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SCAVENGING AND CHARGING OF TWO-CYCLE ENGINES

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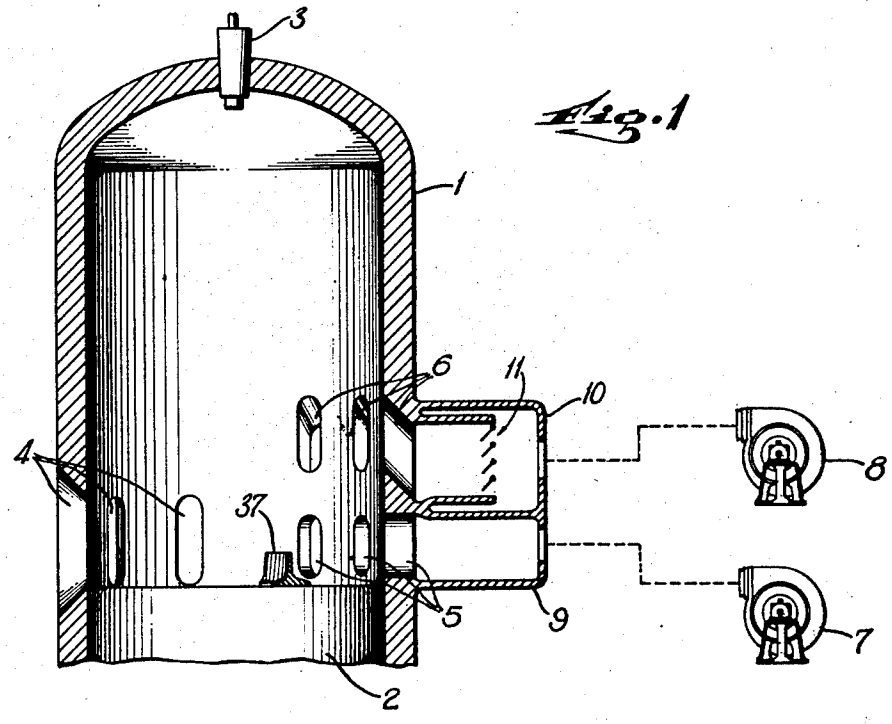


Fig. 1

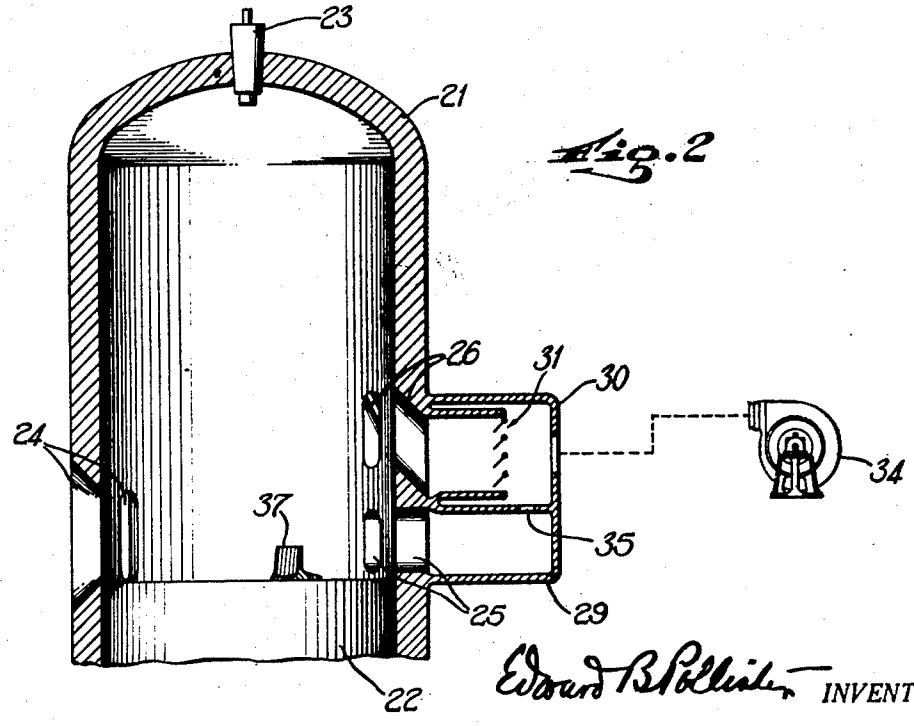


Fig. 2

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BY Jeffery Kinsman & Eggleston ATTORNEYS.

