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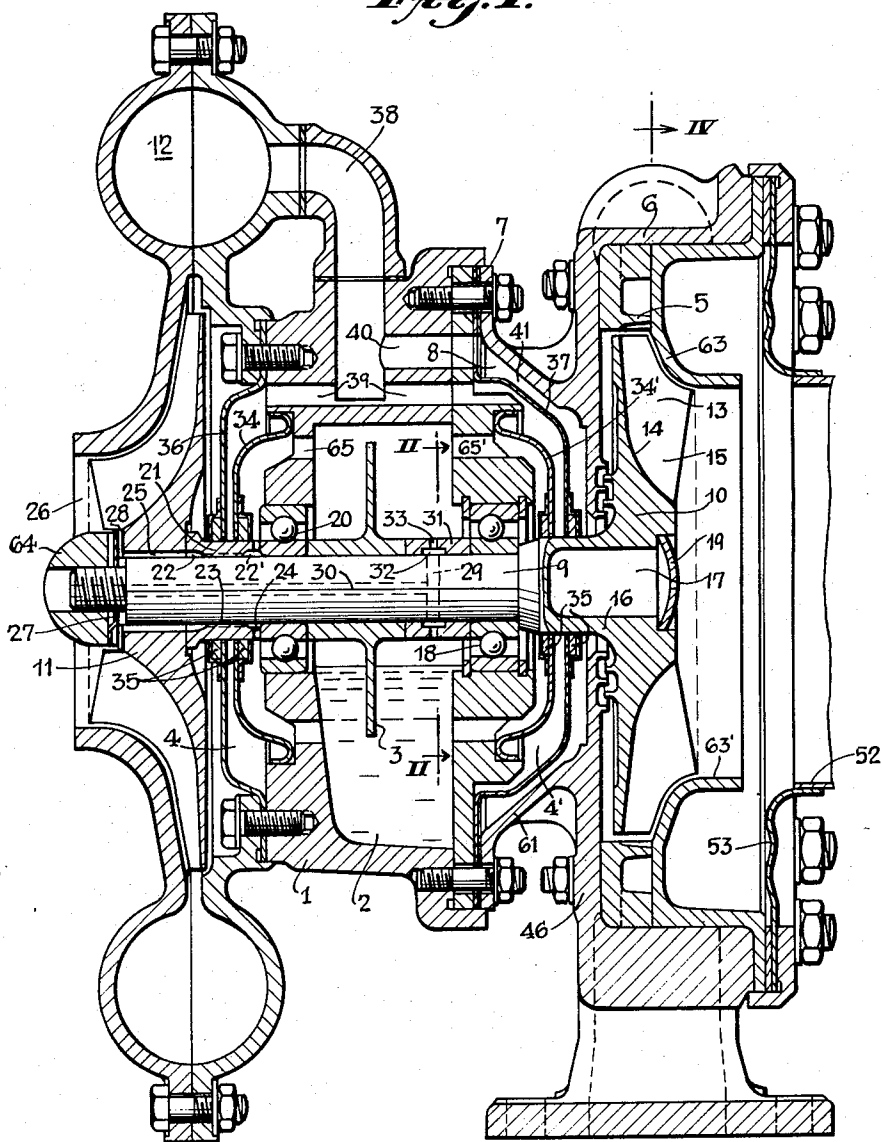
2,646,210

TURBOCOMPRESSOR

Filed May 5, 1951

3 Sheets-Sheet 1

Fig. 1.



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Fig. 3.

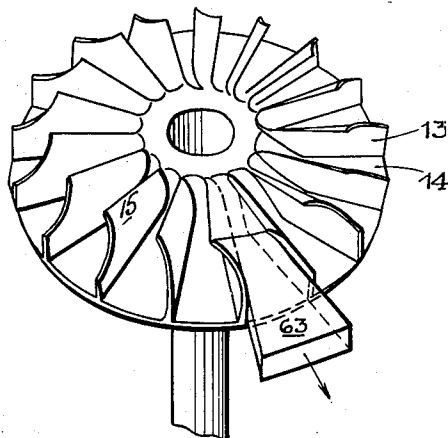


Fig. 2.

