

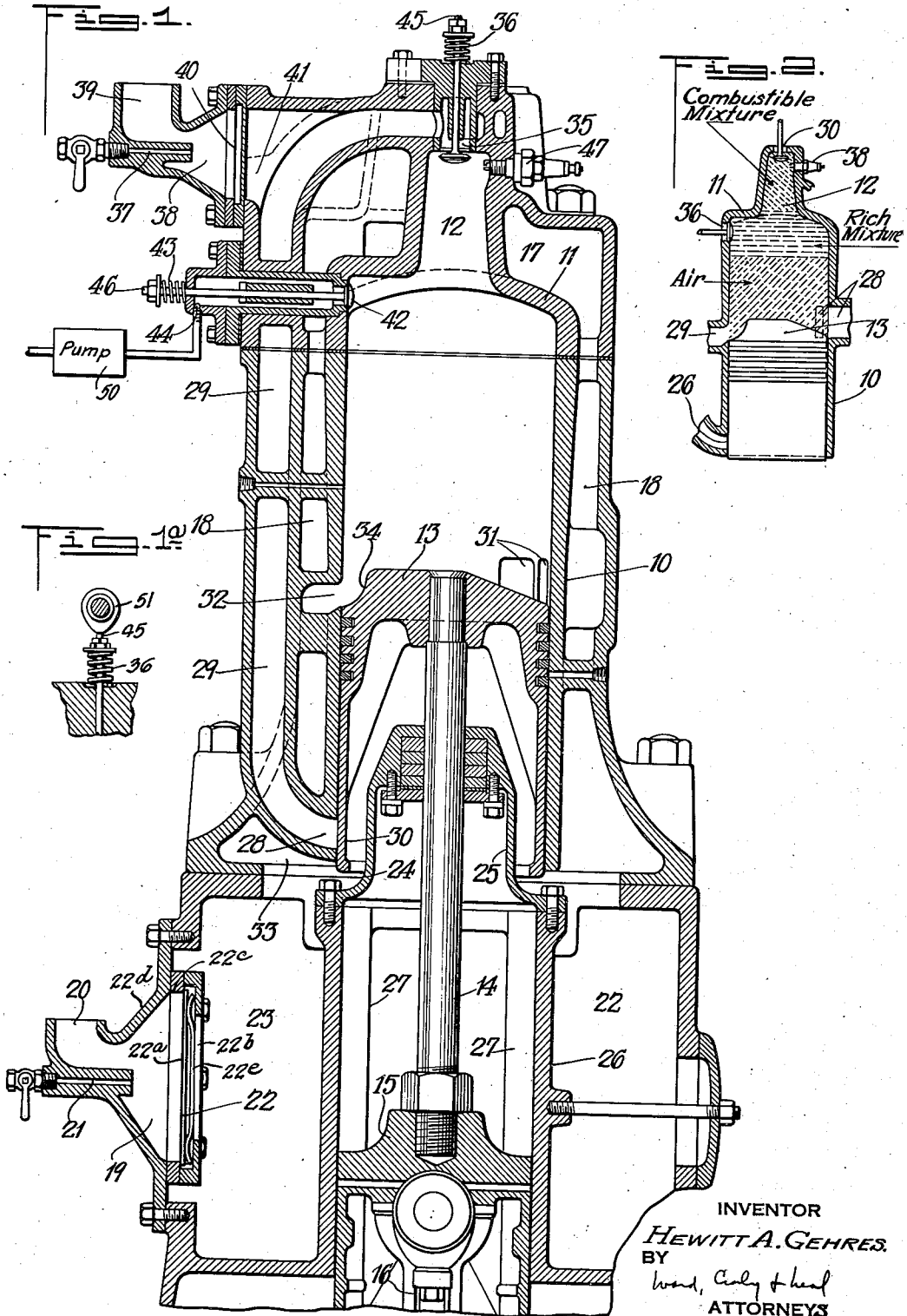
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H. A. GEHRES

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INTERNAL COMBUSTION ENGINE

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INTERNAL COMBUSTION ENGINE

Hewitt A. Gehres, Mount Vernon, Ohio, assignor
to Cooper-Bessemer Corporation, Mount Ver-
non, Ohio, a corporation of Ohio

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7 Claims. (Cl. 123—65)

This invention relates to improvements in internal combustion engines, and particularly to engines of the two-cycle type disclosed in my copending application Serial Number 146,185, filed June 3, 1937, of which this application is a continuation in part.

