March 8, 1955 H. J. WOOD 2,703,674

TURBINE DRIVEN FAN UNIT

Filed July 21, 1950 3 Sheets-Sheet 1

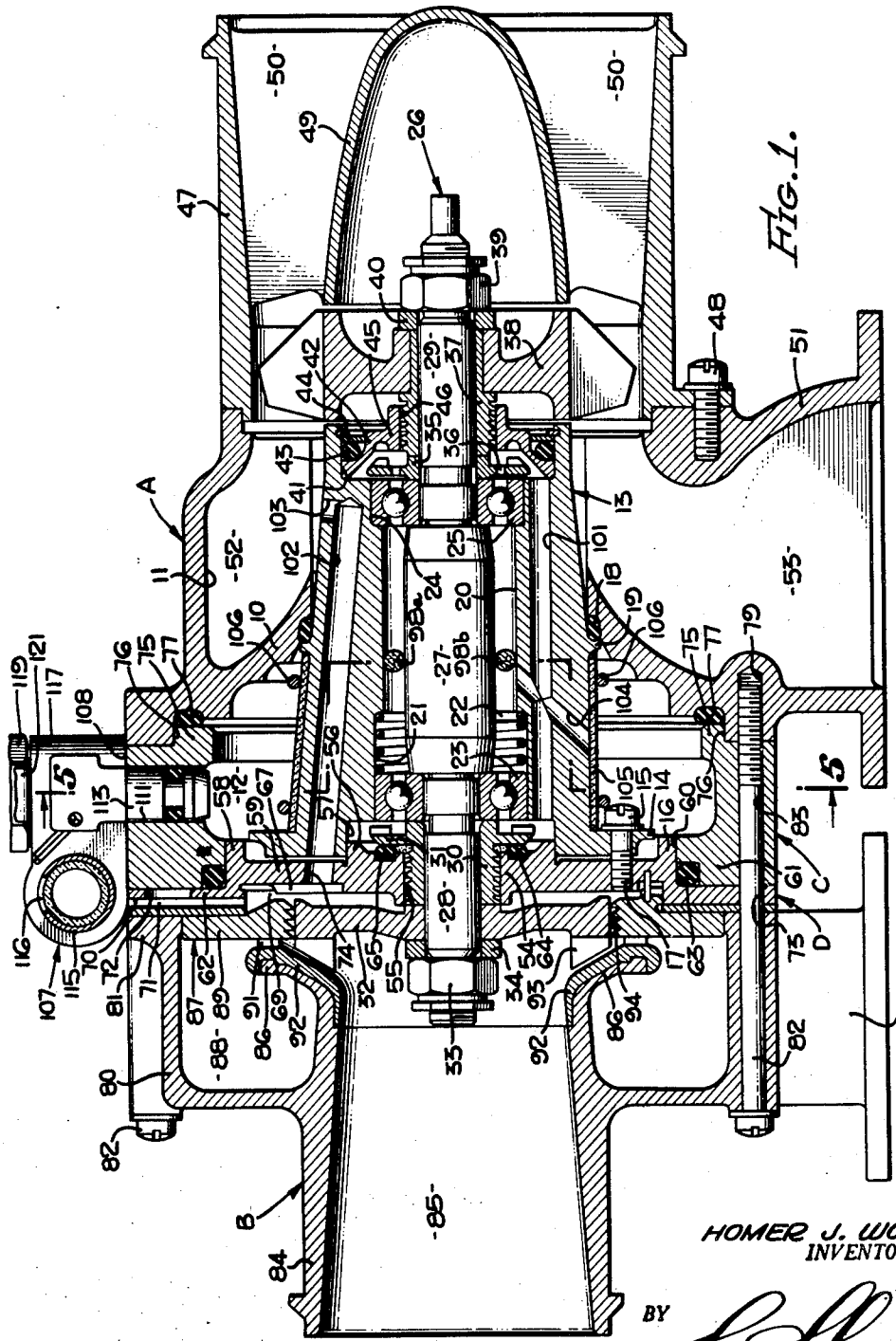


FIG. 1.

