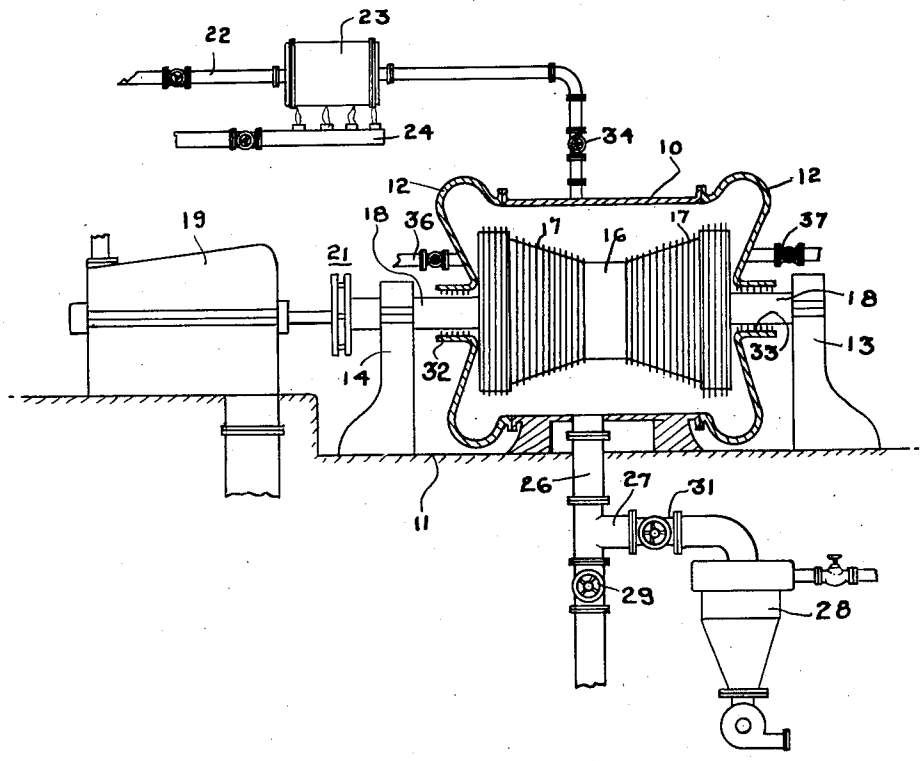
June 5, 1928. 1,672,126

F. HODGKINSON

ELASTIC FLUID TURBINE

Filed April 11, 1925



WITNESSES:

F. Hodgkinson
INVENTOR

BY D. C. Davis

ATTORNEY

Patented June 5, 1928. 1,672,126

UNITED STATES PATENT OFFICE.

FRANCIS HODGKINSON, OF SWARTHMORE, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELASTIC-FLUID TURBINE.

Application filed April 11, 1925. Serial No. 22,364.

My invention relates to elastic fluid turbines, more particularly to the rotors thereof, and has for its object to provide a process for seasoning said rotors before being placed into service whereby they shall be maintained in permanent dynamic balance.

Apparatus adapted to carry out my improved process is illustrated in the accompanying drawing in which the single figure illustrates schematically, apparatus adapted to carry out my invention.

In the manufacture of elastic fluid turbines, especially of relatively large turbines having relatively long rotors, it is the usual practice to insert the blades in the rotor and to dynamically balance it before placing it in service. It has been found, however, especially with such large rotors that, after being placed in service and when subjected to the high temperatures employed in modern apparatus, the rotor may become seriously unbalanced. I have found that this is due to a slight movement of the blades in the slots or to a slight flow of material in the rotor when subjected to the high temperature and stresses of operation so that the material thereof assumes different relative positions from those when originally balanced.

In accordance with my invention, after the rotor is first dynamically balanced, I gradually heat it to a predetermined temperature, preferably to somewhat above its designed working temperature, slowly rotating it during this part of the process in order to secure an even distribution of heat. I then rotate the rotor at a speed somewhat above its designed operating speed and finally gradually and uniformly cool it while rotating at a lesser speed. When this process has been carried out I have found that the metal of the rotor and the blades in the slots will have assumed their permanent set. If, in assuming this condition, the rotor has become dynamically unbalanced, it may be again balanced and permanently remain in balance.

Referring now to the drawing I show, by way of example, a closed vessel 10 mounted upon a suitable foundation 11. The vessel 10 may be provided with removable heads, 12—12, and heads of different shapes provided to accommodate rotors of different lengths. Associated with the vessel 10 are two bearing pedestals 13 and 14 disposed at opposite ends of the vessel 10 so as to accommodate the shafts of rotors to be tested. Within the vessel 10 I show a rotor 16 to which blades 17 have already been applied. The shaft 18 of the rotor 16 is mounted in the bearing pedestals 13 and 14. At 19 I show a relatively small turbine employed to drive the rotor 16 during the seasoning process and which is coupled to the shaft 18 of the rotor 16 by means of a flexible coupling 21. At 22 I show a heating medium supply mains, such, for example, as a steam main, leading through a super-heater 23 to the vessel 10. The super-heater 23 is provided with heating means 24, such as an oil burner, the intensity of which may be readily varied. Steam admitted to the vessel 10 is exhausted through a conduit 26. Leading from the conduit 26 is a branch conduit 27 which is connected to a condenser 28. Valves 29 and 31 are provided in the conduit 26 and branch conduit 27 respectively, so that the steam passing through the vessel 10 may be exhausted either directly to the atmosphere or through the condenser 28, thereby creating a vacuum within the vessel 10. The vessel 10 is provided with glands 32 and 33 to prevent material leakage of fluid from or to the interior thereof. A valve 34 is also provided in the steam main 22 so that when it is desired to quickly evacuate the vessel 10, the valve 34 is closed and the condenser 28 put in operation. Means should also be provided for admitting air at atmospheric pressure, when desired, to the vessel 10. To this end I show pipes 36 and 37 leading to the interior of the vessel 10.

