A single shell extraction casing includes a stepped shell which is formed from a plurality of circumferentially shaped ledge rings located along the axial length of the casing between turbine stages and covered by a casing wrapper. The stepped shell has a simpler construction than the double shell configuration of a conventional turbine extraction casing. Pockets for supporting diaphragms between the multiple stages in the stepped single shell extraction casing are connected directly between ledge rings so they are away from the casing wrapper. This decreases the amount of welding and manufacturing complexity needed to install the diaphragm support pockets.
The present invention relates to steam turbines, and more particularly, to a turbine casing with a simpler structure requiring less internal bolting to join together the casing’s halves.

BACKGROUND OF THE INVENTION

Steam turbines are machines that are used to generate mechanical (rotational motion) power from the pressure energy of steam. Steam turbines are typically comprised of a series of different size stages. Each stage has a set of moving and fixed blades. The moving blades are attached to the turbine’s rotor, while the stationary blades are called diaphragms. Each diaphragm guides the steam to glide over the moving blades for the purpose of producing rotary motion. To maximize turbine efficiency, the steam is expanded as it flows through the turbine, generating work in the multiple stages of the turbine.

In an extraction type turbine, steam is released from various stages of the turbine, and used for industrial process needs or sent to boiler feed water heaters to improve overall cycle efficiency. Conventionally, an extraction turbine casing is constructed in a double shell configuration due to the extraction. To satisfy the extraction area the diaphragm pockets are supported away from the turbine shell major structure. However, several problems with turbines of this type of construction are the weight of the turbine casing, the amount of time needed to construct the casing, and the complexity of the casing structure.

The present invention is directed to constructing a turbine extraction casing in a simpler manner using a single shell, instead of a conventional double shell configuration. According to the present invention, the inner casing of the turbine is a stepped inner casing, instead of the conical and cylindrical casing used on conventional extraction casings. Conventionally, extraction casings are constructed using double shell configurations due to extractions. To satisfy the extraction area, the diaphragm pockets are supported away from the turbine’s shell major structure. According to the present invention, instead of building one more shells inside the casing, small diaphragm pockets are built, as required, so as to build a simpler structure. The extraction casing is simplified by eliminating the complexity of the conventional structure through the use of a stepped inner casing. Use of the stepped inner casing can also result in a significant reduction of the amount of internal bolting needed to connect the two halves of the casing together, which, in turn results in easier accessibility to the internal components of the turbine. The shape and size of the diaphragm support pockets and structure is also changed. Pockets for supporting diaphragms between the multiple stages in the stepped single shell extraction casing are connected directly between ledge rings so they are away from the casing wrapper. This decreases the amount of welding and manufacturing complexity needed to install the diaphragm support pockets.

In an exemplary embodiment of the invention, a single shell turbine casing with stepped structure comprises a plurality of ledge rings positioned along an axial length of the turbine casing so as to be located between a plurality of stages located within the turbine casing, and a casing wrapper covering the outer circumferences of the plurality of ledge rings, a plurality of diaphragm support pockets extending along an axial length of the turbine casing, each of the plurality of diaphragm support pockets being connected between a corresponding pair of the plurality of ledge rings, and a plurality of steam extraction pockets through which steam is extracted from an interior of the single shell turbine casing’s stepped structure, the plurality of steam extraction pockets being connected to a plurality of steam extraction pipes to which the turbine casing is connected by a plurality of connecting conduit areas located behind the plurality of diaphragm support pockets and between the casing wrapper and an inner wrapper extending between a portion of the plurality of ledge rings.

In a further exemplary embodiment of the invention, a single shell turbine casing with stepped structure comprises a plurality of ledge rings positioned along an axial length of the turbine casing so as to be located between a plurality of stages located within the turbine casing, the plurality of ledge rings having varying diameters so as to form the stepped structure of the casing, and a casing wrapper covering the outer circumferences of the plurality of ledge rings, and a casing being formed from first and second halves joined together, and wherein the single shell turbine casing, by reason of its stepped structure, requires a number of bolts to join together the casing’s first and second halves that is less than a number of bolts required to join together a dual shell turbine casing that is formed from first and second halves and that is comparable in size to the single shell turbine casing.

