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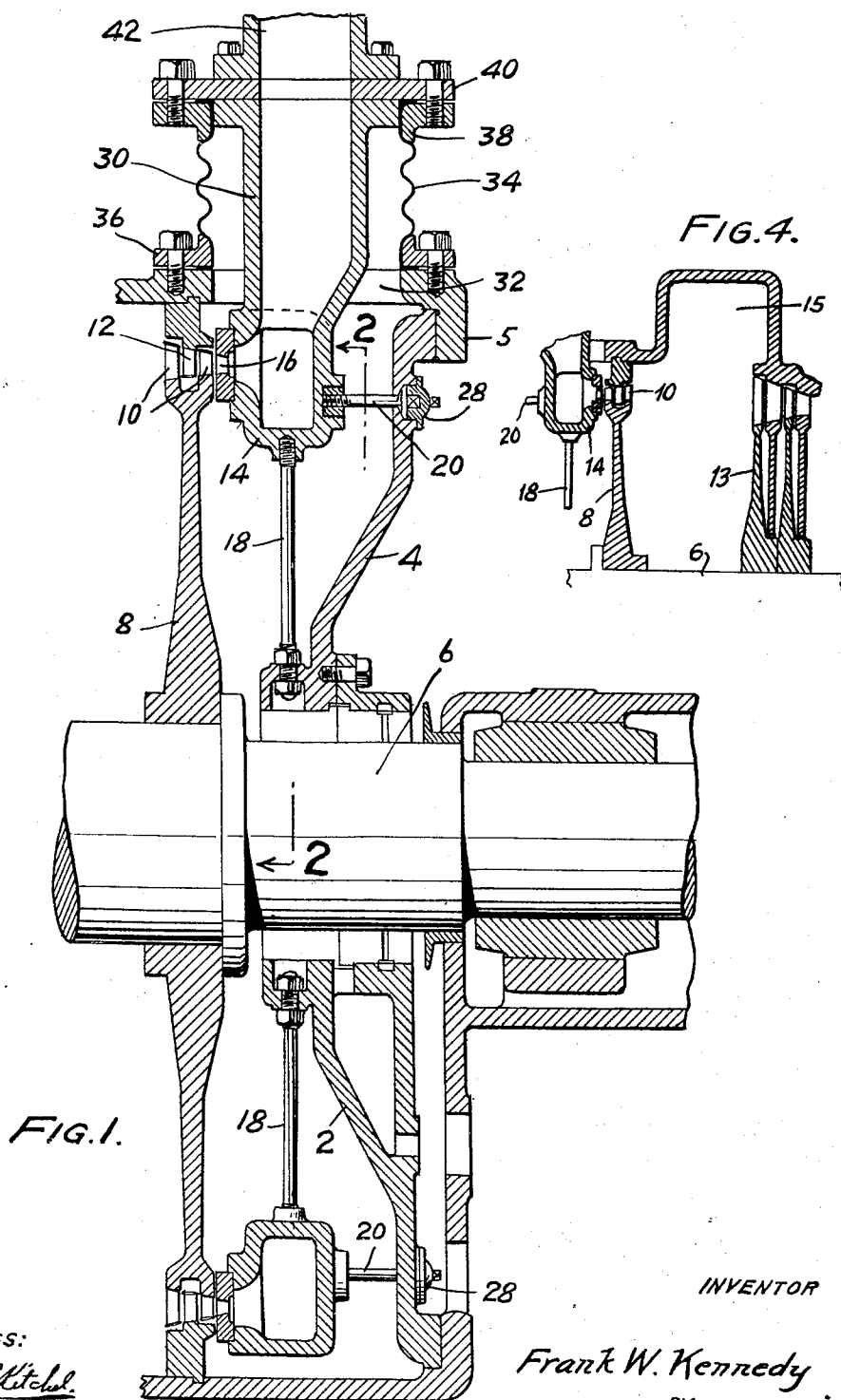
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STEAM CHEST CONSTRUCTION FOR STEAM TURBINES

Filed June 27, 1930

2 Sheets-Sheet 1



WITNESS:

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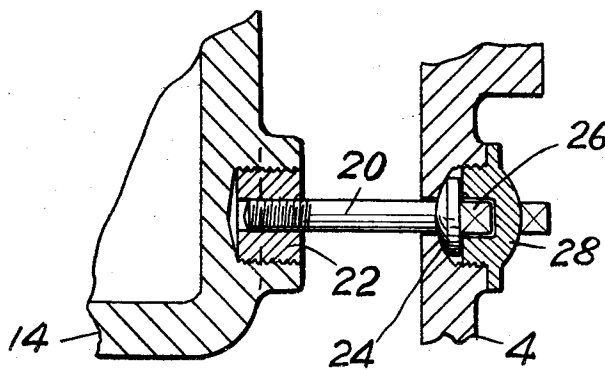
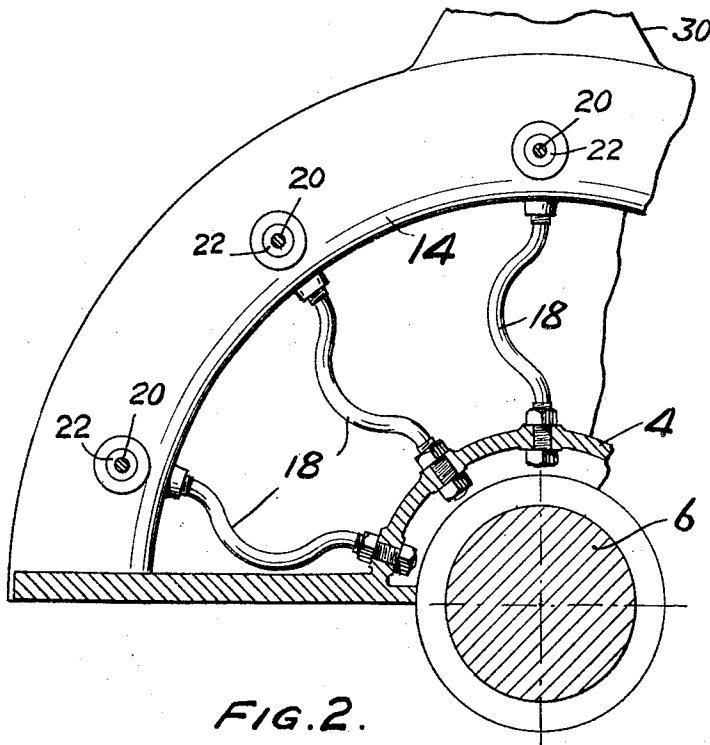
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STEAM CHEST CONSTRUCTION FOR STEAM TURBINES

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2 Sheets-Sheet 2



WITNESS:

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UNITED STATES PATENT OFFICE

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STEAM CHEST CONSTRUCTION FOR STEAM TURBINES

Application filed June 27, 1930. Serial No. 464,140.

This invention relates to a steam chest construction particularly adapted for steam turbines, the construction being such that the steam chest may expand independently of the turbine casing to prevent distortion thereof.

It is desirable, in the construction of a steam turbine, to provide means whereby only a minimum amount of distortion of the turbine casing can be caused by sudden or unequal heating thereof. If steam is admitted suddenly to a steam chest which is a part of the main turbine casing, there results, due to sudden heating of the portions of the turbine casing coming into intimate contact with the steam, unequal expansion and consequent distortion due to the fact that other portions of the casing are at much lower temperatures than the temperature of the incoming steam.

In a marine turbine, where a reversing element is necessary, the reversing element is usually mounted in the exhaust end of the turbine. If the steam chest of the reversing element be made a portion of the main turbine casing, the sudden admission of high temperature steam to the reversing element results in uneven heating and distortion. In the case of a marine turbine no previous warming up of the reversing element is possible and the steam is turned into the reversing element's steam chest quite suddenly.

In view of the fact that the reversing element of a marine turbine is mounted in the exhaust end thereof, during forward operation it is subject to the full vacuum and the corresponding low temperature. For instance, in a marine turbine operating at a vacuum of 28.5 inches, the exhaust end, which is subject to the full vacuum, is at a temperature of approximately 92° F. The entire exhaust end including the reversing element and its steam chest will accordingly be at this low temperature. If the steam is now suddenly admitted to the reversing element in order to back the ship, the reversing element's steam chest will then be subject to a temperature equal to that of the full steam temperature, which under modern conditions may be from 600° to 750° F. The sudden change in temperature, coupled with the fact

that certain portions of the casing in the immediate vicinity of the steam chest will heat more rapidly than others, results in unequal expansion and distortion of the wheel case.

The object of this invention is the provision of a steam chest which can be subject to sudden great changes in temperature without resulting in the distortion or warping of the wheel case. In view of this feature, the steam chest is particularly adapted for use in connection with the reversing element of a turbine.

This result is accomplished by mounting this steam chest in the turbine in such a manner that the steam chest itself is separate from the main turbine casing and being in the exhaust end of the turbine when used in connection with the reversing element is surrounded with vacuum, thereby preventing, as far as possible, the transmission of heat from the steam chest to the turbine casing. The steam chest is mounted in the casing by comparatively small bolts which, due to their small area and long length, can transmit only a nominal amount of heat from the steam chest to the casing.

