Sept. 13, 1955 M. PESANTE 2,717,515

APPARATUS FOR DETERMINING THE COOLING POWER OF QUENCHING BATHS

Filed Sept. 19, 1952

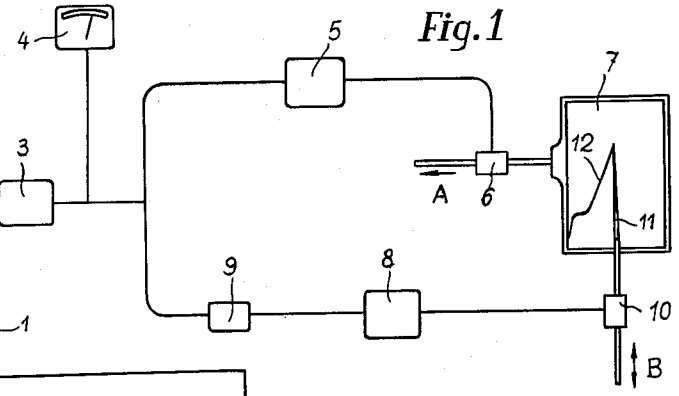


Fig. 1

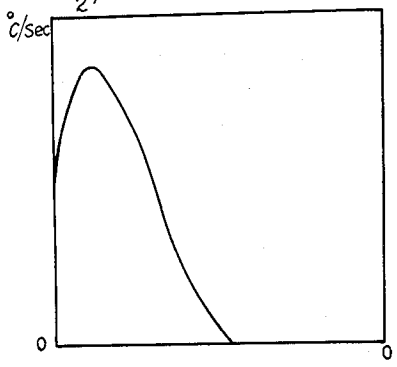
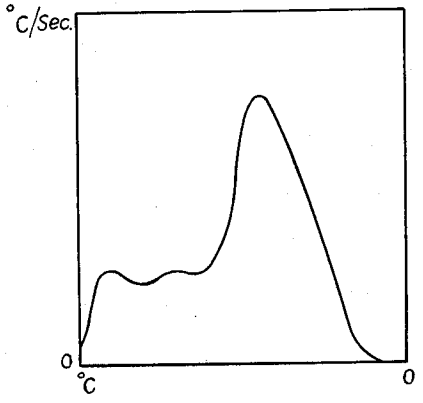


Fig 2

Fig. 3



United States Patent Office 2,717,515 Patented Sept. 13, 1955

2,717,515

APPARATUS FOR DETERMINING THE COOLING POWER OF QUENCHING BATHS

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Application September 19, 1952, Serial No. 310,506

Claims priority, application Italy September 20, 1951

3 Claims. (Cl. 73—15)

The properties of a hardened steel vary according to the speed at which the steel has been quenched, the speed depending, other conditions being equal, upon the quenching bath. The quantity of heat which the bath can subtract from the workpiece under standard conditions in a unit of time at various temperatures should, therefore, be investigated for each quenching bath. For this purpose, the "cooling power" of each quenching bath is considered, which is exactly defined by the "cooling speed/temperature" curve, taken of course under standard conditions.

Determination of the cooling power of a given quenching bath is of essential importance, as is well known to metallurgists. At present, the cooling power is ascertained through lengthy comparative tests carried out under variable circumstances.

This invention relates to an apparatus which considerably simplifies the determination of the cooling power. In a particular embodiment of this apparatus the "cooling speed/temperature" curve is directly plotted for a quenching bath of a given composition under standard conditions.

The invention is based upon the observation that the derivative with respect to time of the "temperature/time" curve is the "cooling speed/time" curve. From the "cooling temperature/time" and "cooling speed/time" curves a third curve, viz. the "cooling speed/temperature" curve may be plotted, which defines the "cooling power" of the quenching bath investigated. The apparatus according to this invention permits directly determining the "cooling speed/temperature" curve, without necessitating any intermediate calculation.

In the apparatus according to this invention a good heat conductor body, preferably a silver ball, having centrally welded therein a thermocouple, is heated to a given temperature indicated by an instrument connected to the thermocouple, and quickly immersed into the quenching bath being investigated. The thermocouple connected to the ball actuates two distinct apparatus, namely a first amplifier provided with a power stage and a further amplifier provided with a differentiating stage and a power stage, whereby the two curves "temperature/time" and "cooling speed/time" are plotted simultaneously, from which the curve "cooling speed/temperature" is easily derived, which defines the cooling power of the bath.

We understand by "differentiating stage" a stage which receives at its input a given voltage curve and gives at its output a derivative voltage curve, that is, a voltage curve, of which the values at the different points are the values of the derivative of the curve at the inlet. Differentiating stages of various types are known in electronics.

