ABSTRACT

Steam turbines of different types require casings having lengthwise extending portions with parameters of length and cross-sectional contour and size determined by the encased turbine working elements and which, therefore, differ for the different types of turbines. Instead of the turbine casing being a single casting including all of these portions, the latter are formed by separate interfitting parts which are separate castings. A plurality of such parts are made for each portion with the parameters of each part differing from those of each other as required for the parts to form that portion of a plurality of differing types of turbines. That is to say, for each portion an inventory of parts is provided having differing parameters as required for differing types of turbines. To make a turbine casing for a desired type of turbine, the parts required for the various portions of the casing are selected having the parameters of that type of turbine and these parts are interfitted and interconnected to form the casing.

4 Claims, 4 Drawing Figures
STEAM TURBINE ASSEMBLY PROCESS

BACKGROUND OF THE INVENTION

Fluid-powered turbines, such as steam turbines, are designed as different types adapted for the service for which they are to be put, and consequently even for a relatively restricted range of external cross-sectional dimensions, their other design parameters vary widely. For example, when using live steam the steam pressures may range between 2 and 140 bar, the steam input temperatures may range between 200 and 540°C, the exhaust pressures may vary between 0.05 and 70 bar, and turbine rotor speeds may vary between 3,000 to 25,000 rpm and develop power ranging from 1 to 50 MW. Academically, custom-made turbines are the best solution to providing the maximum efficiency at the lowest cost to meet such widely varying conditions, but to do so requires the making of a turbine casing of differing dimensions, contour and internal construction in each instance. Such casings are steel castings requiring in each instance extensive pattern shop and foundry shop work, making this concept extremely expensive.

Therefore, the development of so-called “standard turbines” was initiated. In this case the entire turbine casing with all of its various necessary portions are standardized so that only the internal parts, such as the rotor with its blades and the stator blades mounted by the casing, have to be adapted to meet the differing operating conditions to which the differing types of turbine design are directed. This permits the casting of only one design of casing and effectively reduces the pattern and foundry costs. However, this means that the casing design must be a compromise with the design of the inlet and exhaust portions and all of the portions in-between the same regardless of the type of turbine to be constructed by using the casing.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a method for manufacturing turbine casings which avoids the expense of custom-designed turbine casings while providing much if not all of their advantages, but at the same time avoiding the inflexibility of the so-called “standard turbine” casings.

This object is attained by the present invention through a method for making fluid turbine casings having lengthwise extending functionally differing portions such as the inlet and exhaust portions, and the intermediate portions therebetween which may include portions encasing either single or multiple turbine stages and which may be encased by casing portions of either the same or successively increasing diameters. Keeping in mind that these portions have differing parameters of length and cross-sectional contour and size, in at least one or more instances, which differ for different types of turbines, by this invention these portions are made in the form of separate interfitting parts. These parts are cast separately and may be stocked by the turbine manufacturer in the form of an inventory. The parts for each portion are made with differing parameters as required for differing types of turbines. Each part, of course, requires pattern shop and foundry expense but once this expense is incurred, an inventory of parts is provided for each of the turbine portions required by a variety of turbine types. Therefore, a large manufacture of turbines, or of turbine casings, may have a variety of parts which interfit so that by selecting the appropriate parts for the portions required for any particular type of turbine and combining them with the other parts required for this type, a turbine casing involving little or no compromise may be produced at the least possible expense considering the savings obtained from quantity production methods.

In other words, for each portion of the turbine casing, a plurality of parts are made with the previously described parameters of each differing from each other as required for the parts to make the corresponding portion of different types of turbines, to form an inventory of parts for that portion, and with each part of this inventory represented by a stock of parts having design parameters the same, and by other stocks of parts having differing parameters as required to meet the expected requirements for different types of turbines, a turbine or turbine casing manufacturer may select from the stocks of parts those required to form a turbine casing of a particular type such as may be indicated.

The parts may be interfitting in the sense that, for assembly, for any given inlet or front portion of the desired turbine casing, the portion which is to be joined with it as the next or intermediate or succeeding portion has a standardized contour, the next portion being interfitting and connected with this intermediate or succeeding portion and so on until the exhaust portion of the turbine is selected and applied to complete what might be called a stack of parts. The interconnections of the parts selected may be by flanges which are bolted together, or welding, and in some cases two or more of the portions required may be produced as integral units or single castings.

