This invention relates to rotary fluid pressure motors, pumps and the like adapted to be operated by or to operate upon a fluid, whether gaseous or liquid, hereinafter termed the working fluid and whether employed primarily to act on or be acted upon by the working fluid or employed as or incorporated in devices such as transmission devices or fluid meters.

For brevity such motors or pumps will be hereinafter referred to as rotary engines.

The invention is concerned with rotary engines of the kind comprising a casing in which is provided an annular blade chamber, a rotor having blades which extend across the blade chamber so as to make a sealing fit with the inner and outer circumferential walls thereof relatively to which the rotor rotates about the axis of the blade chamber, at least one rotary abutment with its axis parallel to the axis of the rotor lying mainly within and making a sealing fit with an abutment recess (hereinafter termed the larger abutment recess) in the inner or outer circumferential wall of the blade chamber and extending across the blade chamber between inlet and outlet ports therein to make a sealing fit with an abutment recess (hereinafter termed the smaller abutment recess) in the other circumferential wall of the blade chamber, blade-receiving recesses being provided in the periphery of the abutment each of which during rotation of the abutment comes into position to receive a blade and permit it to pass the abutment as the blade during its rotation comes to the part of the blade chamber across which the abutment extends.

In such engines it has already been proposed for the purpose of reducing or eliminating unbalanced radial forces on the abutment due to fluid pressure, to provide in the circumferential surface of the larger abutment recess, two recesses (hereinafter termed pressure recesses) respectively lying diametrically opposite the parts of the abutment which are exposed to the high and low pressure parts of the blade chamber, the area of each pressure recess measured at the circumference of the abutment being equal to the diametrically opposite area exposed to the interior of the blade chamber, each blade-receiving recess in the abutment being connected by a passage in the abutment to a diametrically opposite recess (hereinafter called a balancing recess) of the same area in the circumference of the abutment.

While this arrangement provides for the desired radial balance in constructions wherein each blade-receiving and balancing recess comes into communication with each part of the blade chamber and with each pressure recess before the preceding blade-receiving or balancing recess leaves it this necessity limits the area of the seal provided by the abutment between the inlet and outlet ports and places restrictions on the design of the abutment and hence of the rotary engine as a whole.

The object of the present invention is to provide a rotary engine of the kind referred to which, while providing for radial pressure balance on the abutment, will be simpler to manufacture and will enable longer effective sealing surfaces to be provided by the abutment between the inlet and outlet ports.

To this end in a rotary engine of the kind referred to according to this invention, the abutment has two or four blade-receiving recesses so spaced and dimensioned that only one is ever in communication with the same part of the blade chamber at any time, each diametrically opposite pair of blade-receiving recesses being in continuous communication with one another through a passage in the abutment, pressure-balancing passages are provided in the abutment extending between diametrically opposite parts of the circumferential surface of the abutment and so spaced that either a blade-receiving recess or a pressure-balancing passage is in communication with each part of the blade chamber at all times, and two pressure recesses are formed in the circumferential wall of the larger abutment recess, each lying respectively diametrically opposite to and being of the same area measured at the circumference of the abutment as the diametrically opposite area of the abutment which is exposed to the interior of the blade chamber.

The invention may be carried into practice in various ways but one construction according to the invention is illustrated by way of example somewhat diagrammatically as applied to a pump in the accompanying drawings, in which

Figure 1 is a cross-section through the blade chamber, rotor and abutment at right angles to the axes of rotation of the rotor and abutment,

Figure 2 is a side elevation of the abutment,

Figure 3 is a longitudinal section in a vertical plane containing the axes of the rotor and abutment, and

Figure 4 is a perspective view partly in section and partly broken away of part of the interior of the pump.

In the construction illustrated the pump comprises a pressure-tight casing A through one end wall A' of which extends through a pressure-tight gland A² a driving shaft B engaging a coupling.
member comprising a boss portion B mounted in ball bearings B and an annular extension B rigidly secured to the boss portion and mounted in ball bearings B carried in a transverse plate C located between a shoulder A and the end wall A. The boss portion B is a body part D in which is formed an annular recess constituting one end wall D and the inner circumferential wall of a blade chamber D the other end wall of which is constituted by the end face B of the annular extension B while its outer circumferential wall is constituted by a part D of the wall of the casing A. 

Formed in the annular extension B are two diametrically opposite longitudinal slots B while a shaft E mounted in bearings in the body part D carries at one end a rotor E formed with two blades B which engage with a close fit and can slide in the slots B and extend therefrom across the blade chamber D to make a substantially fluid-tight seal with the end wall D. The shaft E is thus free to rotate within the body part D but is held from axial movement relatively to it while the part D can move axially within the casing A but is held from rotation relatively thereto. It will further be seen that the rotor D is supported in the ball bearing B.

Communicating with the blade chamber D are inlet and outlet ports F and G and mounted in a part-cylindrical abutment recess H between these ports is a rotary abutment H which extends across the blade chamber to make a fluid-tight seal with a part-cylindrical recess H in the part of the member D constituting the inner circumferential wall of the blade chamber. The abutment H is carried by a shaft F mounted in bearings F and connected by 1 to 1 ratio gearing J to the shaft E. The abutment H is provided with two blade-receiving recesses H, H diametrically opposite one another each adapted to receive one of the blades as it comes to the part of the blade chamber across which the abutment extends and thus permit it to pass the abutment. The two blade-receiving recesses communicate with one another through a passage H in the abutment.