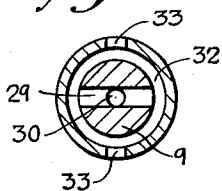


Fig. 4.

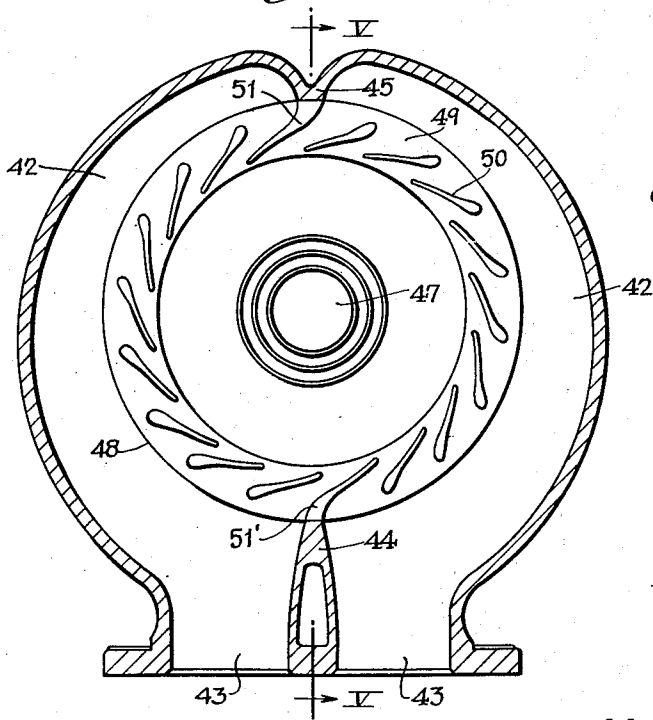
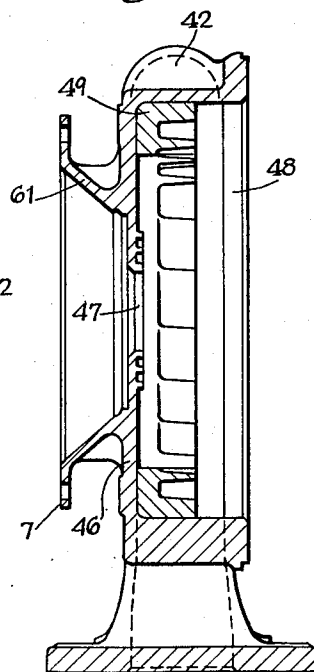


Fig. 5.



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TURBOCOMPRESSOR

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The present invention relates to a radial hot gas turbine driving a compressor and forming with the latter a mechanically self-contained unit. The unit may be used for compressing air for many different purposes but particularly for charging internal combustion engines having four or six cylinders.

It is an object of the invention to provide a turbo-compressor unit suitable for charging an internal combustion engine having four or six cylinders and whose turbine is provided with a nozzle device having two separated gas admission conduits and being so designed as to be conveniently inserted in axial direction and removed through the exhaust side of the turbine.

A further object of the invention is the provision of a turbo-compressor unit having extremely small overall dimensions and weight and being so constructed as to substantially reduce manufacturing cost and simplify assembly.

Another object of the invention is to provide a turbo-compressor unit having air-cooled bearing and support means reducing consumption of lubricating oil and in which the bearing means are not only insulated by air but also shielded against heat radiation from the hot turbine parts.

A further object of the invention is the provision of a turbo-compressor unit in which undesired vibration of the rotor is prevented by the provision of an additional bearing loaded to counter-balance otherwise unbalanced forces.

Other objects will appear from the following description of this invention.

