R. H. RICE.

GEARED TURBINE DRIVEN SET.

APPLICATION FILED MAY 25, 1915.

1,155,163.

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Fig. 1.

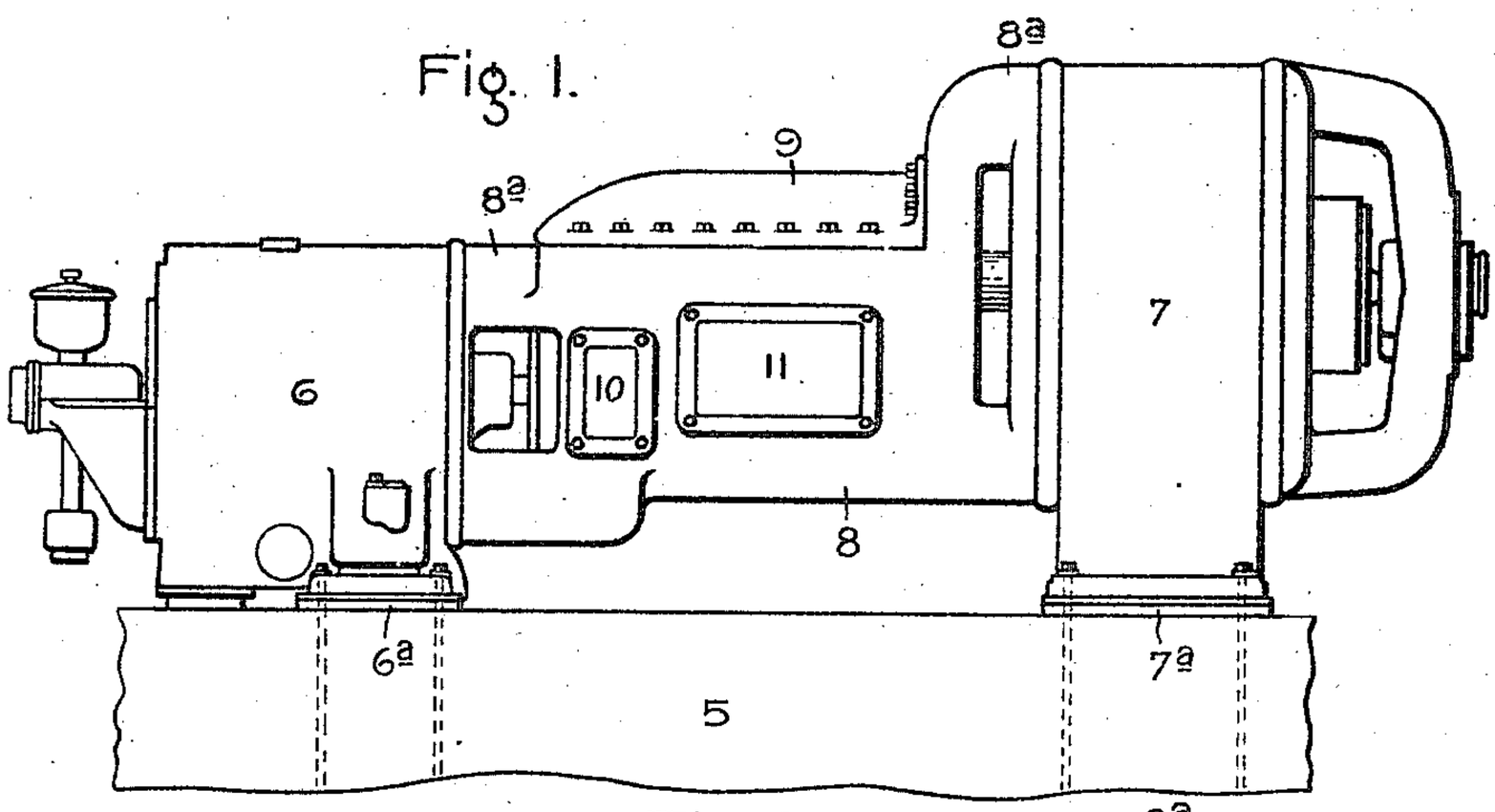


Fig. 2.

