United States Patent [19]

Widmer

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[54] **COMPONENTS USING CAST-IN COOLING TUBES**

[76] Inventor: **Colin Frederick Widmer**, 67 Levenside, Stokesley, Middlesbrough, Teesside, England

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 342,486, March 19, 1973, abandoned.

[30] **Foreign Application Priority Data**

Mar. 20, 1972 Great Britain 12993/72

[52] **U.S. Cl.** **266/41**, 266/32, 308/77, 165/168, 165/180

[51] **Int. Cl.** **C21b 7/16**

[58] **Field of Search** 165/168, 169, 180; 308/77; 164/111; 266/32, 41

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Primary Examiner—Gerald A. Dost

[57] **ABSTRACT**

A casting intended for heat transference between the body of the casting and a fluid passing therethrough, for example, a tuyere or other water-cooled cooling element for a blast furnace, comprises a thin-walled flexible corrugated tube with metal cast round it. The surface area of the inside of the tube should be within the limits of about 1.75 to 5 times that of a cylindrical surface of the same diameter as the minimum diameter of the tube. Metals which may be used for the tube are stainless steel or cupro nickel and the metal cast round the tube may be a copper alloy, though the invention is not limited to these materials.

13 Claims, 6 Drawing Figures

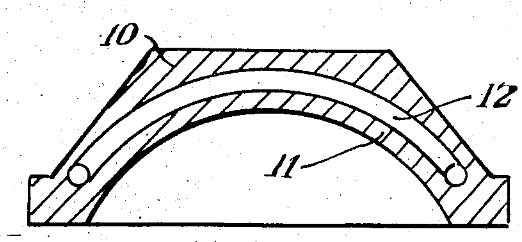

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Fig. 1.

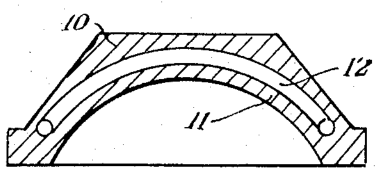


Fig. 2.

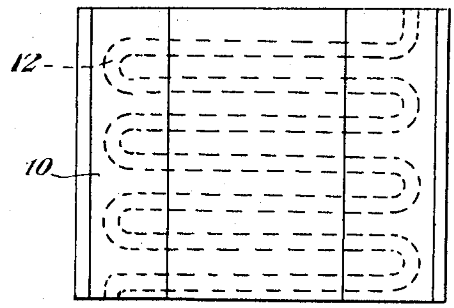


Fig. 3.

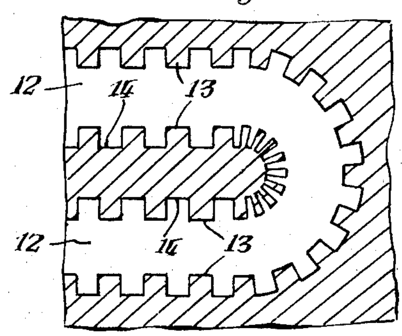
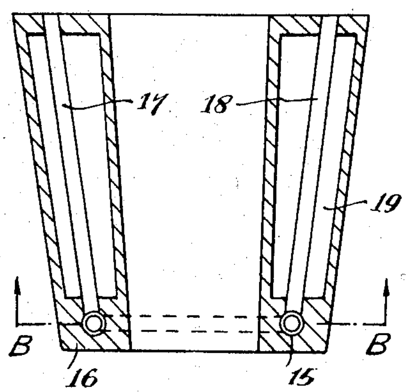


Fig. 4.



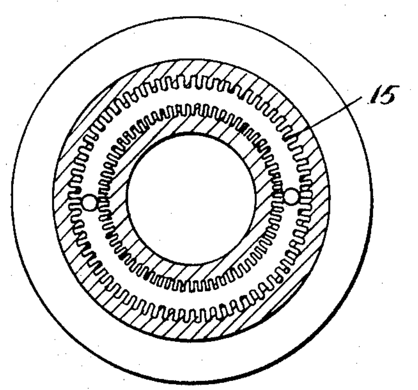


Fig. 5.

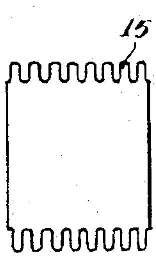


Fig. 6.

COMPONENTS USING CAST-IN COOLING TUBES

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of my copending U.S. Pat. application, Ser. No. 342,486 filed Mar. 19, 1973 and now abandoned.

