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Bricmont

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[54] **FURNACE AND COOLING CONTROL THEREFOR**

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[52] **U.S. Cl.** **432/42,** 432/77, 432/83

[51] **Int. Cl.** **F23m 5/08**

[58] **Field of Search** 432/42, 77, 83

[56] **References Cited**

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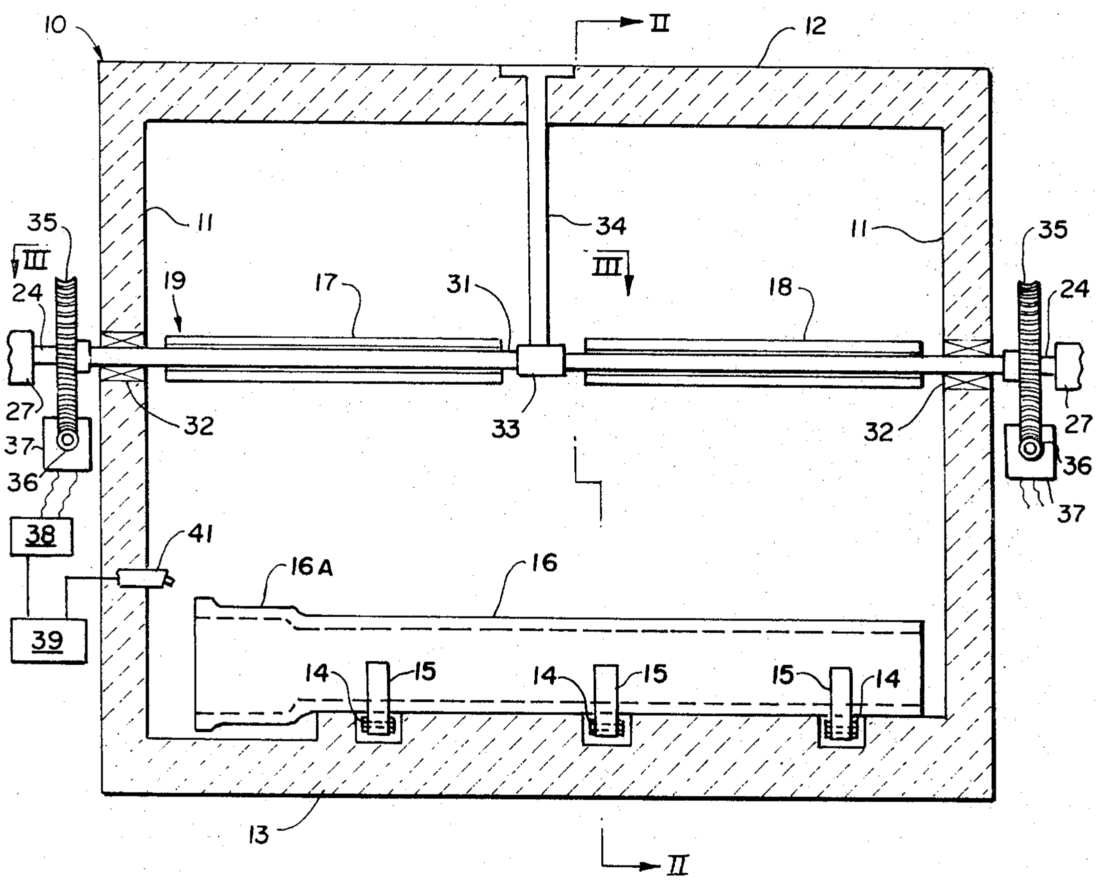
Attorney, Agent, or Firm—Brown, Murray, Flick & Peckham

[57] **ABSTRACT**

A furnace cooling control apparatus provided by a plurality of water-cooled panels supported within a furnace above a conveyor used to transport heated workpieces along the furnace hearth. The panels are arranged in an edge-to-edge relationship along the length of the furnace with pairs of panels arranged end-to-end across the width of the furnace. A drive connected to a centrally-located shaft on each panel independently, or if required a group of panels, rotates the panels to expose a portion or the entire area of either an insulated face on one side of the panel for slow cooling or a water-cooled face on the other side of the panel for fast cooling. A temperature control system is connected to the drive for adjusting each panel or a group of panels position to maintain a desired cooling rate of the workpieces.