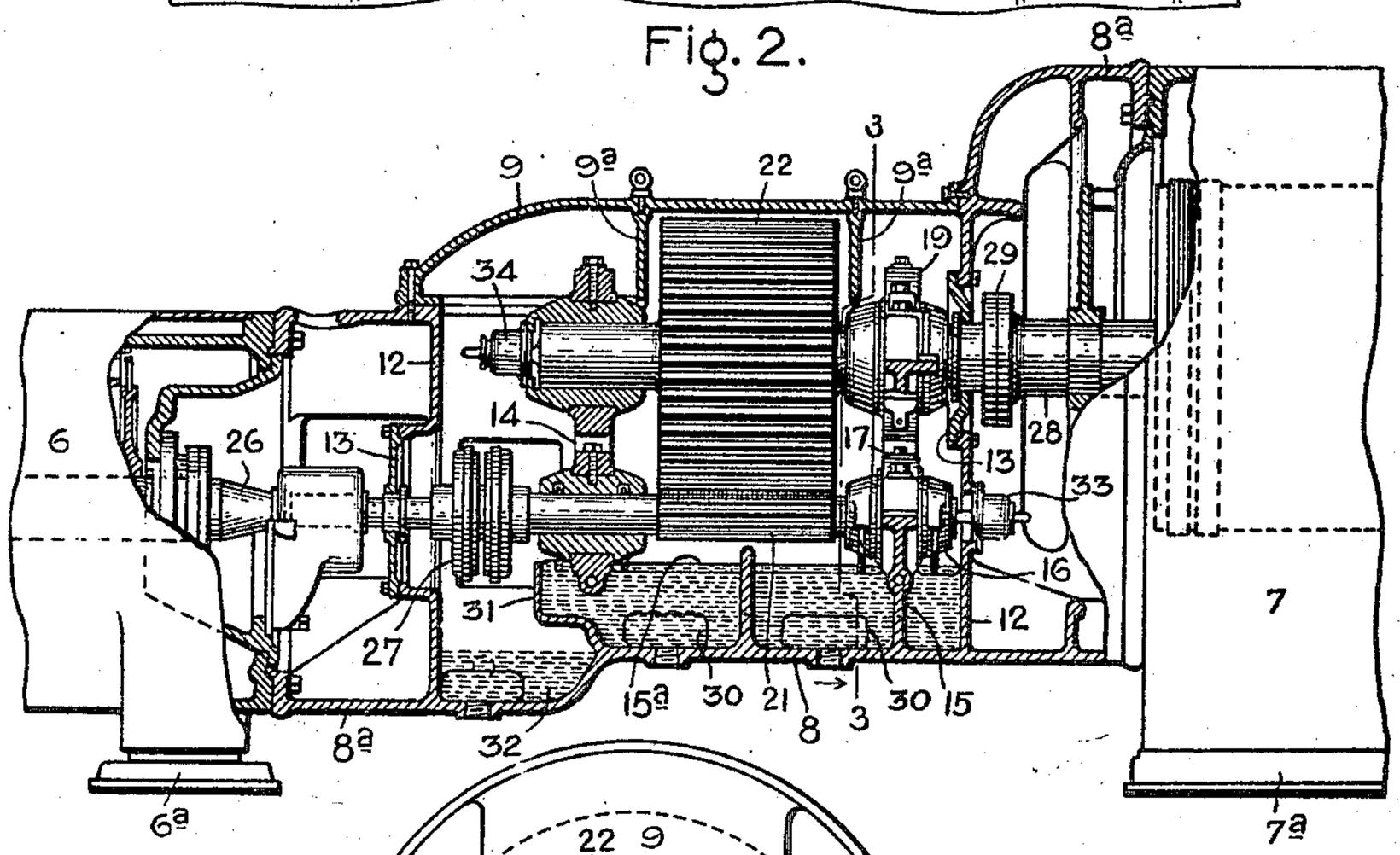
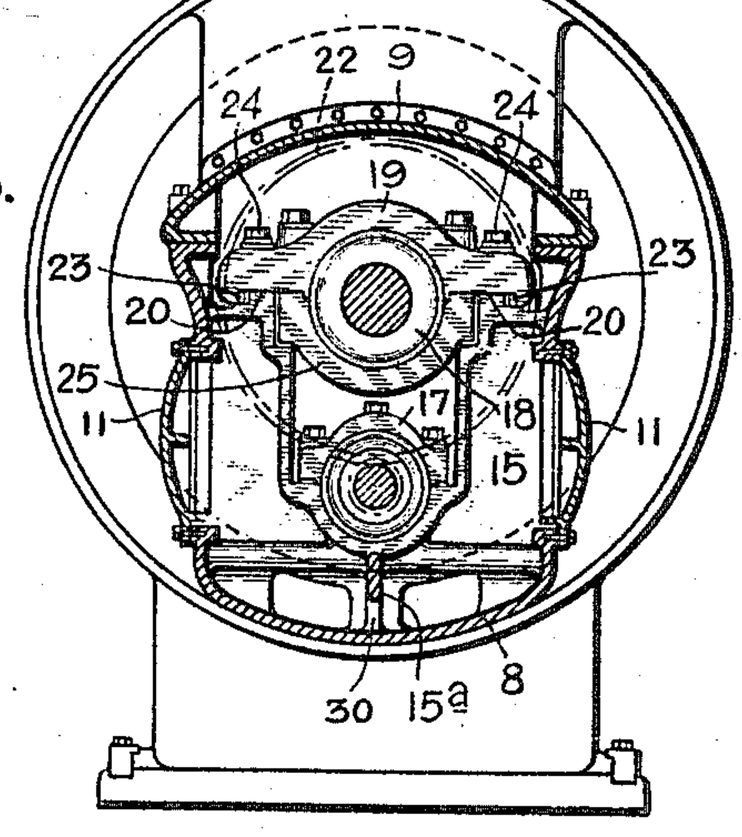


