Oct. 8, 1957 J. O. JACKSON 2,809,265

TEMPERATURE CONDITIONING PORTIONS OF A METAL SHAPE

Filed March 16, 1956 2 Sheets-Sheet 1

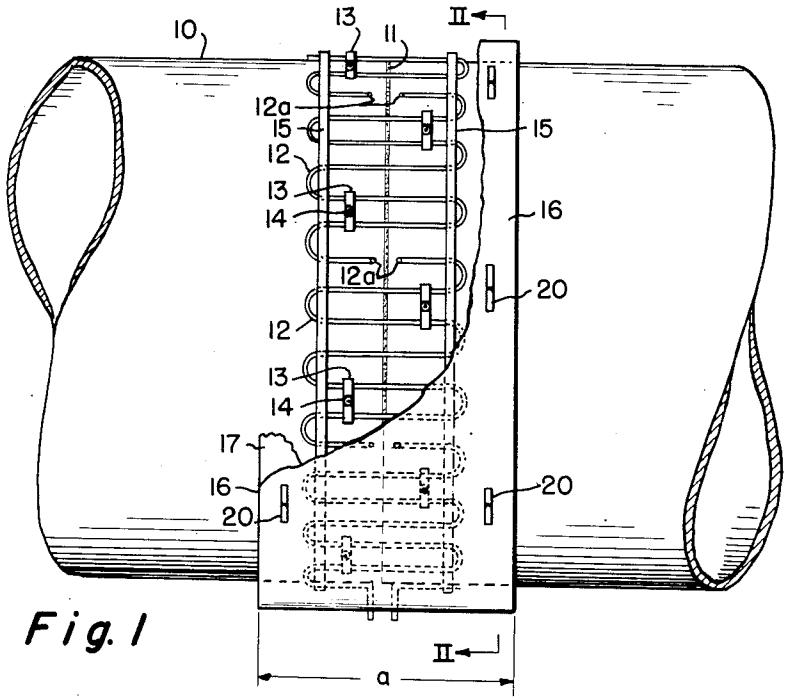

Fig. 1

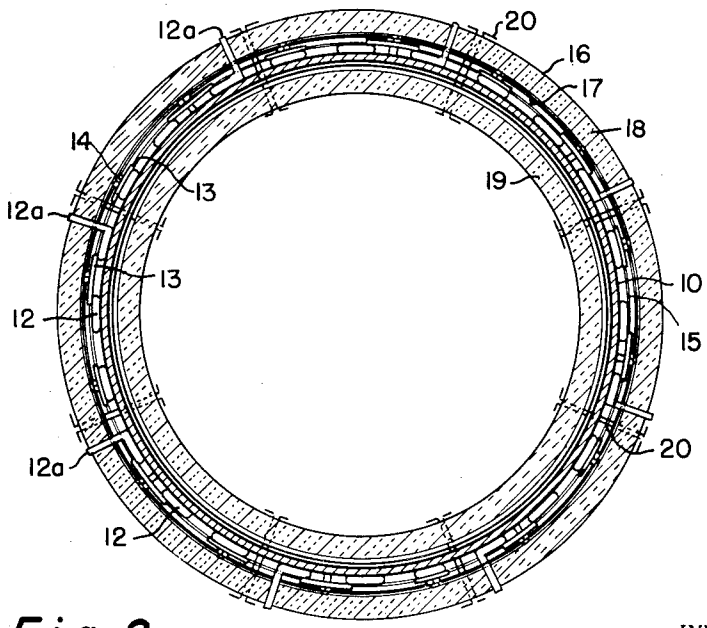

Fig. 2

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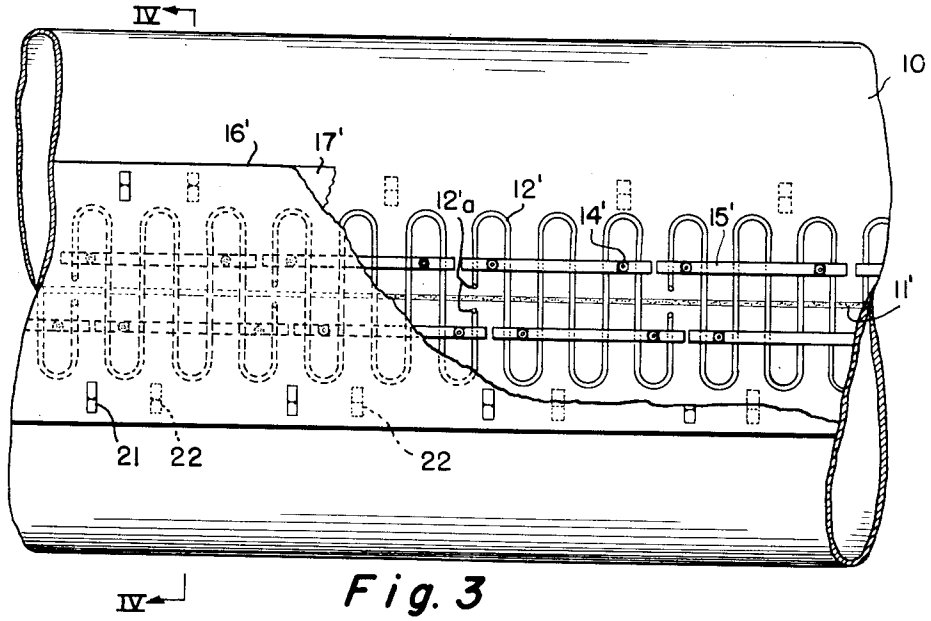

Fig. 3

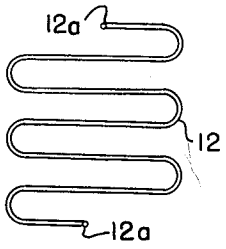

Fig. 5

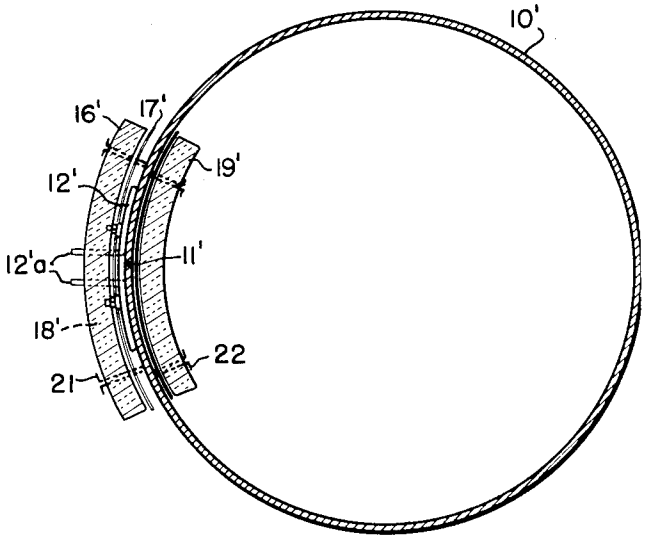

Fig. 4

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TEMPERATURE CONDITIONING PORTIONS OF A METAL SHAPE

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Application March 16, 1956, Serial No. 571,905

3 Claims. (Cl. 219—19)

This invention relates to localized temperature treatment of shapes or objects and particularly, of metal shapes of substantially continuous form.

A phase of the invention deals with an improved heat treating apparatus or mounting construction for a localized area of treatment, such as along a weld joint of a steel cylinder. It will be noted that the invention is devised to provide effective temperature conditioning or treatment of adjacent portions or areas along and about a weld joint or seam, irrespective of whether the joint extends longitudinally of the shape or transversely thereabout.

My construction has been devised to meet the problem involved in providing a construction or mounting which will be efficient in its temperature treatment action, will provide an even and a fully controllable temperature at localized areas or portions of the shape or object that are to be treated, and will operate effectively under expansion and contraction incident to heating and cooling. In addition, the active element or elements used to supply the temperature treatment should be of such a construction as to avoid permanent deformation and to minimize distortion due to expansion and contraction.

A weld may extend transversely about the waist or circumference of the shape or may extend longitudinally or axially along its wall and parallel to its length. In either case, the temperature treating elements or means are required to heat a curvilinear or arcuate area or surface and this, in itself, plus the fact that the treating elements will normally have a different coefficience of expansion and contraction than the portions of the shape to be treated, all contribute to the complexity of the problem.

