April 20, 1965 I. A. MacCOLL 3,179,330

ROTARY ENGINES AND COMPRESSORS

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FIG.1.

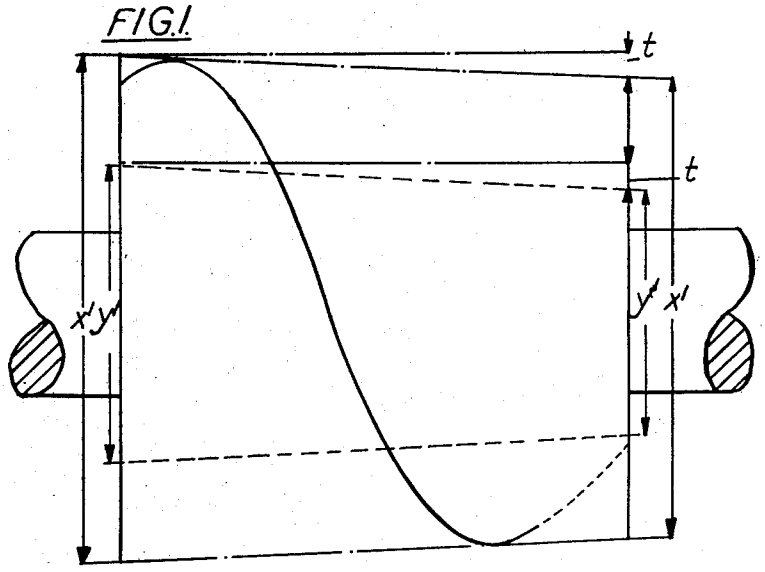
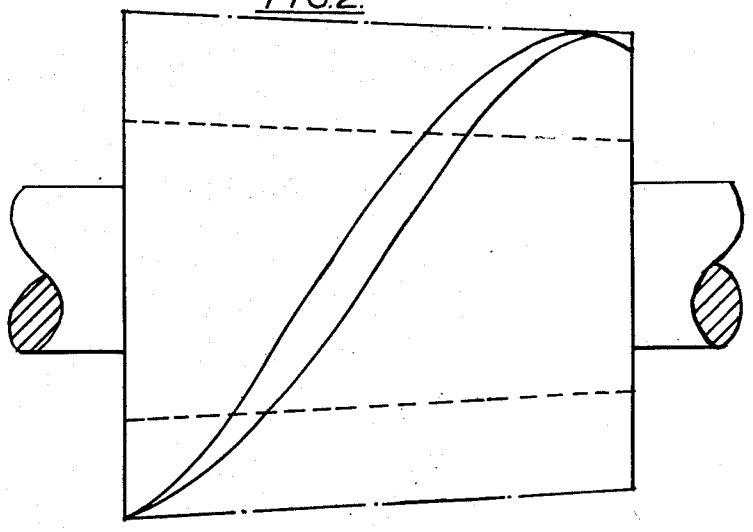


FIG.2.



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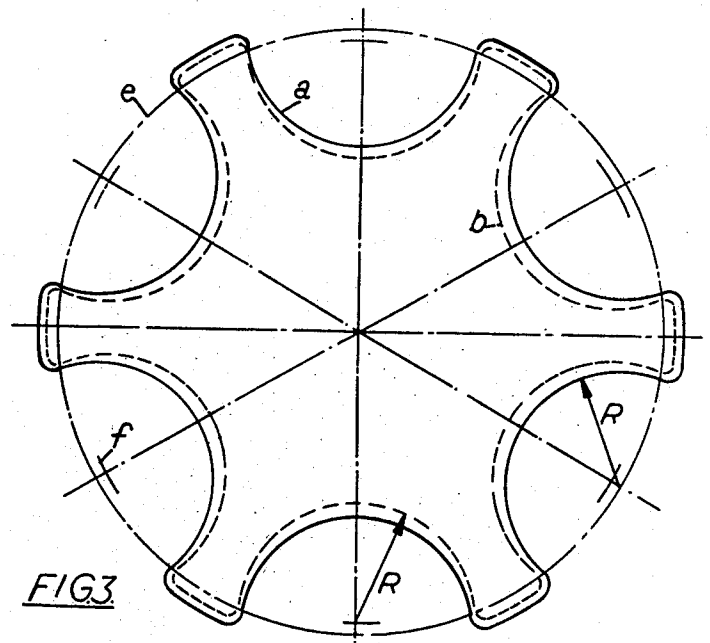