Fig. 3.



Inventor,
Richard H. Rice,
by Albert G. Davis
Att'y.

UNITED STATES PATENT OFFICE.

RICHARD H. RICE, OF LYNN, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

GEARED TURBINE-DRIVEN SET.

1,155,163. Specification of Letters Patent. Patented Sept. 28, 1915.

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To all whom it may concern:

Be it known that I, RICHARD H. RICE, a citizen of the United States, residing at Lynn, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Geared Turbine-Driven Sets, of which the following is a specification.

The present invention relates to apparatus wherein speed reducing gearing is interposed between the turbine and the apparatus driven thereby. These may be of any character, but I have chosen to illustrate an electric generator driven by a high speed steam turbine as the conditions presented are rather more severe and exacting than with most other apparatus.

There are on the market at the present time geared horizontal shaft turbines arranged to drive electric generators and pumps. In these constructions the driving and the driven shafts are located side by side and in the same horizontal plane with the gears between. The turbine and apparatus driven thereby are bolted to a bed plate as is also the gear box, the latter containing bearings for the shafts and being entirely independent of the turbine and driven apparatus. Such a construction, is open to very serious objections, especially for large sizes. In the first place it requires the use of a bed plate which, of itself, is costly and heavy. In the second place the driving and driven shafts are located side by side but spaced apart in the same horizontal plane instead of being in the same vertical plane, which gives rise to heavy twisting strains or stresses, and to reduce the effects thereof the bed plate has to be made abnormally heavy thereby increasing its cost. In the third place, the independent mounting of the turbine, gear box and generator require that the bed plate shall be further increased in weight to reduce the effects of vertical strains or stress. Furthermore, a relatively long and thin flat bed plate is not well adapted to resist vertical stresses no matter how it is constructed. This arrangement also makes it more difficult to machine the parts and to aline them.

