C. F. KETTERING.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 5, 1917.

1,380,974. Patented June 7, 1921.

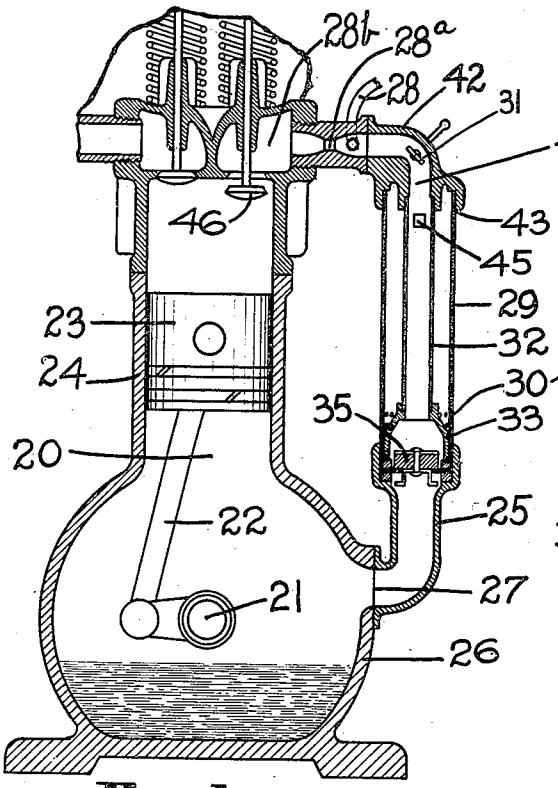

Fig. 1.

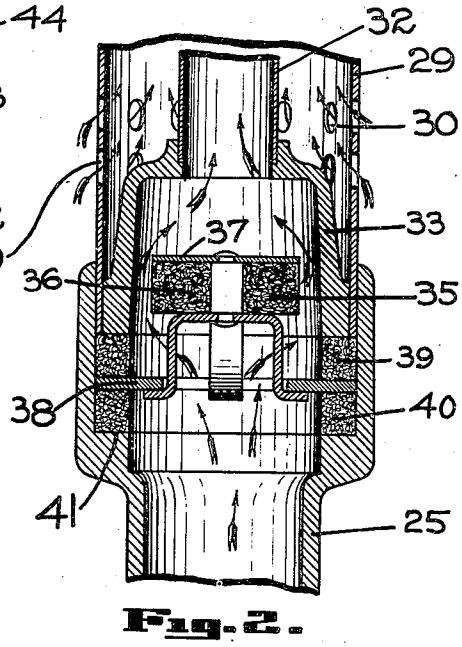

Fig. 2.

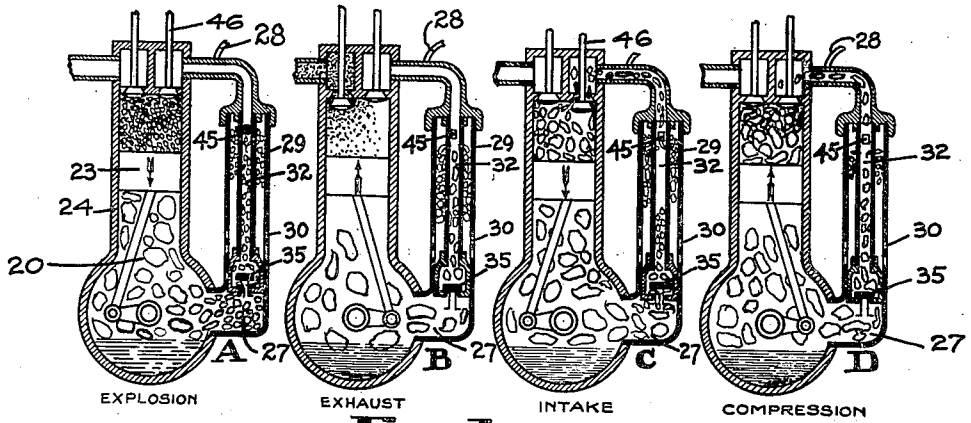

Fig. 3.

