United States Patent [19]
Ulbrich

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[54] **RADIANT LINING**

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[52] **U.S. Cl.** ....**263/40 R,** 431/347
[51] **Int. Cl.** **F27b 3/02**
[58] **Field of Search** ....263/40 R, 43, 50; 431/347

[56] **References Cited**

UNITED STATES PATENTS

3,282,578	11/1966	Ulbrich	263/40 R
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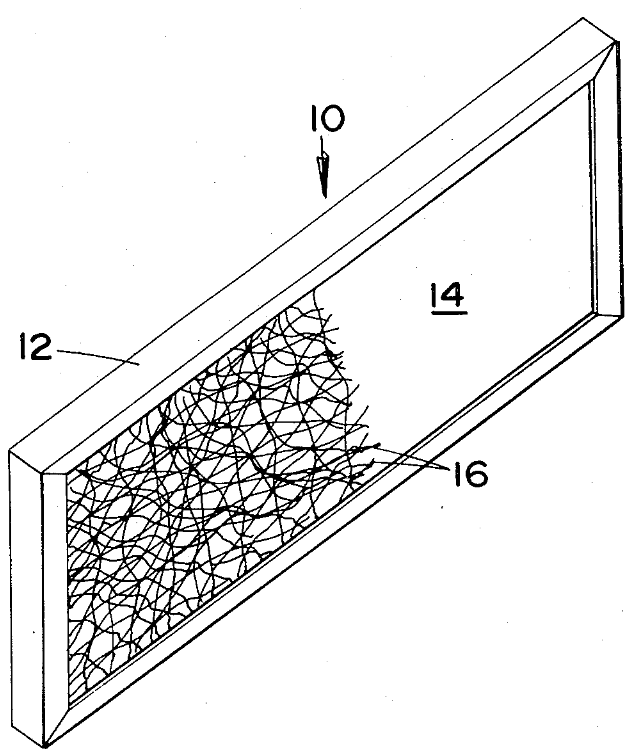
[57] **ABSTRACT**

The radiant screen lining comprises a plurality of randomly oriented discrete strands of heat resistant metal pressed into a mat of appropriate density and thickness. The mat is applied to a variety of heating apparatus by suitable securing means and positioned therein to interfere with radiated heat so that each strand is heated and radiates its heat for utilization by the heating apparatus. The lining can be applied to the inner walls of an oven, furnace, fire box, and the like.

