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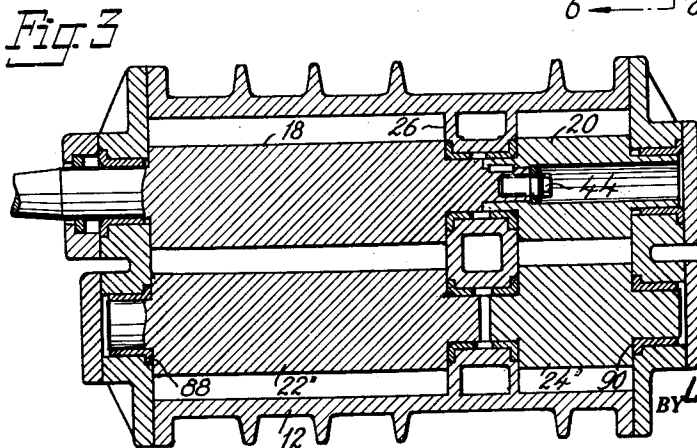
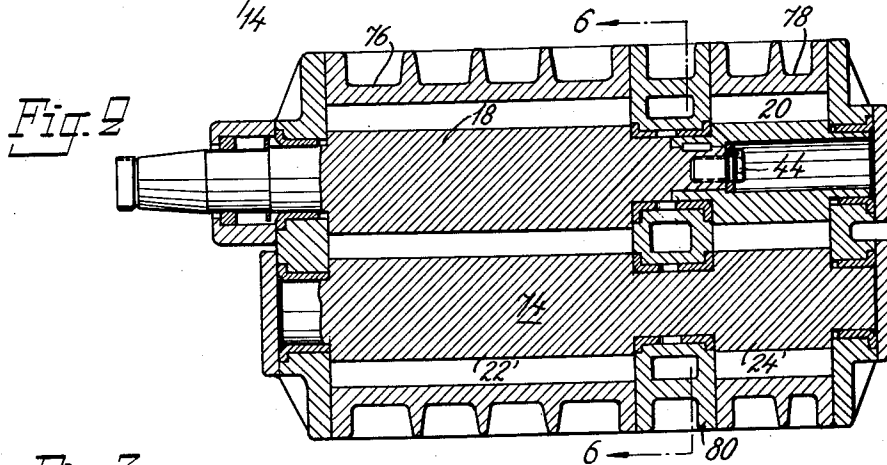
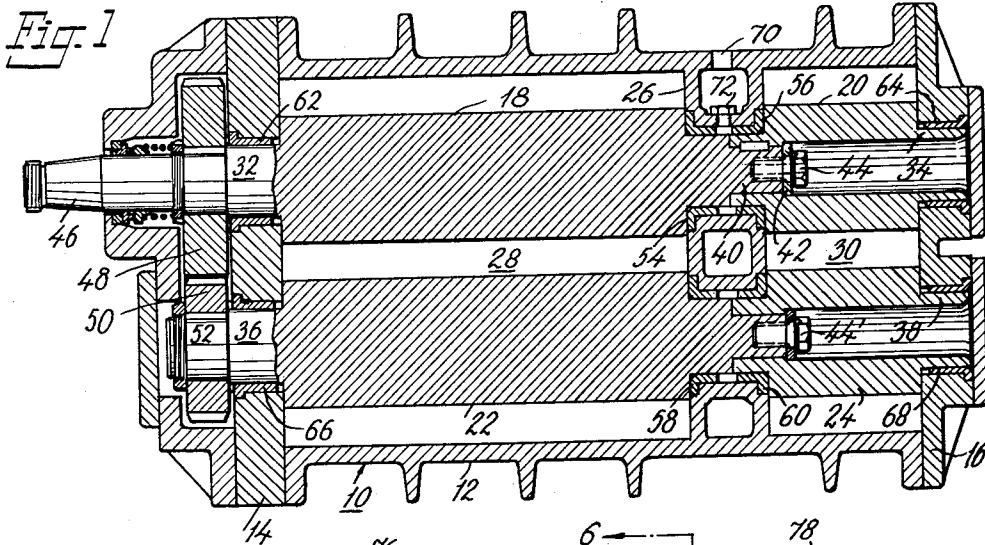
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3,074,624

ROTARY MACHINE

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3 Sheets-Sheet 1



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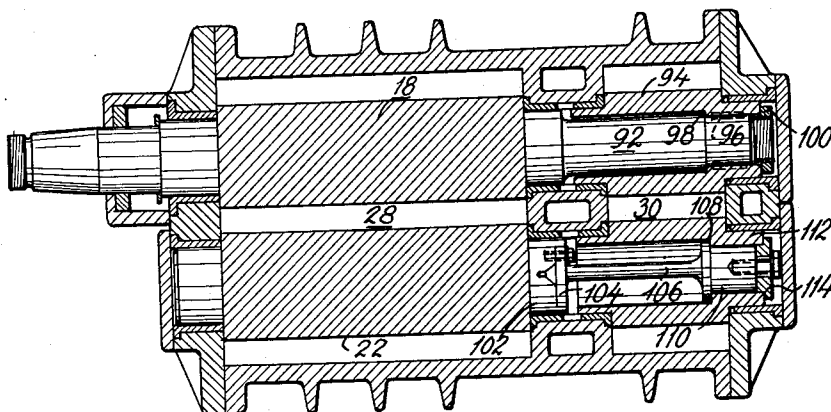


Fig. 4

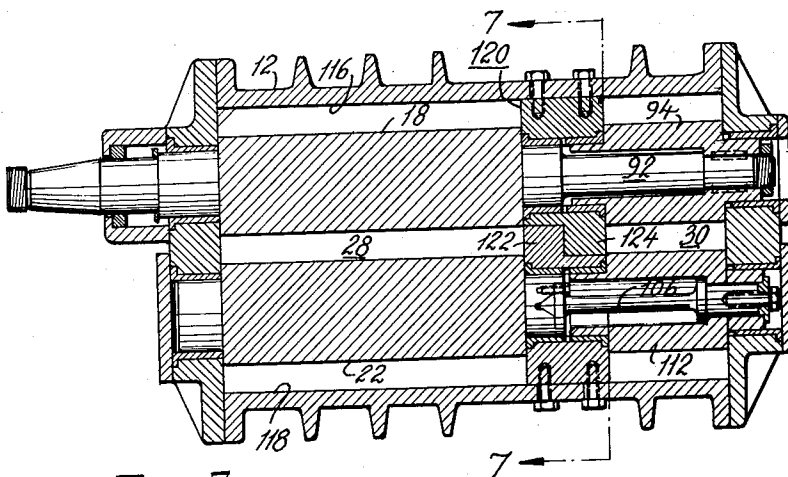


Fig. 5

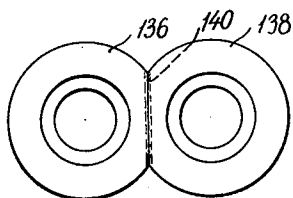


Fig. 6

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Fig. 6

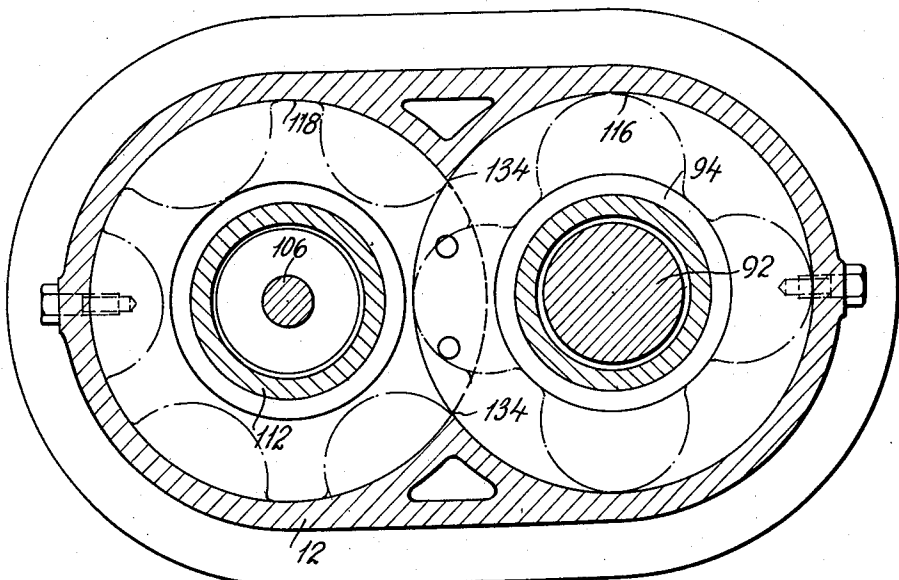
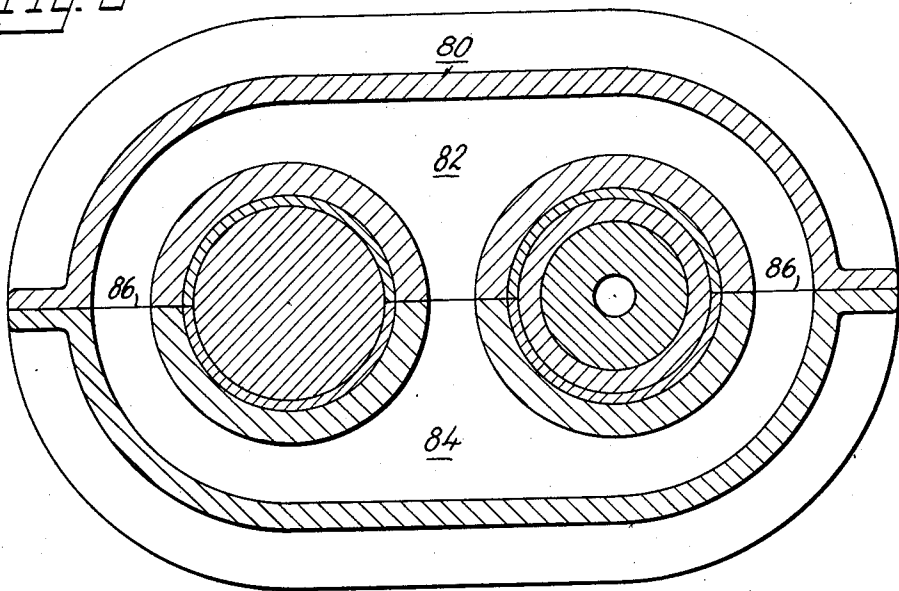


Fig. 7

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ROTARY MACHINE

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8 Claims. (Cl. 230—158)

The present invention relates to a rotary machine operating with at least two pressure stages and being provided with rotors enclosed in a casing each of said rotors comprising male and female sections corresponding to the number of the stages. Of said sections the former are provided with helical convex lands and intervening grooves and the latter with helical concave lands and intervening grooves.

For compression to a higher pressure of a medium it previously has been proposed to utilize such helical rotors cooperating in stages. In such constructions the helical rotors have been so formed that in a primary stage compression of the working medium is effected up to a desired pressure level whereafter in a succeeding stage further compression up to a high final pressure is accomplished. Several stages may be provided but in practice only a two-stage tandem has been applied.

Near to hand has been to design these both stages of rotors as a coherent unit. Such solution was perfect in the respect that hereby the rotors could be cut together in one and the same erection.

In order to obtain the desired compression in multistages it was proposed previously to design the stage with the lower pressure with particularly constructed rotors provided with addendum portions on the lands of the male rotor and corresponding dedendums in the grooves of the female rotors. Such a design as per se good in aggregate operating for compression of a medium to a high pressure in stages by synchronizing gear means. Arrangements for synchronizing are previously proposed and may also be applied in rotary machines according to the invention. The invention, however, embraces also the arrangement of the rotors in several stages cooperating mutually without application of for instance synchronizing gearing therebetween. The rotary machine according to the invention may also be realized in the function of an expander instead of operating as a compressor.

The present invention has in first hand as a primary characteristic that a shaft member in respective rotor connects pair of sections and further in that said shaft member is journaled in the casing of the rotary machine.

By means of such form of construction the total rotor length is no longer limited in consideration of the support of each rotor solely at its outer ends. The arrangement hereby proposed provides a support between the stages.

Starting from the point of compression in stages the invention proposes to separate the pressure stages which otherwise usually are connected mechanically into units. Hereby is avoided the need to dimension the rotors of each stage with regard to the swaying oscillations between the outer ends which support the rotors. As the invention hereby discloses between the pressure stages is located a bearing instead of the previously sealing means therebetween.