Two-cycle engines in general have a number of disadvantages which may be overcome by the invention of my copending application and by the further improvements of the present invention. With the usual two-cycle engine, a mixture of air and gas is drawn into a chamber through a check valve by the action of the power piston during its compression stroke. This charge is compressed during the expansion stroke of the piston and near the end of the expansion stroke and when the intake and exhaust ports are opened, the mixture of air and gas flows into and to some extent through the cylinder, forcing out the burned gases and leaving a mixture in the cylinder of widely varying and often unsatisfactory combustion characteristics. Regulation of such prior engines has been affected by way of varying the quantity of gas admitted with the air, and since the quantity of air admitted remains practically constant, the percentage of gas in the mixture varies widely. Since for ideal or even satisfactory combustion conditions, this percentage has to be kept within a very narrow range, it is evident that at light loads and at extremely heavy loads, the mixture becomes either too lean or too rich to give proper combustion. As a result, in prior two-cycle engines, the firing is intermittent and the operation of the engine is irregular and uneconomical. The low economy of this type of engine is not only caused by irregular operation but also because of the scavenging being done with a mixture of air and gas, a substantial part of the gas escapes through the exhaust ports unburned.

According to the invention of my said copending application and also with the simplified and improved arrangements of this application, an engine construction and method of operating the same is provided whereby scavenging air may be admitted at one end of the cylinder and the burned gases with some air may be exhausted at or adjacent the same end of the cylinder, but meanwhile the fuel may be admitted at the other end of the cylinder or at a point remote from the scavenging air intake and exhaust ports, in a manner such that no valuable amount of unburned fuel escapes. Furthermore, with the preferred form of my invention, gas or other fuel admitted to the cylinder may be introduced into

two different zones within the combustion chamber, one of the zones being for example supplied with a fuel and air mixture having substantially the ideal percentage of fuel for prompt and substantially complete combustion, and the other zone being supplied with a quantity of gas or other fuel in which the percentage of fuel may be widely varied to meet different loads but is generally too rich for ideal combustion conditions. With this type of arrangement and method, the atmosphere within the combustion chamber is more or less stratified, i. e. with first a stratum remote from the scavenging ports and comprising substantially an ideal combustible mixture, second, a stratum embodying a variable quantity of fuel generally too rich for ideal combustion and, third, a stratum or volume of air remaining from the scavenging operation. Upon compression of these strata by action of the piston, ignition and combustion of the first causes the second stratum to be forced into admixture with the air stratum and at some moment when the second stratum is being mixed with the air, conditions will be ideal for thorough combustion of the fuel of the second stratum. With this operation, regular firing, even with widely varying loads, is insured with no substantial loss of unburned fuel. The two supplies of fuel may be introduced and compressed by apparatus forming part of and automatically actuated by action of the engine proper, for example, by providing an air or air and gas compression chamber at the external surface of the piston and pressure-operated valves under control of the compression chamber. Or, if desired, one or both of the fuel supplies may be introduced under pressure through mechanically operated valves suitably timed to deliver their respective charges into the cylinder shortly prior to or after closure of the exhaust ports, so as to minimize or prevent loss of unburned fuel. Also, if desired, both of the separate fuel supplies may be varied either manually, or automatically by well-known governing apparatus.

The invention of this application is more particularly directed to the simplification of and improvement upon the construction and operation of the invention described in my above-mentioned copending application. Means are hereinafter disclosed for eliminating a number of the valves and passages and chambers of the construction of my above-mentioned application.

Various further and more specific objects, features and advantages will clearly appear from the detailed description given below taken in

connection with the accompanying drawing which forms a part of this specification and illustrates merely by way of example a preferred form of the invention. The invention consists in such novel features, arrangements and combination of parts as may be shown and described in connection with the construction herein disclosed.

In the drawing, Fig. 1 is a longitudinal sectional view of an engine cylinder and adjacent parts illustrating one example of the invention;

Fig. 1a is a detail illustrating cam-actuation of the valves of the Fig. 1 showing; and

Fig. 2 somewhat schematically indicates the stratified conditions in the engine cylinder at the beginning of compression of the fuel charges.

The engine as shown in Fig. 1 comprises a cylinder 10 and a removable cylinder head 11 formed with an elongated cavity or chamber 12 comprising an extension of the combustion chamber including the cylinder. A piston is shown at 13 connected to a piston rod 14 which in turn may be connected to a cross-head 15 and connecting rod 16, the latter being connected to a suitable crank shaft (not shown). The cylinder may be substantially surrounded by a suitable water jacket or similar cooling means. For example, as here shown, cooling fluid cavities are provided as at 17 and 18 surrounding respectively the cavity 12 and the cylinder.

