at this point.

A location intermediate the cylinder and the said zone of return may evidently be chosen for the said device, and in a preferred and advantageous embodiment of the invention the said location will be so chosen that the volume of the depression or void left in the exhaust system will be restricted to an amount such that the entering charge can always fill the cylinder and the depression or void left in the exhaust system, whereby in addition to destroying or attenuating the return of the burnt gases any objectionable effect of a prolonged outward movement of the said gases will be annulled.

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

Figure 1 is an axial section through a device constructed in accordance with a first embodiment of the invention, showing the mounting of the device upon an engine cylinder.

Figure 2 is a section on the line II—II in Figure 1.

Figure 3 is a diagrammatic representation of an engine having disposed in the exhaust conduit thereof a device constructed in accordance with a second embodiment of the invention, the device being shown in axial section.

Figure 4 is a diagrammatic representation of an engine having disposed in the exhaust conduit thereof a device constructed in accordance with a third embodiment of the invention, the device being shown in axial section.

In the drawings the invention, simply by way of example is applied to an engine comprising a cylinder 1, in which moves a piston 2 controlling inlet orifices 3 situated at the base of the cylinder and communicating with an inlet duct 4, and having at the head of the cylinder an injector 5 for the introduction of the combustible fuel and an exhaust orifice 6, communicating with an exhaust duct 7 and controlled by a poppet valve 8 operated by a push rod 9 and rocker arm 10 from the engine shaft 11.

It is to be understood that this engine is given

by way of example only and that it will have the timing of inlet opening hereinbefore specified.

The device illustrated in Figures 1 and 2 is fitted close to the engine cylinder. It will be seen that the gases issue from the cylinder through the exhaust orifice 6 into a short neck or nozzle 12, from which they enter the exhaust duct 7 proper. This nozzle 12 is surrounded by a chamber 13 containing an arrangement of guiding vanes 14 and communicating with an annular space 15 left between the outlet end of the nozzle 12 and the entry to the exhaust pipe 7, and the arrangement is such that the returning gases are guided and directed into this chamber 13 and are given a rotary or helical motion by the vanes 14 whereby the action of the return of the gases is annulled or very greatly attenuated immediately before reaching the cylinder.

With the arrangement illustrated in Figures 1 and 2 it will be understood that the mass of burnt gases issuing from the cylinder is free to travel outwards through the exhaust duct until its movement is reversed in direction and that device protects the cylinder from the action of the returning gases but offers no protection against the action of a prolonged suction on the contents of the cylinder. A deflector 27 is placed at the outlet end of the nozzle 12, and is so formed that it does not impede the outward movement of the burnt gases, but assists in guiding returning gases into the chamber 13.

In the arrangement illustrated in Figure 4 the exhaust pipe 7 leads into an elongated chamber 16 having an inner space 17 into which the gases enter, an outer space 18 communicating with an extension 19 of the exhaust pipe and a tubular ring of vanes 20 separating the two spaces 17 and 18. The space 17 is closed at its outer end 21 so that the gases cannot pass directly through but are compelled to issue through the vanes 20.

In this example it is to be understood that the chamber 16 will be situated in the exhaust duct at the zone from which the return of the burnt gases would occur, and that with any particular exhaust system, this zone can be determined.

As this zone varies somewhat according to the intensity of the explosion, the device will be so situated that it will still be effective when the zone from which the return occurs varies within chosen limits.

At the moment at which the return of the burnt gases occurs there is a violent reaction in the two directions towards and away from the cylinder, and by placing an arrangement such as that shown in Figure 4 at this zone, this reaction is allowed to exert its effect outwardly so that the gases are forced through the vanes into the outer chamber 18 in which they are given a rotational motion as a whole as a consequence of their passage through the vanes which will be suitably arranged for this purpose. Thereafter when this rotational motion dies down the gases will expand and flow through the extension pipe 19.

In this construction any action of the return of the burnt gases on the cylinder is prevented but the suction is allowed to exert its full action and may have an objectionable action on the cylinder under certain conditions.

