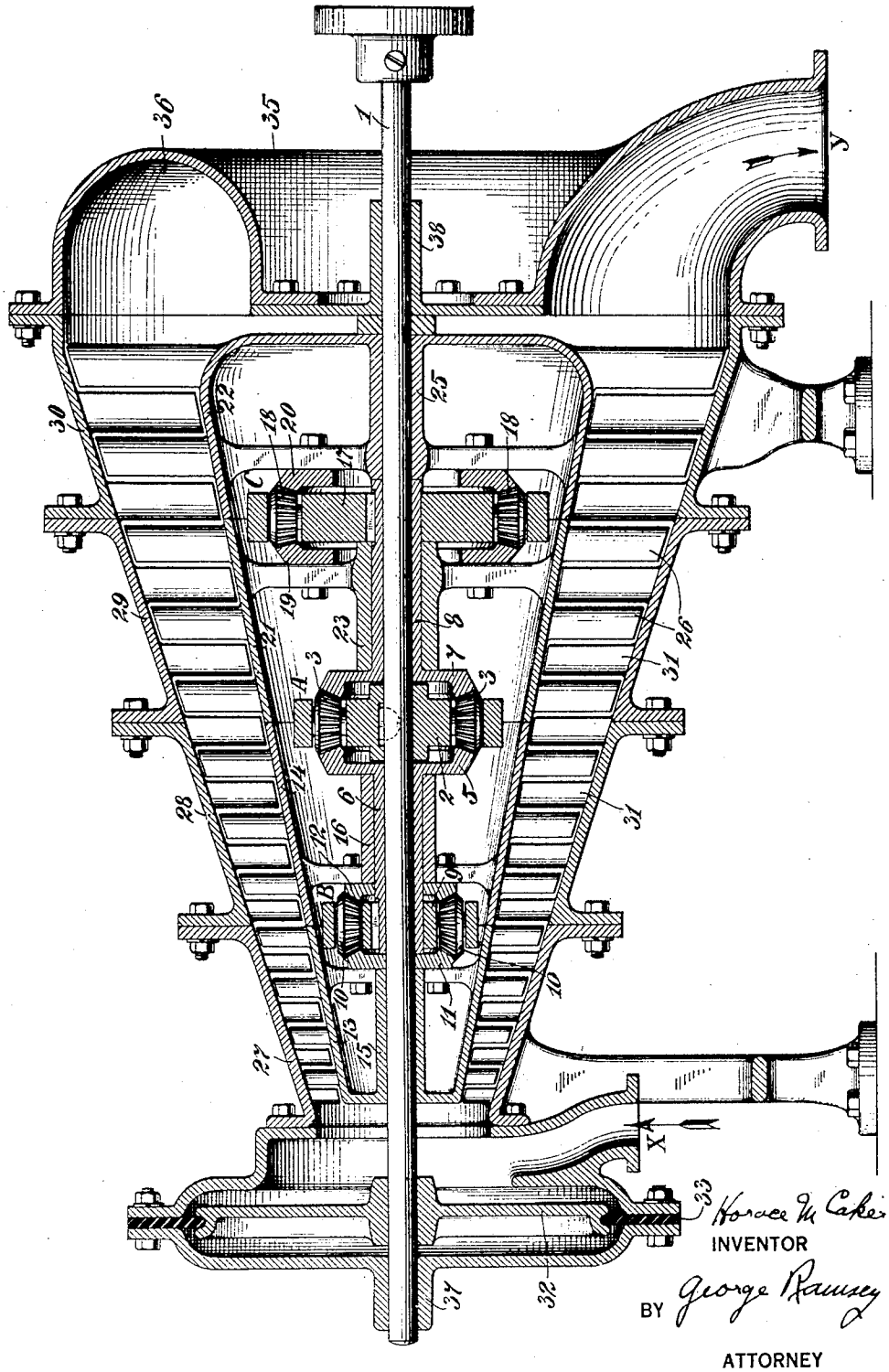
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TURBINE.

APPLICATION FILED JULY 6, 1918.

1,398,124. Patented Nov. 22, 1921.



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TURBINE.

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To all whom it may concern:

Be it known that I, HORACE M. CAKE, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Turbines, of which the following is a specification.

This invention relates broadly to prime movers and more particularly to turbines.

The principal object of the present invention is a turbine having a plurality of rotors all of which are connected one to another and to the power shaft by compensating means in such manner that each of the several rotors delivers the same amount of energy to the power shaft.

A still further object of the present invention is a turbine of the character specified wherein a plurality of rotors are connected through differential gears with the power shaft in such manner that the energy transmitted to the power shaft is derived in equal amounts from each rotor.