The accomplishment of the above broad object of the invention and also of more specific objects relating to details of construction will be apparent from the following description, read in conjunction with the accompanying drawings, in which:

Fig. 1 is a vertical section through the axis of a portion of a turbine involving a construction in accordance with the invention;

Fig. 2 is a fragmentary view, being a transverse section on the broken planes indicated by line 2-2 of Fig. 1;

Fig. 3 is an enlarged sectional view illustrating a detail of construction; and

Fig. 4 is a vertical axial section on a reduced scale showing the relationship of the forward and reversing elements.

The turbine illustrated in the drawings is of the usual marine type, the reversing end only being illustrated in detail. The casing of the turbine consists of a lower member 2 and an upper member 4, the upper member being surmounted by a casing 5. The shaft 6

is mounted in suitable bearings in the casing in the usual fashion and carries the reversing rotor 8 carrying the spaced series of buckets indicated at 10, between which are located the stationary buckets indicated at 12. The shaft also carries the forward rotors 13, the buckets of the last stage of which discharge into the discharge chamber 15 common to both the forward and reverse elements, and being subject to the condenser vacuum.

In the improved construction, the steam chest comprises a hollow ring shaped member 14 which is preferably continuous in small turbines. This steam chest is provided with discharge nozzles 16 of usual form arranged to direct steam into the buckets 10 carried by the reversing rotor. The annular steam chest is held in position by a series of radial bolts 18 and a series of axial bolts 20. The bolts 18 are connected between the steam chest and a central ring shaped portion of the casing, which has a small diameter so that all of the stresses on the casing due to radial expansion will act at its small diameter and upon a rigid ring which is not in itself liable to distort. The bolts 18 are of long length, bent as illustrated in Fig. 2 so that expansion of the steam chest tending to increase its diameter can be taken care of by the bend in the bolts without unduly stressing the turbine casing.

The axial bolts 20 are threaded into bushings 22 carried by the steam chest and are provided with heads 24 having spherical seating surfaces engaging within spherical recesses formed in the casing. The bolts are provided with squared heads 26 engaged in cooperating openings in caps 28 which are threaded into the casing. By rotation of caps 28 the bolts 20 may be readily adjusted, the caps 28 forming an airtight closure of the casing so as not to affect the vacuum. It will be understood, of course, that the bolts are seated at 24 so as to be free to move angularly to take care of outward expansion of the steam chest when heated.

Steam is led into the steam chest through a neck 30 which passes outwardly through an opening 32 in the cover plate 5 without contacting therewith. An expansion joint is formed by the use of an annular member 34 of corrugated metal which is clamped at its lower end to the cover 5 by a ring 36 held down by bolts and at its upper end to a flange plate 40 by an annular ring 38, the flange plate 40 being bolted to both the neck 30 and the steam admission pipe 42. By reason of the provision of this expansion joint, it will be obvious that expansion of the steam chest may take place without distortion of the casing. On the other hand, the casing is completely closed so that proper vacuum may be maintained therein during operation.

The expansion joint, besides serving the purposes just noted, also permits the ready

disassembly of the cover from the casing, since the various elements forming the expansion joint may be readily disconnected and the cover may be withdrawn from the neck 30, the flanges of which will pass through the enlarged opening 32.

By the construction just described, it is possible to make the steam chest as a continuous ring, thereby avoiding joints which are necessary when the ring is split into a plurality of parts and which are undesirable in the use of high pressure and high temperature steam. On the other hand, the use of the solid ring does not make the turbine unduly difficult to disassemble.

The accomplishment of the primary purpose of the construction, namely the conduction of heat to parts of the casing other than the steam chest itself, will be readily apparent. The small cross section of the bolts 18 and 20 and the absence of any enlarged conducting path in the expansion joint 34 assures that there is no substantial direct conduction of heat through metallic parts from the steam chest to the case.

During operation the space surrounding the steam chest is under high vacuum, being in communication with the discharge space 15 through the buckets 10 and about rotor 8 and is accordingly at a low temperature of steam corresponding with that vacuum. In other words the portions of the casing adjacent the steam chest are maintained at substantially the temperature of the exhaust steam and conduction or convection is practically eliminated by reason of the existence of a high vacuum surrounding the chest.

Due to the fact that the expansion joint 34 is only subject to the vacuum temperature and pressure, it does not involve any difficulties in construction.

While the invention has been specifically described as applicable to the reversing element of the turbine, in which case it is of very particular utility as pointed out above, it may sometimes be advantageous to have the main steam chest of a similar construction in order to prevent warping or distortion of the turbine casing, particularly where very high temperature steam is used or there are other conditions which might ordinarily cause unequal heating or excessive expansion of the casing.

While the steam chest is preferably a solid ring, it need not necessarily be so. It may, for convenience and to meet special conditions, be divided into two or more parts bolted together with internal joints in the turbine casing or cast in separate pieces with separate connections on the outside of the turbine casing. In other words the solid ring construction is not essential but it is the most desirable construction for most conditions.