Either air or a mixture of air and combustible gas may be admitted to a chamber 19, the air through a pipe 20 and the gas or fuel through a jet 21 whereby the fuel is aspirated in with the air. When the piston is moving on its compression stroke, the air or air and gas will be drawn from chamber 19 through a suitable form of flap check valve 22 into a chamber 23. The check valve comprises a closure disk 22a, normally covering a valve opening 22b and resiliently held against a shoulder 22c of the valve housing 22d, by means of a spring 22e. It will be noted that the chamber 23 is open through passages 33 and 24 to the under surface of the piston 13, i. e. the piston surface external to the combustion chamber. The chamber 23 may be closed with respect to the crank case by any suitable means such as a flanged member 25 having a central aperture with suitable packing, permitting the piston rod to reciprocate therethrough. The member 25 may be mounted on an extension 26 of the crank case, which extension carries the ways 27 for the cross-head.

During the expansion stroke of the piston, the air or air and gas in chamber 23 will be compressed, and also for a time, the resulting pressure will cause some of the air or air and gas to be forced through a port 28 formed in the wall of the cylinder at its lower end, and thence into a passage 29. But approximately at the termination of the expansion stroke, it will be noted that the lower edge 30 of the piston, will act to close the port 28 and keep this port closed until after the compression stroke is under way, thereby trapping the air or air and gas under pressure in passage 29.

The cylinder may be provided with exhaust ports, as at 31, in a position such that the same will be opened when the piston approaches the end of its expansion stroke, and soon thereafter an air intake port 32 connected to chamber 23 through a passage 33, will be opened for admitting air or a mixture of air and gas under pressure from chamber 23 into the cylinder 10 for scavenging purposes. The upper face of the piston may be shaped as shown at 34, so as to suitably

deflect this air or air and gas upwardly into the cylinder in order to cause thorough scavenging, and whereby some of this air, together with the burned gases, is forced out through the exhaust ports 31 to a suitable discharge connection.

Means are also provided as hereinafter described, for supplying, at the time of or shortly after this scavenging operation, a quantity of a substantially ideal combustible mixture of fuel and air within the upper end or zone in the elongated cavity 12, and optionally also a variable quantity of raw gas or other fuel generally too rich for perfect combustion into a somewhat lower zone, for example, at a point near where cavity 12 joins the main body of the cylinder. The two supplies of fuel thus separately admitted to these zones will be more or less stratified in the manner indicated in Fig. 2, and the scavenging air and burned gases during the scavenging operation will have little opportunity to mix therewith, and thus exhaust of unburned fuel from these sources, through the ports 31, will be avoided.

Referring now to the fuel intake means, a valve 35 may be provided at the upper end of chamber 12 for admitting the volume of combustible medium having the ideal mixture. This valve may comprise any suitable well-known type of poppet valve held normally closed by a compression spring 36 as shown. The combustible mixture which is being admitted through valve 35 may comprise gas or other fuel introduced through a suitable jet 37 and aspirated in with the air in a chamber 38 admitted through conduit 39. The mixture may be controlled by any suitable well-known adjustable valve means for the jet 37 and for the air inlet conduit 39, respectively. The chamber 38 may be connected through a suitable flap check valve 40 to a chamber 41, which latter chamber in turn communicates with the valve 35 and also with passage 29, as shown.

The combustible mixture which is generally over-rich in fuel may be introduced through a valve 42 located, for example, at the upper end of the main body of the combustion chamber and held normally closed by a compression spring 43 as shown. This valve 42 may be of a poppet type similar to valve 35 and may communicate, as through a passage 44, with a suitable source of fuel supplied under pressure, as from a pump 50. The operation of valves 35 and 42 may be made automatic by appropriate adjustment of the tensions in springs 36 and 43, so that they will open and close at the proper intervals due to variations of pressure within the combustion chamber of the cylinder. Alternatively, and as shown by Fig. 1a, these valves may be mechanically operated, if desired, by suitable cams, such as 51, operating against the exposed ends 45 and 46 of the valve stems in the well-known manner.

A spark plug or other suitable ignition means may be provided as at 47 at the upper end of the cavity 12, and energized with proper timing in any suitable well-known way.

The operation of the engine as shown may be summarized as follows: During the compression stroke of the piston, either air or a mixture of gas and air is drawn through valve 22 into the chamber 23. Since port 28 is now uncovered, a charge of air and gas is also drawn in through valve 40. The valve for jet 37 is so adjusted as to control the fuel here admitted in relation to the air from inlet 39 as to give substantially an ideal combustion mixture. Some of this mixture as drawn into chamber 41 will also be drawn down into the upper end of passage 29. As the

piston returns on its expansion stroke, the air or air and gas in chamber 23, will be compressed and some will pass through port 28 and thereby cause compression of the charge within the upper end of passage 29 and chamber 41. Then when the piston on its downward movement covers port 28, the mixture in 29 and 41 will be trapped under compression. Also at the end of the expansion stroke, the exhaust and air intake ports 31 and 32 will be opened, and the pressure within the cylinder reduced. That is, scavenging then takes place through exhaust ports 31, from the air or air and gas forced in through port 32 from chamber 23, but at the same time, the covering of port 28 serves to maintain the pressure in passage 29, so that when the pressure in the cylinder is reduced sufficiently, the valve 35, if made automatic in operation as above described, will momentarily open and admit a volume of the ideal combustible mixture into the chamber 12. Meanwhile, also upon sufficient reduction of the pressure in the cylinder, valve 42, if likewise made automatic in operation as explained, will momentarily open for admitting a volume of the rich fuel mixture into the upper region of the main body of the cylinder. Thereupon, the three strata, comprising the readily combustible mixture, the rich mixture, and air, respectively, will be established in general as indicated in Fig. 2.

Upon the succeeding compression stroke of the piston, the charge of the ideal mixture substantially remains within the cylinder extension 12 due to its elongated shape, and this charge is compressed within the upper portion of chamber 12 adjacent the spark plug 47, whereby prompt ignition of this charge may be insured when the piston is near the end of its compression stroke. The ignition of the charge within the chamber 12 will thereupon cause the charge admitted through valve 42 to be expanded downwardly and become mixed with the air or air and gas within the lower zone of the cylinder, whereby at some moment, a good combustible mixture will be formed in the main body of the cylinder and thereupon ignited, with assurance that thorough combustion of substantially all of the fuel admitted to the cylinder will take place.

The mixture admitted through valve 40 will ordinarily comprise only a minor part of the total cylinder charge. The major portion of the fuel may be introduced through valve 42.

The engine may be provided with a suitable well-known type of governing means acting in a well-known manner to throttle either the amount of fuel entering at valve 22 or at valve 42. Although the mixture coming in through valve 40 may generally and preferably be of a constant volume, however, if desired, governing means can also be applied to throttle the amount of the mixture entering through this valve.

If valves 35 and 42 are made automatic in operation as explained, the valves will open and supply fuel to the combustion chamber at the same time that scavenging occurs, so that some of this fuel may escape unused through the exhaust port. This tendency may be overcome by mechanically operating these valves, for example, by means of rotating cams, in which event, opening of the valves can be delayed until at or near closure of the exhaust ports, and such that the fuel cannot reach the exhaust ports prior to their closures, thereby improving the economy of operation. Also, if a mixture of gas and air is introduced through valve 22, some of this fuel will be lost during the scavenging operation, so

that from the standpoint of economy, it is preferable to introduce only air through this valve and to supply fuel to valve 42 from a separate source rather than through valve 22. Alternatively, valve 42 may be entirely eliminated, in which event the introduction into chamber 23 of a mixture of gas and air from jet 21 and conduit 20 would be required, the mixture to be introduced thence into the engine cylinder through port 32 to provide an appropriate fuel mixture in the lower stratum of the cylinder. This arrangement would, of course, reduce the economy of operation, inasmuch as considerable unburned fuel would be lost in scavenging at heavy loads.

Fuel economy is, however, of lesser importance compared to fundamental purpose of the invention, which is to provide an engine of the character described which will fire regularly under all operating conditions including light loads at which prior engines of this type are defective. This feature is attained with the present invention irrespective of the above-mentioned alternatives for supplying fuel and operating the valves.

In the appended claims where reference is made to the admission of "air" to the chamber 23, it will be understood that such air if desired may be considered as accompanied by combustible gas.

While the invention has been described with respect to a certain particular preferred example which gives satisfactory results, it will be understood by those skilled in the art after understanding the invention, that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended therefore in the appended claims to cover all such changes and modifications.

I claim:

1. In a two-stroke cycle internal combustion engine, a cylinder, a reciprocating piston therein, intake valves at the head end of the cylinder for admitting two different fuel mixtures at spaced points, intake and exhaust ports for scavenging air adjacent the face of the piston when at the end of its expansion stroke, a compression space at the external surface of the piston, a passage from said space to one of said intake valves, and a port in the cylinder wall and under the control of the piston for interconnecting said space and passage.

