April 10, 1951 S. C. FISHER ET AL 2,548,714

ELASTIC FLUID TURBINE

Filed May 9, 1950 2 Sheets-Sheet 1

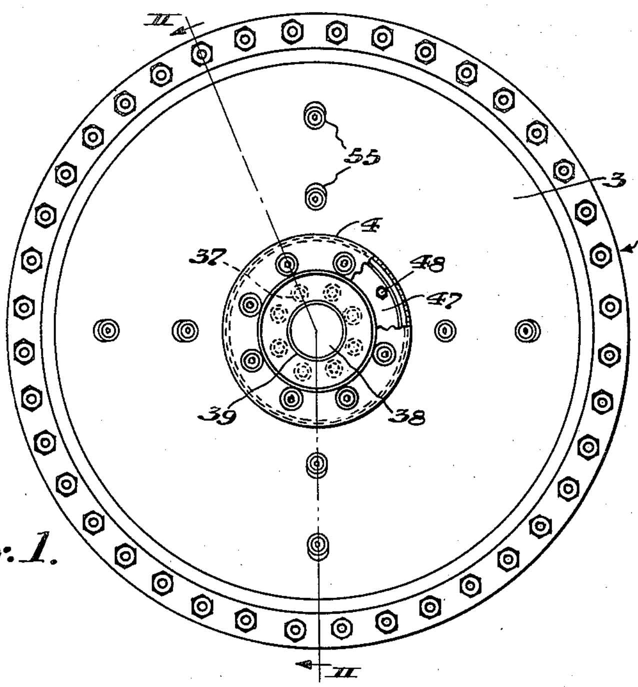

Fig. 1.

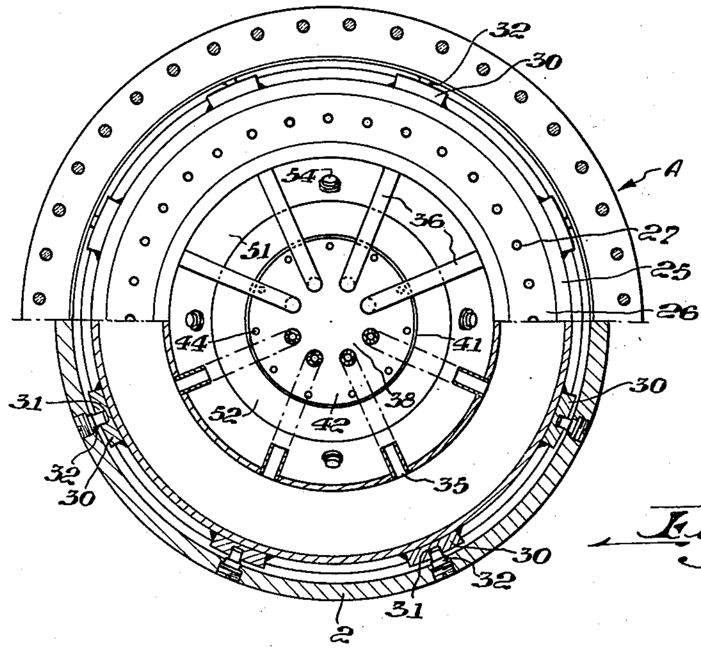

Fig. 3.

