

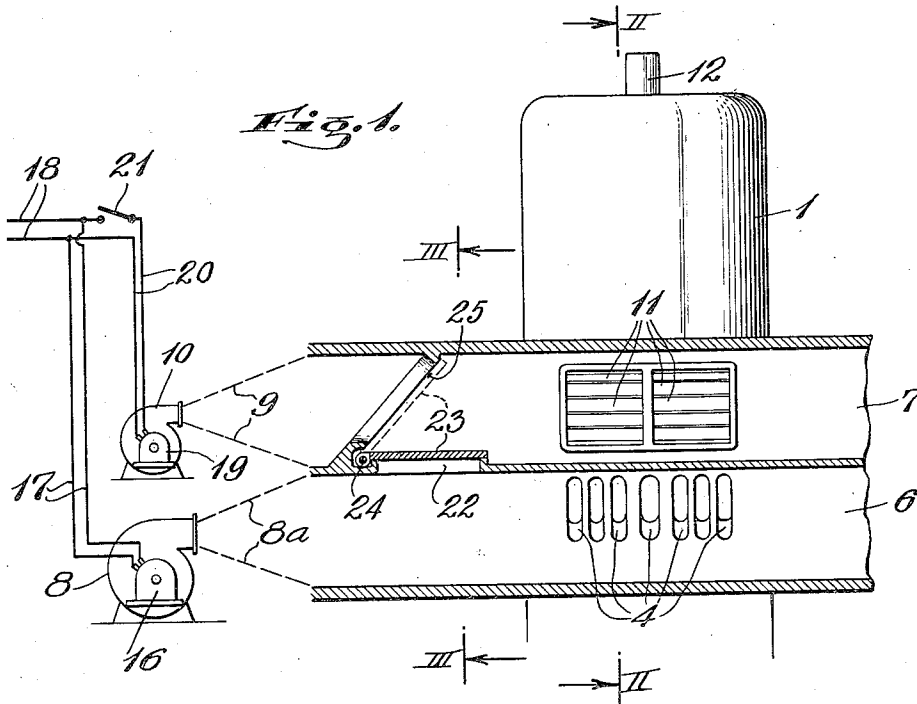
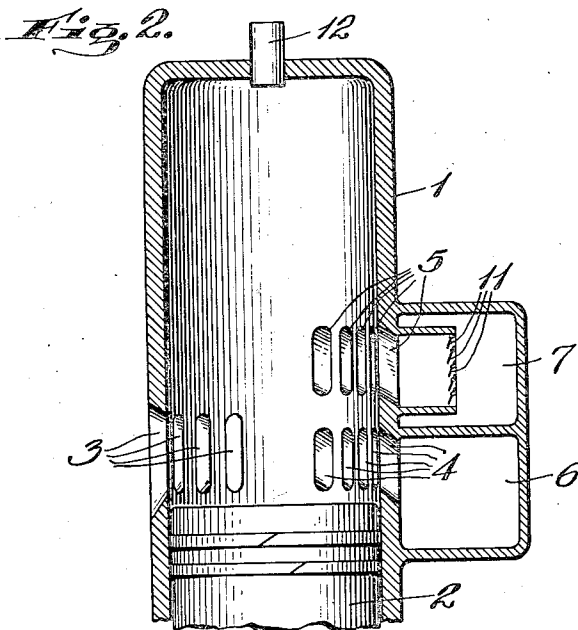
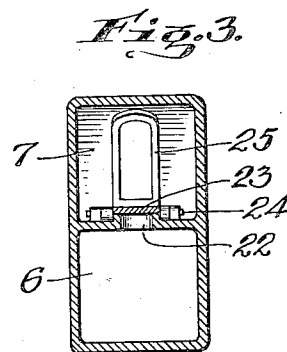
Nov. 6, 1934.

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1,979,770

TWO-CYCLE ENGINE SCAVENGING AND CHARGING

Filed Oct. 7, 1931



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UNITED STATES PATENT OFFICE

1,979,770

TWO-CYCLE ENGINE SCAVENGING AND CHARGING

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Application October 7, 1931, Serial No. 567,347

9 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 engines of this customary form, that is to say, Diesel engines in which the fuel is introduced at or about compression dead center.