More specifically the present invention comprises a turbine wherein the power transmitted from a plurality of rotors to the driving shaft is transmitted to differential gearing in such manner that each rotor is allowed independent rotation in order to permit each rotor to operate at the same efficiency as any other rotor in the system so that each rotor transmits a definite proportionate amount of the total horse power irrespective of the load on the turbine or the fluid pressure used in driving the turbine.

Other and further objects of this invention will in part be obvious and will in part be pointed out hereinafter by reference to the accompanying drawings.

The figure of the drawings is more or less diagrammatic and illustrates one form of turbine to which the present invention is applied and shows a longitudinal section through the turbine.

Heretofore in the art of turbines it has been customary where an elastic fluid, such as steam, is used as a driving power to provide a plurality of rotors for utilizing the expansion of the steam as a driving force. It has been customary to rigidly lock each of these rotors upon a common driving shaft so that it is necessary to design the turbine in such manner that its highest efficiency is obtained when the turbine is supplied with a predetermined fluid pressure and rotates under a predetermined load. Variations either of the load or of the initial pressure depreciates the efficiency of such a turbine. Heretofore in the art of turbines it has been necessary, in most types of turbines, to heat, or "warm up" the turbine before the full steam pressure for driving the turbine can be turned on since turning the steam into a cold turbine causes condensation which may produce enough water to break the blades if a sufficient head of steam be admitted to furnish power to drive the rotor.

The present invention overcomes the difficulties of the known art by providing a plurality of rotors all of which are connected to the driving shaft through compensating members, preferably differential gears, in such manner that each rotor may have a relatively independent rotation controlled, however, by the amount of horsepower being delivered by each other rotor, so that if any one rotor is not delivering full efficiency the other rotors will tend to check until the lagging rotor picks up. In view of the fact that the ability of the rotors to continually compensate is always present, the compensating action is substantially continuous throughout the entire driving mechanism when the machine is operating, so that at all times one rotor is operating at the same efficiency as any other motor; the result of this is a higher efficiency for the entire turbine, which efficiency is not depreciated by a change of load and change of fluid pressure. Furthermore where steam is turned into the cold turbine and condensation occurs the particular rotor wherein the condensation is greatest may slow down while the force of the steam is equalized by other rotors, so that the breakage of blades is avoided.

Referring now to the drawings, wherein one form of the invention is illustrated, the driving shaft 1 is provided with a header 2 that carries compensating gears 3 which mesh on one side with a bevel gear 5 carried upon the tubular shaft 6 and which mesh on their opposite sides with a bevel gear 7 carried by the tubular shaft 8. The compensating gears 3 pivoted on the header 2 together with the beveled gear 5 and the beveled gear 6 comprise the main differential gearing A, through which all power from the rotors is transmitted to the driving shaft,

The tubular shafts 6 and 8 are mounted to rotate upon the main drive shaft 1 and the tubular shaft 6 carries a sub-header 9 upon which are pivoted compensating gears 10 that mesh on one side with a bevel gear 11 and mesh on the other side with a bevel gear 12. The bevel gear 11 is carried by the first stage rotor 13 and the bevel gear 12 is carried by the second stage rotor 14. The first stage rotor 13 is provided with a bearing 15 adapted to freely rotate around the main driving shaft 1 and the second stage rotor 14 is likewise provided with a bearing 16 adapted to freely rotate upon the tubular shaft 6. The compensating gears 10 pivoted on the sub-header 9, together with the bevel gears 11 and 12 comprise a sub-differential gearing B. The tubular shaft 8 is also provided with a sub-header 17 which carries compensating gears 18 that mesh on one side with a bevel gear 19 and on the other side with a bevel gear 20. The bevel gear 19 is carried by the third stage rotor 21 and the bevel gear 20 is carried by the fourth stage rotor 22. The third stage rotor 21 is provided with a bearing 23 adapted to freely rotate around the tubular shaft 8 while the fourth stage rotor 22 is provided with a bearing 25 adapted to freely rotate upon the main driving shaft 1. The compensating gears 18 pivoted on the sub-header 17 together with the bevel gears 19 and 20 comprise the sub-differential gearing C. The rotors 13, 14, 21, and 22 are provided with curved blades 26, as is common in the art, and these blades increase in length and width from the inlet or first stage rotor to the outlet or fourth stage rotor. The rotors are surrounded by a casing which preferably is made in sections 27, 28, 29, and 30, each section comprising the frustum of a cone and may be provided with flanges adapted to be bolted together. These sections carry stationary or directing blades 31 which are mounted in rings between the movable curved blades 26 on the rotors. The inlet end of the turbine is provided with an end casing in which is the inlet opening X, and this end casing is enlarged to form a chamber for the counter balancing disk 32. This disk 32 coöperates with a fluid tight ring 33 and compensates and counterbalances the end thrust of the motive fluid on the rotors. The outlet end of the casing may be provided with an enlarged terminal section 35 in which is provided a relatively large chamber 36 into which the exhaust steam, or other motive fluid, escapes and this terminal casing 35 is provided with an outlet or exhaust opening Y. Suitable bearings 37 and 38 are provided for the main shaft and in large size motors it may be desirable to provide intermediate bearings, which may be done by introducing diaphragms at suitable intervals in the casing. While there are numerous features to the present invention the main and principal features reside in the arrangement of differential gearing, or its equivalent connecting the rotors and the main shaft, so that there is a balance or compensating action throughout the entire driving element of the turbine; and while a preferred form is illustrated, it is obvious that this broad feature may be incorporated in constructions other than those herein shown. While the form illustrated is best adapted for expansible motive fluid such as steam or compressed air it is obvious that this compensating feature is equally adaptable to water turbines.