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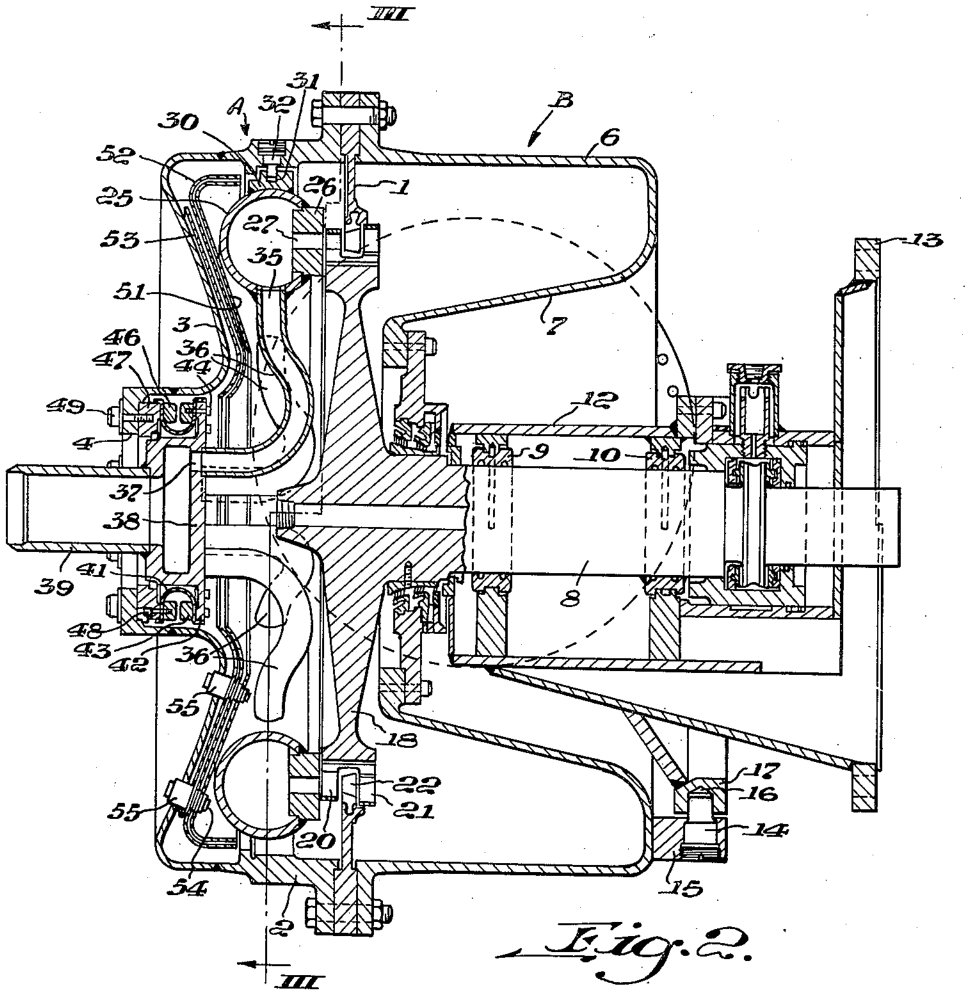

Fig. 2.

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ELASTIC FLUID TURBINE

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10 Claims. (Cl. 253—65)

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This invention relates to elastic fluid turbines, and more particularly to the means therein through which fluid is delivered to the turbine wheels.

It is among the objects of this invention to provide a turbine in which fluid is delivered to the nozzle ring symmetrically to provide for symmetrical expansion and contraction of the fluid conducting members, in which there is stress-free relative movement between parts due to expansion and contraction, in which the sealing problem is simplified, and in which the flow distribution to the nozzle ring is improved.

In accordance with this invention, the turbine casing has a side wall, and an end wall provided with a central opening. Rotatably mounted inside the casing near the end wall is a turbine rotor. A toroidal nozzle ring is mounted in the casing between its end wall and the rotor and is spaced from the side wall of the casing in a manner to allow for radial expansion of the ring when it becomes hot. This preferably is done by radially disposed pins and sockets. The ring is provided with a plurality of circumferentially spaced inlet ports, most suitably disposed radially around the inside of the ring. These ports are connected by hollow spokes with the inner end of a tubular hub that extends through the central opening in the casing end wall. The outer end of the hub is adapted to be connected to a source of elastic fluid, such as steam. The spokes are curved lengthwise so that they will not interfere with radial expansion of the nozzle ring. The hub extends loosely through the end wall opening and is encircled by flexible sealing means to allow for axial and radial movement of the hub relative to the casing when the hub expands and contracts.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which Fig. 1 is a view of the front end of the turbine; Fig. 2 is a vertical longitudinal section of the turbine, with the section through the front portion taken on the line II—II of Fig. 1; and Fig. 3 is a transverse section of the turbine taken on the line III—III of Fig. 2.