Witnesses
Walter M. Reedel
Joseph W. McDonald

By Kerr, Page, Cooper & Haynard
Attorneys

Inventor
Charles F. Kettering

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DELCO-LIGHT COMPANY, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

INTERNAL-COMBUSTION ENGINE.

1,380,974. Specification of Letters Patent. Patented June 7, 1921.

Application filed February 5, 1917. Serial No. 146,825.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a full, clear, and exact description.

This invention relates to an improvement in internal combustion and explosion engines.

One of the objects of the present invention is to provide means for eliminating the ejection of gases from the crank case of the engine directly to the atmosphere.

Another object of the present invention is to provide for the elimination of the ejection of gases from the crank case of the engine directly to the atmosphere by utilizing these gases in forming a part of the fuel charges which are delivered to the combustion chamber of the engine.

Prior to the present invention, it has been the practice, in some instances, to provide the crank case of a single cylinder engine with a breather tube having a check valve therein adapted to open in response to pressure from the crank case chamber during the down strokes of the piston. During the up strokes of the piston, the valve is closed so that air cannot enter the crank case chamber through the breather tube. However, owing to the partial vacuum created in the crank case chamber during the up strokes of the piston, a small quantity of air will, under ordinary conditions, be sucked through the bearings or other parts of the crank case, and be subsequently discharged to the atmosphere through the breather tube when the valve opens during the down strokes of the piston. Such a breather tube has the advantage that it prevents the entrance of dust and other material to the crank case during the up strokes of the piston, and that it prevents the escape of oil through the bearings at all times, but it has the disadvantage that it discharges noxious gases and smoke directly to the atmosphere. Where the engine is operated indoors, this is very objectionable if not actually dangerous to the health of the attendant.

The preferred form of the present invention comprises a breather tube connected with the crank case chamber and having a valve adapted to operate in a manner similar to that of the prior breather tube so far as the prevention of the entrance of dust to, and the escape of oil from, the crank case is concerned. The breather tube, beyond the valve, constitutes a reservoir and is of sufficient capacity to hold or store, substantially at atmospheric pressure, the gases or smoke discharged into it from the crank case chamber. It has communication with the engine intake and also, at a remote point, with the atmosphere, the arrangement being such that during the suction stroke atmospheric air is drawn into the breather tube where it mixes with the gaseous contents thereof and this mixture then passes, under the influence of the engine suction, into the engine cylinder to be consumed and eventually discharged to the atmosphere as part of the exhaust gases. Thus, by storing the noxious gases and smoke in the breather tube and then scavenging the latter at each suction stroke of the engine, in the manner described, the present invention provides a simple and efficient means for disposing of objectionable gases and smoke and at the same time retains the important advantage of prior breathers in preventing the escape of oil through the bearings of the crank case.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein one preferred form of the present invention is clearly illustrated.

In the drawing:

Figure 1 is a side elevation of an engine embodying the present invention, certain parts of the engine being shown in section.

Fig. 2 is a detail view of the valve mechanism shown in section in Fig. 1.

Fig. 3 is a diagrammatic showing of the engine embodying the present invention, each of the successive parts of this figure

disclosing the different positions of the engine piston in one complete cycle of its operation.

Referring to the drawing, and more particularly to Figs. 1 and 2, the numeral 20 designates the engine, which may be of the combustion or explosion type, and which in the present instance is shown as having but a single cylinder. This, however, is not intended as a limitation, as this type of engine has simply been selected for purposes of illustration.

The numeral 21 designates the crank shaft of the engine, carrying the connecting rod 22, to which is secured the piston 23 in the usual manner. This piston reciprocates in the engine cylinder 24.

The crank case of the engine is adapted to contain suitable oil for lubricating purposes, and this oil may be distributed by a system similar to that disclosed and claimed in the patent to Ernest Dickey, 1,271,140, dated July 2, 1918.