19 Claims, 7 Drawing Figures



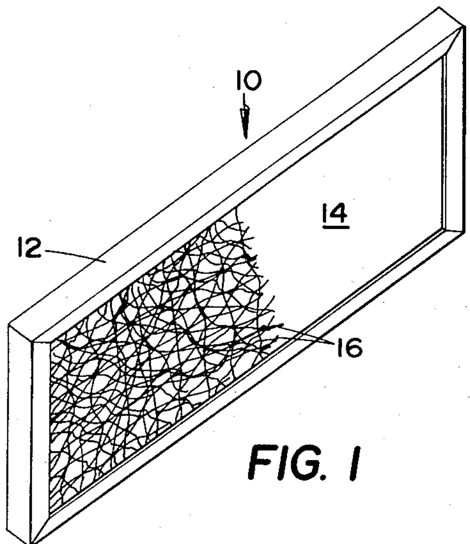


FIG. 1

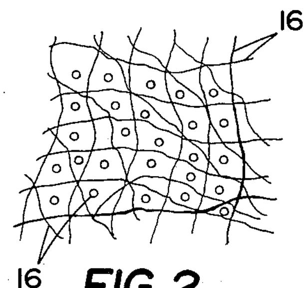


FIG. 2

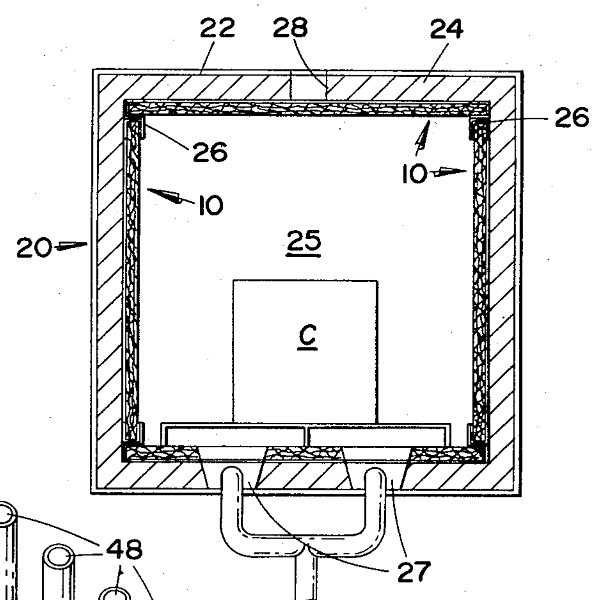


FIG. 3

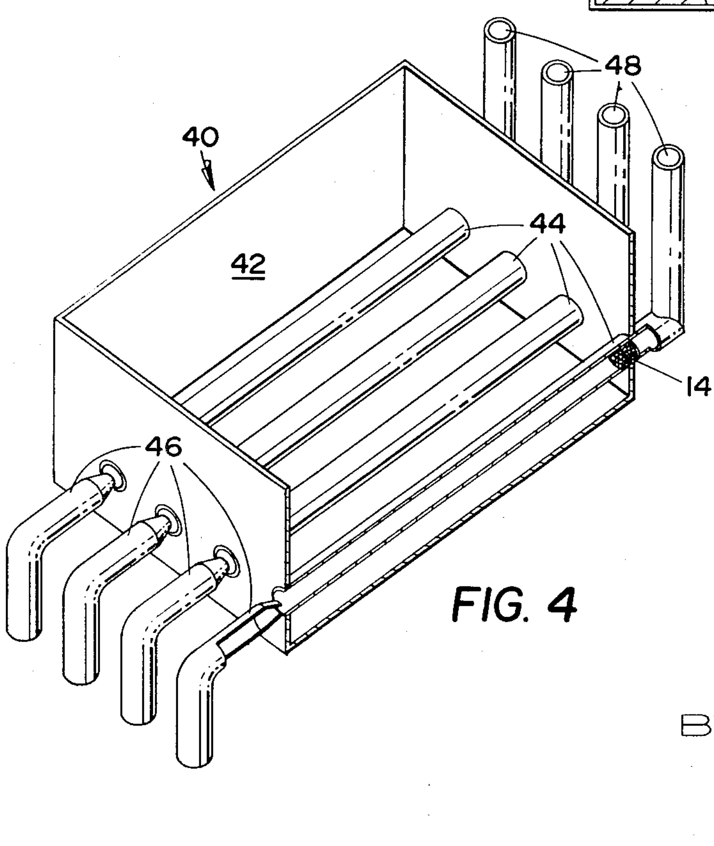


FIG. 4

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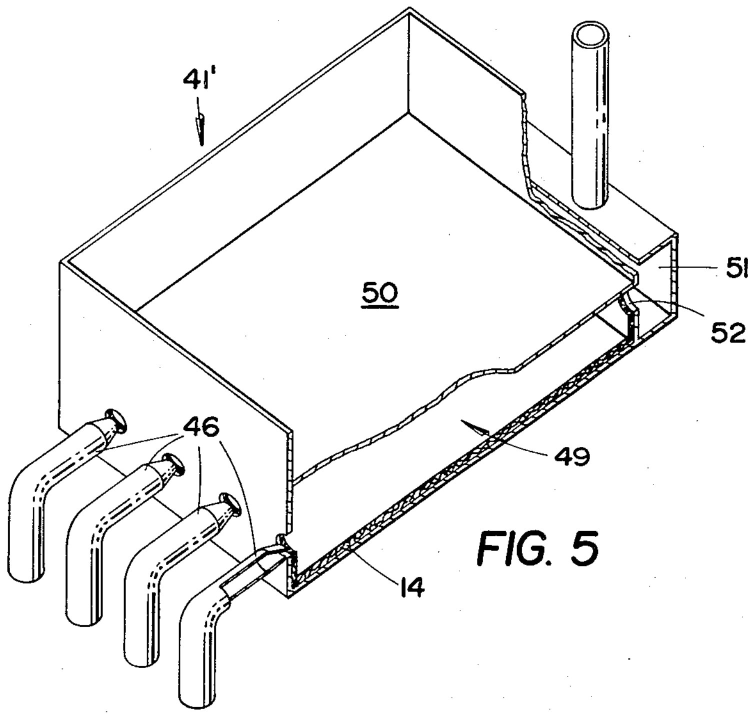

