June 19, 1951 I. LUBBOCK ET AL 2,557,607

HOT GAS ENGINE WITH FINNED CYLINDER HEAD

Filed March 29, 1949 2 Sheets-Sheet 1

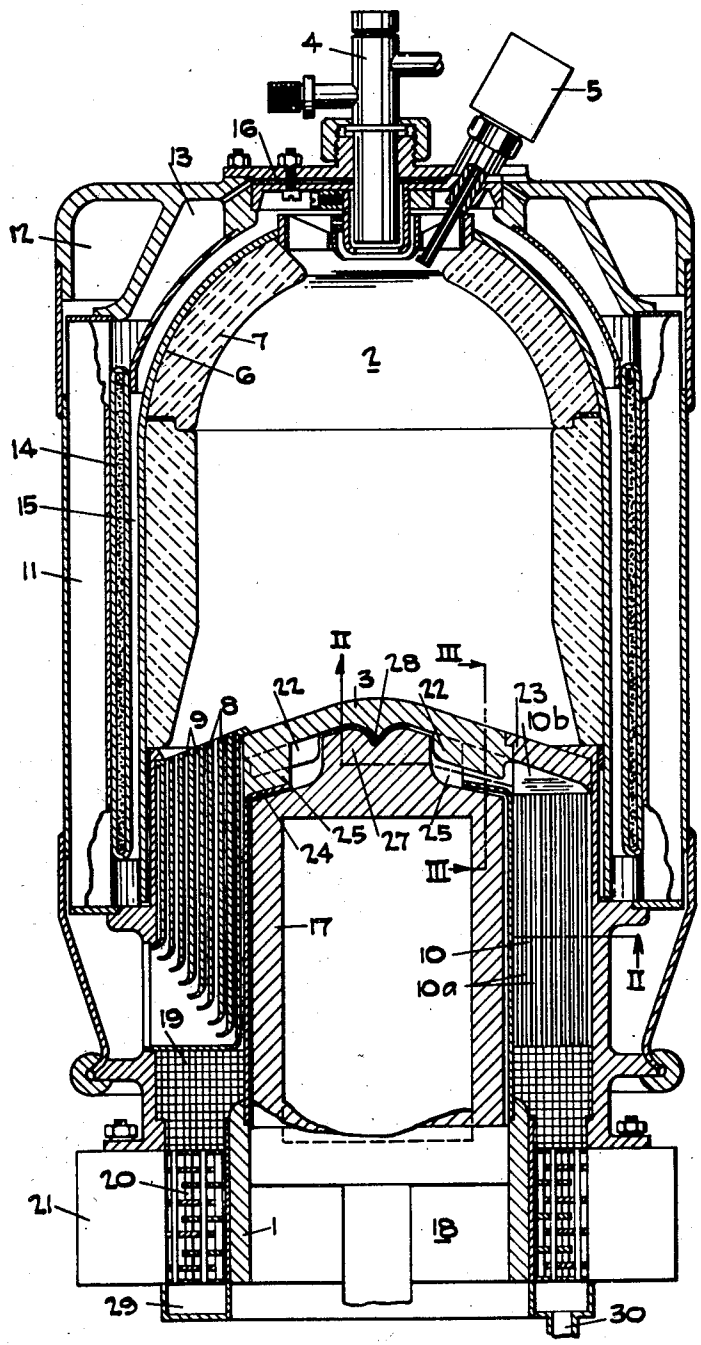


Fig. I

Inventors: Isaac Lubbock
William Tipler
By Oswald H. Milmore
Their Attorney

June 19, 1951 I. LUBBOCK ET AL 2,557,607

HOT GAS ENGINE WITH FINNED CYLINDER HEAD

Filed March 29, 1949 2 Sheets-Sheet 2

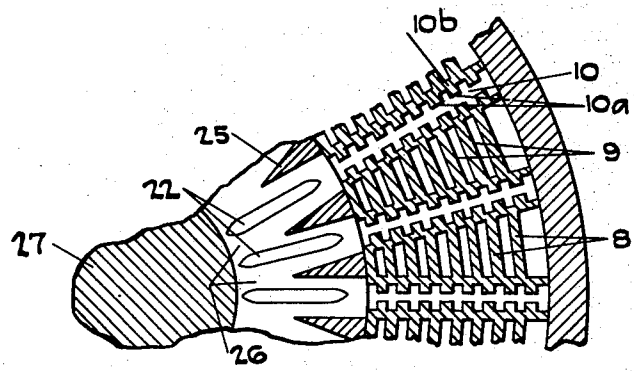


Fig. II

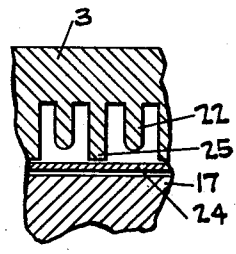


Fig. III

Inventor: Isaac Lubbock
William Tipler
By Oswald H. Milmore
Their Attorney

Patented June 19, 1951 2,557,607

UNITED STATES PATENT OFFICE

2,557,607

HOT GAS ENGINE WITH FINNED CYLINDER HEAD

Isaac Lubbock and William Tipler, London, England, assignors to Shell Development Company, San Francisco, Calif., a corporation of Delaware

Application March 29, 1949, Serial No. 84,152
In Great Britain March 30, 1948

8 Claims. (Cl. 60—24)

1

This invention relates to reciprocating engines of the kind in which a working gas is heated by gaseous combustion products generated externally to the working cylinder in a combustion chamber open to the cylinder head, the combustion products being maintained separate from the working gas, which latter is admitted to and/or ejected from the cylinder through ports adjacent to the cylinder head. Examples of engines of this kind are hot gas engines of certain constructions working on the Stirling cycle.

In engines of the aforesaid kind, the temperature of the working gas at the hot end of the working cycle must be of a high order if the thermal efficiency is to compete with that, for example, of internal combustion engines. In order that the working gas may attain the required high temperature, it is necessary for the temperature in the combustion chamber to be something in excess of 1,000° C. Since the cylinder head is exposed to the temperature prevailing in the combustion chamber, the difficulty of protecting the head is a serious one especially as the cylinder is subject to stress owing to the pressure of the working gas. In order to minimize this difficulty, it has been proposed to fit a cap of refractory material to the external face of the cylinder head, that is, the face exposed to the combustion chamber, but this has the drawback that the cap is difficult to fit and, when fitted, has poor resistance to mechanical and thermal shock. Moreover, the refractory material is liable to disintegrate, and the resulting particles obstruct the labyrinthine elements through which the combustion gases pass in order to heat the working gas.

