

Feb. 15, 1966

D. B. SPALDING
PRESSURE EXCHANGER

3,234,736

Filed Nov. 6, 1963

3 Sheets-Sheet 1

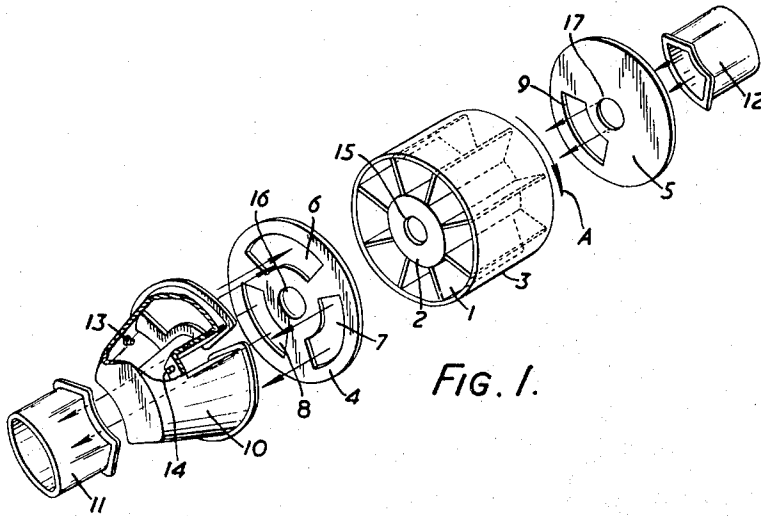


FIG. 1.

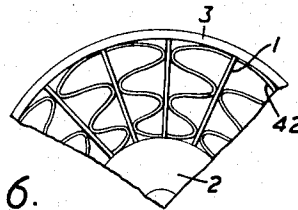


FIG. 6.

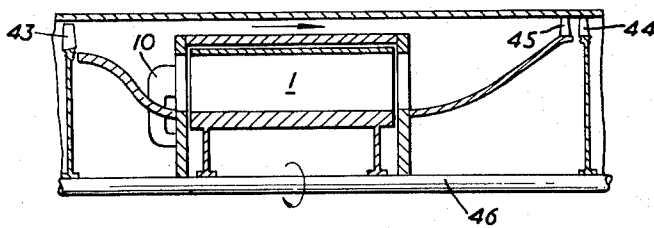


FIG. 7.

