June 22, 1948. R. J. HERRINGTON 2,443,957

INTERNAL-COMBUSTION ENGINE

Filed June 6, 1946

Fig. 1

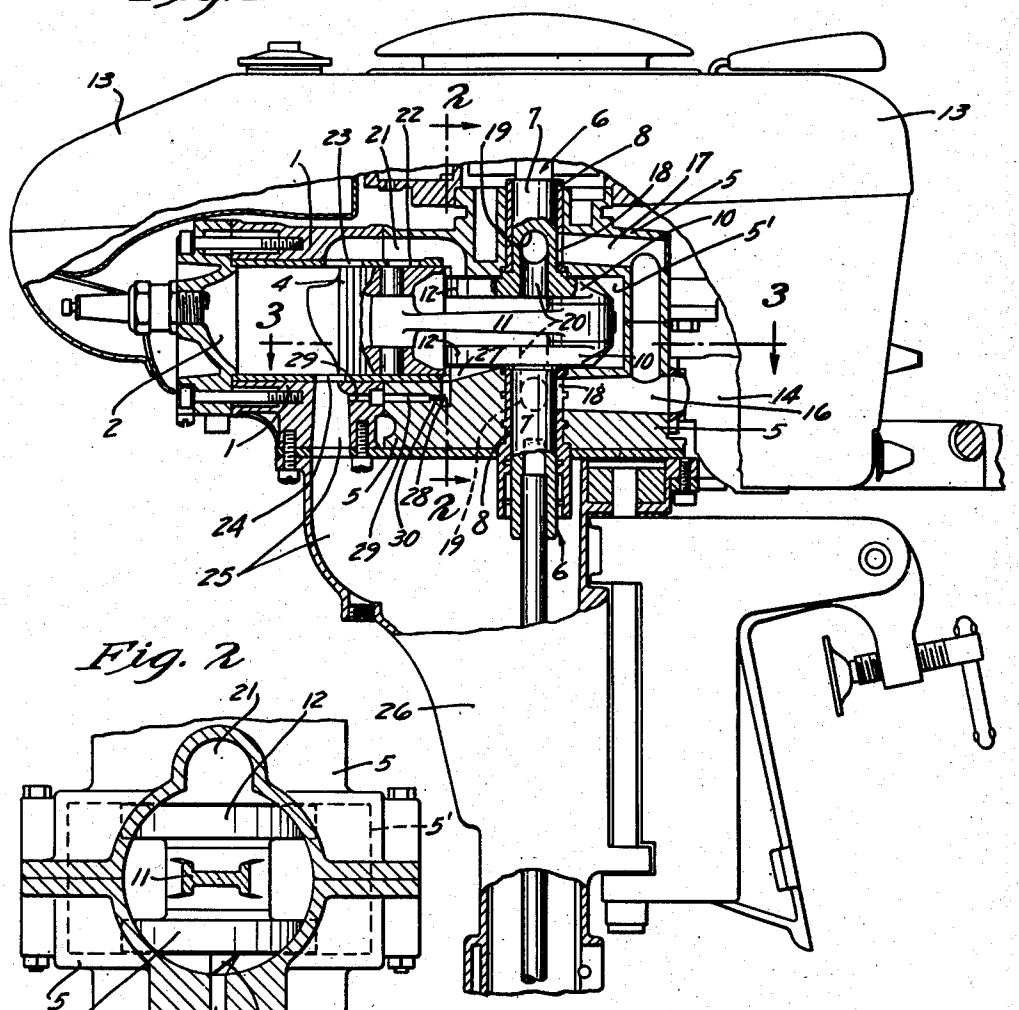
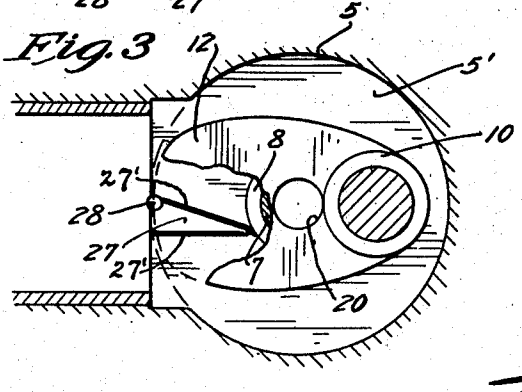