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TURBINE DRIVEN FAN UNIT

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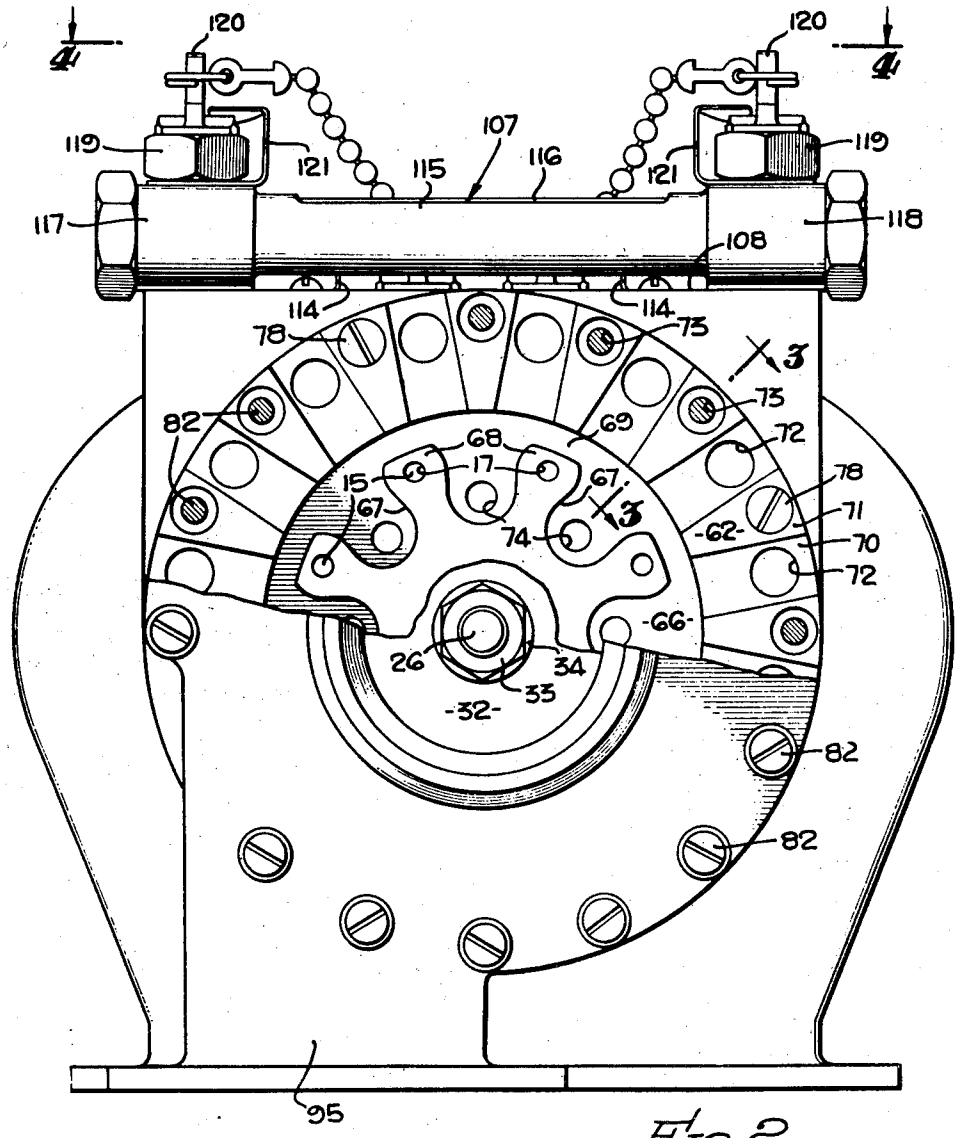


FIG. 2.

