Dec. 22, 1959 W. BECKER 2,918,208

MOLECULAR PUMP

Filed Jan. 29, 1957

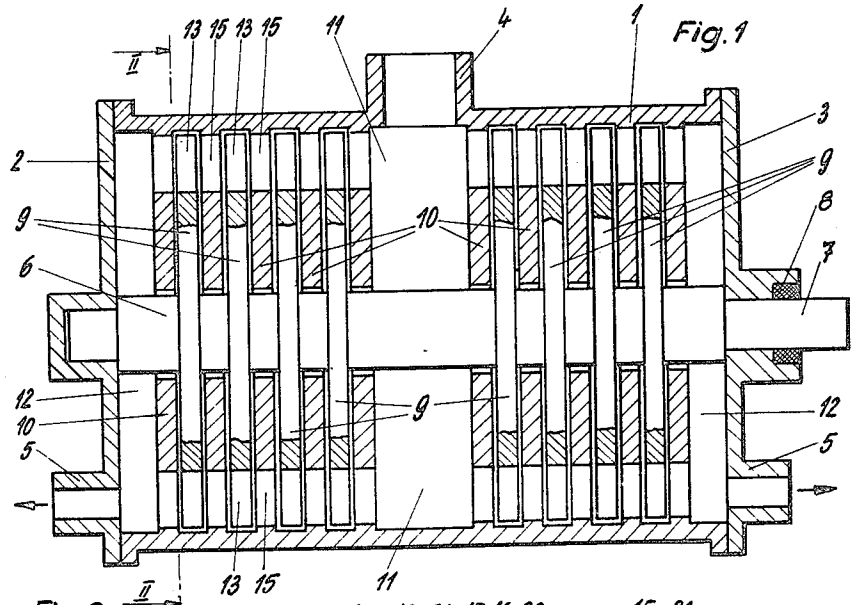


Fig. 1

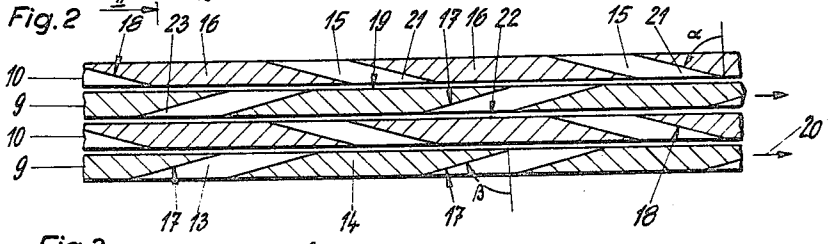


Fig. 2

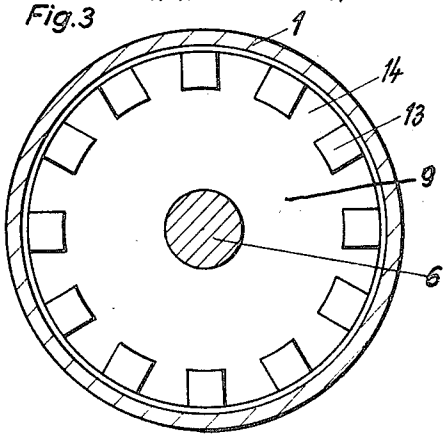


Fig. 3

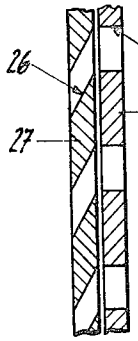


Fig. 4

INVENTOR

Willi Becker

Watson, Cole, Grindle & Watson

attorneys

United States Patent Office

2,918,208

Patented Dec. 22, 1959

2,918,208

MOLECULAR PUMP

Willi Becker, Ehringshausen Kreis Wetzlar, Germany

Application January 29, 1957, Serial No. 636,969

Claims priority, application Germany February 2, 1956

5 Claims. (Cl. 230—118)

This invention relates to pumps for producing a high degree of vacuum, which are effective between the vessel to be evacuated and a preliminary vacuum and are known in various embodiments as molecular pumps.

Known pumps of this nature possess a closed casing, a member rotating at high speed therein and a passage in the casing leading from the suction to the pressure side, the said passage being confined on one side by the rotary member. The known method of operation of these pumps is based on the fact that an impulse inducing motion is imparted to the gas or the gas molecules in the direction towards the preliminary vacuum by outer friction against the rotating member.