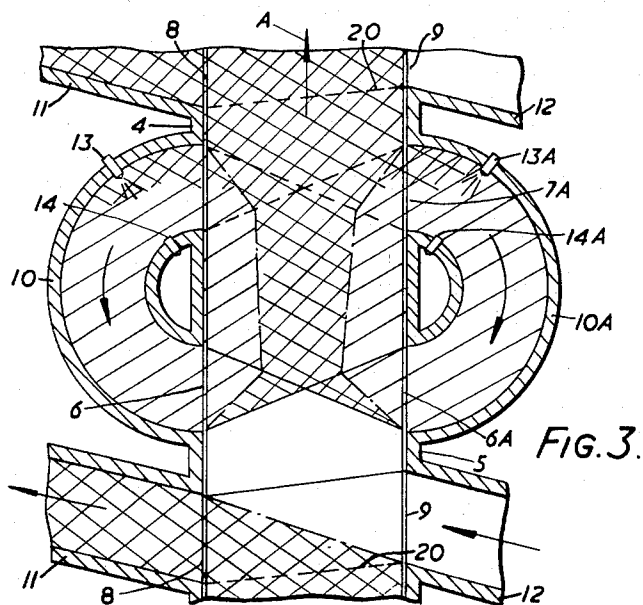
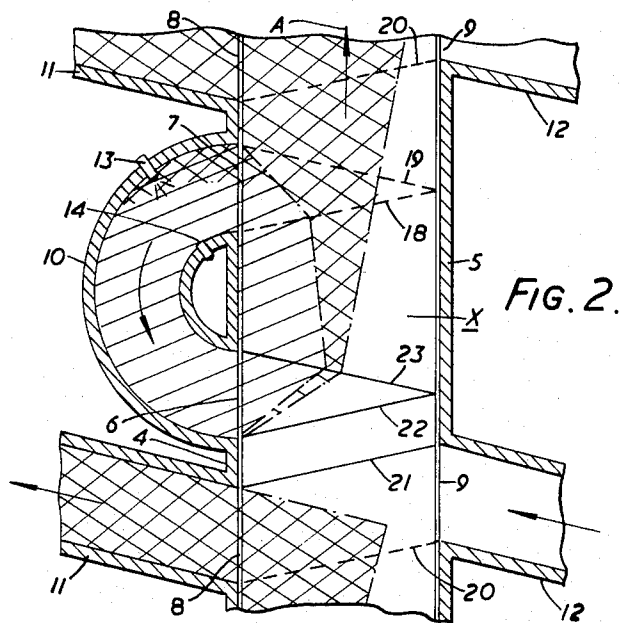
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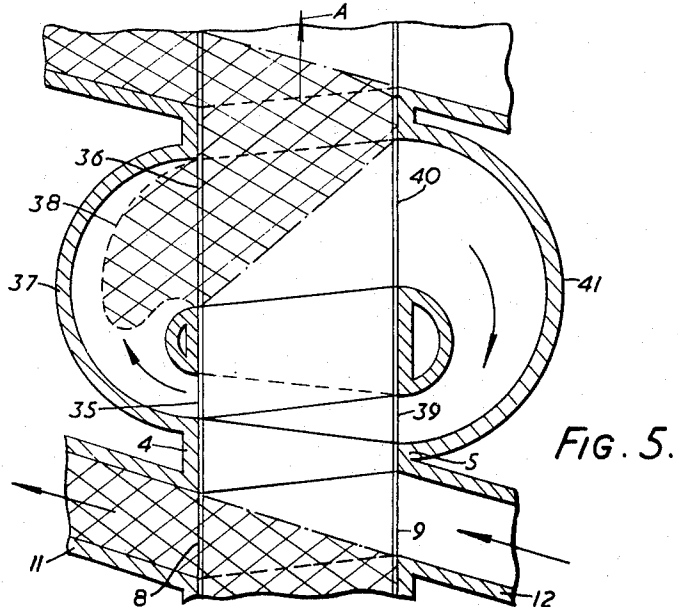
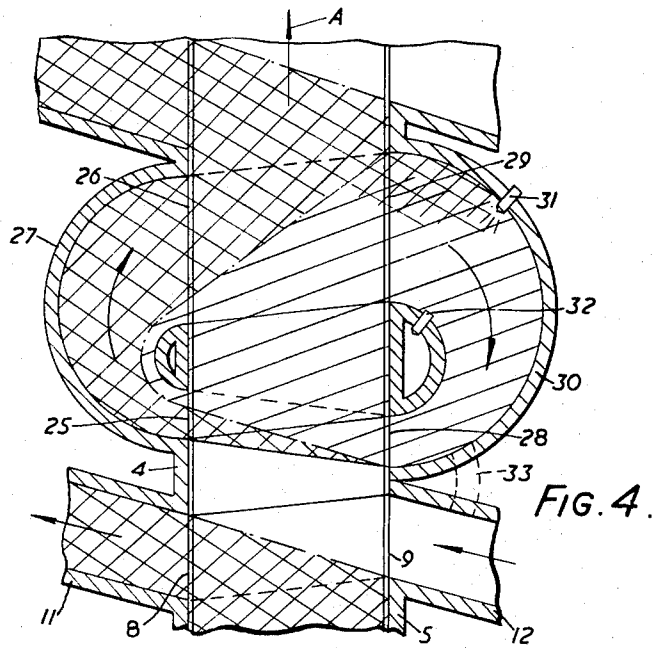
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3,234,736

PRESSURE EXCHANGER

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43,336/62

14 Claims. (Cl. 60—39.45)

The present invention relates to pressure exchangers and to gas turbine or like plant in which a pressure exchanger serves as a combustion means for the plant.

The term "pressure exchanger" is used herein to mean apparatus including cells in which one gas quantity expands so compressing another gas quantity with which it is in direct contact, ducting to lead gas at different pressures steadily to and from the cells and means to effect relative motion between the cells and the ducting. The cells are arranged around a cell rotor in the form of a ring.

According to the present invention a pressure exchanger includes a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, at least one of the end-plates having a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, one of which ports is positioned in the end-plate immediately to follow the other in the direction of rotation of the cell ring, ducting to provide communication between the two ports, and fuel injection means interposed in the ducting. In operation, the direction of fluid flow through the ducting may be generally opposite to the direction of rotation of the cell ring.

Each end-plate may include a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring. Ducts are then provided to permit communication between the two ports of each pair of ports and fuel injection means is interposed in one or both of the ducts. The two ports in one end-plate may be disposed directly opposite the two ports in the other end-plates.

