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[54] **APPARATUS FOR THE COOLING OF BODIES UNDER PROTECTIVE GAS**

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[58] **Field of Search** ..... 266/2 R, 5 R, 5 C, 266/5 T

[56] **References Cited**

FOREIGN PATENTS OR APPLICATIONS

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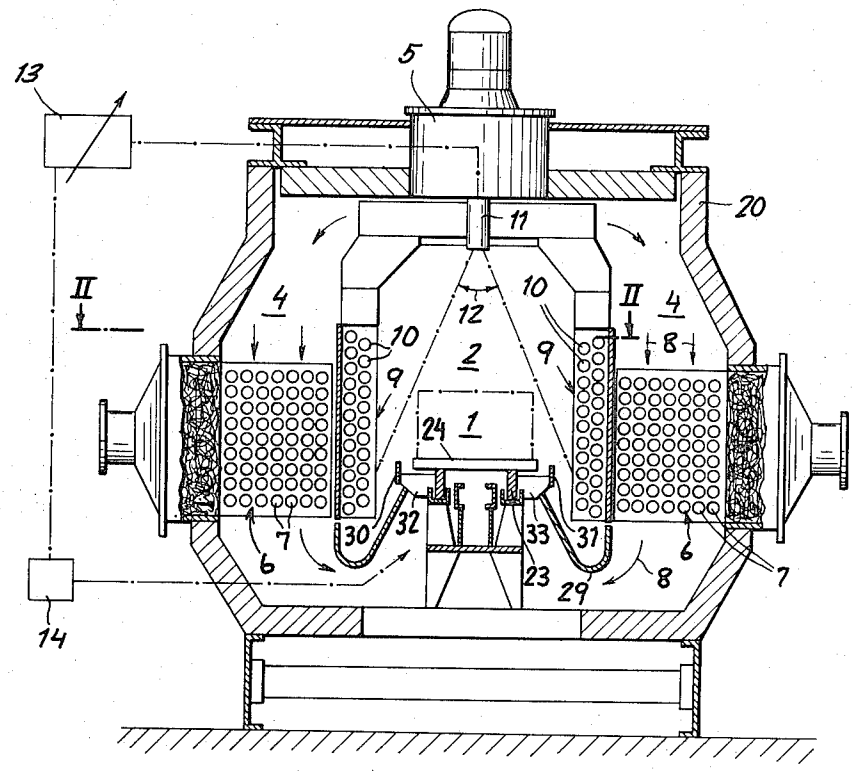
[57] **ABSTRACT**

A system for the cooling of metallurgical workpieces and other singular bodies under a protective gas (i.e., a non-oxidizing or reducing gas) has a pair of cooling registers forming the walls flanking the path of the workpiece and consisting of ducts through which a cooling fluid passes transverse to the direction of flow of the protective gas. The latter passes into the cooling chamber from below after traversing a pair of heat exchangers of the tube-bank type while a control arrangement responsive to the mean value of the radiant energy omitted from the body serves to advance the workpiece from the chamber when a predetermined threshold value is attained.

