Aug. 26, 1930. W. E. GOLDSBOROUGH 1,773,995

TRANSFER VALVE

Filed Dec. 24, 1926

Fig. 1.

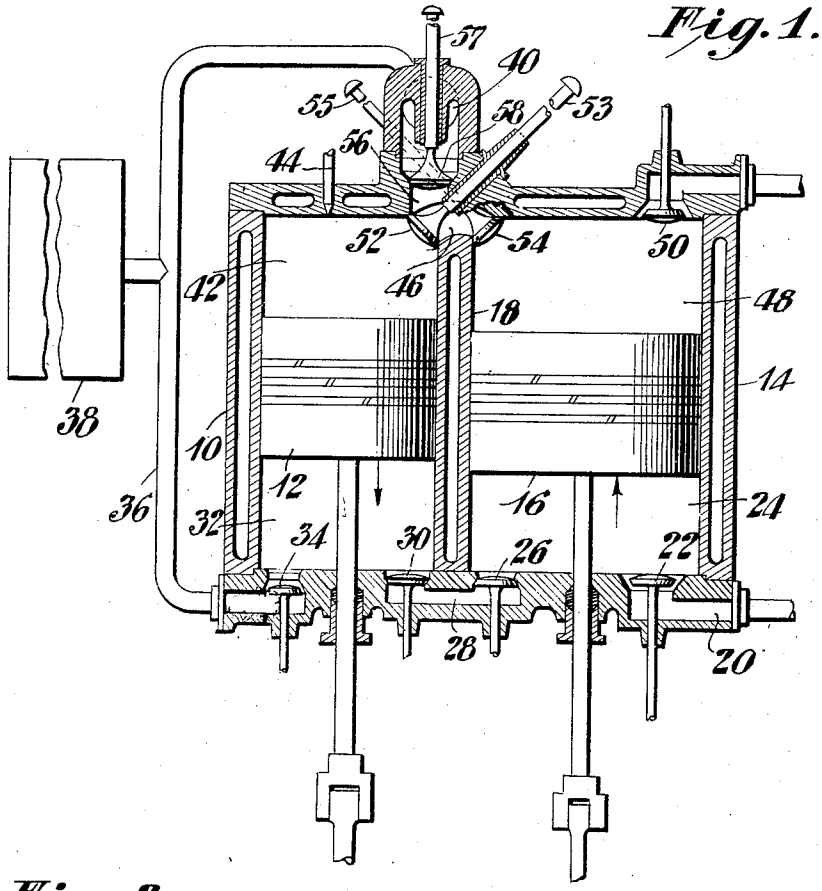



Fig. 2.

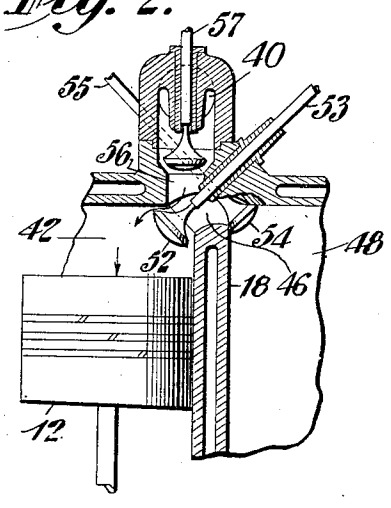
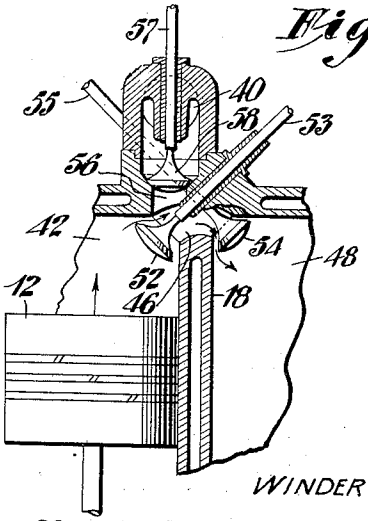



Fig. 3.




Inventor
WINDER E. GOLDSBOROUGH

By his Attorney
Edmund G. Borden

Patented Aug. 26, 1930 1,773,995

# UNITED STATES PATENT OFFICE

WINDER E. GOLDSBOROUGH, OF NORWALK, CONNECTICUT, ASSIGNOR TO DOHERTY RESEARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

## TRANSFER VALVE

Application filed December 24, 1926. Serial No. 156,823.

The present invention relates to internal combustion engines and more particularly to multiple expansion internal combustion engines.