The manner in which the foregoing objects are achieved is shown in the appended drawings, wherein like numerals designate like parts throughout the several views, and in which:

Fig. 1 is a longitudinal sectional view of a turbo-blower unit according to the invention;

Fig. 2 is a cross-sectional view of the shaft of the unit shown in Fig. 1, the section being taken along line II—II of Fig. 1;

Fig. 3 is a perspective view of the rotor of the turbine of the unit according to Fig. 1 at the moment when the last core is removed after the rotor has been cast in a chill mould;

Fig. 4 is a cross-sectional view of the casing of the turbine of the unit according to Fig. 1, the section being taken along line IV—IV of said figure;

Figure 5 is a transverse section taken at line V—V of Fig. 4;

Fig. 6 is a longitudinal section through a modified bearing arrangement;

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Fig. 7 is a transverse section taken at line VII—VII of Fig. 6.

Referring more particularly to Fig. 1, the unit according to the invention comprises a centrally disposed hollow bearing support member 1 containing lubricating oil. A ball bearing is provided at each end of member 1, the bearings being designated by numerals 18 and 20. They support a shaft 9 made in one piece with a turbine rotor 10. Air lock chambers 4 and 4' are provided at the left and right ends, respectively, of member 1, which chambers are interconnected and contain air under the same pressure. A casing 6 is disposed at the right side of member 1 for receiving a radial turbine having a stationary nozzle member 5 and the aforementioned rotor 10. At the left side of member 1 is a radial blower having a rotor 11 and a spiral casing 12.

A cylindrical shaft portion 16 connects the turbine wheel or rotor 10 with the shaft 9, the bore or cavity 17 of portion 16 being so dimensioned that the transverse section of portion 16 is not greater than one half of the cross-section of shaft 9 and the moment of inertia of portion 16 is the same as that of shaft 9. The described construction reduces the flow of heat from the turbine wheel to the shaft.

As seen in Fig. 3, the blades 13 of the turbine wheel have a rectangular transverse sectional configuration and extend at a right angle from the rotor disc. The channels formed by the blades 13 have bottoms 14 which form an angle with a plane at a right angle to the rotation axis of the rotor, the axial inclination of the bottoms 14 beginning at the inlet end of the channels and increasing progressively toward the center of the rotor so that the gas operating the turbine exhausts in axial direction.

The entire outlet portions 15 of the blades 13 are so bent in circumferential direction that the gas leaves the buckets in a direction assuring great operating efficiency; this curvature, however, is so limited that the cores 63, which fill the channels completely, can be pulled out as a whole. This permits forming of the turbine wheel in a chill mould and precision casting of the wheels. In cases where it is difficult to cast the turbine wheel in one piece with the shaft, the wheel is cast with a hollow shaft trunk 16 and connected with the shaft 9 by pressure-butt-welding. The cavity 17 in the shaft trunk 16 is closed by a pressed-on cover 19 to prevent entry of hot gases into the cavity.

A disc 3 rotating with shaft 9 is provided between bearings 18 and 20. The disc picks up oil

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from the bottom of chamber or cavity 2 and throws it in finely divided or atomized state into the upper part of the chamber wherefrom the oil enters the inside of bearings 18 and 20. The oil is also conducted toward the outside of the bearings through openings 65 and 65' in member 1 and through chambers formed at the outsides of said member by means of covers 34 and 34'. Escape of oil from the spaces within covers 34 and 34' is prevented by the compressed air at the outside of covers 34 and 34', which fills the previously described spaces 4 and 4' which are supplied with compressed air from the spiral casing 12 through conduits 38 and 39 and are closed at their outsides by covers 36 and 37. If the rotational speed of the unit changes, the pressure changes in the air chambers 4 and 4' and also in the oil chamber 2, and oil may enter the air chambers if the speed is reduced. To prevent this, a longitudinal bore 30 is provided in shaft 9 which bore connects the inlet 26 of the blower with transverse bores 29 terminating in an annular channel or groove 32 in a sleeve 31 rotating with the shaft. See Fig. 2. Channel 32 is connected with the oil chamber 2 by means of bores 33. The pressure in chamber 2 is thus maintained lower than in the chambers 4 and 4', there being always a flow of air from the air chambers into the oil chamber and therefrom through conduits 33, 32, 29 and 30 to the outside wherefrom it is drawn into the compressor. Flow of oil through conduits 33, 32, 29 and 30 is prevented by placing the conduits 33 preferably at a right angle to the bore 29 in shaft 9 as seen in Fig. 2.