7 Claims, 2 Drawing Figures



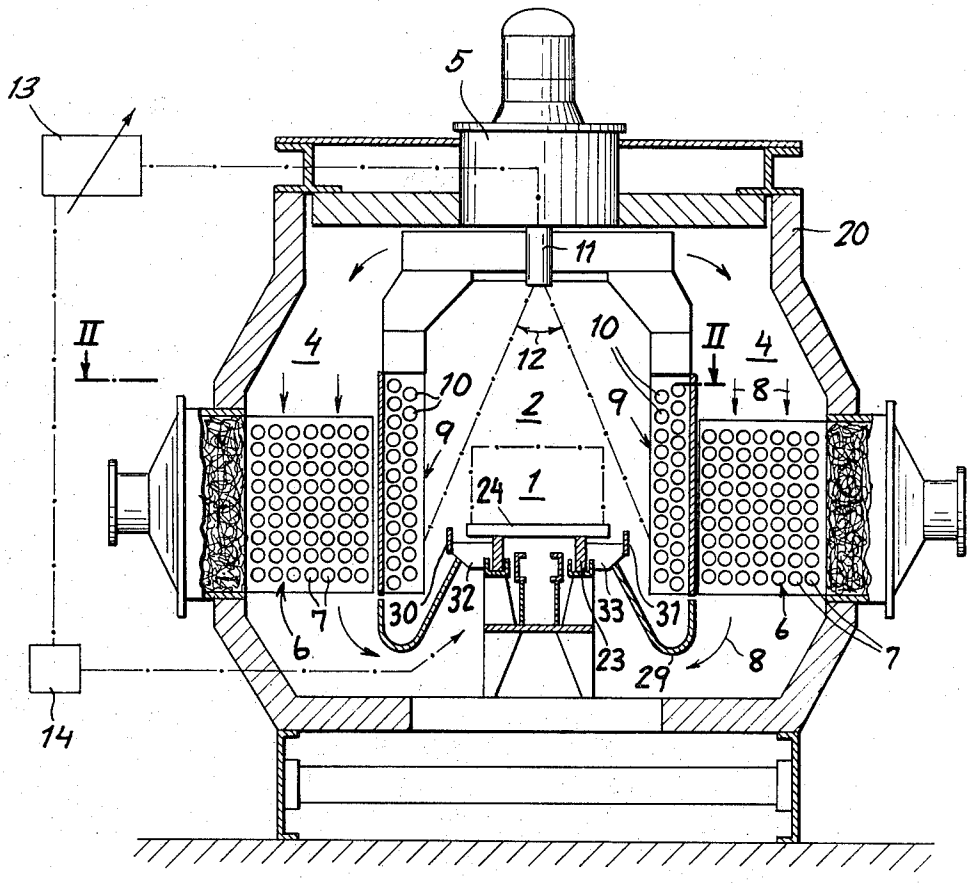


FIG. 1

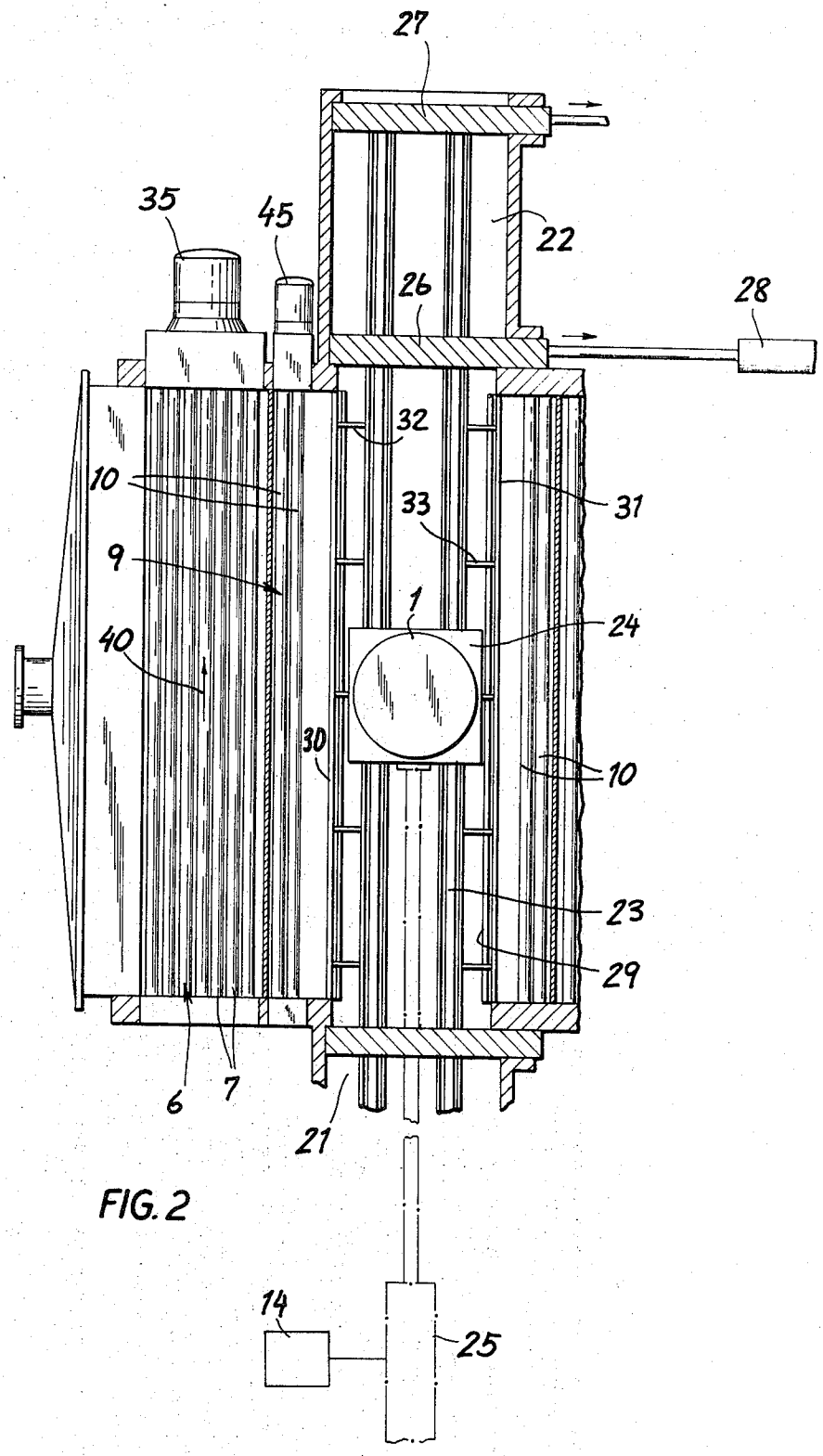


FIG. 2

APPARATUS FOR THE COOLING OF BODIES UNDER PROTECTIVE GAS

FIELD OF THE INVENTION

The present invention relates to an apparatus for the cooling of singular bodies, generally metallurgical workpieces or metal objects, under a protective gas, especially for the isothermal annealing of forgings. More particularly, the invention relates to an apparatus for the controlled cooling of metal bodies.

BACKGROUND OF THE INVENTION

In the isothermal annealing of metal bodies and for other metallurgical purposes, a metal body must be controlledly cooled generally under a protective gas or atmosphere, to accomplish a desired transformation of the crystal structure or prevent undesired internal transformations.

In prior cooling devices for this purpose, a series of metal bodies may be passed in spaced relationship or in contiguous relationship through a chamber at a rate which is regulated in accordance with the gas-flow rate or temperature to bring about cooling. These systems have significant disadvantages because the cooling pattern and rate varies from place to place in the chamber, is irregular and is difficult to control.

Attempts have been made to avoid these disadvantages by providing apparatus for the cooling of singular bodies in a discontinuous manner. In these systems, the singular body is introduced into the cooling chamber, is contacted with the cooled protective gas therein and is advanced outward the chamber subsequent to cooling. In general the term "singular body" is used herein to refer to the article or articles displaced in common into the cooling chamber removed in common therefrom and treated without the chamber with the cooling gas in common. The body may thus be a single object (e.g., a casting or large forging), a stack of objects such as a pile of metal plates, a single object coiled in a number of turns (e.g., a coil of a wire) or a number of objects bundled together or carried upon a pallette. For the most part, the present system will be described as being used for the isothermal annealing of forgings so that the "singular body" may be a single forging or a group of forgings carried by a pallette.

The system thus differs from those which are used in the continuous processing of material traversed by continuously fed wire, metal profiles or the like. In conventional apparatus for the cooling of singular bodies, the protective gas is generally circulated through the cooling chamber and passes through the cooling chamber and passes through heat exchangers disposed in compartments flanking the cooling chamber. The walls defining the cooling chamber, however, may have different temperatures under varying conditions and influence the cooling of the treated body. Since it is important to control the rate of cooling in order to regulate the internal or structural transformations of metallurgical bodies, conventional system of the type described have proved to be unsatisfactory.