According to a particular embodiment of this invention the "cooling speed/temperature" curve is automatically plotted by the recording apparatus during cooling. The recording stage of the apparatus comprises for this purpose a frame carrying a paper sheet and movable in a given direction, and of a scriber movable perpendicularly to the frame. The frame is moved by the power stage

of the first amplifier, while the scriber is moved by the power stage of the second amplifier. The "cooling speed/temperature" curve is therefore automatically plotted.

The accompanying drawing shows the apparatus according to this invention.

Figure 1 is a diagram of the apparatus.

Figures 2 and 3 are two "cooling speed/temperature" diagrams obtained by the apparatus shown in Figure 1.

Referring to Figure 1, a body **2** is pre-heated in an oven at a given temperature, thereupon plunged into a receptacle **1** filled with the quenching bath, of which the cooling power should be determined. The body **2** is conveniently made of silver, which is a good conductor of heat and is spherical in shape and of small size, to afford a substantially uniform distribution of heat. Silver does not undergo structural modifications within the range of temperatures used, possesses a high heat conductivity, is generally unattacked by quenching baths and is easily cleaned and polished.

The ball **2** has welded thereto in a suitable recess a thermoelectric couple, from which conductors lead through a silver tube welded to the ball **2** and extending up through the bath, to a direct current amplifier **3** connected at its outlet to an instrument **4** which indicates the value of temperature. The outlet of the amplifier **3** controls also two distinct circuits constituting a power amplifier **5** and a differentiating stage **9** followed by a power amplifier **8** respectively.

The recording unit of the apparatus consists of a light frame **7** carrying a reticulated paper and capable of rectilinear displacement in the direction of the arrow A, and of a scriber **11** secured to an actuator **10** and capable of rectilinear displacement in the direction of the arrow B, that is, in a direction normal to the direction of movement of the frame **7**.

On variation of temperature the power stage **5** energizes an actuator **6** to move the frame **7** in the direction of the arrow A. At the same time, on variation of the cooling speed, the differentiating stage **9** followed by the power stage **8** moves the actuator **10** in one or the other of the directions of the arrow B. Displacement of the frame in one direction and of the scriber transversely thereto plots the curve **12** which is the "cooling speed/temperature" diagram.

Figure 2 shows, by way of example, the diagram for a molten salt bath, while the diagram shown in Figure 3 relates to quenching in a water bath.

The invention is not limited to the example shown, but covers any apparatus adapted to simultaneously plot the "temperature/time" and "cooling speed/time" curve.

What I claim is:

1. In an apparatus for determining the cooling power of a quenching bath, a body surrounding and touching a thermoelectric couple and adapted to be heated to a predetermined temperature immersed in a quenching bath, a direct current electronic amplifier connected to the output of the thermoelectric couple and amplifying said output, a first circuit controlled by the output from said direct current electronic amplifier comprising a power stage, a chart bearing movable frame, means for displacing said movable frame along a line, said means being driven by the output of the previously mentioned power stage, a second circuit connected to the output from said direct current electronic amplifier and comprising a differentiating stage followed by a power stage, a movable member driven transversely to the direction of movement of the frame by the output from said last mentioned power stage, scriber means carried by the member for plotting on the previously mentioned movable frame the position of said last mentioned movable member, the

resulting curve corresponding in the "cooling speed/temperature" curve of the quenching bath.

2. In an apparatus for determining the cooling power of a quenching bath, a silver ball connected to a thermoelectric couple, and adapted to be heated to a predetermined temperature and immersed in a quenching bath, a direct current electronic amplifier connected to the output of the thermoelectric couple and amplifying said output, a first circuit controlled by the output from said direct current electronic amplifier comprising a power stage, a chart bearing movable frame, means for displacing said movable frame along a line, said means being driven by the output of the previously mentioned power stage, a second circuit connected to the output from said direct current electronic amplifier and comprising a differentiating stage followed by a power stage, a member movable in a direction perpendicular to the movement of the previously mentioned movable frame and actuated by the output from said last mentioned power stage, and scriber means carried by the member for plotting on the previously mentioned movable frame the position of said last mentioned movable member.

3. In an apparatus for determining the cooling power of a quenching bath, a silver ball connected to a thermoelectric couple, and adapted to be heated to a predetermined temperature and immersed in a quenching bath, a direct current electronic amplifier connected to the output of the thermoelectric couple and amplifying said output, a

first circuit controlled by the output from said direct current electronic amplifier comprising a power stage, a chart bearing movable frame carrying a reticulated paper, means for displacing said movable frame along a line, said means being driven by the output of the previously mentioned power stage, a second circuit connected to the output from said direct current electronic amplifier and comprising a derivative stage followed by a power stage, a member movable in a direction perpendicular to the movement of the previously mentioned movable frame and actuated by the output from said last mentioned power stage, a scriber fixed to said member for plotting on the reticulated paper carried by the movable frame in its position, the curve plotted on said reticulated paper corresponding to the cooling speed/temperature curve of the quenching bath.

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