The pressure exchanger in accordance with the invention may be interposed between a turbine and a compressor of a gas turbine plant.

Embodiments of the invention will now be described with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 is an exploded perspective view of a pressure exchanger in accordance with the invention;

FIGURE 2 is a developed view of the pressure exchanger illustrated in FIGURE 1, the cell walls of the pressure exchanger being omitted for the sake of clarity;

FIGURES 3, 4 and 5 are developed views of further pressure exchanger embodiments in accordance with the invention, the cell walls of the pressure exchangers again being omitted for the sake of clarity;

FIGURE 6 is a fragmentary end view of a pressure exchanger cell ring including cells of honeycomb construction; and

FIGURE 7 shows a pressure exchanger according to the invention included in a gas turbine plant.

In each of the embodiments to be described, structure for effecting only one cycle of operation has been shown and described. In practice, it would normally be desirable to construct the pressure exchanger for multiple cycle operation.

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Referring now primarily to the exploded perspective view of FIGURE 1, it will be appreciated that for the sake of clarity the number of cell walls shown is smaller than would be used in practice. The pressure exchanger includes a cell ring having a plurality of radial walls 1 arranged around a cell rotor 2 and having a cylindrical shroud 3. The cells defined by the walls 1, the cell rotor 2 and the shroud 3 are open-ended but the effective opening and closing of the ends of the cells are controlled by end-plates 4 and 5, one positioned at each end of the cell ring. The end-plate 4 has a port 6 to lead gas to the cells of the pressure exchanger and ports 7 and 8 to lead gas from the cells. The end-plate 5 has a port 9 to lead air to the cells. The port 6 communicates with one end of a duct 10, the other end of the duct 10 communicating with the port 7. Ducts 11 and 12 communicate with the ports 8 and 9 respectively. Although the ducts 11 and 12 are necessary for certain applications, it is to be understood that when a pressure exchanger as shown in this figure forms part of a jet propulsion plant, then these ducts may be omitted. A fuel injection nozzle 13 and an igniter 14 are disposed in the duct 10. A shaft (not shown) passes through bores 15, 16 and 17 in the rotor 2 and the end-plates 4 and 5.

The ports 8 and 9 together with the cells at any one time in communication with these ports constitute a scavenging stage for the pressure exchanger. The end-plate 5 is shown with a port 9 which occupies only a minor proportion of the circumferential extent of the end-plate. In practice, it is desirable that this port should be considerably larger than illustrated in order to avoid restriction of flow through the pressure exchanger. The ports 6 and 7 should, in practice, occupy as little as is practical of the circumferential extent of the end-plate 4.

FIGURE 2 shows a developed view of the pressure exchanger illustrated in FIGURE 1, the cell walls 1 being omitted for the sake of clarity.

In operation, the cells of the cell ring are continuously moving past the ports and the lands between the ports in the direction indicated by arrow A, and for the purpose of description the cycle may be considered to start at any position.

Assuming that the cycle starts at a position X (FIGURE 2), the cell at this position contains combustion gases, indicated by a series of parallel lines, a mixture of combustion gases and air, indicated by cross-hatched lines, and air, indicated by that part of the cell ring left blank. As the cell continues to rotate, continued mixing of the combustion gases and the fresh air takes place. On continued rotation, the cell is opened at its left-hand end, as shown in FIGURE 2, to the outlet port 7. Since the gas in the cell is at a higher stagnation pressure than the stagnation pressure existing in that part of the duct 10 adjacent the port 7, expansion waves and reflected expansion waves, diagrammatically represented at 18, 19 by broken lines respectively will pass through the cell as the combustion-supporting mixture of combustion gases and air in the cell pass through the port 7 into the duct 10. The nozzle 13 continuously injects fuel into the gases passing through the duct 10, and the combustible mixture is initially ignited by the igniter 14. However, during steady running the igniter need not be operative. On continued rotation, the cell becomes closed to the port 7 by the end-plate 4 and is then opened, again by the end-plate 4, to the scavenging stage outlet port 8 which communicates with the duct 11. Mixed combustion gases and air pass out of the cell and into the duct 11. The stagnation pressure of the gas originally in the duct 11 is lower than the initial stagnation pressure of the contents of the cell. Consequently, expansion waves of small

