To all whom it may concern:

Be it known that I, WILLIAM A. GODFREY, a citizen of the United States, residing at Hyde Park, Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Elastic-Fluid Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to elastic-fluid engines and more particularly to elastic-fluid engines having a shaft passing through the wall of the casing which holds the elastic fluid under pressure.

One object of the present invention is to produce a stuffing box surrounding the shaft where it emerges from the engine casing which will follow the lateral movements of the shaft relatively to the casing.

Another object of the present invention is to so mount the stuffing box on the engine casing that the stuffing box will act as a relief valve when the pressure in the casing becomes excessive.

With the above objects in view, the present invention relates to the elastic-fluid engine hereinafter described and particularly pointed out in the claims.

Referring to the drawings; Figure 1 is a vertical sectional view of an elastic-fluid engine of the steam turbine type in which is embodied the preferred form of the present invention; Fig. 2 is an enlarged vertical section showing the stuffing box and its mountings in more detail, and Fig. 3 is a view taken on the line 3—3 of Fig. 1 showing the outer end of the stuffing box.

Referring to the drawings, the elastic-fluid engine is a steam turbine of the impulse type in which steam is expanded in nozzles, is delivered at high velocity to the turbine buckets and then escapes at low velocity and pressure into an exhaust chamber surrounding the bucket wheel. The turbine comprises a rotor and a stator. The rotor comprises a bucket wheel and a supporting shaft. The stator comprises a casing indicated generally by reference numeral 8 forming an exhaust chamber 10 around the bucket wheel 4. The casing 8 is made up of two castings 12 and 14 respectively, which are bolted together around their peripheries to form the exhaust chamber 10. The steam from the boiler passes through the throttle and emergency valves 16 and 18 respectively which are controlled by governor mechanism 20, and enters an annular steam chamber 22, which distributes the steam to the nozzles 24. The steam is expanded in the nozzles 24 and is delivered at high velocity and low pressure to buckets milled in the periphery of the bucket wheel 4 and return buckets formed integral with the nozzle members. The steam is discharged from the buckets at exhaust pressure into the exhaust chamber 10 from which it passes through an exhaust opening 26 to a condenser or the like. The shaft 6 is supported in bearings 30 and 32 which are mounted on brackets 34 and 36 which are cast integral with the side plates 12 and 14 respectively of the turbine casing. The center parts of the side plate castings 12 and 14 are somewhat concave to reduce the size of the exhaust chamber near the center of the bucket wheel. Openings 40 are left through the side plates for the passage of the rotor shaft 6. Over the mouths of the openings 40 are secured, by means of screws 42, flat annular metal plates 44 which have openings 46 therein of a diameter less than the diameter of the openings 40 but somewhat greater than the diameter of the shaft 6. Rings 48 of suitable packing interposed between the plates 44 and the castings 12 and 14 form steam tight joints. The outer faces of the plates 44 are carefully smoothed and lie at substantially right angles to the axis of the shaft 6. A metallic stuffing box 50 is provided for holding a steam tight packing 52 around the shaft 6. The packing 52 is a metallic packing consisting of shreds of an alloy of lead, antimony and tin. The stuffing box 50 has a laterally extending flange 54 on its inner end. The inner face of the flange 54 is cut away somewhat at 56 so that an annular bearing surface 58 is left to bear against the face of the plate 44. The annular bearing surface 58 is ground against the plate 44 with emery to form a steam tight ground joint 59 between the stuffing box 50 and the outer surface of the plate 44. The packing 52 is compressed by means of a gland which comprises a follower 60 and a screw cap 62. The follower 60 is a split ring, the two halves of which are held assembled by means of a spring wire clip 110.
64. The screw cap 62 is formed in two parts held together by bolts 66. The screw cap is threaded on the outer end of the stuffing box 50 so that it can be turned to force the follower 60 against the packing 52 to compress it and form a steam-tight joint around the shaft.