All together, the foregoing features result in a significant impact on extraction inner casing design, manufacturing and cost, resulting in a decrease in weight, manufacturing time and simpler structure for the extraction casing.

FIG. 1A is a cross sectional elevational view of a conventional double shell continuous cylindrical extraction casing for a dual axial flow low pressure steam turbine.

FIG. 1B is a cross sectional perspective view of the bottom half of the conventional cylindrical extraction casing shown in FIG. 1A.

FIG. 2A is a cross sectional elevational view of a single shell stepped extraction casing for a dual axial flow low pressure steam turbine constructed according to the present invention.

FIG. 2B is a cross sectional perspective view of the bottom half of the single shell stepped extraction casing shown in FIG. 2A.

DETAILED DESCRIPTION OF THE INVENTION

A low pressure (LP) turbine can be either single or dual axial flow machine. An LP turbine is typically located next to a high pressure (HP) turbine. In dual axial flow LP turbines, steam enters the center of the turbine from a cross
over pipe and flows across the reaction blading in two opposite directions. The steam flows parallel to the turbine’s rotor and exhausts into a main condenser.

[0014] FIG. 1A is a cross sectional, elevational view of a conventional double shell continuous cylindrical extraction casing 10 for a dual axial flow LP steam turbine. FIG. 1B is a cross sectional, perspective view of the bottom half of the conventional cylindrical extraction casing 10 shown in FIG. 1A.

[0015] Extraction casing 10 has an upper half 11 and a lower half 13, which are bolted together along a horizontal joint 17 by a plurality of bolts (not shown), so as to create a metal to metal fit that is sealed. Extending along horizontal joint 17 are a plurality of diaphragm support pockets 19 for supporting the diaphragms (not shown) between the multiple stages 15 in casing 10.

[0016] The casing 10 includes a conical shaped inlet pipe 22 through which steam from a crossover pipe (not shown) enters the center of the turbine casing 10 and flows across the reaction blading in two opposite directions. This crossover pipe is connected to inlet pipe 22 at an inlet crossover ring 21.

[0017] In an extraction type turbine, steam is released from various stages of the turbine, and used for industrial process needs or sent to boiler feedwater heaters to improve overall cycle efficiency. Conventionally, an extraction casing is constructed in a double shell configuration due to the extractions. Thus, casing 10 includes a continuous cylindrically shaped outer shell 12 with a plurality of circumferentially shaped ledge rings 16 and a stepped inner shell 14 with a plurality of circumferentially shaped ledge rings 20. To satisfy the area needed for the extractions, the diaphragm support pockets 19 are supported away from the major structure of shell 12. The casing 10 is also connected to a plurality of steam extraction pipes 24 through which steam is extracted from casing 10.

[0018] Ledge rings 20 are connected together by axially extending continuous internal ribs 18. Internal ribs 18 are circumferentially shaped. The axially extending continuous internal ribs 18 connecting together the ledge rings 20 in the turbine’s casing serve to control axial deflections and mechanical stresses that may occur in the casing 10. However, several problems with turbines of the type of construction shown in FIGS. 1A and 1B are the weight of the turbine casing, the amount of time needed to construct the casing, and the complexity of the casing structure. For example, a turbine casing of the type shown in FIGS. 1A and 1B requires a large amount of internal bolting to join together the casing’s halves 11 and 13.

[0019] FIG. 2A is a cross sectional, elevational view of a single shell stepped extraction casing 30 for a dual axial flow steam turbine, such as an LP steam turbine.

[0020] Casing 30 has an upper half 31 and a lower half 33, which are bolted together at a horizontal joint 35 by a plurality of bolts (not shown) so as to create a metal to metal fit that is sealed. FIG. 2B is a cross sectional, perspective view of the bottom half of casing 30 shown in FIG. 2A. The single shell stepped extraction casing 30 shown in FIGS. 2A and 2B excludes the axially extending continuous internal ribs 18 used with the casing 10 shown in FIGS. 1A and 1B.