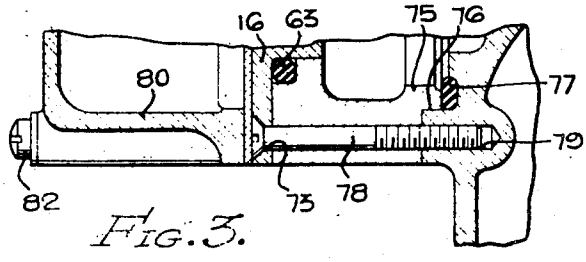


FIG. 3.

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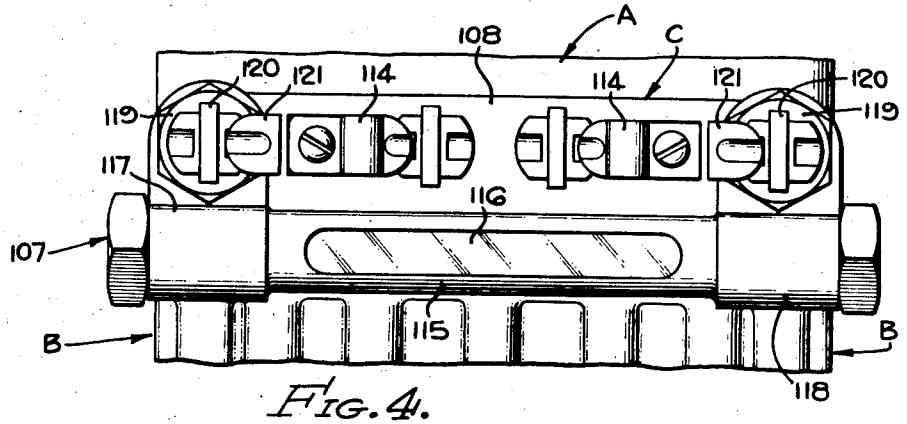


FIG. 4.