As indicated in Fig. 1, a sleeve 21 rotating with shaft 9 is provided at the left side of bearing 20, which sleeve abuts against the compressor rotor 11, the latter being pressed to the sleeve by a nut 64. A spring washer 27 is interposed between the nut and the rotor. Each end of sleeve 21 is provided with an interior recess or groove forming annular channels 22 and 22' which are interconnected by one or more longitudinal grooves 23. Channel 22' is connected by radial recesses or bores 24 with the space inside cover 34 and therefore with the oil chamber 2. The hub of the compressor wheel 11 has interior grooves 25 connected with radial grooves 28 at the outer end of the hub, so that air may flow from the oil chamber through conduits 24, 22', 23, 22, 25, and 28 to the outside. Simultaneous escape of oil is prevented by placing the radial grooves 24 at other points of the circumference of shaft 9 than the grooves 23.

The covers 34 and 36 enclosing the air chamber 4 at the compressor end of the unit and the covers 34' and 37 enclosing the air chamber 4' at the turbine end are made of thin sheet metal, covers 34 and 34' each having a curved rim portion which is press-fitted into member 1. The disc portions of covers 34, 34', 36, and 37 adjacent to shaft 9 are adapted to hold packing rings 35.

Conduit 38 conducting compressed air from the compressor to the bearing member 1 has a branch 40 conducting cooling air into a space 8 formed by cover 37 and turbine casing 6 and extending over the whole side of member 1 facing the turbine. Cover 37 is so formed relatively to a flange 61 on the turbine casing 6 as to produce a throttling passage 41 forcing the air coming from conduit 40 to be distributed equally in the annular space 8 and to flow radially inward toward the shaft trunk 16. From there the air flows radially outward along the back of the turbine wheel and is mixed with the gas operating the turbine in

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the clearance between the turbine rotor and the turbine nozzles. The described construction provides two adjacent air spaces, 4' and 8, 41, between the hot turbine casing and the shaft bearing and an efficient heat insulation for the latter. A third air space insulates the back of the turbine wheel from the turbine casing portion facing the bearing.

The turbine casing comprises two symmetric substantially semicircular conduits 42 disposed in a common plane and in opposite relation, as illustrated in Figs. 4 and 5. Each channel has an inlet portion 43 and the two inlet portions are separated by a wall 44. The semicircular cross-section of the channels diminishes gradually, resulting in a tongue portion 45 of the casing which portion is diametrically opposed to wall 44.

The back wall 46 of the turbine faces the bearing member 1 and has an opening 47 through which the turbine shaft extends. A funnel-shaped flange 61 projects from wall 46 and is provided with an annular portion 7 which is bolted to member 1. Flange 61 is thin and does not conduct much heat. It is cooled at its outside by the surrounding air. Cover member 37 has an annular portion interposed between the annular portion 7 and member 1. The inside of flange 61 is cooled by the air flowing radially through space 41. Opposite wall 46 is a large cylindrical portion 48 receiving the annular nozzle or guide blade member 49. Tongue 45 and wall 44 terminate at the circumference of the nozzle or guide blade member 49.

