Sept. 15, 1959 R. D. PEARSON 2,904,246

PRESSURE EXCHANGERS

Filed June 28, 1956

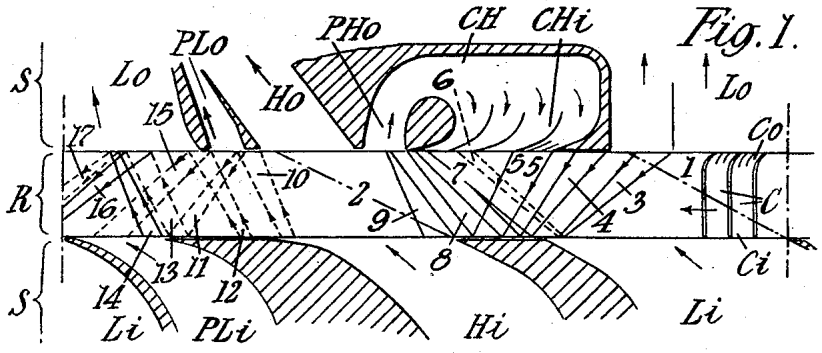


Fig. 1.

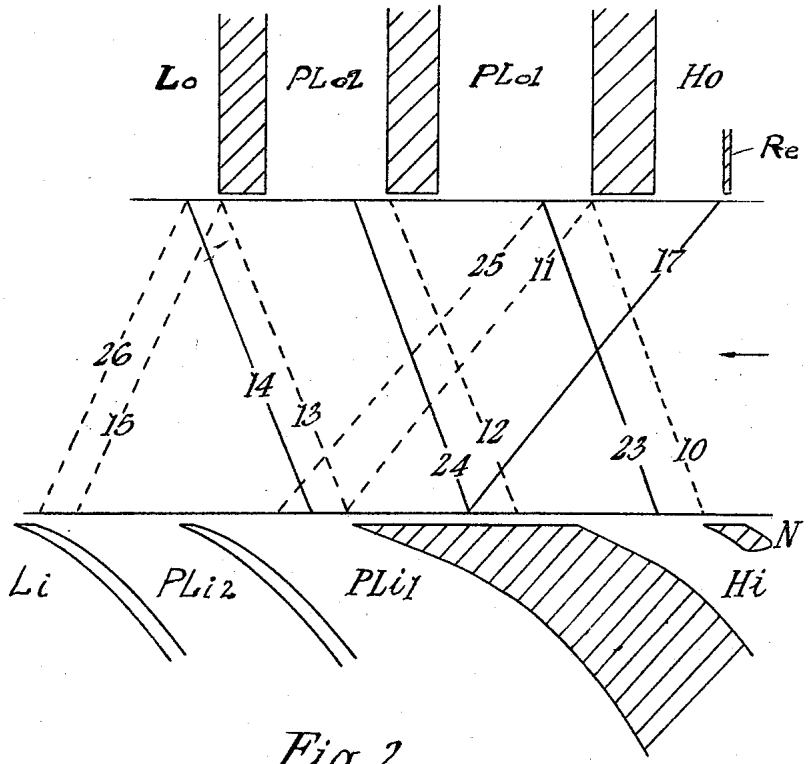


Fig. 2.

United States Patent Office 2,904,246 Patented Sept. 15, 1959



2,904,246

# PRESSURE EXCHANGERS

Ronald D. Pearson, Chesterfield, England

Application June 28, 1956, Serial No. 594,465

4 Claims. (Cl. 230—69)

This invention relates to machines, hereinafter referred to as pressure exchangers, in which each of a plurality of cells serves cyclically to receive gas from a source of lower pressure and discharge it to a pressure-increasing means, and to receive gas from said pressure-increasing means and discharge it to a region of lower pressure. The cells are arranged around the periphery of a rotor mounted to pass over appropriate permanently-open ports in a stator. (Of course, the terms rotor and stator are used relatively, the one to the other, so that it might be that the "rotor" is stationary in space and the "stator" rotates about the rotor. The admission and discharge of the gas to and from the cell in the lower and in the higher pressure stages is hereinafter referred to as "scavenging"; being defined as a condition in which both ports of the cell being open together for a sufficient duration of time, there occurs a displacement of a substantial part of the former contents from the cell, and their replacement by fresh gas.

The pressure-increasing means is conveniently a combustion chamber wherein the received gas is made to burn with a fuel to increase both its volume and temperature.

Conveniently, too, but not necessarily, the motion of the gas into and out of the cell in both of the scavenging stages is unidirectional, so that it is possible to speak of an inlet to and an outlet from the cell, the inlet being on one flank of the rotor and the outlet on the other flank.

When the machine is arranged as an engine, it serves to convert some of the pressure energy from said pressure increasing means into kinetic energy.