amplitude, diagrammatically represented at 20 by a broken line, will pass through the cell thus creating a low-pressure region at the right-hand end of the cell. As the cell ring continues to rotate, the cell is opened by the end-plate 5 to the scavenging stage inlet port 9 through which air is admitted to the cell via the duct 12. On continued rotation of the cell ring, the cell is closed by the end-plate 4 and a compression wave, diagrammatically represented at 21 by a full line, will pass through the cell thus compressing the contents of the cell. The static pressure at the outlet port 8 is the same or lower than the static pressure at the inlet port 9. However, the stagnation pressure at the outlet port 8 will be higher than, or at least equal to, the stagnation pressure at the inlet port 9 in consequence of the increased velocities of the gases leaving through the port 8. As the cell ring continues to rotate, the cell is opened by the end-plate 4 to the inlet port 6 which forms a termination of the duct 10 and the high-pressure combustion gases pass into the cell. The gases in the duct 10 are at a higher pressure than the air in the cell, consequently, a compression wave and a reflected compression wave, diagrammatically represented at 22 and 23 respectively by full lines, will pass through the cell thus compressing the contents of the cell. As the cell continues to rotate, the cell becomes closed at both ends by the end-plates 4, 5 and then once again reaches the position X. The cycle of operation is thereafter continuously repeated during operation of the pressure exchanger.

FIGURE 3 shows a pressure exchanger arrangement similar to that described in accordance with FIGURES 1 and 2 and like integers have the same reference numerals. In this figure the pressure exchanger includes additional ports 6A and 7A in the end-plate 5, and a duct 10A which communicates at its ends with the ports 6A and 7A. A fuel injection nozzle 13A and igniter 14A are positioned in the duct 10A. The ports 6A and 7A and the duct 10A correspond as regards position and purpose to the ports 6 and 7 in the end-plate 4, and the duct 10 respectively. The port 6A lies directly opposite the port 6 and the port 7A directly opposite the port 7.

The operation is, in general, similar to that of the FIGURE 2 embodiment. Air is admitted to the cells through the port 9 and is compressed by combustion gases admitted to the cells through the ports 6 and 6A. The air then mixes with the combustion gases during that part of the cycle of operation when the cells are closed at both ends by the end-plates 4, 5. When the cells are opened to the ports 7 and 7A the mixture of combustion gases and air enters the ducts 10 and 10A respectively. Fuel is continuously injected into the mixture by the nozzle 13A and the combustible mixture is initially ignited by the igniter 14A. The mixed gases are expelled from the cells through the scavenging stage outlet port 8 into the duct 11.

Referring now to the embodiment of FIGURE 4, in which like integers to those previously described have the same reference numerals, the end-plate 4 includes the scavenging stage outlet port 8, a port 25 for the extraction of a mixture of combustion gases and air, and of combustion gases from the cells and a port 26 for the admission of these gases to the cells. The port 26 is of larger circumferential extent than the port 25, for example, in the order of the ratio 3:1. A duct 27 communicates at its ends with the ports 25 and 26. The end-plate 5 includes the scavenging stage inlet port 9, a port 28 to lead combustion gases to the cells, and a port 29, of larger circumferential extent than the port 28, to lead combustion-supporting gases and combustion gases from the cells. A duct 30 connects the ports 28 and 29. The inlet port 28, the outlet port 25 and cells at any given time in communication with these ports together constitute a scavenging stage. The inlet port 26, the outlet port 29 and cells at any given time in communication with these ports together form another scavenging stage.

A fuel injection nozzle 31 and a fuel igniter 32 are provided within the duct 30.

In operation, fresh air admitted to the cells through the port 9 is mixed with combustion gases entering the cells through the port 28. The mixed gas together with a quantity of combustion gases leave the cells through the port 25 and enter the duct 27 in which further mixing of the gases takes place. The direction of flow in the duct 27 is in general the same as the direction of motion of the cells of the cell ring. This may be explained as follows. If the embodiment of FIGURE 4 did not include the duct 27 and associated ports then a compression wave would be reflected from the end-plate surface occupying the notional position of the outlet port 25 and the pressure there would be higher than the pressure in the cells at the notional position of the inlet port 26. This pressure difference arises because an expansion wave set up by the opening edge of the outlet port 29 gives rise to a pressure drop in the cell at a position between the opening and closing edges of the notional inlet port 26, whereas a compression wave is set up by the opening edge of the port 28 which gives rise to a pressure increase in a cell just arriving at the opening edge of the notional outlet port 25. When however, the ports 25 and 26 are physically present, then because of the pressure difference across the expansion wave at the port 26 there is a drop in pressure at the downstream part of the port 26 (considered in the direction of motion of the cells) and this pressure difference is communicated to the upstream part. Thus, because of the pressure difference between the two ports there is a gas flow from the port 25 to port 26. Consequently, the mixed gases together with any combustion gases enter the cells through the inlet port 26. The combustion-supporting gases are then admitted by the port 29 to the duct 30 in which combustion is effected. Finally, the mixed gases are expelled from the cells through the scavenging stage outlet port 8.