FIG. 5

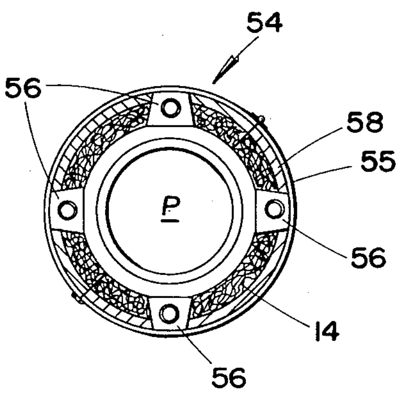

FIG. 6

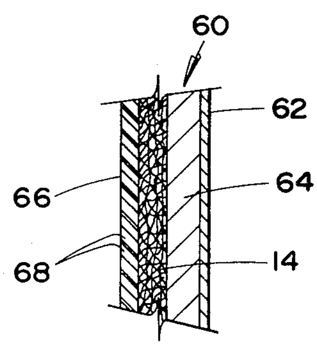

FIG. 7

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RADIANT LINING

BACKGROUND OF THE INVENTION

This invention relates to a lining for furnaces, ovens, kilns, boilers, vats, and various types of heating apparatus.

The heating industry in general is not as accustomed to using radiant heating as it is to the much more prevalent methods of heating by convection and conduction. There are several methods to generate radiant heat, or the infra-red waves constituting radiant heat. The common method for generating radiant heat is to use infra-red electric lights, or infra-red gas burners, surrounded by reflectors, such as polished aluminum. These methods are limited by the maximum temperature the reflector can withstand, which for aluminum is in the neighborhood of 800°F.

Another method for generating radiant heat is to surround an infra-red burner in a chamber with a number of layers of wire mesh screen to increase the radiation surface area. In this application, the walls, door, roof, and bottom of a chamber surrounding the radiant burner would be lined with multiple layers of radiant woven-wire mesh screening. This method appears to be the most efficient of the current state-of-the-art methods of obtaining rapid radiant heat-up and cool-down for temperatures up to about 2,100°F and is represented by applicant's U.S. Pat. No. **3,282,578**.

The mesh screen lining, however, presents a problem in arranging the numerous screens to close the open areas of screen by adjacent screens. This is necessary to prevent the radiant rays from radiating beyond the layer farthest from the heat source. The above-identified patent proposes use of different gauge wire and mesh numbers for the screens comprising the screen lining to present as much surface radiating area for a given lining volume as possible and in this way minimize the quantity of radiation passing through open areas in the lining. This solution leads to complex construction problems involving installing and anchoring numerous unwieldy screen layers of different wire meshes and wire gauges to inside surfaces of a chamber. Yet open areas may still occur in spite of precise calculations and manufacturing techniques.

The present invention includes as a preferred embodiment a radiant lining comprising a plurality of randomly oriented metal strands or wires compressed into a mat or pad configuration. The mats are installed against the inner wall of the furnace, or other heat chamber so as to be directly exposed to the heat. This lining is intended to be used in lieu of the present lining of firebrick, insulating brick, fire clay, or multiple layers of radiant woven-wire mesh screening. However, the lining can be applied over conventional insulating materials in existing devices to upgrade performance.

The material selected for the wire wool-mesh mat must be able to withstand the maximum operating temperature and environment of the heating apparatus in which it is to be used. The material may be stainless steel or high temperature nickel-steel alloys for temperatures up to 2,100°F. For temperatures above 2,100°F, a radiating thermal attenuator may be applied between the lining and the heat source. An example of a commercially available attenuator suitable for this application is ceramic honeycomb.

A typical, inexpensive, and readily-available source of lining material is stainless steel or nickel-steel turnings from finishing cuts on a machine tool. For higher temperature applications, material of ceramic or carbon strands, or other such high temperature materials may be used.