[0021] The number of bolts needed to join together upper half 31 and a lower half 33 of casing 30 and seal horizontal joint 35 is reduced due to the stepped structure of casing 30. This reduction in the number of bolts needed is best seen by comparing the cross sectional perspective view of the bottom half of the single shell stepped extraction casing 30 shown in FIG. 2B with the cross sectional perspective view of the bottom half of the conventional cylindrical extraction casing shown in FIG. 1B.

[0022] The single shell extraction casing 30 includes a stepped shell 34 which is formed from a plurality of circumferentially shaped ledge rings 36 positioned between the turbine stages 44 located along the axial length of casing 30. The plurality of circumferentially shaped ledge rings 36 have varying diameters so as to form a stepped shell 34 having a dual conical shape with the smallest circumferences being in the center of the axial length of casing 30. Covering the outer circumferences of ledge rings 36 is a casing wrapper 32. The stepped shell 34 is designed to have a simpler construction than the double shell configuration of the conventional turbine casing 10 shown in FIGS. 1A and 1B, which includes the continuous cylindrically shaped outer shell 12 and the stepped inner shell 14.

[0023] Casing 30 includes a conical shaped inlet pipe 39 through which steam from a crossover pipe (not shown) enters the center of the turbine casing 30 and flows across the reaction blading in two opposite directions. The crossover pipe is connected to inlet pipe 39 at an inlet crossover ring 38. Surrounding inlet pipe 39 is an inlet flange 49. In the center of inlet pipe 39 is a stiffening plate 41.

[0024] Turbine extraction casings are conventionally done in double shell configurations because of the steam extraction function they perform. However, rather than building one or more shells inside a turbine casing, in casing 30 shown in FIGS. 2A and 2B, small diaphragm pockets 37 for supporting the diaphragms (not shown) between the multiple stages 44 in casing 30 are built, as required, with simpler structure along casing 30. As can be seen in FIGS. 2A and 2B, a plurality of diaphragm support pockets 37 extend along horizontal joint 35 of casing 30, and along the axial length of casing 30. To satisfy the steam extraction area that may be needed for a particular application or customer, the diaphragm pockets 37 are supported away from the major structure of shell 34. Stated differently, diaphragm support pockets 37 are connected directly between the ledge rings 36 so that they are away from the casing wrapper 32. This arrangement decreases the amount of welding and manufacturing complexity needed to install the diaphragm support pockets 37.

[0025] As can be seen in FIGS. 2A and 2B, casing 30 is also connected to a plurality of steam extraction pipes 40. Steam is extracted from stepped shell 34 through extraction pockets 43, after which it passes through conduit areas 45 behind diaphragm support pockets and between outer casing wrapper 32 and an inner wrapper 42 extending between some of the ledge rings 36. The steam in conduit areas 45 passes out of casing 30 through openings 46 in casing wrapper 32 and into steam extraction pipes 40. Steam is also extracted through additional openings 47 in casing wrapper 32.

