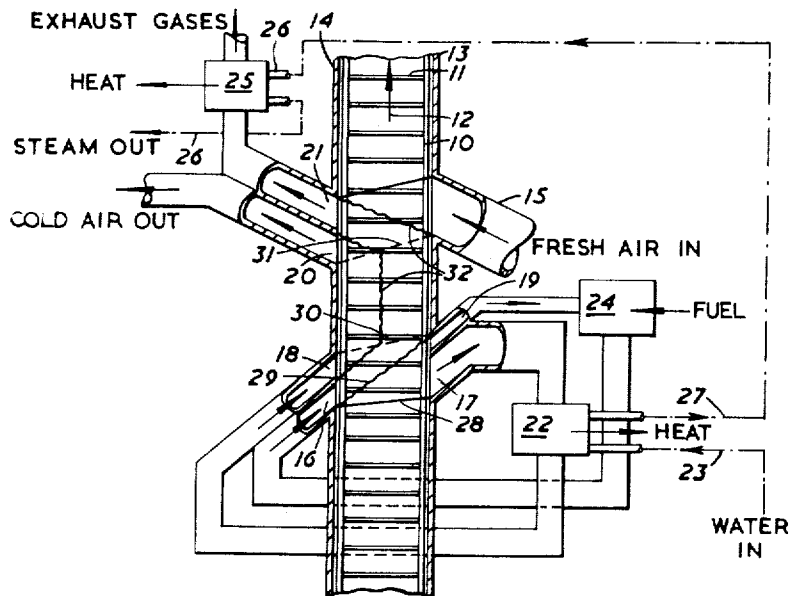


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PRESSURE EXCHANGER APPARATUS

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PRESSURE EXCHANGER APPARATUS
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4 Claims. (Cl. 60—39.45)

This invention relates to heat pump apparatus including a pressure exchanger.

The term "pressure exchanger" is used herein to mean apparatus comprising cells in which one fluid quantity expands, so compressing another fluid quantity with which it is in contact, ducting to lead fluid substantially steadily to and from the cells at different pressures and means to effect relative motion between the cells and the ducting.

An object of the present invention is to employ a heat pump which can be utilized as a steam generator which has certain advantages over known steam generator plants.

A further object of the invention is to provide a draught system for a conventional steam generator plant.

An embodiment of the invention is shown by way of example only in the accompanying diagrammatic drawing.

The sole FIGURE of the drawing shows a heat pump including a pressure exchanger drawn as a developed view for the sake of clarity.

A cell rotor 10 has open-ended cells 11, which rotor is rotatable in the direction indicated by an arrow 12 relative to ports and stationary ducts. The cell rotor 10 is mounted for rotation between end-walls, here in the form of end-plates 13, 14 which serve to close the ends of the open-ended cells 11, but are provided with a series of ports for the admission or removal of gas or other fluid to or from the cells. Each port communicates with a duct and a series of ducts communicating with the series of ports include, an inlet duct 15 to admit atmospheric air to the cells of the rotor through the end-plate 13, an inlet duct 16 to admit high-pressure high-temperature fluid to the cells through the other end-plate 14, an outlet duct 17 to remove compressed gas from the cells through the end-plate 13, an inlet duct 18 to admit cooled intermediate-pressure fluid to the cells through the end-plate 14, and an outlet duct 19 to remove fluid from the cells through the end-plate 13. An outlet duct 20 communicating with the cells through the end-plate 14 serves to remove gas which has been expanded within the cells and is thus at a low temperature. A further outlet duct 21 communicating with the cells through the end-plate 14 serves to remove exhaust gases from the cells. The ports communicating with the inlet ducts 16 and 18 are disposed adjacent one another, the closing edge of the port communicating with the duct 16 lying immediately adjacent to the opening edge of the port communicating with the duct 18. Similarly the respective closing and opening edges of the ports communicating with the outlet ducts 17 and 19 lie immediately adjacent to one another, and the respective closing and opening edges of the ports communicating with the outlet ducts 20 and 21 lie immediately adjacent to one another. All the ducts are inclined relatively to the direction of rotation, thereby reducing the risk of mixing between the fluid quantities in the cells.

A heat-exchanger 22 serves as a connecting link between the outlet duct 17 and the inlet duct 18 thus forming a circuit. A pipe connection 23 to the inlet of the cold pass of the heat-exchanger provides a supply of cold water. A combustion-chamber 24 serves as a connecting link between the outlet duct 19 and the inlet duct 16. Fuel is supplied to the combustion-chamber 24. The outlet duct 20 is connected to an apparatus which requires a supply of cold air. A heat-exchanger 25 is interposed along the length of the outlet duct 21, the cold pass of the heat-exchanger having pipe connections 26 one of

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which communicates with an outlet connection 27 of the cold pass of the heat-exchanger 22.

In operation, fresh air is drawn into the cell rotor 10 through the inlet duct 15 and on rotation of the cell ring is compressed by hot high-pressure gases produced in the combustion-chamber 24. The hot high-pressure gases are admitted to the cells through the port at one end of the inlet duct 16. A shock wave 28 emanates from the opening edge of the port at one end of the inlet duct 16 and travels across the cells to the opening edge of the port communicating with the duct 17. The fresh air which has been compressed by the shock wave passes partly through the duct 17 to the hot pass of the heat-exchanger 22 and partly through the duct 19 to provide a supply of combustion air for the combustion-chamber 24. The interface between the combustion gases admitted through the inlet duct 16 and the fresh air admitted through the inlet duct 15 is indicated by a wavy line 29. After the compressed air has passed through the heat exchanger 22 it is re-admitted to the cells through the duct 18 and the pressure is reduced by a rarefaction wave 30 emanating from the closing edge of the port communicating with the duct 18. This rarefaction wave 30 brings about a partial expansion and cooling and further cooling takes place by the expansion across the expansion wave 31 indicated in the figure. At the outlet duct 20 the air has been sufficiently expanded to enable it to be used for refrigeration purposes. Interface lines 32 indicate the approximate boundaries between the fresh air and the combustion gases. The combustion gases are removed from the cells through the port communicating with the duct 21 and these combustion gases give up most of their heat in the heat-exchanger 25.