2. In a two-stroke cycle internal combustion engine, a cylinder, a reciprocating piston therein, means for admitting and exhausting scavenging air adjacent one end of said cylinder, means adjacent the other end of the cylinder for admitting two different combustion fluid mediums at separate points, in substantially a predetermined timed relationship with the admission and exhaustion of the scavenging air, means including the external surface of said piston for providing a supply of air or air and combustible gas under pressure, a passage for conducting the latter supply to one of the two above mentioned supplies of combustion fluid medium, said passage having a port adapted to be closed and opened by said piston also in timed relationship with the admission and exhaustion of the scavenging air.

3. In a two-stroke cycle internal combustion engine, a cylinder, a reciprocating piston therein, valves for admitting fuel at two spaced points adjacent one end of the cylinder, means connected to one of said valves for supplying therethrough to the cylinder a stratum of a readily combustible fuel mixture, means connected to the other of said valves for supplying therethrough to the cylinder a stratum of a fuel mix-

ture embodying a greater proportion of fuel, ports for admitting and exhausting scavenging air to and from the cylinder under control of the piston, means utilizing an external surface of said piston for providing a supply of air under pressure, a passage for conducting such air into said readily combustible mixture to form a part thereof, and an intake port for said passage adapted to be closed and opened by a portion of the piston spaced from the piston face.

4. In an internal combustion engine, a cylinder, a reciprocating piston therein, a chamber for receiving a combustion medium, an air compression space, a passage for connecting said chamber and compression space, means whereby the piston on a compression stroke draws air into said compression space and combustion medium into said chamber and whereby said piston on its expansion stroke compresses the air in said compression space and forces air therefrom into said passage toward said chamber thereby applying pressure to the combustion medium in said chamber, and means whereby approximately at the termination of the expansion stroke the piston opens an exhaust port and closes said passage from access to said compression space and combustion medium is admitted from said chamber to the upper portion of the cylinder, and air from said space is admitted to the lower portion of said cylinder.

5. In an internal combustion engine, a cylinder, a reciprocating piston therein, a chamber for receiving a combustion medium, an air compression space, a passage for connecting said chamber and space, means whereby the piston on a compression stroke draws air into said space and combustion medium into said chamber and whereby said piston on its expansion stroke compresses the air in said space and forces air therefrom into said passage toward said chamber thereby applying pressure to the combustion medium in said chamber, means whereby approximately at the termination of the expansion stroke the piston closes said passage from access to said space and combustion medium is admitted from said chamber to the cylinder, and valve means for also concurrently admitting to the cylinder, a volume of combustion medium overrich in fuel content, at a point spaced in the cylinder from the point of admission of the combustion medium from said chamber.

6. In a two-stroke cycle internal combustion

engine, an explosion chamber with a reciprocating piston therein, means including an intake port adjacent one end of the chamber for introducing air under pressure, means for concurrently discharging products of combustion from the chamber, including an exhaust port adjacent said end but spaced from said intake port, said ports being closed by the piston except when the piston is adjacent its extreme position at said end, means for introducing gas or a rich gas mixture into a zone adjacent the other end of the chamber when the piston is adjacent the first named end of the chamber, means for then also introducing a gas mixture highly favorable to combustion into a second zone adjacent said first named zone in the chamber, ignition means located in said second zone and actuated when the piston has compressed the gas and gas mixtures in said zones, the means for introducing the mixture to said second zone including an air or gas compression space at the external face of the piston, a passage from said space to the point of admission of the mixture to said second zone, and a port for interconnecting said space and passage, said last named port being closed by the piston when the piston is adjacent the first named end of the chamber.

7. In an internal combustion engine, an explosion chamber with a reciprocating piston therein, means including an intake port for introducing air under pressure into said chamber at the termination of an expansion stroke of the piston, means for concurrently discharging products of combustion from the chamber, including an exhaust port spaced from said intake port, means for introducing gas or a rich gas mixture into a zone of said chamber spaced from said ports, means for then also introducing a gas mixture highly favorable to combustion into a second zone adjacent said first named zone in the chamber, ignition means located in said second zone and operable when the piston has compressed the gas and gas mixtures in said zones, the means for introducing the mixture to said second zone including an air or gas compression space at the external face of the piston, a passage from said space to the point of admission of the mixture to said second zone, and a port for interconnecting said space and passage, said last named port being closed by the piston when approximately at the end of its expansion stroke.

HEWITT A. GEHRES.