8 Claims, 3 Drawing Figures



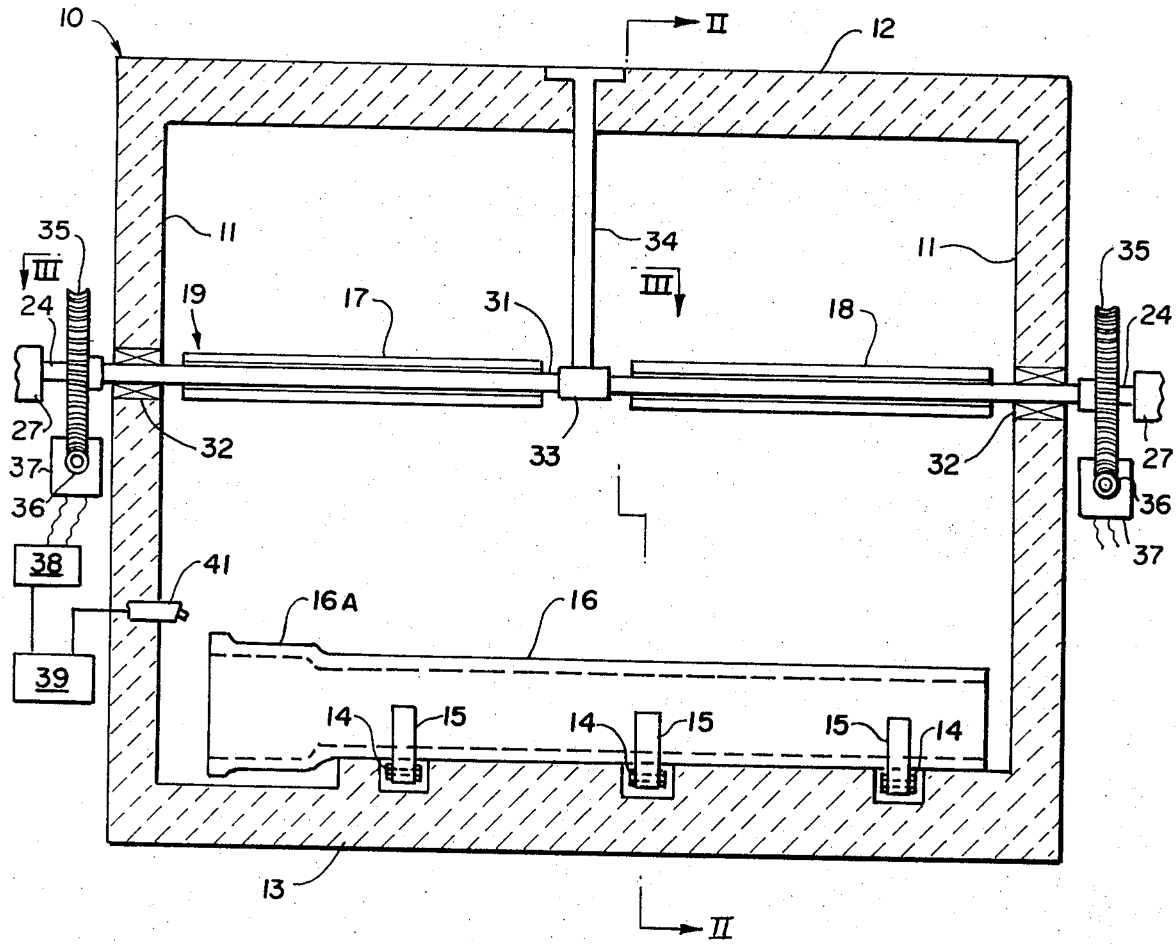

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Fig.1.

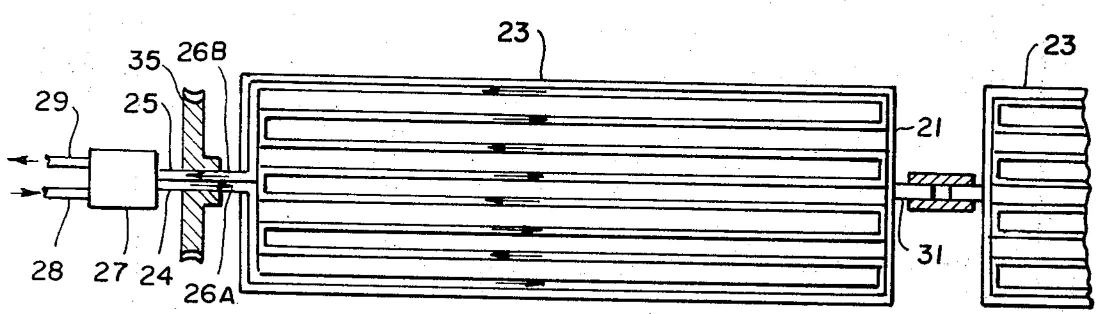
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Fig.3.