In carrying out my process, I place the rotor 16 within the vessel 10, as previously described, and slowly rotate it by means of the turbine 19. At the same time, I admit steam, which need be only at a pressure slightly above atmospheric, from the main 22. During this part of the process the valve 29 is opened so that there is a circulation of steam through the vessel 10. With rotors of relatively large size this operation is continued for about two hours when the burners 24 under the super-heater 23 are lit and the temperature of the steam at the exit of the super-heater 23 slowly brought up to

about 700° F. About six hours are consumed in this operation. At the same time I maintain a constant flow of steam through the vessel 10. With the temperature of the steam at about 700° F., or somewhat above the designed normal working temperature, and a constant flow through the heater box I continue slowly rotating the rotor 16 for about six hours more. By this time the temperature of the rotor has reached approximately the temperature of the steam. It should be understood however, that in stating approximate periods of time I have in mind relatively large rotors which require that period of time to acquire the temperatures mentioned. It will be obvious however, that the time required for carrying out this process would be less with relatively smaller bodies and greater with relatively greater bodies and that the periods of time mentioned are given only by way of example.

After the steps previously described have been carried out, I close off the valves 34 and 29 and open the valve 31, putting the condenser 28 in operation. This quickly evacuates the vessel 10 so that the rotor 16 may now be rotated by the turbine 19 at the expense of relatively little power. The turbine 16 is then rotated at a speed somewhat above its designed normal operating speed. I have found that a 20% overspeed is sufficient to successfully carry out this process. With the rotor 16 operating above its normal operating speed and at a temperature somewhat above its designed normal operating temperature any flow of material within the rotor which might occur in operation occurs in this process and the material of the rotor assumes its permanent set. This part of the operation is continued for about twenty minutes when the speed of the rotor is reduced to the slow rotation employed in the earlier part of the process.

The condenser 28 is then cut out of operation, the valves 29 and 34 are opened and the fire extinguished from under the superheater 23. This again provides for a circulation of saturated steam through the vessel 10, which permits a gradual cooling of the rotor 16. This operation is continued for about six hours when the rotor will have cooled sufficiently so that the valves in the openings 36 and 37 may be opened, permitting air at atmospheric pressure to pass to the interior of the vessel 10 and out at the exhaust conduit 26. When air is being admitted to the vessel 10, the valve 34 is kept closed.

The rotor is kept slowly rotating while being cooled by air being drawn in through the openings 36 and 37 for a period of about six hours when it will have cooled down to approximately the temperature of the surrounding atmosphere. After this process has been carried out it may again be checked for dynamic balance and if any marked flow of material has resulted from the heating and cooling process it should be again balanced and again put through the same heating and cooling process, repeating the process a sufficient number of times until no marked change in condition of balance is noted after the process. When this has been done I have found that rotors will, when placed in service, retain their dynamic balance over much longer periods of time than were they not so seasoned.

From the foregoing it will be apparent that I have invented an improved process for seasoning rotatable bodies whereby they may be placed in service and remain permanently in dynamic balance.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:—

1. The process of seasoning a rotatable body comprising rotating the body and simultaneously heating it to a predetermined temperature approximately as high as its designed working temperature, subjecting it to stresses incident to service operation, and then gradually and uniformly cooling it.

2. The process of seasoning a rotatable body comprising rotating the body at a speed below its designed normal operating speed and simultaneously gradually heating it to a predetermined temperature approximately as high as its designed working temperature, increasing the rotational speed to above its designed operating speed, and gradually and uniformly cooling it.

3. The process of seasoning a turbine rotor comprising rotating the rotor within a closed vessel and simultaneously subjecting it to a gas at a predetermined temperature somewhat above that of the designed temperature of motive fluid to be employed with the rotor until it acquires a temperature approximately that of the gas, then rotating it at a speed somewhat above its designed normal operating speed, and then slowly rotating it in the vessel in an atmosphere of heat absorbing medium until cooled.

4. The process of seasoning a turbine rotor comprising slowly rotating the rotor within a closed vessel and simultaneously subjecting it to an atmosphere of fluid at a predetermined temperature approximately as high as its designed temperature until the rotor acquires a temperature approximating that of the fluid, rotating it at a speed somewhat above its designed normal operating

speed, and slowly rotating it and circulating through the vessel a heat absorbing medium until the rotor is cooled.

5. The process of seasoning a turbine rotor comprising, placing the rotor in a closed vessel and rotating it slowly and at the same time circulating through the vessel steam superheated somewhat above the designed normal temperature of motive fluid at admission until the rotor acquires a temperature approximating that of the superheated steam, evacuating the vessel and rotating the rotor at a speed slightly above its designed normal operating speed for about twenty minutes, slowly rotating the rotor in an atmosphere of saturated steam, and circulating air at atmospheric pressure through the vessel and at the same time slowly rotating the rotor until cooled.

6. The method of seasoning a turbine rotor comprising, placing the rotor in a closed vessel and slowly rotating it in an atmosphere of steam superheated to approximately 700° F. until the rotor acquires a temperature approximating that of the steam, evacuating the vessel and rotating the rotor at approximately 20% overspeed for about twenty minutes, reducing the speed of the rotor and circulating saturated steam through the vessel until the rotor is partially cooled and then circulating air at atmospheric pressure and temperature until the rotor is finally cooled.

In testimony whereof, I have hereunto subscribed my name this third day of April 1925.

FRANCIS HODGKINSON.