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(54) Rotary positive displacement pump.

(57) A mechanical vacuum pump comprising at least one pumping chamber having mounted therein on respective contra rotatable shafts a pair of "claw" type rotors arranged for pumping gas through the chamber during a pump cycle from an inlet port to an outlet port, each rotor having a substantially circular hub portion about the shaft one surface of which communicates with a wall of the chamber containing a port but with a part of the hub portion cut away for opening and closing the port at predetermined intervals of the pump cycle and a claw portion extending substantially radially from the hub portion, wherein the surface of at least one rotor which communicates with the port is enlarged relative to the remainder of the rotor, and to the hub portion in particular, and orifice means are provided therein for communication with the port.

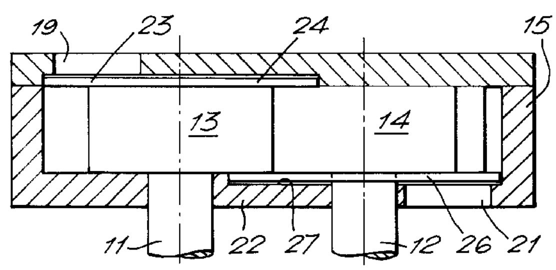

FIG.5.

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This invention relates to mechanical vacuum pumps and more particularly to such pumps incorporating rotor pairs of the Claw type.

Vacuum pumps incorporating a pair of Claw rotors mounted on respective shafts and positioned for interengagement in a chamber of the pump as the shafts are synchronously rotated in opposite directions are well known. Each pump may comprise one or more such chambers with one rotor of each pair being mounted on a first shaft and the other rotor of each pair being mounted on a second shaft. A multi-chamber pump may employ Claw type rotors exclusively in each chamber or may also have a chamber or chambers having Roots type rotors therein.

Gas being evacuated from a vessel or container (or whatever) to which the pump is attached is drawn into the pump chamber through an inlet and the general function of each rotor pair of the Claw type is to "sweep" a volume of such gas by trapping the volume between the claws of the rotors during each cycle and expel it from the chamber during a relevant part of the rotor cycle, ie. when the swept volume communicates with a pump outlet.

The maximum size, ie. cross-sectional area, of the inlet to, and also the outlet from, the chamber is dictated by the shape of the claw rotor profile. In particular, the shape and size of the inlet and outlet must be such that:

i) they are positioned between the rotor shaft and within the rotor base diameter,

ii) they are exposed only by the claw "cut-out" portion,

iii) they extend circumferentially only during that part of the rotor cycle when, in use, gas is being drawn in or expelled from the inlet and outlet respectively.

The shape of a typical inlet for an existing pump design is shown schematically in Figure 1 which is a transverse section through the pump. It shows two contra-rotatable shafts 1, 2 having mounted thereon respective claw rotors 3,4 which, in use, rotate in the directions shown by the arrows within the confines of the chamber walls 5.

The rotor 3 communicates, during part of its cycle, with generally arcuate inlet port 6 in the uppermost wall of the chamber and positioned about the shaft and between (with clearances) the diameter of the rotor hub (or base circle) 7 (completed by dotted lines 8) and the innermost part of the rotor cut-out 9. The rotor 4 similarly communicates with an outlet port 10 in the lowermost wall of the chamber and positioned in relation to the rotor 4 in a similar manner to the inlet port 6 and the rotor 3. In use, therefore communication between the rotors and the respective port occurs when the rotating rotor exposes the port as the cut-out part of the rotor passes across the port. That is the basis of the pump cycle.

Such restrictions on the area of the inlet (and similar restrictions on the area of the outlet) constitute an impedance to the flow of gas into (and from) the swept volume which generally results in a reduction of volumetric efficiency and also in a higher power requirement; the former applies particularly at low pressures and the latter applies particularly at high pressures.

The present invention is concerned with minimising or even removing such restrictions by allowing for the size of the inlet and/or the outlet of such pumps to be increased commensurate with the overall size of the pump chamber(s).

