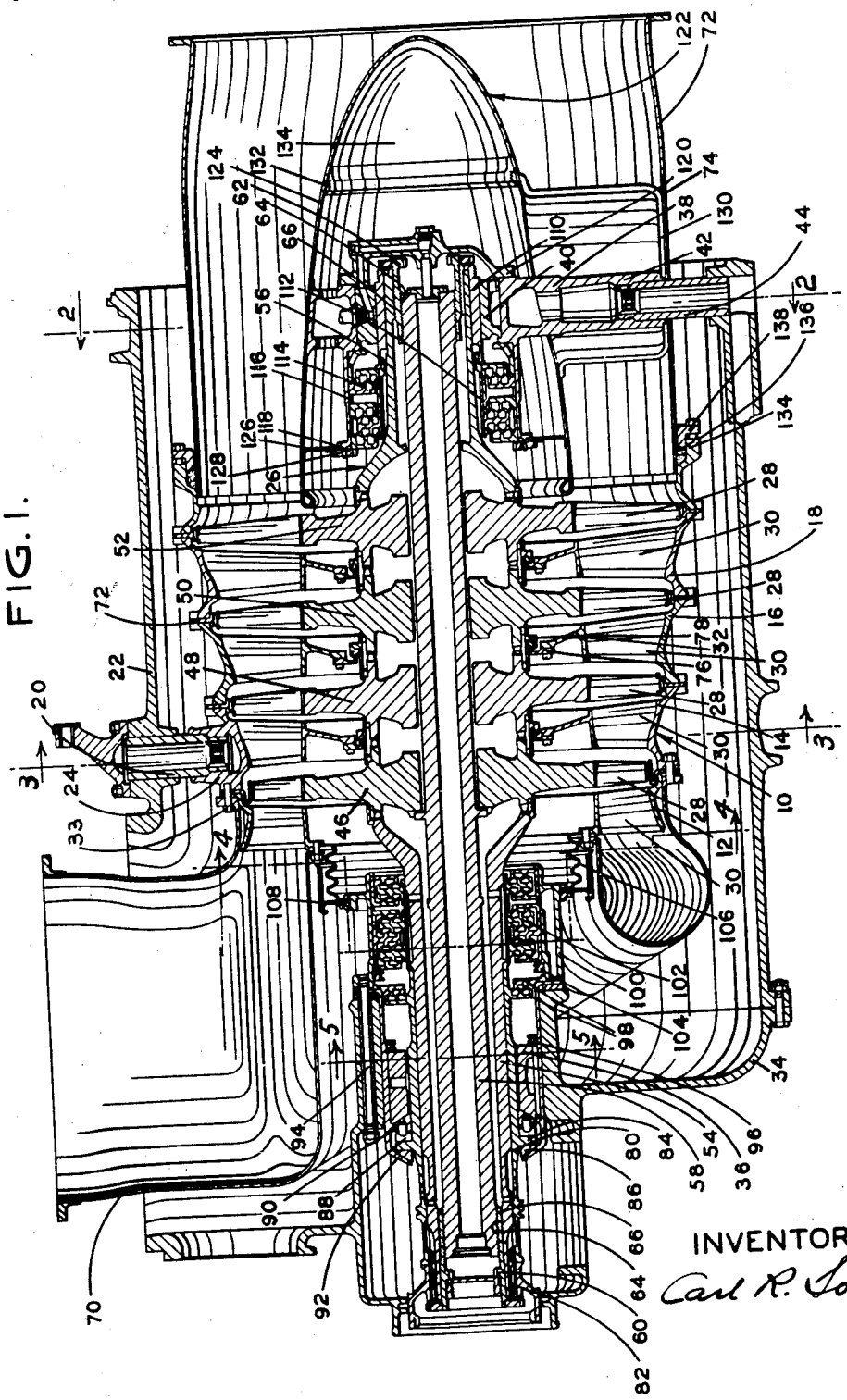
Feb. 7, 1950 C. R. SODERBERG 2,497,049

TURBINE CONSTRUCTION

Filed Aug. 23, 1944

3 Sheets-Sheet 1

FIG. 1.



