E. F. W. ALEXANDERSON.

METHOD OF MANUFACTURING ROTATING BODIES FOR HIGH SPEED MACHINERY.

APPLICATION FILED AUG. 3, 1907.

998,734. Patented July 25, 1911.

Fig. 1.

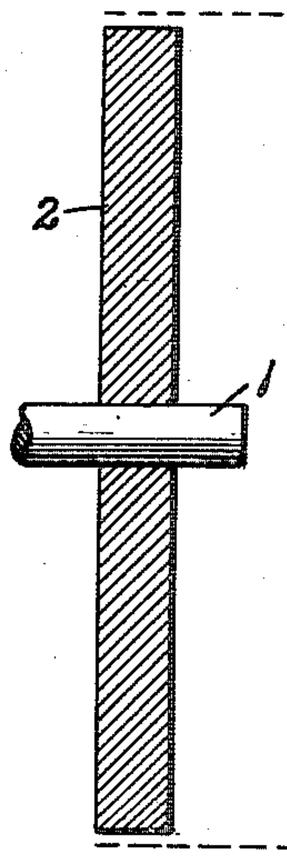


Fig. 2.

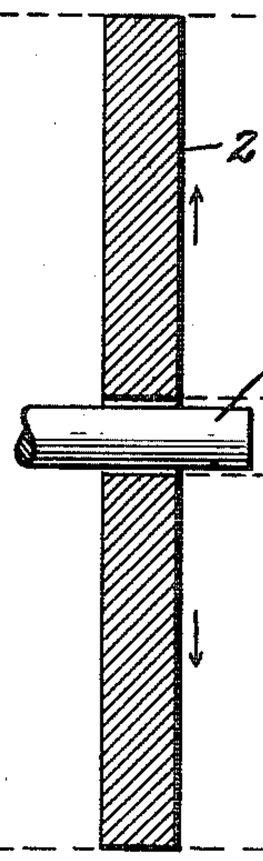


Fig. 3.

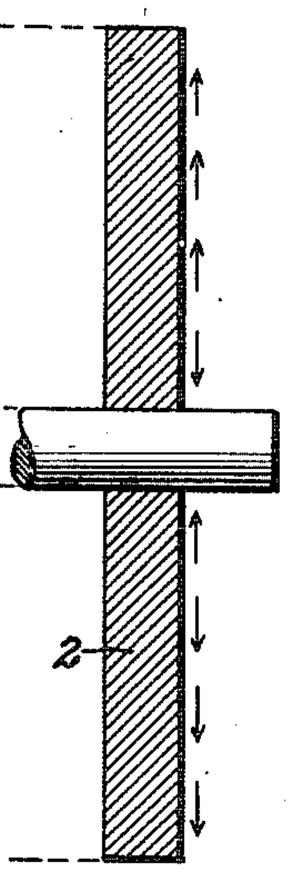


Fig. 4.

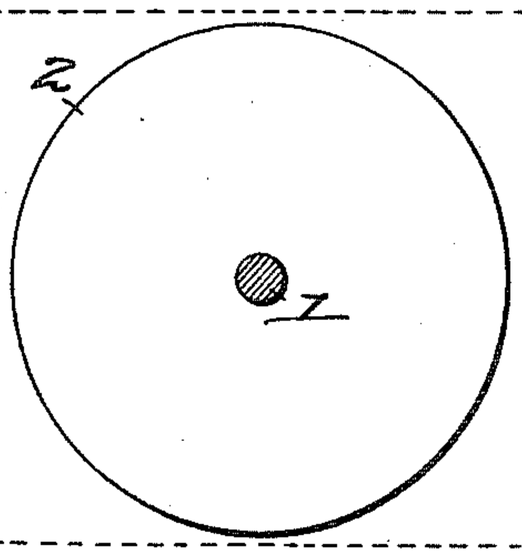


Fig. 5.

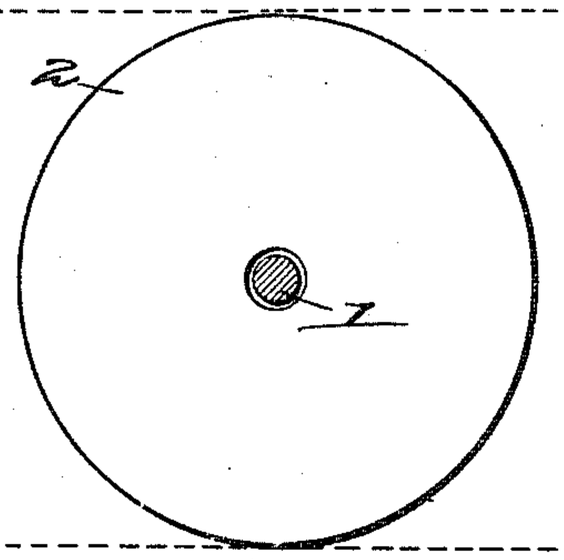
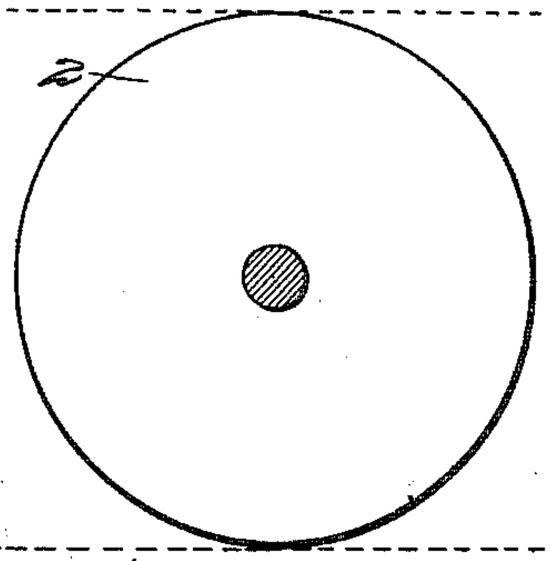


Fig. 6.