Formed in the abutment recess H are balancing pressure recesses K, K each lying diametrically opposite to and having approximately the same effective area exposed to the abutment as one of the portions K, K of the blade chamber adjacent to the abutment. Also formed in the abutment diametrically opposite to one another and communicating with one another through pressure balancing passages K, K are two pairs of pressure balancing chambers K, K and K, K formed by slots and so disposed that either a blade-receiving recess or a pressure balancing chamber is in communication with each part K, K of the blade chamber at all times.

The end face B of the blade chamber has two recesses D, D which during the first part of the travel of each blade from the abutment and the last part of this travel as the blade approaches the abutment permit fluid to pass the end of the blade respectively into the blade chamber from the inlet port and out of the chamber from the outlet port. A rack D formed on the body portion D is engaged by a pinion L on an adjusting shaft L whereby the axial position of the body D and with it that of the rotor D can be varied relatively to the annular extension B so as to vary the effective axial length of the blade chamber D and hence the capacity of the pump.

It will be seen that the radial pressures exerted on the abutment H where it is exposed to the blade chamber at K, K will at all times be counterbalanced by equal and opposite pressures in the balancing recesses K, K, the effective areas exposed to each of the two opposite pressures always being the same at any moment in the rotation of the parts owing to the diametrically opposite arrangement and interconnection of the blade-receiving recesses H, H and of the balancing chambers K, K and K, K.

In addition owing to the provision of the two recesses D, D, the reduction of the areas of the abutment exposed to the pressures in the blade chamber which would otherwise occur with axial movement of the body D to reduce the capacity of the blade chamber is eliminated. Further the abutment with two blade-receiving recesses represents a simpler construction from a manufacturing point of view than other forms and also readily provides for a large sealing area between adjacent blade-receiving recesses and the inlet and outlet ports at all times, while the arrangement of pressure-balancing passages with or without chambers or slots and balancing pressure recesses ensures radial pressure balance without any substantial diminution in the effective sealing area maintained by the abutment between inlet and outlet ports. Thus without materially reducing the large sealing area afforded by the comparatively large uninterrupted circumferential surface between adjacent blade-receiving recesses, the pressure-balancing passages ensure that the pressure conditions in each balancing pressure recess shall at all times be the same as that acting on the diametrically opposite part of the abutment so that at all times the pressures acting on the abutment, including those represented by pressure drop across the clearance spaces between surfaces of the abutment and the abutment-receiving recesses shall be the same at diametrically opposite points on the abutment which is thus not subject to unbalanced radial forces due to fluid pressure.

It is to be understood that although in the construction illustrated the larger abutment recess is in the outer circumferential wall of the blade chamber, the invention is equally applicable to constructions in which this larger abutment recess is in the inner circumferential wall. It will, however, in most cases be more convenient to provide it in the outer circumferential wall since the diameter of the abutment is not then controlled or restricted by the diameter of the blade chamber but may be either smaller than, equal to or larger than the diameter of the rotor as desired.

The number of pressure-balancing passages with or without chambers or slots required according to the invention in each circumferential surface portion of the abutment between two blade-receiving recesses depends upon the circumferential length of each of such surface portions in relation to the corresponding dimension of the area of the abutment exposed to each part of the blade chamber but the dimensions of the parts of the rotary engine will in the case of a construction having an abutment with two blade-receiving recesses generally be such that two pressure-balancing passages are necessary in each circumferential surface portion of the abutment between the blade-receiving recesses whereas, with an abutment having
four blade-receiving recesses generally only one pressure-balancing passage will in general be required between each adjacent pair of blade-receiving recesses, the pressure-balancing passages opening through the surface of the abutment at points which considered circumferentially of the abutment are midway between the blade-receiving recesses.

What I claim as my invention and desire to secure by Letters Patent is:

1. In a rotary engine of the kind referred to, the combination with a casing having an annular blade chamber provided within it and having inlet and outlet ports, an abutment making fluid-tight contact respectively with larger and smaller abutment recesses in the two circumferential walls of the blade chamber between the ports and having less than three pairs of diametrically opposite blade-receiving recesses so spaced and dimensioned that only one is ever in communication with the same part of the blade chamber at any time, each diametrically opposite recess of a pair of blade-receiving recesses being in continuous communication with one another through a passage in the abutment, of pressure balancing passages in the abutment extending between diametrically opposite parts of the circumferential surface of the abutment and said blade receiving recesses and pressure balancing passages being so spaced that either a blade-receiving recess or a pressure balancing passage is in communication with each part of the blade chamber at all times, two pressure recesses formed in the circumferential wall of the larger abutment recess and each lying diametrically opposite to and being of approximately the same area measured at the circumference of the abutment as the diametrically opposite area of the abutment which is exposed to the interior of the blade chamber, and a rotor having blades which extend across the blade chamber to make a sealing fit with the inner and outer circumferential walls thereof relatively to which it rotates about the axis of the blade chamber.

2. A rotary engine as claimed in claim 1 in which the abutment has two blade-receiving recesses and two pressure balancing passages.

3. A rotary engine as claimed in claim 1 in which pressure balancing chambers or slots are provided in the circumference of the abutment into which the pressure balancing passages open.

4. A rotary engine as claimed in claim 1 in which one end wall of the blade chamber is movable axially and the other has slots through which the blades extend and can slide, the capacity of the engine being adjustable by moving the axially movable end wall and the rotor axially relatively to the other end wall so that the blades slide through the slots in said other end wall the blade chamber being provided adjacent to the abutment with cut-away portions or recesses permitting fluid to pass around the ends of the blades to or from the ports during the periods when the blades tend to mask these ports.

EDWARD HARRY JOHNSON.