In accordance with the invention, there is provided a mechanical vacuum pump comprising at least one pumping chamber having mounted therein on respective contra rotatable shafts a pair of "claw" type rotors arranged for pumping gas through the chamber during a pump cycle from an inlet port to an outlet port, each rotor having a substantially circular hub portion about the shaft one surface of which communicates with a wall of the chamber containing a port but with a part of the hub portion cut away for opening and closing the port at predetermined intervals of the pump cycle and a claw portion extending substantially radially from the hub portion, wherein the surface of at least one rotor which communicates with a port is enlarged relative to the remainder of the rotor and to the hub portion in particular and orifice means are provided therein for communication with the port.

Such an arrangement allows the pump to operate in the same manner as the normal pump but with the ability to allow a greater throughput of gas by allowing for a greater port cross-sectional area.

The invention is preferably put into effect by securing to the surface of a Claw rotor adjacent the port a disc which by itself forms the surface of the rotor and which defines the interface between the rotor and the wall of the chamber containing the port.

Preferably, the disc has a radius which is larger than that of the hub portion of the rotor itself, ie between the hub portion radius and the radius of the rotor including the additional radial dimension of the claw itself. The disc could be greater than the radius of the rotor including the radial dimension of the claw but this is generally unnecessary. Most preferably, the disc has a diameter which is substantially equal to the rotor including the radial dimension of the claw.

The orifice means in the enlarged rotor surface preferably extends from the outer edge of the surface of the disc to a position near the rotor surface and can itself advantageously be approximately circular or square in shape. The radial dimension of such an orifice can therefore be much larger than that possible in the usual rotor "cut-out" portion and, of course, the radial dimension of the port itself may be made correspondingly larger to effect a greater throughput of gas through the port.

The invention is applicable to both the chamber inlet port and the chamber outlet port; preferably, it is applied to each port. In multi-chamber vacuum pumps, the invention can advantageously be applied to both ports in all chambers, thereby effecting a lower impedance to gas flow throughout the pump as a whole.

It may be advantageous for the disc (or at least the relevant surface thereof) to be made from a material which minimises friction between it and the wall of the chamber containing the port, for example carbon-graphite or a PTFE coating on the relevant surface should the rotating member touch the stationery members due to, for example, temperature expansion effects. In such embodiments in particular, the rotors of the pump can operate with small clearances relative to the pump walls and are thus able to reduce gas leakage (gas slip) therebetween.

For a better understanding of the invention, reference will now be made for the purpose of exemplification only, to the following drawings in which:

Figure 2 is a transverse section through a pump of the invention, in particular a first stage chamber thereof

Figure 3 is an axial section through the pump of Figure 2 along line III-III

Figure 4 is a transverse section through a modified pump of the invention, in particular a first stage chamber thereof

Figure 5 is an axial section though the pump of Figure 4 along the line V-V

Figure 6 is an axial section through a pump of the invention in particular an intermediate or first stage chamber thereof.

Figure 7 is a schematic representation of a modified plate for attachment to a rotor incorporated in the pump of Figures 2 and 3 or Figures 4 and 5 hereof.

With reference to the drawings and in particular Figures 2 and 3, the pump shown therein is in accordance with the invention and incorporates a modified rotor communicating with the first stage chamber inlet in particular.

The pump comprises two contra-rotatable shafts 11,12 having mounted thereon respective Northey or Claw type rotors 13,14 which, in use of the pump, rotate in the directions shown by the arrows within the confines of chamber walls 15.

The rotor 13 comprise a substantially circular hub portion 16 having a cut-out portion 17 and claw portion 18. Rotor 14 has a similar construction and the basic positioning and operation of this rotor pair within the chamber walls 15 is standard for this type of vacuum pump.

Figure 3 in particular shows an axial section of the rotor arrangement shown in Figure 2. It also shows an inlet port 19 in chamber wall portion 20 and an outlet port 21 in chamber wall portion 22. Whereas the latter is of standard generally arcuate shape and size, the generally arcuate inlet port 19 is substantially larger, particularly in the radial dimension as clearly shown in both Figure 2 and in Figure 3.