Fig. 2

Fig. 3



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INTERNAL-COMBUSTION ENGINE

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18 Claims. (Cl. 123—195)

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My present invention relates to improvements in internal combustion engines of the crankcase compression type wherein combustible mixture, usually gasoline and air, is admitted to and compressed in the engine's crankcase preparatory to injection into the engine's combustion chamber or chambers, and more especially to that type of engine in which lubrication is usually provided by oil mixed with the gasoline or other liquid fuel and admitted to the crankcase with the combustible mixture; it being, generally stated, an object of the present invention to provide an engine of this type that is devoid of certain detrimental operating characteristics commonly considered inherent in such engines. This invention is therefore an attempt to solve a long recognized fundamental defect in engines of this type.

In engines of the character described, the fuel mixture delivered to the crankcase, and which usually contains a small proportion of relatively heavy lubricating oil, is subject to violent centrifugal action within the crankcase which tends to separate from the mixture heavy portions thereof and deposit the same on the bottom of the crankcase in the form of condensate, which, if not immediately removed, will collect to a certain volume and then be whipped up by the fast-moving mixture within the crankcase and delivered in concentrated form to the combustion chamber or chambers, where it will inevitably upset the mixture balance and cause erratic operation of the engine. This detrimental operation of engines of the character in question, resulting from periodic injection into the engine's combustion chamber or chambers of condensate from the crankcase, has been heretofore endured by the industry as a necessary evil, and can take any one of the following, and possibly other, forms, to wit:

a. Periodic sputtering with partial or complete stalling of the engine during periods of otherwise normal operation;

b. Periodic four-cycling of the engine (meaning periods when the engine misses fire on every second revolution), and which is most prevalent during periods of acceleration after prolonged operation at relatively low speed; and

c. Occasional hard starting of an engine that normally has good starting characteristics; and

d. Undue formation of deposits of carbon in the cylinders of the engine, resulting in overheating, pre-ignition, loss of power, excessive wear and more serious defects.

In view of the above, it is, therefore, a specific object of the present invention to provide means

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whereby the liquid condensate accumulating on the bottoms of the crankcases of such engines will be automatically and rapidly removed from the crankcase without being given an opportunity to collect and be returned to the moving column of combustible mixture.

Another and more specific object of the invention is the provision of a means for placing the crankcase into continuous communication with the exhaust pipe, and for advantageously and expeditiously discharging said condensate into said exhaust pipe, without detriment to the operation of the engine.

Yet another important purpose of the invention resides in utilizing the conventional moving parts within an engine crankcase for positively separating heavier constituents of the mixture in the crankcase, delivering and impelling said separated constituents into a condensate discharge means and then applying timed pressure impulses thereto for facilitating its removal from the crankcase.

Still another aim of the invention contemplates the utilization of the pressure impulses and flow through the exhaust pipe for inspirating the flow of condensate from the crankcase without deleterious effect upon the normal functioning of the engine.

In practice, it has been found that difficulties of the kind mentioned are greatest in engines of the above noted type, wherein the cylinder or cylinders are horizontally disposed, and, therefore, a very particular object of the invention is the provision of ways and means for proper disposal of crankcase condensate in engines having horizontally disposed cylinders.

In accordance with the present invention, I render engines of the kind described completely immune to the undesirable operating characteristics such as above described, and which are quite generally accepted as inherent in such engines, and to my knowledge this is the first time that this objective has been achieved to such a high degree in any engine of the type described and particularly among engines of this type which are operated over a wide range of speeds, as, for example, in outboard marine use. Fortunately, this improved operation also results in notably improved over-all efficiency of operation. In connection with improved efficiency, it is, of course, particularly important that the condensate removed from the crankcase, and which is often referred to as "sludge" and represents very poor potential fuel, be permanently disposed of, as by being delivered to the exhaust passage, and never

permitted to find its way to the engine's combustion chamber.