The radiant lining according to the present invention provides an effective radiating surface area which is many times larger than a comparatively flat surface of firebrick or other solid insulating material. As heat from the burners in a fossil-fuel furnace, or electrodes in an electric furnace, raise the temperature of the radiant lining, its larger radiating surface radiates and re-radiates back and forth inside the furnace, or other similar heat chamber, with an accumulative effect. Since heat radiation has a fourth power relationship to temperature, the result is an extremely rapid rise in temperature for even a modest input of fuel or electric power.

The strands of wire radiate in straight lines in all directions. Some of the rays of radiant energy are radiated back into the heat chamber to impinge on, and give off, the radiant energy in the form of heat to the charge and to strands of wire on opposite walls. Some radiant rays will be given off to adjacent strands of wire, and other rays will be radiated away from the furnace chamber into adjacent wire strands, which in turn radiate. Thus, the amount of re-radiated heat received and re-radiated by each succeeding wire strands is gradually attenuated down to the last wire. The primary limitation on the use of radiant lining is the maximum operating temperature of the furnace, which must not exceed the melting or oxidizing point of the lining material.

It is, therefore, an object of this invention to provide an improved lining for a furnace, oven, kiln, boiler, or other such heat chamber and which generates radiant infrared heat more efficiently than those of prior art.

An additional object of this invention is to simplify the manufacture, installation, and removal of an efficient radiant lining for furnaces, etc.

Another object of this invention is to provide a radiant lining which uses lower cost materials by utilizing stainless steel or similar high temperature alloy turnings.

These and other objects will become apparent to one skilled in the art from the following description of the invention made in conjunction with the drawings and in which:

FIG. **1** is a perspective view of a radiant lining mat embodying the present invention;

FIG. **2** is an elevational view of a portion of the mat of FIG. **1** on a larger scale;

FIG. **3** is a sectional view of an oven incorporating the radiant lining according to the present invention;

FIG. **4** is a perspective view with parts broken away of another type of heating apparatus which incorporates an application of the radiant lining according to the present invention;

FIG. **5** is a perspective view similar to FIG. **4** of another type of heating apparatus to which the radiant lining has been applied;

FIG. **6** is a sectional view of still another type of heating apparatus embodying the radiant lining of the present invention;

FIG. 7 is a partial sectional view of a wall of a heating apparatus illustrating a thermal barrier according to the present invention.

Referring to the drawings which illustrate preferred embodiments of the invention and initially to FIG. 1, which discloses a radiant lining panel **10** according to the present invention. Panel **10** is illustrated as being rectangular and including an edging or frame **12** enclosing a mat **14**. The frame **12** is preferred where the configuration of the heating chamber permits such as in a regular-shaped heating chamber. It should be appreciated, however, that there may be application for the lining where the use of a frame such as frame **12** is not practical. However, where practical, it is preferred since it makes the mat **14** easier to handle, install, and remove.

The mats **14** comprise a plurality of randomly oriented wires or strands **16** of heat resistant material pressed into a mat-like configuration. The discrete strands **16** should be made from material that is capable of withstanding the heat and corrosive effects of the heating environment in which it is to be used. For example, it has been found that many of the stainless steels or high temperature nickel-steel alloys are suitable for temperatures below 2,100°F. One relatively inexpensive source for strands **16** is finishing turnings produced by machine tools. When turnings are used for strands **16**, they are normally received in a random orientation relative to one another and they can be loaded into a suitable pressing apparatus of the appropriate configuration and dimension. After pressing the strands **16**, a fairly stable mat **14** is provided.

The random orientation of the strands is illustrated in FIG. 2. Each strand presents substantially its entire surface area as a radiating surface, and when compressed into the mat, it provides a substantial increase in radiating surface area as compared to a screen or a continuous surface.

The density and thickness of the mat varies depending on the operating temperature, gauge of the wire, type of wire used, size of chamber, and space available. There is a point of diminishing returns for the amount of re-radiation obtained by increasing the mat density per unit volume of radiant lining. This point is where the mat density approaches that of a solid radiating panel. Therefore, a density should be selected which presents the optimum surface area without defeating its ability to radiate.

FIGS. 3 through 7 illustrate examples of typical heating apparatus and how the lining may be applied to each of these representative types of devices. It should be apparent that numerous other types of heating devices may also utilize the radiant lining according to the present invention.