The present invention affords a practicable and efficient method of cooling a metal cylinder head in an engine of the aforesaid kind, by providing the interior face of the head with a plurality of passages or channels, and by so arranging the aforesaid ports in relation to these passages or channels that the working gas entering and/or leaving the cylinder is constrained to flow through the said passages or channels. By this means the working gas, which, although it is at the hot end of its cycle, has a temperature much below that of the combustion chamber, maintains the cylinder head at a sufficiently low temperature. At the same time, the temperature of the working gas is raised, thus increasing the efficiency of the cycle.

The passages or channels and ports may both be formed or defined by a series of radial fins projecting from the interior face of the cylinder head in an axial direction, the fins stopping short

2

of the centre of the head so as to leave a circular central gap. The piston head then has a projecting portion which enters this central gap, so that as the piston moves towards the cylinder head it forces the working gas from the gap out through the passages or channels between the fins, and vice versa. The interior face of the cylinder head at the central gap may advantageously have the general form of a cone projecting into the cylinder, the base of the cone merging in a smooth curve into the main part of the cylinder head, and the projecting portion of the piston head having a corresponding conical depression, so that gas passing into and out of the passages or channels sweeps over the surface of the cone and aids in the cooling of the central part of the cylinder head.

Instead of passages defined by a series of fins, the aforesaid passages may consist of a large number of fine bores or channels in the cylinder head, each communicating with the cylinder and with the cylinder ports so as to provide cooling for the cylinder head by the working medium. Alternatively the cylinder head may be fabricated from a system of fine pipes, so arranged as to be cooled by the working medium flowing into and out of the cylinder.