BACKGROUND OF THE INVENTION

In the manufacture of castings which have to transfer heat it is common practice to cast the metal around a tube through which a liquid or gas can be passed. The tube may be shaped to suit the form of the casting and situated where the maximum heat transference is required. The tube in this way forms a passage which will not leak irrespective of the soundness of the casting and may provide a conduit of a shape which could not be achieved by normal casting techniques using cores.

The use of a plain tube has disadvantages in that it is difficult to achieve fusion or even intimate contact of a large proportion of the surface area. A plain tube can, in some instances, be the cause of large defects in the casting which result in a very low local heat transference and casting weakness. It is also difficult to achieve adequate heat transfer, in use, across the plain tube to give a balance with the heat transfer properties required of the casting as a whole. This is partly because there is liable to be the inadequate contact of the tube with the casting discussed above, but mainly because there is inefficient transfer to the coolant fluid (usually a liquid) at its interface with the inner surface.

SUMMARY OF THE INVENTION

I have found that remarkable results can be achieved by the use of a thin walled flexible corrugated tube as the tube round which the metal is cast. Firstly, the corrugations themselves not only modify the flow of the coolant fluid, thus ensuring turbulence within the tube, and obviating the likelihood of a temperature gradient being built up across the cross-section of the coolant, which would, in the case of a plain surface tube, limit the degree of heat transference from the wall of the tube. Secondly the corrugations themselves not only modify the flow, but provide a greater surface area than a plain tube, thus increasing the cooling efficiency.

Furthermore the corrugated form of the outside of the tube increases the area of contact between the tube and the cast metal and in some instances the casting defects adjacent to the tube can be reduced or eliminated. By using a thin walled tube, it has been found possible to use a poor conductor such as stainless steel, even in cases where the contraction of the cast metal is different from that of the tube; in such cases the use of corrugated tube results in intimate mechanical contact over an area much greater than that achieved when a plain tube is used.

For example, if a high conductivity tube of copper is to be cast into a copper alloy bearing, it is necessary to use a cool tube to prevent it melting when the metal is poured around it. With this improvement a thin wall corrugated tube of stainless steel would withstand the molten metal and reach the same temperature, thus cooling at the same rate as the casting. In addition, as the tube can reach the temperature of the molten metal, defects due to gas or inclusions are less likely to be trapped against the surface of the tube. It has also been found that the thin corrugated tube facilitates fabrication as it can very easily be bent to the required form.

Another problem is this: it is accepted that, in the case of water-cooled copper components used in blast furnace construction, it is necessary to have an efficient cooling system to avoid the components being melted or damaged by the heat to which they are exposed. It is also accepted that there are certain advantages to be gained by having more than one chamber wtihin the component so that in the event of damage to the front portion the water can be shut off without affecting the rear chamber.

In the case of blast furnace tuyeres it has been found convenient to use a pipe cast into the nose to act as a separate chamber, but if a plain tube is used it is necessary to select a high conductivity material such as copper. However, the internal surface has of necessity a small area compared with the surface of the tuyere exposed to heat, resulting in inadequate cooling of the nose area. To ensure that the copper tube does not melt when the castin is made it has to be cold and consequently there is a degree of danger in the casting operation and defects due to gas or inclusions tend to be trapped by the rapid solidification of copper against the cold tube. The voids, inclusions and the lack of intimate contact between the cast copper and the tube reduce the thermal transfer between the cooling water and the cast copper.

The tube should have an internal surface area of between 1.75 and 5 times that of a cylindrical surface of the same diameter as the minimum diameter of the tube. A preferred form of tube is a corrugated stainless steel tube with an internal surface area between 2½ times and 4 times that of its corrugations occurring at between 4 to 12 times per inch along the axial direction of the tube. By thin-walled we mean a tube having a wall thickness of up to 0.03 inches. In general the corrugations will have a depth of 6 to 12 times the wall thickness of the tube, and this depth will not be greater than the internal radius of the tube.

DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings illustrate, by way of example only, two separate forms of the invention.

In the drawings:

FIG. **1** is a section through a water-cooled bearing;

FIG. **2** is a view on the arrow A of FIG. **1**;

FIG. **3** shows a detail of FIG. **2** on a larger scale;

FIG. **4** is a section through a water-cooled tuyere for a blast furnace;

FIG. **5** is a section through the line B—B of FIG. **4**; and

FIG. **6** is a section through a straight length of the tube shown in FIG. **5**.