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TURBINE CONSTRUCTION

Filed Aug. 23, 1944 3 Sheets-Sheet 2

FIG. 2

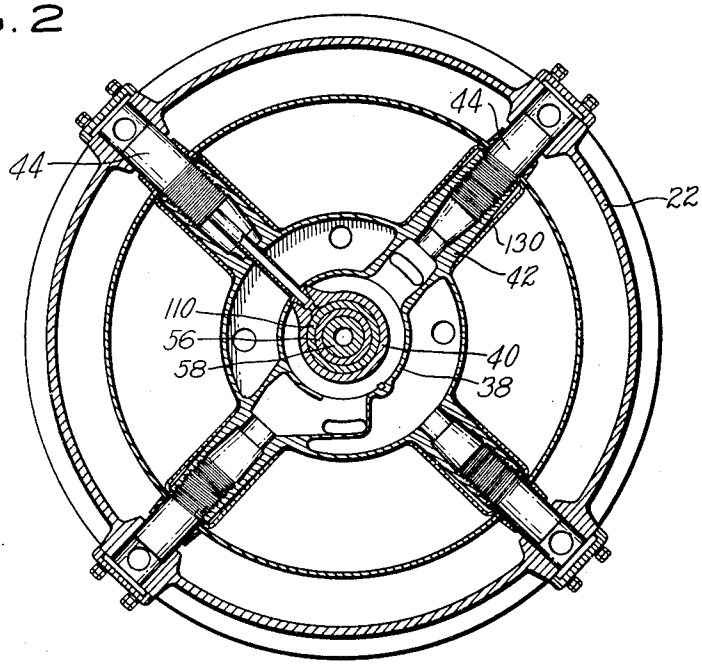
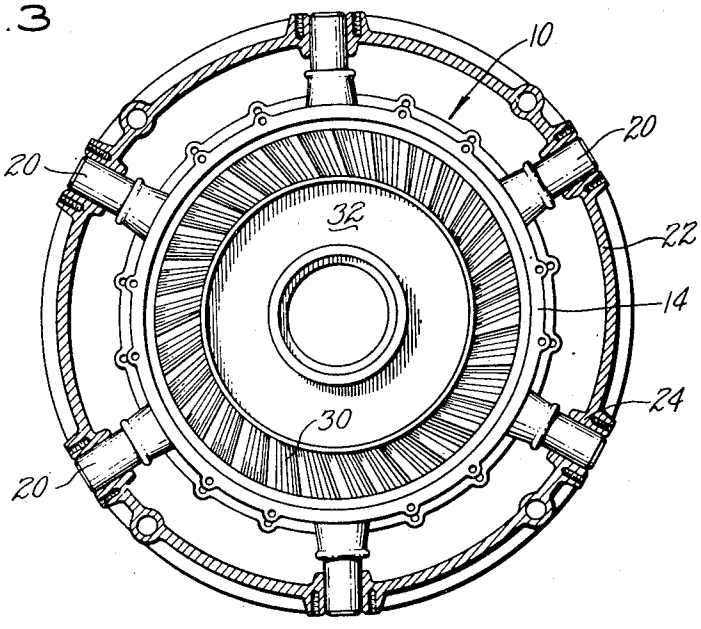


FIG. 3



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TURBINE CONSTRUCTION

Filed Aug. 23, 1944 3 Sheets-Sheet 3

FIG. 4

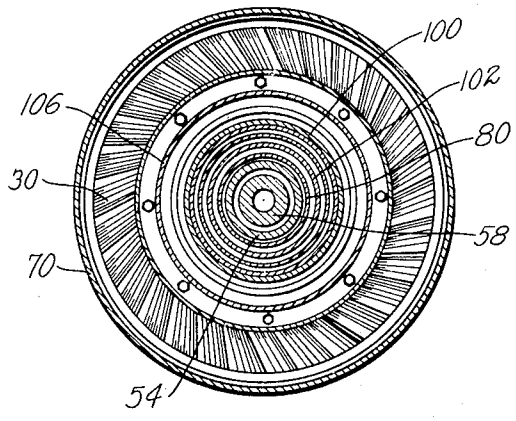
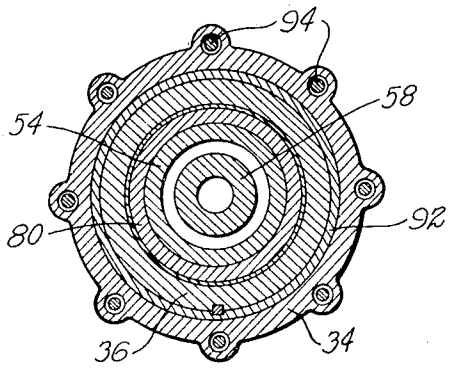


FIG. 5



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UNITED STATES PATENT OFFICE

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TURBINE CONSTRUCTION

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Application August 23, 1944, Serial No. 550,901

6 Claims. (Cl. 253—69)

1

This invention relates to a turbine and particularly to one adapted to be driven by hot gases.

