Dec. 17, 1946. G. B. WARREN 2,412,848

TURBINE-GENERATOR

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Fig. 1.

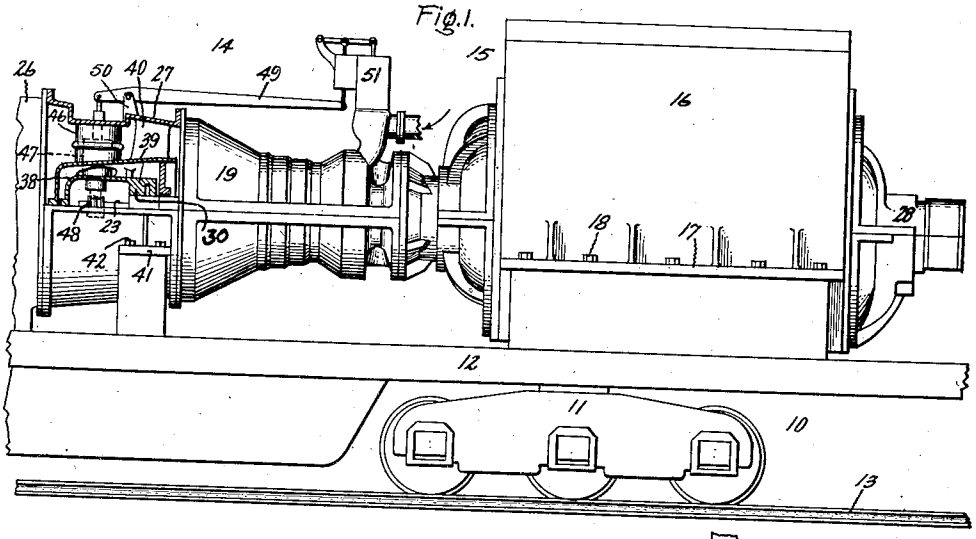
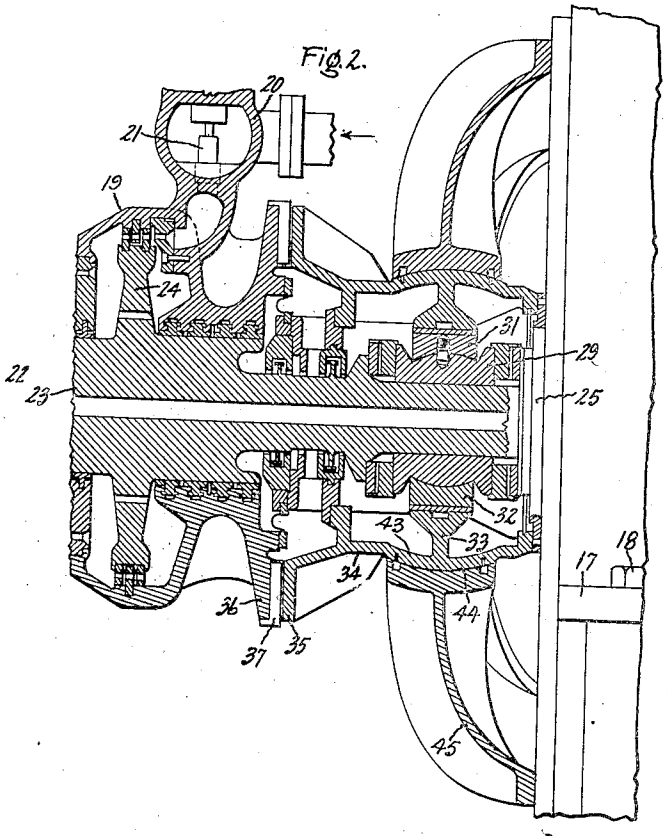


Fig. 2.



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TURBINE-GENERATOR

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6 Claims. (Cl. 290—52)

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The present invention relates to turbine-generators and like machine sets or aggregates having two casings connected together to support the end of one casing on the adjacent end of the other casing. Such support may be accomplished by rigidly securing or flanging the adjacent casing ends together. In certain instances, as where the casings are subject during operation to considerable stresses or bending forces or misalignment, a rigid connection between them may be injurious to the safe operation of the machines.

The object of my invention is to provide an improved construction and arrangement for supporting the adjacent ends of two aligned machine casings on each other whereby the setting up of stresses due to such connection or support is substantially avoided.

This is accomplished in accordance with my invention by the provision of a ball and socket support between the casings, the socket being formed by an end portion of one casing and the ball by the adjacent end portion of the other casing. Such arrangement constitutes a firm support between the casings and at the same time permits limited angular movement between them.

For a consideration of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing Fig. 1 illustrates an arrangement embodying my invention, and Fig. 2 is an enlarged detail view of a part of Fig. 1.

