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MULTICYLINDER DOUBLE-ACTING HOT-GAS RECIPROCATING ENGINE

Filed Nov. 10, 1951

2 Sheets-Sheet 1

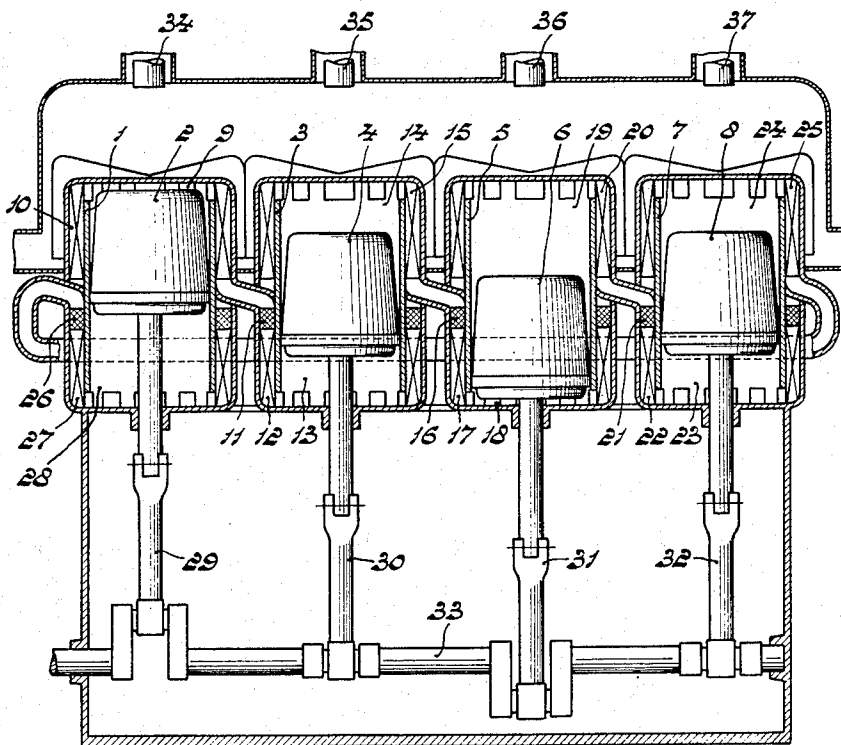


Fig. 1

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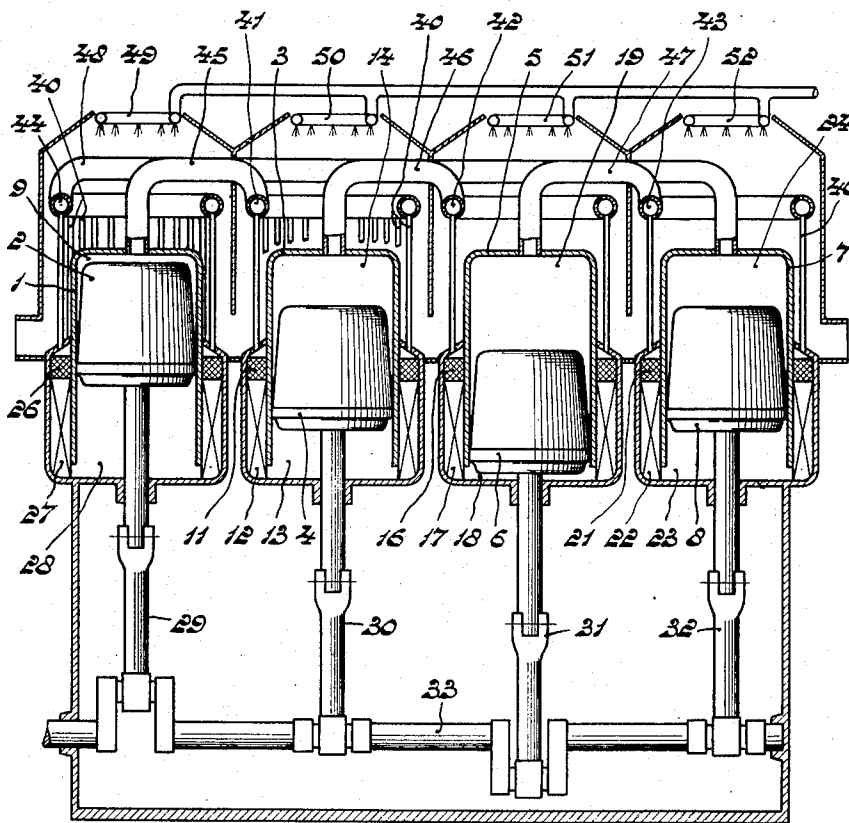


Fig. 2

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MULTICYLINDER DOUBLE-ACTING HOT-GAS RECIPROCATING ENGINE

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4 Claims. (Cl. 60—24)

1

2

This invention relates to multi-cylinder double-acting hot-gas reciprocating engines of the type in which each hot chamber located at one side of a cylinder is connected through a heater, a regenerator and a cooler to a cold chamber located at the opposite side of another cylinder, the coolers surrounding the cold chambers of the cylinders.

According to the invention, a hot-gas engine of the said type is characterised in that each cooler directly adjoins the cold chamber surrounded by this cooler, and the regenerator directly adjoins the other end of the cooler, the connections between the regenerators and the associated hot chambers being at least partly occupied by the heater.

In known double-acting hot-gas reciprocating engines, the position of heaters, regenerators and coolers is such that one end of the heater directly adjoins the hot chamber, the regenerator directly adjoining the other end of the heater, and the cooler directly adjoins the regenerator.