The object of my invention is to provide an improved arrangement of horizontal shaft geared turbine driven sets and one which is free from the objections above noted.

In carrying out my invention I do away with the bed plate altogether thereby effecting a saving in cost and weight at the outset. I provide both the turbine, and the apparatus driven thereby, in this case an electric generator, with good substantial feet which rest directly on the foundation. Between the turbine and generator is located a bridging member which rigidly unites the two and which has its greatest strength in a vertical plane where the greatest stresses occur. This bridging member, or suspended gear box, as it may be called, also contains the gears and bearings for the driving and driven shafts, said shafts being located in the same vertical plane with the driving shaft preferably, but not necessarily, at the bottom. This vertical arrangement avoids the twisting strains which are so objectionable in prior constructions. The side stresses in this case are insignificant.

My invention is particularly applicable to turbine driven sets of large size where the power transmitted from the turbine to the driven apparatus is correspondingly great and where the stresses to be taken into account are of a high order.

As illustrating the problem confronting the engineer, and not as a limitation of my invention, the following figures are given of a 1000 kw. turbo-generator set constructed by me in which the turbine shaft rotates at 3600 R. P. M. and the generator at 600 R. P. M. The complete set measures in length in round numbers 24 feet and weighs approximately 53,500 pounds, of which the turbine weighs about 19,200 pounds and the generator about 16,700 pounds. The combined bridging member and suspended gear box is roughly 10′ long and 4′ 10″ high at the narrowest point. The total weight thereof is about 17,600 pounds. From these figures it is apparent that the bridging member has considerable weight and length. Owing to the weight the tendency of the parts to get into vibratory motion is reduced to a small value, and owing to its length the member possesses a certain degree of elasticity, the two factors coöperating to reduce vibration and noise and largely prevent vibrations from being transmitted to the foundation.

In the accompanying drawing illustrating one of the embodiments of my invention, Figure 1 is a view in side elevation of a

geared turbo-generator; Fig. 2 is a longitudinal section through the hollow bridge member or suspended gear box, and Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 2.

Referring to the drawing, 5 indicates a foundation usually of concrete, upon which the set is directly mounted.

6 indicates the turbine and 7 the generator or other apparatus driven thereby, each mounted on two feet as indicated at 6^a and 7^a. Only one foot for each machine shows in the drawing, but it will be understood that there is another similar foot on the opposite side. Between the casings of the machines is a hollow bridge member or suspended gear box 8 for uniting them. This member has three principal features: First, it rigidly and mechanically connects the casings of the driving and driven apparatus; second, it carries the four bearings for the shafts and gears, and third, it forms an inclosing and protecting housing for the gears and associated parts and contains a well or receptacle for lubricant such as oil. At each end of the member is a circular head 8^a having an internal flange which is rabbeted to the corresponding surface of the turbine and apparatus driven thereby. Such a joint, while simple in construction, is very strong. The cross-section of the member between heads is substantially rectangular, the greatest dimension of which is vertical to resist vertical stresses. The top of the member is closed by a removable cover 9 which is bolted to said member and also to the right hand head. This cover is arched to increase its strength and is also provided with transverse stiffening ribs 9^a located on opposite sides of the driven gear and which also serves to confine the lubricant to the gear containing chamber. The member also has side openings closed by cover plates 10 and 11 to permit access to the gears.