It has been an object of my invention to provide a new and improved construction or procedure for a localized and effective temperature conditioning or treatment of shapes and particularly, metal shapes;

Another object has been to devise an approach to the temperature conditioning of localized portions or areas of a shape, such as portions adjacent to and along a weld joint;

A further object of my invention has been to maintain a substantially constant treating effect upon localized areas or portions that are to be treated and also for extremes of temperature;

A still further object of my invention has been to control and limit the expansion and contraction of heating elements and particularly, to prevent serious warping or distortion thereof while maintaining an efficient heat transfer relationship with the shape to be treated;

These and many other objects of my invention will appear to those skilled in the art from the exemplary embodiments shown in the drawings.

In the drawings,

Figure 1 is a side view in elevation along a fragment or segment of a circular cylindrical shape, such as a large conduit or shell; in this figure, a construction in accordance with my invention is shown in a treating position about the shape and as partially broken away to illustrate details;

Figure 2 is an end section taken along the line II—II of Figure 1 and on the same scale as such figure;

Figure 3 is a view similar to Figure 1, but showing a construction or treating apparatus of my invention positioned or mounted to treat longitudinally or axially, as distinguished from transversely or circumferentially, extending portions of the shape;

Figure 4 is an end view in section taken along the line IV—IV of Figure 3 and on the same scale as Figures 1 to 3; and

Figure 5 is a side fragment in elevation on the scale of the other figures illustrating the serpentine shape of individual temperature treating or heating elements, such as employed in the construction of Figures 1 and 3.

My invention provides a novel and improved construction for temperature conditioning of localized areas of a shape and particularly, of a large metal or steel shape such as used in wind tunnels, large conduits, etc. It enables an effective treatment at a greater range of and within greater extremes of temperatures. At the same time, it maintains a substantially uniform temperature distribution at or about the localized portions or areas that it is desired to treat. Treating elements are securely mounted in abutment with and at least in close proximity to the wall of the shape and from one side or surface thereof. Individual portions of each treating element or member of the treating assembly are laid out in a sepentine, spaced-apart and transversely-reversed relationship. Thus, transverse and longitudinal portions of the assembly project or extend perpendicular or at substantially right angles to the joint or line area of the wall that is to be treated and substantially parallel to the outer surface or body of the wall, itself. I secure these elements, such as heating elements **12**, in position along the axis of a weld seam **11** or of the area to be treated, with such elements in close proximity and in a projecting relationship at right angles to the longitudinal axis of the area, as well as centrally of and projecting substantially equally from opposite sides of the seam.

Insulating means or layers are employed along both inner and outer surfaces of the wall area and over the temperature conditioning elements, so as to substantially enclose the elements, as well as the area during the treating operation. The whole is securely mounted in position to retain such positioning during extremes of expansion and contraction that may be caused in the shape, as well as in such a manner as to minimize warping and avoid damage to the elements, so that they may be used in subsequent operations.

In the illustrated embodiments of the drawings, I have shown an apparatus or construction utilizing electrical heating elements **12** which are temperature conductive, but which are electrically non-conductive as to their outer surfaces. For example, so-called Calrod elements **12** may be utilized in this connection. These elements employ a current-energized resistance core within an enclosing but electrically insulated metal sheath, such as of stainless steel.

The construction is practical for heat treating various types of shapes and particularly, arcuate shapes at relatively high temperatures. It maintains a more uniform temperature distribution at a desired localized area, for example, at an area along a weld joint.

Although electrical resistance elements have long been used for heating, difficulty has heretofore been encountered in endeavoring to utilize them in heating objects to relatively high temperatures. In temperatures in excess of about 500° F., the difference in rate of and in the total of expansion between a surface or area to be heated and the sheath of an electrical heating element (which is at

a higher temperature than the surface being heated), has heretofore been sufficient to cause serious warping or distortion of the conditioning or heating element. I have determined that this distortion has the effect of limiting the proximity of the conditioning element with respect to the surface being heated which, in turn, requires a higher sheath temperature and produces uneven heating of the material being heated, as well as permanent distortion of the heating element.

I have found that it is important to maintain the conditioning elements or their assembly in close proximity to the surface or wall to be treated, and throughout the entire treating operation with a controlled expansion and contraction. The treating assembly will not then be seriously warped or distorted. I control the expansion and contraction of the temperature conditioning elements by their shape and positioning and by utilizing means to properly locate, attach, and hold them. As shown, the elements 12 are of tubular or rod-like section and are preformed or bent to a cyclic or serpentine pattern. The elements are fastened in such a manner that they are at least in close proximity and preferably, in actual physical contact with one surface of the wall of the structure or shape to be treated.

