H. B. LEE.

STEAM TURBINE.

APPLICATION FILED AUG. 16, 1910.

979,077.

Patented Dec. 20, 1910.

2 SHEETS—SHEET 1.

Fig. 2.

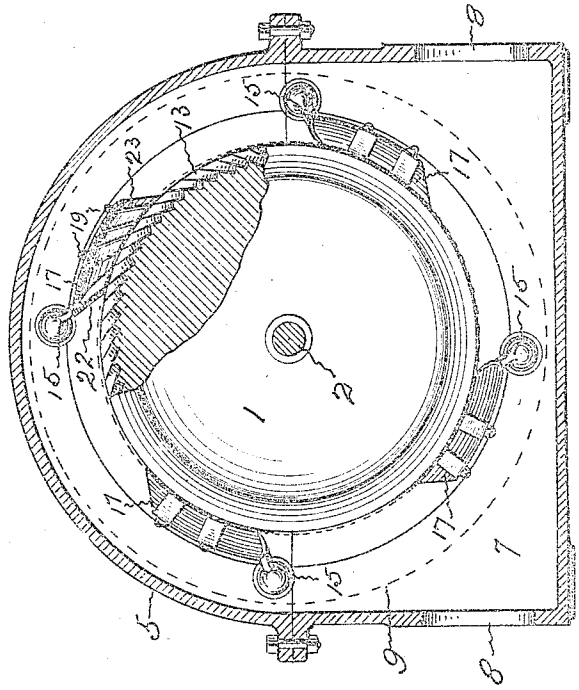
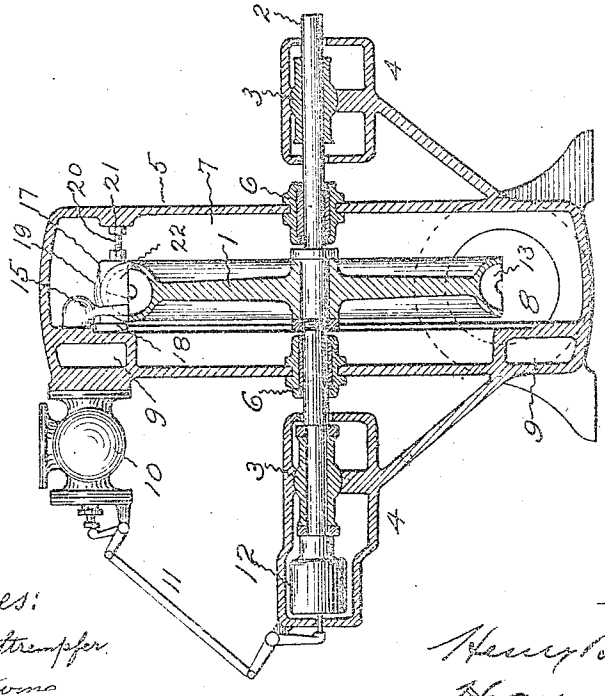


Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 3

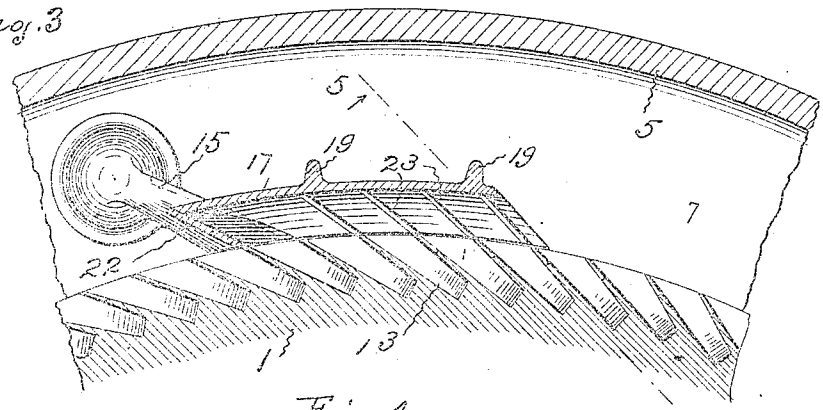
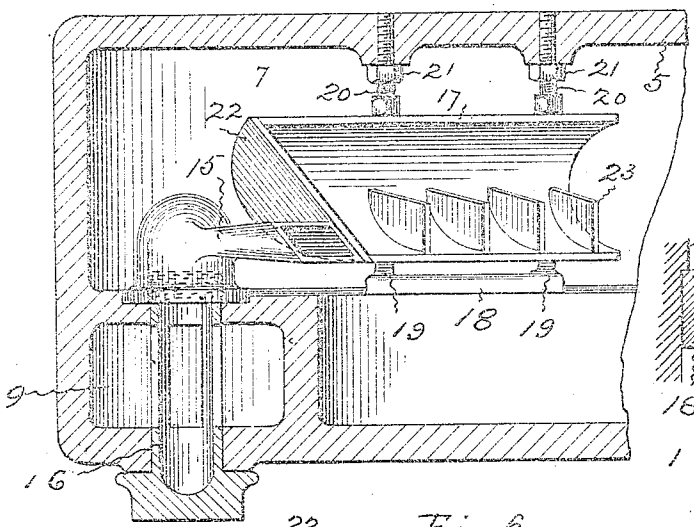