The numeral 25 indicates a tube resembling the old type of so-called breather tube which has a valve that permits the gases in the crank case chamber to escape upon each downward stroke of the piston.

It is well understood, in the operation of combustion engines, that a part of the products of combustion in the explosion chamber of the engine seeps by the piston and gathers in the crank case chamber of the engine. Heretofore it has been the practice to allow these gases to escape through the breather tube to the atmosphere, but where the engine is actuated indoors, this is very injurious, if not actually dangerous, due to the composition of the escaping gases.

Therefore, in the present invention, the gases from the crank case of the engine are permitted to pass out of the crank case chamber, but are conveyed to the intake or inlet header 28^b, where they form a part of the next successive fuel charge taken into the cylinder of the engine.

In the form of the invention shown in the drawing, the breather tube or unit comprises a tube or pipe 25, mounted on the crank case 26, so as to communicate with the interior of said case, through the opening 27, the interior of said case being referred to herein as the crank case chamber. The opposite end of this tube is connected to the outer casing 29, which is provided with a series of openings as indicated by the numeral 30, for the purpose of permitting fresh air to be drawn into the engine cylinder.

In the present form of the invention, the main air intake comprises the openings 30, above referred to. That is, the air which is taken into the combustion chamber, as forming a part of the fuel charge, is sucked through these openings by the suction stroke of the piston 23, as will be described hereinafter. The gas or fuel intake is designated by the numeral 28, which communicates with the Venturi tube 28^a, which of course is in communication with the inlet header 28^b. The arrangement of fuel intake 28 and Venturi tube 28^a herein illustrated constitutes a mixing valve which is equivalent to the well known carbureter, its function being to produce a suitable mixture of air and fuel for the combustible fuel charge. The term mixing valve is employed herein to describe generally any device of whatever nature for producing a suitable combustible mixture with a fuel either initially liquid or gaseous. The passage through the inlet header 28^b is the engine intake, though, broadly speaking, the passage through the inlet header 28^b and the mixing valve combined may be considered as the engine intake.

In order to vary the relative proportions of air and gas forming the fuel charge, to compensate for change in temperature or load conditions, a butterfly valve 31 is formed in the element 42, and is adapted to be manually adjusted so as to control the flow of air from the breather tube to the combustion chamber of the engine.

An inner casing consisting of a tube or pipe 32 is concentrically mounted within the outer casing 29, one end thereof being supported by means of the element 33. Adjacent to the upper end of the tube 25, there is provided an automatically actuated valve 35. This valve comprises as its movable element a disk of any suitable material. As herein shown, a disk of felt 36 is secured to the metallic disk 37 and tends to normally seat on the ring 38, which in turn is mounted between the two rings of felt 39 and 40.

This assembly of the two felt rings 39 and 40, and the metallic ring 38, is held in place between the end of the element 33 and a shoulder 41, formed adjacent to the upper end of the tube 25.

The opposite end of the outer casing 29 is secured to the element 42, as at 43, while the inner tube or casing 32 is connected to said element, so that the opening of said tube lies in direct alinement with the opening 44 of the said element.

Adjacent to the end of the inner tube, which connects with the element 42, a series of openings 45 are provided for the purposes hereinafter set forth.

The operation of the present invention, when combined with a four-stroke cycle engine, commonly known as a "four cycle engine," such as is shown in the accompanying drawing, will be as follows:

Supposing that the engine is brought into operation and that the first stroke of the piston will be its explosion stroke. That is, it is well understood that engines of the

four-cycle type have a determined cycle of operation, which includes, first, the explosion stroke, second, the exhaust stroke, third, the intake or suction stroke, and fourth, the compression stroke.