Referring to Fig. 2 of the drawings, the turbine casing is formed from an inlet section A and an outlet section B which are bolted together with a blade diaphragm 1 between them. The inlet section has a cylindrical side wall 2 and a concave end wall 3 provided at its center with an opening encircled by an axially projecting portion of the end wall. The outer or front end of this latter portion is provided with an inner radial flange 4. The outlet casing B has an outer

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side wall 6 and a re-entrant inner side wall 7. The front end of the latter encircles the overhanging front end of a rotor shaft 8 that extends back through axially spaced bearings 9 and 10 mounted in a bearing housing 12. The rear end of the housing is provided with a bolting flange 13 for fastening it to the machine (not shown) that the shaft is to drive. The bearing housing supports the surrounding outlet section B of the turbine casing through radial pins 14 that are mounted in lugs 15 projecting from the rear end of the casing. The inner ends of the pins are slidably mounted in socket 16 in a broken ring 17 that partially encircles the bearing housing, to which it is rigidly connected. Integral with the front end of the shaft is a turbine rotor 18 provided with two axially spaced rows of turbine blades 20 and 21. The inside of the diaphragm 1 is provided with a row of stationary blades 22 that project into the space between the two rows of rotor blades.

In order to deliver elastic fluid, such as hot gases or steam, to the turbine blades, a nozzle ring 25 is mounted in the inlet section of the casing between the rotor and the front wall 3 of the casing. This ring is a toroid, like an automobile tire, and includes a flat annulus 26 welded in the side of it facing the rotor. This annulus is provided with a plurality of circumferentially spaced axial nozzle openings 27 directed against the first row of blades 20 of the turbine wheel. The nozzle ring is supported by the side wall 2 of the inlet section of the casing, but is spaced therefrom when cold so that the ring can expand radially in the casing without obstruction from the latter. To mount the ring in the casing in this way it preferably has a plurality of circumferentially spaced blocks 30 welded around its outside, as shown in Fig. 3, and provided with radial sockets 31. Slidably fitted in these sockets are pins 32 that are rigidly mounted in radial openings in the side wall of the casing inlet section. These pins hold the ring in correct position in the casing, but permit it to expand and contract radially without restraint. Expansion of the ring relative to the casing is especially pronounced when the ring is made of stainless steel and the casing of a low alloy steel.

For admitting fluid to the nozzle ring it is provided around its inside with a plurality of uniformly spaced radial inlet ports 35. Elastic fluid is delivered to these ports through tubular spokes 36 which are welded to the ring and which extend radially inward therefrom and then axially of the casing toward the central opening in the end wall 3 of the casing inlet section. The inner or inlet ends of these hollow spokes are mounted in circumferentially spaced outlet ports 37 extending through the inner end wall 38 of a tubular hub 39 that extends out of the casing through the end wall opening. The outer end of this hub is adapted to be connected to a steam supply line or the like by which vapor or gas under pressure is delivered to the hollow spokes which conduct it into the nozzle ring. The hub is spaced from the end wall of the casing so that there can be relative movement between them in all directions without restriction. The central portion of each spoke, between its radially and axially extending end portions, is curved inward toward the rotor to make the spoke more flexible, especially lengthwise. Consequently, the spokes do not interfere with radial expansion and contraction of the nozzle ring, because their curved central portions are free to bend either more or less as the diameter of the ring changes. Likewise, the curved central portions of the spokes permit unrestrained axial movement of hub 39 relative to the nozzle ring.

The space between the casing end wall and the hub is closed by sealing means which include a flexible sealing member 41. This member encircles the portion of the hub inside the casing and is concave in cross section. In other words, the sealing member is substantially semitoroidal. The inner edge portion of the sealing member engages a radial flange 42 that encircles and is integral with the inner end of the hub. The sealing member is clamped against this flange by a clamping ring 43 and cap screws 44. The edge of the sealing member projects from between the ring and flange and is bent over the periphery of the flange and welded to it to form a seal. The weld is not put under any strain when the sealing member is flexed, because the sealing member is held tightly between the clamping ring and flange. The opposite edge portion of the sealing member is clamped in like manner between inner and outer clamping rings 46 and 47 which are fastened together by cap screws 48. The inner edges of the clamping rings 43 and 46 adjacent the concave surface of the sealing member are relieved or curved so that the sealing member will not bend sharply around them when flexed. The outer edge of the sealing member is welded to the outer ring, which is fastened tightly against the inner surface of the end wall flange 4 by means of cap screws 49. It will be seen that when these last cap screws and radial pins 32 are removed, the fluid inlet assembly consisting of nozzle ring, hollow spokes, hub and attached sealing means, can be removed as a unit from the inlet section of the casing. It is mounted in the inlet section originally by just reversing this procedure. Sealing member 41 permits unrestrained movement of the hub in all directions in the end wall opening, due to expansion and contraction of the different parts of the turbine.

