H. J. SCHARNAGEL.

MULTIPLE EXPANSION INTERNAL COMBUSTION ENGINE.

APPLICATION FILED NOV. 23, 1917.

1,353,542. Patented Sept. 21, 1920.

Fig. 1.

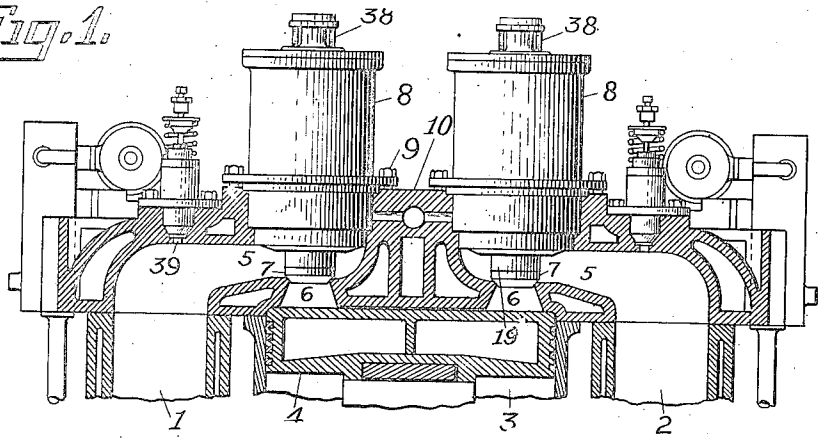


Fig. 2.

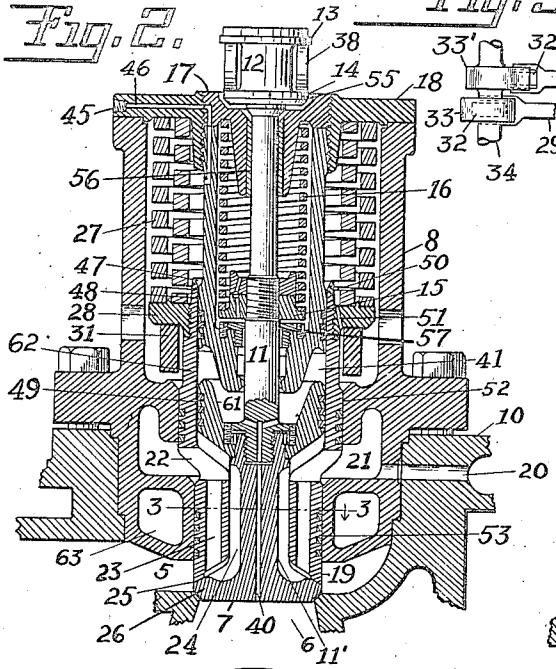


Fig. 5.

Fig. 4.

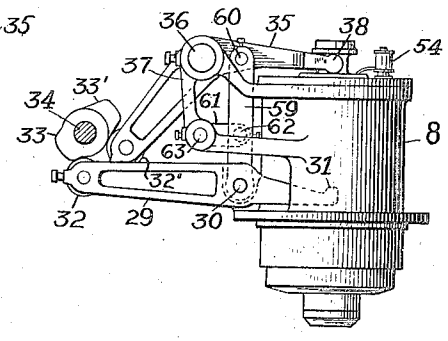


Fig. 6

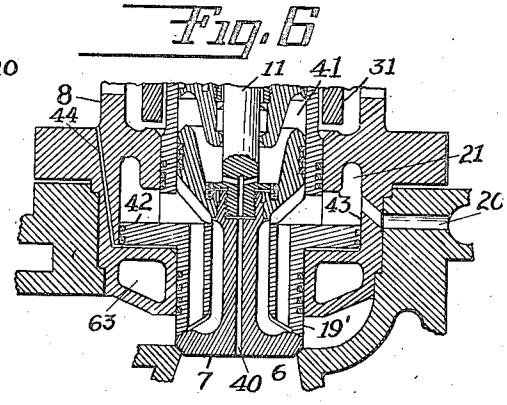
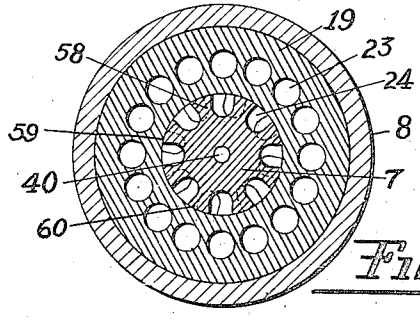


Fig. 3.