If further the different pressure stages are supplied with a lubrication medium or the like the intermediate bearing is hereby simultaneously brought to function as a perfect sealing between the different pressure stages the compressor is composed of. In other words, the invention provides a good solution of the problem to compress in

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stages in such a manner that a first portion of the compressor effects desired rise of the admission pressure to the high intermediate pressure simultaneously as said intermediate pressure becomes compressible to a desired final pressure in the next portion of the compressor.

The compression in stages according to the principle of the invention differs essentially from previous proposals in so far in that the rotor stage sections of respective rotor may be designed mutually conform and in the work shop be cut in the most simplified manner.

The invention is accordingly based upon that cooperating rotor sections in each stage need not longer provide an integral unit but may instead be formed as separate sections. By means of proper mechanical coupling the rotor sections are interconnected.

In a complete two-stage arrangement the male rotor for instance can be interconnected in the mechanical manner proposed while the female rotors are jointed differently. According to one embodiment the female rotor sections form an integral unit. According to an acceptable modified construction said female rotor sections may also consist of separate members. Said female rotor sections need not be mechanically interconnected but in conceivable realizations of the invention said female rotor sections may be free from each other. It may be noted from the proposed variants of designs according to the invention that with regard to the intermediate bearing between the stages a multiplicity of forms of the invention may be realized.

Said characteristics of the invention and other details thereof will be apparent together with the advantages by means of illustrated forms of realization in the annexed drawings. Said embodiments are in no manner limiting the invention but instead the same is as wide as within the scope of the adhering claims.

In the drawings:

FIG. 1 shows a longitudinal section of a rotary machine according to the invention provided with synchronizing gearing.

FIG. 2 shows a longitudinal section of another embodiment of the rotary machine according to the invention but in this case as in all that follow without synchronizing gearing.

FIG. 3 shows in longitudinal section another embodiment of rotary machine according to the invention.

FIG. 4 shows in longitudinal section a still further embodiment of rotary machine according to the invention.

FIG. 5 shows also in longitudinal section a variant of the rotary machine according to the invention most equivalent to that shown in FIG. 4.

FIG. 6 shows a cross-section of the embodiment according to FIG. 2 seen in the direction of the arrows 6—6.

FIG. 7 shows a cross-section of the embodiment according to FIG. 5 seen in the direction of the arrows 7—7.

FIG. 8 shows a detail view of a varied construction similar to that in FIG. 7.

The embodiment in FIG. 1 as all the other examples illustrated are referring to compressors, however, without any limitation of the invention to this application. That means that the invention can also be utilized in a rotary machine according to the invention when it operates as expander.

The rotary machine shown in FIG. 1 comprises a casing 10 having a jacket portion 12 and end plates 14 and 16 closing the ends of the machine. In the illustrated example said rotary machine is a two-stage compressor provided with two-stage sets of male and female rotors 18, 20 and 22, 24. The casing 10 of the machine forms an integral intermediate wall 26 which separates the rotor sections 16, 22 and 20, 24 of the low and high pressure

stages 28 and 30. In a conventional manner the outer ends 32, 34 and 36, 38 of the rotor sets are journaled in the end walls of the casing, but further the rotor sections 18, 20 and 22, 24 of respective pressure stage are supported in the intermediate wall 26. The embodiment shown in FIG. 1 exemplifies a male rotor set provided with a rotor section 18 in the first stage 28 journaled in the end wall 14 of the first stage and in the intermediate wall 26. Said male rotor 18 of the first pressure stage provides a shaft member 40 directed towards the first pressure stage 20 and supporting the male rotor 20 of the second pressure stage 30 which rotor in its turn is formed as a sleeve with descent and abutment 42 in order to be connected by a bolt 44 with the male rotor 18 of the first stage 28.

As regards the design of the female rotor set 22, 24 the same is in this case similar to that of the male rotor set 18, 20 just described. In order to avoid repetition it seems therefore superfluous to describe the female rotor set more in detail.

The rotor sections 18, 20 of the male rotor set are fixed in circumferential direction in relation to each other by means of keys 46 but such fixed relation may also be provided by means of for instance splines, claws or the like. The rotor sections 22, 24 of the female rotor are interconnected, it is true by means of the bolt 44', however, without any key of the like, that will say in such a manner that a relative adjustment may be performed in circumferential direction at the mounting.