DETAILED DESCRIPTION

The water-cooled bearing of FIGS. **1** to **3** consists of a copper alloy material **10** presenting a part cylindrical bearing surface **11** (which may subsequently be lined with white metal or another bearing material if desired) which has been cast round a thin wall corrugated tube **12** of stainless steel. In this tube the internal and external surface areas are 2½ times those of cylindrical surface of the same minimum diameter and there are 5 corrugations per inch. The corrugations of the tube **12** are not shown in FIGS. **1** and **2** but can be seen in FIG. **3**, and it can be seen from this figure that the corrugations form ridges **13** and pockets **14** inside the tube equivalent to pockets **13** and ridges **14** on the outside of the tube. This corrugated tube is flexible, having a wall thickness of 0.01 inches, 5 corrugations per inch and a minimum diameter of 0.4 inch, and can easily be bent to the required convoluted form. The depth of the corrugations (from crest to trough) is 0.1 inch, and the internal and external surface areas are each approximately 2½ times that of a cylindrical surface of the same diameter as the minimum diameter of the tubes, i.e., the diameter between the parts **13**.

The corrugations may provide a series of pockets and ridges lying at right angles to the length of the tube, i.e., in the form of concentric rings, or they form a single or multi-start helix.

The water cooled tuyere of FIGS. **4** and **5** is of generally known type formed by casting copper alloy round a circular cooling tube **15** in the nose **16** of the tuyere, and an inlet pipe **17** and an outlet pipe **18** communicating with the tube **15**. A water chamber **19** in the main body of the tuyere has an inlet and outlet (not shown) for cooling water, and the nose **16** is cooled separately through the pipe **17**, the tube **15** and the pipe **18**.

The tube **15** is a stainless steel corrugated tube with a minimum diameter of 1 inch, a wall thickness of 0.025 inches and 8 corrugations to the inch along the tube. The depth of the corrugations is 0.15 inch and the internal and external surface areas are each approximately 4 times that of cylindrical surface of 1 inch diameter. The pipes **17,18** may also be of stainless steel but, as no heat transfer is necessary to and from these pipes, finning is not required.

The same principle can be applied to other water-cooled cooling element used on blast furnaces, to water-cooled electrode clamps for electric furnaces and other liquid-cooled and air-cooled elements.

The invention is, of course, not limited to the particular metals and combination of metals referred to above, as any suitable materials can be used, but its advantages are most clearly realised when the tube is a flexible thin-walled corrugated stainless steel tube cast into copper or a copper-based alloy.

What is claimed is:

1. A casting intended for heat transference between the body of the casting and a fluid passing through a tube embedded therein during casting, the said tube being a thin walled flexible corrugated tube with an internal surface area between 1.75 and 5 times that of a cylindrical surface of the same diameter as the minimum diameter of the tube.

2. A casting according to claim **1**, wherein the tube is made of stainless steel.

3. A casting according to claim **2**, wherein the internal surface area is between 2½ and 4 times that of a cylinder of the same minimum diameter.

4. A casting according to claim **2**, wherein the wall thickness is not more than 0.03 inches.

5. A casting according to claim **2**, wherein the corrugations occur at between 4 and 12 times per inch of axial length of tube, and have a depth of from 6 to 12 times the wall thickness of the tube, this depth being no greater than the minimum radius of the tube.

6. A copper or copper-based casting have cast therein a flexible, thin-walled, stainless steel tube for heat transference between a fluid to flow in the tube and the metal of the casting, the stainless steel tube being a corrugated tube with surface areas, for contact with the fluid and with the casting respectively, which are between 1.75 and 5 times that of a cylinder of the same diameter as the minimum diameter of the tube.

7. A casting according to claim **6** wherein the surface area is between 2½ and 4 times that of a plain tube of the same minimum internal wall diameter.

8. A casting according to claim **6** wherein the corrugations occur at between 4 and 12 times per inch of axial length of tube.

9. A casting according to claim **6** wherein the corrugations have a depth of between 6 and 12 times the wall thickness of the tube.

10. A casting according to claim **6** wherein the corrugations have a depth which is not greater than the internal radius of the tube.

11. A casting according to claim **6** in the form of a bearing.

12. A casting according to claim **6** in the form of a water-cooled cooling element for a blast furnace.

13. A casting according to claim **6** in the form of a tuyere wherein the corrugated tube is cast into the nose of the tuyere.

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