FIG3

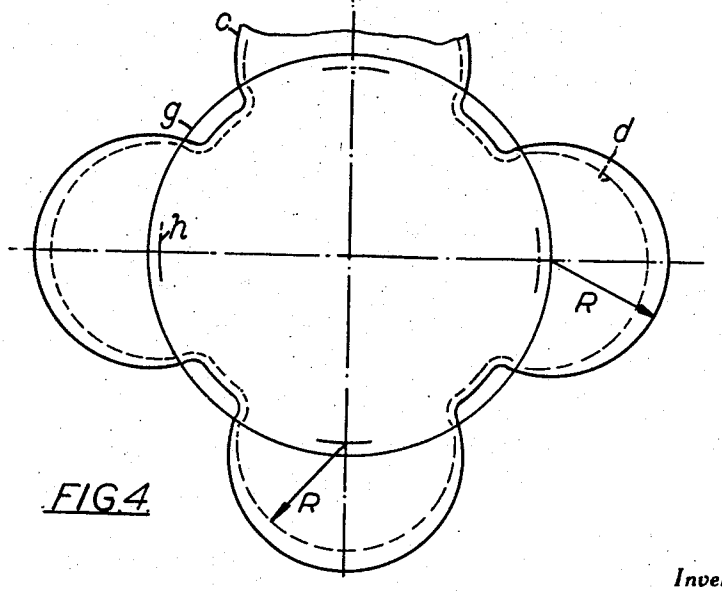


FIG4

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ROTARY ENGINES AND COMPRESSORS

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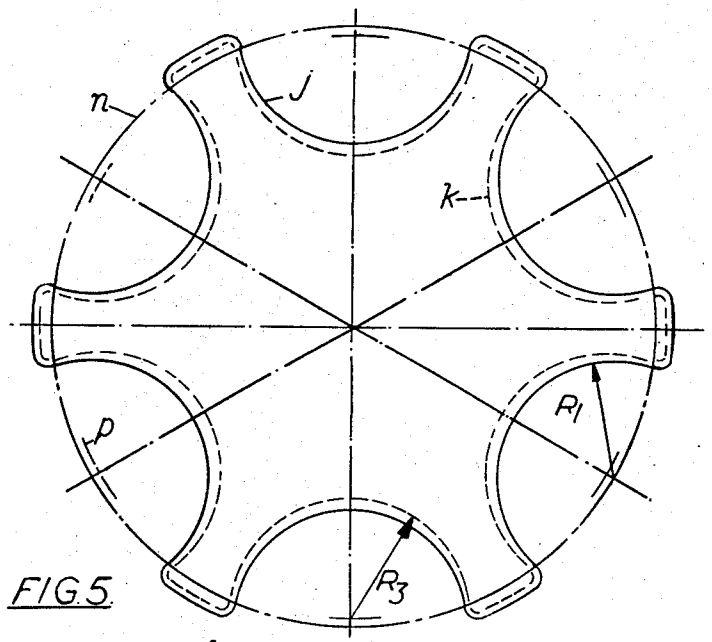


FIG.5

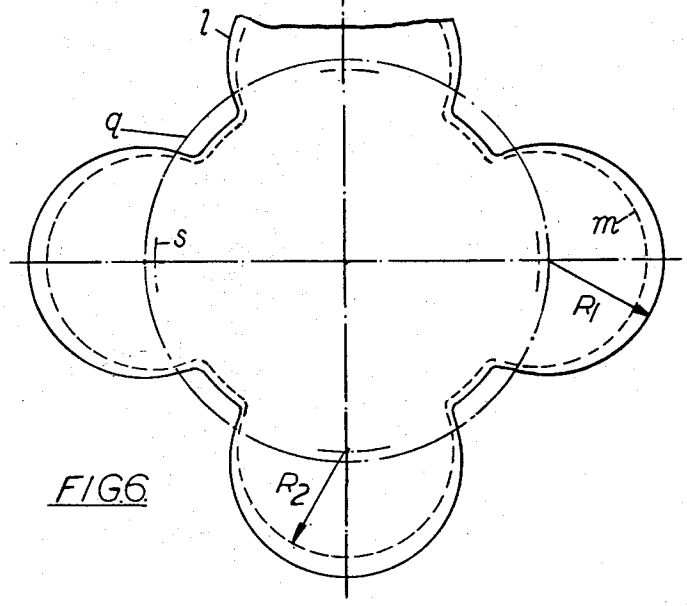


FIG.6

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United States Patent Office

3,179,330

Patented Apr. 20, 1965

3,179,330

ROTARY ENGINES AND COMPRESSORS

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Filed Aug. 28, 1961, Ser. No. 134,447

Claims priority, application Great Britain, Aug. 30, 1960, 29,920/60

10 Claims. (Cl. 230—143)

This invention relates to rotary compressors and engines of the type comprising a casing presenting two side-by-side intersecting bores, two side-by-side rotors rotatably mounted in the respective bores and having helical grooves and threads which mesh at the intersection of the bores, inlet and outlet ports respectively at opposite ends of the casing, and means for driving the rotors so that the working medium is compressed or expanded in working chambers formed between the rotors and the casing, and there is a gradual increase in temperature from end to end of the rotors and a corresponding gradual increase in the thermal expansion of the rotors from end to end of the rotors.