During the course of the explosion stroke, the piston will travel downward, as indicated by the arrow in part A of Fig. 3, and this downward stroke of the piston will have a determined displacement of air or of any gathered smoke and gases in the crank case chamber, thereby tending to force these gases through the opening 27, against the movable element of the valve 35. This will immediately cause the movable element of the valve to rise and permit the gas and smoke to escape through the valve opening to the inner casing 32.

The internal contents of the inner and outer casings 32 and 29 of the breather tube or unit is of a substantial amount, and preferably this amount is greater than the cubical displacement of the piston throughout its complete downward stroke. It will therefore be seen that as the gas and smoke from the crank case chamber passes into the breather tube, a portion of said gases will tend to seep through the openings 45, formed in the inner casing 32.

However, inasmuch as there is no pressure on these gases after the completion of the explosion stroke of the piston, the valve 35, will tend to close as soon as the piston starts on its upward or exhaust stroke.

Therefore, the gas and smoke within the breather tube will remain inert or dormant as shown in part B of Fig. 3, or will move with such slowness that before the gas and smoke reaches the openings 30, formed in the outer casing of the breather tube, the exhaust stroke of the piston will have been completed and the intake stroke of the piston commenced.

On the intake or suction stroke, as is shown in part C of Fig. 3, the inlet valve 46 in the inlet header is opened, and at the same time due to the displacement of the downward stroke of the piston, the pressure of the gases within the crank case will force the valve 35 to be opened in the same manner as described for the explosion stroke. Therefore, a direct suction will be created on the gas and smoke contained within the breather tube, and inasmuch as the air inlet for the carburation of the fuel is through the perforations or openings 30, formed in the outer casing 29, a flow of fresh air will be sucked through the openings 30 and thus tend to drive all of the gases upward into the inlet header, and thence to the combustion chamber.

From the above description, it will be seen that at the conclusion of the intake stroke, the breather tube will be substantially clear of the smoke and gas the same having been sucked into the combustion chamber of the engine, together with the usual charge of air and gas.

The next successive stroke of the piston will be the upward compression stroke, and during this movement of the piston, the valve 35 will be closed, as will also the inlet and exhaust valves in the cylinder head.

The same sequence of operation as that described above will take place during each of the successive cycles of operation of the engine, and it has been proven, by experiments that substantially all escape of the gas and smoke from the crank case chamber of the engine, directly to the atmosphere, is eliminated. It is also found that during the up strokes of the piston, the valve 35 being closed, a partial vacuum is created in the crank case chamber, which under ordinary conditions will cause a small quantity of air to be sucked in through the bearings or other parts of the crank case thus preventing the escape of lubricating oil from the crank case.

While the operation described above is directed to engines of the four cycle type, it should be clearly understood that this is not to be considered as a limitation in any respect, inasmuch as the invention is equally applicable to engines of different cycle of operation, wherein noxious fumes or gases tend to gather in the crank case chamber of the engine and are displaced by the operation of the engine piston to the atmosphere.

It will be observed that the operation of the breather tube herein described, so far as the external characteristics are concerned, is essentially a breathing operation, since it alternately inhales and exhales air through the openings 30. Beginning with the intake or suction stroke of the piston, fresh air is drawn or inhaled into the breather tube through the openings 30, thereby scavenging the tube of any noxious gases and smoke previously received from the crank case chamber. This is followed by an almost imperceptible pause as the valves 46 and 35 close and the piston moves upwardly on its compression stroke. Then comes the explosion stroke during which a volume of noxious gases is ejected or expelled from the crank case chamber into the inner casing of the breather tube, as previously described, thereby displacing or pushing ahead of it a corresponding volume of fresh air which escapes from the outer casing of the breather tube through the openings 30, causing the effect of exhaling. Another almost imperceptible pause while the piston moves upwardly on its exhaust stroke, and the breathing cycle begins all over again.

