Oct. 16, 1962 W. GLAMANN 3,058,652

DISPLACEMENT COMPRESSORS

Filed Sept. 5, 1958 2 Sheets-Sheet 1

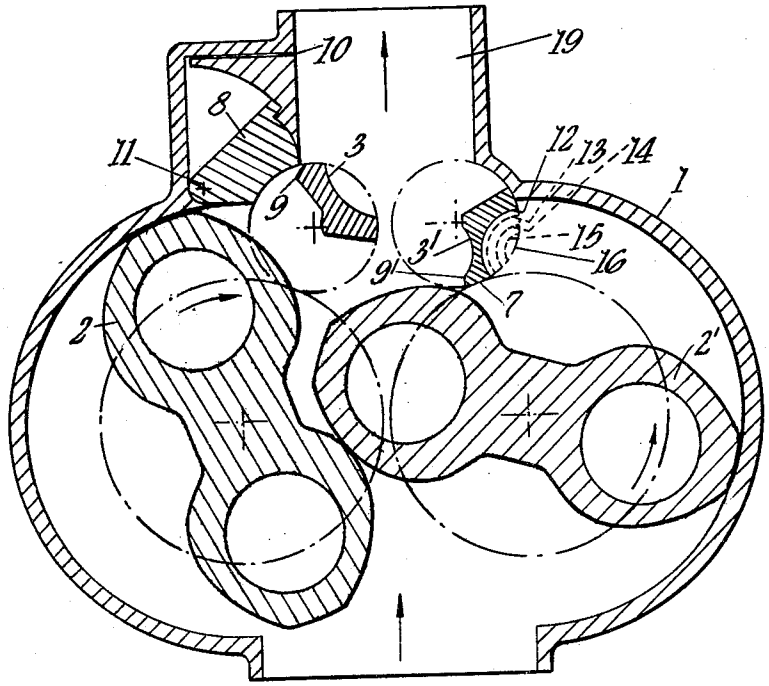


Fig. 1.

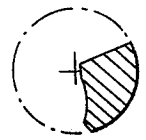


Fig. 2a.

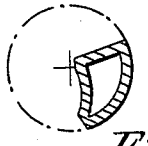


Fig. 2b.

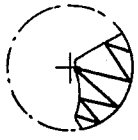


Fig. 2c.



Fig. 2d.

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DISPLACEMENT COMPRESSORS

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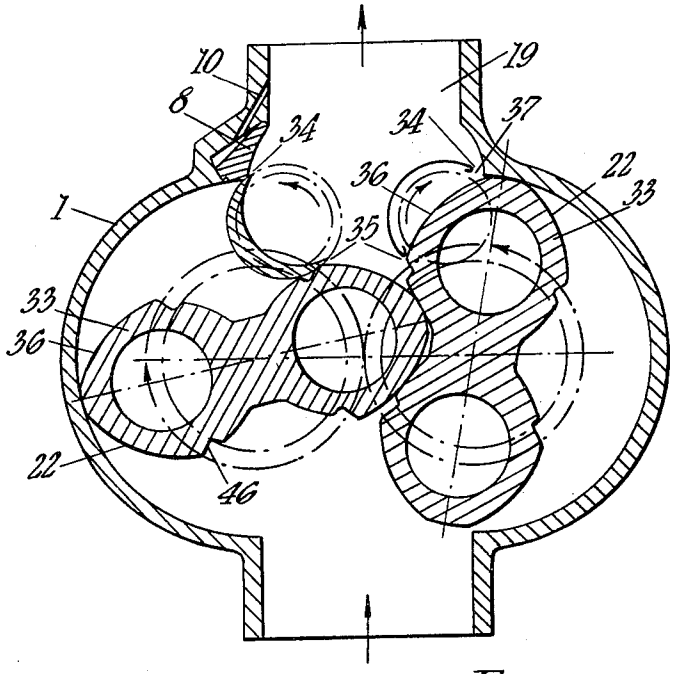


Fig. 3.