Turbines in general have a solid rotor which is mounted in a longitudinally split casing. All the stationary parts of the turbine must be split to permit assembly on the rotor including the nozzle rings, the diaphragms and diaphragm seals, the seals at the periphery of the rows of turbine blades and the seals and bearings at the ends of the power section of the rotor. The split elements are difficult to machine and present problems of alignment and interconnection. A feature of this invention is a turbine in which the number of split elements is reduced to a minimum. Another feature is a turbine having no split pieces.

A feature of this invention is a turbine adapted for endwise assembly in which the rotor is made up of disks clamped together to permit the construction of a turbine having very few or no split pieces.

The co-pending application of Cronstedt Serial Number 550,879, filed August 23, 1944 (Patent No. 2,479,038, dated August 16, 1949), described a turbine having substantially all the stationary elements unsplit except for the nozzle rings and the outer elements of the diaphragm seal. The present invention is in certain respects an improvement on that application by making these parts continuous.

Since the annular parts of the turbine are continuous they may in many instances be made lighter in weight without being overstressed. Another feature of the invention is a lightweight turbine, thereby making feasible the use of the turbine in aircraft.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a longitidinal sectional view through the turbine.

Fig. 2 is a transverse sectional view on line 2—2 of Fig. 1.

Fig. 3 is a transverse sectional view on line 3—3 of Fig. 1.

Fig. 4 is a transverse sectional view on line 4—4 of Fig. 1.

Fig. 5 is a transverse sectional view on line 5—5 of Fig. 1.

The turbine shown includes a casing 10 built up of continuous rings 12, 14, 16 and 18 supported by radial pins 20 in an unsplit housing 22. These pins which are all in substantially the same plane engage bores in bosses 24 in one ring 14 of the casing. Rotor 26 within the casing has a number

2

of rows of blades 28 alternating with rows of nozzles 30 in the casing. Each casing ring has one row of nozzles preferably integral with the outer periphery of the ring and also an integral diaphragm 32 extending inwardly from the nozzles. The casing rings are connected by bolts 33.

Housing 22 has a head 34 which forms a part of the housing and supports an unsplit bearing sleeve 36 for the front end of rotor 26. At the other end of the turbine, housing 22 supports a mounting 38 within which is a bearing 40 for the rotor. The mounting has a number of legs 42 engaging radial pins 44 in the housing.

Rotor 26 is made up of a number of continuous disks 46, 48, 50 and 52 and shaft-forming end elements 54 and 56. The disks and end elements are held together by a central bolt 58. The ends of the bolt are positioned within the end elements 54 and 56 and are connected to the end elements by threaded rings 60 and 62. Each of rings 60 and 62 has inner and outer threads 64 and 66 engaging respectively with cooperating threads on the bolt and on the end elements. On one of the rings the inner and outer threads may differ in pitch so that as the ring is screwed into place a substantial tension may be applied to the bolt.

To assist in aligning the disks during assembly each disk has projecting annular flanges on opposite sides and these flanges may have interengaging elements in the form of face splines 68. The inner ends of the shaft elements 54 and 56 may have face blinds cooperating with the splines in the end disk.

Gas enters the first stage nozzles of the turbine through an inlet scroll 70 which is continuous and which is connected to the end of casing 10. Leakage of power gas past the outer ends of the blades is prevented by continuous seals 72 projecting flanges of which may be clamped between adjoining casing rings. Gas from the turbine discharges through a duct 74 connected to the end casing and surrounding the rear bearing mounting.

Leakage around the inner edges of diaphragm 32 is prevented by a labyrinth seal including a stationary element 76 connected to the inner edges of the diaphragm and a rotating element 78 mounted on the rotor. The turbine is adapted for endwise assembly since both casing and rotor are made up of annular elements and assembly of these seal elements 76 and 78 is possible without having these elements split.

At the forward end of the turbine a bearing

sleeve 80 is mounted on the shaft forming element 54 and is held against rotation on the rotor by interengaging splines 82. Sleeve 80 has a projecting flange 84 located between a bearing ring 86 and a series of bearing shoes 88 forming the thrust bearing for the turbine rotor. Shoes 88 are carried by a continuous ring 90 and ring 86 is connected to a sleeve 92, also continuous.