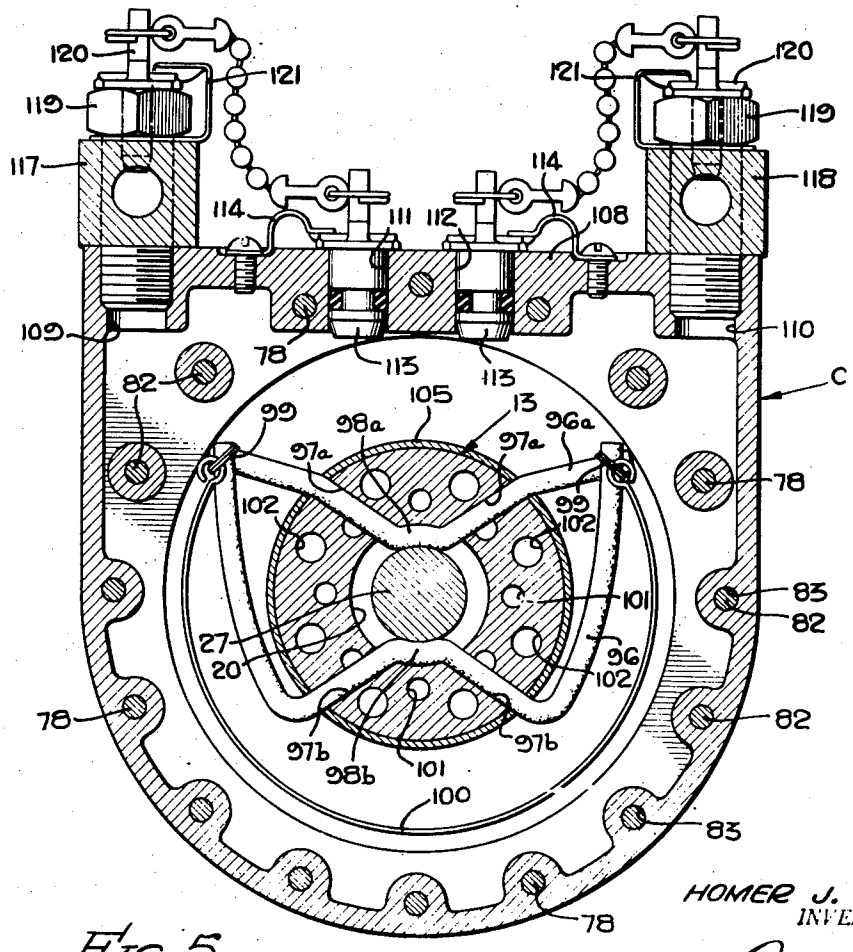


FIG. 5.

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2,703,674

TURBINE DRIVEN FAN UNIT

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Application July 21, 1950, Serial No. 175.228

6 Claims. (Cl. 230—116)

The present invention relates generally to power driven devices, and is more particularly concerned with a compact high velocity turbine driven unit of the type utilized for fluid circulation in connection with air conditioning and refrigeration.

According to the general concepts of the present invention, the invention relates to a high velocity expansion turbine having extremely high volumetric capacity for a given size and weight of device, thereby making the unit especially suitable for use in aircraft.

One object of the present invention is to provide a turbine driven fan unit in which the turbine casing and fan casing are separably constructed and arranged to be interconnected in axial alignment with an intermediate oil sump spacer section, and wherein the spacer section may be installed in a plurality of angularly spaced positions circumferentially of the unit axis so as to meet different installation requirements for the unit.

A further object is to provide in a unit of the herein described type an adjustable casing section having novel oil filling and drain openings and containing an oil sight-gauge, the section being adjustable with the sight-gauge to a plurality of positions, whereby the sight-gauge may be maintained in a generally vertical position irrespective of the angular mounting position of the unit about its longitudinal axis.

Still another object is to provide novel oil gauge means for indicating oil level in a power driven unit, such as a turbine driven fan unit, which may be mounted in a plurality of positions to meet varied installation requirements.

Briefly, the attainment of the above noted and other objects is accomplished by providing a sectionalized casing in which a sump or intermediate spacer section is clampingly engaged between end sections which are respectively utilized for the power means and the fluid circulating means, in this case turbine means and fan means. An oil gauge is associated with the sump section and this section is so formed that it may be angularly disposed in a plurality of mounting positions circumferentially of the unit axis so that the sight-gauge may be disposed in a vertical position for proper operation, without interfering with the particular requirements with respect to the unit mounting and the connections for the turbine means and fan means.

The invention is of particular advantage in aircraft installations, since the unit is more flexibly adaptable to varied installation requirements and conditions, particularly where it becomes necessary to connect the fan end of the casing and turbine end of the casing at different angular positions about the unit axis, which connections may vary in different installations. It is thus possible to utilize the same unit, and merely by adjusting the sections of the casing upon assemblage of the unit, the unit is readily adapted for the varied installation requirements without the necessity of having to provide a plurality of individually adaptable casing sections.

Further objects and advantages of the invention will be brought out in the following part of the specification wherein a detailed disclosure is made for the purpose of disclosing the invention without limiting its scope.

Referring to the accompanying drawings, which are for illustrative purposes only:

Fig. 1 is a longitudinal sectional view of a turbine driven fan unit embodying the features of the present invention;

Fig. 2 is an end elevational view of the turbine end of the unit, portions being cut away to show details of construction of the air seal casing section;

Fig. 3 is a fragmentary sectional view, taken substantially on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view looking towards the casing of the unit, as seen substantially from line 4—4 of Fig. 2; and

Fig. 5 is a transverse sectional view through the oil sump spacer section and bearing structure, taken substantially on line 5—5 of Fig. 1.