The male rotor set 18, 20 forms on the input side of the first pressure stage 28 a driven shaft 46 on which a gear 48 is provided which synchronously cooperates with a corresponding gear 50 on the input shaft member 52 of the female rotor 22 of the first rotor stage 28.

The intermediate wall 26 is provided with axial bearings for the rotor sections 18, 20 and 22, 24 meeting each other. In the shown example is respective bearing, axially divided into halves 54, 56 and 58, 60 to simplify the mounting. Together with the end bearings 62, 64 and 66, 68 in the end walls 14, 16 thus the invention provides in a two-stage aggregate support for each rotor set as well at the ends as in the intermediate wall. Hereby it is possible to choose most proper rotor lengths for each pressure stage and further most proper total rotor length between the end walls. The embodiment shown in FIG. 1 is further advantageous in that respect that bearing means are provided for each rotor set in four points.

From the foregoing it may be seen that the intermediate wall 26 forms a carrying or supporting bearing means for respective sets of rotors in order to prevent swaying or other inconveniences associated with large overall length of the machine. The intermediate wall 26 is further utilized according to the invention for sealing effectively both the rotor stages 28, 30 mutually. A good bearing support as well as an effective sealing is obtained further according to the invention in the manner disclosed in FIG. 1 thereby that lubrication medium or other sealing liquid is supplied in the intermediate wall 26—preferably hollow—through opening 70 and nozzle 72 in order to distribute the same to the supporting or carrying bearings 54, 56, 58, 60 in the same. Such admission, however, may be effected in other manner, for instance in the low pressure stage 28, whereby the intermediate wall in this way also may be supplied with lubricant and sealing medium.

The embodiment shown in FIG. 1 illustrates perfectly the improvement which has been obtained for choosing most accurate rotor length in each pressure stage. From the shop practice view the advantage is also obtained that the rotors can be cut with one and the same basic profile, and FIG. 1 also intimates that the turning of the threads opposite to each other for balancing of the pressure difference between both the stages is simplified from manufacturing point of view due to the new rotor design the invention is disclosing.

As above mentioned the rotary machine according to the invention is not limited to conventional design with synchronizing gearing between the rotor sets. FIG. 2 as well as following examples makes it clear that the invention is realizable even at driving the female rotor set directly from the male rotor set.

In relation to the embodiment in FIG. 1 are thus in FIG. 2 the synchronizing gears omitted. The joint 44 between the rotor sections 18, 20 of the male set is the same as in FIG. 1 but in contradiction thereto the rotor sections 22, 24 of the female set form an integral unit 74. FIG. 2 and associated FIG. 6 show further details of modifications according to the invention. The casing is shown here forming separate jacket portions 76, 78 for each pressure stage and between said jacket portions the also separate intermediate wall 80 is located. The jacket portions and the intermediate wall are thus piled up after each other in axial direction and such an assemblage simplifies and cheapens in many cases the rotary machine according to the invention from manufacturing point of view. As also is best disclosed by FIG. 6 the intermediate wall may conveniently be divided into halves 82, 84 along the plane 86—86 through the central axes of the rotors. The same design can be applied to the jacket portions of the casing, see FIG. 2.

FIG. 3 shows another variant of the design according to FIG. 1 having an intermediate wall 26 integral with the jacket portion 12 of the casing and similar joint between both the sections 18, 20 of the male rotor. The sections 22', 24' of the female rotor are instead formed entirely separate and thus free from each other. The set of the male rotors thus is driving the set of the female rotor sections by means of the helical intermesh of the sections. In order to take up the axial thrusts at both the ends of the female rotor set properly designed axial bearings 88, 90 are provided.

In the embodiment according to FIG. 4 the male rotor section 18 from the low pressure stage 28 passes over to the high pressure stage into a rigid shaft member 92 which serves as a carrier for the rotor section of the high pressure stage 30, said latter section comprising a sleeve 94 slipped upon said shaft member 92 in relation to which the sleeve is fastened by means of a key joint 96 against turning in circumferential direction and against axial displacement by means of proper descents or abutments 98 and the tightened nut 100. The female rotor section 22 of the low pressure stage 28 forms a reduced shaft member 102 in the direction towards the high pressure stage 30. Bolted to the end of the shaft member 102 is a flange 104 of a yielding shaft member 106 which by means of descent or abutment 108 passes over into an enlarged part 110 on which the female section 112 of the high pressure stage 30 is slipped upon. Said female rotor section comprises a sleeve which is fixed against axial displacement by means of the descents 108 and a lock nut 114. In order to adjust the female rotor section of the high pressure stage in relation to the remaining rotor sections any key joint or the like is omitted between the shaft member of said section and the rotor sleeve. The yielding shaft provides for most convenient distribution of the bearing thrusts at all the four bearing places of each rotor set.