Sleeve 92 fits within a bore in head 34 and is held in place by bolts 94. This sleeve 90 also carries the bearing sleeve 36 which may be locked in place by a clamped ring 96.

Sleeve 80 carries the inner element of a labyrinth type of oil seal 98, the outer or stationary element of which is continuous and is clamped against head 34 by the bolts 94. These bolts also support the outer seal carrying member 100 of the labyrinth seal 102 which prevents leakage of power fluid at the intake end of the power section of the turbine. This seal is of the Ljungstrom type in which the elements consist of disks having laterally extending annular flanges fitting between cooperating flanges on the adjoining disk. By making the disks a separate element the outer stationary disks may be fitted within sleeve 100 and clamped in place by a ring 104. Similarly, the inner rotating elements of the seal may be assembled on a cylindrical part of sleeve 80 in alternating relation to the stationary sealing elements. The seals and bearings constitute a sub-assembly, all of the parts of which are continuous and which may be placed on the shaft as a unit during assembly of the turbine.

The sleeve 100 is connected to the inner periphery of the first row of nozzles by a flexible seal 106 which may be continuous and which has its forward edge clamped against a shoulder on sleeve 100 by a ring 108. The other edge of the seal is clamped between the intake duct and the inner periphery of the first nozzle.

The rear bearing and seal also forms a subassembly which may be mounted on the turbine rotor as a unit. As shown, the shaft forming element 56 has a bearing sleeve 110 held against rotation on the rotor and carrying at its inner end a sleeve 112 which supports the inner elements of a Ljungstrom type of labyrinth seal 114. As in the front seal the stationary elements are assembled within a sleeve 116 extending from and integral with the rear bearing mounting and the inner seals are assembled on sleeve 112 to alternate with the stationary elements. A clamping ring 118 holds the outer seal elements in place and the inner elements are clamped between shoulders on sleeve 112 and sleeve 110. Bearing 40 is clamped within the rear bearing mounting by a cap 120 which may be bolted to the end of the rear bearing housing.

The rear bearing mounting is covered by a fairing 122 which combines with duct 74 to define an annular path for the gas discharging from the turbine. This fairing includes an annular section 124 having an inwardly extending flange 126 which may be clamped by a ring 128 to sleeve 116. The section 124 has integral projecting fairings 130 covering the legs 42. Section 124 may be made up of several segments welded together around the rear bearing mounting. The rearward edge of section 124 carries a threaded ring 132 engaging with cooperating threads on a cap 134 which closes the end of the fairing and which when removed permits access to the end of the turbine rotor.

To permit axial expansion of the turbine casing a sliding joint is provided between a ring 134 which forms an extension of casing 10 and duct 74. This flexible joint includes packing 136 between duct 74 and ring 134, the packing being held in place by a clamping ring 138.

As above described all of the annular elements of the turbine are continuous and it is unnecessary to split any part of the turbine to permit assembly. The turbine casing and the turbine rotor may be assembled by placing the casing rings and the rotor disks alternately in position and the rotor assembly may then be completed by positioning the central bolt and fastening the rings 60 and 62 in place. The remaining parts may be assembled as will be apparent, the duct 74 being held in position by the same pins 44 that hold the rear bearing mounting. These pins also locate the rear bearing accurately within the outer housing and as will be apparent are slidable within the outer housing to permit relative expansion. The outer housing also locates the front bearing 36 and thereby assures alignment of both bearings. Locating pins 20 for casing 10 are slidable in the outside housing to permit expansion of the casing. Axial expansion of the casing is possible by reason of the expansion joint between the casing and the duct 74. Bearing sleeve 110 is axially slidable within bearing 40 to permit axial expansion of the rotor during operation, the forward end of the rotor being fixed by the thrust bearing.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. A multistage axial flow turbine having a rotor including a number of separate discs each having a row of blades at its periphery, end shafts at opposite ends of said set of discs, and means for releasably holding said discs and end shafts in assembled relation, said means being accessible at one end of said rotor, a casing surrounding said rotor and including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, means for securing said casing rings directly together in end-to-end relation to form an enclosing casing for the rotor, each ring being of a width to engage with the adjoining rings and to maintain the desired spacing between successive nozzle rings, a circumferentially unsplit housing surrounding said casing, means releasably interconnecting said housing and casing and supporting the casing within the housing, and unsplit bearing and seal elements engaging said end shafts, said housing having means associated therewith in engagement with and supporting said bearing and seal elements.