INVENTOR

HERMAN J. SCHARNAGEL.

BY

Herbert H. Thompson

ATTORNEY.

UNITED STATES PATENT OFFICE.

HERMAN J. SCHARNAGEL, OF TOMPKINSVILLE, NEW YORK, ASSIGNOR TO ELMER A. SPERRY, OF BROOKLYN, NEW YORK.

MULTIPLE-EXPANSION INTERNAL-COMBUSTION ENGINE.

1,353,542. Specification of Letters Patent. Patented Sept. 21, 1920.

Application filed November 28, 1917. Serial No. 204,349.

To all whom it may concern:

Be it known that I, HERMAN J. SCHARNAGEL, a citizen of the United States of America, residing at 85 Hannah street, Tompkinsville, in the county of Richmond and State of New York, have invented certain new and useful Improvements in Multiple-Expansion Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines; especially to multiple expansion oil engines.

One of the principal objects of the invention is to improve upon the valves used in such engines for the admission of air to the high pressure cylinder and for the transfer of the gases from the high to the low pressure cylinder after the completion of the working stroke of the piston in the high pressure cylinder.

Another object of the invention is to provide means for the effectual cooling of the transfer valve; and to accomplish this with the use of the intake air for the high pressure cylinder.

A further object is to provide means for preventing the pressure of the gases entering the low pressure cylinder from one high pressure cylinder, from forcing open the valve between the low pressure cylinder and the second high pressure cylinder, if employed. A further specific object is to devise a transfer valve especially adapted for the type of engine shown in the copending application of Elmer A. Sperry for multiple expansion gas engines Serial No. 181204, filed July 18th, 1917.

Referring to the drawings wherein I have shown what I now consider to be the preferred form of my invention:

Figure 1 is a sectional side elevation of the upper part of an engine embodying my invention.

Fig. 2 is a sectional elevation of the combined inlet and transfer valve.

Fig. 3 is a section taken on line 3—3 of Fig. 2.

Fig. 4 is a side elevation of levers for operating the valves.

Fig. 5 is a detail showing the cams for actuating the said levers.

Fig. 6 is a modification showing means for keeping the air intake valve normally closed.

In the drawings, 1 and 2 represent high pressure cylinders, while 3 represents a low pressure cylinder; the low pressure piston being shown at 4. Passages 5 leading from the high pressure cylinders are provided to afford communication through ports 6 from said high pressure cylinders to the low pressure cylinder. The said passage preferably forms a continuation of the clearance space 5′ in the high pressure cylinder by extending the clearance space laterally to overlie the low pressure cylinder as shown.

Two valve casings 8 are shown secured by bolts 9 in the top or cylinder head 10 of the engine. The said valve casings are preferably immediately above the low pressure cylinder and adjacent the inner end of the aforesaid passages 5. The parts within each of these casings are the same, so that a description of one will suffice for both. The preferred details are shown in Fig. 2. The structure comprises a common transfer and intake valve mechanism or two part valve, which for convenience will be treated as two separate valves, the transfer valve 7 and the intake valve 19.

Valve 7 is shown below the valve casing 8, with a stem portion or shank 11′ reaching into said casing. A stem 11 fastened to said shank continues up through the top of the casing. Valve 19 is shown as a sleeve mounted over the shank 11′ and seating at 25 on the flaring or flanged portion 26 of valve 7. Grooves or passages 24 are shown in the shank 11′ adjacent the sleeve or valve 19. The upper part 62 of sleeve 19 is preferably larger than the lower part and has therein a balancing piston 61 fixed on the shank 11′ of valve 7.