The above and other highly important objects and advantages of the invention will be made apparent from the following specification, claims, and appended drawings.

In the accompanying drawings, like characters indicate like parts throughout the several views.

Referring to the drawings:

Fig. 1 is a fragmentary view in side elevation, with some parts broken away and some parts shown in section, of an outboard marine engine incorporating a preferred embodiment of my invention;

Fig. 2 is an enlarged fragmentary sectional view taken on the vertical line 2—2 of Fig. 1; and

Fig. 3 is a similarly enlarged horizontal sectional view taken on the line 3—3 of Fig. 1.

The engine illustrated in the present drawings is a 1947 model "Champion" outboard boat engine, and comprises a horizontally disposed sleeved cylinder 1 closed at its outer end to afford a combustion chamber 2, the usual reciprocating piston 4, a crankcase 5, and a vertically disposed crankshaft 6. The crankshaft 6 has upper and lower journals 7 mounted in upper and lower crankcase-carried main bearings 8, the usual crank 10 connected to the piston 4 by a conventional connecting rod 11, and radially extending counterweight-acting flanges 12.

Gasoline or other liquid fuel and a predetermined proportion of lubricating oil, which may be assumed to be stored in the gas tank 13, is mixed with air to form a combustible mixture within a conventional carburetor 14. This combustible mixture is drawn into the crank chamber 5' within the crankcase through crankcase manifold passages 16 and 17, cooperating valve ports 18 and 19 in the crankshaft main bearings 8 and crankshaft journals 7 respectively, and axially extending crankshaft passages 20. The admission of combustible mixture to the crank chamber 5' is, of course, timed with relation to piston position. More specifically, the cooperating valve ports 18 and 19 will be open only for intervals during outward movements of the piston after a partial vacuum has been built up in the crank chamber and as a result of which, partial vacuum, charges of combustible mixture will be injected in to the crank chamber. Of course, each time the piston approaches its innermost position, the combustible mixture compressed in the crank chamber by such inward movements of the piston will be transferred in the usual manner to the combustion chamber end of the cylinder 1 through a conventional transfer passage 21 and piston controlled cylinder transfer ports 22 and 23.

By reference to the drawings, it will be seen that the cylinder opens into the compression chamber 5' of the crankcase through a substantially circular approximately vertical wall thereof, and by further reference to the drawings it will be seen that the bottom inside wall surface of the crank chamber 5' is substantially annular and is cross-sectionally substantially flat. As will be seen particularly by reference to Fig. 1, the bottom surface of the lower counterweight flange 12 of the crankshaft and the bottom of the crank 10 work in very closely spaced relation to the said substantially flat bottom annular wall surface of the crank chamber and are shaped to match the cross-sectional contours of said flat annular bottom surface so that during their rotation the crankshaft parts mentioned will tend to sweep

before them any condensate deposited on the flat annular bottom of the crank chamber. Moreover, the rotation of the moving parts in the crankcase will induce a corresponding swirling motion of the combustible gases therein, and the resultant centrifugal force acting thereon will cause condensation of the heavier components thereof upon the vertical crankcase wall, as well known in the art.

The engine illustrated is provided with the usual piston controlled cylinder exhaust port 24 leading into an exhaust passage 25 formed in part in the cylinder 1 and in part in a propeller shaft housing 26, although exhaust passage may be formed in any desired manner.

In carrying out the present invention, I provide by way of illustration a condensate receiving chamber connected with the crankcase, which may be formed in the bottom wall of the crank chamber 5' as a collecting channel 27 that opens upwardly through the relatively flat annular upper surface thereof and extends transversely across said annular surface. This collecting channel 27 (see Figs. 1 and 3) actually extends from the bottom of the inner end of the cylinder sleeve 1' to the lower crankshaft bearing 8 and the bottom thereof slopes from its inner end to its outer end adjacent the end of the cylinder. The sides 27' of this recess are radii of the circular crankcase bottom (see Fig. 3). Opening upwardly into the deepest portion of the collecting channel 27 is a well 28 which receives condensate and excess lubricant from the channel 27 and the lower portion of which is connected by a passage 29 to the exhaust conduit 25. By reference particularly to Fig. 1, it will be seen that this passage 29 includes a highly restricted portion or orifice 30 immediately adjacent the well 28.