The breathing characteristics as explained above may be very pronounced or may be scarcely perceptible, depending greatly on the size and proportion of the engine cylinder, the crank case chamber, the breather

tube, the leakage into the crank case chamber, and other factors. It will be evident that the volume of air exhaled from the breather tube is no larger than the volume of gas received from the crank case chamber, and, when the volume of gas received from the crank case chamber is small the pressure will not be raised high enough in a breather tube of large volume to cause a very pronounced exhalation. By increasing the area of the openings 30 the exhalations can be made still less pronounced, and, indeed, with certain adjustments of the mechanical relations the exhalation can be rendered scarcely perceptible if not entirely suppressed. The volume of gas expelled from the crank case chamber represents the leakage of combustion gases past the piston and of air through the bearings and other parts of the crank case. Ordinarily this is small, but as is evident, it will vary greatly with different types of engines, the kinds of pistons and bearings used, and their general condition. Thus, with certain types of engines in which the volume of gas expelled from the crank case chamber is very small, it is possible to reduce the volume of the breather tube accordingly. In the particular construction illustrated, the breather tube is said to be preferably of greater volume then the cubical displacement of the piston throughout its complete downward stroke, but it should be understood that this is not intended in any sense as a limitation, it being evident that the breather tube need only be large enough in volume to store or hold dormant all the gas received from the crank case chamber between successive engine suction strokes, as herein explained, and that when the volume of gas received from the crank case chamber is small, the breather tube may likewise be made of small capacity.

In the foregoing description, the term breather tube or unit has been used, in its limited sense, to indicate the connections between the crank case chamber and the combustion chamber but it should be understood that in its broader sense it describes the elongated air passage or conduit into which the noxious gases are injected and stored between suction strokes of the piston. It should be understood, further, that in the use of this term in the present application, no limitation is intended, as to the particular shape or configuration of the breather tube or the passage, it being evident that any suitable form may be used, other than that herein illustrated, which will operate in the manner herein described.

It should also be understood that while only a single cylinder engine is shown in the drawing, the present invention can be readily combined with engines having any number of cylinders.

While the form of mechanism herein shown and described constitutes a preferred embodiment of one form of the invention, it is to be understood that other forms might be adopted, and various changes and alterations made in the shape, size, and proportion of the elements therein, without departing from the spirit and scope of the invention.

What I claim is as follows:

1. In a device of the character described, the combination with a four cycle engine of the type wherein the flow through the engine intake is intermittent provided with a combustion chamber and a crank case chamber and having a piston operable relative to said chambers; of a breather tube connected to said engine and having provisions for permitting the gases displaced from the crank case chamber by the suction and explosion strokes of the piston to pass into said breather tube and to then pass from said breather tube to the combustion chamber on the suction stroke of the piston, said breather tube being provided with an opening to the atmosphere, whereby air will be taken through said breather tube to the combustion chamber along with said gases during the suction stroke of the piston, said opening being of such remoteness from the crank case chamber as to provide a storage space within said breather tube of sufficient capacity to retain, without escape to the atmosphere, all the gases received from said crank case chamber between successive suction strokes of the piston.

2. In an internal combustion engine of the type wherein the flow through the engine intake is intermittent, a passage between the crank case and engine intake for conducting noxious gases from the crank case to the intake, said passage also providing means of conduit for the incoming air, said passage having an opening for the air of such remoteness from the crank case as to provide a storage space within said passage sufficient to hold the gases substantially dormant, between the compression and suction strokes of the engine.

3. In an internal-combustion engine of the type wherein the flow through the engine intake is intermittent, the combination of a chamber connected to the engine intake; means for intermittently injecting noxious gases into said chamber; an opening in said chamber providing a passage to the atmosphere, said opening being remote from the point of injection of said noxious gases, whereby said gases are retained within the chamber between successive flow movements through said engine intake.

4. The combination with an internal-combustion engine of the type wherein the flow through the engine intake is intermittent including an intake and a closed crank case; of means providing an elongated passage connected with said crank case at one end

and connected freely with atmosphere at a point remote from the crank case, and at an intermediate point with said engine intake.