Holding means is provided for securing each stuffing box 50 to the casing 8. The holding means has provision for permitting the stuffing box 50 to float or slide laterally on the plate 44, so that the stuffing box may follow the lateral movements of the shaft 6 relative to the casing 8, and also has provision for permitting the stuffing box to be moved outward against a yielding tension so that it may act as a relief valve in case the steam pressure in the exhaust chamber becomes excessive. The holding means comprises studs 70 screw-threaded into the casing and passing through stud-receiving holes in the flange 54, and helical compression springs 72 surrounding the studs 70 and acting to hold the stuffing box 50 yieldingly against the plate 44. The stud receiving holes in the flange 54 are provided with cupped bushings 74 having stud receiving openings thereon somewhat larger than the diameter of the studs so that the stuffing box 50 is allowed a limited lateral sliding movement with relation to the casing, and the ground joint 59 forms a sliding joint between the stuffing box and casing. The outer cupped ends of the bushings 74 form abutments for the springs 72. The outer ends of the studs 70 are screw-threaded to receive adjusting and locking nuts 76 and 78 respectively which form adjustable abutments for the outer ends of the springs 72.

The springs 72 hold each stuffing box 50 yieldingly against the casing so that when there is sufficient steam pressure against the inner end of the stuffing box, the spring 72 will yield and the two faces of the ground joints will separate, allowing the steam to escape between the outer face of the annular plate 44 and the inner face of the flange 54. In this connection it is to be noted that the openings 46 through the plates 40 are somewhat smaller than the openings 40 through the casting pieces 12 and 14. The effective pressure of steam against the stuffing boxes is therefore reduced, so that the total pressure at any time against either one of the stuffing boxes is equal to the pressure of steam per unit area times the area of the opening 46. By making the area 46 comparatively small, the springs 72 which hold the two faces of the ground joint together need not be made very stiff. If for any reason the pressure in the exhaust chamber 10 becomes abnormally great, the pressure of the steam through the annular openings 46 against the stuffing boxes will be sufficient to overcome the springs 72 and the stuffing boxes 50 will act as relief valves for the exhaust chamber 10.

Since the two surfaces of the ground joint 59 between each plate 44 and stuffing box 50 have a limited sliding movement, it is evident that the stuffing box will follow any lateral movements of the shaft 6, whether caused by bodily displacement of the shaft 6 due to a shifting in position of the bearings 30, or to any eccentricity in the shaft itself. The use of the floating stuffing box is particularly important when a metallic packing is used. In steam turbines similar to the turbine illustrated in Fig. 1, and provided with stuffing boxes rigidly bolted to the casing 8, it has been found that, when steam was first admitted in starting the turbine, the parts of the castings 12 and 14 which made up the side plates of the casing 8, expanded more rapidly than the brackets 34 and 36 which held the shaft bearings 30 and 32. The result was that the stuffing boxes containing the metallic packing were lifted relatively to the shaft 6. The metallic packing is sufficiently unyielding so that a small leakage space was left between the top of the packing and the shaft through which the exhaust steam escaped, and the shaft ground against the bottom of the packing. After the turbine had been running for some time the brackets 34 and 36 became heated by conduction and in expanding lifted the shaft bearings 30 and 32 so that the shaft 6 was lifted to approximately the same position relative to the stuffing boxes as it had when the turbine was cold. It was found, however, that the shaft 6 in grinding against the bottom of the packing during the starting of the turbine was sufficient to wear a small leakage space in the packing, so that the exhaust steam escaped between the bottom of the shaft and the packing. The above mentioned difficulty has been entirely obviated by the floating stuffing box 50 of the present invention, which allows the packing 52 to follow the shaft 6 as it moves relatively to the side plates of the turbine casing to a greater or lesser extent than the other parts of the stator or to any other cause. Moreover, it is found that if the shaft 6 is slightly eccentric, the stuffing box 50 will float relatively to the casing and follow the eccentricity of the shaft. The floating stuffing box greatly lengthens the life of the metallic packing and insures that a steam-tight packing around the shaft is maintained very much longer than it has been found possible to maintain a steam tight packing with a stuffing box bolted rigidly to the casing.