For example, in the case of a back-pressure turbine it may be advantageous to have the intermediate portion and the exhaust portion cast as one piece which will subsequently be connected, by welding or bolted flanges, to the inlet portion. In a condensation turbine, several intermediate portions may be cast together as a single unit and connected to the inlet portion as welding or the like. In this case the exhaust portion may be cast as a separate unit and connected to the balance of the construction through bolted flange connections. The portions between the inlet and exhaust portions may comprise cylindrical intermediate portions and transition portions having differing front, and back, or inlet and outlet diameters. These portions may have mounting webs for the guide blade carriers.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings preferred embodiments of the present invention are schematically illustrated as follows:

FIG. 1 is an overall flow diagram showing the manner in which the various turbine portions are made and combined;

FIG. 2 is a longitudinal section showing an example of the manner in which the portions are combined in the case of a back-pressure type of turbine;

FIG. 3 is a corresponding view showing the manner in which the portions are combined to produce a casing for a condensation type turbine; and

FIG. 4 in the same way shows the manner in which the portions are combined to produce the casing for a back-pressure type turbine.
DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates the various standardized casing portions comprising two front or inlet portions 50 and 51, seven exhaust portions 60 to 66, and eleven intermediate portions in the form of lengthening sections 80 to 85 which have fronts and backs of the same diameter, and diameter transition sections 70 to 74, each having a back diameter the same as the front diameter of the next to provide a casing of expanding diameter. The portion 50 is shown as a low pressure inlet portion while the portion 51 is illustrated as a high pressure inlet portion, and with the other portions illustrated, permit making forty-one different turbine housings, for forty-one different types of turbines, which can be manufactured by selection of the appropriate portions illustrated and fitting them together and interconnecting them as required for the type of turbine desired and as shown by this FIG. 1 flow diagram.

It is to be understood that each of the portions, of which there are only twenty in all, by appropriate selection and combination, permit the production of these 41 different turbine casings as required for 41 different types of turbines.

In other words, with this invention, the need for running forty-one different casing designs through the pattern-making shop and the foundry shop have been replaced by the need for only twenty designs to go through these departments. Furthermore, with the turbine manufacturer having an inventory of parts as to each portion involving the different parts, the parts may be produced by methods approaching or equaling mass production methods.

To exemplify the manner in which the turbine casings are made, reference may be had first to FIG. 2 where the turbine consists only of the front or inlet portion 50, selected from the inventory of front or inlet portions 50 and 51, and the exhaust portion 60 appropriately selected from the inventory of exhaust portions 60 through 66, so that a turbine casing suitable for a turbine of Type 1 results, this Type 1 being indicated in FIG. 1 where the uniformly broken line leads from 50 through 60 to the numeral 1 representing this type 1.

To make the casing the two casing portions 50 and 60 which interfit are positioned together and welded together along the junction line shown by a broken line at 100. In FIG. 2 there are also shown the turbine rotor shaft seals 110, 111 and 112 and also the nozzle housing block 113 as well as the guide blade carriers 114 and 115 held in a mounting web 120 in the front portion 50 and, a further mounting web 121, for the same purpose, in the exhaust portion 60.

In FIG. 3 the casing required for a condensation type turbine is shown. Here the same front or inlet portion 50 of the casing is again used, but an intermediate lengthening portion 80 is inserted to provide an intermediate turbine stage and a condensation exhaust steam portion 64 is used so that a casing for a turbine type 26 results. The selecting of the parts for this assembly is shown in FIG. 1 by the "-" line. By use of the lengthening portion 80, a greater number of rows of turbine blades is made possible and by the transition portion 73 also included, the larger diameter of the condensation exhaust steam portion 64 is accommodated. It can be seen that by the use of the transition portion 73 the front or inlet portion 50 shown by FIG.

2 is used, the lengthening portion 80 and the portion 64 completing the combination from the type shown by FIG. 2 to the type shown by FIG. 3. The portion 80 and the portion 73 respectively provide mounting webs 121, 122 and 123 for the necessary guide blade carriers required for the type of turbine shown by this FIG. 3.

Although the various portions have been described as being manufactured as separate parts, it is advantageous in some instances to combine what may be called separate portions into one part. For example, in FIG. 3 the two portions 80 and 73 shown as being interfit and welded together, may advantageously be cast as a single part with the portion 80 joined to the front or inlet portion 50 by welding and with the back end of larger diameter of the transition portion 73 simply bolted to the condensation exhaust portion which is 64 in FIG. 3 via the surface 102. It is to be noted that the portion 80, whether or not the portions 80 and 83 are cast together as an integral piece, may be fitted to the portion 50 shown by FIG. 2 as well as FIG. 3.