One of the pronounced difficulties encountered by designers of multi-stage expansion combustion engines has been the high loss of power in the transfer passages from one cylinder to another. It is not generally realized how large a part is played by the volume of the transfer passage in augmenting the losses due to transferring the gases. While, in steam engine designs it is customary, for sufficient reasons, to make the transfer passage of large volume and include in it a receiver, when handling products of combustion, for equally sufficient reasons, this practice is entirely inadmissible. I have found that in a 2-cylinder compound internal combustion engine, a decrease in capacity, or output, at full load of 1% is caused by each percent of the volume of the high pressure cylinder which is allotted to the transfer passage.

It is one of the objects of the present invention to provide a design of multi-stage expansion internal combustion engine in which the feature of small transfer passage is combined with general features of design of known value.

The novel features of the present invention are pointed out with particularity in the appended claims. The invention itself, together with further objects and advantages, will best be understood from the following description taken in connection with the accompanying drawings in which—

Fig. 1 is a central vertical section through the cylinder of a 2-stage expansion pistoned internal combustion engine embodying the present invention;

Fig. 2 is a sectional view of a portion of the engine cylinder illustrated in Fig. 1 and illustrating the transfer valves for the flow of fluid during the intake stroke of the high pressure piston;

Fig. 3 is a sectional view of a portion of the engine illustrated in Fig. 1 and illustrating the transfer valves for the flow of the fluid during the transfer of hot gases from one cylinder to the other.

In the drawing, 10 is a high pressure cylinder having piston 12 therein. Alongside the cylinder 10 is a low pressure cylinder 14 containing the piston 16. Cylinders 10 and 14 are set as close together as practicable so that the wall 18 between the two cylinders is as thin as practical considerations will permit. This is especially desirable along the plane connecting the axes of the two cylinders. However, as will presently appear, the essential feature is that the corners of the cylinders connected by the transfer passage for the hot gases shall be close together. The engine of which cylinders 10 and 14 are a part may be operated according to any desired cycle, the ordinary Diesel cycle being a suitable one. However, the engine of Fig. 1 is designed to operate on a cycle according to which the air is given its maximum compression before entering the combustion space. As illustrated, air is drawn in from the atmosphere or from a supercharger, through a port 20 and passes through a valve 22 on the upstroke of piston 16 and into a space 24 in cylinder 14 below the piston 16. On the downstroke of piston 16 the air is partially compressed and expelled from space 24 through valve 26. The air thereupon passes through port 28 and valve 30 into the space 32 below the piston 12. On the downstroke of piston 12, the air is expelled from space 32 through valve 34 and passes off through pipe 36. Preferably pipe 36 is in free communication with a receiver 38. Air from pipe 36 enters a valve chamber 40 and thence, at the appropriate point in the cycle, passes into the space 42 above the piston 12. The air is used in the space 42 to burn fuel which may be injected through pipe 44. On the downstroke of piston 12 the gases or products of combustion are partially expanded. The necessary valves are then opened and the gases allowed to enter a transfer passage 46. Passage 46 lies substantially in the plane determined by the axes of cylinders 10 and 14. It will be seen that the cylinders 10 and 14 are of an ordinary type which may be cast en bloc and having the heads of the cylinders in

the same planes whereby the cylinders may be manufactured and the pistons connected to a crank in the ordinary manner. As above mentioned, however, the wall 18 between the cylinders 10 and 14 is of minimum thickness along the line connecting the centers of the cylinders. As illustrated the transfer passage passes almost directly from the upper corner of one cylinder to the adjacent upper corner of the other.

A major feature of the present invention resides in the transfer passage 46. I have found that the transfer passage should have a volume not in excess of 10% of the volume of the high pressure cylinder in order that the designs involving multi-stage expansion shall maintain some advantage as compared with a simple expansion multi-cylinder engine. A compound engine having a transfer passage volume of 5% of the high pressure cylinder is quite satisfactory. By the arrangement above described I am able to reduce the volume of the transfer passage with some designs to as low at 1% of the expansion chamber of the high pressure cylinder. The transfer passage of the engine illustrated in the drawing is approximately 2% of the volume of the combustion or expansion chamber of the high pressure cylinder when the piston is at the crank end dead center.

It is evident that in the engine illustrated in Fig. 1 the passage 28, connecting compressing chambers 24 and 32 may be made of small dimensions also. However, the effects of large volume in passage 28 are not as serious as in the case of passage 46. Moreover, the cylinders of the engine may easily be placed so that the transfer passage 46 for the hot gases may be made of the small size required by the present invention, but so that it is impossible to also make the air passage 28 of similar small volume. Therefore, while it is preferred to make passage 28 of small volume, the invention is not limited to this. It is preferred, however, that the sum of the volumes of passages 28 and 46 shall be not more than 20% of the volume of the expansion chamber of the high pressure cylinder 10.