Figure 3 additionally shows a circular disc 23 securely attached to the surface of the rotor 13 which communicate with the inlet port 19. The disc 9 is therefore adapted for rotation with the rotor 13 in use of the pump within a circular cavity 24 in the chamber wall portion 20 having a size corresponding to that of the disc 23.

The disc 23 has a cut-out portion 25 which at the inner end has a shape and size corresponding substantially to the shape and size of the cut-out portion 17 of the rotor 13 and which at the outer end extends to the periphery of the disc 23 as shown in Figure 2 in particular.

In use of the pump of the invention, its operational cycles are essentially identical to that of a standard pump of known design. Thus, a volume gas being evacuated by the pump is drawn into the inlet port 19, is "swept" by the rotating rotor claws in particular and is expelled through the outlet port 21.

In contrast to standard pumps, however, the presence of the disc 23, having the effect of enlarging the surface of the rotor 13 which communicates with the inlet port 19 and thereby allowing the cut-out portion in that surface, and hence the inlet port itself, both to be greater than in a standard pump. Clearly this effect is accomplished without changing the dimensions of the pump overall or of the volumes, etc formed in the pumping chambers.

The benefit of the invention can conveniently be applied not only to one port of a chamber of a vacuum pump of the invention but to both ports. Figures 4 and 5 show a modified pump to that shown in Figures 2 and 3 in that a second disc 26 is securely fixed to the surface of the rotor 14 which communicates with the outlet port 21. The outlet port 21 can therefore be enlarged on the same basis as inlet port 19. The disc 26 rotates with the rotor 14 within the confines of a cavity 27 in the chamber wall portion 22. In the case of the plate 26, it contains a central aperture to allow the presence of the shaft 12.

Turning to Figure 6, this shows an intermediate chamber of a multiple stage pump with both the inlet port 19 and the outlet port 21 having the benefit of associated discs 23 and 26 respectively. In this case, both the discs contain a central aperture to allow for the presence of the shafts 11 and 12 respectively.

Finally, Figure 7 shows an alternative disc for use either in conjunction with an inlet port or an outlet port in which the cut-out portion 17 does not extend to the periphery of the disc but has the shape shown with a retained circumferential strip as an outer edge to the cut-out portion.

With reference to the discs themselves, these could generally be made of any suitable material. However, they are preferably made from a low friction or self lubricating material (at least on the side communicating with the chamber wall containing the port). PTFE coatings or carbon graphite are preferred in this respect.

Claims

1. A mechanical vacuum pump comprising at least one pumping chamber having mounted therein on respective contra rotatable shafts a pair of "claw" type rotors arranged for pumping gas through the chamber during a pump cycle from an inlet port to an outlet port, each rotor having a substantially circular hub portion about the shaft one surface of which communicates with a wall of the chamber containing a port but with a part of the hub portion cut away for opening and closing the port at predetermined intervals of the pump cycle and a claw portion extending substantially radially from the hub portion, wherein the surface of at least one rotor which communicates with the port is enlarged relative to the remainder of the rotor, and to the hub portion in particular, and orifice means are provided therein for communication with the port.

2. A pump according to Claim 1 in which a disc is secured to the surface of a Claw rotor adjacent the port which disc by itself forms the surface of the rotor and which defines the interface between the rotor and the wall of the chamber containing the port.

3. A pump according to Claim 2 in which the disc has a radius which is larger than that of the hub portion of the rotor itself, ie. between the hub portion radius and the radius of the rotor including the additional radial dimension of the claw itself.

4. A pump according to Claim 2 or 3 in which the disc has a diameter which is substantially equal to the rotor including the radial dimension of the claw.

5. A pump according to any preceding claim in which the orifice means in the enlarged rotor surface extends from the outer edge of the surface of the disc to a position near the rotor surface.

