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THERMO-DYNAMIC RECIPROCATING APPARATUS

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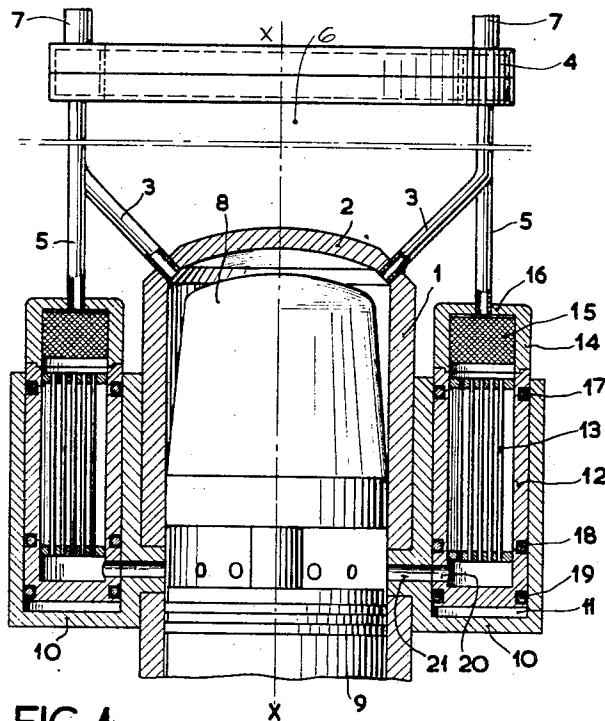


FIG. 1

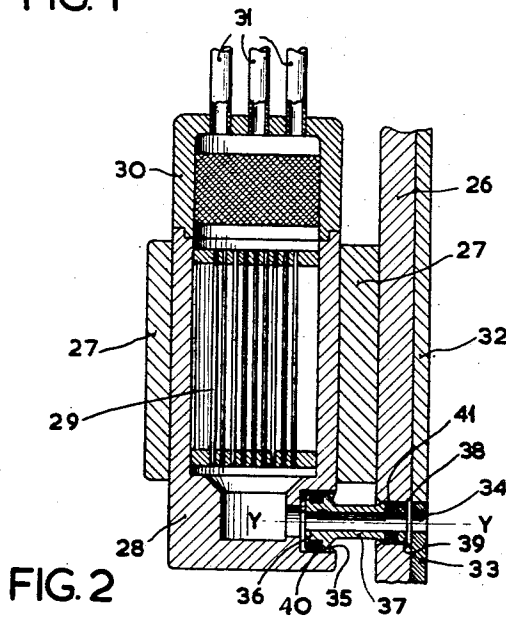


FIG. 2

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THERMO-DYNAMIC RECIPROCATING APPARATUS

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5 Claims. (Cl. 62—6)

The present invention relates to a heat exchanger construction utilized in a hot-gas engine. There is known a thermo-dynamic reciprocating apparatus comprising a first heat-exchanger, through the wall of which heat energy is supplied to the medium contained in this heat-exchanger. This heat-exchanger comprises a plurality of ducts, which are arranged in a rim and of which the parts connected with the head of the apparatus have shorter lengths than the duct portions connected with regenerator of the apparatus. This apparatus comprises furthermore a second heat-exchanger, located on the other side of the regenerator than the first heat-exchanger; through the wall of this second heat-exchanger heat energy of the medium contained therein is conducted away to the outside.

When the thermo-dynamic reciprocating apparatus constitutes an engine, the first heat-exchanger is formed by a heater, the temperature of which will, as a rule, be higher than 700° C. during operation. If the thermo-dynamic reciprocating apparatus is a refrigerator, the first heat-exchanger will be the so-called freezer of this apparatus, the temperature of which will be usually lower than -150° C. during operation. If it is assumed that the engine or the refrigerator is operating in surroundings where approximately room temperature prevails (so that the second heat-exchanger will give off heat energy at a temperature which differs strongly from room temperature) it is evident that measures are to be taken with respect to expansion and shrinkage of the material of the said heat-exchangers during the operation of the apparatus. The present invention has for its object to provide structurally simple means, with the aid of which this can be achieved.

To this end the thermo-dynamic reciprocating apparatus according to the present invention has the feature that one or more of the stuffing areas between the structure elements in that portion of the medium duct system which is located between the regenerator side facing the second heat-exchanger and the junction of this duct system and the cylinder are constructed so that the structure elements are capable of performing a slight relative movement in the direction of the cylinder axis of the apparatus.