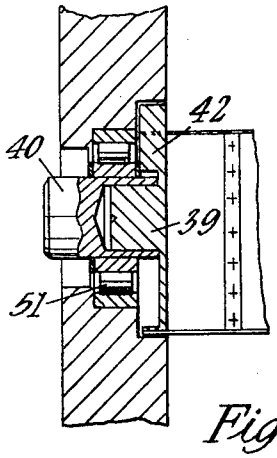


Fig. 3a.

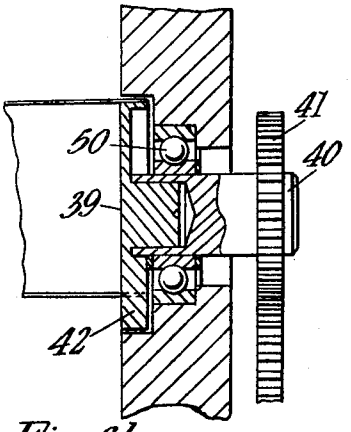


Fig. 3b.

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DISPLACEMENT COMPRESSORS

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8 Claims. (Cl. 230—138)

This invention relates to displacement compressors and more particularly to displacement compressors of the so-called Roots type in which two rotors rotate in opposite directions in a common casing and are so arranged and phased that the paths of the lobes of the two rotors overlap one another without such lobes touching or fouling one another during rotation.

The present invention has for its main object to improve the efficiency of a compressor of this character and the invention accordingly consists in a displacement compressor of the kind referred to in the preceding paragraph, wherein the compressor is provided with a set of valve members which are arranged to cooperate with the rotors in such a way as to effect a gradual opening of the outlet from the compressor after the building up of a predetermined interior pressure.

According to the preferred arrangement, the aforesaid valve members are rotatably mounted at the outlet side of the compressor casing so as to control the outlet orifice and are operatively associated with the rotors in such a way as to cooperate only with the heads and rear edges of the lobes of the rotors, whereby any sluicing action between the valves and the leading edges of the rotor lobes is substantially obviated.

Preferably the valve members are disposed in the side wall of the outlet channel of the compressor or at the point of intersection between the side walls of the outlet channel and the rotor casing and means may be provided for relieving the pressure within the compressor when such pressure exceeds the outlet pressure.

The invention will be more completely understood from the following detailed description which is given in conjunction with the accompanying drawings, in which

FIGURE 1 is a sectional view of a displacement compressor constructed in accordance with the invention;

FIGURES 2*a*, 2*b*, 2*c* and 2*d* show sectional views of four modified forms of timing valves for use in the compressor;

FIGURE 3 is a sectional view of a modified form of displacement compressor, and

FIGURES 3*a* and 3*b* are sectional views of the rotor mountings.

Referring first to FIGURE 1 of these drawings, **1** is the casing of a Roots type of displacement compressor in which **2** and **2'** are rotors which are adapted to be driven in opposite directions, each of these rotors having a pair of lobes of involute form and the two rotors being so arranged and phased that the paths traced out by the heads of the lobes of the two rotors overlap one another without such lobes touching or fouling one another during rotation. In order to control the timing of the outlet opening and effect an interior precompression of gas within the compressor **2**, timing valves **3** and **3'** are provided which are rotatably mounted and are positioned at the point of intersection between the side walls of the outlet passage **19** and the rotor casing **1**, these valves being shaped as shown and being geared up to the two rotors so that as the latter are rotated, the valves also are rotated so as to open and close the outlet passage **19** at the appropriate moment in the cycle of rotation of the rotors.

In order to achieve the optimum result, these timing valves must be so arranged that their axes of rotation

are disposed inside the circular path described by the heads of the rotor lobes and within the spaces between the central axis of the compressor and the parallel lines passing through the axes of the rotors and the valves are so timed as to cooperate only with the heads and rear edges of the rotor lobes so that the outlet is gradually opened after a predetermined interior pressure has been built up without the valves first acting after the manner of a sluice. The valves are preferably shaped as shown in FIGURE 1, the surfaces **9**, **9'** being the timing surfaces which engage with the lobes of the rotors, the surfaces being so shaped as to roll over the rear edges of the lobes as they rotate. Alternatively, these timing valves may be constructed and shaped according to any of the modifications shown in FIGURES 2*a*, 2*b*, 2*c* and 2*d*, the modification shown in FIGURE 2*a* being of solid cast formation, that shown in FIGURE 2*b* being of hollow cast formation, that shown in FIGURE 2*c* being a gate device after the manner of a pair of aeroplane wings, and that shown in FIGURE 2*d* being formed of pressed sheet steel.