Attention is now directed more specifically to Fig. 1, wherein it will be seen that the conduit 29 discharges into the exhaust pipe 25 at a portion of relatively enlarged cross section adjacent the port 24, whereby the sharp pulsations of pressure in the exhaust conduit will produce a corresponding succession of inspirating impulses upon the drainage passage and any condensate collected therein. In order to augment the inspirational effect, a venturi may be inserted in the exhaust pipe adjacent the outlet of passage 29.

With the arrangement described, all surplus liquid, condensate or otherwise, deposited on the bottom of the crank chamber will be continuously swept into the collecting channel 27 by the bottom surfaces of the lower parts 10 and 12 of the crankshaft, and all surplus liquid, condensate or otherwise, pushed inwardly from the cylinder by the piston 4 will be deposited directly into the collecting channel 27. From the collecting channel 27, this fluid drains into the well 28 from which it will be pressure injected into the exhaust conduit 25 through the restricted passage 29 during each period of crankcase compression, and inspirated by the exhaust pulsations as set forth above. In this way, condensate will be collected and discharged from the crank chamber without being given an opportunity to puddle or collect in globules which can be whipped back into the fast-moving stream of combustible mixture and delivered therewith to the combustion chamber to cause the kind of uncertain or detrimental operation mentioned above. Of course, there will be a slight, but highly controlled, leakage from the crank chamber to the exhaust passage during each crankcase compression period, which, in

itself, would seem to indicate a slight loss in efficiency. However, practice has indicated clearly that any efficiency loss that might be attributed to this small leakage through the restricted passage 29 is more than offset by the increase in efficiency resulting from disposal of the crankcase condensate independently of the combustion chamber or chambers, so that the over-all result is a noteworthy improvement not only in performance characteristics but in efficiency as well.

It will be further understood that the aforementioned bleeding or leakage of crankcase combustible may be minimized and in certain cases entirely eliminated by properly proportioning the diameter and length of the restriction 30 and the associated passages whereby the combined and simultaneous propulsive effect of the exhaust suction and the crankcase compression are necessary to effect a flow of liquid through the passages.

Recognition should also be made of the periodic and timed admission of gases to the crankcase through the valves ports 18 and 19, which periodic admission contributes to and facilitates the establishment of a timed fluctuation of pressure in the crankcase.

Of course, it is important that the lower crankcase elements 10 and 12 are close enough to the bottom of the crank chamber to sweep surplus liquid into the collecting channel 27, and that the passage 29 be restricted as highly as possible without interfering with its ability to carry away surplus liquid from the crankcase as fast as it collects in the particular engine involved. While I do not wish to in any way limit myself, I may say that the above ends have been successfully attained on a commercial basis in engines of the kind herein illustrated by maintaining working clearances between the crankshaft elements 10 and 12 and the bottom of the crank chamber of between .005 of an inch and .015 of an inch and by providing a minimum restricting diameter in the passage 29 at 30 of .0280 of an inch.

What I claim is:

1. In an internal combustion engine, a cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for receiving products of combustion from the cylinder, a crankcase into which the other end of the cylinder opens and in which combustible mixture and lubricant is admitted and compressed preparatory to injection into the combustion chamber, and a highly restricted and continuously open scavenging passage leading from the lowermost portion of the crankcase to the said exhaust conduit, whereby during periods of crankcase compression condensate collected in the bottom of the crankcase will be injected into the exhaust conduit and discharged therefrom as a vapor.