More particularly, my invention relates to engines of the kind indicated which are required to operate under loads that vary widely from time to time, and especially engines of this kind that are required to operate at different speeds, such as marine engines.

As appears in co-pending applications, I have discovered that better scavenging than heretofore, and improved charging and supercharging, of engines of the kind indicated, are obtainable by the joint use of high and low pressure air where the low-pressure air is admitted as and while the exhaust port is open and the admission of the high-pressure air is begun early, at the very instant the pressure within the cylinder has fallen sufficiently to receive it. I have discovered also that such process is particularly desirable for injection type engines which operate at such high speeds that the periods available for air admission are too short for adequate scavenging and charging by the simpler scavenging and charging process heretofore employed, and especially is well adapted for Diesel engines designed for operation at higher speeds than usual 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. From one aspect the object of my present invention is to apply, in an economical manner, this scavenging and charging or supercharging process to engines of the kind indicated which are required to operate under widely varying load conditions, and especially to engines which are called on to operate at times at high speeds and at other times at low speeds; more specifically, to apply such a process to such engines in a manner which is economical of the power required for providing the scavenging and charging or supercharging air.

To this end I employ separate sources for the high and low pressure air. For the source or sources of low pressure air, I employ apparatus capable of supplying an adequate volume of air at adequate pressure to satisfy the needs of the engine at some degree of load or speed less than the maximum, and capable of supplying such needs throughout a certain range of load or speed variation less than the maximum; the highest

degree of load or speed for which the lower pressure source or sources will serve is chosen from the standpoint of economy. The higher-pressure source or sources is designed to be adequate to supply the engine needs at higher loads or speeds when used jointly with the lower-pressure source or sources. Then at the higher loads, and especially at the higher speeds, and where supercharging is required, I employ the scavenging and charging process above outlined, using, when doing so, the separate sources for the high and the low pressure airs as stated, resulting in substantial operating economy in the power consumed in compressing the scavenging and combustion air under these conditions. But at lower loads, where less combustion air will serve, and at the lower speeds, when the air admission periods are of relatively long duration, this invention discontinues the higher-pressure air, using then only the lower-pressure source or sources alone; and preferably, instead of simply discontinuing or cutting out the higher-pressure source from service, I then direct the lower-pressure air into the engine cylinder or cylinders through the high-pressure passage or passages as well as through the low pressure passage or passages, thus making use of the high-pressure passages to secure adequate scavenging and charging, or some supercharging if desired. Thus I secure economical and convenient operation under those operating conditions which do not require the extra high air pressure, as well as under those conditions for which the extra high pressure is desirable.

As will be understood from the foregoing, some convenient means must be included for stopping (and starting again) the supply of higher-pressure air at the proper times, and this without stopping the lower-pressure source or sources. By preference, I employ for this purpose an automatic or self-operating valve or valves (i. e., a valve or valves opened and closed by a difference between the gas pressures on its opposite sides) for controlling the communication between the low-pressure source or sources and the high-pressure passage or passages (preferably a passage between the high and lower pressure receivers), and also, when necessary (as will usually be the case), for closing and opening the connection from the higher-pressure receiver to the higher-pressure air source or sources, when the higher-pressure source is taken out of and is returned to action.

An embodiment of my invention is illustrated diagrammatically in the accompanying drawing,

Figure 1 being an elevation, partly in section, of one cylinder and the adjacent portion of the air receivers of a multiple cylinder Diesel engine, its sources of air being also indicated, Figure 2 being a sectional view substantially on the line II—II of Fig. 1, the head of the piston being shown in elevation, and Fig. 3 being a section on line III—III of Fig. 1.