Referring now to the drawings, a fan unit constructed according to the present invention is illustrated, and in Fig. 1 is shown as comprising a multi-section casing structure in which the various sections are secured together in axial alignment to form a unitary assemblage. The casing structure comprises a fan casing section A, a turbine casing section B, an oil sump spacer section C and an air seal section D.

The fan casing section A is of hollow construction and provided with an internal annular septum 10 which forms a common wall between an air inlet chamber 11 and an oil chamber 12 surrounding the bearing structure of the unit.

This bearing structure is constructed with a tubular bearing support 13 having an end flange 14 by which it is secured as by a plurality of screws 15 to a seal member 16, the screws 15 being threaded into threaded openings 17 of the seal member. The bearing support 13 and seal member 16 are thus secured together to form an assembly which may be mounted and removed as a unit from the unit casing. The bearing support 13 is resiliently supported and sealed with respect to the septum 10 by a sealing ring 18 which is interposed between a circumferentially extending shoulder 19 on the exterior surface of the bearing support 13 and the adjacent inner peripheral margin of the septum 10.

The tubular bearing support 13 is of generally tapered construction from the end flanges 14 to its opposite end and is provided with a longitudinally extending axial bore 20. Adjacent the flange 14, the bore 20 is provided with a counterbore 21 which receives a bearing loading spring 22 and the outer race of a ball bearing 23. The other end of the bearing support 13 contains a counterbore 24 to receive the outer race of ball bearing 25.

The ball bearings 23 and 25 support a shaft 26 having a central body portion 27 and contracted end extensions 28 and 29. The extension 28 carries the ball bearing 23 at its inner end, the inner race of the ball bearing being secured between the end of the central body portion and a hub 30 of a slinger or fan element 31. A turbine wheel 32 is secured on the end extension 28 in abutment with the outer end of hub 30 by means of securing nut 33, a washer 34 being interposed between the securing nut and the adjacent turbine wheel. At the opposite end, the inner race of ball bearing 25 is similarly supported between a slinger or fan element 35 and the adjacent end of the central body portion 27, the element 35 being provided with flow passages 36 therein. The extension 29 has mounted thereon also a sleeve member 37 which carries a fan 38, this assembly being secured by a nut 39, a washer 40 being interposed between the fan and nut.

The extreme end of the bearing support 13 at the fan end is provided with a counterbore 41 within which there is seated a seal ring 42, the seal ring being sealed at its periphery with a packing gasket 43 and retained in operative position by a snap ring 44. The seal ring 42 is centrally formed with a tubular sleeve 45 which is associated with the adjacent portion of sleeve member 37 in such a manner as to provide a labyrinth seal 46 between the fan element 35 and the fan 38.

A cylindrical wall 47 is secured at its inner end to the adjacent end of a fan casing section A by means of a plurality of screws 48 to house the fan 38 and also form an outlet passage for the air from the fan. The air outlet also includes a hollow dome 49 which is supported on the axis of the cylindrical wall 47 by means of a plurality of vanes 50 which separate the outlet into a plurality of outlet passages. The air inlet chamber 11 communicates at its bottom with an inlet conduit connection

51, which is divided into two inlet passages by vertically disposed vanes 52 and 53, so that the inlet air as it enters is divided and passes through separate passages in the air inlet chamber.

Considering again the turbine end of the unit, it will be noted that the seal member 16 which forms the seal section D of the unit casing is of general disc-like construction containing a tubular hub 54 defining a tubular bore 55. Adjacent this hub, but spaced outwardly slightly therefrom, is an annular flange 56 which projects from the inner face of the seal member and is adapted to fit within a counterbore 57 of the adjacent end of the bearing support 13 so as to axially align these parts in assembled relation. Outwardly spaced from the flange 56 is a second flange 58, the flanges 56 and 58 being interconnected by a web 59. As shown in Fig. 1 the flange 58 is arranged to fit within an opening 60 defined by the inner periphery of an end flange 61 formed on the adjacent end of the oil sump spacer section C of the unit casing. The outer end of the flange 58 is deformed to provide a right angled flange 62 which makes face engagement with the end face of flange 61. The seal member 16 is sealed adjacent its outer periphery with respect to the end flange 61 by means of a ring gasket 63, and adjacent its inner periphery by means of a gasket 64 which is seated in an annular groove 65 and bears against adjacent fan element 31.