6. A pump according to Claim 5 in which the orifice means is approximately circular or square in shape.

7. A pump according to any preceding claim in which the surface of both rotors communicating with a port is enlarged in accordance with the invention.

8. A pump according to any preceding claim in which relevant surfaces of the disc are made from a material which minimises friction between it and the wall of the chamber containing the port.

9. A pump according to Claim 8 in which the relevant surfaces have a PTFE or carbon-graphite coating thereon.

FIG.1.

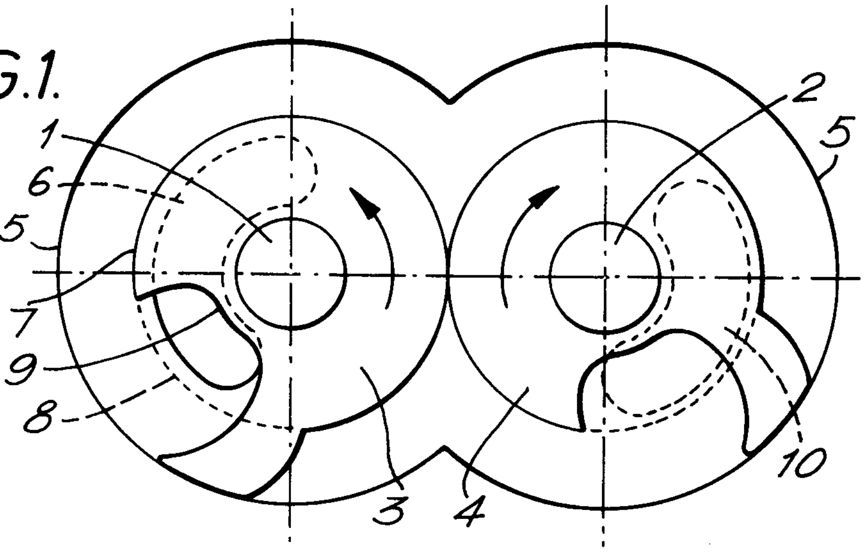
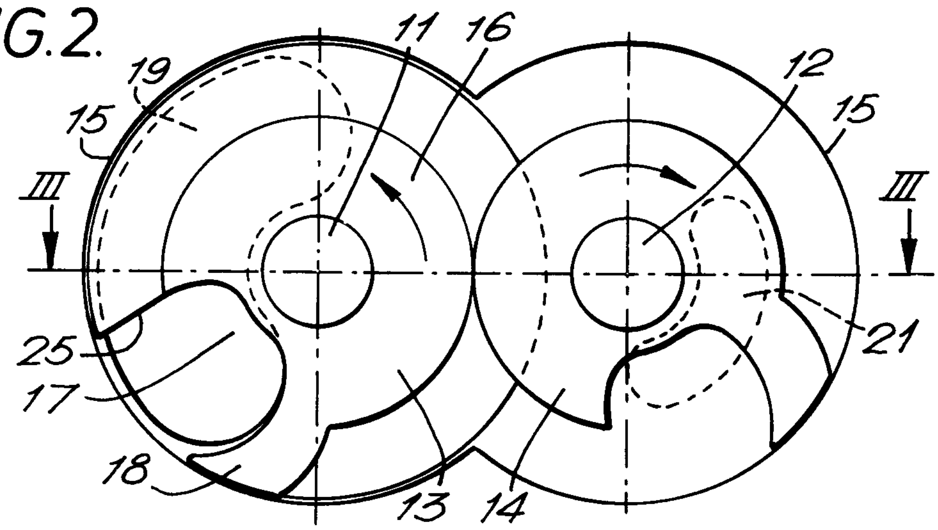


FIG.2.