Member 49 is provided with an even number of nozzle blades 50. Two diametrically opposed blades each have an outwardly extending portion, portion 51 abutting the inner end of tongue 45 and portion 51' abutting the inner end of the separating wall 44. The gas streams in the two channels 42 are thus separated from and cannot interfere with each other. This is of particular importance if the unit is used for supercharging internal combustion engines. The nozzle member 49 is open at the right side, as seen in Figs. 1 and 5, and is closed by a cover 63 closing also the right side of the cylindrical clearance between the nozzles and the turbine wheel and having a cylindrical portion 63' for guiding the turbine exhaust gases. The latter are additionally guided by an exhaust conduit 52 which is connected with the turbine casing by means of an annular membrane member 53 which equalizes expansion and tension caused by heat between the exhaust conduit 52 and the turbo-compressor unit.

The radial compressor together with cover 36 is bolted to the left side of the bearing member 1. The described arrangement facilitates assembly of the unit.

Since perfect balancing of the turbo-compressor rotor and reduction of the bearing clearances to zero is practically impossible, the rotor will make a circular movement in the bearings causing additional unbalancing, particularly at high rotational speeds, and additional stresses and operating noise. To avoid this, a third bearing, 54, may be provided between bearings 18 and 20, according to the invention and illustrated in Figs. 6 and 7, which is externally so much loaded that the bearing reactions in bearings 18 and 20 are always at least equal to the forces produced by the residual unbalance of the rotor, which forces counteract the bearing reaction caused by the static load of the rotor. External loading is effected by two compression springs 55 disposed symmetrically with respect to the radial center

line of the bearing. One end of each of the springs 55 rests against a support part 56 which has a shoulder 66 abutting the inside of the bearing casing 67 and a threaded portion 68 extending outside of casing 67. A cap nut 62 is screwed on the threaded portion 68 for securing the support member 56 to the casing 67. The other ends of springs 55 rest on a second support part formed by lateral extensions 57 of a pin 69 which is longitudinally slidable and guided in a bore of part 56, which bore extends radially of bearing 54. Part 57, 69 rests on and is forced against a block 58 in which bearing 54 is mounted. To prevent rotation of part 57, 69 about the axis of pin 69 and for guidance of springs 55 studs or pins 59 having ends screwed into part 56, 68 extend through spiral springs 55. The free ends of studs 59 extend through holes 60 in the extensions 57 and into recesses in member 59 and thus not only prevent rotation of member 57, 69 but also sliding of member 58 along the axis of shaft 9.

While the preferred embodiments of this invention are shown and described, modifications other than those disclosed herein may be made without departing from the spirit of the invention, and reference is therefore made to the appended claims for a definition of the scope of this invention.

What is claimed is:

1. A turbo-compressor comprising, in combination, a radial turbine, a casing therefor, a radial compressor, a casing therefor, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, a cooling air chamber disposed between said support member and said turbine, a cooling air chamber disposed between said support member and said compressor, a conduit interconnecting both said chambers for equalizing the air pressure therein, said support member having a cavity containing lubricating oil and communicating with both said bearings, said compressor having a wheel having a hub portion, a sleeve on and rotating with said shaft and disposed between said hub portion and the one of said bearings which is next to said compressor, said sleeve having an interior annular groove adjacent to said hub portion and an interior annular groove adjacent to said bearing, at least one longitudinal internal groove in said sleeve communicating with both said annular grooves, radial conduits extending from the annular groove which is adjacent to said bearing, to the outside of said sleeve for conducting air from said cavity into said last mentioned annular groove, and conduit means in said hub portion connecting the annular groove, which is adjacent to said hub portion, with the suction side of said compressor for drawing air from the annular groove adjacent to said bearing through said longitudinal groove into the annular groove adjacent to said hub portion and through said conduit means to the outside for ventilating said cavity.

2. A turbo-compressor as set forth in claim 1, said radial conduits being placed at a different diameter in said sleeve than said longitudinal groove.