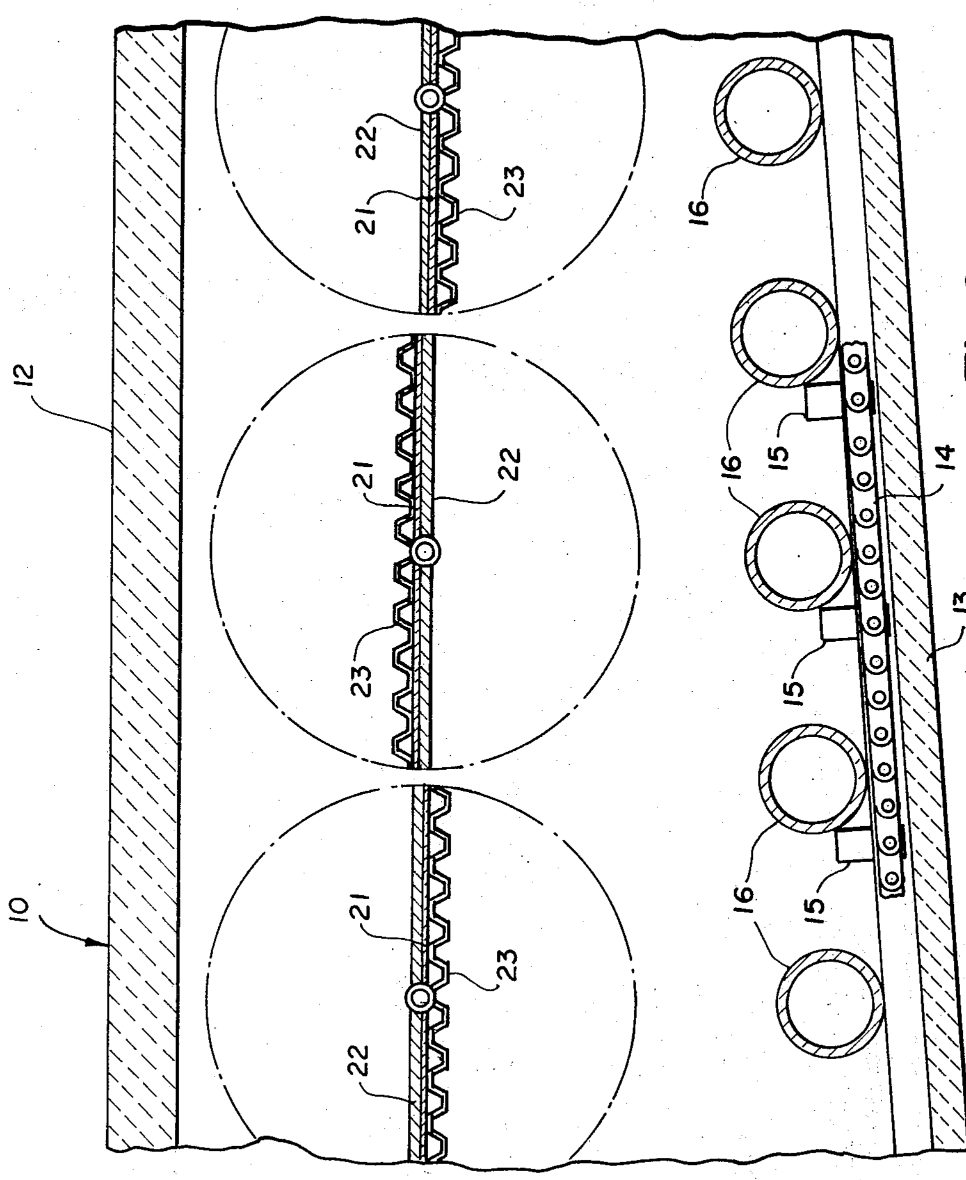

Fig.2.