5. In a device of the character described, the combination with a four cycle engine of the type wherein the flow through the engine intake is intermittent provided with a combustion chamber and a crank case chamber and having a piston operable relative to said chambers; of a breather tube connected to said engine and having a valve operable on the suction and explosion strokes of the piston to permit communication between the crank case chamber and the breather tube, whereby the gases contained in the crank case chamber will be displaced by the operation of the piston and forced into the breather tube; and an inlet valve operable on the suction stroke of the piston to permit communication between the breather tube and the combustion chamber of the engine, whereby the gases forced into the breather tube will be sucked into the combustion chamber of the engine, said breather tube being of such capacity as to hold, substantially dormant and substantially at atmospheric pressure, the gases expelled thereto from said crank case chamber between the compression and suction strokes of the engine.

6. In a device of the character described, the combination with a four cycle engine of the type wherein the flow through the engine intake is intermittent, having a combustion chamber and a crank case chamber and a piston operable relative to said chambers; of a breather tube having provisions for permitting communication between the crank case chamber and the breather tube during the suction and explosion strokes of the piston, and permitting communication between the breather tube and the combustion chamber during the suction stroke of the piston, said breather tube being of such capacity as to hold, substantially dormant and substantially at atmospheric pressure, the gases expelled thereto from said crank case between the compression and suction strokes of the engine.

7. In a device of the character described, the combination with an engine of the type wherein the flow through the engine intake is intermittent, having a combustion chamber and a crank case chamber and a piston operable relative to said chambers; a breather tube having communication with the crank case chamber and the combustion chamber of the engine; a valve adapted to open and close said communication between the crank case chamber and the breather tube; said breather tube being of such capacity as to hold, substantially dormant and substantially at atmospheric pressure, the gases expelled thereto from said crank case chamber between the compression and suction strokes of the engine.

8. In a device of the character described, the combination with an engine of the type wherein the flow through the engine intake is intermittent, including a crank case having a breather tube communicating with the interior thereof; and means for connecting said breather tube to the combustion chamber of the engine, said breather tube being of such capacity as to hold, substantially dormant and substantially at atmospheric pressure, the gases expelled thereto from said crank case between the compression and suction strokes of the engine.

9. The combination with an internal-combustion engine of the type wherein the flow through the engine intake is intermittent, including an intake and a closed crank case; of means connected with said crank case and said intake for accumulating, substantially at atmospheric pressure, the gaseous content expelled from the crank case and delivering said content mixed with atmospheric air to said intake.

10. In an internal-combustion engine of the type wherein the flow through the engine intake is intermittent, a passage between the crank case and engine intake for conducting noxious gases from the crank case to the intake, said passage also providing means of conduit for the incoming air, said passage having an opening for the air of such remoteness from the crank case as to provide a storage space within said passage sufficient to hold the gases substantially dormant, between the compression and suction strokes of the engine, and a fuel supply pipe connected to said passage at the engine intake end of said passage.

11. In an internal-combustion engine of the type wherein the flow through the engine intake is intermittent, the combination of a mixing valve connected in operative relation to said engine intake; a chamber connected to the air inlet of said mixing valve; means for intermittently injecting noxious gases into said chamber; an opening in said chamber providing a passage to the atmosphere, said opening being remote from the point of injection of said noxious gases, whereby said gases are retained within the chamber between successive flow movements through said engine intake.

12. In an internal-combustion engine of the type wherein the flow through the engine intake is intermittent, the combination of a mixing valve connected in operative relation to said engine intake; a chamber connected to the air inlet of said mixing valve; and means for injecting noxious gases into said chamber and retaining them therein during periods of non-flow through said engine intake.

13. In a vertical internal-combustion en-

gine of the type wherein the flow through the engine intake is intermittent, a vertical passage connecting the crank case chamber and the engine intake for conducting noxious gases intermittently from the crank case chamber to the engine intake, said passage also providing means of conduit for the incoming air from a point adjacent the lower end thereof, and a fuel supply pipe connected to said passage adjacent the upper end thereof.