In the drawing the engine cylinder 1, its piston 2, piston-controlled exhaust ports 3, and two tiers of air inlet ports 4 and 5 will be recognized. The element at 12 will serve to represent fuel injection means whereby fuel is injected into the cylinder at about the end of each compression stroke as usual. The exhaust ports 3 and air inlet ports 4 are placed substantially as in ordinary two-cycle Diesel engines scavenged and charged by low pressure air, that is to say, the exhaust ports 3 are so placed that the piston begins to open them before it reaches the end of its power or working strokes and the air inlet ports 4 are so placed that the piston begins to open them shortly after the opening of the exhaust ports 3 is begun, both said ports being completely opened as the piston reaches the extreme end of the power or working strokes. The tier of ports 4 is for the low-pressure air. The ports 5 for the higher air pressure are preferably placed nearer the upper or head end of the cylinder than the lower-pressure ports and usually they are placed respectively above the lower-pressure air-inlet ports, as represented; usually, the higher pressure ports are so placed that the piston 2 at least begins to uncover them before it begins to uncover the exhaust ports 3, and usually so close to the cylinder head that they are uncovered in part at least before the pressure within the cylinder (during the power or working strokes) falls to equality with the pressure of the higher-pressure air supplied to them; in these latter respects however, the exact placement of these air inlet ports 5 will depend on the service or services to be performed by the air admitted through them, and the pressure of this air, as will be understood. A receiver 6 is provided for the air-inlet ports 4, this being connected by an appropriate duct (indicated generally by the broken lines 8a in Fig. 1) to the source 8 of air. Likewise a receiver 7 is provided for the air inlet ports 5, this being connected by an appropriate duct (indicated at 9) to the source 10 of air. Each of these receivers 6 and 7 may be common to and supply the corresponding air-inlet ports of all or a number of the cylinders of the engine, as will be understood from common Diesel engine practise. An automatic or self-opening valve (or valves) 11, opening toward the interior of the cylinder, is provided for the air inlet ports 5. As here illustrated, this automatic or self-opening valve or valves can conveniently have the form of louvers or a series of light horizontally-pivoted plates or vanes opening toward the interior of the cylinder when the pressure within the receiver 7 is superior to that within the cylinder, and closing against each other when the pressure backward through the ports 5 predominates. The air source 8 is so designed and constructed as to supply air at a relatively low pressure or pressures, say a pressure about equal to some of the pressures now used in the simple low-pressure scavenging processes of Diesel engines; it may be higher however, or even lower than this; in general the pressure produced by this source 8 in any instance will be determined in accordance with the service de-

sired of the air from this source, such as the amount of scavenging and charging to be done by the air, and whether some supercharging is desired when the air source 10 is out of operation as later referred to. The air source 10 is designed and constructed to deliver air at a higher pressure than the source 8; and in general the pressure to be developed by this source 10 will be determined by the service desired of the air from it, such as the amount of scavenging and charging or supercharging.

Assuming both air sources 8 and 10 to be in operation, it will be recognized that the apparatus so far described embodies the scavenging and charging or supercharging process before referred to. As the piston 2 descends during each power or working stroke, the air-inlet ports 5 are first opened, thereafter the exhaust ports 3 are opened, and later the air-inlet ports 4 are opened. Just as soon as the pressure of the combustion gases within the cylinder has fallen below the relatively-high air pressure within the receiver 7, the automatic or self-opening valves 11 open and air from source 10 begins to enter through the ports 5; as the ports 4 are opened, air from source 8 enters through the ports 4, to join with air from the ports 5 in scavenging and charging the cylinder. As the piston 2 ascends on each compression stroke, the ports are closed and the air inflows are discontinued in the reverse order.

The low-pressure source 8 however is capable of supplying the engine with all the scavenging and charging or supercharging air the engine may require at some degree of load or speed whereat the use of a single low-pressure compressor such as 8 is more economical than the use of the two compressors such as 8 and 10. This degree of load or speed will be less than the maximum, and in each instance the degree of load or speed for which the low-pressure source will be designed to satisfy these air requirements of the engine will be determined by the economics of the particular situation, including convenience. Furthermore, it is by preference a centrifugal blower and its pressure-volume characteristic is represented by a curve which begins to droop when the range for which it is designed is exceeded; that is to say, the air pressure developed by this blower will decline if and as a greater volume of air (a greater rate of air flow) is permitted to come from it. The design of blowers of such a characteristic is well known. Moreover, such blower is so constructed and operated, and its pressure-volume characteristic is such, that it can supply all the scavenging and charging air (and also such supercharging air as may be needed or desired) throughout its selected range of low loads and speeds, so that having once taken over the air service of the engine to the exclusion of blower or compressor 10, it can continue to supply the needs of the engine for scavenging and combustion air below and up to its designed limit, as, for example, the load or speed is or are further reduced.