FURNACE AND COOLING CONTROL THEREFOR

BACKGROUND OF THE INVENTION

The present invention relates to a controlled cooling furnace for rapid air-quenching of heated workpieces such as employed for a controlled cooling process of ductile iron pipe. In place of open air cooling of certain types of workpieces such as ductile iron pipe, cooling furnaces have been provided with a system of air ducts in the roof of the furnace. Air circulated through the ducts provides a medium for withdrawing heat from the furnace due to radiation cooling of the workpieces. This form of cooling furnace has been found to be inefficient and unacceptable for present-day requirements, particularly to meet the demands of a heat removal rate necessary to drastically cool such workpieces. The air duct system cannot be effectively controlled to provide a differential workpiece cooling as a function of time. Another aspect concerning the concept of differential cooling relates to different cooling rates along the length of a workpiece. Thus, for example, with respect to a ductile iron pipe, in order to effectively remove the greater quantity of heat from an enlarged bell-mouthed section at one end of the pipe requires a heat removal rate different from that of the rate for the remaining length of the pipe. Moreover, this furnace cooling arrangement lacks the capacity to remove the quantity of heat from within the furnace necessary to drastically air-quench a workpiece particularly large sectional areas from 1800°F–1275°, for example, within 7–10 minutes and then continue cooling at a lower rate down to an ambient temperature or other desired temperature before discharging the workpiece from the furnace.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a workpiece cooling furnace incorporating panels which are fluid-cooled on one side and insulated on the other side and which are adjustably arranged above and/or below hot workpieces within the furnace.

It is a further object of the present invention to provide an improved workpiece cooling furnace operative to cool a workpiece by radiation to a fluid cooled surface which is adjustably arranged within the furnace for controlling the cooling rate of the workpiece.

It is a still further object of the present invention to provide a control system for adjustably positioning fluid cooled panels supported within a furnace above and/or below heated workpieces for cooling by radiation to the surface of the panel.

According to the present invention, there is provided a cooling furnace and control therefor comprising a furnace hearth and conveying means for transferring a workpiece through the furnace, a plurality of panels arranged above and/or below the conveying means within the furnace, each panel being rotatably supported for selectively adjusting the location of opposed surfaces on the panels.

In the preferred form of the invention, one of the aforesaid panel surfaces is fluid cooled and the other panel surface is insulated. An automatic control system incorporating a temperature measuring device for the workpiece is provided for controlling the position of the panel surfaces. The panels are preferably arranged in a side-by-side relationship along the length of the furnace and in an end-to-end relationship across the width thereof.

These features and advantages of the present invention as well as others will become more apparent to those skilled in the art when the following description is read in light of the accompanying drawings, in which:

FIG. 1 is an elevational view, in section, of a cooling furnace embodying the features of the present invention;

FIG. 2 is a sectional view taken along line II—II of FIG. 1; and

FIG. 3 is a partial plan view taken along line III—III of FIG. 1.

With reference now to FIGS. 1 and 2 of the drawings, there is illustrated a cooling furnace **10** which includes side walls **11** supporting a roof **12** above a furnace hearth **13**. The hearth **13** is formed with spaced-apart troughs containing conveyor chains **14** each provided with a plurality of dogs **15** for transferring heated workpieces through the furnace. According to the embodiment of the present invention illustrated in the drawings, the furnace hearth is inclined to the horizontal and pipe sections **16** are shown being conveyed along the furnace hearth by the dogs and conveyor chains. The sections of pipe **16**, as illustrated in FIG. **1**, have enlarged bell-mouthed ends **16A** which define an increase in both diameter and mass of metal when compared to the remaining length of the pipe. To accommodate this shape of workpiece, the furnace hearth has a wide trough at one side extending along the length of the furnace. While the features of the present invention are particularly useful for the controlled cooling of ductile iron pipes, those skilled in the art will appreciate that other types and shapes of workpieces may be loaded into the furnace and cooled according to the features of the present invention without departing from the features and advantages thereof.

As shown in FIG. **1**, rectangular-shaped cooling panels **17** and **18** are arranged in an end-to-end relationship to extend across the width of the furnace. These panels form a cooling panel unit **19** of which a plurality of these units are arranged along the length of the furnace such that the panels in each unit are positioned in an edge-to-edge relationship. Each panel includes a rectangular-shaped plate **21** that supports on one surface a mat-like layer of heat resistant, insulation material **22**. This material may be selected from any one of a numerous products presently available in the industry and one such product is sold under the trade name of KAOWOOL. This product is an aluminum silicon fiber formed into a sheet or mat with a 14-pound density and operating temperature range of up to 2200°F.