In the operation of the turbine, the steam or other motive fluid enters through the inlet opening X and flows between the blades 26 and 31 to the outlet opening Y. During the flow and expansion of this motive fluid the rotors are driven and the energy of the first and second rotors 13 and 14 is transmitted through the sub-differential gearing B to the tubular shaft 6. Obviously any tendency of the first rotor 13 to deliver less than its full proportion of the total energy will be met by a reaction on the second rotor 14 so that through the medium of the differential gearing B these two rotors are at all times balanced, so far as the energy delivered is concerned. A similar condition exists between the third and fourth stage rotors 21 and 22 since these rotors are balanced through the sub-differential gearing C. The total energy of the first two rotors 13 and 14 is transmitted through the tubular shaft 6 to the bevel gear 5, and the total energy of the second pair of rotors 21 and 22 is transmitted through the tubular shaft 8 to the bevel gear 7. Therefore the entire energy of all of the rotors is transmitted to the main driving shaft through the main differential gearing A.

In view of the arrangement of the differential gearings described it will be evident that the entire rotor system is so balanced by compensating mechanism that each rotor will at all times deliver a definite proportional amount of the total energy being delivered to the driving shaft. This compensating action very greatly reduces vibration, thereby eliminating this loss and conserving for useful work energy that heretofore has been wasted and which has been detrimental to the turbine and plant in which the turbine may be operating.

I claim—

1. In a turbine or the like the combination of a casing, stationary director blades carried by said casing, a plurality of rotors within said casing, blades on said rotors and adapted to pass between the stationary blades, a driving shaft comprising the support for said rotors, a power shaft, a pair of tubular shafts mounted on said power

shaft, a differential gearing connecting said power shaft to said tubular shafts, and differential gearing connecting said tubular shafts to said rotors.

2. In a turbine or the like the combination of a power shaft, a differential gearing carried by said power shaft, tubular shafts rotatably mounted on said power shafts and being connected to said differential gearing, secondary differential gearings connected with said tubular shafts, and rotors operatively connected with said secondary differential gearings.

3. In a turbine or the like the combination of a driving shaft, a plurality of rotors mounted to rotate around said power shaft, secondary differential gearings between certain of said rotors, and a main differential gearing operatively connecting the secondary differential gearings with the power shaft.

4. In a turbine or the like the combination of a power shaft, a differential gearing comprising a header carried by said power shaft, tubular shafts extending in opposite directions from said header and operatively connected to said differential gearing, said tubular shafts being mounted to rotate upon said power shaft, a plurality of bladed rotors mounted to rotate around said power shaft, secondary differential gearing operatively connecting certain of said rotors with one tubular shaft, another secondary differential gearing operatively connecting other of said rotors with the other tubular shaft, and a blade carrying casing surrounding said rotors.

5. In a turbine or the like the combination of a power shaft, a header carried by said power shaft, compensating gears mounted to rotate on said header, a pair of tubular shafts mounted on said power shaft and on opposite sides of said header, beveled gears on said tubular shafts in engagement with said compensating gears, headers on the end of each tubular shaft, compensating gears carried by said last mentioned headers, a pair of rotors adjacent each of said last mentioned headers, and bevel gears carried by said rotors and in engagement with the last mentioned compensating gears carried by the headers adjacent to the respective rotors, whereby the effective driving power of each rotor is equal to the effective driving power of any other motor in the system.

6. In a turbine or the like the combination of a power shaft, a plurality of rotors mounted to rotate around said power shaft, differential gearing operatively connecting said rotors with said power shaft, blades mounted upon said rotors, a casing surrounding said rotors and stationary blades secured to said casing, said casing comprising sections, the length of each section being substantially the same as the length of the rotor adjacent thereto.

7. In a turbine or the like the combination of a plurality of rotors, a power shaft, compensating means operatively connecting said rotors to said power shaft in such manner that the speed of rotation of each rotor may be variable relatively to the other rotors, and is dependent on the speed of rotation of the other rotors, and means for directing motive fluid to said rotors.

HORACE M. CAKE.