The bridge member or suspended gear box is braced by transverse walls 12 located near its ends, each wall having a shaft opening with a removable cover 13 to confine the lubricant to the gear chamber. It is also provided with transverse webs 14 and 15 which, in addition to bracing the member, also serve as supports for the bearings. There are also fore and aft ribs 15^a which are united with those extending across the member to further strengthen the structure. The arrangement of the bearings is important as much depends upon the accuracy with which they are made and upon their exact positions and their capacity for adjustment. As both sets of bearings are similar, a description of one of them will suffice. The web 15 has, generally speaking, a U-shaped opening, and at the bottom is provided with a seat to receive the bearing 16 for the short lower driving shaft. In horizontal cross-section the web is made T-shaped to add strength, thereby compensating for the cut-away portion which receives the bearings. The bearing 16 is held in place by the cap 17 through which extends bolts that enter the web. The cap is slightly shorter than the distance between the vertical legs or sides of the web to facilitate its removal, and also that of the bearing. The shaft is lubricated by oil rings that engage the upper surface thereof and dip into the oil in the chamber below.

The bearing 18 for the low speed or driven shaft is supported from above and is so arranged that it can be removed with the shaft when necessary or desirable. The bearing is held in place by a cross-member 19 which forms a seat therefor. The ends of the member are seated on large flat shoulders 20 formed at the upper end of the U-shaped web or rib. It is also to be noted that the vertical legs of the web extend from the bottom to practically the top of the bridging member or gear box thereby increasing the stiffness of the structure. Between the cross-member and said flat surfaced shoulders thin shims may be readily inserted to change the vertical distance between the shaft centers in order to adjust the relation of the teeth of the driving pinion 21 and driven gear 22. In order to provide for lateral adjustment the cross-member 19 has down turned ends and between said ends and shoulders on opposite sides of the web are located long and relatively thin wedges 23 so that by slightly easing the wedge or wedges on one side and driving in the other or others on the opposite side, the bearing support, and hence the bearing, can be moved bodily from one side to another by the necessary amount. Instead of wedges metal strips of different thickness may be employed. The bolts 24 which secure the member in place have a small clearance between their bodies and the walls of the receiving holes to permit of this adjustment. The cap 25 for the bearing 18 is located below it so as not to interfere with the adjusting devices. It is supported wholly by the cross-member, being separated from the web by small clearances. To assemble the gears the pinion and its shaft are first mounted in place with the bearings and then the driven gear and its shaft and bearings. To disassemble the reverse operation is followed.

The pinion, which may be of any suitable construction both as to body and tooth formation, is mounted on a short shaft which is connected to the turbine shaft 26 by a flexible coupling 27 of any suitable construction. The driven gear, which also may be of any suitable construction both as to body and tooth formation, is mounted

on a short shaft which is connected to the shaft 28 of the generator or other apparatus by a solid or flexible coupling 29, as occasion demands.

In the lower part of the gear box is a chamber containing lubricant, the ribs and webs being provided with openings, such as 30, to permit oil to freely flow from one place to another. To keep a constant level a dam 31 is provided from which oil flows from the main supply to the sump 32 from which it is drained back to its source. Owing to the character of the figures the supply pipe for the oil is not shown. I have not specifically illustrated the means for lubricating the bearings of the shaft of the driven gear because this can be done in a variety of ways.

In some cases it is necessary or desirable to employ thrust bearings for one or both gears which also serve to position the rotors of the turbine and generator. In the present case, the turbine shaft is provided with a thrust bearing 33 and the generator or driven shaft with a thrust bearing 34. Both of these bearings are of a character to limit the motion in either direction, and being old and well known have not been specifically illustrated or described.

In illustrating my invention I have shown an elastic fluid turbine arranged to drive an electric generator but it is evident that a pump, or compressor may form the driven apparatus. Also in other cases I may drive the low speed shaft by a turbine and cause it to rotate the other element of the system at a higher speed.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

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

1. In combination, an elastic fluid turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a bridging member which is suspended between and supported by the casings of said turbine and apparatus, and gearing between the shafts which is wholly supported by said member.

2. In combination, an elastic fluid turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a member which forms a bridge uniting the turbine and driven apparatus, said member being suspended between and supported by said turbine and apparatus, gearing between the shafts, the axes of said gears being located in the same vertical plane, shafts for said gears, and bearings for the gear shafts, said gear shafts and bearings being supported wholly by the bridge.