Fig. 4



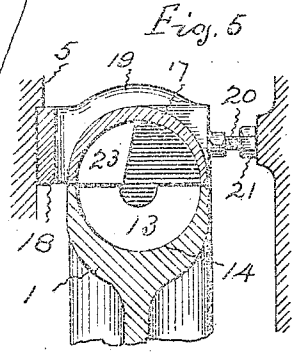


Fig. 5

Fig. 6

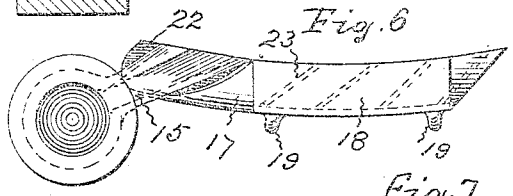
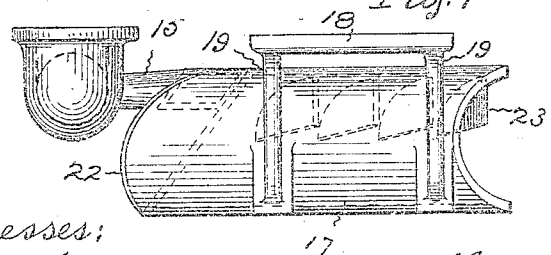


Fig. 7



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UNITED STATES PATENT OFFICE.

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STEAM-TURBINE.

979,077. Specification of Letters Patent. Patented Dec. 20, 1910.

Application filed August 16, 1910. Serial No. 577,461.

To all whom it may concern:

Be it known that I, HENRY B. LEE, a subject of Great Britain, residing at Hartford, in the county of Hartford and State of Connecticut, have invented a new and useful Improvement in Steam-Turbines, of which the following is a specification.

This invention relates to a steam turbine of the class having a multiplicity of curved steam buckets on the periphery of the wheel, and guides arranged in steam guiding chambers that are fixed about the periphery of the wheel adjacent to the steam inlet nozzles, for directing the steam in such manner that it flows through the buckets a number of times before losing its vitality, and thus to a maximum degree utilizing the effective force of the steam's velocity and thereby obtaining a high efficiency with a comparatively low peripheral speed of the wheel.

Prior multiple-impulse peripheral-bucket turbines are designed to attain highest efficiency when the wheels are running at a maximum rated speed. The prior constructions are such that if it is desired to drive the wheels faster than the designed speed, or to have the wheels run slower, or should there be a temporary variation of steam pressure, there is great loss of energy due to the interference with each other of the spiral whirls of the streams of steam as they flow out of and are returned to the buckets, unless there are fixed unalterable passages for the steam through the guide chambers, in which case the skin friction is great and choking of the passages frequently results. It is highly desirable to have the frictional resistance to the flow of steam against the walls of the buckets in the wheel and the walls of the guide chamber and guides, as low as possible, and also to so direct the steam that the various spiral whirls, caused in order to obtain the multiple impulses, will not interfere with, break up, or distort each other, nor choke the chamber and diminish the velocity of the flow, thus wasting energy. It is also desirable to arrange the wheel buckets, the guide chambers and steam guides therein so that the path of the flowing steam while to an extent directed, can automatically accommodate itself to the existing conditions of pressure and speed of the wheel, and the dead steam exhaust without choking the chambers.

The object of this invention is to so construct the fixed guiding chambers of a peripheral bucket turbine that the streams of steam, while properly guided to the buckets to give the desired number of impulses to the wheel, are not required to flow in an absolutely fixed path, thereby imparting flexibility to the engine and providing for wide variations of steam pressure without waste of energy. This object is attained by arranging about the bucketed periphery of the wheel, and adjacent to the steam inlet nozzles, a number of steam guiding chambers. In each of these chambers are several guide plates located on the injecting side only, that is, the side on which the stream of steam leaves the chamber and enters the buckets. The guides do not extend across the chamber to the return side, that is, the side on which the steam enters the guiding chamber when returning from the buckets during its spiral whirl through the chamber and buckets. This provides a series of passages on the injecting side of the chamber, which direct the steam into the buckets but leaves a free space from end to end of the chamber on the side into which the steam returns from the buckets. In this free space the steam can automatically assume such a course as its velocity requires. In other words, while the steam is directed to the buckets to give the required impulses by the guides on the injecting side of the chamber, if the velocity is high and the wheel is rotating rapidly, the steam can flow out and over in the open space of the chamber with a greater spiral forward pitch than if its velocity is low and the speed of the wheel is slow. The steam returning to the guide chamber from the buckets being unobstructed on the return side may assume its own spiral path according to its velocity, but having assumed its path, it is directed on the injecting side by the guides into the buckets to effect the desired action. Furthermore, the unobstructed space on the return side of the chamber permits the dead or ineffective steam to collect so that it may immediately exhaust without interfering with the spiral stream of steam, the velocity of which is still sufficient to be effective.

Figure 1 of the accompanying drawings shows a vertical diametrical section of a steam turbine engine which embodies this invention. Fig. 2 shows a vertical section of the same on a plane at right angles to

that of Fig. 1. Fig. 3 shows on an enlarged scale a section of a part of the rim of the wheel, the casing, and one of the guide chambers. Fig. 4 is a view looking up at the guide chamber and steam inlet-nozzle seen in Fig. 3, and showing a section of the casing through the nozzle fastening means. Fig. 5 shows a section through a wheel bucket and the guide chamber on the plane indicated by the dotted line 5—5 on Fig. 3. Fig. 6 is a view looking at one side of the guide chamber and an adjacent steam inlet-nozzle. Fig. 7 is a plan of one of the guide chambers and nozzles.

In the embodiment of the invention illustrated, the wheel 1 is mounted on the shaft 2 which is journaled in bearings 3 held in boxes 4. The casing 5, which may be any size and shape, but is desirably formed in two horizontally divided sections that are bolted together, is provided with boxes 6 that are packed in any suitable manner to keep the exhaust chamber 7 tight. Openings 8 are made in the walls of the casing for the outflow of steam from the exhaust chamber. Extending completely around the interior on one side near the periphery of the casing is a live steam passage 9. Communicating with this is the throttle valve 10 that is operated in the usual manner through the mechanism 11 by a common governor which is arranged in the box 12 at one end of the shaft.

Around the periphery of the wheel are the steam buckets 13. These wheel buckets are shown as cut at an angle in the solid stock of the periphery of the wheel by a milling cutter, in such manner that the bottom wall 14 (Fig. 5) of each bucket is substantially semi-circular, but of course the buckets could be formed in any other well known way.

There may be any number of steam inlet nozzles 15. In the engine illustrated there are four nozzles. These nozzles are seated upon the inner wall of the live steam passage with which they communicate, and they are held in place by hollow screw plugs 16 (Fig. 4). The discharge ends of the nozzles open adjacent to the periphery of the wheel on the injecting side of the buckets, in such manner that they project jets of steam forward, practically tangentially of the wheel, and also tangentially of the wheel buckets.

There are four steam return or guide chambers 17, one being located with its closed end adjacent to and in front of each nozzle. These chambers are semi-circular in cross section, as shown in Fig. 5, and their outer walls are curved so as to extend parallel with the periphery of the wheel. On one side of each of these chambers, and connected therewith by ribs 19 are brackets 18. The brackets are set against the inner wall of the live steam passage in the casing with the closed ends of the chambers bearing against the nozzles. The chambers are held in these locations by jam screws 20, which are forced against the sides of the chambers and are held against accidental turning by clamp nuts 21. The ends of the guide chambers adjacent to the nozzles are closed by plates 22. The other ends of the chambers are open to the exhaust chamber in the casing. In each chamber are a number of guide plates 23. These plates are attached to the inner wall of the chamber on the injecting side, that is, the side which returns the steam to the wheel buckets. The plates are inclined forwardly at the desired angle so as to direct the steam into the buckets in practically the same manner as the nozzle, and they extend out into the chamber from the wall on the injecting side, less than half of the inner diameter of the chamber, as clearly shown in Fig. 5. This provides a series of guides on the side of the chamber which directs the steam to the wheel buckets, which guides form on that side a series of injecting nozzles or passages, but leave the return side, that is, the side of the chamber into which the steam returns from the buckets, open from end to end so that as the steam returns from the buckets to the chamber, it may take such a spiral course forward as its velocity demands, and yet be directed by the guides, after it has circulated around the chamber, to the buckets in an efficient manner.

Live steam from the passage around the casing flows through each of the nozzles into the steam buckets on the periphery of the wheel and drives the wheel forward according to the velocity of the steam. As the steam enters the buckets on one side, and the bottoms of the buckets are circular, the steam is circulated across the periphery of the wheel as it is rotated, and is returned therefrom into the chamber in a spiral direction on the side of the chamber which is unobstructed by guide plates. The steam then, according to its velocity and degree of expansion, moves spirally forward and around the circular inner wall of the chamber and passes between the several guide plates on the injecting side into the buckets, from which it is again returned to the chamber. This process continues until the effective velocity of the steam is exhausted, or the steam passes out of the ends of the guide chambers into the exhaust space, which, as is common in engines of this type, may have its pressure reduced by any of the usually employed means. Such steam as loses its velocity and becomes dead from any cause during circulation around the buckets and through the chambers passes out of the open side of the guiding chambers into the exhaust space without interfering with the sheets or streams of steam which have sufficient velocity to be effective and pass around the

walls of the parts. As a result of this, only steam having enough velocity to effect the desired action is guided against the several buckets for imparting the multiple impulses, the ineffective steam passing out to the exhaust without interfering with this live flow. As previously stated, although the live flow is directed by the guides on the injecting side in the form of streams or jets, the spiral direction of the steam as it emerges from the buckets is not immediately absolutely fixed, and according to its velocity and the speed of rotation of the wheel, on its return into the chambers may take such course as the conditions require. The arrangement of internal annular steam passages which is illustrated, provides means for equalizing the pressure at the several nozzles about the wheel, and leaves a large exhaust space about and at the sides of the wheel for the free flow of exhausted steam. This insures ample exhaust space without requiring a casing of large diameter, and provides convenient means for setting the guide chambers and the inlet nozzles without obstructing the exhaust space.

The invention claimed is:

1. A steam turbine having a wheel with a plural number of semi-cylindrical buckets around its periphery, a casing inclosing the wheel, a nozzle communicating with the supply of live steam and arranged to direct the steam substantially tangentially into the buckets, a steam guiding chamber extending over a number of said buckets, said chamber being semi-circular in cross section and having its outer wall parallel with the periphery of the wheel, and guide plates arranged to extend forwardly in the chamber on the injecting side only, whereby the said chamber is unobstructed on one side from the live steam inlet nozzle to the final exhaust outlet.

2. A steam turbine having a wheel with a plural number of curved buckets arranged around its periphery, a casing inclosing the wheel, a live steam passage extending around the interior of the casing, nozzles communicating with said live steam passage and projecting toward the periphery of the wheel on one side of the buckets, steam guiding chambers located adjacent to the nozzles, said chambers being semi-circular in cross section and covering several of the buckets, and forwardly inclined guide-plates on the injecting side only of said chambers.

3. In a steam turbine, the combination with a wheel having a plural number of buckets in its periphery, a casing surrounding said wheel, a nozzle connected with the supply of live steam and projecting toward the buckets, of a steam guiding chamber that is closed at the end adjacent to the nozzle and open at the other end, said chamber being semi-cylindrical and provided with inclined guide plates on the interior of its injecting side only.

4. A steam guiding chamber for a turbine which is semi-circular in cross section and has its outer wall extending on a circle that is concentric with the wheel with which it is to be used, the intake end of said chamber being closed by an inclined plate and the exhaust end being open, said chamber being provided in its interior on the injecting side with inclined guide plates, said plates extending from the injecting side into the chamber and obstructing only a portion of the passage in the chamber, leaving the passage in the chamber on the return side open from end to end.

5. In a steam turbine, the combination of a wheel with a plural number of buckets in its periphery, a casing surrounding the wheel, a live steam passage extending around the interior of the casing, nozzles seated on the inner wall of the steam passage and communicating therewith, and steam guiding chambers fixed about the periphery of the wheel and covering the buckets.

6. In a steam turbine, the combination of a wheel with a plural number of buckets in its periphery, a casing surrounding said wheel, a live steam passage extending around the interior of the casing, nozzles seated upon the inner wall of said passage and communicating therewith, steam guiding chambers seated upon the inner wall of said steam passage adjacent to the nozzles, and screws turning in the casing and against the walls of said chambers for holding them in place against the wall of the steam passage.

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