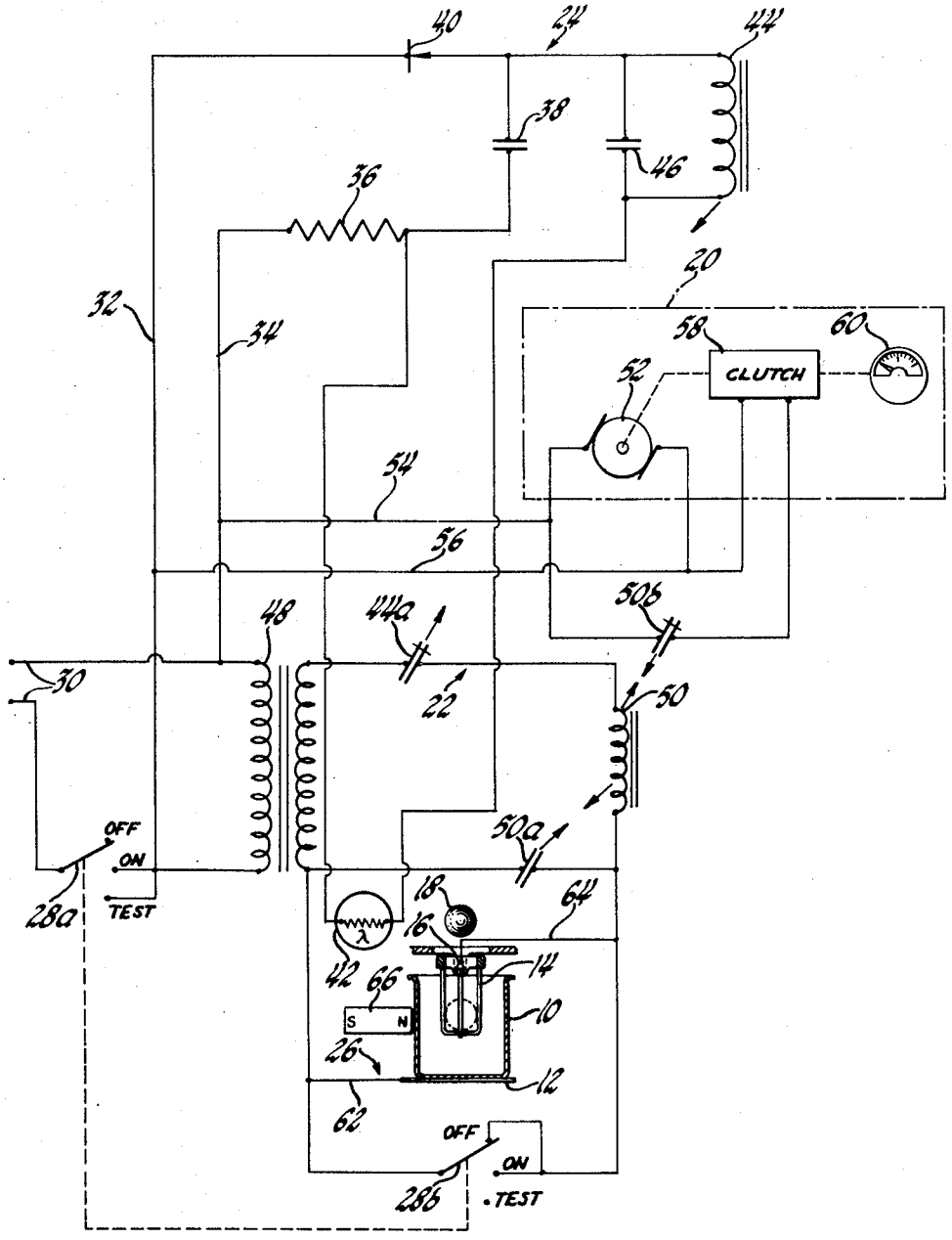
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APPARATUS FOR EVALUATING QUENCHING MEDIA

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APPARATUS FOR EVALUATING QUENCHING MEDIA

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6 Claims. (Cl. 324—34)

This invention relates to testing apparatus and more particularly to an arrangement for evaluating the heat transfer capacity of materials. A particular field of application is the evaluation of quenching media used in metallurgical heat treatment processes in which the rate of temperature change is a significant factor.

This invention is based upon the behavior of metals described by Curie's law that the permeability of paramagnetic substances is inversely proportional to the absolute temperature up to the Curie point. At the Curie point, the substances cease to have a permeability in excess of unity and become non-magnetic. The Curie point of a given metal specimen may be utilized as a convenient reference temperature in the evaluation of quenching media since the occurrence of this known temperature is signified by the change in magnetic properties. A method and apparatus based upon this principle is described and claimed in the copending application Serial No. 711,485, filed January 27, 1958 by Edward A. Bender for "Method of Evaluating Quenching Media," and assigned to the assignee of the present invention.

In accordance with this invention, an automatic timer is provided to measure the elapsed time required for a particular quenching medium to change the temperature of a specimen having a known Curie point from a predetermined value to its Curie point. This is accomplished by a control circuit which is responsive to the entry of the specimen into the quenching medium and to the occurrence of the Curie point for starting and stopping the timer. More particularly, a movable support member is disposed within the quenching medium and is adapted to receive the specimen at an elevated temperature. Specimen sensing means such as a photosensitive element influences the control circuit to start the timer when the specimen enters the medium. Magnetic means adjacent the support member are effective to cause displacement thereof by magnetic linkage with the specimen upon the occurrence of the Curie point in its temperature change. Circuit means responsive to this displacement influence the control circuit to stop the timer. Thus the elapsed time for a predetermined temperature change is measured.