The invention is of particular significance in connection with turbine-generators for mobile power plants supported on railroad cars or like vehicles. Such turbine-generators are of considerable length and arranged lengthwise of the supporting truck. When moving through a curve or over a rough track and also due to temperature changes the car and the turbine-generator casings thereon are subject to considerable bending forces which would set up excessive stresses if the adjacent ends of the casings of the turbine and the generator were rigidly secured together. The provision of yieldable or loose supporting means, such as a ball and socket connection between the turbine and generator casings, however, precludes the setting up of great stresses in the casings. More specifically, the arrangement as shown in the drawing comprises a railroad car 10 having truck means 11 and a frame 12 supported on a railroad track 13. The frame 12 constitutes a foundation or support for a turbine-generator comprising a turbine 14 and a generator 15 driven from the turbine and arranged in alignment therewith lengthwise of the railroad car of vehicle 10. The generator 15 has a casing 16 with flanges 17 on each side rigidly secured to a support on the frame 12 by means including bolts 18. The turbine has a casing 19 with an inlet chest 20 adjacent the generator 15. The flow of elastic fluid from the chest to the turbine is controlled by valve means 21. The turbine has a rotor 22 with a shaft 23 and a bucket wheel or wheels 24 secured thereto and in the present instance integrally formed therewith. The shaft 23 is rigidly secured to the generator shaft by means of a coupling 25. The exhaust end of the turbine casing 19 is connected to a condenser 26 in alignment with the turbine by means of a substantially cylindrical exhaust conduit 27 flanged at its right-hand end to the exhaust end of the turbine casing 19 and its left-hand end to a flanged inlet of the condenser 26.

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The turbine-generator in the present example is a three-bearing set, that is, the rotors of the generator and turbine are supported by three bearings. A bearing 28 is arranged to support the outer end of the generator rotor on the generator casing 16 in conventional manner. Another bearing 29 is arranged between the turbine and the generator to support the adjacent ends of the two rotors, and a third bearing 30 located in the exhaust conduit 27 supports the outer end of the turbine rotor on the conduit 27. The bearing 29 has an outer spherically-shaped surface 31 engaging a similarly shaped supporting ring 32 which in turn is supported by an annular bracket 33 secured to, in the present instance integrally formed with, an annular casing 34 which at its left-hand end has a flange 35 secured to a flange 36 of the turbine casing 19 and circumferentially positioned relative to the latter by radial key means 37. The casing 34 broadly is an extension of the turbine casing 19 and the turbine shaft 23 is supported on the extension 34 by the bearing 29, which latter through the rigid coupling 25 also acts as a support for the generator shaft.

The bearing 30 for supporting the shaft 23 near the exhaust end of the casing 19 is held on and enclosed by an inner casing 38 which in turn is enclosed by and supported on an outer casing 39 located within the exhaust conduit 27 and held and centered thereon by a plurality of circumferentially spaced supports 40. Both casings 38, 39 are sealed to each other and to the turbine shaft to permit the annular space between to be vented to the atmosphere and also to preclude substantial heat transfer from the elastic fluid in the

exhaust conduit 27 to the interior of the inner casing 38 and to the bearing 30. The exhaust conduit 27 has opposite flanges or feet 41 rigidly secured to the frame 12 by means including bolts 42, thus forming a rigid support for the exhaust end of the turbine casing 19. The inlet end of the turbine casing according to my invention is yieldingly or loosely supported on the adjacent end of the generator casing 16 by means of a ball and socket connection between them. In the present example the extension 34 of the turbine casing 19 has an annular spherically-shaped portion 43 engaging and supported on a socket formed by a spherically-shaped portion 44 of an end shield 45 of the generator casing 16. Thus the end of the turbine casing is loosely supported on the adjacent end of the generator casing by a ball and socket connection formed between them. This permits each casing to move angularly about the center of the ball and socket connection without thereby setting up stresses in the other casing. The feet 41 on opposite sides of the exhaust conduit 27 together with the socket 44 near the inlet end of the turbine casing broadly constitute a three-point support for the turbine casing.

The ball and socket connection completely encloses the shaft 23. Therefore the speed-governing mechanism for controlling the valve means 21 is operated from the other end of the shaft 23 enclosed within the exhaust conduit 27. In the present example a vertical duct 46 is formed between an opening of the exhaust casing 27 and an opening in the outer casing 39. A speed governor 47 is accommodated in the duct 46 and driven from the shaft 23 by a worm gear 48. The governor is connected to the left-hand end of a governor beam 49 which has an intermediate point held on a fulcrum 50 and a right-hand end connected to actuate a conventional hydraulic governing mechanism 51 for positioning the valve means 21 in response to speed changes of the turbine-generator. The duct 46 also serves to accommodate an oil pump driven from the worm gear 48 for supplying oil under pressure to the hydraulic governing mechanism 51 and to the bearings.