If desired, baffles (not shown) may be disposed in the duct 27 in order to increase the rate of mixing between the fresh air and the combustion gases. It is further possible to vary the effect of these baffles during operation of the pressure exchanger.

In order to increase further the rate of mixing a feedback loop 33 (indicated by broken lines) may connect the duct 30 just upstream of the inlet port 28 to the duct 12 just upstream of the inlet port 9.

FIGURE 5 shows a pressure exchanger in which the end-plate 4 includes the scavenging stage outlet port 8, a port 35 for the extraction of compressed air from the cells and a port 36 for the admission of a mixture of combustion gases and air to the cells. A duct 37 communicates at its ends with the ports 35 and 36 and a flame tube 38 is mounted within the duct 37 with its outlet adjacent the port 36. The flame tube 38 is required within the duct 37 because there is only pure relatively cold air present in that duct. The flame tube of conventional design sets up requisite vortices to ensure stable combustion. The end-plate 5 includes the scavenging stage inlet port 9, a port 39 to lead compressed air to the cells and a port 40 for the extraction of compressed air from the cells. A duct 41 communicates at its ends with the ports 39 and 40. The inlet port 39, the outlet port 35 and cells at any given time in communication with these ports together constitute a scavenging stage. Similarly, the inlet port 36, the outlet port 40 and the cells at any given time in communication with these ports constitute another scavenging stage.

In operation, air entering the cells through the port 9 is compressed by compressed air admitted through the port 39, and enters the duct 37 via the outlet port 35. Part of the compressed air passing through the duct 37 supports combustion in the flame tube 38 and the remainder of the air is thoroughly mixed with the combustion products from the flame tube before being admitted to the cells through the port 36. The mixed gases enter-

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ing the cells through the port 36 serve to compress the air already in the cells, which compressed air leaves the cells through the port 40. The mixed gases are finally expelled from the cells through the scavenging stage outlet port 8.

The duct 41 may have a tapping connected to a duct through which relatively cool fresh air can be supplied to hot parts of the pressure exchanger or to hot parts of an associated gas turbine plant.

It will be appreciated that in all of the embodiments hereinbefore described, the stagnation pressure of gases leaving the cells through the outlet port 8 is higher than, or at least equal to, the stagnation pressure of the air admitted through the port 9. A pressure rise therefore exists between air admitted to the cells and gas extracted from the cells of the pressure exchanger combustion arrangement of the invention. This is in direct contrast to the pressure loss inherent in conventional combustion arrangements.

FIGURE 6 shows a fragmentary end view of a cell ring of a pressure exchanger having cells of honeycomb construction. It will be seen that the cells defined by the walls 1, the hub 2 and the shroud 3 include corrugated strips 42 which are brazed to the cell walls 1 to give a honeycomb configuration. Such a configuration will strengthen the cell walls which is desirable since the walls will be subjected to high differential pressures during operation of the pressure exchanger.

FIGURE 7 shows a pressure exchanger in accordance with the invention serving as the combustion means of a jet propulsion plant. The pressure exchanger receives compressed gases from a compressor 43 and delivers combustion gases to a turbine rotor blade row 44 via inlet guide blades 45. The compressor, the pressure exchanger and the turbine are co-axially mounted upon a shaft 46. The pressure exchanger rotor would normally rotate independently of the compressor and turbine rotors. As can be seen from FIGURE 7 a proportion of the compressed air from the compressor 43 by-passes the pressure exchanger cells in order to cool the outside of the pressure exchanger rotor and to limit maximum temperature at the entry to the turbine 44.

In each of the above described embodiments the ratio of the recirculated combustion gases to the fresh air is of the order of 4:1, but may be higher.

The rotor of the pressure exchanger may be driven by providing guide vanes at the inlet ports of the rotor or by skewing the vanes relative to the axis of rotation. An electric motor may be provided for starting purposes.