While in the preferred embodiment of the present invention, annular bearing plates 44 are interposed between the stuffing boxes 50 and the casing castings 12 and 14, it will be evident that the stuffing boxes may be
held to form a sliding joint directly against the casing castings without the interposition of an intermediate plate or plates or may be mounted in any other suitable manner, so that they may follow the lateral movements of the shaft relative to the casing. While the present invention has been illustrated as embodied in a steam turbine, nevertheless it is evident that the floating stuffing box of the present invention may be employed to pack a shaft extending through any diaphragm or partition upon opposite sides of which a difference of pressure is maintained, and the term "elastic-fluid engine" as used in the specification and claims, is intended to define any apparatus in which an elastic fluid is employed and is confined within a chamber through the wall or walls of which is passed a movable member or shaft capable of either rotary or reciprocatory motion.

While the present invention in its more limited aspects contemplates a stuffing box having the combined functions of a laterally sliding floating stuffing box and of a relief valve, it is within the purview of the invention to provide an elastic-fluid engine or apparatus with a stuffing box which may have but a single one of these two functions.

While the preferred embodiment of the present invention has been specifically illustrated and described it is to be understood, however, that the present invention is not limited to the details of construction hereinafter set forth, but may be embodied in other structures within the purview of the following claims.

I claim—

1. An elastic-fluid engine having, in combination, a casing for holding fluid under pressure, a movable member extending through an opening in the casing, and means for forming a fluid-tight joint around the movable member including a stuffing box mounted on the casing, and means for supporting the stuffing box so as to permit it to move bodily with respect to the casing, substantially as described.

2. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening for the passage of the shaft, a stuffing box for holding a fluid-tight packing around the shaft, and means for securing the stuffing box to the casing having provision for a limited lateral bodily movement of the stuffing box relatively to the casing so that the stuffing box may follow the lateral movements of the shaft relative to the casing, substantially as described.

3. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening for the passage of the shaft and having a smooth surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface around the opening, and means for securing the stuffing box to the casing with the two smooth surfaces in sliding contact to permit the stuffing box to follow the lateral movements of the shaft relative to the casing, substantially as described.

4. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening for the passage of the shaft and having a smooth surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface around the opening, and means, including a spring, for securing the stuffing box to the casing with the two smooth surfaces in sliding contact to permit the stuffing box to follow the lateral movements of the shaft relative to the casing, substantially as described.

5. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening for the passage of the shaft and having a bearing surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating bearing surface adapted to fit against and form a fluid-tight joint with the bearing surface on the casing, and means for securing the stuffing box to the casing with the two bearing surfaces in yielding engagement so that the stuffing box may act as a relief valve when the pressure in the casing becomes excessive, substantially as described.

6. An elastic-fluid engine having, in combination, a casing for holding fluid under pressure, a movable member extending through an opening in the casing, and a stuffing box for the movable member mounted on the casing and acting as a relief valve when the pressure in the casing becomes excessive, substantially as described.

7. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening somewhat larger than the shaft for the passage of the shaft, a stuffing box for holding a fluid-tight packing around the shaft, including a spring and means for securing the stuffing box to the casing having provision for a relative sliding movement between the stuffing box and the casing to allow the stuffing box to follow the lateral movements of the shaft.
relative to the casing and having provision for a movement of the stuffing box away from the casing against the force of the spring so that the stuffing box may act as a relief valve when the pressure in the casing becomes excessive, substantially as described.

8. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening for the passage of the shaft somewhat larger than the shaft and having a smooth substantially plane surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface around the opening, and means, including a spring, for securing the stuffing box to the casing with the two smooth surfaces in sliding contact to permit the stuffing box to move laterally and follow the lateral movements of the shaft relative to the casing, substantially as described.

9. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having in one of its walls an opening somewhat larger than the shaft for the passage of the shaft and having a smooth substantially plane surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface around the opening, and means, including studs secured to the casing, and received through openings in the stuffing box of somewhat greater diameter of the studs and springs, for securing the stuffing box to the casing with the two surfaces of the joint in sliding and yielding engagement, whereby the stuffing box may follow the lateral movements of the shaft relative to the casing and may move away from the casing against the pressure of the springs to act as a relief valve when the pressure in the casing becomes excessive.

10. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid under pressure having an opening in one of its walls for the passage of the shaft, a plate secured to the casing around the mouth of said opening having an opening therein for the passage of the shaft somewhat larger than the shaft and having a smooth outer bearing surface, a stuffing box for holding a fluid-tight packing around the shaft having a smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface of the plate and having a laterally extending flange, and means, including studs secured to the casing and projecting through the openings in the flange of the stuffing box of a diameter somewhat greater than the diameter of the studs and compression strings surrounding the studs and pressing against the flange, for securing the stuffing box to the casing with the surfaces of the joint in sliding and yielding engagement so that the stuffing box is permitted to follow the lateral movements of the shaft relative to the casing and to move away from the casing against the pressure of the springs and act as a relief valve when the pressure in the casing becomes excessive, substantially as described.

11. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid in one of its walls an opening for the passage of the shaft and having a smooth, flat surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a cooperating smooth, flat surface fitting against and forming a fluid-tight sliding joint with the surface around the opening and means for securing the stuffing box to the casing with the two smooth, flat surfaces in sliding contact to permit the stuffing box to slide laterally and follow the lateral movements of the shaft relative to the casing, substantially as described.

12. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid in one of its walls an opening for the passage of the shaft and having a smooth, flat surface around the mouth of the opening, a stuffing box for holding the fluid-tight packing around the shaft having a cooperating smooth, flat surface fitting against and forming a fluid-tight sliding joint with its surface around the opening and means including a spring for securing the stuffing box to the casing with the two smooth, flat surfaces in sliding contact to permit the stuffing box to move laterally and follow the lateral movements of the shaft relative to the casing, substantially as described.

13. An elastic-fluid engine, having, in combination, a movable shaft, a casing for holding the elastic fluid in one of its walls an opening for the passage of the shaft, a stuffing box for holding the fluid-tight packing around the shaft, and means for securing the stuffing box to the casing having provision for holding the stuffing box against rotation relatively to the casing but permitting a limited lateral movement of the stuffing box relatively to the casing.
so that the stuffing box may follow the lateral movements of the shaft relative to the casing, substantially as described.

14. An elastic-fluid engine having, in combination, a movable shaft, a casing for holding the elastic fluid having in one of its walls an opening for the passage of the shaft and having a smooth surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a co-operating smooth surface adapted to fit against and form a fluid-tight sliding joint with the surface around the opening, and means for securing the stuffing box to the casing with the two smooth flat surfaces in sliding contact having provision for holding the stuffing box from rotation relative to the casing but permitting the stuffing box to follow the lateral movements of the shaft relative to the casing, substantially as described.

15. An elastic-fluid engine having, in combination, a movable shaft, a casing for holding the elastic fluid having in one of its walls an opening for the passage of the shaft and having a smooth, flat surface around the mouth of the opening, a stuffing box for holding a fluid-tight packing around the shaft having a co-operating smooth, flat surface fitting against and forming a fluid-tight sliding joint with the surface around the opening, and means for securing the stuffing box to the casing with the two smooth flat surfaces in sliding contact having provision for holding the stuffing box from rotation relative to the casing but permitting the stuffing box to slide laterally on the casing and follow the lateral movements of the shaft relative to the casing, substantially as described.

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Witnesses:

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