The function of valve 19 is to admit air to the high pressure cylinder, while valve 7 is to permit the gases in the high pressure cylinder after the completion of the working stroke of the piston (not shown) therein, to enter the low pressure cylinder. Valve 7 closes port 6, and is normally held in such position by a spring 16 engaging member 17 fixed to the top 18 of casing 8 and a collar 15 locked on the stem 11 of valve 7.

A top portion 12 is shown fixed to stem

11 and having flanges 13 and 14 thereon. A bell crank lever 35 pivoted at 36 to a frame or bracket 37 secured to the valve casing may be bifurcated at one end 38 to engage stem 11 between flanges 13 and 14 and is shown as having a roller 32′ to engage a cam 33′ on the cam shaft 34 of the engine. The cam shaft is designed to be rotated by the engine crank shaft through any suitable gearing (not shown). Cam 33′ is designed to rock lever 35 to effect the opening of valve 7.

Valve 19 is held normally closed by springs 27 pressing at one end against the top 18 of the valve casing, and at the other against a shoulder or collar 28 on said valve. A lever 29 pivoted at 30 (see also Fig. 4) is bifurcated at one end 31. This end may reach into the valve casing and engage shoulder 28 as shown in Figs. 2 and 4. The other end of the lever is shown as having a roller 32 engaging a cam 33 on cam shaft 34. The rocking of lever 29 effects the opening of valve 19.

According to the aforesaid application of Elmer A. Sperry, the intake air is precompressed. Said compressed air, or other intake air, may be admitted through a channel 20 into a chamber 21 in the valve casing. It then passes through openings 22 in valve 19, then down through passages or grooves 23 therein, and also down through passages or grooves 24 in valve 7 (see Fig. 3). Upon the opening of valve 19 at 25 the air is forced through passage 5 into the high pressure cylinder.

The channels 23 and grooves 24 are so arranged as to expose a sufficient surface of valves 7 and 19 to the incoming air to effect the proper cooling of these valves; the object being to cool the valves sufficiently to insure the proper working and preservation of these parts, and yet not enough to materially reduce the temperature of the gases passing from the high to the low pressure cylinder. The valves in addition are of course made preferably of heat resisting material. It should also be noted that not only is the transfer valve effectively cooled but that the heat which is abstracted therefrom is not wasted but taken up by the intake air and hence wholly conserved. The particular construction of the valves adopted lends itself well to the rapid transfer of heat from the exposed surface of the transfer valve 7 to more shielded parts of the valve where the heat is rapidly and effectively dissipated. A valve stem 11′ of substantial cross section is employed which serves to rapidly conduct the heat away from the exposed surface of the valve. Moreover, the valve stem is channeled or fluted by grooves 24 thereby not only increasing its radiating surface but also furnishing channels for the passage of the compressed intake air. This air flows down the channels, which are preferably spiraled around the stem as indicated in Fig. 3, over the top of the valve 7 proper and into the combustion cylinder.

It will be noted that the lifting of valve 7 will also effect the lifting of the air intake valve 19, without, however, opening the latter.

It will also be seen that while spring 16 is designed to hold valve 7 normally closed, springs 27 pressing down on valve 19 which in turn rests on valve 7 at 25, will also bear down on said valve 7 holding it more firmly in its seat. When valve 19 is open, however, it will, as has been seen, be raised off valve 7. I desire therefore to provide means, responsive to the opening of valve 19 for applying the downward pressure of springs 27 to said valve 7 in another manner. For this purpose I have shown the fulcrum 30 of lever 29 as being pinned to a link 59 suspended at 60 from bell crank lever 35. When cam 33 rocks lever 29 on floating fulcrum 30 to open valve 19, a force will be applied to lever 35 through link 59 causing said lever to bear down on stem 11 of valve 7. Another link 61 pivoted to link 59 at 62 and to bracket 37 at 63 may serve to hold lever 29 against longitudinal movement. The system, furthermore, is so designed that when one of valves 7 is open, and during the entire period in which the products of combustion entering therethrough are at work in the low pressure cylinder, the valve 7 of the opposite cylinder is subject to a maximum pressure from springs 27, since valve 19 is also closed during this period.