3. A turbo-compressor as set forth in claim 1, said shaft extending through said hub portion, said conduit means in said hub portion compris-

ing longitudinal grooves adjacent to said shaft, and conduits extending radially in said hub portion from said last mentioned grooves to the outside.

4. A turbo-compressor comprising, in combination, a radial turbine, a casing therefor, a radial compressor, a casing therefor, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, a cooling air chamber disposed between said support member and said turbine, a cooling air chamber disposed between said support member and said compressor, a conduit interconnecting both said chambers for equalizing the air pressure therein, said support member having a cavity containing lubricating oil and communicating with both said bearings, a conduit extending from the intake side of said compressor and longitudinally through said shaft and ending therein, a transverse conduit in said shaft connected with said conduit and having an intake end at the outside of said shaft, a sleeve on and rotating with said shaft and covering said intake end, an annular interior groove in said sleeve adjacent to said intake end, and radial conduits in said sleeve extending from said annular groove to the outside of the sleeve for receiving air from said cavity and conducting it into the conduit extending through said shaft.

5. A turbo-compressor according to claim 4, said radial conduits being angularly displaced with respect to said transverse conduit.

6. A turbo-compressor comprising, in combination, a radial turbine having a casing, a radial compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, an air lock chamber disposed between said support member and said turbine, an air lock chamber disposed between said support member and said compressor, a conduit interconnecting both said chambers for equalizing the air pressure therein, said support member having a cavity containing lubricating oil and communicating with both said bearings, an annular recess at each side of said support member, a cover plate disposed at either side of said support member and having a disc portion axially spaced from the support member and having a rim portion press-fitted into said recess, said rim portion being resilient for maintaining a tight press fit at varying temperature conditions, an opening in said cover plates through which said shaft extends, and packing rings surrounding said shaft and individually connected with said cover plates adjacent to said openings.

7. A turbo-compressor comprising a radial turbine having a casing, a radial compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending

through said bearings, a cooling air chamber at either side of said support member, one of said chambers being disposed between said support member and said turbine and the other between said compressor and said support member, a conduit interconnecting both said chambers for equalizing the air pressure therein, the air chamber between said support member and said turbine having an outside wall, and an additional air chamber disposed between said outside wall and said turbine casing, extending around said shaft, and having an annular portion of relatively great diameter and axial extension and having an annular portion of relatively small diameter adjacent to said shaft, a compressed air conduit connecting said first annular portion with said compressor, said additional air chamber having an intermediate portion of relatively small axial extension between said annular portions, said intermediate portion constituting a throttle passage for throttling the flow of air toward said shaft and affording uniform distribution of the air in said additional chamber.

8. A turbo-compressor comprising a radial turbine having a casing, a radial compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, an air lock chamber at either side of said support member, one of said chambers being disposed between said support member and said turbine and the other between said compressor and said support member, a conduit interconnecting both said chambers for equalizing the air pressure therein, said turbine casing comprising two diametrically opposed substantially semicircular conduits disposed symmetrically in the same transverse plane to the rotation axis of the turbine and having a semicircular cross-sectional configuration, an inlet portion, a separating wall therein extending radially of the rotation axis of the turbine and dividing said inlet portion into two conduits individually connected with said semicircular conduits, the flow area of the latter gradually diminishing as they extend from said inlet portion, said casing having a tongue portion diametrically opposed to said separating wall and separating the semicircular conduits thereat, said casing having a rear wall at the side facing said support member, an opening in said rear wall receiving said shaft, a flange portion extending from said rear wall and being connected with said support member, said casing having a hollow cylindrical portion extending axially from said rear wall, and an annular guide blade member fitted into said cylindrical portion, said separating wall and said tongue extending inwardly as far as the circumference of said guide blade member.

9. A turbo-compressor as defined in claim 8, said flange portion being funnel-shaped with the small diameter end at said rear wall, the air chamber between said support member and said turbine having an outside wall spaced from and facing said flange portion and said rear wall and forming therewith a cooling air chamber, and a conduit connecting said cooling air chamber for compressed air flow with said compressor.