2. A multistage axial flow turbine having a rotor including a number of separate discs each having a row of blades at its periphery, end shafts at opposite ends of said set of discs, and means for releasably holding said discs and end shafts in assembled relation, said means being accessible at one end of said rotor, a casing surrounding said rotor and including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, means for securing said casing rings directly together in end-to-end relation to form an enclosing casing for the rotor, each ring being of a width to engage with the adjoining rings and to maintain the desired spacing between successive nozzle rings, a circumferentially unsplit housing

surrounding said casing, means releasably interconnecting said housing and casing and supporting the casing within the housing, unsplit bearing and seal elements supported by said housing and engaging said end shafts, said housing having means associated therewith in engagement with and supporting said bearing and seal elements, and an unsplit scroll connected to the casing and admitting fluid to the end row of nozzles, said scroll having an unbroken annular discharge opening for full admission of working fluid to the nozzles.

3. A multistage axial flow turbine having a rotor including a number of separate discs each having a row of blades at its periphery, end shafts at opposite ends of said set of discs, and means for releasably holding said discs and end shafts in assembled relation, said means being accessible at one end of said rotor, a casing surrounding said rotor and including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, means for securing said casing rings directly together in end-to-end relation to form an enclosing casing for the rotor, each ring being of a width to engage with the adjoining rings and to maintain the desired spacing between successive nozzle rings, a circumferentially unsplit housing surrounding said casing, means releasably interconnecting said housing and casing and supporting the casing within the housing, and unsplit bearing and seal elements supported by said housing and engaging said end shafts, said housing having means associated therewith in engagement with and supporting said bearing and seal elements, said housing having a substantially cylindrical surface at one end and one of said bearing and seal elements having a cooperating substantially cylindrical surface to permit endwise assembly of the bearing element within the housing.

4. A multistage axial flow turbine having a rotor including a number of separate discs each having a row of blades at its periphery, end shafts at opposite ends of said set of discs, and means for releasably holding said discs and end shafts in assembled relation, said means being accessible at one end of said rotor, said releasable holding means being a central bolt engaging with the end shafts and accessible at one end of the rotor for fastening the rotor into a unitary structure after the casing rings and rotor discs have been placed in operative position with respect to each other, a casing surrounding said rotor and including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, means for securing said casing rings directly together in end-to-end relation to form an enclosing casing for the rotor, each ring being of a width to engage with the adjoining rings and to maintain the desired spacing between successive nozzle rings, a circumferentially unsplit housing surrounding said casing, means releasably interconnecting said housing and casing and supporting the casing within the housing, and unsplit bearing and seal elements supported by said housing and engaging said end shafts, said housing having means associated therewith in engagement with and supporting said bearing and seal elements.

5. A multistage axial flow turbine having a rotor including a number of separate discs each having a row of blades at its periphery, end shafts at opposite ends of said set of discs, and means for releasably holding said discs and end shafts in assembled relation, said means being accessible at one end of said rotor, a casing surrounding said rotor and including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, means for securing said casing rings directly together in end-to-end relation to form an enclosing casing for the rotor, each ring being of a width to engage with the adjoining rings and to maintain the desired spacing between successive nozzle rings, a circumferentially unsplit housing surrounding said casing, unsplit bearing and seal elements supported by said housing and engaging said end shafts, and means extending between the housing and one of the casing rings for supporting the casing within the housing, the remaining casing rings being supported from the casing ring with which the supporting means engage.

6. A multistage axial flow turbine including a circumferentially unsplit housing, a casing having a smaller diameter than the housing for endwise positioning within said housing, means interconnecting said casing and housing for supporting the casing within the housing, said casing including a number of continuous casing rings each having a row of nozzles and a diaphragm extending inwardly from the nozzles, a rotor surrounded by said casing and including a number of separate discs each having a row of blades at its periphery and end shaft at opposite ends of said discs, said rows of blades being positioned between the successive casing rings with the blades alternating with the rows of nozzles, means for releasably holding said discs and end shafts in assembled relation including a central bolt engaging the end shafts and accessible at one end of the rotor for fastening the rotor into a unitary structure after the casing rings and rotor discs have been placed in operative position with respect to each other, unsplit bearing elements supported by said housing and engaging said end shafts, said housing having a substantially cylindrical surface at one end and one of said bearing elements having a cooperative surface to permit endwise assembly of the bearing element within the housing, and a bearing supporting structure engaging with said other bearing element and having its outermost diameter smaller than that of the housing to permit endwise insertion of the structure within the housing, said housing having means engageable with said bearing supporting structure for holding the latter in position.

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