FIG. 3 discloses a generally rectangular shaped furnace or heating apparatus **20**. The furnace **20** comprises an outer shell **22**, a layer of insulation **24**, and radiant lining panels **10**. The panels **10** can be removably inserted into the heating chamber **25** through channels **26** and secured in place by suitable locking means. For irregular configurations, the mats **14** with or without frame **12** can be secured directly to the insulation **24** by means of suitable fastening devices.

When the mats **16** are installed as shown in FIG. 3 and heat is directed to the charge C from the fossil-fuel burners **27**, heat is radiated toward the radiant lining **14**. The radiant energy heats the strands **16**, and each strand **16** in turn radiates heat. Part of the radiation is directed toward charge C while other portions are intercepted by other strands **16** of the lining **14**. The net result of operation of the lining is to conserve the energy radiation from the heating chamber **25** and redirect it back into the chamber **25** to produce economies heretofore unrealized. In addition to conserving fuel to produce a given heat, the lining also reduces the time required to reach a particular heat and the time required to cool down after a given heat has been reached.

The embodiment of the invention shown in FIG. 3 incorporates fossil-fuel burners. However, electrical heating elements, electric arcs, or other heat sources may be used as the heat source with the same advantages.

The lining **14** may be applied as illustrated in FIG. 3 or it can be applied over existing insulation such as firebrick. Also, in existing ovens, a benefit can be obtained by merely covering the mouth or inlet to the exhaust for the oven, such as exhaust **28** in FIG. 3, with an appropriately configured mat **14**. In this application, the mat **14** is heated by hot gas passing therethrough in the process of exhausting as well as by radiation from chamber **25**. The mat **14** in turn radiates the heat back into chamber **25**, leaving only the exhaust flue gases to pass out the flue at approximately one-half the operating furnace temperature.

The heating apparatus **40** disclosed in FIG. 4 is intended to be representative of heating devices heated by fire tubes. Examples of these devices are boilers and vat cookers commonly employed in the food industry. The apparatus **40** comprises a vat structure **42** which receives the substance to be heated. Heat is transferred to the vat **42** through a series of heat pipes or fire tubes **44** located beneath the vat. Heat is directed into the tubes **44** by a plurality of gas nozzles **46** which are positioned to direct flame into the forward end of tubes **44**. The tubes **44** are heated by the flame and transfers heat to the vat **42**. The gas is exhausted from tubes **44** into flues **48**.

In the embodiment shown in FIG. 4, a radiant insulation mat **14** is inserted into the fire tubes **44** at a location such that the hot gases pass through the mat before entering flues **48**. The mat **14** is thereby heated and radiates heat back into the fire tubes **44**, thereby reducing the flue gas temperature for greater utilization of heat, and also distributing the heat more evenly throughout the surface of the fire tubes.

The heating apparatus **41'** disclosed in FIG. 5 illustrates another type of vat cooker. As illustrated in this figure, a rectangular fire box **49** transfers heat from gas nozzles **46** into liquid in contact with plate **50**. The fire box **49** has mats **14** applied to all sides thereof except plate **50**. The fire box **49** is exhausted by flue **51** through openings **52**.

The heating apparatus disclosed in FIG. 6 is representative of another type of heating apparatus **54** which anneals pipe welds. The pipe annealing apparatus **54** includes an outer circular shell **55** comprised of two hinged parts which can be wrapped about the welded area of a pipe and locked. A plurality of heating devices **56** are spaced about the periphery of shell **52**. A suitable insulating material **58** is applied to the interior of shell **52** between heating units **54**. The radiant lining **14** is suitably applied to the insulation **54** and exposed to the pipe **P**. For this application, the mat **14** is of tubular configuration and operates to radiate heat to pipe P and primarily to the weld between adjacent sections of pipe. The heat radiated from the pipe exterior is intercepted by the lining to minimize heat losses.

The foregoing applications of the lining are illustrative of several typical applications of the pressed mat lining **14** and it should be apparent to those skilled in the art that many other applications for the pressed mat exist but have not been disclosed specifically.

The application of the lining disclosed heretofore used metal strands **16** which may be metal turnings, and such lining material has been satisfactorily tested for applications up to 2,100°F. For example, a furnace similar to the furnace disclosed in **FIG. 3** was built and tested. The heating chamber **25** was 25 × 8 × 10 inches, the insulation **24** was 5 inches thick, mat **14** was 2 inches thick, and burners **27** were commercially available gas burners modified to prevent pre-ignition in the mixing chamber. This furnace was brought up to 2,100°F. in 6 minutes. The panels **10** were removed after the tests were completed and showed no deterioration from the temperatures reached in the test.