3. In combination, a turbine, an apparatus driven thereby, main shafts for the turbine and apparatus which are located in the same vertical plane, a suspended bridge member which unites the turbine and apparatus, short shafts which are united with the main shafts and are located one over the other, gearing between the short shafts, and bearings for the short shafts which are supported wholly by the bridge member.

4. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a suspended bridge member which unites the turbine and apparatus, said member being hollow and provided with cross-ribs for stiffening it, gears for transmitting motion from one shaft to the other, which are located one above the other within the member, shafts for said gears, and bearings for the last named shafts which are supported by the cross-ribs.

5. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a suspended bridge member which unites the turbine and apparatus, said member being hollow and provided with transverse walls near its ends through which the shafts extend and also with internal supports, gearing for transmitting motion from one shaft to the other, shafts for said gearing, and bearings for the gearing shafts which are carried by said internal supports.

6. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a suspended bridge member which unites the turbine and apparatus, said member being hollow and provided with a pair of webs or ribs each having a U-shaped opening therein, gearing for transmitting motion from one shaft to the other, shafts for said gearing, bearings for the gearing shafts arranged in sets, one set of bearings being mounted in the bottoms of said openings and the other set located at the top and in vertical alinement with the first set.

7. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a suspended bridge member which unites the turbine and apparatus, said member being hollow and provided with a pair of vertically disposed webs, each of which has a seat at its lower end and finished surfaces at its upper end, gears for transmitting motion from one shaft to the other located one above the other, shafts for said gears, bearings for the lower gear shaft which engage the seats, and bearings for the upper gear shaft which are supported by said finished surfaces.

8. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a suspended bridge member which unites the turbine and apparatus, said member being hollow and provided with a pair of vertically disposed webs, each of which has a seat at its lower end and shouldered surfaces at its upper end, gears for transmitting motion from one shaft to the other, shafts for said gears, bearings for the lower gear shaft which are supported by the lower part of said webs, bearings for the upper gear shafts which are supported on the shouldered surfaces by cross-members having overhanging ends, and means cooperating with the shoulders and overhanging ends to adjust the bearings sidewise.

9. In combination, a turbine, an apparatus driven thereby, shafts for the turbine and apparatus, a hollow suspended bridging member which unites the turbine and apparatus, said member being braced internally by webs, an arched cover for the member which is rigidly bolted thereto and forms a part of the gear casing, gears for transmitting motion from one shaft to the other located within the member, shafts for said gears, and bearings for the gear shafts supported by the member.

10. In combination, a turbine and apparatus driven thereby, shafts for the turbine and apparatus, a hollow suspended bridging member which has enlarged circular heads bolted to the turbine and apparatus, gears for transmitting motion from one shaft to the other whose axes are in the same vertical plane, shafts for said gears, bearings for the gear shafts, and means carried by the member which support the bearings, and also brace the member internally.

11. In combination, a turbine, an apparatus driven thereby, main shafts for the turbine and apparatus, a hollow suspended bridging member which unites the turbine and apparatus, short shafts carried by bearings in the member which are alined with the main shafts, couplings between the main and short shafts located within the member, and gears on the short shafts for transmitting motion from one to the other.

12. In a geared turbo-generator set, the combination of a turbine casing having supporting feet, a generator casing having supporting feet, a combined bridge and gear box supported in suspension between said casings, said bridge and casings forming a rigid frame for the set, bearings carried by the gear box, vertically alined shafts in said bearings, and reduction gearing carried by said shafts.

13. In a geared turbo-generator set, the combination of a turbine casing, a generator casing, a combined bridge and gear box carried in suspension between them and forming therewith a rigid frame structure, and a driving pinion and a driven gear arranged in said gear box with their shafts in vertical alinement and with the pinion below the driven gear.

In witness whereof, I have hereunto set my hand this 21st day of May, 1915.

RICHARD H. RICE.