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SCAVENGING AND CHARGING OF TWO-CYCLE ENGINES

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7 Claims. (Cl. 123—65)

My invention relates to two-cycle internal combustion engines having piston-controlled scavenging-air and exhaust ports, and more particularly to injection-type or Diesel engines of this class, and is particularly suited for so-called high speed Diesel engines, normally operating at speeds of 400 R. P. M. and higher and intended to be used at variable loads and speeds.

The object is to improve the scavenging and charging process of such engines, and more particularly the scavenging, so that the cylinder will be thoroughly evacuated of combustion products notwithstanding the high speed and the consequent shortness of the periods available for air admission, such periods being too short for adequate scavenging and charging by the customary simpler scavenging and charging process heretofore employed.

I have discovered that better scavenging than heretofore, and especially better scavenging of the upper or head ends of the cylinders, and improved charging and supercharging, are obtainable by the joint use of high and low pressure air, where the low pressure air is admitted substantially as and while the exhaust port or ports is or are open and the high pressure air is admitted as soon as the pressure within the cylinder has fallen sufficiently to receive it and is continued thereafter until, at least, the inflow of low pressure air is stopped. Especially for better charging and for super-charging however, the admission of the high-pressure air may be (and usually it is) continued for some time after the inflow of low pressure air is discontinued. I have discovered also that such a scavenging and charging, or super-charging, process is adequate for the high speed engines before mentioned, and especially is well suited for engines, of the kind indicated, designed for the higher speeds now contemplated for Diesel engines, say from 400 to 1000 R. P. M. and wherein it is desirable to eliminate all valve gearing in the vicinity of the scavenging and charging ports.

I have found it is important that the high-pressure air be admitted as soon as the cylinder pressures have fallen below the pressure of the high-pressure air, and according to my invention, I use automatic, or self-opening, valves to control the high-pressure ports, i. e. valves operated by the difference between the pressure within the cylinder and the pressure of the high-pressure air, so that there may be no delay whatsoever, under any condition of speed, load or fuel control, in the introduction of the high-pressure air after the cylinder pressure has fallen sufficiently to admit it. For the higher-pressure air, I have obtained excellent scavenging at speeds above 400 with pressure around four pounds above atmosphere; however, the pressure of the high-pressure air may vary with the construction of the ducts and ports, and it may vary with changes in the engine speed, etc., and may also be considerably greater than four pounds above atmospheric pressure, especially if considerable supercharging is to be accomplished. The low-pressure air is admitted at about the same time, and, for example, at about the same pressures as heretofore customary when scavenging with low-pressure air alone, this including of course maintaining the air pressure constant outside the ports to about the same degree at least as has heretofore been customary in practice.

I employ entirely separate ports in the cylinder side walls for the high and low pressure airs. I have found too that it is desirable to locate the high-pressure air ports somewhat nearer the head ends of the cylinders than the low-pressure ports. Further, minimum power consumption in air compression is obtained by providing separate sources for the high-pressure air and the low-pressure air, with separate ducts and receivers for conveying the high-pressure air and the low-pressure air to their respective ports.

The accompanying drawing illustrates the invention diagrammatically, Figure 1 representing a section of a cylinder of a two-cycle Diesel engine with my invention applied in a form employing (as preferred) separate sources for the high-pressure and the low-pressure air, and Figure 2 representing a similar section but showing the use of a single initial source for both the high-pressure and the low-pressure air.

In Fig. 1 the engine cylinder is shown at 1 and its piston at 2; the member 3 will serve to indicate the fuel injection valve whereby fuel is injected into the cylinder at or near the substantial completion of the compression stroke, as in ordinary Diesel engine practice. Piston-controlled exhaust ports are shown at 4. At 5 are shown a number of air inlet ports for the low-pressure air, likewise opened and closed by the reciprocating piston. As in ordinary low-pressure scavenging, these low-pressure air ports 5 are so placed that the piston begins to uncover them only after the exhaust ports 4 have been so far opened that the cylinder pressure has