On its outer face, as shown in Fig. 2, the seal member 16 is provided with a surface 66 which is recessed in relation to the outer surface of the flange 62, the surface 66 being continuous adjacent the hub 54, but at its periphery being cut out to form plenum spaces 67 separated by spaced radially extending raised ribs 68, the plenum spaces being interconnected by a circumferentially extending channel 69.

The outer face of the flange 62 is formed to provide radially extending channels 70 each separated by a rib 71.

The channels have lightening openings 72 therein and the ribs 71 have openings 73 therein which are countersunk at their outer ends.

With the above described arrangement of channels and plenum spaces, it will be observed that each plenum space 67 has two channels 70 in communication therewith, and at the innermost end of each plenum space 67 there is provided a port opening 74.

The end of the oil sump spacer section C, adjacent the fan casing section A, is provided with a projecting end flange 75 which is adapted to extend into a counterbore 76 formed in the fan casing. By this construction the sump section C is axially aligned with section A. The joint between these two sections is sealed by a gasket 77.

As shown in Fig. 3, the oil sump spacer section C and the seal section D are secured in assembled cooperative relation with the fan casing section A by means of screws 78 which are inserted through openings 73, which are in 90° relationship and threadedly engage threaded sockets 79 in the adjacent end of the fan casing A.

Referring again to Fig. 1, the turbine casing section B is constructed with an outer shell 80 which terminates in an end flange 81 for abutting the outer surfaces of the ribs 71 of the seal section D, when secured in clamped relation thereagainst by means of a plurality of securing screws 82 positioned in the remaining openings 73 and likewise extending through suitable passages 83 in the periphery of casing section C into threaded engagement with threaded sockets 79 as previously described.

The shell 80 is formed with an axially arranged tubular wall 84 which defines an outlet passage 85 for the turbine operating fluid. At its innermost end, the wall 84 is outwardly deflected to form a radial wall portion 86 axially spaced outwardly from the adjacent face of the seal member 16 to leave a space in which a nozzle member 87 is mounted, this nozzle space serving to connect a fluid inlet chamber 88 with the fluid outlet passage 85.

The nozzle member 87 comprises a ring shaped body 89 the periphery of which is adapted to fit snguly within the end flange 81, and is provided on its inner surface with circumferentially spaced projections arranged to extend into the channel 69 and thus align the nozzle member with respect to the seal member 16. The outer face of the ring body 89 carries a plurality of circumferentially spaced apart projecting vanes 91 having outer edges for abutment with a protective shroud 92 lining the adjacent surface of the radial wall portion 86. Fluid nozzles are thus formed leading from the inlet chamber 88 to conduct the turbine operating fluid against turbine blades 93 carried at the periphery of the turbine wheel 32. The periphery of this turbine wheel is sealed with respect to the inner periphery of the ring body 89 by means of a labyrinth seal 94.

With the above described arrangement, it will be noted that the end flange 81 and ring body 89 cooperate to close the open side of channels 70 so that a plurality of flow passages circumferentially spaced around the exterior of the unit casing operate to connect the port openings 74 with ambient air exteriorly of the unit. The inlet chamber 88 communicates with an inlet conduit connection 95.

For lubricating the bearings 23 and 25, provision is made for conducting oil lubricant from the oil chamber 12 to the central body portion 27 of the shaft by means of wicks 96*a* and 96*b* as shown in Fig. 5. These wicks are respectively threaded through passages 97*a*—97*a* and 97*b*—97*b*, so that intermediate portions 98*a* and 98*b* will engage the surface of body portion 27 of the shaft. The ends of the wick projecting on oppostie sides of the bearing support are brought together and secured by tie means 99 which are respectively connected to the ends of a U-shaped wire retainer 100.