Conveniently, the source 10 can be a centrifugal blower also, as illustrated, having the proper pressure characteristics. As representative of means for driving the two air sources whereby the higher-pressure source 10 can be discontinued from operation at will, that is to say, at the lesser engine loads or speeds, and restarted again at will, i. e., for the higher engine loads or speeds. I have shown the two blowers driven by individual electric motors 16 and 19, the former being

connected by the lines 17 to the source of current or supply lines 18, and the motor 19 being connected to the same supply lines by the lines 20, and the interposed manual switch 21.

5 As representative of arrangements whereby the lower-pressure blower 8 can deliver to the engine cylinder through the higher-pressure passages, as well as through its own passages, when this air source alone is in operation (and also as
10 generally representative of the preferred arrangement to this end) I have shown the common wall between the two receivers 6 and 7 pierced with a passageway 22 of adequate size, and an automatic or self-operating valve therefor in the
15 form of a light flap valve 23 hinged on axis 24; when both sources 8 and 10 of air are in operation, the superior pressure from source 10 holds this valve closed over the passage 22, but when source 8 alone is in operation, air from this source
20 will serve to open the flap and thus gain admittance to the air-inlet ports 5. Consideration of the matter will show that it is advantageous to permit the lower-pressure air to use the higher-pressure air passages, as well as its own passages,
25 when the higher-pressure source is taken out of operation. Also as representative of automatic or self-operating valves for closing the passage from the high-pressure receiver 7 to the high-pressure source when the latter is out of operation,
30 I have shown back seat 25 for the flap 23; when the latter opens passage 22 it bears on this valve seat 25 and thus prevents escape of air from receiver 7 through the (now stationary) blower 10.

35 The method of operation will be apparent from the foregoing. At the higher engine loads or speeds, both sources 8 and 10 are in operation (switch 21 being closed), and the scavenging and charging, or supercharging, is done as before
40 described. At lower engine loads and speeds the higher-pressure air source 10 is held inoperative (by the opening of switch 21), and source 8 alone serves to supply scavenging and charging air through both tiers of ports 4 and 5, flap valve
45 23 being held back against its seat 25, with or without some supercharging depending on the pressure of the air delivered by this source 8.

Usually it is desirable to direct the air from both tiers of ports somewhat toward the head
50 end of the cylinder. This is done, preferably, by sloping ports 4 and 5 upwardly as appears in Fig. 2.

It will be understood from the foregoing that my invention is not limited to using air at only
55 two different pressures, and the claims which follow will be understood accordingly; however air at only two different pressures seems to be adequate to satisfy present conditions. Obviously in general my invention is not limited
60 to the exact operation and the constructions illustrated in the accompanying drawing and described in detail above. This will be apparent to the engineer without further description.

The following is claimed:

65 1. Means for scavenging, charging and supercharging a cylinder of a two-cycle internal combustion engine, comprising a source of low pressure air, a source of higher pressure air, a duct communicating with and receiving the air from
70 the source of low pressure, a duct communicating with and receiving scavenging air from the source of higher pressure, a passage connecting said ducts, valve means to open and close said passage, valve means between the source of higher pressure and the high pressure duct, to open and

close the communication between them, the cylinder having piston-controlled ports in its wall connected to the low pressure duct and other piston controlled ports in its wall connected to the higher pressure duct, a valve or valves between the higher pressure duct and its ports, and means for placing the source of higher pressure into and out of operation.

2. In a two-cycle internal combustion engine having piston-controlled exhaust and air inlet
85 ports in the side wall of a cylinder, separate sources for scavenging air at different pressures, means providing passageways connecting said air sources to said air inlet port or ports, and means for discontinuing and restarting one or
90 more of said air sources which deliver air at a relatively high pressure, the remainder of said air sources remaining in operation, said passageways including a passageway connecting, when said relatively-high pressure source is out of
95 action, other of said air sources to the air-inlet port or ports through which said higher-pressure source delivers when in action.