A plurality of spaced annular radiation shields 51, 52 and 53 may be connected to the end wall 3 of the casing between its inner surface and the nozzle ring. These shields are held in place by screws 54 screwed into plugs 55 rigidly mounted in the casing end wall.

Another advantage of this invention is that, due to the use of hollow radial spokes for conducting the fluid to the nozzle ring, the flow resistance to the ring is axially symmetric. Also, as the fluid is admitted to the ring at a number of uniformly spaced points around it, instead of at only one point, the circumferential flow distribution in the ring is greatly improved.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring mounted in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes being curved lengthwise to prevent interference with radial expansion of the ring.

2. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes extending from the hub toward the rotor and then curving outward toward the ring.

3. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of radial inlet ports around its inside, a tubular hub extending through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes extending from the hub toward the rotor and then curving outward and extending substantially radially of the ring to said ports.

4. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of radial inlet ports around its inside, a tubular hub extending through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, the hub having an inner end wall provided with a plurality of circumferentially spaced outlet ports,

and a plurality of hollow spokes connected to said outlet ports and extending toward the rotor and then curving outward and extending substantially radially of the ring to said inlet ports.

5. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring mounted in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending loosely through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, expansible sealing means connecting the hub to said end wall to allow for axial expansion of the hub, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes being curved lengthwise to prevent interference with radial expansion of the ring.

6. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending loosely through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, a flexible sealing member encircling the hub and being concave in cross section, means for connecting the opposite edges of the sealing member to said end wall and hub, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes being curved lengthwise to prevent interference with radial expansion of the ring.

7. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring mounted in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending loosely through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, the inner end of the hub being encircled by a radial flange spaced from said end wall, an axially expansible sealing member encircling the hub between said flange and end wall, a clamping ring clamping one edge portion of the sealing member against the flange, clamping means connecting the opposite edge portion of the sealing member to said end wall, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports.

8. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring mounted in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending loosely through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, the inner end of the hub being encircled by a radial flange spaced from said end wall, a flexible sealing member encircling the hub between said flange and end wall, said member being concave in cross section, a clamping ring clamping one edge portion of the sealing member against the flange, a pair of clamping rings clamping the opposite edge portion of the sealing member between them, means tightly connecting one of said pair of clamping rings to said casing end wall, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports.

9. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring mounted in the casing between said end wall and rotor and spaced from said side wall to allow for radial expansion of the ring, said ring being provided with a plurality of radial inlet ports around its inside, a tubular hub extending loosely through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, the inner end of the hub being encircled by a radial flange spaced from said end wall, a flexible sealing member encircling the hub between said flange and end wall, said member being concave in cross section, a clamping ring clamping one edge portion of the sealing member against the flange, a pair of clamping rings clamping the opposite edge portion of the sealing member between them, means tightly connecting one of said pair of clamping rings to said casing end wall, said hub having an inner end wall provided with a plurality of circumferentially spaced axial outlet ports, and a plurality of hollow spokes connected to said outlet ports and extending toward the rotor and then curving outward and extending substantially radially of the ring to its inlet ports.

10. An elastic fluid turbine comprising a casing provided with a side wall, a turbine rotor rotatably mounted in the casing, the casing having an end wall in front of the rotor provided with a central opening, a toroidal nozzle ring disposed in the casing between said end wall and rotor and spaced from said side wall, said ring being provided around its outer side with a plurality of circumferentially spaced radial sockets, radial pins slidably fitted in said sockets and rigidly mounted in the casing side wall for supporting the ring concentrically within the case, said ring also being provided with a plurality of circumferentially spaced inlet ports, a tubular hub extending through said end wall opening with its outer end adapted to be connected to a source of elastic fluid, and a plurality of hollow spokes connecting the inner end of the hub with said ring ports, said spokes being curved lengthwise to prevent interference with radial expansion of the ring.

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