Extending from end to end of the tubular bearing support 13, there are provided a plurality of longitudinal extending passages 101 circumferentially spaced at equal intervals around the bore 20 in the bearing support wall. Relatively larger passages 102 are arranged in alternate relation with the passages 101, but have their axes disposed upon a slightly larger circumference than the passages 101. The passages 102 at one end open into the end flange 14 of the bearing support 13, and each passage 102 thus registers at this end with one of the port openings 74 of the seal member 16. The opposite end of the passages 102 communicate with port openings 103 which connect this end of each of the passages 102 with the air inlet chamber 11.

As shown in Fig. 1, the passages 101 are intersected intermediate their ends by an angularly extending passage 104 having its outer end opening in the outer surface of the bearing support 13, and its inner end opening in the wall of bore 20 at a position substantially intermediate the ends of the central body portion 27. Overlying the outermost ends of the passages 104, is a blanket element 105 of fibrous sheet or suitable fabric to form a cover or strainer to prevent entry of foreign particles into the lubricant circulation system. This blanket extends longitudinally of the bearing support between the end flange 14 and the shoulder 19, and is held in position by any simple means such as binding wires 106.

In operation, lubricant is conducted from the oil chamber 12 to the surface of the central body portion 27 of the shaft by means of the wicks 96*a* and 96*b*. The high velocity of the shaft causes the oil to be formed into a mist within the bore 20 surrounding the central body portion 27 of the shaft. The action of the slinger or fan elements 31 and 35 produces airflows outwardly to the bearing 23 and 25 which will carry the fine mist into the bearings from whence it is returned through passages 101, and thence through the inner end of the passage 104 to the bore 20 space surrounding the central body portion 27. Moreover, oil may drain from the bore space through the lowermost passages 104 by gravity and be filtered by the blanket 100 in its passage into the oil chamber 12.

Cooling of the bearing support 13 and the lubricant is accomplished by airflow through the passages 102, which is set up by the suction created by fan 38. Ambient air is drawn in through the channels 70 from the exterior of the unit casing. This ambient air in its passage to the port openings 74 is conducted over the inner faces of the nozzle member 87 and turbine wheel 32 in heat transfer relation therewith. Advantage is thus taken of the cooling effect which results from the expansion of air passing through the nozzles and blades of the turbine which will cool the turbine wheel 32 and consequently the ambient airflow.

In the present embodiment of the invention, the unit is disclosed as having its fan inlet conduit connection 51 and its turbine inlet connection 95 as having the same angular position circumferentially with respect to the longitudinal axis of the unit. On some installations it is desirable to have these connections disposed at different angular positions about the longitudinal axis to facilitate connections thereto, or the entire unit may be bodily po-

sitioned in different installations so that these connections come out vertically, horizontally or at some other desired angle from the longitudinal axis of the unit. It will therefore be appreciated that, as between different installations, the construction of the oil sump spacer section as described so as to permit its being assembled in different angular mounting positions between the fan casing section A and the turbine casing section B will provide increased flexibility and adaptability to meet varied installation requirements.

As shown in Fig. 5, the passages **83** are arranged at equally spaced intervals so that this spacer section C may be shifted to a plurality of positions about the unit axis and thus placed in proper functioning position for a particular installation.

The oil sump spacer section C is arranged for the mounting of an oil sight-gauge assembly **107** thereon. For such purpose, the oil sump spacer section is laterally extended on one side to provide a projecting portion **108** having a straight wall instead of curved wall. At the opposite sides of the casing section, threaded drain openings **109** and **110** are provided, and closely positioned on each side of the intermediate point of the projecting portion **108** there are provided fill openings **111** and **112**. These fill openings are arranged to be closed by sealing plugs **113** which are normally retained in closed positions by snap springs 114, as shown in Fig. 4.