It is desirable that immediately before a cell reaches a scavenging stage, the gas in the cell should be accelerated towards that port, usually the cell outlet, from which the gas is to be discharged in said stage. Hereinafter this acceleration is referred to as "prescavenging."

The present invention is concerned with improving a pressure exchanger in respect of certain wave occurrences within the cells.

When the cell at high pressure is but partially opened to a duct at lower pressure, there will occur an outrush of gas from the cell excessive in velocity and wrong in direction. This invention is further concerned with reducing that outrush while the cell is but partially opened, permitting the full difference of pressure to become effective only when the cell is fully opened.

The following description relates to the accompanying drawing wherein is shown, by way of example only, one embodiment of the invention. In the drawing,

Figure 1 is a developed view of a pressure exchanger as more fully described and claimed in my copending application Serial Nos. 594,461 and 594,462 filed June 28, 1956; and

Figure 2 is a developed view of part of such a pressure exchanger modified in accordance with the present invention.

In Figure 1 a rotor R comprises a plurality of cells



moving from right to left as indicated by the arrow between the two flanking parts of a stator S. The general flow of gas through the cells is in the upward direction, so that the cell ports may be identified as inlet *Ci* and outlet *Co*. In their motion the cell ports sweep over the mouths of certain ducts in the stator. Thus the cell inlet *Ci* passes over the low pressure scavenging delivery duct L*i*, and high pressure scavenging delivery duct H*i*, and the low pressure pre-scavenging delivery duct PL*i*. Similarly the cell outlet *Co* passes over the low pressure scavenging discharge duct L*o*, the compression delivery duct CH*i*, the high-pressure prescavenging discharge duct PH*o*, the high-pressure scavenging discharge duct H*o*, and the low pressure pre-scavenging discharge duct PL*o*. Various compression and rarefaction waves are generated and reflected, some being desirable, to be utilised, and others being undesirable, to be suppressed if possible. Further details of such a pressure exchanger are to be found in the above-mentioned copending applications.

The method of working in accordance with the present invention is shown in Figure 2 applied to the two-stage expansion system which has been more fully described in my copending patent application Serial Number 594,464 filed June 28, 1956; but it may be applied to any expansion system as disclosed in my last mentioned copending application, $PLi_2$ is a second prescavenging nozzle and L*i* is a low pressure scavenging delivery duct. Prescavenging low pressure delivery ducts $PLo_2$ and $PLo_1$ are provided between the high and low pressure scavenging ducts H*o* and L*o* respectively. The method relies on rarefaction waves super-imposed on the normal compression waves to form pulses so timed that the pressure difference between cells and duct is temporarily reduced or eliminated during at least part of the open period of each cell.

The first pulse **10, 23** is produced by an obstruction N placed near the end of the high pressure scavenging delivery duct H*i*. The rarefaction **10** is reflected as rarefaction **11, 13, 15**; while the compression wave **23** is reflected as rarefaction **25** and is then substantially cancelled at the nozzle $PLi_1$.

The second pulse **12, 24** is generated by closure of the cell inlet to H*i* and by reflection of compression wave **17** produced by the partial restriction R*e* of receiving duct H*o*.

In a similar way the third pulse **13, 14** is generated by the reflection of the rarefaction **11** and opening of the cell inlet to the prescavenging nozzle $PLi_1$.

An improvement in efficiency is given over a narrow speed range at the expense of a reduction outside this range, but operation over a wide speed range is still possible. In certain designs only the pulse **10—23** is desired the remainder being omitted. For improved working at low speed the obstruction N can be made retractable.

What I claim is:

1. In a pressure exchanger, a rotor provided with a plurality of cells formed about its periphery, two stator parts between which the rotor is mounted to rotate, said stator parts each provided with ducts communicating with said cells and cooperating to form a high-pressure scavenging stage followed by a low-pressure scavenging stage, means in the high pressure scavenging stage rendered effective during the passage of a cell from said high-pressure stage to said low-pressure stage to transmit a compression wave through said cell followed by a rarefaction wave so timed as to reduce the pressure difference between the pressure at a port of said cell and the pressure in a duct to which that port is communicating.

2. A pressure exchanger according to claim 1 wherein said means for transmitting a rarefaction wave through

said cell comprises an obstruction arranged within the high-pressure scavenging delivery duct.

3. A pressure exchanger according to claim 1 wherein said means for producing a rarefaction wave comprises a partial restriction in the high-pressure scavenging receiving duct and a wall surface upon said high-pressure scavenging delivery duct for reflecting the compression wave produced by said partial restriction.

4. A pressure exchanger according to claim 1 wherein said means for producing a rarefaction wave comprises a low-pressure pre-scavenging delivery duct following



said high-pressure delivery duct and serving, upon opening of the cell to said pre-scavenging delivery duct, to reflect a wave caused by an earlier change of condition of the cell inlet.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,045,152 | Lebre | June 23, 1936 |
| 2,399,394 | Seippel | Apr. 30, 1946 |