3. In a two-cycle internal combustion engine having a piston-controlled exhaust port and piston-controlled air-inlet ports, a source of scavenging air at a relatively low pressure capable of supplying all the scavenging and charging air the engine requires at some degree of working
100 load less than the maximum, means providing a passageway for air connecting said source to some of said air-inlet ports, another source of scavenging air at a higher pressure, means providing a passageway for air connecting the latter
105 source to other of said ports, means for stopping the operation of and restarting said source of scavenging air at the higher pressure, the said source of lower pressure remaining in operation, and means for connecting said lower-pressure scavenging-air source to the said air-inlet port
110 or ports of said higher-pressure source, so as to deliver air therethrough as well as through its own inlet port or ports, while the said higher-pressure source is inoperative.

4. In a two-cycle internal combustion engine
120 having a piston-controlled exhaust port and piston-controlled air-inlet ports, a source of scavenging air at a relatively low pressure connected to some of said air-inlet ports, another source of scavenging air at a higher pressure connected to other of said ports, means for stopping
125 the operation of and restarting said source of scavenging air at the higher pressure, the said source of lower pressure remaining in operation, and a passage being provided leading from said scavenging-air source of lower pressures to the air inlet port or ports for said higher pressure scavenging-air, and an automatic self-operating valve to hold said passage closed while said
130 higher-pressure source is in operation and opening said passage when said higher-pressure source is inoperative.

5. In a two-cycle internal combustion engine having a piston-controlled exhaust port and piston-controlled air-inlet ports, a source of scavenging air at a relatively low pressure connected to some of said air-inlet ports, another source of scavenging air at a higher pressure connected to other of said air-inlet ports, means for stopping the operation of and restarting said source of
140 scavenging air at the higher pressure, the said source of lower pressure remaining in operation, a passage leading from said scavenging-air source of lower pressure to the air-inlet port or ports for said higher-pressure scavenging-air, 150

said air-inlet port or ports for the air from said higher pressure source being located nearer the head end of the cylinder than the said air-inlet ports for the air from said lower pressure source,

5 automatic self-operating valve means closing the said air-inlet port or ports for said higher-pressure scavenging-air when the cylinder pressure predominates, closing said passage when said higher-pressure source is operating, and closing
10 the connection to said higher-pressure source while the latter is out of operation.

6. The method of scavenging and charging a two-cycle internal combustion engine having piston-controlled exhaust and air-inlet ports, which
15 consists in, at higher engine loads, supplying scavenging and charging air through said air-inlet ports at a plurality of different pressures, for a part of the time at least air at a plurality of different pressures being supplied simultaneously,
20 and, at lower engine loads, supplying scavenging and charging air through the same air-inlet ports at a lesser number of pressures.

7. The combination with a two-cycle internal combustion engine, of means connected to said
25 engine for providing scavenging air therefor at a relatively high pressure, means independently connected to said engine for providing scavenging air therefor at lower pressures, said latter means being, at an engine load or speed less than maximum, capable of supplying scavenging air to the
30 engine in adequate volume at adequate pressure to meet the engine requirements, and means for discontinuing the operation of the first mentioned means and restarting the same, the second mentioned means remaining in operation.

35 8. The combination with a two-cycle internal combustion engine having piston-controlled side

exhaust and air-inlet ports, of a source of relatively high pressure air, a source of lower pressure air, said source of lower pressure being, at an engine load or speed less than maximum, capable of supplying air to the engine in adequate
80 volume at adequate pressure to meet the engine requirements, each of said sources of air being connected to said air-inlet ports to supply scavenging air thereto, and means to discontinue the operation of said higher pressure source and re-
85 start it, the said lower-pressure source remaining in operation.

9. The combination with a two-cycle internal combustion engine having piston-controlled side
90 exhaust and air-inlet ports, of a source of relatively high pressure air connected to some of said air-inlet ports to supply air for scavenging, a source of air at a lower pressure, said source of lower pressure being, at an engine load or speed less than maximum, capable of supplying air to
95 the engine in adequate volume at adequate pressure to meet the engine requirements, said lower-pressure source being connected to other of said air-inlet ports than that or those to which said higher pressure source is connected, a passage be-
100 ing provided for leading air from said lower-pressure source to said air-inlet port or ports to which said higher-pressure source is connected, means for opening said passage when said higher-pressure source is inoperative and for
105 holding said passage closed while the higher-pressure source is operative, and means for discontinuing the operation of said higher-pressure source and restarting it again, the said lower-pressure source remaining in operation. 110

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