While reference is made above and in the claims to a steam turbine, it is intended that

the term "steam" should include other hot vapors or gases used for driving the turbine; for example, the construction, which is particularly adapted for operation at high temperatures, might be used in the case of turbines driven by mercury vapor.

What I claim and desire to protect by Letters Patent is:

1. A turbine comprising a casing, a rotor within the casing, a chest within the casing provided with means arranged to direct driving vapor to the rotor, and rods securing the chest to the casing, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

2. A turbine comprising a casing, a rotor within the casing, a chest within the casing provided with means arranged to direct driving vapor to the rotor, and rods securing the chest to a portion of the casing of small radius, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

3. A turbine comprising a casing, a rotor within the casing, a chest within the casing provided with means arranged to direct driving vapor to the rotor, and axially extending elements free to move outwardly during expansion of the chest and securing the chest to the casing.

4. A turbine comprising a casing, a rotor within the casing, a chest within the casing provided with means arranged to direct driving vapor to the rotor, readily longitudinally distortable rods securing the chest to a portion of the casing of small radius, and axially extending elements free to move outwardly during expansion of the chest and also securing the chest to the casing.

5. A turbine comprising a casing, a rotor within the casing, a chest providing in annular driving vapor receiving space within the casing provided with means arranged to direct driving vapor to the rotor, and rods securing the chest to the casing, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

6. A turbine comprising a casing, a rotor within the casing, a chest providing an annular driving vapor receiving space within the casing provided with means arranged to direct driving vapor to the rotor, and rods securing the chest to a portion of the casing of small radius, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

7. A turbine comprising a casing, a rotor

within the casing, a chest providing an annular driving vapor receiving space within the casing provided with means arranged to direct driving vapor to the rotor, and axially extending elements free to move outwardly during expansion of the chest and securing the chest to the casing.

8. A turbine comprising a casing, a rotor within the casing, a chest providing an annular driving vapor receiving space within the casing provided with means arranged to direct driving vapor to the rotor, readily longitudinally distortable rods securing the chest to a portion of the casing of small radius and axially extending elements free to move outwardly during expansion of the chest and also securing the chest to the casing.

9. A turbine comprising a casing, a rotor within the casing, an annular chest within the casing provided with means arranged to direct driving vapor to the rotor, radially extending readily longitudinally distortable rods securing the chest to the casing, axially extending elements free to move outwardly during expansion of the chest, a neck for conducting vapor to the chest through the casing, and an expansion joint between the neck and casing where the neck passes through the casing.

10. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing, provided with means arranged to direct driving vapor to the reversing element, said chest being substantially heat insulated from the casing and adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, and rods securing the chest to a portion of the casing of small radius, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

11. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing providing an annular driving vapor receiving space and provided with means arranged to direct driving vapor to the reversing element, said chest being substantially heat insulated from the casing and adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, and rods securing the chest to a portion of the casing of small radius, said rods being readily longitudinally distortable by reason of deviation of portions thereof from straight lines joining their points of engagement with the shaft and casing.

12. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing provided with means arranged to direct driving vapor to the reversing element, said chest

being substantially heat insulated from the casing and adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, readily longitudinally distortable rods securing the chest to a portion of the casing of small radius, and axially extending elements free to move outwardly during expansion of the chest and also securing the chest to the casing.

13. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing providing an annular driving vapor receiving space and provided with means arranged to direct driving vapor to the reversing element, said chest being substantially heat insulated from the casing and adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, readily longitudinally distortable rods securing the chest to a portion of the casing of small radius, and axially extending elements free to move outwardly during expansion of the chest and also securing the chest to the casing.

14. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing provided with means arranged to direct driving vapor to the reversing element, said chest being mounted so that it may expand relatively to the casing without imparting substantial strain thereto and being adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, a neck for conducting vapor to the chest, said casing having an opening through which the neck passes outwardly, and an expansion joint between the neck and casing where the neck passes through the casing, said joint closing the opening to prevent the escape of vapor.

15. A reversing turbine comprising a casing, a rotor within the casing including a reversing element, a chest within the casing providing an annular driving vapor receiving space and provided with means arranged to direct driving vapor to the reversing element, said chest being mounted so that it may expand relatively to the casing without imparting substantial strain thereto and being adapted to be surrounded by exhaust vapor at low temperature from the ahead stages of the turbine, a neck for conducting vapor to the chest, said casing having an opening through which the neck passes outwardly, and an expansion joint between the neck and casing where the neck passes through the casing, said joint closing the opening to prevent the escape of vapor.

In testimony of which invention, I have hereunto set my hand, at Trenton, county of Mercer, N. J., on this 23rd day of June, 1930.

FRANK W. KENNEDY.