Generally, in the aforesaid type of compressor or engine the casing presents parallel cylindrical bores, and the rotors have parallel axes of rotation and are interconnected through timing gears. A compressor or engine of the aforesaid type is described for example in British patent specification No. 627,162.

Up to now it has been the practice to machine the rotors so that the root and tip diameters of the grooves and threads are constant throughout the length of the rotor. If the temperature of the rotors remained constant throughout their length during operation, the thermal expansion of the rotors and consequently the general clearances between the intermeshing parts and between the rotors and the casing would be uniform throughout the length of the rotors although they might differ from the clearances when cold. In practice, however, the temperature of the rotors and consequently their thermal expansion may vary along their length in operation. This variation is dependent upon the cooling arrangements when such are provided, and upon the degree of expansion or compression of the working medium in the working chambers.

When a rotor is machined, as previously referred to, the clearances when cold must be such as to provide the requisite working clearances for the hottest part of the rotor when in operation. This means that the clearances at the colder end of the rotor are larger than necessary with a consequent loss of efficiency.

The object of the invention is to so construct the rotors that this reduction of efficiency is prevented or mitigated.

According to the present invention, in a rotary compressor or engine of the aforesaid type, the rotor and tip diameters of the grooves and threads of a rotor gradually reduce from end to end of the rotor to provide tapered clearances between the rotor on the one hand and the casing and second rotor on the other hand, said clearances gradually increasing in correspondence with said gradual increase in the thermal expansion of the rotors to permit said thermal expansion so that in operation optimum working clearances for maximum efficiency are provided at all points along the length of the rotors.

In one form of the invention the rotor is so machined that what may be termed the circumferential width of each thread is gradually reduced from end to end of the rotor, with consequent gradual increase in the circumferential width of each groove from end to end of the rotor.

This tapering of the rotor may be present in the female rotor only, in the male rotor only, or in both rotors.

As an example of one way of carrying the invention into effect, when machining a female rotor the rotor may be inserted into a thread miller in such a way that the centre line of the rotor blank is arranged at a small angle to the centre line of the thread miller so that in the finished product there is a slight taper at the bottom of the grooves and the tips of the threads from end to end of the rotor. The degree of taper chosen may be such that the tapering feature disappears at the temperatures of normal operation. The variations of radial dimensions which are introduced by the invention will have little effect on the important clearances between the tips of the female threads and the developed portions of the male rotor threads or lobes, which clearances are not affected appreciably by the temperature gradient.

The following data, which is given by way of example only, relates to the degree of diametral taper we have found to be desirable in a particular design of female compressor rotor of 200 mm. diameter. The corresponding male rotor was not tapered.

In a compressor with a discharge pressure of 35 lbs. per square inch gauge, a taper of .004 inch was found to be satisfactory.

With a compressor discharging at 60 lbs. per sq. inch gauge a taper of .010 inch was necessary.

The invention may be applied to compressors wherein the land combinations of the male and female rotors are 3/3, 4/4, 4/6 or other desired combination.

Although the invention has been described in connection with a compressor only, it may also be applied in connection with an engine or machine in which expansion of the working medium occurs instead of compression, with a consequent temperature gradient along the length of the rotor.

The invention is illustrated, by way of example, in the accompanying diagrammatic drawings as applied to compressors wherein both rotors are tapered.

In the drawings, FIGS. 1 and 2 are side views of a male and a female rotor; FIGS. 3 and 4 show profiles of a female and a male rotor of a compressor having a land combination of the male and female rotors of 4/6; and FIGS. 5 and 6 show a modified form of the rotors of FIGS. 3 and 4.

In FIGS. 1 and 2, the tip diameters of the threads are gradually reduced from x at the inlet end to x' at the outlet end to provide a taper t. Similarly, the root diameters of the grooves are gradually reduced from y at the inlet end to y' at the outlet end to provide a taper t. The tapers t are identical and are shown exaggerated for the sake of clearness.

FIG. 3 shows the profiles of a female rotor, the inlet end profile being shown by a full line a and the outlet end profile being shown by a broken line b, and

FIG. 4 shows the corresponding profiles of the male rotor, the inlet end profile being shown by a full line c and the outlet end profile being shown by a broken line d.

The degree of tapering has been exaggerated considerably for the sake of clearness of illustration.