fallen below the pressure of the low-pressure air, and the complete opening of these inlet air ports 5 takes place at about the end of the power or working stroke as indicated in Fig. 1. At 6 are a number of high-pressure air inlet ports, these being placed (in accordance with the preference before expressed) nearer the head end of the cylinder than the low-pressure ports 5. The high-pressure air port or ports 6 may be, and usually will be, so placed as to be uncovered by the piston, in part at least, prior to the beginning of the opening of the exhaust ports 4, in order that the high-pressure air may have adequate means of access to the interior of the cylinder at the instant the pressure within the cylinder has fallen sufficiently to admit the entrance of this high-pressure air; and so as to be closed by the piston only after the exhaust ports have been closed, in order to provide for the entrance of some charging air (and super-charging air if desired) after the closing of the exhaust ports on the compression strokes. The blower 7 and blower 8 represent the separate sources for the low-pressure air and the high-pressure air respectively, these being separately piped to the low-pressure air receiver 9 and the high-pressure air receiver 10 at the engine.

As before indicated, my invention contemplates the use of automatic or self-opening valves to prevent entry of the cylinder combustion gas into the high-pressure air duct or ducts prior to the time when the cylinder pressure has fallen below the pressure of the high-pressure air. In Diesel engines operating at the high speeds to which this invention particularly relates, it is found impractical, if not impossible to prevent such entry without unduly abbreviating the period of scavenging with high-pressure air, unless the valve is closed by the pressure of the combustion gas itself; attempts to time a positively operated valve so as to obtain the same length of period of high-pressure scavenging as is obtainable with gas-operated self-opening valves, result in blow backs and explosions of dangerous character. Such self-closing valve is indicated at 11, consisting of a number of louvers or light and easily moved horizontally-pivoted vanes opening toward the cylinder when the pressure in the receiver 10 exceeds the pressure within the cylinder, but closing quickly one against the other when the pressure within the cylinder predominates.

It will be observed that the descent or outward movement of the piston 2 during each power stroke, by uncovering the exhaust ports 4 ultimately permits the pressure within the cylinder to fall to such a degree that the pressure of the air within the higher-pressure receiver 10 predominates and as soon as this happens the high-pressure air begins to enter the engine cylinder through the then partially or fully open air ports 6. After the exhaust ports have been opened, the piston uncovers the low-pressure ports 5, and thereupon low-pressure air also enters the cylinder, the higher-pressure flow continuing. The cylinder is scavenged, therefore, and recharged with combustion air by the joint action of the high-pressure air and the low-pressure air. On the return of the piston on the next compression stroke, the low-pressure ports 5 are first closed; thereafter the exhaust ports are closed, and the high-pressure ports are not completely closed until some time after the closing of the exhaust ports; during this interval between the closing of the exhaust and higher-pressure ports air may continue to enter through the higher-pressure ports 6 to complete the charging of the cylinder with combustion air, or (by placing or extending these ports 6 sufficiently toward the cylinder head, and by using adequate pressure in the receiver 10) super-charging may be done to any desired degree.

In this two-source process there is, it will be observed, minimum power consumption in compressing the air for scavenging and charging or super-charging, inasmuch as only the high-pressure air is compressed to the higher pressure, the air for the receiver 9 being compressed to only the lower pressure.

My invention is not limited however to using separate sources for the high-pressure and the low-pressure air, although that is more economical, but one source alone may serve, as indicated in Fig. 2, the pressure being reduced for the low-pressure receiver, by throttling or other means. The cylinder 21, piston 22, fuel injection valve 23, exhaust ports 24, low-pressure air inlet ports 25, high-pressure air inlet ports 26, low-pressure air receiver 29, high-pressure air receiver 30, and the automatic self-opening valve or louvers 31 (opening toward the cylinder) will be recognized from and correspond to similar parts in Fig. 1. The single blower 34 serves to provide air at the higher-pressure needed for the high pressure air inlet ports 26, and also air in sufficient volume to supply the low-pressure ports 25 as well. By passing a limited quantity of this air into the low-pressure receiver 29, through a sufficiently restricted passageway or connection, such a single source of air will suitably serve both sets of air inlet ports. To this end, as illustrated in Fig. 2, the air source 34 may be piped directly and solely to the receiver 30, and the wall between this receiver 30 and the low-pressure receiver 29 may be provided with one or more passages 35 adequate to admit only the volume of air needed for the low-pressure ports 25 of the several cylinders, but so restricted as to maintain within the receiver 29 only the lower pressure contemplated therefor. Obviously my invention is not limited to a passage or connection from the high-pressure receiver to the low-pressure receiver of a fixed and invariable area. The air receivers 9 and 10 and likewise the receivers 29 and 30 will be understood to be common to and supply all the cylinders of a multicylinder engine, although only one cylinder has been illustrated, the capacity or air storage thus provided, plus the continuous flow of air from the blowers 7 and 8 (or from the blower 34 and through the inter-receiver passages 35), serving to maintain the air pressures outside the engine ports during the scavenging periods, that is to say, to keep these pressures constant at all times during the scavenging period to at least substantially the same degree as has been the practice heretofore with single low-pressure scavenging.