In this construction, the cooler surrounds a cold chamber which does not form part of the cycle from which heat energy is withdrawn by means of this cooler. A connection is provided between the cooler and its corresponding cold chamber in the other cylinder. This connection is, in general, recessed in the cylinder block of the engine and located at the side of the crank case.

It has now been found that the provision of the said connection in the said position adversely affects the efficiency and a power output of the engine.

In order to mitigate this adverse effect, the cooler, in the construction according to the invention, is arranged about the corresponding cold chamber and the regenerator is arranged with its cold end directly against the other end of said cooler. In this construction, the heater may surround or may not surround the associated hot chamber. A connection, if any, may be located either between the heater and the hot chamber or between the regenerator and the heater. Since, however, there is no driving mechanism at this side of the engine, the connection between the regenerator and the hot space may alternatively be such as to be completely occupied by the heater. This may, for example, occur if the heater is a tubular heater.

In the known double-acting hot-gas reciprocating engine, which comprises a comparatively large connection between the cooler and the cold chamber, the working medium will experience

considerable resistance of flow in flowing from the cooler to the cold chamber and back. In order to reduce this flow resistance, guide blades are provided in the connection between cooler and cold chamber in the known engine.

In the construction according to the invention, the cooler directly adjoins the cold chamber thus materially improving the flow to and from the cooler so that guide blades may, in general, be dispensed with.

Furthermore, in the engine according to the invention, similarly to another hitherto known hot-gas reciprocating engine, which is constructed as a replacer engine, the cold chamber is surrounded by a cooler which permits the cold chamber to be readily maintained at the desired temperature and the efficiency of the engine to be improved.

For the sake of completeness, it is pointed out that in a two-cylinder single-acting hot-gas reciprocating engine, wherein one cylinder comprises the hot chamber and the other cylinder comprises the cold chamber, and the two cylinders are interconnected at the top through a heater, regenerator and cooler it is known to connect the cooler directly to the cold chamber. In this construction, however, the problem solved by the present invention, viz by the provision of a thermo-dynamically optimum connection between the top of one cylinder and the bottom of another cylinder, does not arise.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying diagrammatic drawings.

Figs. 1 and 2 show views partly in section and partly in elevation of two embodiments of the hot-gas reciprocating engine according to the invention.

The hot-gas reciprocating engine shown in Fig. 1 is a four-cylinder double-acting hot-gas reciprocating engine having a fin-shaped heater and Fig. 2 shows a four-cylinder double-acting hot-gas reciprocating engine having a tubular heater.

Referring now to Fig. 1, pistons 2, 4, 6 and 8 reciprocate in cylinders 1, 3, 5 and 7, respectively. A chamber 9 above piston 2 is connected through a heater 10, a regenerator 11 and a cooler 12 to a chamber 13 below piston 4. Similarly, a chamber 14 above piston 4 is connected through a heater 15, a regenerator 16 and a cooler 17 to a chamber 18 below piston 6. A chamber 19 above piston 6 is connected through a heater 20, a regenerator 21 and a cooler 22 to a cham-

3

ber 23 below piston 8. Similarly, a chamber 24 above piston 8 is connected through a heater 25, a regenerator 26 and a cooler 27 to a chamber 28 below piston 2.

The chambers 9, 14, 19 and 24 are the hot chambers of the hot-gas reciprocating engine, the chambers 13, 18, 23 and 28 being its cold spaces. The pistons 2, 4, 6 and 8 are connected to a crank shaft 33 through connecting rod mechanisms 29, 30, 31 and 32, respectively.

Heat energy is supplied by burners 34, 35, 36 and 37 to the heaters 10, 15, 20 and 25, respectively. Coolers 12, 17, 22 and 27 surround directly the associated cold chambers. The cold terminal surface of each regenerator directly adjoins the associated cooler. The connection between regenerators and hot chambers contain the heaters. This construction yields under similar conditions, an increase in power output of more than 10% over known double-acting hot-gas reciprocating engines.

In Fig. 2, elements corresponding to those of the engine shown in Fig. 1 are designated by the same reference numerals. The heaters of this engine are tubular heaters consisting of pipes 40. These pipes adjoin ring ducts 41, 42, 43 and 44 which are connected to the hot chambers 9, 14, 19 and 24 through conduits 45, 46, 47 and 48. Ring burners 49, 50, 51 and 52 supplying heat energy to the tubular heaters.

What I claim is:

1. A multi-cylinder, double-acting hot-gas reciprocating engine comprising a heater, regenerator, cooler, and hot and cold chambers in each cylinder wherein each hot chamber is connected through a heater, a regenerator and a cooler to the cold chamber of another cylinder, and said

4

cooler surrounds said cold chamber and has part thereof abutting the latter, said regenerator being also positioned to abut said cooler, and the connection between said regenerator and said hot chamber being at least partly occupied by said heater.

2. A multi-cylinder, double-acting hot-gas reciprocating engine as claimed in claim 1 wherein said heaters comprise a plurality of pipes.

3. A multi-cylinder, double-acting hot-gas reciprocating engine comprising a heater, regenerator, cooler, and hot and cold chambers in each cylinder wherein each hot chamber is connected through a heater to a regenerator, cooler and cold chamber of another cylinder, and said cooler surrounds said cold chamber and has part thereof abutting the latter, said regenerator being also positioned to abut said cooler, and the connection between said regenerator and said hot chamber being at least partly occupied by said heater.

4. A multi-cylinder, double-acting hot-gas reciprocating engine as claimed in claim 3 wherein said heaters comprise a plurality of pipes, each connected to its associated hot chamber by means of a conduit.

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