The threads or lobes of the male rotor and the grooves of the female rotor are shown as having a radius R. This radius is constant throughout the length of the rotors. The pitch circles from which the lobes and grooves are struck are shown by chain-dotted lines for the inlet ends of the rotors, and by short spaced arcs from the outlet ends.

In FIG. 3 the pitch circles are shown by chain-dotted line e and spaced arcs f and in FIG. 4 they are shown by line g and arcs h.

In each rotor the differences between the two pitch circles referred to gives the taper on that rotor.

FIG. 5 shows the profiles of a female rotor, the inlet profile being shown by a full line *j* and the outlet end profile by a broken line *k* and

FIG. 6 shows the corresponding profiles of the male rotor, the inlet end profile being shown by a full line *l* and the outlet end profile being shown by a broken line *m*.

The degree of tapering has again been exaggerated considerably for the sake of clarity.

In this case the radius R2 (FIG. 6) of the male rotor lobes at the outlet end is less than the radius R1 of the lobes at the inlet end, and the radius R3 (FIG. 5) of the female rotor grooves at the outlet end is greater than the radius R1 of the grooves at the inlet end. This change in radius is combined with the reduction in pitch circle diameter from the inlet end to the outlet end to provide the required degree of taper.

In FIG. 5 the pitch circles are shown by chain-dotted lines *n* and spaced arcs *p* and in FIG. 6 by line *q* and arcs *s*.

I claim:

1. In a rotary compressor or engine comprising a casing presenting two side-by-side intersecting bores, two side-by-side rotors rotatably mounted in the respective bores and having helical grooves and threads which mesh at the intersection of the bores, inlet and outlet ports respectively at opposite ends of the casing, and means for driving the rotors so that the working medium is compressed or expanded in working chambers formed between the rotors and the casing and there is a gradual increase in temperature from end to end of the rotors and a corresponding gradual increase in the thermal expansion of the rotors from end to end of the rotors, the root and tip diameters of the grooves and threads of a rotor gradually reduce from end to end of the rotor to provide tapered clearances between the rotor on the one hand and the casing and second rotor on the other hand, said clearances gradually increasing in correspondence with said gradual increase in the thermal expansion of the rotors to permit said thermal expansion so that in operation optimum working clearances for maximum efficiency are provided at all points along the length of the rotors.

2. A compressor or engine according to claim 1, wherein the reduction in the root diameter of the rotor is the same as the reduction in the tip diameter.

3. A compressor or engine according to claim 2, wherein the circumferential width of each thread of the tapered rotor is gradually reduced from end to end of the rotor with consequent gradual increase in the circumferential width of each groove from end to end of the rotor.

4. A compressor or engine according to claim 3, wherein the grooves or threads of the tapered rotor are of arcuate profie, and the pitch circles from which the grooves or threads are struck gradually reduce in diameter from end to end of the rotor to provide the taper.

5. A compressor or engine according to claim 4, wherein the radius of each groove or thread of the tapered rotor is the same from end to end of the rotor.

6. A compressor or engine according to claim 4, wherein the radius of each groove or thread of the tapered rotor increases or reduces from end to end of the rotor

to contribute to the production of the required degree of taper.

7. In a rotary compressor or engine comprising a casing presenting two parallel cylindrical intersecting bores, two male and female rotors mounted in the respective bores for rotation on parallel axes and having helical grooves and threads which mesh at the intersection of the bores, inlet and outlet ports respectively at opposite ends of the casing, and means for driving the rotors so that the working medium is compressed or expanded in working chambers formed between the rotors and the casing and there is a gradual increase in temperature from end to end of the rotors and a corresponding gradual increase in the thermal expansion of the rotors from end to end of the rotors the root and tip diameters of the grooves and threads of the rotors gradually reduce from end to end of the rotors to provide tapered clearances between the rotors and between the rotors and the casing, said clearances gradually increasing in correspondence with said gradual increase in the thermal expansion of the rotors to permit said thermal expansion so that in operation the taper of the clearances tends to disappear and optimum working clearances for maximum efficiency are provided at all points along the length of the rotors.

8. A compressor or engine according to claim 7, wherein the grooves of the female rotor and the threads of the male rotor are of arcuate profile, and the pitch circles from which the grooves and threads of the rotors are struck gradually reduce in diameter from end to end of the rotors to provide the taper.

9. A compressor or engine according to claim 8, wherein the radius of each groove or thread of each tapered rotor is the same from end to end of the rotor.

10. A compressor or engine according to claim 8, wherein the radius of the male rotor threads at one end is less than the radius of said threads at the other end, and the radius of the female rotor grooves at said one end is greater than the radius of said grooves at said other end, said change in radii from end to end of the rotors contributing to the formation of the desired tapered clearances.

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