If desired, some means can be provided for directing the scavenging and charging airs toward the head of the cylinder. This is indicated, by way of example, by the deflector 37 on the piston head, and shown partly in section in the two figures, and the forms and use of which, in connection with scavenging by low pressure air alone, are well known. Or this directing may be accomplished by the appropriate sloping of the port passages through the cylinder walls.

My co-pending application Serial No. 561,130 has to do with sloping port passages.

In general, it will be understood that my invention is not limited to the exact operation and details of construction illustrated and described above, except as particularized by the claims.

I claim:

1. In a two-cycle injection-type engine having piston-controlled exhaust and air inlet ports, means for supplying both low-pressure air and higher-pressure air to said air inlet ports, said means substantially maintaining the pressure of at least the low-pressure air during the scavenging operation, and an automatic valve, self-opening toward the cylinder when the pressure of the higher-pressure air exceeds the pressure within the cylinder, said valve controlling flow through the passage through which said higher pressure air is passed into the cylinder.

2. In and for scavenging and charging the cylinders of two-cycle injection-type engines, a source of low-pressure air, a source of higher-pressure air, a duct communicating with and receiving air from the source of low-pressure, a duct communicating with and receiving air from the source of higher-pressure, an engine cylinder, a piston working therein, ports being provided in the wall of the cylinder, means providing a passage between said ports and the low-pressure duct, said means, low-pressure duct and low-pressure source substantially maintaining the pressure of the low-pressure air at said ports during the scavenging operation, other ports also being provided in the wall of the cylinder, means providing a passage between said other ports and said higher-pressure duct, said other ports being located nearer the cylinder head than the first mentioned ports, and an automatic valve between the higher-pressure duct and its ports, said valve opening solely by the pressure of the air toward the interior of the cylinder and closing by the pressure of the cylinder contents.

3. The method of scavenging and charging, or supercharging, a two-cycle injection-type engine cylinder wherein the exhaust passes from the cylinder through the wall of the latter at a point relatively remote from the cylinder head, which consists in passing air under pressure into the cylinder through the cylinder wall at a point remote from the cylinder head, and thereafter and while said air is continuing to pass into the cylinder also passing air under a substantially maintained lower pressure into the cylinder at a point more remote from the head end of the cylinder, characterized by the fact that the entry of said higher-pressure air is begun on the instant that the pressure within the cylinder has fallen below the pressure of this air.

4. The subject matter of claim 1, characterized by the fact that said means for feeding air includes separate blowers for the air at the higher-pressure and the air at the lower-pressure.

5. The subject matter of claim 1, characterized by the fact that separate ports are provided for the inlet of the higher-pressure air and the inlet of the low-pressure air to the cylinder.

6. The subject matter of claim 1, characterized by the fact that separate ports are provided for the inlet of the higher-pressure air and the inlet of the low-pressure air to the cylinder, and by the fact that the said port or ports for said higher-pressure air enter closer to the cylinder head than said port or ports for said low-pressure air.

7. A two-cycle injection-type engine having piston-controlled exhaust ports and two sets of piston-controlled air inlet ports, said inlet ports being respectively connected with conduits supplied with air, one at a relatively low pressure and the other at a higher pressure and the higher pressure air inlet ports being nearer to the head end of the cylinder than the lower pressure air inlet ports and a self-opening valve in the communication between said high pressure conduit and the higher pressure inlet ports adapted to pass said high pressure air to the cylinder instantly on the falling of the cylinder pressure below the pressure of said air.

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