10. A turbo-compressor as defined in claim 8, said guide blade member comprising an even number of guide blades, two of said blades being

diametrically opposed, each of said two guide blades having an outward extension, the extension of one guide blade ending at said separating wall and the extension of the other guide blade ending at said tongue portion for keeping separate in said guide blade member the gas streams received from said semicircular conduits.

11. A turbo-compressor comprising, in combination, a radial turbine having a casing, a radial compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, an air lock chamber disposed between said support member and said turbine, an air lock chamber disposed between said support member and said compressor, a conduit interconnecting both said chambers for equalizing the air pressure therein, an oil containing cavity disposed in said support member and communicating with said bearings, and conduit means in said shaft and rotating therewith and communicating with said cavity for removing air therefrom.

12. A turbo-compressor as defined in claim 11, comprising disc-shaped atomizing means extending radially from and driven by said shaft and disposed in said cavity for atomizing the oil therein.

13. A turbo-compressor as defined in claim 11, said turbine having a rotor having a radial disc portion, said disc portion having a front surface inclined in axial direction, the inclination increasing toward the center of the rotor, and sheetlike blades extending at a right angle from the front surface of said disc portion and radially of the rotor axis, said blades having curved end portions, the generatrices of the curvature of said end portions extending through the rotor axis.

14. A turbo-compressor as defined in claim 11, said turbine having a rotor having a disc portion, an axial bore in the center of said disc portion, and a hollow cylindrical shaft trunk extending from the center of said disc portion toward said support member and being rigidly connected with said shaft and having a greater outside diameter than the latter, the annular cross-section of said trunk being not greater than half the cross-section of the connected shaft and the moment of inertia of said shaft trunk being therefore substantially the same as that of said shaft.

15. A turbo-compressor according to claim 14, comprising a cover closing the bore in the center of said disc portion.

16. A turbo-compressor comprising, in combination, a radial turbine having a casing, a radial compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, an air lock chamber at either side of said support member, one of said chambers being disposed between said support member and said turbine and the other between said compressor and said support member, a conduit interconnecting both air chambers for equalizing the pressure therein, a cavity in said support member containing lubricating oil

and communicating with each of said two bearings, a third bearing axially aligned with and interposed between said two bearings, and means connected with said support member and said third bearing and comprising a first support part 5 rigidly connected with said support member, a second support part resting on said third bearing and being slidably connected with and guided by said first support part for radial movement to and from said shaft, two coil springs interposed 10 between said support parts and disposed symmetrically with respect to a radial center line of said third bearing, a pin connected with one of said support parts, extending through one of said springs and slidably into the other support 15 part, and a pin connected with one of said support parts, extending through the other spring and slidably into the other support part.

17. A turbo-compressor comprising, in combination, a radial turbine having a casing, a radial 20 compressor having a casing, a support member disposed between said turbine and said compressor and having a side to which said turbine casing is bolted and a side to which said compressor casing is bolted, at least two axially aligned bearings borne in said support member, a shaft interconnecting said turbine and said compressor and extending through said bearings, an air lock chamber disposed between said support member and said turbine, an air lock chamber disposed 30 between said support member and said compressor, a conduit interconnecting both said chambers for equalizing the air pressure therein, said support member having a cavity containing lubricating oil and communicating with both said bear-

ings, an annular recess at each side of said support member, a cover plate disposed at either side of said support member and having a disc portion axially spaced from the support member and having a rim portion press-fitted into said recess, an opening in said cover plates through which said shaft extends, said air lock chambers having an axial side wall individually formed by said cover plates, each of said air chambers having a second side wall individually axially spaced from said cover plates and constituted by a cover plate having a rim portion, the rim portion of one second side wall being interposed between said support member and said compressor casing and the rim portion of the other second side wall being interposed between said support member and said turbine casing.

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