An oil level indicating gauge **115** provided with a viewing window **116** is connected at its ends by suitable passaged brackets **117** and **118** with the drain openings **109** and **110** by bolts **119**, these bolts being fitted with removable drain plugs **120**. These plugs are likewise retained in closed position by snap springs **121** in each case.

It will also be appreciated that by constructing the oil sump spacer section C so that it may be assembled in different mounting positions as described above, it is possible to always dispose the sight-gauge in substantially vertical position so that it will function properly.

I claim:

1. In a power driven fluid circulating unit; a turbine casing end section; a fan casing end section; a generally tubular oil sump spacer casing section; a seal casing section; means securing said casing sections in axially aligned end-to-end relation with the spacer section and seal section clamped adjacent their peripheries between the end sections; a bearing carrier axially positioned within said spacer section supported at one end from said seal section and having a sealed connection adjacent its other end with an adjacent part of the fan casing end section; a shaft rotatably supported in said carrier; a turbine rotor carried by one end of said shaft said rotor being positioned within the turbine casing end section; a fan carried by the other end of the shaft said fan being positioned within the fan casing end section; means for circulating oil from said spacer section to said shaft for lubricating the same; and a flow channel for a cooling fluid including a passage through said carrier.

2. In a power driven circulating unit: a casing comprising a driving means end section, a fan end section, a seal section and an oil sump section; means for securing said seal section, said oil sump section and said fan end section in assembled end-to-end horizontal axial alignment for cooperatively forming a sump for a lubricant; means for removably mounting said driving means end section in axial end-to-end assembled relation with respect to said seal section, said driving means end section and said seal section having facing surfaces coperating to form inlet radial air flow channels between the exterior and interior of said casing and an air flow connection between the casing interior and said fan end section for inducing outflow of air from the casing interior.

3. In a power driven fluid circulating unit: a casing comprising a pair of end sections and a plurality of intermediate sections in axial end-to-end alignment, said sections being independently variable as to relative angular positions circumferentially of the unit axis; bearing means in said casing; a rotor structure supported at axially spaced points in said bearing means including power means in one of said end sections and air moving means in the other of said end sections; passages for ambient cooling air in one of said intermediate sections and said bearing means, the passages in the bearing means extending between said spaced points and having inlets at one end and outlets at the other end; and passages for circulating a lubricant from the other of said intermediate sections through said bearing means.

4. In a power driven fluid circulating unit: a casing comprising a driving means end section, a fan end section and a hollow intermediate oil sump section having a projecting side portion; an oil level sight-gauge supported on said side portion having a flow connection with the interior of said intermediate section; a filler opening in said side portion; and means interconnecting said sections in horizontal axially aligned end-to-end relation, said intermediate section and sight-gauge being angularly positionable about the unit axis so as to accommodate said sight-gauge to relative angular shifting of the plane of the oil level surface due to different installation mounting positions of the unit.

5. In a power driven fluid circulating unit: a hollow casing having an oil sump therein; a rotor structure rotatably supported within said casing for rotation about a horizontal axis and including power driving means within one end of the casing and fluid moving elements within the other end of the casing; means for circulating oil from said sump to lubricate said rotor structure; gauge means for indicating the oil level in said sump; and a support for said gauge means selectively positionable to maintain the gauge in operative relationship with changed positions of the oil level surface in said casing due to variable unit installation requirements.

6. In a power driven fluid circulating unit: a casing comprising a driving means end section, a fan end section and a hollow intermediate oil sump section; an oil sight-gauge supported on said intermediate section having oil flow connections with the interior thereof; and means interconnecting said sections in horizontal axially aligned end-to-end relationship, said intermediate section and sight-gauge being angular positionable circumferentially of the unit axis and maintained in operative relationship with changed positions of the oil level surface due to different installation mounting positions of the unit.

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