If desired, the cylinder head may be provided both with a system of fins and with a series of fine bores or channels.

The invention is illustrated by way of example by the accompanying drawings, in which

Figure I is a longitudinal section through one cylinder of a multi-cylinder hot gas engine working on the Stirling cycle;

Figure II is a section on the line II—II of Figure I drawn to an enlarged scale; and

Figure III is a further enlarged section developed on a circumferential section line indicated at III—III of Figure I.

Referring to Figure I, each cylinder 1 of the engine (one cylinder only being shown in the drawings) is provided with a combustion chamber 2 arranged directly above the cylinder head 3. A burner 4 and igniter 5 are inserted in the combustion chamber, which is constructed of a metal wall 6 with a refractory lining 7.

The products of combustion generated in the chamber 2 pass into spaces 9 between fins 8 which are arranged in sectors round the upper part of the cylinder 1. Alternating with the fins 8 are radial pockets 10 defined by vertical partition walls 10b that extend upwards to the walls 23. These partition walls have vertical fins 10a on the interior surfaces thereof (facing the pockets 10),

as best shown in Figure II, and these fins extend from the bottoms of the walls 10b almost to the upper ends thereof. As described below, the pockets 10 provide a path for the working gas (usually air) separate from that of the combustion products. The latter pass from the spaces 9 to a preheater 11 for preheating the air for combustion, and are then exhausted to atmosphere through a duct 12. The air for combustion enters from atmosphere through a duct 13 and passes by way of the preheater 11 to a cooling jacket 15 between the wall 6 of the combustion chamber and the refractory wall 14 of the preheater 11, and thence into the combustion chamber 2. An air bleed 16 from the duct 13 serves to cool the burner 4 and prevent carbon deposition. The preheater 11 consists of a metal sheet having corrugations running parallel to the axis of the combustion chamber, the exhaust gas and combustion air ducts being so arranged that these gases pass through the corrugations on opposite sides of the metal sheet.

Surrounding the cylinder 1 below the pockets 10 is a regenerator 19, and below this regenerator is a tubular cooler 20. The arrangement is such that the working gas can pass freely through the tubes of the cooler 20, the regenerator 19, and the pockets 10, and thence into the upper or hot end of the cylinder 1. The exteriors of the cooling tubes are cooled by a fluid (for example water) circulated by a pump (not shown) from a tank 21.

The cylinder 1 contains a piston 17, and the space 18 at the cold end of the cylinder below the piston communicates with the cooling tubes of the second cylinder of the engine, that shown in Figure I being regarded as the first. Likewise the space 18 of the second cylinder communicates with the cooling tubes of the third cylinder and so on, the space 18 of the last cylinder communicating with the cooling tubes of the first. The communication between the spaces 18 of the several cylinders and the interiors of the appropriate cooling tubes is effected by way of headers 29 and ducts 30.

The pistons are so phased that the working gas contained in the space 18 of one cylinder is alternately caused to flow from this space through the cooler, regenerator and hollow fins of the next cylinder into the space above the piston of that cylinder, and then to flow through the same path in reverse direction back into the space 18. The phasing is such that the gas in each cylinder performs the Stirling cycle or a cycle approximating thereto.

The top walls 23 of the pockets 10 form extensions of the cylinder head 3, and the upper end of the cylinder wall is turned inward to form an annular lip 24. Above this lip is a space communicating freely with the upper ends of the pockets 10 to which the fins 10a do not extend. A series of radial fins 25 extends from the cylinder head 3 to the lip 24, and in between these fins a second series of fins 22 project from the cylinder head as illustrated further in Figure III. Thus the working gas, on passing from the pockets 10 into the hot end of the cylinder 1, or vice versa, flows through the passages 26 formed between the two sets of fins 22 and 25, and thus cools the cylinder head. The fins 22 are streamlined and the fins 25 are triangular in cross-section, so that the passages 26 afford the minimum resistance to the flow of gas.