In FIG. 4 a back pressure turbine is shown with its necessary casing. This is particularly interesting since it shows the possibilities of the variations permitted by this new turbine casing making method.

In this FIG. 4 the casing is assembled from the portions which in FIG. 1 are connected by the "-" line. In this case the high pressure front or inlet portion 51 is used together with the intermediate lengthening portion 70, the transition portion 71, the intermediate lengthening portion 81 and the back pressure exhaust portion 61. This produces a turbine of the type 11 as illustrated in FIG. 1. In this case a turbine casing is produced consisting of five different portions joined together at the various locations indicated at 100, 103, 104 and 105. In this case it is possible and may be advisable for the intermediate portion 70 to be cast together with the front or inlet portion 51 as a single casting, and the intermediate portion 71 and 81 may be cast together as a single unit together with the exhaust portion 61, so that these two cast parts meet together and as units may be welded at the line 103.

As a general principle, it must be a design consideration, depending on the type of turbine the turbine manufacturer produces, as to which of the portions or parts are cast together and which of the portions are separately cast and welded together.

In addition to the advantages of mass production of the various parts which form the various portions as separate units, there is the advantage that one or more of these portions may be made of different metals with respect to the other parts. In the single casting of the prior art the casing must always be made throughout of the same metal and this must be the metal required for the most highly stressed part of the casing. However, with the present invention less expensive materials may be used where lower stresses are anticipated, leaving the more highly stressed portions to be made of more expensive materials.

The transition portion 71 and 72 and possibly others may be standardized as to length and diameter sizes in such a manner that they include guide blade carriers of one turbine type and as to the same turbine type, a turbine of the next larger size. Secondly, the front or inlet portion of one turbine type may be connected with the exhaust portion of a next larger turbine model of the same type to produce a new turbine size. The rotative orientation of the exhaust portion may be varied as re-
quired to bring the exhaust line conduits out at various rotative angles.

In general, it can be seen from the foregoing that the present invention contemplates a method for making fluid turbine casings having length-wise extending differing portions with parameters of length and cross-sectional contour and size of one or more of these differing portions for different types of turbines.

If the casings for the different types of turbines, including different sizes of one type, are to be made from a single casting as has heretofore been customary, a great amount of expensive pattern shop and foundry work is required and it is practically impossible for a turbine manufacturer to have the advantages of an inventory of parts.

However, according to the present invention, the various portions of the turbine casing are made in the form of separate interfitting parts which for each portion comprise an inventory of parts, or groups of parts, with the parts of each group having the parameters described differing from those of each other as required for the parts of each group to form the corresponding portion of different types of turbines. With this inventory the manufacturer may select from the parts those required for the corresponding portions of the casing of the particular type of turbine which must be manufactured. The parts are made so that they interfit and the manufacturer simply interfits and interconnects the selected parts to form the casing desired.

These parts include as many as is necessary of the front or inlet portions of the turbine casing, correspondingly as to the exhaust or outlet portions of the casings, and this being equally true as to the intermediate portions of the two kinds. These intermediate portions include the lengthening or spacing portions which are typically cylindrical in contour as, for example, those shown at 80 in the drawings. Transition portions may be included wherein the front of the portion fits the back of the preceding portion, with the back of this portion being enlarged to fit a succeeding portion of larger diameter such as is shown in the case of parts 71 and 73 in FIGS. 4 and 3 of the drawings.

We claim:

1. A turbine housing for use with steam which is comprised of a plurality of axially adjoining sections, said sections including an inlet section, an exhaust section and at least one intermediate and transition section, the improvement wherein said housing is formed based on the basic turbine design required as reflected by the input and output performance requirements and turbine speed by selecting said inlet section, said exhaust section and at least one intermediate and transition section from corresponding groupings of each, said groupings of each having a plurality of pieces varying one from the other in at least one of the parameters of length, cross-sectional contour, cross-sectional size at input and/or output of each section and material of construction and mechanically joining said inlet section, said intermediate section, and transition section and said outlet section together to thereby form said housing.

2. The housing of claim 1 wherein at least two of said adjoining sections are cast as one piece before assembly to the remaining ones of said sections.

3. The housing of claim 2 where the sections cast as one piece consist of said intermediate sections and said exhaust section.

4. The housing of claim 2 where the sections cast as one piece include at least two of said intermediate sections and where said cast intermediate sections are welded to said inlet section and bolted to said outlet section.

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