In the drawings I have shown a four cycle engine. Taking high pressure cylinder 1 for instance; presuming the cylinder to be in the exhausted state and the piston therein (not shown) nearing the limit of its down stroke. Cam 33 is designed at this moment to tilt lever 29 and open valve 19, permitting the air which is under initial compression in chamber 21 to fill the said cylinder. The valve then closes as the piston starts on its up stroke, and the air in the cylinder becomes further compressed to a very high degree. At the end of the up stroke, the fuel is admitted through valve 39 and becomes ignited whereupon the piston is then forced down. At the end of this down stroke cam 33′ is designed to rock lever 35, opening valve 7, and permitting the gases in cylinder 1 to pass into the low pressure cylinder 3 to force piston 4 down. The same process takes place in cylinder 2 as in cylinder 1; the two acting alternately.

In order to prevent the pressure of the gases passing from one of the high pressure cylinders from forcing open the valve 7 between the low pressure cylinder and the

other high pressure cylinder, I have shown a passage 40 through valve 7 to chamber 41. The gas entering at the opposite valve will thus pass into chamber 41 and produce a downward pressure on the balancing piston 61 of the valve, substantially equal to the upward pressure. Thus, beside subjecting the valve 7 which is closed to the maximum spring pressure during the working stroke of the low pressure cylinder, means are provided for equalizing the gas pressure on both sides of the valve.

In Fig. 6 I have shown a slight modification in the air inlet valve. In this figure the air valve is shown at 19' and is provided with a balancing piston in the form of a flange 42 extending to the walls 43 of the valve casing 8. The purpose of this piston is to present to the compressed air circulated through the valve, a greater surface exposure for downward than for upward pressure. Thus, instead of the air under high pressure tending to force its way through the valve when closed into the high pressure cylinder, it will hold the valve more tightly closed. A small air channel 44 may be provided to allow any air which may force its way under piston 42 to escape. Such a piston may be used to supplement or replace entirely springs 27 for holding the valves closed.

The lubrication of the various parts of the valve may be effected by forcing oil into the valve casing at 45. Passing through channel 46, it will run down the inside of the valve casing into a groove 47 to lubricate the bearing surfaces 48. The oil seeping through bearing 48 will suffice to lubricate bearing 49 and also the rubbing surfaces 59 between valves 7 and 19. Holes 50 through the upper portion of valve 19 permit oil to run out from groove 47, down through holes 51 in collar 28, to bearing 52 and down to bearing 53.

An oil cup 54, shown in Fig. 4, may be provided to supply oil through recess 55 in the top of the valve casing to bearings 56 and 57 for valve stem 11.

As shown at 58 in Fig. 3, grooves 24 extending down the side of valve 7 may be slightly spiral, so that the rib or fins 60 will engage a greater surface on valve 19 when the latter is opened and closed, and thus reduce the tendency toward the wearing of furrows in said valve 19.

While my invention is illustrated in connection with a compound engine, it may be used also in simple engines, in which case valve 7 would serve as the exhaust valve. When so used, the means provided for balancing the valve by admitting the gases to the rear thereof may be dispensed with.

Fluid passages or ducts 63 may be provided in the valve casing, through which air or water or other cooling fluid may be caused to flow. Any suitable means (not shown) may be provided for controlling the temperature of the said fluid for controlling the temperature of the valves.

One advantage of constructing the valves according to my invention is that a minimum surface of the transfer valve is exposed to the hot gases, thereby rendering the temperature of said valve more easily controlled. The air inlet valve, on the other hand which covers a large part of the exhaust valve is thereby subject to much of the heat to which the exhaust valve would otherwise be subject, but the air passing through the valve into the cylinder, and the cooling fluid in duct 63 serve to keep this valve properly cooled. It should also be noted that the area of the surfaces exposed to the heated gases is much less than the area exposed to the cooling fluid, the interior surfaces being channeled and fluted while the exposed surfaces are smooth.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In an internal combustion engine, the combination with a cylinder, of a unitary intake and exhaust valve mechanism therefor comprising an outwardly opening exhaust valve, a stem therefor, a port normally closed by said valve, a sleeve surrounding said stem and normally seated upon said other valve forming an intake valve and means for raising each valve from its seat.