Water which has been partially heated in the cold pass of the heat-exchanger 22 and conveyed through the duct 27 to the cold pass of the heat-exchanger 25 is converted to steam and thus provides the main useful output of the plant.

I claim:

1. According to the present invention heat pump apparatus includes

a pressure exchanger having cells for the compression and expansion of at least one fluid, the cells having open ends,

means defining common end-walls at each end of the cells, each end-wall having circumferentially spaced ports therein,

a series of ducts communicating with the cells through the circumferentially spaced ports in the end-walls, means for causing relative motion between the cells and the end-walls,

the series of ducts including in succession in the direction of relative motion of the cells,

an inlet duct for admitting low-temperature fluid to the cells through the other one of said end-walls,

an inlet duct for admitting cooled high-pressure fluid to the cells, the opening edge of the port of which immediately follows the closing edge of the port communicating with the duct for admitting high-temperature compressed fluid to the cells,

a second outlet duct for leading high-pressure fluid derived from the first-mentioned inlet duct from the cells, the opening edge of the port of which immediately follows the closing edge of the port communicating with the first outlet duct,

an outlet duct for leading cooled low-pressure fluid from the cells through a port in the said other end-wall,

and an outlet duct for leading fluid from the cells,

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which fluid is derived from the inlet duct for admitting high-pressure high-temperature fluid to the cells and the opening edge of the port through which the outlet duct communicates with the cells immediately following the closing edge of the port which communicates with the duct leading cooled low-pressure fluid from the cells,

ducting forming

a first closed circuit between the second outlet duct and the inlet duct for admitting high-pressure high-temperature fluid to the cells and a second closed circuit between the first outlet duct and the inlet duct for admitting cooled high-pressure fluid to the cells,

a combustion chamber in the first-named closed circuit, a heat-exchanger in the second-named closed circuit, and a further heat-exchanger the hot pass of which communicates with the duct for leading fluid from the cells which fluid is derived from the inlet duct for admitting high-pressure high-temperature fluid to the cells and the cold pass of which heat-exchanger is in communication with the cold pass of the first-mentioned heat-exchanger.

2. Apparatus as claimed in claim 1, in which the ducts to lead fluid to and from the cells are inclined to the direction of relative motion.

3. According to the present invention heat pump apparatus includes a pressure exchanger having cells for the compression and expansion of at least one fluid, the cells having open ends, means defining common end-walls at each end of the cells, each end-wall having circumferentially spaced ports therein, a series of ducts communicating with the cells through the circumferentially spaced ports in the end-walls, means for causing relative motion between the cells and the end-walls, the series of ducts including in succession in the direction of relative motion of the cells, an inlet duct for admitting low-temperature fluid to the cells through the one of the end-walls, an inlet duct for admitting high-pressure high-temperature fluid to the cells through the other one of the said end-walls, a first outlet duct for leading high-pressure fluid derived

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from the first-mentioned inlet duct from the cells through the said one of the end-walls, an inlet duct for admitting cooled high-pressure fluid to the cells, the opening edge of the port of which immediately follows the closing edge of the port communicating with the duct for admitting high-temperature compressed fluid to the cells, a second outlet duct for leading high-pressure fluid derived from the first-mentioned inlet duct from the cells, the opening edge of the port of which immediately follows the closing edge of the port communicating with the first outlet duct, an outlet duct for leading cooled low-pressure fluid from the cells through a port in the said other end-wall, and an outlet duct for leading fluid from the cells, which fluid is derived from the inlet duct for admitting high-pressure high-temperature fluid to the cells and the opening edge of the port through which the outlet duct communicates with the cells immediately following the closing edge of the port which communicates with the duct leading cooled low-pressure fluid from the cells, ducting forming a first closed circuit between the second outlet duct and the inlet duct for admitting high-pressure high-temperature fluid to the cells and a second closed circuit between the first outlet duct and the inlet duct for admitting cooled high-pressure fluid to the cells, a combustion chamber in the first-named closed circuit, a heat-exchanger in the second-named closed circuit, and a further heat-exchanger the hot pass of which communicates with the duct for leading fluid from the cells which fluid is derived from the inlet duct for admitting high-pressure high-temperature fluid to the cells and the cold pass of which heat-exchanger is in communication with the cold pass of the first-mentioned heat-exchanger.

4. Apparatus as claimed in claim 3, in which the ducts to lead fluid to and from the cells are inclined to the direction of relative motion.

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Disclaimer

3,095,704.—*Dudley Brian Spalding*, London, England. PRESSURE EXCHANGER APPARATUS. Patent dated July 2, 1963. Disclaimer filed Nov. 13, 1963, by the inventor.

Hereby enters this disclaimer to claims 1 and 2 of said patent.
[*Official Gazette February 4, 1964.*]

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,095,704

July 2, 1963

Dudley Brian Spalding

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the drawing, line 3, for "Filed Dec. 9, 1960" read -- Original Filed Mar. 19, 1956 --; in the heading to the printed specification, line 5, for "Filed Dec. 9, 1960, Ser. No. 74,941" read -- Original application Mar. 19, 1956, Ser. No. 572,379, now Patent No. 2,971,343, dated Feb. 14, 1961. Divided and this application Dec. 9, 1960, Ser. No. 74,941 --.

Signed and sealed this 23rd day of June 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents