J. W. RENO.

SPIRAL TOOTHED GEAR TURBINE.

APPLICATION FILED MAR. 17, 1917.

1,234,213.

Patented July 24, 1917.

2 SHEETS—SHEET 1.

Fig. 2.

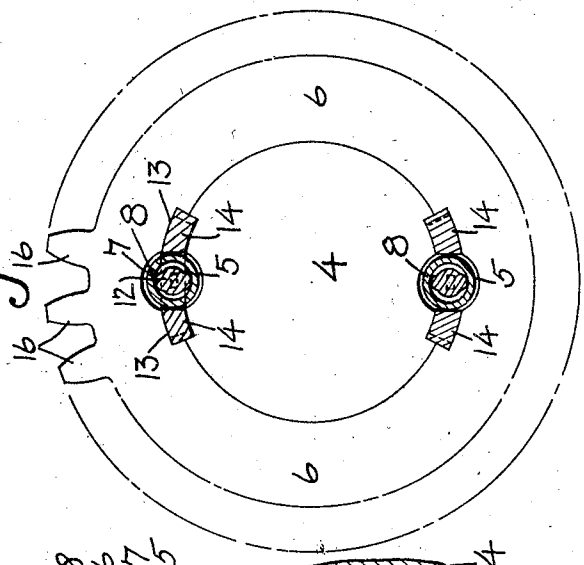


Fig. 3.

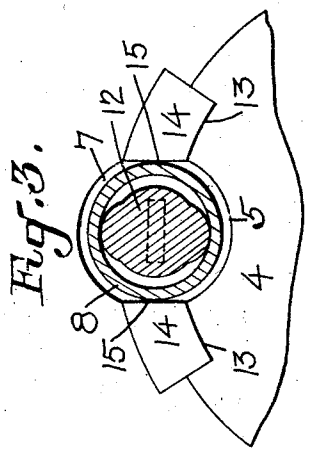


Fig. 1.

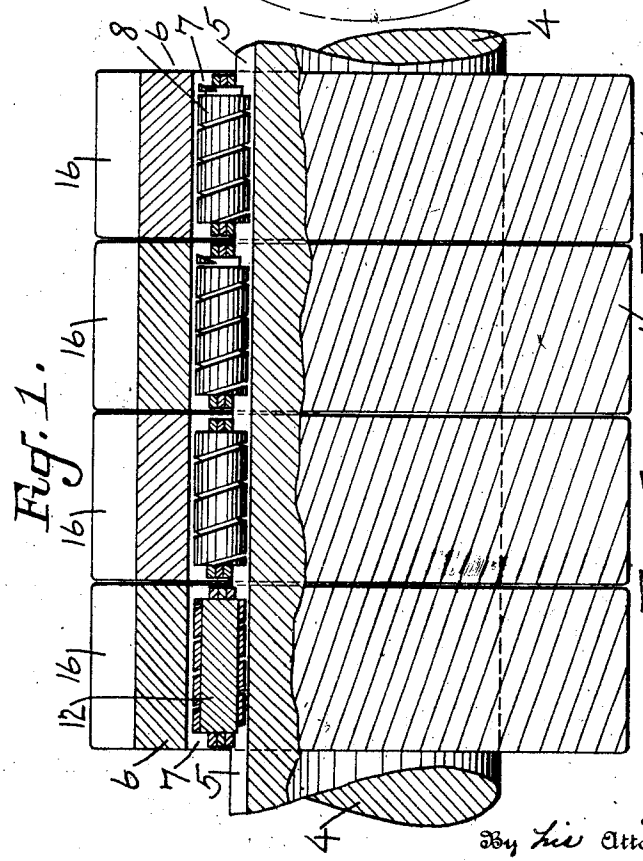


Fig. 4.

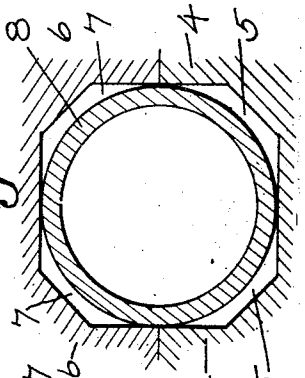
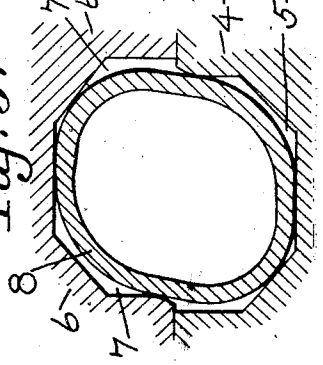


Fig. 5.



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2 SHEETS—SHEET 2.

Fig. 6.

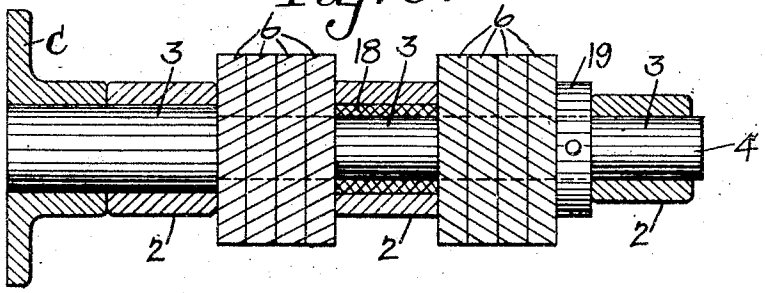


Fig. 7.

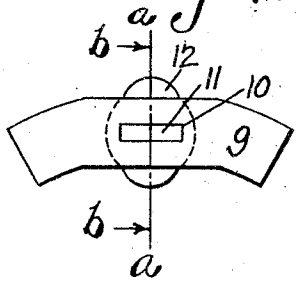


Fig. 8.

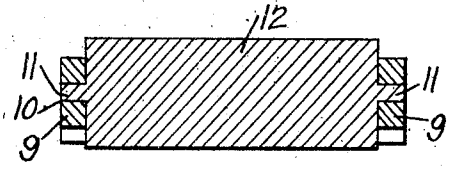
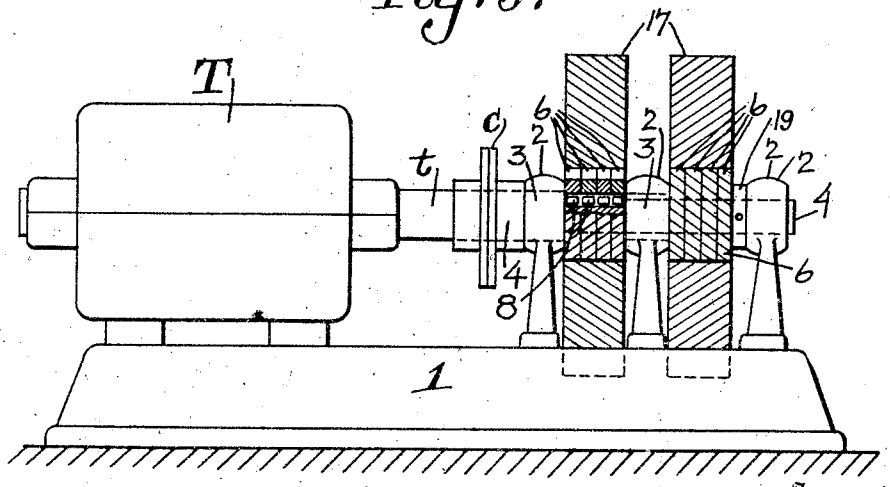


Fig. 9.



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UNITED STATES PATENT OFFICE.

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SPIRAL-TOOTHED-GEAR TURBINE.

1,234,213. Specification of Letters Patent. Patented July 24, 1917.

Application filed March 17, 1917. Serial No. 155,482.

To all whom it may concern:

Be it known that I, JESSE W. RENO, a citizen of the United States, residing in New York, in the county of New York and State of New York, have invented a new and useful Improvement in Spiral-Toothed-Geared Turbines, of which the following is a specification.

My invention relates to a new and useful improvement in reduction gears in spiral toothed geared turbines.

The development, construction and operation of spiral toothed geared turbines to the present time have not been as satisfactory as might be wished for, in the respect of preserving and maintaining the intermeshing spiral toothed gears of the reduction gear in alinement with each other, or, more specifically, in preserving the alinement between the spiral toothed driving gear pinion and the driven spiral toothed gear wheel of the reduction gear; the horse power transmitted by the driving spiral toothed gear pinion to the driven spiral toothed gear wheel is comparatively large, say, for example, in passing, anywhere from one hundred and fifty horse power to forty-five hundred horse power and five thousand horse power and even to a still larger number of horse power. The effect of the transmission of such large horse power by the driving spiral toothed gear pinion to drive the spiral toothed gear wheel upon the alinement of the gears, is frequently seriously to change or destroy the alinement, more or less, thereby causing a lack of uniformity in the transmission of the power and its proper and equable distribution among the teeth of the gearing; and, even in those instances wherein the perfection of the alinement is preserved, during the operation of the gear, as it was originally upon the construction and installation of the gear, the wearing down of the teeth of the gears in the course of time in the operation of the gear serves to allow the teeth of the respective gears to become too far apart from each other, then, and as a consequence, the proficient and efficient intermeshing of the teeth, which originally obtained when the gears were first set and alined relatively to each other and their teeth intermeshed, falls off with the amount of the wear of the teeth and the efficiency likewise of the gear is reduced, as is well known in the art.

In steam turbine engines, especially where the power transmitted through the gear is large, it has been found expedient to make the face of the gears very wide, for example, about four times the diameter of the gear pinion; therefore, a six inch gear pinion, say, has a face approximately twenty four inches wide. It is difficult to maintain the wide faces of the gears parallel with each other, and to distribute the pressure evenly along the entire face of the intermeshing teeth of the gears. To attain this end, a number of plans have been proposed, several of which have been put into practice; for instance, in one well known construction it is sought to maintain the parallelism of the gear pinion and gear wheel by the use of a floating pinion shaft, in which the journal bearings are supported by individual oil dashpots. The applicant also discloses another plan in a patent granted to him, as patentee, Number 965,408, July 20, 1910, in which the pinion shaft is permitted to move slightly about an axis at right angles to the gear pinion shaft. Those plans require the whole pinion and shaft and bearing, to move, in order to accommodate itself to any irregularities in alinement or unevenness in the surface of the teeth of the gears, and as the speed of rotation of the pinion is usually very high, say 2000 per minute, there is a very high moment of inertia to resist the sudden changes in position and the action is not by any means ideal for the purpose intended. For example, if it will be considered that there may be a high spot in the face of the teeth of the large gear; in order to pass over this high spot it would be necessary for the entire pinion, shaft, and bearings of the same rapidly to adjust themselves to the change in the position required.

Briefly speaking, in my present plan, I have made an improved reduction gear for a spiral toothed geared turbine in that, I have substituted for the usual, conventional gear pinion, a number of rings or tubular circular sections or laminations, with teeth in their outer periphery, spirally set, and mounted on—what was—the pinion gear drive shaft, side by side with each other, so that their teeth relatively considered as constituting a unit, form a spiral toothed gear; and I have connected the toothed sections to the shaft, to be driven thereby, by means of resilient, yielding elements, in the form, generally speaking, of a hollow cylinder

preferably comprised of helices. The transmitting elements have to be strong enough to transmit the full power of the drive shaft to the toothed sections, and yet allow of their compression, and therefore, I have designed a transmitting element suitable to perform both of those functions, whereby the intermeshed teeth will be allowed automatically to accommodate themselves to any irregularities in their working faces and their alinement be restored and preserved.

It will be perceived that the improved spiral toothed geared turbine corresponds broadly to the usual well-known spiral toothed geared turbine in which the reduction gear comprises a gear pinion; but differs therefrom in the particulars and functions heretofore generally pointed out, and which I will now proceed to describe more specifically.

In the accompanying drawings, Figure 1 is a view, partly in section, of a part of the reduction gear of my improved turbine.

Fig. 2 is a side or end view, in outline, of a toothed ring on the drive shaft and connecting elements between the ring and shaft.

Fig. 3 is a view in cross section of the connecting element.

Fig. 4 is a view in cross section of a connecting element in place between the shaft and toothed ring, the shaft and ring being shown only in part and section.

Fig. 5 is a view of a connecting element, in place between the shaft and toothed ring, but deformed by the pressure of the shaft upon the ring.

Fig. 6 is a view of the shaft and rings assembled.

Fig. 7 is an end view of a part of the connecting element.

Fig. 8 is a vertical longitudinal section on the line *a*—*a* of Fig. 7.

Fig. 9 is a view of my improved turbine, comprised of improved reduction gear.

Similar letters of reference designate the corresponding parts in all the figures of the drawings.

In the drawing, Fig. 9, I have indicated the usual turbine proper, T, and shown the usual bed plate, 1, therefor, in which are the usual rigid journal bearings, 2, for the journals, 3, of the drive shaft, 4, of the usual gear pinion; there being the conventional coupling, C, between the drive shaft, 4, and the turbine shaft, *t*; but, instead of employing the usual form of pinion drive shaft, with the gear pinion secured rigidly thereto or formed integrally therewith, I form seats, ways or recesses, 5, in the surface of the drive shaft, 4; the seats may be spaced apart, around the surface of the shaft, as many as may be considered desirable; in Fig. 2, I have indicated two seats around the surface of the shaft. Instead of using the usual gear pinion, formed integrally with the drive shaft or rigidly secured thereto, to be driven thereby without turning thereon, I use a series of annular ring sections or rings, 6, having grooves or seats, 7, in the inner or annular surface; the grooves, 7, are spaced apart from each other, around the inner surface of the rings, 6, as many as may be necessary, to correspond to the number of ways or seats, 5, in the drive shaft, 4; the ways, 5, and grooves, 7, register with each other, and when together, constitute a recess, and, preferably circular in cross section; the grooves, 7, extend the whole length of the ring, and, when the rings are placed side by side, form a continuous recess extending the entire length of the faces of the adjacent or adjoining rings. In the recesses, I place a resilient, yielding element, comprised of a circular tube or circular hollow cylinder, 8, preferably, constituted of a strip of steel, wound in the shape of a helix, with the helices slightly separated from each other, by an air gap, as shown in the drawing; one suggestion, or reason, for adopting this form of resilient element, between the drive shaft, 4, and rings, 6, is that the grain of the metal shall follow the spiral or helical turns of the coils or convolutions of the strip, and therefore, the element be more resilient than a plain tube or holiow cylinder or even of a series of rings, independent of each other, made of drawn steel, where the grain of the metal would be parallel with the longitudinal axis of the cylinder. The purpose of the octagon shape, of the recess, Figs. 4 and 5, is to reduce the friction of the resilient element against the side of the recess. The octagon form of recess also allows the resilient ircular tube, to change its shape readily, under pressure, conforming more or less to the sides of the recess, which shape further serves to hold the circular tube in its preferable proper relative position to the drive shaft and ring, that is to say, with the diameter of the tube coinciding with the line between the meeting surfaces of the shaft and ring.

I have made a calculation as to the pressure coming upon each spring, and I find that in transmitting 2500 HP through a pinion approximately six inches in pitch diameter and a shaft four inches in diameter, at 2000 RPM and assuming that each lamination of the pinion is two inches wide, there being as is usual, two pinions with an aggregate length of face of twenty-four inches, the pressure on each spring (assuming that there are two as shown in the drawing) would be two thousand pounds. I have made some experiments with a resilient element comprised of a coil spring of this character, and I find that this pressure is not excessive and the deformation of the element would not exceed the elastic limit of the high

grade steel of which the element is composed.

In Figs. 1, 2 and 3, I have shown a circular shape of recess, in cross section, which shape is well adapted to the purpose of the recess. In the recess, I place two end plates, 9, with holes, 10, in them, in which are placed the ends, 11, of a bar, 12, to support the bar with its longitudinal axis in the same plane as the meeting surfaces of the drive shaft and rings. The bar, 12, is preferably elliptical or ellipsoidal in cross section, as shown in the drawing, and is set with its longest diameter radially of the shaft, and its shortest diameter substantially in the same plane with the meeting surfaces of the driven shaft and rings. The longest diameter of the bar is the same length as the inner diameter of the rings. On the bar, 12, I place the rings, 6, and the bar serves to retain the rings centrally of the recess, so that the pressure upon the rings may pass substantially through their diameter. The diameter of the recess is that much larger than the external diameter of the rings to leave a space between the walls of the recess and rings; and the shortest diameter of the bar, 12, is shorter than the internal diameter of the rings 8, which, in effect, leaves a space between the larger portion of the surface of the bar and the inner surface of the rings, and allows the rings to be deformed, under pressure, until the surface of the rings is pressed against the surface of the bar, 12, which arrangement also serves the valuable purpose of resisting and preventing the collapse of the rings, to such a degree as to impair their resiliency, or in other words, prevent the rings from being compressed beyond their elastic limit. In the meeting faces of the rings 6, and drive shaft, 4, adjacent to the recesses, I provide seats or ways, 13, in which I place bars, 14, their opposed or free sides, 15, bearing against the rings, 8, externally, at the line opposite the diameter of the circular tube, 8, at the meeting surfaces of the drive shaft, 4, and the rings, 6. The object of the bars, 14, is to distribute the pressure evenly through the axis of the hollow cylinder or circular tube, 8. It is plain that I might have the recess elliptical in cross section, as indicated generally in the octagon shape, Fig. 5, or I might have the internal cross section of the tube, elliptical, instead of circular, and thereupon have the bar, 12, circular in cross section, instead of elliptical or ellipsoidal. Those features are more matters of design than a departure from my invention.

In the outer periphery of the rings, 6, I have formed teeth, 16, spirally arranged; I have indicated a tooth, 16, in outline, in Fig. 2, but I do not limit myself to any particular shape of tooth; I have not shown the teeth, 16, entirely around the periphery of the rings, but have described in the description and indicated in the drawing that such is the case. When the rings, 6, are assembled, side by side, on the drive shaft 4, and properly arranged, their teeth taken together, as a unit, constitute, in effect, a spiral toothed gear pinion, similar in some respects to that of the usual rigid faced gear pinion. I may use as many rings as I please, but I suggest that, ordinarily, the width of the face of a ring may be about two inches, more or less, or say, twelve rings or sections may be used instead of the usual twenty-four inch long gear pinion; of course, the matter of the mere number of sections best to be used in a given case, will be ascertained by calculation or observation in practice. When my improved turbine is constructed the teeth, 16, of the rings or sections, 6, will be intermeshed with the teeth of the driven wheel, 17, of the reduction gear, similar to that of the usual gear pinion and driven wheel.

It will be understood that in the operation of my gear, the resilient element is always under severe compression in transmitting the power. If for any reason the drive shaft and shaft of the gear wheel are out of line, it merely means that one group of resilient elements would be under more pressure than another group. In other words, the whole face of the gear pinion will be at all times free to adjust and accommodate itself automatically to the irregularities of the faces of the teeth or the non-alinement of the shafts. This quality will undoubtedly add to the ordinary life of the gear as compared with the rigid construction of the pinion gear now in use, and the rigid alinement of it with the driven gear wheel.

A further advantage in my form of construction is the possibility after one side of the teeth has been worn down or irregular, of taking the pinion sections off from the shaft and turning them end for end, thus presenting a new and unworn tooth face.

In Fig. 4, I have shown the resilient tube, 8, in cross section, in the recess, in which the tube is not under compression; in Fig. 5, I have shown the tube under pressure, deformed thereby; of course, the showing of deformation is exaggerated and the exact lines or outline of deformation, more or less, assumed.

In Fig. 6, I have shown the rings, assembled on the drive shaft, the rings being in two groups, of four rings each, to correspond in place to the usual two gear pinions, the groups being held spaced apart from each other by a sleeve, 18; and kept from displacement on the shaft by a collar, 19.

It is my desire not to limit my invention by my description of it, but on the contrary, it is my wish and intention to include as

being within the scope of my invention, any spiral toothed gear turbine in which is comprised the idea and practice of providing for the alinement of the faces of the pinion and driven wheel gears and the adjustment or accommodation of the intermeshing teeth of the two gears, because of their de-alined irregular or worm teeth.

What I claim, and desire to secure is:—

1. As an improved spiral toothed geared turbine, the combination of a turbine, a shaft driven thereby, having seats therein, rings, having teeth in their periphery and mounted on the shaft, having seats in their inner surface, the seats on the shaft and rings registered together forming recesses, end pieces and a bar supported in the end pieces, the bar being substantially elliptical in cross section, and resilient tubes, constructed of spiral coils, slightly spaced apart from each other in the recesses, and sleeved on the bar, and distributer bars, seated in the recesses, and bearing against the tubes, and a toothed driven wheel, the teeth in the rings and the wheel, being formed spirally, and intermeshing with each other.

2. A spiral toothed geared turbine, comprising, in combination, a turbine, a drive shaft, having seats in its surface, two or more rings mounted on the shaft, having seats in their internal surface, the seats in the shaft and rings together constituting a recess; two or more circular resilient tubes formed of spiral turns, slightly apart from each other, in the recesses, to allow angular movement or turning movement between the shaft and rings, for the purposes substantially described, and teeth spirally arranged in the periphery of the rings; and a driven toothed gear wheel, the teeth of the rings and gear wheel being intermeshed with each other.

3. In a spiral toothed geared turbine, the combination of a shaft, to be driven thereby, a series of toothed rings, mounted on the shaft, resilient spiral tubing, between the shaft and rings, connecting the rings to the shaft, to be turned thereby, but, by compression, to allow a slight angular movement to take place between the shaft and rings, and bars bearing against the tubing, and engaged by the shaft, to distribute upon the tubing the pressure transmitted thereto by the turning of the shaft.

4. In a spiral toothed geared turbine, the combination of a shaft, to be driven by the turbine, a toothed gear mounted thereon, to be turned thereby, and means connecting the shaft and gear together, comprised of a resilient tubing, constituted of a strip of hardened steel, wound spirally, to form helices, the latter being slightly spaced apart from each other, the tubing being seated longitudinally of the shaft and gear.

5. In a spiral toothed geared turbine, the combination of a shaft, to be driven by the turbine, a toothed gear, to be driven by the shaft, the shaft and gear being provided with a recess between them, a resilient element, in the recess, connecting the shaft and gear together, seated longitudinally of the shaft and gear and means to center the element in the recess.

6. In a spiral toothed geared turbine, the combination of a shaft, to be driven by the turbine, a toothed gear to be driven by the shaft, the shaft and gear being provided with a recess between them, a spirally wound resilient tubing, in the recess, elastically connecting the shaft and gear together, seated longitudinally of the shaft and gear and a member, in the tubing, to center the same in the recess.

7. In a spiral toothed geared turbine, the combination of a shaft, to be driven by the turbine, a toothed gear to be driven by the shaft, the shaft and gear being provided with a recess between them, a resilient tubing in the recess, elastically connecting the shaft and gear together, seated longitudinally of the shaft and gear and a member, in the tubing, to center the same in the recess.

8. In a spiral toothed geared turbine, the combination of a shaft, to be driven by the turbine, a toothed gear to be driven by the shaft, the shaft and gear being provided with a recess between them, a wound resilient tubing, in the recess, elastically connecting the shaft and gear together, seated longitudinally of the shaft and gear and a member, in the tubing, to center the same in the recess.

9. In a toothed geared turbine, comprising the drive shaft, and the pinion to be driven thereby, the shaft and gear being provided with a recess between them, a resilient tubing in the recess, connecting the shaft and pinion together, the tubing being seated longitudinally of the shaft and gear.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

JESSE W. RENO.

Witnesses:
ERNEST L. GALE, Jr.,
JAMES G. BETHELL.