It is thus achieved that the first heat-exchanger is allowed to expand and shrink freely without giving rise to undesired tensions in the material. Owing to the possibility of movement of the stuffing areas in the described portion of the duct system the advantage is obtained that during normal operation of the apparatus the temperature of these stuffing areas is of the order of room temperature. Therefore, there is no need for taking special precautions to close these stuffing areas even at very high or very low temperatures.

In an advantageous embodiment the parallel groups of elements of the second heat-exchanger are slidable in a housing surrounding the cylinder of the apparatus.

In an advantageous embodiment each of the elements of the second heat-exchanger communicates with the

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working space of the apparatus through a duct which is transverse to the axis of the cylinder and which is provided in the wall of the group of elements concerned of the second heat-exchanger, which wall is slidable with respect to the cylinder axis.

According to a modification of one embodiment of the invention each of the groups of the elements of the second heat-exchanger communicates with the working space of the engine via a tube piece which is mainly transverse to the axis of the cylinder and which is secured at both ends with a stuffing, so as to be tiltable, in the wall of the cylinder or in the housing of the group of elements concerned of the second heat-exchanger, which housing is movable with respect to the axis of the cylinder.

According to a further aspect of the apparatus according to the invention an annular duct is provided at the transition area between the tube portions of the first heat-exchanger of different lengths so that the tube portions of different lengths are in open communication with each other. This embodiment has the advantage that owing to the annular duct the load of the various ducts of the heat-exchanger will be more uniform than without this communication between the ducts. Moreover, this annular duct may serve as a structural element to support further parts of the apparatus, for example a thermostat or, if the apparatus constitutes an engine, a burner or parts thereof. The possibility of movement of the parts of the second heat-exchanger of the apparatus according to the invention permits of obtaining an apparatus in which no high tensions in the material occur owing to the presence of the annular duct in the elements of the first heat-exchanger.

The invention will be explained more fully with reference to the drawing.

Fig. 1 shows a first embodiment of the invention, in which the apparatus constitutes an engine. The drawing shows only that part of the engine which comprises part of the cylinder with the displacer piston and the piston and the first heat-exchanger, in this case the heater, the regenerator and the second heat-exchanger, in this case the cooler.

Fig. 2 shows a modified embodiment. This figure shows only the cylinder wall with the ends of the heater-pipes, the regenerator and the cooler.

In the embodiment shown in Fig. 1, reference numeral 1 designates the cylinder wall which terminates at the top end in a head surface 2. In the conical portion of this head surface open out the short duct portions 3 of the heater, which project vertically upwards and are secured at their top ends in a hollow, annular body 4. This body constitutes a communication duct between the heater duct portions 3 of shorter length and the heater duct portions 5 of larger length. These longer and shorter duct portions open out alternately in the lower surface of the annular body 4; therefore, the ducts 3 and 5 are shown one behind the other in Fig. 1. For the sake of clarity only two sets of the heater ducts are shown; in fact, they surround, in common, a cylindrical space 6, which serves as a combustion chamber. In or on top of this space a burner is provided. This burner may be supported from the annular body 4. This body may furthermore be provided with one or more duct portions 7, in which the sensitive element of a thermostat may be arranged.

By means of parts (not shown) the displacer piston 8 and the piston 9 are movable in the cylinder 1. To the outer side of the cylinder wall 1 is secured a cylindrical body 10, which has a plurality of cylindrical bores 11. In each of these bores the housing 12 comprising a plurality of groupwise arranged, tubular cooler ele-

ments 13 is slidable. To the housing 12 is secured a housing 14, which comprises the regenerator filler 15. In the top side 16 of the housing 14 open out a number of the longer duct portions 5 of the heater.

Thus the cylinder 1 is surrounded by a plurality of parallel units, which are each formed by a regenerator 14 and a group of cooler elements 13, accommodated in the housing 12. Each of these units is constructed mainly as a cylindrical body. In order to obtain the slidability aimed at of these groups with respect to the cylinder wall, the housing 12 is adapted, as stated above, to slide up and down in the cylindrical opening of the annular body 10 in the direction of the axis X—X of the cylinder 1. The O-shaped rings 17, 18 and 19 provide the stuffing of this housing with respect to the surrounding parts. The housing 12 comprises a duct 20, which is transverse to the axis X—X and which communicates with a tube piece 21, which is housed in the cylindrical body 10. This tube piece 21 opens out on the inner side in the working space of the cylinder 1. It will be obvious that, if the housing 12 slides up and down in the body 10, the inner side of the duct 20 slides with respect to the opening in the tube piece 21. Under the prevailing circumstances the open communication is maintained. Thus the elements of the heater are allowed to expand freely, while no detrimental material tensions are introduced into the duct system.