However, for environments in excess of 2,100°F, it is necessary to use a radiant thermal attenuator with the mat or lining **14**. **FIG. 7** discloses a wall section **60** for a heating chamber. The wall section **60** includes a shell **62**, insulation **64**, mat **14**, and thermal attenuator **66**. The wall orientation is such that thermal attenuator **66** is directly exposed to the heat. The thermal attenuator illustrated represents one type of ceramic honeycomb material suitable for this application which is a slant cell honeycomb manufactured and sold by DuPont under the trademark TORVEX. When the TORVEX honeycomb is applied to the face of the lining **14**, it reduces the temperature to which the lining **14** and insulation **64** is exposed. The lining **14** is heated by heat passing through the inclined openings **68**. When the lining **14** is heated, it radiates heat back into the chamber **25** through openings **68**. This configuration substantially increases the operating temperature for which the lining according to the present invention has application.

What is claimed is:

1. An apparatus for generating heat in a heating chamber for an oven adapted to receive a charge to be heated comprising, means for directing heat toward said chamber, and radiant lining means contiguous to at least a portion of said chamber for intercepting heat leaving the chamber and radiating heat back into the chamber, said radiant lining means comprising a plurality of discrete strands formed into a mat, said mat being configured to approximate the contiguous portion of said chamber.

2. An apparatus as defined in claim **1**, wherein said discrete strands comprise metal turnings.

3. An apparatus as defined in claim **2**, wherein said metal turnings are stainless steel.

4. An apparatus as defined in claim **2**, wherein said discrete strands are an alloy of nickel-steel.

5. An apparatus as defined in claim **1**, wherein said means for directing heat includes means for generating heats in said chamber in excess of 2,100°F and further including means disposed intermediate said chamber and said mat for providing a thermal attenuator for said mat.

6. An apparatus as defined in claim **5**, wherein said means for providing a thermal barrier comprises a ceramic honeycomb having openings therein inclined relative to said chamber.

7. An apparatus as defined in claim **1**, wherein said radiant lining means further includes a frame forming an edging disposed about the peripheral edges of said mat.

8. A radiant lining adapted to be disposed about at least a portion of a heated area and exposed to said area to receive heat therefrom, said lining comprises a plurality of randomly oriented discrete strands of heat resistant material pressed into a stable mat structure whereby the surface of each strand becomes a radiating surface when heated, and a frame extending around the peripheral edge of said mat.

9. A radiant lining as defined in claim **8**, wherein said strands are made from metal turnings.

10. A radiant lining as defined in claim **9**, wherein said strands are stainless steel.

11. A radiant lining as defined in claim **9**, wherein said strands are an alloy of nickel-steel.

12. An apparatus for generating heat in a plurality of tubes adapted to exchange heat directed therein to a medium in contact with the exterior thereof and including means for exhausting said tubes, and radiant lining means disposed within said tubes and radiating heat back into said tubes, said radiant lining means comprising a plurality of discrete strands formed into a mat configured to approximate the contiguous portion of said tubes, said mat being disposed immediately upstream of said means for exhausting said tubes.

13. An apparatus as defined in claim **12**, wherein said discrete strands comprise metal turnings.

14. An apparatus as defined in claim **13**, wherein said metal turnings are stainless steel.

15. An apparatus as defined in claim **13**, wherein said discute strands are an alloy of nickel-steel.

16. An apparatus for generating heat in a confined area including the circumference of a weld joining two pipe sections comprising means for directing heat toward said area, and radiant lining means contiguous to at least a portion of said area for intercepting heat leaving said area and radiating heat back into said area, said radiant lining means comprising a plurality of discrete strands formed into a mat configured to approximate the contiguous portion of said area.

17. An apparatus as defined in claim **16**, wherein said discrete strands comprise metal turnings.

18. An apparatus as defined in claim **17**, wherein said metal turnings are stainless steel.

19. An apparatus as defined in claim **17**, wherein said discrete strands are an alloy of nickel-steel.

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