Referring to the drawings, and particularly to Figures 1, 2 and 5, I have shown an arrangement of my invention for treating a circumferential wall portion of a circular cylinder 10 made up of two portions joined or secured together by a weld bead or seam 11. The apparatus or construction of my invention is, as shown, mounted along the weld seam or bead 11 and its temperature-treating elements 12 of tubular construction are securely attached to or mounted on the outer surface of the tubular or circular structure 10 by clamping pieces or bars 13 and bolt and nut assemblies 14. The head of the stud portion of each of the assemblies 14 is welded to the surface of the shape or structure 10 to project outwardly therefrom.

It will be noted that the elements 12 are employed as a plurality or a series of elements which have been brought into close serpentine proximity with each other. They are also shown as further fastened or held down along their outer transverse extremities by continuous metal bands 15. Suitable insulating material, such as a sheet asbestos layer 17, is then placed over the heating elements 12 and a suitable thermal insulation layer, such as of fibre glass 18, is placed over and around the inner layer 17. A layer of thermal insulation, such as fibre glass 19, is shown positioned about or along the inside or opposed wall surface of the shape 10 in the same relationship and of the same extent as the outer insulation layer 18 (including 17). The insulating parts 17, 18 and 19 may, as shown particularly in Figure 2, be held securely in position by impaling them on cotter type of split-pin studs 20 that are mounted to extend through holes in the wall of the shape 10.

The serpentine nature of the conditioning elements 12 is illustrated in Figure 5. Each element (see particularly Figure 1) has terminals 12*a* for a suitable source of electrical power. In this connection, each element 12 may be of any suitable length, but I have found that about 83½ inches is a suitable length for a 215 volt heater. Thus, the elements may be used singularly at that voltage or in a series of two for 440 volt service. The transverse width of each element 12 is important, since it not only has to put a given quantity of heat into the steel wall 10, but must do so over a wide enough band such that the heat which conducts away from the joint 11 will not lower the temperature of the joint too much.

The heat treatment can be well used for conditioning the metal at the edges of the welds in the case of stainless steel and it is entirely possible to quench the steel on the inside surface after it has been heated on the outside surface. Thermocouples or other temperature-indicating devices may be used. For example, thermocouples may be put on opposite sides of the steel from the heater element assembly in holes drilled ⅛ of an inch into the steel, so that the correct temperature may be measured. Such thermocouples will not be positioned immediately over the weld metal 11, as the temperature is about constant for some 6 or 8 inches of width of the wall or plate 10.

In the embodiment of Figures 1 and 2, the wing portions of each element 12 are made arcuate in shape along their longitudinal axis. In another embodiment of Figures 3 and 4, the elements 12' lie on substantially a common plane longitudinally of their axis, but are curved or made concave transversely to conform to the surface of the shell or metal shape 10'.

In the latter embodiment, I have designated parts which are similar to those of the embodiment of Figures 1 and 2 by prime affixes. The same principles of construction and mounting and operation are involved, but the elements 12' extend along the axial length of the shape 10'. As heretofore, the elements 12' extend across the weld seam, such as 11', and along the area of the wall of the shell 10' that is to be treated.

In this embodiment, I have slightly modified the mounting of the elements 12', wherein the metal bands 15' are moved-in slightly along the transverse extent of the convolutions of the elements 12'. The bands 15' are employed to both position and mount the coils by the utilization of stud and bolt assemblies 14'. The heads of the studs of assemblies 14' are shown welded to extend from the outer surface of 10. This construction eliminates the bars or clamps 13 of Figure 1.

In operating the constructions shown, electrical energy is supplied to the heating elements 12 (or 12'), by their terminals 12*a*, and from suitable electric starting and control equipment, to bring the structure 10 (or 10') to a required temperature and at a required rate, as well as to hold it for a required time. In addition to thermocouples, temperature may be indicated by surface contact pyrometers and other suitable measuring devices. The cooling rate may be controlled in a like manner.