2. In an internal combustion engine, an approximately horizontally disposed cylinder closed at its outer end to afford a combustion chamber, a crankcase into which the other end of said cylinder opens and in which combustible mixture and lubricant is admitted and compressed preparatory to injection into the combustion chamber, an approximately vertically disposed crankshaft having a crank working within the crankcase, said crankcase having a substantially flat approximately annular inside bottom surface and a collecting channel extending substantially across said bottom surface, said crankshaft having a portion that works closely over said substantially flat bottom surface and the channel therein and tends to sweep condensate deposited on said bottom surface into said collecting channel, and a highly restricted passage leading from said collecting channel to a relatively low pressure zone outside of the crankcase for permanently removing said condensate from said crankcase.

3. In an internal combustion engine, an approximately horizontally disposed cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for products of combustion, a crankcase into which the other end of said cylinder opens and in which combustible mixture and lubricant is admitted and compressed preparatory to injection into the combustion chamber, said crankcase having a substantially flat approximately annular inside bottom surface and a collecting channel extending substantially across said bottom surface, an approximately vertically disposed crankshaft having a portion that works closely over the said substantially flat bottom surface of the crank chamber and the channel therein and tends to sweep condensate deposited on said bottom surface into said collecting channel, and a highly restricted passage leading from said collecting channel to the exhaust conduit, whereby during periods of crankcase compression condensate collected in said channel will be injected into the exhaust conduit and discharged therefrom as a vapor.

4. In an internal combustion engine, a cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for receiving products of combustion, a crankcase in which combustible mixture and lubricant is admitted preparatory to injection into the combustion chamber, said crankcase having a substantially circular inside surface through which the cylinder opens and having a substantially flat approximately annular inside bottom surface, said crankcase being further formed to provide a collecting channel opening upwardly through said approximately flat inside bottom surface and extending substantially across said flat annular surface, the outer end of said collecting channel being located closely adjacent the inner end of the cylinder whereby to receive fluid directly therefrom, an approximately vertically disposed crankshaft having a portion that works closely over said flat annular bottom surface and the channel therein and tends to sweep condensate deposited on said bottom surface into said collecting channel, and a highly restricted passage leading from said collecting channel to a relatively low pressure zone outside of the crankcase for permanently removing said condensate from said crankcase.

5. In an internal combustion engine, a cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for receiving products of combustion, a crankcase in which combustible mixture and lubricant is admitted preparatory to injection into the combustion chamber, said crankcase having a substantially circular inside surface through which the cylinder opens and having a substantially flat approximately annular inside bottom surface, said crankcase being further formed to provide a collecting channel opening upwardly through said approximately flat inside bottom surface and extending substantially across said flat annular surface, the outer end of said collecting channel being located closely adjacent the inner end of the cylinder whereby to receive fluid directly therefrom, an approximately vertically disposed crankshaft having a portion that works closely over said flat annular bottom surface and tends to sweep

condensate deposited on said bottom surface into said collecting channel, and a highly restricted passage leading from said collecting channel to said exhaust conduit, whereby during periods of crankcase compression condensate collected in said channel will be injected into the exhaust conduit and discharged therefrom as a vapor.

6. In an internal combustion engine, a cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for receiving products of combustion, a crankcase in which combustible mixture and lubricant is admitted preparatory to injection into the combustion chamber, said crankcase having a substantially circular inside surface through which the cylinder opens and having a substantially flat approximately annular inside bottom surface, said crankcase being further formed to provide a collecting channel opening upwardly through said approximately flat inside bottom surface and extending substantially across said flat annular surface, the outer end of said collecting channel being located closely adjacent the inner end of the cylinder whereby to receive fluid directly therefrom, an approximately vertically disposed crankshaft having a portion that works closely over said flat annular bottom surface and tends to sweep condensate deposited on said bottom surface into said collecting channel, a well opening upwardly into said collecting channel, and a highly restricted passage leading from said well to the exhaust conduit, whereby during periods of crankcase compression condensate collected in said well will be injected into the exhaust conduit and discharged therefrom as a vapor.