The device illustrated in Figure 3 is fitted in the exhaust pipe 7 at a point between the cylinder and the zone from which the return of the burnt gases would occur. In this example, the burnt gases, after travelling a predetermined distance along the exhaust pipe 7 enter the passage 22 closed at its outer end 23 and are guided by vanes 24 into a chamber 25, the vanes 20 being so arranged as to impart rotational motion as a whole to the issuing mass of burnt gases as in Figure 4, the gases passing ultimately into the extension 26 of the exhaust pipe.

It will be seen that provided this device is placed between the cylinder and the zone in the exhaust pipe from which the return of the gases would occur, the position of the device will determine the volume of the depression or void left in the exhaust pipe by the issuing mass of burnt gases.

If this device is placed at such a distance from the cylinder that the volume of the depression or void left by the mass exit of the burnt gases is such that the charge entering the cylinder always fills the cylinder and fills this depression or void, then the objectionable actions of the return of the burnt gases and of a prolonged outward movement will both be avoided.

Such an arrangement will be of particular advantage when applied to an engine in which the inlet port is closed before the exhaust port closes, since in such an engine the return of the burnt gases may foul the charge at low speeds and a prolonged suction may draw the charge out of the cylinder through the exhaust ports at high speeds. With an arrangement constructed and arranged as described with reference to Figure 3, both these objections may be avoided in such an engine without resorting to any special timing of exhaust and inlet closures.

In principle, and when the chief requirement is that of protecting the cylinder from the abrupt return of the burnt gases into the cylinder, it is advantageous for the operation of the engine for the exhaust to occur as rapidly as possible and for the time of duration of the admission period to be lengthened.

The volume of the depression or void engendered by the issuing mass of burnt gases must be as great as possible for the same conditions of intensity of the explosion. For this purpose a free path must be allowed over the whole possible trajectory for the column of the exhaust gases.

The constructions illustrated by way of example in Figures 1 and 2, and in Figure 4, permit this result to be obtained. But in certain cases and particularly in engines in which exhaust closes after inlet and at high engine speeds, the total duration of the suction and the volume of the depression or void left in the exhaust system may be such that this volume cannot be filled during the charging period, and that there is a tendency for the charge to be drawn out of the cylinder into the exhaust system.

In such a case it is advantageous to employ an arrangement such as that shown in Figure 3, wherein a certain proportion of the depression or void that can be left in the exhaust system by the issuing mass of gases is utilised for the purpose of passing fresh charge through the cylinder and thereby cooling the latter, while at the same time the objectionable action of a return of the burnt gases or of a prolonged outward movement of the burnt gases is avoided.

The devices described with reference to Figures 3 and 4, while annulling the action of the return of the gases, also prolong the duration of the depression or void in the cylinder and in the piping of the exhaust system by retarding the destruction of this depression or void by the

reversal of the movement of the gases in the exhaust system.

A further advantage of the arrangement described with reference to Figure 3 is that the rotation imparted to the gases in the exhaust duct may be so prolonged that it still continues when the next exhaust phase occurs.

The effect of this will be to maintain a depression in the exhaust pipe outside the exhaust orifice, so that exhaust will occur in a reduced period of time.

I claim:

1. Method of controlling two-stroke cycle internal combustion engines, which comprises establishing communication between the cylinder and exhaust system during the firing stroke, providing for the issuance of the burnt gases from the cylinder substantially as a mass in an interval of time shorter than that which would be required for the burnt gases to expand down to the ambient pressure by adiabatic flow, whereby the mass of gases moves outward and thereafter returns, permitting the free and unrestricted outward motion of the issuing mass of burnt gases, pushing before it all the gases in its path until it reaches a predetermined position in the exhaust system which is located not further from the cylinder than the zone from which the return of the burnt gases would occur, and at such position imparting a gyratory motion to the said gases as a whole, which all rotate substantially in said position so that any subsequent rectilinear motion of the gases is hindered until the exhaust orifice is closed, maintaining the admission orifice closed until the said issuance of the mass of burnt gases is in full progress and admitting fresh charge into the cylinder when the said issuance of the burnt gases is in full progress and causes a suction effect to be exerted in the cylinder, while the exhaust port is still open.

