CONDENSABLE VAPOR ENGINE CONSTRUCTION

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ABSTRACT

A condensable vapor engine, such as a steam engine, wherein the piston reciprocates between a top dead center position adjacent the closed end of the cylinder and a bottom dead center position in which vapor outlet ports are uncovered and the vapor escapes. The engine includes a valve located in the cylinder head and in communication with the source of vapor, this valve being disposed in a cavity having a cylindrical caging surface and facing a valve seat. The valve is arranged in spaced relation to the cylindrical surface so as to permit freedom of opening and closing movement and tilt, and the valve and valve seat define cone-to-sphere cooperating surfaces providing full seating engagement despite tilt of the valve body.

2 Claims, 3 Drawing Figures
CONDENSABLE VAPOR ENGINE CONSTRUCTION

BACKGROUND OF THE INVENTION

This invention relates to condensable vapor engines, particularly steam engines, and is concerned with preventing excessive forces on the operating parts by reason of trapped vapor condensate in the cylinder.

In one form of steam engine, each piston reciprocates within its cylinder between a bottom dead center position where steam outlet ports are uncovered and a top dead center position where the piston most nearly approaches the closed end of the cylinder. Between the instant the ports are covered on the upstroke and the time steam is admitted to the cylinder at about top dead center, the piston and cylinder form a confined space of progressively decreasing volume. So long as the only material within the space is in vapor form, the only forces exerted on the parts as the piston approaches top dead center are progressively increasing forces associated with compression of the vapor. However, any liquid present in the cylinder will effectively reduce residual cylinder volume, causing increased compression pressures. If there is sufficient liquid within the cylinder to approach the residual cylinder volume at top dead center, the forces can increase precipitously and impart hammerlike blows to the cylinder, piston, connecting rod, crankshaft and other parts, with resulting undesirable noise, vibration and possible breakingage.

Since engine efficiency, specific power output, and other characteristics are, in part, determined by the residual volume at top dead center, it is desirable to minimize this volume. However, the possibility of receiving or condensing liquid in the cylinder during various operating conditions, particularly cold startup, requires that provision be made for the relief of resulting high cylinder pressures before they can become excessive.

SUMMARY OF THE INVENTION

The general object of the present invention is to provide an improved condensable vapor engine, particularly a steam engine, wherein the forces occasioned by entrapped liquid are effectively relieved.

A more particular object of the present invention is to provide an improved condensable vapor engine, particularly a steam engine, having features of construction, combination and arrangement, providing an effective, reliable and yet inexpensive apparatus for relieving the forces occasioned by entrapped liquid in the cylinders.

The various objects of the invention are accomplished in part through the provision of a relief valve for each cylinder, which opens whenever cylinder pressure rises above the pressure in the steam supply chamber so that any tendency for excessive pressures to be reached is avoided. A particularly light and freely acting relief valve arrangement is provided which is loosely caged to permit freedom of opening and closing movement and tilt. The relief valve includes a spherical seat engaging surface that contacts a conical valve seat to assure positive seating despite tilt of the valve body.

These and other advantages of the invention will be more clearly understood from the following description of a preferred embodiment, taken together with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

In the drawing,

FIG. 1 is a cross-sectional view of a steam engine, including the improvements of the present invention;

FIG. 2 is an enlarged cross-sectional view showing the cylinder pressure relief valve of the engine of FIG. 1; and

FIG. 3 is a pictorial view further illustrating the relief valve of FIG. 2.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring first to FIG. 1, numeral 10 generally indicates a piston-type steam engine formed according to the invention and including a crankcase 12 supporting a cylinder box 14 to which is secured a cylinder head 16.

Crankcase 12 is closed at the bottom by an oil pan 18 and supports a crankshaft 20 rotatably journalied in conventional bearings (not shown). A plurality of connecting rods 24 (only one being shown) connect the throws of crankshaft 20 with the wrist pins 26 of crossheads 28 reciprocably mounted in the upper portion of the crankcase 12. Piston rods 30 respectively connect the crossheads 28 with pistons 32. The pistons each carry piston rings 34 that sealingly engage the walls of their respective cylinders 36 retained within the cylinder box 14.

Seal retainers 38, each carried by the cylinder 36 and secured to the cylinder head 16 (not shown) are mounted in the cylinder box 14 so as to seal the piston rods 30 against leakage of steam or water into the crankcase. The cylinders 36 each include a circumferential band of exhaust ports 42, which are uncovered when piston 32 is at its lower dead center position. Drain openings 44 are also provided to permit the escape of steam and water which leaks past the piston rings 34.

Cylinder head 16 retains a plurality of valve plates 46 which sealingly engage the upper ends of the cylinders 36 so as to form end walls thereof. The valve plates include steam inlet openings 48 which are closed by inlet poppet valves 50. Valves 50 include stems 52 which are received within valve guides 54 formed as part of the cylinder head 16. The valve stems 52 are engaged by rocker arms 56 which are pivotally carried to the cylinder head and are, in turn, actuatingly engaged by the cams of a camshaft 58 rotatably supported by the cylinder head and driven by the crankshaft through suitable drive means (not shown).

Between each valve plate 46 and the cylinder head 16 there is defined a steam inlet chamber 60, the cylinder head surface of which is insulated as at 62 to reduce the transfer of heat from the incoming steam to the valve gear and its lubricant.

Tubular members 64 each define a steam inlet passage which connects its respective steam inlet chamber with an inlet fitting 66. Fitting 66 is, in turn, connected to a source 68 of pressurized steam which may be a boiler or other suitable device. Delivery of the steam from the source to the engine is controlled by suitable throttle means, such as throttle valve 70.