In the arrangement shown in FIGURE 1, the timing valves are driven by the same gears which drive the rotors and the valves are so positioned as to engage with the rotor lobes at the proper moment in the cycle of rotation. Thus, in the arrangement shown, the right main rotor lobe has already left its timing valve but the distance separating it from such valve is very small in spite of the fact that the lobe has already moved through a substantial angular distance since it left contact with the timing valve at point **7**. It will thus be seen that the opening of the outlet is progressive with the result that there are no shocks, no torque variations, no driving gear overload, and no noise formation, but that by means of the valves an interior pressure is built up within the compressor before the gas is discharged with the result that the efficiency of the compressor is considerably increased. It will also be seen however, that if these valves are not required, they can be easily removed from the equipment thus leaving a conventional compressor of the ordinary well-known Roots type and the arrangement thus has the advantage that the same factory can produce the same basic compressor for different purposes and include timing valves or not according to different requirements.

In the case of twin lobe Roots compressors, these timing valves permit a theoretical pressure ratio of 2:1, but in three lobe and four lobe compressors, it may be somewhat higher, the effective pressure ratio being greater than the theoretical value on account of the fact that there is still compression work to be done after the valves begin to open.

It will be appreciated however, that in the pressure ratio range below that for which the compressor is designed, the internal compression work will be partly wasted and in order to avoid this a movable timing wall or shutter **8** is provided behind the timing valves which is so arranged as to open automatically as soon as the pressure inside the compressor exceeds the outlet pressure so that any unuseful precompression work is avoided. In the arrangement shown, the movable wall **8** is adapted to pivot about an axis **11** and a small helical spring, not shown, is provided for holding the timing wall in its normal position. In addition a small throttling hole **10** is provided which connects the space behind the timing wall **8** with the outlet channel **19** in order to prevent any vibrational movements of the timing wall. The shape of the timing valves shown in FIGURE 1 is particularly resistant to bending, it being understood that the lines **12**, **13**, **14**, **15** and **16** correspond to different sections through the cylinder, the line **16** corresponding to the

end sections, and the lines **13**, **14** and **15** being intermediate sections.

In the modification shown in FIGURE 3, the rotor lobes **33** are of cycloidal form, the profile representing an elongated epicycloid. The border lines **34** and **35** of the timing valves are so shaped as to follow exactly the profile of the rotor lobe **33** so that no special formed contact area on the timing valve is necessary. In the arrangement shown, each timing valve can be regarded as a simple section of a short steel tube, the border lines **34** and **35** being slightly rounded to give them greater stiffness. If still greater stiffness is required, the tube section may be reinforced by transverse pieces of sheet steel or the whole may be formed solid or closed in to form a crescent shaped member. With this arrangement, while the forward side **34** of the valve follows closely the rear side **22** of the lobe profile the rearward side **35** of the valve will follow the forward side **36** of the lobe profile. To avoid compression of the gas in the space embraced by the timing valves, the length of the circumference of the timing valves must be adjusted so that a small constant clearance space **37** always remains open through which air can escape. Also in this arrangement, the timing valves may be very low in weight so that the balancing of the valves is greatly simplified. The end bearings of the valves are shown in FIGURES 3*a* and 3*b* and in this arrangement the sheet steel of the valves is spot welded to the discs **39** which are inserted in the axles **40**. It will be seen however, that these supporting discs **39** are of unequal thickness, the thicker side **42** being disposed opposite the eccentric part of the timing valves. Thus balancing is facilitated without taking up much space.

FIGURE 3*b* shows the driven axle and as shown, it may be driven by means of a gear **41**. Conveniently the axle is mounted in bearings at both ends, one bearing **50** being a ball bearing and the other bearing **51** being a roller bearing. This arrangement allows for any longitudinal movement of the timing cylinder which may be brought about by variations in temperature.