Thus, with my invention I have accomplished an improved construction and arrangement of turbine-generators and like machine sets having aligned shafts securely fastened together and supported by three bearings of which one is located between the sets and held on one of the casings, which latter together with a portion of the other casing forms a ball and socket connection. With such arrangement misalignment of the bearings and bending forces acting on the casings are taken care of by the flexible connection between the castings.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. A turbine-generator designed and constructed to be supported on a foundation having appreciable flexibility comprising a turbine and a generator having aligned casings with the inlet end of the turbine casing adjacent one end of the generator casing, the inlet end of the turbine casing having a valve chest with valve means in the chest for controlling the flow of elastic fluid to the turbine, means forming a ball and socket connection between the adjacent ends of the casings to support one casing on the other casing so as to permit limited angular displacement between the casings without creating excessive stresses therein, and a speed-governing mechanism for controlling the valve means including a speed governor driven from the exhaust end of the turbine shaft, and means connecting the governor to the valve means.

2. In a mobile power plant, a car having a frame of appreciable flexibility, and a turbine-generator set arranged lengthwise on the frame and including a generator having a flanged casing of substantial axial length rigidly secured throughout its length to the frame and a turbine having a casing of substantial axial length with an inlet end adjacent the generator, means forming a two-point support for the exhaust end of the turbine on the frame, and means flexibly supporting the inlet end of the turbine casing on the adjacent end of the generator casing so as to permit limited angular displacement between the casings without creating excessive stresses therein.

3. A turbine-generator designed and constructed to be mounted on a foundation having appreciable flexibility including a turbine having a casing and a rotor with a shaft, a generator having a casing and a rotor with a shaft aligned with and rigidly connected to the turbine shaft, a three-bearing support for the shafts including separate bearings at the opposite ends of the shafts and a single bearing for supporting adjacent ends of the shafts, spherical self-aligning supporting means for supporting said single bearing on an end portion of one of the casings, said casing end portion having a spherically-shaped portion, and a spherical support formed on the other casing for supporting said portion.

4. A turbine generator designed and constructed to be supported on a foundation of appreciable flexibility comprising a turbine and a generator each having a casing of appreciable axial length, the inlet end of the turbine casing being located adjacent an end of the generator casing and forming a ball and socket connection therewith to support the end of one casing on the end of the other casing so as to permit limited angular displacement between the casings without creating excessive stresses therein, a cylindrical exhaust conduit extending axially from the exhaust end of the turbine casing, the turbine having a rotor with a shaft extending into the exhaust conduit, bearing means disposed in the exhaust conduit for supporting the turbine shaft, a sealed housing supported within the exhaust conduit and enclosing the bearing, a duct formed through and sealed to the conduit and the housing, and accessory actuated means driven from the turbine shaft and at least partly disposed in said duct.

5. A turbine-generator designed and constructed to be mounted on a foundation having appreciable flexibility comprising a generator having a casing of substantial axial length arranged to be rigidly secured to the foundation throughout its length, a multi-stage turbine with a casing of substantial axial length having a high pressure end of comparatively small diameter axially aligned with and closely arranged to one end of the generator casing and a comparatively large diameter low pressure end disposed remotely from the generator casing, means constructed and arranged to provide a two-point support for

the turbine casing on the foundation at a location remote from the generator, and means providing a third point of support for the high pressure end of the turbine casing on the adjacent end of the generator casing, said last-named means including a ball and socket joint permitting limited angular displacement between the turbine and generator casings without creating excessive stresses therein.

6. A turbine-generator designed and constructed to be mounted on a foundation having appreciable flexibility comprising a generator having a casing of substantial axial length arranged to be rigidly secured to the foundation throughout its length, a multi-stage turbine with a casing of substantial length having a high pressure end of comparatively small diameter axially aligned with and closely arranged to one end of the generator casing and a comparatively large diameter low pressure end disposed remotely from the generator casing and a cylindrical exhaust casing extending axially from the low pressure

end of the casing, means constructed and arranged to provide a two-point support for the turbine casing on the foundation at a location remote from the generator, and means providing a third point of support for the high pressure end of the turbine casing on the adjacent end of the generator casing, said last-named means including a ball and socket joint permitting limited angular displacement between the turbine and generator casings without creating excessive stresses therein, the turbine having a rotor with a shaft supported in a first bearing within the ball and socket joint at the generator end and in a second bearing within the exhaust conduit at the low pressure end of the turbine, a sealed housing within the exhaust conduit and enclosing said second bearing, walls forming a duct through and sealed to the conduit and the housing, and turbine accessory actuating means driven from the turbine shaft and disposed in said duct.

GLENN B. WARREN.