From passage 46, the products of combustion pass into the space 48 above piston 16 in cylinder 14 where they are expanded further in the usual manner and then exhausted through valve 50.

The valve or valves controlling the direct connection between the cylinders and the transfer passage 46 is or are placed across the corner or corners of the cylinder or cylinders at the ends of the transfer passage. For instance, a valve 52 is illustrated at the point of connection between the space 42 and passage 46, valve 52 having its spindle 53 inclined to the horizontal at an angle of about 45° and lying substantially in the plane connecting the axes of the two cylinders. As illustrated, moreover, the valve 54 is placed at the point where the passage 46 enters the space 48, the spindle 55 of valve 54 also inclines approximately 45° to the horizontal but inclines to one side so as to avoid the spindle 53.

So far as only the transfer products of combustion from space 42 to space 48 is concerned, one valve only is needed to control the passage 46. If one valve only is used, it is preferred that it be located as illustrated at 52. It is often times advantageous, however, to combine the air intake passage with the transfer passage. This results in only one opening into the high pressure cylinder for both the intake of air and the transfer or exhaust of the products of combustion. Moreover, in the arrangement illustrated, the air intake passage has been so associated with the transfer passage that the ingoing air cools the transfer valves. As illustrated, the intake chamber 40 is connected with the transfer passage 46 by air port 56 and an air valve 58 is provided controlling the passage from the chamber 40 to the port 56. Stem 57 of the valve 58 may be conveniently arranged vertical and in the plane of the passage 46. When air is being drawn into space 42, valves 58 and 52 are opened and the relatively cool air passing into the engine cools not only air valve 58 but also transfer valves 52 and 54. The position of the valves when air is passing into cylinder 10 above piston 12 is illustrated in Fig. 2, valve 54 being closed. When the hot gases are to be transferred from space 42 to space 48, valve 58 is closed and valves 52 and 54 are opened and the flow of gases is accomplished as illustrated clearly in Fig. 3.

It will be clear that the triple valve arrangement just described while conveniently adapted to multi-stage expansion engines, may also be used on single cylinder engines.

The design illustrated in Fig. 1 is that of an engine well adapted to use recuperative heating of the air passing from the compression spaces to the combustion space as well as to use refractory heat insulating coverings on the cylinders, cylinder heads, and pistons, these features, however, not being essential to the present invention are not illustrated herein.

It being well-known in the art to build internal combustion engines to utilize heavy oil fuel and to provide suitable means for injecting it into the combustion space of an engine, no injection means is illustrated herein. Moreover, means and methods for governing internal combustion engines and mechanism for operating the valves of such engines being well-known, no governing mechanism or valve operating mechanism is illustrated herein.

It will be understood that while I have illustrated herein only a two cylinder engine,

the present invention is not so limited and that, wherever the following claims refer to a high pressure cylinder, the phrase is intended to include any expansion cylinder from which the products of combustion pass through a transfer passage to another cylinder in which the products are expanded further.

Having thus described my invention, I claim:

1. A compound internal combustion engine having high and low pressure piston cylinders arranged side by side with a thin wall separating them, a transfer passage in said wall leading from the upper end of one cylinder into the upper end of the other cylinder, a valve in each cylinder for closing the ends of said passage and a valve controlled passage opening into said transfer passage intermediate said valves.

2. An engine comprising a high pressure cylinder and a low pressure cylinder having a single opening for the intake to and the discharge of gases from the high pressure cylinder, a passage leading from said opening to said low pressure cylinder, valves spaced apart and controlling the flow of fluid in said passage, an inlet passage connecting with said passage at a point intermediate said valves, and an inlet valve controlling the inlet passage.

3. A multi-stage expansion engine having larger and smaller cylinders set side by side with their heads substantially in the same plane, and separated by a thin wall, a transfer passage through said wall from one cylinder to the other substantially at the point of minimum thickness of said wall and connecting adjacent corners of the cylinders, and a pair of valves controlling said passage, said valves having their stems set at an angle to the axes of said cylinders and a third valve opening into said passage intermediate said pair of valves.

4. In a compound internal combustion engine, a transfer passage connecting the high and low pressure cylinders of the engine, means to close each end of said passage, the engine having an admission port connected to said passage and a valve for closing said admission port.

In testimony whereof I affix my signature.

WINDER E. GOLDSBOROUGH.