I claim:

1. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, at least one of the end-plates having a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, one of which ports is positioned in the end-plate immediately to follow the other in the direction of rotation of the cell ring, ducting to provide communication between the two ports, and fuel injection means interposed in the ducting.

2. A pressure exchanger as claimed in claim 1, in which, in operation, the direction of fluid flow through the ducting is generally opposite to the direction of rotation of the cell ring.

3. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the

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cells, means to effect rotation of the cell ring end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in one of the ducts.

4. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in both of the ducts.

5. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, the port for the admission of fluid to the cells in one end-plate being disposed directly opposite the port for the admission of fluid to the cells in the other end-plate, the port for the extraction of fluid from the cells in the one end-plate being disposed directly opposite the port for the extraction of fluid from the cells in the other end-plate, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in one of the ducts.

6. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, the port for the admission of fluid to the cells in one end-plate being disposed directly opposite the port for the admission of fluid to the cells in the other end-plate, the port for the extraction of fluid from the cells in the one end-plate being disposed directly opposite the port for the extraction of fluid from the cells in the other end-plate, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in both of the ducts.

7. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction

of fluid from the cells, the port for the admission of fluid to the cells in one end-plate being disposed directly opposite the port for the admission of fluid to the cells in the other end-plate, the port for the extraction of fluid from the cells in the one end-plate being disposed directly opposite the port for the extraction of fluid from the cells in the other end-plate, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in one of the ducts, the direction of fluid flow through the one duct being, in operation, generally opposite to the direction of rotation of the cell ring.

8. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned on one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, the port for the admission of fluid to the cells in one end-plate being disposed directly opposite the port for the admission of fluid to the cells in the other end-plate, the port for the extraction of fluid from the cells in the one end-plate being disposed directly opposite the port for the extraction of fluid from the cells in the other end-plate, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, and fuel injection means interposed in both of the ducts, the direction of fluid flow through both of the ducts being, in operation, generally opposite to the direction of rotation of the cell ring.

9. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, fuel injection means interposed in one of the ducts, and flame holding means disposed in the one duct.

10. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, fuel injection means interposed in one of the ducts, and baffles disposed in the other of the ducts.

11. A pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, which cells are of honeycomb construction, the cell rotor and the walls forming parts of the cell ring, means to introduce fluid

to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, at least one of the end-plates having a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, one of which ports is positioned in the end-plate immediately to follow the other in the direction of rotation of the cell ring, ducting to provide communication between the two ports, and fuel injection means interposed in the ducting.

12. A gas turbine plant including a compressor, a turbine, and a pressure exchanger, said pressure exchanger including a cell ring, a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of a cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, at least one of the end-plates having a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, one of which ports is positioned in the end-plate immediately to follow the other in the direction of rotation of the cell ring, ducting to provide communication between the two ports, fuel injection means interposed in the ducting, a duct to connect the compressor of the plant to said means to introduce fluid to the cells of the pressure exchanger, and a duct to connect said means to extract fluid from the cells of the pressure exchanger to the said turbine of the plant.

13. A gas turbine plant including a compressor, a turbine, and a pressure exchanger, said pressure exchanger including a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of a cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, fuel injection means interposed in one of the ducts, a duct to connect the compressor of the plant to said means to introduce fluid to the cells of the pressure exchanger, and a duct to connect said means to extract fluid from the cells of the pressure exchanger to the said turbine of the plant.

14. A gas turbine plant including a compressor, a turbine, and a pressure exchanger, said pressure exchanger including a cell rotor, a plurality of walls arranged around the rotor to define a plurality of open-ended cells, the cell rotor and the walls forming parts of a cell ring, means to introduce fluid to the cells, means to extract fluid from the cells, means to effect rotation of the cell ring, end-plates positioned one adjacent each end of the cell ring, each end-plate having a pair of ports comprising a port for the admission of fluid to the cells and a port for the extraction of fluid from the cells, each pair of ports having one port positioned immediately to follow the other in the direction of rotation of the cell ring, ducts to provide communication between the two ports of each pair of ports, fuel injection means interposed in both of the ducts, a duct to connect the compressor of the plant to said means to introduce fluid to the cells of the pressure exchanger, and a duct to connect said means to extract fluid from the cells of the pressure exchanger to the said turbine of the plant.

References Cited by the Examiner

UNITED STATES PATENTS

1,515,101 11/1924 Fowler ----- 230—75

SAMUEL LEVINE, *Primary Examiner*.