14. The combination with an internal-combustion engine comprising an engine of the type wherein the flow through the engine intake is intermittent, intake and a crank case chamber; of a breather device providing a passage from the crank case chamber to the engine intake for conducting noxious gases from the crank case chamber to the engine intake, said breather device having communication with the atmosphere near the crank case end thereof to provide an air intake; and a fuel supply pipe connected to said passage at the engine intake end thereof.

15. The combination with an internal-combustion engine comprising an engine of the type wherein the flow through the engine intake is intermittent, intake and a crank case chamber; of a breather device comprising a passage connected with the engine intake and communicating with the atmosphere to provide an air intake; a fuel intake communicating with said passage; and a second passage connected with the crank case chamber and communicating with said first mentioned passage between the fuel and the air intakes, said breather device being adapted to store noxious gases intermittently received from the crank case chamber.

16. In a device of the kind described, the combination with an internal-combustion engine having a crank case and an intake, of a breather pipe extending vertically from the crank case, a coupling connected with the engine intake and breather pipe and forming a closure for the upper end thereof, said coupling having a passage from the breather to the intake which includes a mixing chamber, and a fuel supply pipe for delivering a quantity of fuel to the mixing chamber at each suction stroke of the engine.

17. The combination with an internal-combustion engine comprising an inlet and closed crank case; of a breather device connected between said crank case and said engine inlet comprising a pair of concentric chambers, the inner chamber connected at its lower end with the crank case and at its upper end with the inlet and with the outer chamber, and the outer chamber connected at its lower end with atmosphere.

18. The combination with an internal-combustion engine comprising an inlet and closed crank case; of a breather device connected between said crank case and said engine inlet comprising a pair of concentric chambers, the inner chamber connected at its lower end with the crank case and at its upper end with the engine inlet and with the outer chamber, and the outer chamber connected at its lower end with atmosphere; and a check valve between the inner chamber and the crank case.

19. A breather device comprising an outer chamber, and an inner chamber having a passage therethrough, said inner chamber communicating with said outer chamber, and said outer chamber communicating with atmosphere.

20. In combination with an internal-combustion engine having opposed abutments with passages therein; a breather device comprising outer and inner tubular members seating upon and supported by said abutments to form outer and inner chambers, said outer chamber connecting with the atmosphere, and said inner chamber connecting with the outer chamber and with the passages in said abutments; and a valve seating on one of said abutments to close one end of the inner chamber.

21. The method of operating an internal-combustion engine of the type wherein the flow through the engine intake is intermittent and in which part of the gaseous content of the crank case is intermittently expelled by the down strokes of the engine piston, which consists in accumulating all such expelled gaseous content in a reservoir substantially at atmospheric pressure, and then admitting said gaseous content admixed with atmospheric air into the engine combustion chamber.

22. The method of continuously operating an internal-combustion engine of the type wherein the flow through the engine intake is intermittent and in which part of the gaseous content of the crank case is intermittently expelled by the down strokes of the engine piston, which consists in temporarily accumulating such expelled gaseous content in a reservoir substantially at atmospheric pressure against return to the crank case, and then admitting said gaseous content admixed with atmospheric air into the engine combustion chamber at the next suction stroke of the piston.

23. The method of operating a four stroke cycle engine of the type wherein the flow through the engine intake is intermittent including a cylinder and a closed crank case from which a part of the gaseous content of the crank case is expelled during the explosion stroke of said engine, which consists in accumulating said expelled gaseous content substantially at atmospheric pressure in a reservoir against escape therefrom

during the exhaust stroke of said engine, and admitting said gaseous content together with atmospheric air into the engine combustion chamber during the suction stroke of said engine, while discharging a further part of the gaseous content of the crank case into said reservoir during the suction stroke.

In testimony whereof I affix my signature in the presence of two subscribing witnesses.

CHARLES F. KETTERING.

Witnesses:
J. W. McDONALD,
O. D. MOWRY.