The fins 22 and 25 stop short of the centre of the cylinder, leaving a central circular gap, and the piston 17 has a projecting portion 27 which enters this gap when the piston is at top dead centre, thus forcing the working gas from the gap out through the passages 26. In order to assist in the cooling of the central part of the cylinder head where the cooling fins do not extend the head is formed with a conical internal projection 28 which fits a corresponding depression in the part 27 of the piston. The base of the projection 28 merges, as shown, into the main part of the head 3, so as to aid the flow of the working gas.

The invention claimed is:

1. In a hot gas engine of the type having a reciprocating piston within an engine cylinder in which a working gas is heated by gaseous combustion products generated in a combustion chamber externally to the engine cylinder, the combustion products being maintained separate from the working gas, the combination of: a cylinder head for said engine cylinder having the outer face thereof exposed to the interior of said combustion chamber and an inner face thereof exposed to and directed toward said piston; duct means for said working gas terminating in a plurality of ports located peripherally about the engine cylinder and near said cylinder head; and a plurality of fins extending from said interior face of the cylinder head providing therebetween a plurality of restricted passages extending from the periphery of the cylinder head toward the central part of said face, said passages being registered with said ports so that working gas entering or leaving the engine cylinder through said ports is constrained to flow through the passages for abstracting heat from the cylinder head.

2. The combination according to claim 1 wherein said fins and passages extend substantially radially.

3. The combination according to claim 1 wherein said fins and passages stop short of the center of the cylinder head so as to leave a central gap and the piston head has a projection toward the cylinder head shaped to enter said gap when the piston approaches the cylinder head.

4. The combination according to claim 3 wherein the part of said interior face of the cylinder head at said gap has the general shape of a cone extending into the engine cylinder and the projection on the piston which enters the gap has a corresponding generally conical depression.

5. The combination according to claim 3 wherein the said interior face of the cylinder head is generally cone shaped and concave toward the engine cylinder, the part of said interior face at said gap has the general shape of a smaller cone extending into the engine cylinder, and the projection on the piston which enters the gap has a corresponding generally conical depression.

6. In a hot gas engine of the type having a reciprocating piston within an engine cylinder in which a working gas is heated by gaseous combustion products generated in a combustion chamber externally to the engine cylinder, the combustion products being maintained separate from the working gas, the combination of: a cylinder head for said engine cylinder having the outer face thereof exposed to and directed toward said piston; duct means for said working gas terminating in a plurality of ports located peripherally about the engine cylinder and near said cylinder head; and wall structure on said interior face of the cylinder head providing a plurality of substantially radial, restricted passages, said passages being in registry with said ports at their radially outer ends and in communication with

the interior of the engine cylinder at their radially inner ends, whereby working gas entering or leaving the engine cylinder through said ports is constrained to flow through the passages for abstracting heat from the cylinder head.

7. The combination according to claim 6 wherein the wall structure comprises a first set of radial fins extending axially from said interior face of the cylinder head and extending radially outwardly to the periphery of the cylinder head, said fins being located to lie between adjacent ports and a second set of radial fins extending axially from said interior face and alternating with the fins of the first set, said second set of fins stopping short of the periphery of the cylinder head.

8. The combination according to claim 6 wherein the cylinder is provided with an annular, peripheral lip spaced axially from said interior face of the cylinder head so that said ports lie between the cylinder head and the said lip, and the wall structure comprises a first set of radial fins extending axially from said interior face of the cylinder to said lip and extending radially

outwardly to the periphery of the cylinder head, said fins being located to lie circumferentially between adjacent ports, and a second set of radial fins extending axially from said interior face and alternating with the fins of the first set, the second set of fins stopping short of the periphery of the cylinder head.

ISAAC LUBBOCK.
WILLIAM TIPLER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
324,061	Woodbury et al.	Aug. 11, 1885

FOREIGN PATENTS

Number	Country	Date
34,036	Germany	Dec. 23, 1885
92,720	Germany	July 24, 1897
501,017	France	Jan. 14, 1920