[0026] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A single shell turbine casing with stepped structure, the turbine casing comprising:
a plurality of ledge rings positioned along an axial length of 
the turbine casing so as to be located between a plurality 
of stages located within the turbine casing, and 
a casing wrapper covering the outer circumferences of the 
plurality of ledge rings, 
the plurality of ledge rings have varying diameters so as to 
form the stepped structure of the casing. 
2. The turbine casing of claim 1 further comprising a plu-
rality of diaphragm support pockets extending along an axial 
length of the turbine casing. 
3. The turbine casing of claim 2, wherein the casing is 
formed from first and second halves joined together along a 
joint extending along the axial length of the turbine casing, 
and wherein the plurality of diaphragm support pockets 
extending along the joint between the first and second halves. 
4. The turbine casing of claim 2, wherein each of the 
plurality of diaphragm support pockets is connected between 
a corresponding pair of the plurality of ledge rings. 
5. The turbine casing of claim 2, wherein each of the 
plurality of diaphragm support pockets is connected between 
a corresponding pair of the plurality of ledge rings so as to be 
mounted away from the casing wrapper. 
6. The turbine casing of claim 2 further comprising a plu-
rality of steam extraction pipes to which the turbine casing is 
connected, and through which steam is extracted from the 
turbine casing. 
7. The turbine casing of claim 1, wherein the plurality of 
ledge rings are each substantially circular in shape. 
8. The turbine casing of claim 7, wherein the turbine casing 
has a dual conical shape formed by the smallest diameters of 
the varying diameter ledge rings being located substantially 
in the center of the axial length of casing. 
9. The turbine casing of claim 8, wherein the single shell 
turbine casing is a steam extraction casing for a dual axial 
flow steam turbine. 
10. The turbine casing of claim 9 further comprising an 
inlet pipe through which steam enters the center of the turbine 
casing and flows in two opposite directions through the tur-
bine casing. 
11. The turbine casing of claim 10, wherein the inlet pipe is 
conical shaped. 
12. The turbine casing of claim 1, wherein the casing is 
formed from first and second halves, and wherein the single 
shell turbine casing, by reason of its stepped structure, 
requires a number of bolts to join together the casing’s first 
and second halves that is less than a number of bolts required 
to join together a dual shell turbine casing that is formed from 
first and second halves and that is comparable in size to the 
single shell turbine casing. 
13. The turbine casing of claim 6 further comprising a 
plurality of steam extraction pockets through which steam is 
extracted from an interior of the single shell turbine casing’s 
stepped structure. 
14. The turbine casing of claim 13 further comprising a 
plurality of conduit areas connecting the plurality of steam 
extraction pockets to at least a portion of the plurality of steam 
extraction pipes. 
15. The turbine casing of claim 14, wherein the plurality of 
connecting conduit areas are located behind the plurality of 
diaphragm support pockets and between the casing wrapper 
and an inner wrapper extending between a portion of the 
plurality of ledge rings. 
16. The turbine casing of claim 15 further comprising a 
plurality of openings in the casing wrapper through which 
steam passes from the plurality of conduit areas into the steam 
extraction pipes. 
17. The turbine casing of claim 16 further comprising a 
second plurality of openings in the casing wrapper through 
which steam in an interior of the turbine casing passes directly 
into the steam extraction pipes. 
18. A single shell turbine casing with stepped structure, the 
turbine casing comprising: 
a plurality of ledge rings positioned along an axial length of 
the turbine casing so as to be located between a plurality 
of stages located within the turbine casing, the plurality 
of ledge rings have varying diameters so as to form the 
stepped structure of the casing, 
a casing wrapper covering the outer circumferences of the 
plurality of ledge rings, 
a plurality of diaphragm support pockets extending along 
an axial length of the turbine casing, each of the plurality 
of diaphragm support pockets being connected between a 
corresponding pair of the plurality of ledge rings, and 
a plurality of steam extraction pockets through which steam is 
extracted from an interior of the single shell 
turbine casing’s stepped structure, the plurality of steam 
extraction pockets being connected to a plurality of 
steam extraction pipes to which the turbine casing is 
connected by a plurality of connecting conduit areas 
located behind the plurality of diaphragm support pockets 
and between the casing wrapper and an inner wrapper 
connecting between a portion of the plurality of ledge 
rings. 
19. The turbine casing of claim 18, wherein the turbine 
casing is formed from first and second halves, and wherein 
the single shell turbine casing, by reason of its stepped 
structure, requires a number of bolts to join together the casing’s 
first and second halves that is less than a number of bolts 
required to join together a dual shell turbine casing that is 
formed from first and second halves and that is comparable 
in size to the single shell turbine casing. 
20. A single shell turbine casing with stepped structure, the 
turbine casing comprising: 
a plurality of ledge rings positioned along an axial length of 
the turbine casing so as to be located between a plurality 
of stages located within the turbine casing, 
the plurality of ledge rings having varying diameters so as to 
form the stepped structure of the casing, and 
a casing wrapper covering the outer circumferences of the 
plurality of ledge rings, 
the casing being formed from first and second halves joined 
together, and wherein the single shell turbine casing, by 
reason of its stepped structure, requires a number of 
bolts to join together the casing’s first and second halves 
that is less than a number of bolts required to join 
together a dual shell turbine casing that is formed from 
first and second halves and that is comparable in size to 
the single shell turbine casing.