2. In an internal combustion engine, the combination with a cylinder, of a unitary intake and exhaust valve mechanism therefor comprising an exhaust valve, a stem therefor, a port normally closed by said valve, a sleeve surrounding said stem and normally seated upon said other valve forming an intake valve, a passage along said stem for guiding the intake air into contact therewith, and means for raising each valve from its seat.

3. In an internal combustion engine, a cylinder, a unitary two part valve for said cylinder for admitting air thereto and for permitting the exhaust of the products of

combustion, a casing for said valve, a chamber in said casing adapted to contain air under pressure, a piston in said chamber on one of said parts for holding the same normally closed, means for holding the other of said parts normally closed, and means for opening the said parts.

4. In a compound internal combustion engine, in which the intake air is precompressed, a high and a low pressure cylinder, a port between said cylinders, and a unitary two part valve comprising a central part having a stem for closing said port and a sleeve part surrounding said stem and seated on said central part for guiding air in contact with said stem and for admitting it to said high pressure cylinder.

5. In a compound internal combustion engine, a high and a low pressure cylinder, a port between said cylinders, a unitary two-part valve comprising a central part for closing said port and a sleeve part mounted over and seated on said central part for admitting air to said high pressure cylinder and passages in said parts for a cooling fluid to pass through.

6. In a compound internal combustion engine, a high and a low pressure cylinder, a port between said cylinders, a unitary two part valve comprising a central part for closing said port and a sleeve part mounted over and seated on said central part for admitting air to said high pressure cylinder, a piston on said central part, a chamber adjacent said piston and a passage through said central part of said chamber.

7. In a compound internal combustion engine in which the intake air is precompressed, a high and a low pressure cylinder, a port between said cylinders, a unitary two part valve comprising a central part for closing said port and a sleeve part mounted over and seated on said central part for admitting air to said high pressure cylinder, and a piston on said sleeve part, having its working face exposed to the compressed intake air and operating to hold both valves closed.

8. In an internal combustion engine, a cylinder, a unitary two part valve associated therewith comprising a central part, a sleeve part mounted over and seated on said central part, a chamber in said casing, an air passage leading into said chamber, means for opening said sleeve part to permit air from said chamber to enter said cylinder, means for directing said air into contact with said parts for cooling the same, means for opening said central part and a common means for holding either or both of said parts normally closed irrespective of the position of the other valve.

9. In an internal combustion engine, a high pressure cylinder, a low pressure cylinder, a passage between said cylinders, a common valve mechanism adapted to admit air to said high pressure cylinder and to admit gases from said high pressure cylinder to said low pressure cylinder and means for causing said air to circulate through said mechanism to cool the same.

10. In a multi-stage expansion combustion engine, a high and a low pressure cylinder, means for pre-compressing the air prior to compression in the high pressure cylinder, a passage between said cylinders, a two part valve adjacent said cylinders, one part thereof adapted to open and close said passage and the other part thereof adapted to admit the compressed air to said high pressure cylinder, means for opening said first part between two expansion stages, and means for opening the other part between two compression stages.

11. In an internal combustion engine, a high and a low pressure cylinder, a passage between said cylinders, a two part valve associated with said cylinders, comprising a central part having a stem adapted to seat in said passage for opening and closing the same and an outer part surrounding said stem and seated on said central part and adapted to open and close by moving reciprocally on and relative to said central part for admitting air to said high pressure cylinder and air passages along said stem to cool the same.

12. In an internal combustion engine, a high pressure cylinder, a low pressure cylinder, a passage between said cylinders, a valve adapted to open and close said passage, and a second valve adapted to admit air to said high pressure cylinder, said valves being coaxial and having passages through which the intake air passes to cool the same.

13. In a combustion engine having a multi-stage compression for the intake air and a multi-stage expansion for the working products, the combination with a combustion cylinder and an expansion cylinder, of a common two part valve mechanism acting between the respective stages on both the compression and expansion operations of the cycles.