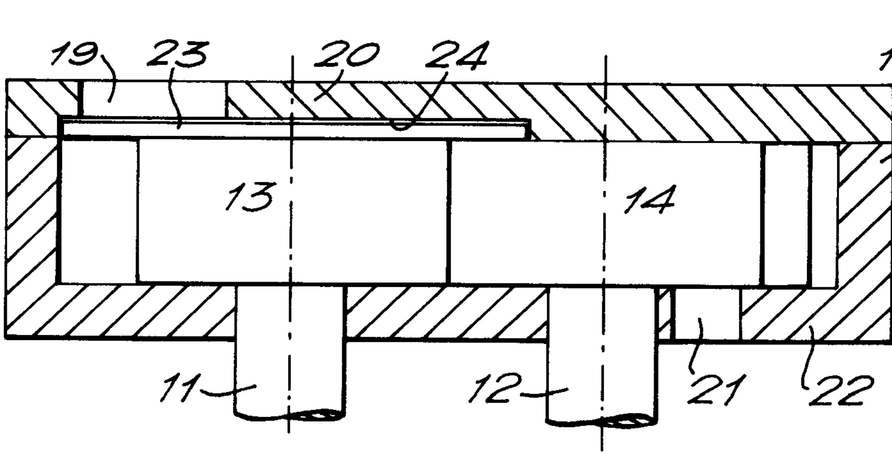


FIG.3.

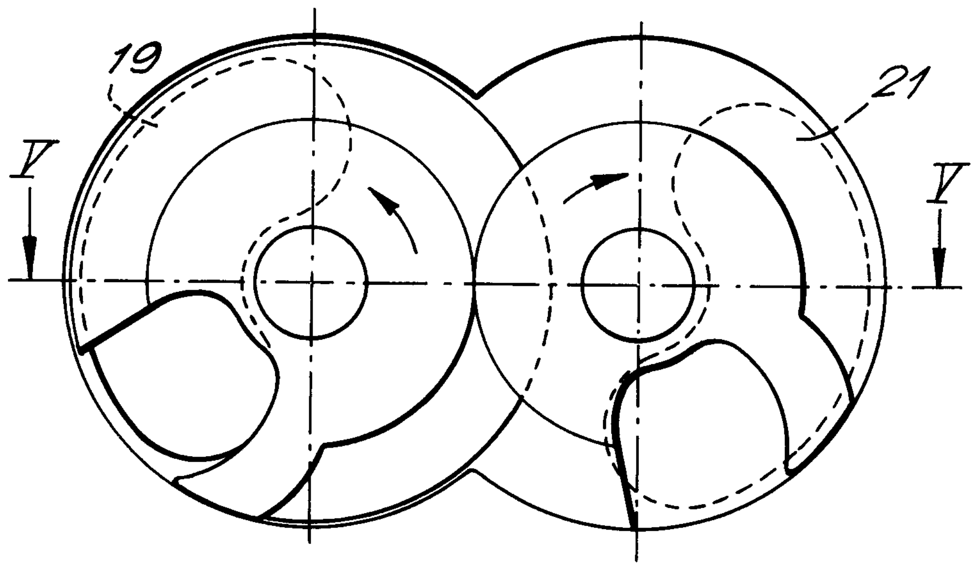


FIG.4.

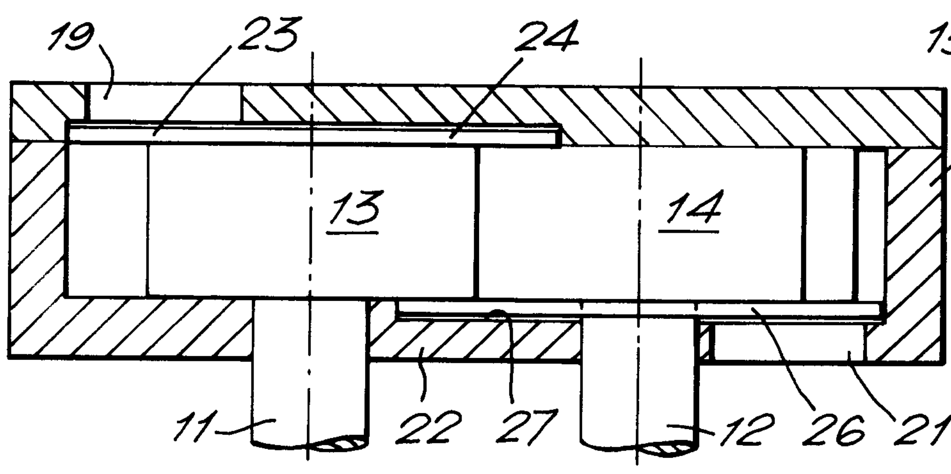


FIG.5.

