STEAM STRAINERS FOR STEAM TURBINE PLANT


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This invention relates to steam strainers used to protect steam turbines against the ingress of foreign matter which may be carried through by the steam coming from the boilers. It applies in particular to the fine strainers used temporarily, during the commissioning period of steam turbine plants. During this period it is customary to fit temporary steam strainers either to supplement, or in place of, the regular steam strainers. The temporary units strain to a finer degree than the regular ones.

The two most common methods of accommodating the temporary strainers are either to fit the temporary unit round the regular strainer or, to substitute a temporary strainer in place of the regular strainer.

In the first case the walls of the temporary strainer are usually thin enough to allow the strainer holes to be punched. These holes are smaller than the holes in the regular strainer and are pitched to coincide with the larger holes when the temporary strainer is fitted over the regular one. The temporary unit relies upon the strength of the regular strainer for protection against the crushing effect caused by the pressure drop through the strainer. This pressure drop increases as the effective area through the strainer is reduced due to the presence of foreign matter on the inlet side of the strainer.

In the second case the temporary strainer is usually as strong as the regular strainer, the only differences generally being in the size and number of strainer holes. In this case, the walls of the temporary strainer are too thick to allow the strainer holes to be punched.

There is an increasing demand for even finer straining of steam during the early life of a plant, but it is difficult to achieve this with any of the methods in current use. For example, in case (1) the total number of holes in the temporary strainer must be the same as in the regular strainer. As the area through the strainer will vary as the square of the diameter of the strainer and the limit on the size of strainer hole is not due to the difficulty of punching the strainer holes but rather the severe loss of strainer area that results if the holes in the temporary strainer are much smaller than those in the regular strainer. It has been found that there is a marked loss of output from the turbine plant when temporary strainers of this type are fitted, particularly when the strainer becomes blocked with foreign matter. It is not considered practicable to reduce the size of holes through the temporary strainer.

In case (2), although the number of holes can be increased, it is very difficult to drill a large number of small holes through metal thicknesses of the order required for the duty.

The object of the invention is to provide a temporary steam strainer that will give the fine degree of straining required by modern steam plant, whilst being robust enough to be used for the highest possible steam conditions and also allowing for long periods of operation without cleaning and with limited loss of power output due to pressure drop.

The improved steam strainer according to this invention consists of the combination of a coarse strainer and a relatively fine strainer concentrically mounted with respect to each other, with an annular gap between them to break down the pressure drop through the assembly, the coarse strainer comprising a rigid cylindrical body having a plurality of radial holes through the side wall, and the fine strainer comprising a series of annular plates separated axially from each other by spacers of predetermined thickness.

Normally the coarse strainer will be outside the fine strainer; it may be the regular strainer which is to be used with the plant, or it may be specially made of similar form with holes the same size as the regular strainer, with the fine strainer assembled within so as to provide a unit that can readily take the place of the regular strainer when required.

According to one embodiment the strainer unit assembly comprises an outer cylinder with a plurality of holes drilled radially therethrough, and an inner plate-type strainer consisting of a stack of annular plates threaded over pillars secured to one end of the outer cylinder, with spacer washers on the pillars between adjacent plates and a cover-plate secured to the pillars at the other end of the cylinder to provide a rigid unit. The gap between the two strainers may conveniently be about one quarter of the diameter of the holes in the outer cylinder.

In another embodiment particularly suitable for larger sizes of strainer (for example around 12 to 14 inches in diameter) the plates of the fine strainer are made up of four 90° segments joined at the pillars, with butt joints between adjacent layers staggered in 45° phases. Preferably these plates are threaded over eight pillars, each 90° segment having a semicircular recess at each end and a central hole to fit around the pillars. The segments are indented to provide projections on one side of the same height as the spacing washers between layers, the indent being positioned so that with only one pattern of segment the staggering thereof around the circumference of the strainer brings the indents in one layer out of line with those in the adjacent layers. Such a construction provides a particularly rigid assembly using but one pattern of plate, which is more economical being less wasteful to produce in large sizes as compared with complete annular plates.

For a better understanding of the invention attention is directed to the following description of the accompanying drawings, in which:

FIG. 1 is an exploded elevational view showing one construction of strainer embodying the invention;

FIG. 2 is a partial plan view illustrating a modified construction; and

FIG. 3 is a developed diagram viewed in the direction of the arrows III in FIG. 2.

Referring to FIG. 1 there is shown an outer coarse strainer 1 and an inner concentric fine strainer 2. The strainer 1 comprises a cylindrical body provided with a large number of radial holes 11 in the usual manner. The fine strainer 2 is built up of a number of plates 20 which are threaded over pillars 4 securely fixed to the lower end of the cylinder. Pillars 4 may for example be screwed into tapped holes (not shown) in an internal flange on body 1. Strainer plates 20 are separated axially by spacers 3 also threaded on to pillars 4. A closing plate 10 is secured on the top of body 1 by nuts or screws 12 engaging the ends of pillars 4 thus making a rugged unit which can readily be substituted for a regular strainer in a steam plant. Strainer 2 is mounted concentrically within strainer 1 and defines an annular gap which breaks down the pressure drop through the complete assembly. This gap will normally be about one quarter of the diameter of holes 11.