14. In a unitary two part valve, a central valve, a sleeve valve mounted thereover and seated thereon, means for holding said sleeve valve normally closed, thereby also holding said central valve normally closed, means for opening each of said valves, and means connected with said opening means for holding said central valve closed when said sleeve valve is opened.

15. In a unitary two part valve, a central valve, a sleeve valve mounted thereover and seated thereon, means for holding said valves normally closed, levers for opening

said valves, and a link between said levers for holding said central valve closed when said sleeve valve is opened.

16. In a unitary two part valve, a central valve, a sleeve valve mounted thereover and seated thereon, means for holding said valves normally closed, a lever for opening said central valve and a lever for opening said sleeve valve, the fulcrum of said second mentioned lever being supported from said first mentioned lever for holding said central valve closed when said sleeve valve is opened.

17. In a two part valve, a central part, an outer part adapted to seat on said central part, a spring for holding said outer part normally closed and thereby also holding said central part normally closed, means for opening each of said parts, and means for causing said spring to continue to hold said central part closed when said outer part is open.

18. In a two part valve, a central part, an outer part adapted to seat on said central part, a spring for holding said outer part normally closed and thereby also hold said central part normally closed, means for opening each of said parts, means for causing said spring to continue to hold said central part closed when said outer part is open and additional means for assisting in holding said central part normally closed.

19. In a multiple expansion engine, a transfer valve having a stem, an intake valve seated thereon, and surrounding the stem of said transfer valve, said intake valve having a passageway therethrough to guide the incoming air over the transfer valve and stem.

20. In a multiple expansion engine in which the intake air is precompressed, a transfer valve, a valve seat therefor, an intake valve seated thereon, and a piston on said intake valve subject to the pressure of the intake air for holding both the valves on their seats.

21. In a multiple expansion engine, a transfer valve having a stem, an intake valve seated thereon, said valves having passages such that the intake air passes along said transfer valve stem in entering the high pressure cylinder.

22. In a multiple expansion engine in which the intake air is precompressed, a transfer valve, an intake valve, one of said valves being seated on the other, and a piston on the valve which is seated on the other valve for holding both valves on their seats.

23. In an internal combustion engine, a double valve comprising a central valve and a sleeve valve, one of which is seated on the other, a common yielding means for holding both valves closed, linkage for opening each valve, and linkage associated therewith for transferring the pressure of said yielding means to the other of said valves when the one which is seated on the other is raised.

24. In a multiple expansion engine in which the intake air is precompressed, a transfer valve, a stem therefor adapted to conduct heat rapidly away from the exposed parts of the valve, and an intake valve adjacent thereto having a passageway leading thereto adapted to cause the air to pass in contact with said stem as it enters the engine.

25. In a multiple expansion internal combustion engine, the combination with high and low pressure cylinders, the former having an elongated clearance space overlying the end of the latter, a transfer passage leading from said space into the low pressure cylinder, an outwardly opening transfer valve having a stem normally closing said passage, a sleeve surrounding said stem and seated on said valve, and means for circulating air through said sleeve to cool the valve.

26. In a multiple expansion internal combustion engine, the combination with high and low pressure cylinders, the former having a substantial clearance space, a transfer valve having a stem passing through said space, and a protective sleeve shielding said valve and stem.

27. In a multiple expansion internal combustion engine, a combined intake and transfer valve comprising a disk transfer valve having a stem, a seat therefor opening into the low pressure cylinder, a sleeve seated on said valve forming the intake valve and surrounding said stem, and means for increasing the surfaces of said sleeve and stem washed by the intake air above the area of the exterior surfaces exposed to the hot products in the two cylinders.

28. In an internal combustion engine, a cylinder receiving hot gases alternately from two other cylinders, a valve communicating with such cylinder having a plurality of surfaces, means for supplying a cooling medium one of said surfaces being exposed to the said hot gases, and another surface for the valve of greater area being exposed to said cooling medium and shielded from said hot gases.

In testimony whereof I have affixed my signature.

HERMAN J. SCHARNAGEL.