For example, when attempts have been made to reach a predetermined point on a particular time-temperature-transformation curve (TTT-diagram), the irregular cooling by radiation or gas contact at the walls of the chamber, the variation of the temperature because of changes in the geometry of the body treated, or the general effect of the walls of the cooling process

have precluded observance of a particular TTT-diagram or attainment of a predetermined point thereon. In practice, an operator was provided to terminate cooling when the appropriate point on the TTT-diagram was reached, without success; although complex programming was provided for the cooling process, also without significant success.

OBJECTS OF THE INVENTION

It is the principal object of the present invention to provide an improved apparatus which avoids the aforedescribed difficulties and allows a predetermined cooling of a singular workpiece to be carried out even when the singular bodies to be cooled have different geometries.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with the present invention, in an apparatus for the cooling of singular bodies under a protective gas, especially for the insothermal annealing of forgings, which comprises a housing forming a cooling chamber having an inlet end and an outlet end, means for displacing the singular body into the chamber through the inlet end and out of the chamber through the outlet end, means for circulating a protective gas through the chamber and opening into the chamber from below, a pair of cooling registers forming the walls of the chamber and traversed by cooling fluid in a direction transverse to the direction of flow of the protective gas and forming tube bundles adapted to cool the singular body by radiation, and cooling registers in the protective gas passage for cooling the latter. In addition, the control means for the apparatus according to the present invention comprises a device responsive to the mean radiated energy from the singular body for operating the transport means when the measured value reaches a predetermined threshold value of the radiated energy.

The threshold value is, of course, established for the particular singular body or type of body provided, the value being changed for each type of body but being independent of the geometry or the arrangement of the objects constituting the body. Preferably, the walls defining the cooling chamber constitute tube-bundle radiation coolers and are disposed adjacent the cooling registers of the heat-exchanger compartments, advantageously at a level equal to that of the radiation cooler.

The system provides numerous advantages, the most significant being a greater uniformity of cooling within the chamber and the ability to establish a well-defined temperature at the TTT-diagram in spite of differences in the geometry of the goods treated. The gases do not alter in temperature at the walls as has been the case heretofore and a surprisingly exact cooling to a predetermined final temperature and with a predetermined cooling pattern can be achieved. The radiation coolers can be designed to maintain a constant temperature and in combination with the control over the temperature of the protective gas enables operation of the device with constant parameters.

According to the present invention, the goods to be treated are disposed within the chamber and are closely flanked by the radiation-cooler walls and arranged so that the protective gas flows substantially into contact with all parts of the body. Any detrimental effect upon the gas temperature or at the external portions of the

body to be treated are compensated by the radiation cooler and it is preferred that the tube-bundle cooling registers and the radiation coolers be individually controllable. Of course, the cooling registers and radiation coolers can be a single heat exchanger with one fluid-displacement fan or with individual fluid-displacement fans.

The temperature-responsive sensing device, detecting the average or mean radiated energy, is preferably arranged above the goods at approximately the geometric center of the chamber. The machining device can include one or more radiation parameters with large sensing apertures or optical angles which are trained upon the goods in the cooling chamber. When they are not arranged directly above the goods, the pyrometer or pyrometers can be located at the side or can be inclined from the top downwardly or from the bottom upwardly.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a vertical cross-sectional view, partly in diagrammatic form, of an apparatus embodying the present invention; and

Fig. 2 is a view taken generally along the line II—II of FIG. 1.