7. In an internal combustion engine, a cylinder closed at its outer end to afford a combustion chamber, an exhaust conduit for receiving products of combustion, a crankcase in which combustible mixture and lubricant is admitted preparatory to injection into the combustion chamber, said crankcase having a substantially circular inside surface through which the cylinder opens and having a substantially flat approximately annular inside bottom surface, said crankcase being further formed to provide a collecting channel opening upwardly through said approximately flat inside bottom surface and extending substantially across said flat annular surface, the outer end of said collecting channel being located closely adjacent the inner end of the cylinder whereby to receive fluid directly therefrom, an approximately vertically disposed crankshaft having a portion that works closely over said flat annular bottom surface and tends to sweep condensate deposited on said bottom surface into said collecting channel, said collecting channel having a sloping bottom, a well opening upwardly through the lowermost portion of the bottom of said channel, and a highly restricted passage leading from said well to a relatively low pressure area outside of the crankcase for permanently removing said condensate from said crankcase.

8. In an internal combustion engine, an approximately horizontally disposed cylinder closed at its outer end to afford a combustion chamber, a crankcase affording a crank chamber in which combustible mixture is admitted preparatory to injection into the combustion chamber and into which the inner end of the cylinder opens, said crank chamber having an approximately annular bottom wall surface and said crankcase being formed to provide a collecting channel opening upwardly through said flat annular bottom wall surface and extending substantially thereacross, the outer end of said collecting channel being located closely adjacent the inner end of the cylinder whereby to receive fluid directly therefrom, an approximately vertically disposed crankshaft having a portion that works closely over the annular bottom surface of the crank chamber and tends to sweep condensate deposited on said bottom surface into said collecting channel, and a highly restricted passage leading from said collecting channel to a low pressure zone outside of the crankcase said low pressure zone including an exhaust conduit for products of combustion.

9. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid condensate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage.

10. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid condensate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage, said receiving means being adjacent to said cylinder for receiving condensate therefrom.

11. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid condensate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage, said restricted passage communicating with said exhaust passage at a point of reduced pressure.

12. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid condensate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage, said restricted passage communicating with said exhaust passage at a point of reduced pressure, said receiving means being adjacent to said cylinder for receiving condensate therefrom.

13. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid condensate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage, and means for periodically applying a pressure upon condensate collecting in said receiving means for assisting flow therethrough.

14. In a crankcase compression engine, a cylinder, an exhaust passage connected to said cylinder, a crankshaft journaled in said crankcase, means in said crankcase for receiving liquid con-

densate collecting in said crankcase, means carried by said crankshaft for delivering condensate collecting in said crankcase to said receiving means, and a restricted passage continuously connecting said receiving means to said exhaust passage, and means for periodically applying a pressure upon condensate collecting in said receiving means for assisting flow therethrough, said receiving means being adjacent to said cylinder for receiving condensate therefrom.

15. In a crankcase compression engine, a crankcase, an exhaust passage, a vertical crankshaft therein, means carried by said crankshaft for removing condensate from the bottom of said crankcase, a receiving means into which said removed condensate is delivered and combined pressure and suction means for discharging said condensate into said exhaust passage.

16. In a crankcase compression engine, a crankcase, an exhaust passage, a vertical crankshaft therein, means carried by said crankshaft for removing condensate from the bottom of said crankcase, a receiving means into which said removed condensate is delivered and combined pressure and suction means for discharging said condensate into said exhaust passage, said last mentioned means being operable at periodic intervals timed relative to the crankshaft rotation.

17. In a crankcase compression engine, a crankcase, an exhaust passage, a vertical crankshaft

therein, means carried by said crankshaft for removing condensate from the bottom of said crankcase, a receiving means into which said removed condensate is delivered, and combined pressure and suction means for discharging said condensate into said exhaust passage, said receiving means including a recess in said crankcase bottom.

18. In a crankcase compression engine, a crankcase, an exhaust passage, a vertical crankshaft therein, means carried by said crankshaft for removing condensate from the bottom of said crankcase, a receiving means into which said removed condensate is delivered and combined pressure and suction means for discharging said condensate into said exhaust passage, said receiving means including a recess in said crankcase bottom, and a flow restricting means in said discharging means.

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