FIG.6.

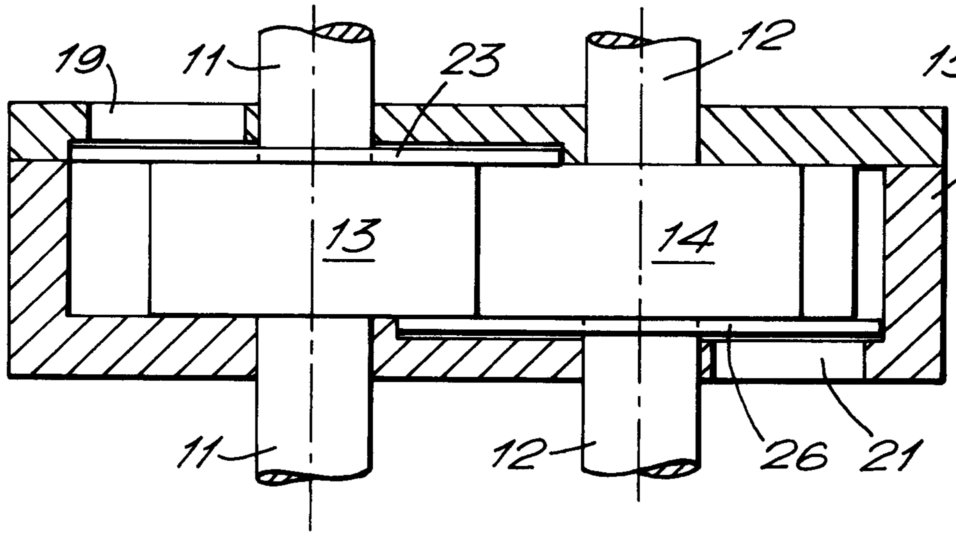
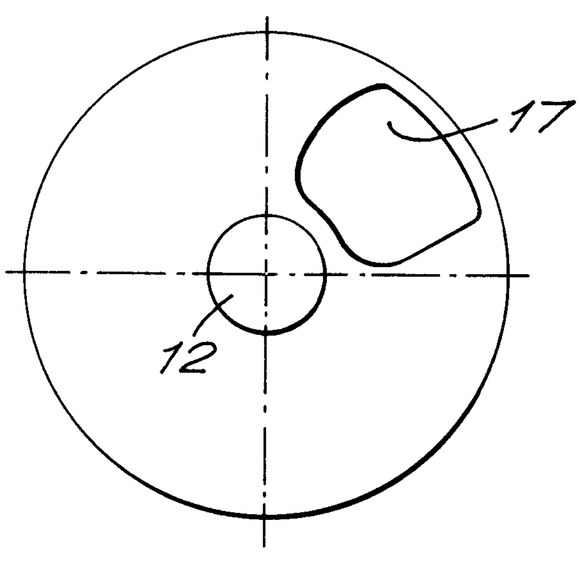


FIG.7.



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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 1781

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	GB-A-800 211 (BREWER) * page 2, line 20 - line 82; figures 1-3 *	1-6	F04C18/12
X	US-A-3 723 031 (BROWN) * column 5, line 24 - line 44; figures VII,VIII *	1-6	
X	FR-A-1 102 554 (LESTAGE) * the whole document *	1-6	
X	US-A-4 324 538 (BROWN) * the whole document *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

F04C
F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 JUNE 1992	DIMITROULAS P.

CATEGORY OF CITED DOCUMENTS

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