The special recess **46** in the profile of the main rotor lobes is a characteristic of the embodiment with an elongated epicycloid profile. The advantage of the elongated epicycloid profile in comparison to an ordinary known epicycloid or a general cycloidal profile is that with the elongated profile, higher internal compression ratios can be obtained. Thus the internal compression ratio of the arrangement shown in FIGURE 3 is approximately 2:1.

In the arrangement shown in FIGURE 3, there is also provided a movable timing wall **8** which is pivotally mounted about a suitable axle and is provided with a throttling hole **10** as in the case of the arrangement shown in FIGURE 1. In this case however, the axis is disposed at the inner side of the timing wall instead of on the outer side as in the arrangement shown in FIGURE 1.

I claim:

1. A displacement compressor comprising a hollow casing consisting of a cylindrical wall between two side walls and having an inlet opening and an outlet opening in said cylindrical wall, two rotors each having only two diametrically opposed lobes mounted in the casing for rotation in opposite directions about parallel axes and movable in paths which intersect the openings, the rotation of the rotors being so phased that the paths of the rotor lobes overlap one another without said lobes touching one another during rotation, and two rotary timing control devices, one for each rotor, each geared to its respective rotor for controlling internal precompression of the compressible fluid displaced by the rotors from inlet to outlet, said timing control devices being rotatable about respective axes on opposite sides of a plane which is normal to the plane of the rotor axes and equidistant from them, each timing control device overlapping the outlet opening and the spaces swept by the lobes, so that said timing devices interfere with the outlet space not swept by the lobes, each timing control device being so shaped that during movement of its corresponding rotor to displace a volume of fluid enclosed between the rotor and the casing, it blocks the passageway between the rotor and the outlet opening in the casing to permit precompression of the fluid so enclosed.

2. A displacement compressor according to claim 1, wherein said timing control devices gradually partly overlap the outlet opening as the volume of fluid enclosed between the rotor and casing is displaced through the outlet opening, the interference between the spaces swept by the timing devices and the outlet opening being such as to bring about an equalization of pressure at the moment of opening, said outlet opening being situated between two parallel planes passing through the respective rotor axes and normal to the plane containing said rotor axes.

3. A displacement compressor in accordance with claim 2, wherein arcuate recesses are formed in said cylindrical wall of the casing at the junction of said wall with the outlet opening, said timing control devices being rotatable within said recesses.

4. A displacement compressor in accordance with claim 2, the shape of the timing control devices being such that their surfaces contact only the radially outwardly extending peripheral surface and the lagging side of a rotor lobe and are spaced from the leading side of the lobe when the lobe and devices are in adjacency during their relative rotations.

5. A displacement compressor according to claim 2, in which the cross-sectional shape of the timing control devices is that of a sector of a circle of substantially 120 degrees.

6. A displacement compressor according to claim 2, in which the timing control devices are hollow and form a sector of a circle less than 180 degrees in cross-section.

7. A displacement compressor according to claim 2, in which said cylindrical wall includes a movable wall portion thereof movable outwardly for bypassing a portion of the fluid to the outlet when the pressure of the fluid within the casing exceeds a predetermined value, and spring means for biasing said movable wall portion inwardly into alignment with the casing wall.

8. A displacement compressor comprising, a hollow casing consisting of a cylindrical wall between two end walls and having an inlet opening and an outlet opening in said cylindrical wall, two rotors each having only two diametrically opposed lobes mounted in the casing for rotation in opposite directions about parallel axes and movable in paths which intersect the openings, the rotation of the rotors being so phased that the paths of the rotor lobes overlap one another without said lobes touching one another during rotation, and two rotatable timing valve members each geared to its respective rotor for controlling internal precompression of the fluid displaced by the rotors from inlet to outlet, said valve members being rotatable about respective axes on opposite sides of a plane normal to the plane containing the rotor axes and centrally located between them, each valve member being located at the junction of the inner wall of the casing and the outlet wall with a portion in the outlet opening and so shaped that during a portion of the movement of its corresponding rotor to displace a volume of fluid enclosed between the rotor and the casing, it blocks the passageway between the rotor and the outlet opening in the casing to permit precompression of the fluid so enclosed.

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