2. Method of controlling two-stroke cycle internal combustion engines, which comprises establishing communication between the cylinder and exhaust system during the firing stroke, providing for the issuance of the burnt gases from the cylinder substantially as a mass in an interval of time shorter than that which would be required for the burnt gases to expand down to the ambient pressure by adiabatic flow, whereby the mass of gases moves outward and thereafter returns, permitting the free and unrestricted outward motion of the issuing mass of burnt gases, pushing before it all the gases in its path, until it reaches the zone from which the return of the burnt gases would occur, and at such position imparting a gyratory motion to the said gases as a whole, which all rotate substantially in said position so that any subsequent rectilinear motion of the gases is hindered until the exhaust orifice is closed, maintaining the admission orifice closed until the said issuance of the mass of burnt gases is in full progress and admitting fresh charge into the cylinder when the said issuance of the burnt gases is in full progress and causes a suction effect to be exerted in the cylinder, while the exhaust port is still open.

3. Method as claimed in claim 1, wherein said predetermined position is so located that the volume of the depression or void and the duration of the suction caused by the issuing mass of burnt gases is such that the said depression or void can always be substantially filled by the entering charge, whereby any action of the return of the burnt gases and of a prolonged outward movement of the burnt gases on the contents of the cylinder is avoided.

4. A two-stroke cycle internal combustion engine wherein the burnt gases are discharged from the cylinder into an exhaust conduit substantially as a mass whereby the said mass moves outward and thereafter returns towards the cylinder, the said conduit providing a free passage for the burnt gases to the limit of outward travel of said mass, and wherein an inlet is opened for the introduction of fresh charge while the exhaust port is still open and when the said issuance of the burnt gases is in full progress and causes a suction effect to be exerted in the cylinder, having a chamber other than the engine cylinder in open communication with the exhaust conduit at a point situated nearer the cylinder than the limit of outward travel of the burnt gases upon their mass exit from the cylinder, means forming a part of the said conduit whereby the said mass is directed past the said communication during its outward motion and returning gases enter said chamber and a plurality of adjacent openings within said chamber provided with deflecting surfaces to impart gyratory motion to said returning gases on entering said chamber.

5. A two-stroke cycle internal combustion engine wherein the burnt gases are discharged from the cylinder into an exhaust conduit substantially as a mass whereby the said mass moves outwards and thereafter returns towards the cylinder, the said conduit providing a free passage for the outward motion of the issuing mass of burnt gases, and wherein an inlet is opened for the introduction of fresh charge while the exhaust port is still open and when the said issuance of the burnt gases is in full progress and causes a suction effect to be exerted in the cylinder, having a chamber inserted in the exhaust conduit at a point situated nearer the cylinder than the limit of outward travel of the burnt gases upon their mass exit from the cylinder, a plurality of adjacent openings within said chamber provided with deflecting surfaces to impart gyratory motion to the outwardly moving gases, and a baffle in said chamber to force said gases to flow through said openings.

6. A two-stroke cycle internal combustion engine wherein the burnt gases are discharged from the cylinder into an exhaust conduit substantially as a mass whereby the said mass moves outwards and thereafter returns towards the cylinder, the said conduit providing a free passage for the outward motion of the issuing mass of burnt gases, and wherein an inlet is opened for the introduction of fresh charge while the exhaust port is still open and when the said issuance of the burnt gases is in full progress and causes a suction effect to be exerted in the cylinder, having a chamber inserted in the exhaust conduit at the limit of outward travel of the burnt gases upon their mass exit from the cylinder, a plurality of adjacent openings within said chamber provided with deflecting surfaces to impart gyratory motion to the outwardly moving gases, and a baffle in said chamber to force said gases to flow through said openings.

MICHEL KADENACY.

4

CERTIFICATE OF CORRECTION.

Patent No. 2,198,730. April 30, 1940.

MICHEL KADENACY.

It is hereby certified that the above numbered patent was erroneously issued to "Armstrong Whitworth Securities Company, Limited" as assignee of the entire interest therein whereas said patent should have been issued to the inventor, said "KADENACY", as assignor of one-half interest to Armstrong Whitworth Securities Company, Limited, of London, England, as shown by the record of assignments in this office; 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 27th day of August, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.

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Patent No. 2,198,730. April 30, 1940.

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