A system of fluid transfer ducts **23** forms a heat exchanger which is attached to the surface of the plate **21** opposite the insulation **22**. These ducts are longitudinally arranged at spaced intervals across the width of the plate **21** and conduct a water-like coolant in opposite direction as indicated by the arrows in FIG. **3**. The ends of the fluid ducts **23** are connected to a pipe **24** having a baffle plate **25** which divides the pipe into a water input channel **26A** and a water discharge channel **26B**. A rotary fluid coupling **27** is mounted on the end of the pipe **24**. Water or other liquid coolant passes from a stationary supply pipe **28** through the rotary fluid coupling **27** and into the channel **26A**. The discharge channel **26B** delivers the liquid from the panel ducts through the coupling **27** and into a stationary pipe **29**.

A trunnion shaft **31** extends from the end of the panel opposite the pipe **24** and coaxially therewith. Rotatably supporting each panel is a pillow block **32** for receiving the pipe **24** and arranged in the furnace wall **11**. At the other end of the panel, the trunnion shaft **31** is received in a sleeve **33** which is carried by a depending plate **34** supported by the furnace roof. The plate **34** may, if desired, contain water coolant openings arranged in a convenient manner within the plate. The panels forming each cooling unit **19** are supported in a like manner by a sleeve **33** and pillow blocks **32** arranged in the opposed furnace walls. For each panel there is provided a worm wheel **35** secured on the pipe **24** between the coupling **27** and the furnace wall **11**. The wheel **35** is driven by a pinion **36** secured to the shaft of a motor **37**. The motor **37** is connected to a power supply **38** having a control **39** which receives a signal from the output line of a pyrometer **41** arranged within the furnace to measure the temperature of the pipe **16**. Based on the actual temperature measurements by the pyrometer, the control **39** produces an error signal based on a desired cooling curve. This error signal is used to control the position of each panel. The wheel **35** could, also, be provided with a handle or crank for manual operation. If desired, these wheels could be driven and controlled in groups. The wheel **35** can also be driven by a chain drive instead of the pinion **36**.

Water circulated through the heat exchange surface of the panel provides a cold surface, which, when exposed to the heated workpieces or pipes **16**, provides maximum radiation form of cooling which is maintained by the flow of water through the ducts **23** in the panels. This cooling rate is changed and controlled by proportionately turning the panel to expose all or part of the insulation **22** to the workpiece thus reducing the radiation cooling rate. The cooling rate through a given temperature is effectively controlled by adjusting the relative position of the ducts **23** with respect to the insulation **22** of the panels forming each cooling unit **19** and from unit to unit.

While the features of the invention may be employed in numerous applications, highly desirable results will be obtained for the cooling of ductile iron pipes where according to cooling rate graphs, a drastic air quench is to be carried out from, for example, an initial temperature of 1800°F to 1450°F within ten minutes and even 7–8 minutes as desired. Following a temperature reduction to 1450°F, the cooling rate is substantially reduced which can be readily accommodated by exposing an increased area of the insulated panel surface to the workpieces.

Although the invention has been shown and described in connection with a certain specific embodiment, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

I claim as my invention:

1. A cooling control apparatus in combination with a furnace or the like having a hearth for supporting heated workpieces, said apparatus comprising:

a plurality of panels arranged from said hearth in a spaced-apart relationship thereto,

means for rotatably supporting said panels within said furnace,

fluid conduit means for cooling a surface on one side of said panels,

insulating means on the surface of the panel opposite said fluid cooled surface, and

drive means for rotatably positioning said panels within an arcuate path of travel to selectively expose said surfaces to said workpieces according to a desired cooling rate.

2. An apparatus according to claim **1** further comprising conveyor means for transferring heated workpieces continuously along said furnace hearth at a spaced relation from said panels.

3. An apparatus according to claim **2** wherein at least two of said panels are supported by said means for rotatably supporting in an edge-to-edge relationship along the length of the cooling furnace.

4. An apparatus according to claim **3** wherein a pair of said panels is supported by said means for rotatably supporting to extend in an end-to-end relationship across the width of said cooling furnace.

5. An apparatus according to claim **4** wherein said means for rotatably supporting said panels includes a plate member projecting from the roof of said furnace for rotatably supporting adjacent ends of said panels while arranged in said end-to-end relationship.

6. An apparatus according to claim **1** further comprising temperature measuring means for workpieces supported on said furnace hearth, and control means responsive to said temperature measuring means for energizing said drive means.

7. An apparatus according to claim **1** wherein said fluid coolant means includes longitudinal ducts arranged at spaced intervals across the width of each panel.

8. An apparatus according to claim **7** wherein said insulation means is further defined to include a fibrous mat of heat insulating material having a working temperature range up to 2200°F.

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