The construction such as described above is suitable for small sizes of strainer and employs complete annular plates for the inner strainer. These are wasteful to produce in larger sizes. FIGS. 2 and 3 illustrate a modified structure in which the strainer 2 is composed of segmental plates instead of complete annuli.
Referring to FIGS. 2 and 3, it is seen that each layer of strainer 2 consists of a number of segments located on pillars 4 as in the FIG. 1 construction. FIG. 2 shows a 30° segment 20, with one adjoining segment 20a, 20c and three pillars 4 out of a total of eight. Each segment has a central perforation and a semicircular recess at each end to fit around the pillars. Specifically, segment 20b has a central hole 30 and end recesses 31. In assembly strainer 2, the segments in one layer are displaced by 45° with respect to the segments of adjacent layers as illustrated in FIG. 3 where parts of six successive layers of segments 20-25 are shown. It will be seen that segment 20b of layer 20 fits over the middle pillar 4 with its end recesses 31 against pillars 4 on each side so that the other sides of these pillars occupy similar recesses in the case of segments 20c and 20e, the ends of the segments having butt joints. The segments 21-25 of successive layers below layer 20 are in turn circumferentially displaced by 45°, so the segments 22, 24 are aligned with segments 20b, their central holes passing over pillars 4, whilst the segments 21, 23, 25 are in alignment with each other with their central holes over pillars 4' and their ends abutting pillars 4, and so on throughout the stack of plates, as shown in FIG. 1, are separated by spacers 6.

In order to afford support for the layers between pillars 4 particularly on large diameter strainers, the segments are indented to provide projections that impinge upon the upper part of the segment to which they adjoin, as shown in FIG. 3, these projections are formed on one side of segments such as 20b to the same height as washers 5 and are offset from the central through the thickness of the segments. In this way, projections 6' in the odd numbered layers are brought out of line with those 6 in even layers, as clearly shown in FIG. 3, while using only one pattern of segments for the whole assembly.

It is to be understood that structural modifications may be made without departing from the scope of the inventions. For example, projections may in some cases be provided on the annular plates 20 of FIG. 1, and in either embodiment such projections may be provided on both sides of the plates or segments. Pillars 4 may be fixed, as by screwing, to a flange 15 at the bottom of body 1 (FIG. 2), or to an end plate secured to the bottom of the body in like manner to the top plate 10 shown in FIG. 1.

The fine strainer is normally fitted downstream of the coarse strainer, so that the relatively more robust coarse strainer gives a measure of protection to the fine strainer, and also gives progressively less area through the strainer stages as the steam becomes progressively cleaner. If the direction of steam flow is radially outward, the fine strainer may be fitted over the outside of the regular strainer.

What we claim is:

1. In a steam turbine, a steam strainer comprising a coarse stage and a fine stage each constructed as substantially cylindrical bodies coaxially arranged with an annular gap therebetweent and arranged to cause a generally radial flow of steam directly through said stages in series without change of flow direction, the coarse stage comprising a hollow cylindrical body with the wall perforated in the radial direction with holes of diameter of substantially the order of magnitude of the wall thickness, such wall thickness being capable of withstanding the crushing effect due to pressure drop in the steam passing through the strainer, and the fine strainer comprising a stack of annular plates threaded over a plurality of pillars, spacer washers threaded on the pillars between the adjacent plates, and rigid end plates which are secured to both ends of the pillars and hold the plates together as a rigid unit.

2. A steam strainer according to claim 1, wherein said annular strainer plates are each composed of a plurality of segments with butt joints at each end of said segments.

3. A steam strainer according to claim 2, wherein said strainer plates are assembled on said pillars with the segments of each layer placed circumferentially with respect to the segments in adjacent layers.

4. A steam strainer according to claim 3, wherein said segments are provided with projections on at least one side face, said projections extending to the same height as the spacing members between adjacent layers of segments.

5. A steam strainer according to claim 4, wherein said projections are offset from the centre towards the ends of said segments, whereby the projections in one layer of plates are brought out of line with the projections in adjacent layers of plates.

6. A steam strainer according to claim 1, wherein said pillars are rigidly mounted radially inward of said cylindrical side wall, the lower end of said wall being provided with an internal flange, means fixing said pillars to said flange, and means including a closing plate secured to the top of said wall and engaging the upper ends of said pillars.

7. A steam strainer according to claim 6, wherein said annular strainer plates are each composed of a plurality of arcuate segments with butt joints at their ends, said segments being assembled on said pillars with the joints in each layer of plates displaced circumferentially with respect to the joints in adjacent layers of plates.

8. A steam strainer according to claim 7, wherein said segments are perforated at the middle to enable them to pass over one of said pillars, and the ends of said segments are formed with recesses which in assembled condition fit around the pillars on each side of said one pillar.

9. A steam strainer according to claim 8, wherein said segments are provided with projections on at least one side face, said projections extending to the same height as the spacing members between adjacent layers of segments.

10. A steam strainer according to claim 9, wherein said projections are offset from the centre towards the ends of said segments whereby the projections in one layer of plates are brought out of line with the projections in adjacent layers of plates.

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