As a specific example, I have employed my invention to heat a circumferential portion of a circular steel girder section of 12 feet inside diameter to 1350° F. Twenty-four tubular heating elements of about ½ inch diameter and 83½ inches heated length, designed for a power density of 30 watts per square inch of the alloy sheath surface and rated at 3625 watts at 240 volts, were used for the heating operation. The elements were wired in a series-parallel delta connection to a 3-phase 440 volt supply system.

The transverse convolution or serpentine portions of each heating element covered a surface area of about 12 inches by 18 inches. Steel bands 15 of ¾ by 1/16 of an inch were covered by ⅛ of an inch asbestos sheet 17. Two inch thick blankets or layers 18' and 19' of fibre glass insulation were impaled upon and held in place by split pins 21 and 22 of 3/16 of an inch centers by 6 inches in length. The heads of these pins were welded to the inner and outer wall surfaces to project therefrom, as indicated in Figure 4. Thus, in Figure 4, instead of using a single, through-extending pin 20, I have shown surface projecting pins 21 and 22 of the same general construction.

In the above specific example, surface temperatures were obtained by Chromel-Alumel thermocouples and recorded on a Leeds & Northrup strip-chart potentiometer. Power was regulated by a Cramer percentage timer that was adjusted manually, as indicated by the temperature record.

Normally, the electrical heating elements 12 or 12' will be operated at a temperature of about 1200° F. and at such a temperature, a large part of the heat is transferred to the wall by radiation. However, such a trans-

fer depends on the fourth power of the distance between the electric heating element and the wall of the structure. Thus, it is important to maintain the elements in close proximity to obtain an efficient heat transfer.

In accordance with my invention, the thermal expansion of the elements **12** is directed or induced at substantially right angles to the wall or surface to be treated or, in other words, transversely of the temperature-controlled structure, rather than in the direction of the section or thickness of the wall. Serpentine flexibility is provided longitudinally of the structure **10** to maintain intimate contact of the elements **12** in an efficient heat-transfer relationship with the wall area that is being treated. The loss of the heat generated is minimized, the localized area which is to be treated is subjected to a substantially uniform temperature, and the adjacent areas are more or less isolated from the standpoint of such treatment. Losses to the ambient atmosphere are minimized.

The area about a weld joint **11** or **11'** may be fully and effectively heat treated or temperature conditioned so as to provide a strong joint that inhibits intergranular graphitization, such as may occur at the extremity of weld-effected base metal. Also, backing rings for the joint are unnecessary and stress and strain may be equalized.

What I claim is:

1. A unit for use with a relatively large curvilinear metal shape to eliminate a weld backing ring and provide a uniform temperature conditioning of a wall band along a length of joint, and for conditioning the joint as welded which comprises, an assembly of electric resistance elements in a heat-transferring relationship with an outer surface of and along the wall band, said elements being enclosed in an electrically-insulated heat-conducting sheeting, said elements being positioned substantially parallel to an outer surface of the wall band in a series of serpentine lengths that lie transversely across the joint of the wall band and extend therealong, a pair of metal bands in a transversely spaced-apart relationship on opposite sides of the joint and along the outer surface of the wall band, said metal bands having means to securely hold the elements of said assembly in position on the outer surface of the wall band in such a manner as to resist outward expansion of the elements of said assembly in a direction perpendicular to the surface of the wall band and to permit expansion of the elements substantially parallel thereto, an outer layer of heat-insulating material along the outer surface of the wall band and covering the elements of said assembly upon the wall band, an inner layer of heat-insulating material along an inner surface of the wall band and in an aligned and opposed relationship with said outer layer, means securely holding said layers in position on the wall band to minimize heat transfer between the ambient atmosphere and the elements of said assembly, and electrical leads extending from said assembly through said outer layer to supply energy to the elements.

2. A unit as defined in claim 1 wherein said means securely holding said layers comprises pin portions secured to the wall band and projecting outwardly from its inner and outer surfaces and through said inner and outer layers.

3. A unit as defined in claim 1 wherein, the elements of said assembly are unconnected with respect to each other along their respective serpentine lengths, the serpentine lengths of the elements have portions in a substantially longitudinally equally-spaced relationship with each other along the joint, said electrical leads are in pairs, and each pair of said leads is connected to an element of said assembly and extends through said outer layer independently of other pairs of said leads.

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