With the embodiment shown in Fig. 2 the cylinder wall 26 is surrounded by a cylindrical body 27, which is provided with a plurality of cylindrical openings. In each of these openings a cooler unit 28 with cooler elements 29 is adapted to slide. On top of each cooler unit is secured the housing 30 of the regenerator, in the top side of which open out the heater pipes 31. Around the space about the cooler pipes 29 circulates cooling water. The inner side of the cylinder 26 is provided with the lining consisting of the portions 32 and 33. The lining portion 33 is provided with an opening 34. A recess 35 of the bottom plate of the cooler unit 28 comprises the enlarged portion 36 of a tube piece 37. The other end 38 of this tube piece bears in a recess 39 of the cylinder wall. The ends 35 and 38 of the tube piece 37 have a certain amount of play in the associated recesses, this clearance space being filled with the O-shaped rings 40 and 41. Consequently, any expansion or contraction of the heater pipes, which variations may give rise to a shift of the cooler unit 28 in the direction of the cylinder axis, are compensated for without causing undesired tensions in the material, since the tube piece 37 tilts to an extent such that its longitudinal axis Y—Y moves away from the horizontal position to be at an angle to this position. Owing to the difference in diameters of the flanges at the ends of the tube piece 37, which flanges comprise the O-shaped rings 40 and 41, it is ensured that the gas pressure in the duct system always urges this tube piece towards the axis of the cylinder.

What is claimed is:

1. A thermo-dynamic reciprocating apparatus provided with a head portion comprising a housing, a first heat exchanger located in said housing adjacent to said head portion, a regenerator in said housing, said heat exchanger including a plurality of ducts arranged in an annular ring, some of said ducts being connected to said head portion and being shorter in length than the other of said

ducts, the latter being connected to said regenerator, a second heat exchanger located on the other side of said regenerator from said first heat exchanger, heat energy being conducted to the outside of said housing from the medium contained in said second heat exchanger, and sealing means between said housing and said head portion whereby the elements of said second heat exchanger may perform a limited sliding movement substantially parallel to the plane of the longitudinal axis of said head portion.

2. A thermo-dynamic reciprocating apparatus as claimed in claim 1 whereby the elements of said heat exchanger are formed in parallel groups which are slidable in said housing.

3. A thermo-dynamic reciprocating apparatus as claimed in claim 1 further comprising an annular duct, said shorter and longer ducts being connected to said annular duct whereby said shorter and longer ducts are in open communication with each other.

4. A thermo-dynamic reciprocating apparatus provided with a head portion comprising a housing, a first heat exchanger located in said housing adjacent to said head portion, a regenerator in said housing, said heat exchanger including a plurality of ducts arranged in an annular ring, some of said ducts being connected to said head portion and being shorter in length than the other of said ducts, the latter being connected to said regenerator, a second heat exchanger located on the other side of said regenerator from said first heat exchanger, heat energy being conducted to the outside of said housing from the medium contained in said second heat exchanger, sealing means between said housing and said head portion whereby the elements of said second heat exchanger may perform a limited sliding movement substantially parallel to the plane of the longitudinal axis of said head portion and a conduit positioned transverse to the axes of said head portion and housing and connecting the former and the latter.

5. A thermo-dynamic reciprocating apparatus provided with a head portion comprising a housing, a first heat exchanger located in said housing adjacent to said head portion, a regenerator in said housing, said heat exchanger including a plurality of ducts arranged in an annular ring, some of said ducts being connected to said head portion and being shorter in length than the other of said ducts, the latter being connected to said regenerator, a second heat exchanger located on the other side of said regenerator from said first heat exchanger, heat energy being conducted to the outside of said housing from the medium contained in said second heat exchanger, sealing means between said housing and said head portion whereby the elements of said second heat exchanger may perform a limited sliding movement substantially parallel to the plane of the longitudinal axis of said head portion, a tube positioned transverse to the axes of said head portion and housing and connecting the former and the latter, sealing means on either end of said tube, and means mounting said tube whereby the latter is slightly tiltable about its axis.

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