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UNITED STATES PATENT OFFICE.

ERNST F. W. ALEXANDERSON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD OF MANUFACTURING ROTATING BODIES FOR HIGH-SPEED MACHINERY.

998,734. Specification of Letters Patent. Patented July 25, 1911.

Application filed August 3, 1907. Serial No. 386,980.

To all whom it may concern:

Be it known that I, ERNST F. W. ALEXANDERSON, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods of Manufacturing Rotating Bodies for High-Speed Machinery, of which the following is a specification.

The present invention relates especially to the manufacture of wheel disks for elastic fluid turbines but is also applicable to other bodies which have high rotative speeds.

One type of turbine wheel or disk with which I am familiar is made of boiler plate with suitably supported buckets at the periphery. These disks are bored centrally to receive a hub or shaft as the case may be. By calculation and experiment I have determined that the tangential stresses in a disk of a certain size and moving at a given speed with a shaft opening therein are 2.85 times greater than the tangential stresses in a solid disk of the same dimensions moving at the same speed, assuming that the elastic limit of the metal is not exceeded. A case has come to my attention where the shaft opening in a turbine disk increased five-sixteenths of an inch after use, thereby showing the effects of the tangential stresses in the metal. I have discovered, however, a method of manufacture whereby a disk with a shaft opening in it can be made nearly as strong as a solid disk.

In carrying out the invention in one of its forms I take a disk made of a metal which will flow when subjected to a force of a predetermined magnitude and bore the shaft opening, then balance it as nearly as possible either statically or dynamically or both, and preferably, but not necessarily, finish it roughly by turning it approximately to finished dimensions. The disk is then rigidly mounted on an arbor and rotated at such a speed that the elastic limit of the metal is exceeded by such an amount as will allow the metal to flow, or in other words to cause permanent deformation to take place. The speed at which the disk is rotated considerably exceeds that at which it will run while in normal operation in a machine, but is well below the speed at which the disk will disrupt. Running the disk at a speed which causes stresses exceeding the elastic limit results in a change in the molecular arrangement and thereafter the stresses instead of being concentrated around the shaft opening will be evenly distributed throughout the disk. This uniform distribution of the stresses materially increases the strength of the disk and it may thereafter be rotated at speeds above those at which it could have been rotated previous to the above described treatment, and this without injury. After the disk has been rotated at the speed mentioned, or in other words, at a speed sufficient to cause the metal to flow, it is turned on a boring mill or on a lathe either on the same or on a different arbor to the finished dimensions. The buckets are then mounted on the disk, or on the disks, if two or more are employed to make a wheel, and it or they are ready to be permanently mounted on the shaft.

Instead of making the disk and shaft out of separate pieces and locking them together, they may be made integral and the benefits above described will follow. My invention may also be utilized with advantage in those constructions wherein the web or disk and the hub are formed integral.

In the accompanying drawings which illustrate diagrammatically bucket or other wheels made in accordance with my invention, Figure 1 is a diametrical section of a wheel or disk mounted on a shaft before it has been rotated at the desired speed; Fig. 2 is a similar section of the same disk after it has been rotated at a speed sufficient to exceed its elastic limit, the deformation being exaggerated to make it more apparent to the eye; Fig. 3 shows the same disk finished and mounted on a shaft of the proper size; Figs. 4, 5 and 6 are face views of the disks of Figs. 1, 2 and 3.

1 indicates a shaft on which the wheel or disk 2 is mounted.

The disk is forged or cast as best suits the requirements and the shape of the cross-section will be made such as will secure the best disposition of the material to withstand the stresses to which it is subjected due to rotation of the finished structure of which it may form a larger or smaller part. The cross-section illustrated is more or less diagrammatic in its character and would not always be followed exactly in practice. In manufacture, the wheel-disks or webs are

partially finished and balanced. They are then run at such speed as will produce elongation of the fiber of the metal and are subsequently finished to the required dimensions. If the wheel is to be used in a turbine, the buckets are then mounted on the disk, usually at the periphery. The results of running at such speed are graphically shown in the drawing in which the deformation is exaggerated in order to catch the eye. The arrows indicate that in Fig. 2 the stresses, due to the high centrifugal force, exert a strain in a radial direction, while in Fig. 3 when the disk has come to rest there are internal stresses acting in opposite directions, those near the center of the disk tending to draw the molecules inwardly, while nearer the center of gyration the stresses act outwardly, diminishing toward the periphery of the disk.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The method of manufacturing a body intended for high rotative speeds which consists in rotating said body at a speed sufficiently great to cause the metal of which it is composed to flow, and finishing it to the required dimensions.

2. As a new article of manufacture, a rotative body comprising a shaft, and a disk carried thereby that is formed of an elastic material deformed beyond its elastic limit so that there exist stresses tending to resist centrifugal force when said body is rotated.

In witness whereof, I have hereunto set my hand this 2nd day of August, 1907.

ERNST F. W. ALEXANDERSON.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.