A molecular pump in its most simple form possesses a normally fixed cylindrical casing having an annular groove, which is open towards the inside and at one point is divided by a wall, and a rotary disc-like cylindrical member, which confines the inner open side of the annular groove. From the annular groove, just in front of and behind the dividing wall, a passage leads in each case to the suction and the pressure side of the pump. A pump of this nature forms a single pressure stage; the points of highest and lowest pressure in the groove are separated by the wall in the annular groove. The suction and the pressure side of the pump are connected by the air gap between the outer periphery of the disc and the interior of the annular groove. Through this gap there are able to pass molecules of gas which limit the pressure ratio capable of being achieved with one stage and the rate of evacuation possible in pumps of this nature. For this reason it is usual to make the gap as small as possible and to provide a plurality of pressure stages, in order to reduce the difference in pressure in the gap between each stage, and thus to increase the rate of evacuation and the pressure ratio of these pumps.

Pumps are known having a helical passage in a fixed casing and a rotary cylindrical member, the outer part of the rotary member imparting a movement-inducing impulse to the gas molecules; or pumps having a disc-like rotary member and a closed casing comprising in substance two discs, wherein the discs are situated on both sides of the rotary member and possess spirally cut grooves.

Pumps are furthermore known in which a helical passage is provided in the rotary member, and the casing wall adjoining the same is made to be smooth.

It is common to all of these pumps that the suction and pressure sides of the pump are connected by a passage, which is provided either in the casing or in the rotary member, and the longitudinal axis of which practically coincides with the direction of movement of the rotary member, and that the length of the passage in respect of each pressure stage increases by the periphery of the rotary member. In a construction of this character the overall length of the pump increases together with the width of the passage and with the number of stages. For mechanical reasons, the longer the pump becomes the larger must be the air gap. Since the pressure ratio

capable of being achieved falls rapidly as the size of the air gap is increased, a condition is already arrived at with a small number of stages, which is such that an increase in the rate of evacuation and in the pressure ratio cannot be accomplished by raising the number of stages.

In contradistinction to known pumps the pump according to the invention, which operates according to the molecular pump principle, is so constructed that the axial length of a pressure stage may be made very small. The pump according to the invention thus provides the possibility, while maintaining a small air gap, of constructing the pump to comprise a large number of stages and of making the differences in pressure between the stages small. The gaps themselves between the co-operating surfaces are furnished with a position which opposes return flow of the molecules between adjacent stages, so that also comparatively large gaps are permissible. A further advantage of the pump consists in the fact that the suction and delivery sides may be connected together by a large number of short passages. In a pump according to the invention the rate of evacuation or drop in pressure may be increased to a multiple extent while maintaining the external dimensions of known pumps.

A molecular pump according to the invention, comprising a closed casing and a rotary member, is so constructed that the cooperating parts of the rotary member and the casing comprise discs having groove-like recesses, that the discs of the two parts alternate in the direction of the axis of the rotary member, and that at least the grooves of the discs of one of the parts possess lateral bounding faces, which are inclined in relation to the axis of the rotary member, and which form with the end face of the discs of the other part a wedge-like space tapering off in the direction of movement of the rotary member.

An embodiment of the invention is illustrated by way of example in the accompanying drawing, in which

Fig. 1 is a longitudinal section through a molecular pump,

Fig. 2 being cross-section taken along the line II—II in Fig. 1.

Fig. 3 is a section through the development of the grooved discs of the two pump parts, and

Fig. 4 is a section similar to Fig. 3 through two co-operating discs, with a modified form of the grooves.

The cylindrical casing of the molecular pump is shown at 1. It is closed at the ends by means of discs 2 and 3 and possesses midway a socket 4 for connection of the suction pipe leading to the vessel to be evacuated. The discs 2 and 3 each have a socket 5 connected to a pressure pipe leading to the preliminary vacuum.

In the discs 2 and 3 is mounted the shaft 6 of the rotary part of the pump. The shaft journal 7 passes through the disc 3 and is either directly coupled to the driving motor or carries a suitable driving element. A seal 8 prevents the penetration of gases into the pump.

The shaft 6 carries a plurality of discs 9; in the embodiment illustrated there are eight discs, which are rigidly rotatable with the shaft. These discs are disposed with a slight clearance between discs 10, which are rigidly secured in the outer part 1 of the casing and at their center possess an opening for the passage of the shaft 6. The fixed discs 10 are so arranged in the pump casing that at the center of the pump there is formed a suction chamber 11 and at each end a pressure chamber 12.

As shown in Fig. 2, the discs 9 are furnished about the periphery with recesses or grooves 13. The individual grooves are separated from one another by tooth-like members 14. Similar grooves 15 are provided about the outer periphery of the discs 10 secured to the casing.

The teeth separating these grooves are shown at **16** (Fig. 3).