SPECIFIC DESCRIPTION

In the drawing, there is shown a housing **20** which may be provided at its forward side with an inlet arrangement **21** and an outlet arrangement **22** through which a set of rails **23** extend to constitute part of a transport device for pallets **24** carrying a forging **1** constituting a singular workpiece. A ram arrangement **25** may be used to advance the workpiece into the cooling chamber **2** from an inlet gate and to shift the workpiece into the outlet gate arrangement **22**, each gate consisting of a pair of sliding doors **26** and **27** operated by suitable fluid-responsive means as represented, for example, at **28**. Aprons **29** rising to a pair of longitudinal beams **30** and **31** define inlet slots **32** and **33** for the rising protective gas.

The protective gas-circulating device comprises the gas passages **4** which open beneath the workpiece in the cooling chamber **2** and extend downwardly along the sides of the cooling chamber, as well as a circulating fan **5** which is disposed above the cooling chamber **2**.

The cooling circulation means **4, 5** includes cooling devices **6** for the protective gas. The cooling devices, which may be tube-bundle heat exchangers, may have a fan **35** connected to the tubes to induce a transverse flow of air through the tubes (in a horizontal direction), transverse to the vertical direction of movement of the protective gas.

Each cooling register **6** is provided with a bundle of tubes **7** traversed by the cooling air in a direction **40** transverse to the direction (**8**) of flow of the protective gas through the registers. Cooling chamber **2** and the protective gas passage **4** are separated from one another by radiation coolers **9** consisting of tube-bundles and constituting the walls flanking the workpiece. The transverse cooling-air flows through the tubes **10** of the radiation cooler which may be provided with a separate fan represented diagrammatically at **45**.

A radiant heat responsive pyrometer is disposed directly above this singular body **1** and has a window or sensitivity angle **12** encompassing the entire mass of goods upon the pallet. The sensed measurement is thus the mean radiated energy which is compared with an adjustable threshold at **13** and triggers at **14** the transport means **25**, etc., when the workpiece is brought to a predetermined point on the temperature curve of the TTT-diagram. Block **13** thus represents a comarator while block **14** represents the switching circuit for the transport device **13**. The coolers **6** are disposed in the passages **4** substantially at the level of the radiant coolers **9, 10**, i.e., have a bottom which lies in the same plane as the bottom of the radiant cooler. Moreover, the gas coolers **6** have a height which is approximately equal to the height of the radiant coolers. As soon as the critical point is reached, the gate **26** is opened, the workpiece is shifted into the antechamber at the discharge side of the apparatus, gate **26** is opened and a new workpiece is introduced into the cooling chamber.

We claim:

1. An apparatus for the cooling of singular bodies, comprising a housing forming a cooling chamber; transport means for advancing a singular body to be cooled into said chamber and out of said chamber; a pair of radiation coolers forming walls of said chamber and flanking a singular body within said chamber; circulating means for passing the protective gas upwardly through said chamber along one side of the radiant coolers and downwardly along the opposite side of said radiant coolers in respective flow passages; respective tube-bundle heat exchangers for cooling said protective gas; and radiant-energy detecting means in said chamber trained on the singular body therein and responsive to the mean energy radiated therefrom for actuating said transport means upon said mean radiant energy attaining a predetermined threshold value.

2. The apparatus defined in claim **1** wherein said tube-bundle heat exchangers are disposed in said passages, said protective gas traversing said tube bundle heat exchangers in a direction perpendicular to the direction of coolant fluid flow therethrough.

3. The apparatus defined in claim **2** wherein said radiant coolers partition said passages and said heat exchangers are disposed at the same level as said radiant coolers.

4. The apparatus defined in claim **3** wherein the radiant coolers and said heat exchangers are individually controllable.

5. The apparatus defined in claim **3** wherein said detecting means includes at least one radiation parameter having a detecting angle encompassing all of said body, trained upon said body in said chamber.

6. The apparatus defined in claim **5** wherein said pyrometer is disposed above said body.

7. The apparatus defined in claim **6** wherein said walls are vertical, said transport means includes a horizontal rail arrangement extending through said chamber, said radiant coolers and said heat exchangers are provided with horizontal pipes traversed by cooling air and a protective gas-circulating blower is disposed above said chamber.

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