In connection with FIG. 5 it will be noted that from manufacturing point of view it may be convenient to form the jacket portion 12 of the casing with bores 116, 118 for the rotors drilled without interruption, that will say in one and the same erection and thus running from one end of the machine to the other. FIGS. 5 and 7 show together an appropriate design of the supporting and sealing intermediate wall 120 between both the pressure stages 28, 30. It is conceivable to form said intermediate wall in a single piece, but a more simple solution is to form the intermediate wall divided into two halves 122, 124, each at least mainly corresponding to the cross-section of corresponding bore 116, 118 of the male and female rotors

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18, 94 and 22, 112. In the design shown in FIGS. 5 and 7 each half 122, 124 is circularly turned and provided with a crescent shaped recess 126, 128 in order to receive mutually corresponding overhung portions 130, 132 in the intersection 134—134 between the bores 116, 118. This design is preferable from manufacturing point of view, but alternatively the halves 136, 138 of the divided intermediate wall can as shown in FIG. 8 contact each other along a plane according to the intersection line 134—134 between both the bores 116, 118. A drilled groove 140 for pressure liquid seals off the pressure stages mutually. For the rest the design of the male and female rotors 18, 94, and 22, 112 in FIGS. 5 and 7 corresponds to the design just described in connection with FIG. 4 so that the repetition thereof seems superfluous.

Further as an important principle at best design of rotary machines according to the invention is to be emphasized that in such rotor set the rotor sections thereof can be provided with the same basic profile but with differently cut helices. Hereby the manufacturing is essentially simplified simultaneously as those losses are avoided which have occurred in previous arrangements. By choosing one and the same basic profile in each rotor stage the relative length of the rotor sections may be chosen most appropriately due to the carrying and supporting action of the intermediate wall as regards the rotor sets. By using the same basic profile in each rotor set the most simplified cutting work is provided, which even may be run programmed or in another manner may form basis of simplified automation.

We claim:

1. A compressor of the rotary helical screw type comprising two stages each of which includes housing structure providing two parallel intersecting bores with the corresponding bores of the two sections in coaxial alignment, male and female rotors having different stage portions each providing helical lands and grooves mounted to rotate in intermeshing relation in the bores of each of said stages and cooperating with each other and said housing structure to form working chambers varying in volume as the rotors revolve, one of said rotors constituting a driving rotor to which power is supplied from an external source and the other of said rotors constituting a driven rotor, said housing including an intermediate wall portion for separating said stages and providing intermediate bearing supports for each of said rotors, the driving rotor comprising rotor stages angularly rigid relative to each other and the driven rotor comprising rotor stages angularly movable relative to each other at all times in

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assembled and operative relation, whereby to permit the different sections of the driven rotor to individually adjust themselves angularly to proper intermeshing relation with the respectively coacting sections of the driving rotor and to thereby avoid developing unacceptably high pressures between the intermeshing surfaces of the several sections.

2. A compressor as defined in claim 1, in which separate bearings are provided in the intermediate wall portion for the confronting ends of the different stage portions of each of said rotors.

3. A compressor as defined in claim 1, in which means is provided for introducing a sealing liquid into both stages of the compressor.

4. A compressor as defined in claim 3, in which the liquid consists of a lubricant introduced into the working spaces of the compressor by way of the bearings provided in said intermediate wall portion.

5. A compressor as defined in claim 4, in which the liquid is introduced through the intermediate bearings for the driving rotor.

6. A compressor as defined in claim 1, in which the different stage portions of the driven rotor are formed by separated rotor elements angularly free with respect to each other.

7. A compressor as defined in claim 6, in which the rotor elements are axially free with respect to each other.

8. A compressor as defined in claim 7, in which the casing structure includes end walls having bearings for supporting the opposite ends of the rotors and the axial positions of the rotor elements of the driven rotor are separately determined by the separate bearings in said end walls and said intermediate wall.

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