In order to avoid the excessive buildup of compression pressures in the cylinders, relief means generally indicated by numeral 72 are provided, the construction of which is best shown in FIGS. 2 and 3. The cylinder relief means include openings 74 in the valve plates 46, which connect the interiors of cylinders 36 with their respective steam inlet chambers 60.

Openings 74 include conical valve seats 76, which face in the direction of the inlet chambers 60. A plurality of cavities 78 are provided in the cylinder head, one facing each of the valve seats 76. Cavities 78 form inwardly facing cylindrical caging surfaces 80.

A relief valve body 82 is received within each cavity 78 and includes a hollow stem portion 84 and a spherical seat-engaging portion 86. Stem portion 84 is arranged to be guided by cylindrical caging surface 80 but is of a substantially smaller diameter so that the parts are normally spaced from one another by a substantial clearance. This permits substantial freedom of the valve body to tilt within the cavity 78. The spherical seat-engaging surface 86 of the valve is adapted to seat against conical valve seat 76 with the spherical-conical surface relationship providing positive closure of the opening 74, no matter what degree of tilt of the valve body may be encountered.

The hollow interior of the stem portion 84 is provided not only to reduce the mass of the relief valve body to the minimum possible but also to receive a coil spring 88 which engages the bottom 90 of cavity 78 and urges the valve body 82 in a closing direction. The upper end 92 of the stem portion
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84 is also arranged to engage the cavity bottom 90 to prevent the valve from being opened too far. This provides for a fast closing action of the valve whenever cylinder pressure conditions permit, while the reduced mass of the valve provides for a fast valve-opening action.

In operation, steam from source 68 is supplied through throttle valve 70 to the engine steam inlet chambers 60 from which it is admitted to the cylinders 36 by the timed action of the inlet valves 80. The admission of the compressed steam forces the pistons 32 downwardly until near the bottom dead center position, exhaust ports 42 are opened, allowing the exhaust of steam and the resultant reduction in cylinder steam pressure to near ambient. Upon upward movement of the piston, ports 42 are again closed and the remaining steam in the cylinder is compressed to a pressure normally determined by the residual volume of the cylinder at the piston top dead center position.

During cold engine starting or operation with low steam temperatures, it is possible that water may be delivered to the cylinders along with the steam through the inlet valves and that additional water may be condensed from the steam vapor engaging the cool walls of the cylinders and pistons. Any of this water which remains within any of the cylinders during the piston upstroke has the effect of partially filling the residual volume so that pressure increases more rapidly and, as top dead center is approached, might exceed the desired maximum, causing rough operation or vibration of the engine and possible failure of certain of its components. Such an eventuality is, however, avoided by the cylinder relief means 72 which, when the cylinder pressure exceeds steam pressure in the respective steam chamber 60, forces the exhaust relief valve body upwardly, permitting the escape of steam and water pressure through the respective opening 74.

Immediate action of the relief valves is assisted by the low mass of the valve body, as well as by the loose caging of the valve stem, which gives a normally friction-free mounting. To prevent steam from entering the engine, the valve stem is closed by an additional valve 76, so that the steam may escape without any possible lubrication for this component. Since the relief valve may tilt freely to some degree within its seating surface 80, the provision of the cylindrical seating surface 86 allows positive closure of the valve on the valve seat 76, irrespective of the degree of tilt of the valve.

What is claimed is:

1. A condensable vapor engine construction comprising in combination:
   - means defining a cylinder having a closed end and a circumferential band of ports axially spaced from the closed end,
   - a piston in said cylinder;
   - a crankshaft and connecting rod mechanism connected to the piston to reciprocate the same between a top dead center position near the closed end of the cylinder and a bottom dead center position uncovering said ports,
   - whereby during stroke towards the top dead center position a confined space is established when the piston covers the ports;
   - said means having a valve seat defining a passage through the closed end for transmission of condensable vapor between said chamber and the cylinder; a valve member in seatable relationship with said valve seat to open and close said passage;
   - means operable on said valve member to open and close said passage in synchronism with piston movement to admit condensable vapor into said cylinder during a predetermined portion of the piston stroke towards bottom dead center;
   - said first-mentioned means further having a second valve seat defining a second passage through the closed end and in communication with the source of condensable vapor, together with a cavity facing said second seat and having a cylindrical caging surface; a valve body having a seat engaging portion and a stem portion and located in cooperative relation with said second valve seat, the valve body being in spaced relationship with the cylindrical surface permitting freedom of opening and closing movement and tilt, and the seat-engaging portion and said valve seat defining sphere-to-cone cooperating surfaces providing full seating engagement despite tilt of the valve body; and
   - means biasing the valve body to seating position.

2. A condensable vapor engine construction comprising in combination:
   - means defining a cylinder having a closed end and a circumferential band of ports axially spaced from the closed end;
   - a piston in said cylinder;
   - a crankshaft and connecting rod mechanism connected to the piston to reciprocate the same between a top dead center position near the closed end and a bottom dead center position uncovering said ports, whereby during stroke towards the top dead center position a confined space is established when the piston covers the ports;
   - means effective during a predetermined portion of the stroke towards bottom dead center to admit condensable vapor into the cylinder at said closed end;
   - said first-mentioned means defining a passage in communication with the source of condensable vapor through the closed end and having a valve seat open to said cylinder at said closed end and a cavity facing said seat and including a cylindrical caging surface; a valve body having a seat engaging portion and a stem portion located in said cavity, the valve body being in spaced relationship with the cylindrical surface, permitting freedom of opening and closing movement and tilt, and the seat-engaging portion and said valve seat defining sphere-to-cone cooperating surfaces providing full seating engagement despite tilt of the valve body; and
   - means biasing the valve body to seating position.