As shown by Fig. 3, the grooves **13** and **15** of the discs **9** and **10** have lateral bounding faces **17** and **18**, which are inclined at an angle in relation to the axis of rotation of the shaft **6**. As regards the bounding faces **18** in respect of the grooves **15**, this angle is shown as α in Fig. 3. The surfaces **18** together with the end faces **19** of the teeth **14** of the adjacent disc **9** enclose wedge-like spaces **21** which taper off in the direction of movement (arrow **20**). Upon rotation of the discs **9**, which takes place at a high speed, there occurs in the passages **15** a pressure, which increases towards the apex of the wedge-like space **21**, occasioned by the end faces of the teeth **14** in accordance with the principle applicable to molecular pumps. This increase in pressure results in a movement of the molecules in the grooves **13** of the discs **9** immediately these grooves register, or commence to register, with the grooves **15**. The bounding faces **17** of the grooves **13** in the discs **9** are inclined at an angle β in relation to the axis of rotation of the rotation of the shaft **6**, but in opposition to the inclination of the faces **18**. The faces **17** also form with the end faces **22** of the teeth **16** wedge-shaped spaces **23** which taper off in the direction of movement. In these spaces, and accordingly in the passages **13**, there is likewise created a pressure, which increases towards the apex and gives rise to a movement of the molecules through the grooves following in the direction of movement. In these grooves the same operation is then repeated, i.e., each disc **9** or **10** forms a pressure stage, in which connection there are at least three discs for two pressure stages.

The height of the discs **9** and **10** in the axial direction is made to be as small as is permissible from the point of view of mechanical considerations. The amount of the pressure is determined by the size of the angles α and β. The larger the angles α and β are, the greater the pressure becomes, while as the angles α and β become larger the rate of evacuation is reduced. The size of the angles is selected in accordance with the fact as to whether a high rate of evacuation or a high pressure per stage is desired. The width of the grooves measured in the peripheral direction, i.e., the distance between the bounding face **17** and the oppositely disposed bounding face of the groove, measured vertically to the axis of rotation, is derived from the consideration that an axis-parallel line passing through the groove intersects at least one bounding face or, as shown by Fig. 3, that the lower and the upper edges of the two faces touch. With such a width of groove molecules are prevented from passing through the grooves **15** or **13** in a straight line. The ratio between the width of groove and width of tooth of a disc is preferably selected to be equal to 1, or slightly greater than 1, as the width of tooth is important as regards bringing about the drop in pressure per stage.

As disclosed by Fig. 2, the suction and delivery sides of the pump are connected together by means of a comparatively large number of passages, being twelve in number in the embodiment illustrated, which are composed alternately of grooves of the fixed and rotary discs. Since

the axial height of the grooves is small, a large number of stages may be accommodated over a short axial length, and accordingly the pressure ratio in each stage may be made small. Return flow losses are very low, so that the rate of evacuation and also the pressure ratio between the vessel being evacuated and the preliminary vacuum may be high. In the spaces between the fixed and rotary surfaces these also act in opposition to return flow of the gas molecules, so that losses in the gaps, even when the latter are large, are very small.

It is not essential to make the lateral bounding faces of the grooves of both co-operating discs inclined in relation to the axis. As shown by Fig. 4, the bounding faces **24** of one disc **25** may be parallel to the axis if the walls **26** of the other disc **27** are made to be inclined to the axis. In this case only the disc having the inclined faces acts as pressure stage.

What I claim is:

1. A molecular pump comprising a closed casing having inlet and outlet means therein, a rotary member mounted in the casing and having a plurality of spaced discs with spaced grooves in the periphery thereof, said casing having a plurality of spaced discs secured therein each having a plurality of grooves adjacent the casing, the cooperating discs of the rotary member and the casing having the groove-like recesses with the discs of the two parts alternating in the direction of the axis of the rotary member, and at least the grooves of the discs of one of the parts having lateral bounding faces which are inclined in relation to the axis of the rotary member and which form with the end face of the discs of the other part a wedge-like space tapering off in the direction of movement of the rotary member.

2. A molecular pump according to claim 1, in which the lateral bounding faces of the grooves of the discs of both cooperating parts are inclined in relation to the axis of the rotary member, and the bounding faces of both parts oppose each other in their inclination.

3. A molecular pump according to claim 1, in which the grooves having lateral bounding faces are inclined relative to the axis of the rotary member of the pump which in the peripheral direction have a width so that an axis-parallel line passed through the groove intersects at least one of the lateral bounding faces.

4. A molecular pump according to claim 1, in which the inclination of the lateral bounding faces of the grooves of the discs adjoining the delivery side of the pump is less than on the suction side.

5. A molecular pump according to claim 1, in which the lateral bounding faces of the grooves of the discs of one of the cooperating parts are inclined in relation to the axis of rotation of the pump, and the bounding faces of the grooves of the other part are parallel to the axis.

References Cited in the file of this patent

UNITED STATES PATENTS

1,421,976	Michell	July 4, 1922
2,417,600	Jutte	Mar. 18, 1947