A more complete understanding of this invention may be had from the detailed description which follows taken with the accompanying drawing in which the single figure is a schematic diagram of the apparatus.

Referring now to the drawing there is shown an illustrative embodiment of the invention in testing apparatus for measuring the elapsed time required for a particular quenching fluid to change the temperature of a specimen from a predetermined value to its Curie point. In general, the apparatus comprises a receptacle **10** of electrically conductive material which contains a liquid quenching medium to be evaluated. The receptacle **10** is disposed upon a support plate **12** and accommodates a movable support member or cage **14** which is mounted for pivotal motion about the support shaft **16**. The cage **14** is open at its top and is adapted to receive the

metal specimen **18**, suitably a spherical element of nickel, which has a known Curie point of 665° F. and which may be heated to 1625° F. just prior to immersion in the quenching liquid. The elapsed time required to cool the specimen from its predetermined high temperature to its Curie point is measured by the timer **20**. The timer is provided with a control circuit including the timer relay circuit **22** which in turn is controlled by the timer starting circuit **24** and the timer stopping circuit **26**. The control circuit is energized through the manual switches **28***a* and **28***b* which are mechanically coupled for concurrent actuation.

The timer starting circuit **24** responds to the introduction of the specimen into the quenching liquid to start the timer **20**. This circuit, energized from alternating voltage source represented by conductors **30**, extends through the manual switch **28***a* with its movable contact in either the "on" position or "test" position to energize a pair of supply voltage conductors **32** and **34** which are connected across a rectifying circuit including the current limiting resistor **36**, a filter condenser **38** and a diode rectifier **40**. The direct voltage thus developed is applied across a photosensitive element **42** through the energizing coil of a relay **44** having a condenser **46** in parallel therewith to prevent relay chatter. The photosensitive element **42** is suitably a photoconductive device of the broad-area cell type which exhibits a change of resistance in response to incident radiation. The photosensitive element **42** is disposed adjacent the receptacle **10** to respond to the radiation from the specimen **18** which emanates therefrom at its elevated temperature during its travel into the support cage **14**. When the resistance of the photosensitive element is decreased momentarily by such radiation, the energizing winding of relay **44** is energized and its relay contacts **44***a*, in a circuit to be described presently, are actuated. Until the specimen enters the receptacle **10**, however, the winding of relay **44** remains effectively deenergized.

To start the timer **20** in response to the entry of the specimen in to the receptacle **10**, the timer relay circuit **22** is provided. This circuit is energized from the conductors **30** through the switch **28***a* and the interposed transformer **48**. The timer relay circuit is connected across the secondary winding of the transformer **48** and includes the normally closed relay contacts **44***a* of relay **44**, the winding of relay **50** and the normally open contacts **50***a* of relay **50**. Switch **28***b* is connected in parallel with the normally open relay contacts **50***a* and in its "on" position completes a circuit for energizing the winding of relay **50**. This in turn closes the normally open contacts **50***a* to establish a holding circuit for maintaining the relay **50** energized, so long as the normally closed contacts **44***a* remain closed, even though switch **28***b* is further displaced to its "test" position. The relay **50** is adapted to actuate a set of timer contacts **50***b* for controlling the timer **20**.

The timer **20** is energized from the conductors **30** when the switch **28***a* is in either its "on" or "test" positions and includes a constant speed motor **52** connected across the conductors **32** and **34** through the conductors **54** and **56**. The motor **52** is mechanically coupled through a suitable gear train and a magnetic clutch **58** to an elapsed time indicator **60**. The magnetic clutch **58** is connected across the conductors **54** and **56** through the normally closed relay contacts **50***b* of relay **50**. Thus when the relay **50** is energized, the relay contacts **50***b* are open and the indicator **60** is stopped. However, upon entry of the specimen into the receptacle **10** and the ensuing momentary energization of relay **44**, the relay **50** is deenergized and the indicator **60** is started.

In order to stop the timer upon the occurrence of the Curie point of the specimen **18**, the timer stopping circuit

26 is provided. This circuit extends across the relay contacts 50*a* from one terminal thereof and includes conductor 62 connected with the conductive support plate 12 which is conductively connected with the metallic receptacle 10. The pivoted cage 14 is also electrically conductive and is connected through conductor 64 to the other terminal of relay contacts 50*a*. A magnet 66, disposed adjacent the receptacle 10, has a magnetic field linking the specimen in its position within the cage 14. Thus when the specimen is at a temperature above its Curie point and is non-magnetic in character, the pivoted cage assumes its normal position, as indicated. However, upon the occurrence of the Curie point, the specimen 18 becomes magnetic in character and is attracted toward magnet 66 causing engagement of the cage 14 and receptacle 10. Thus the relay contacts 50*a* are short-circuited and an energizing circuit for the relay 50 is completed causing the contacts 50*a* to be closed and the contacts 50*b* to be opened to stop the time indicator 60.

In operation, for conducting a test on the quenching liquid in receptacle 10, the manual switches 28*a* and 28*b* are displaced from the "off" position through the "on" position to the "test" position. If desired, the switch may be allowed to dwell at the "on" position to test the photosensitive element by employing radiation from an external source. The time indicator 60 can be started and stopped merely by turning the external radiating source on or off without resorting to the engagement of the cage 14 and receptacle 10. In this condition, the timer starting circuit, including the photosensitive element 42 is energized and the timer relay circuit 22, including the coil of relay 50, is de-energized as the normally closed relay contacts 44*a* are opened while the photosensitive element 42 is energized. Since relay 50 is deenergized, its relay contacts 50*b* are closed to energize the magnetic clutch 58 causing the time indicator 60 to run. When the external energizing source is removed from the photosensitive element 42, the timer starting circuit is deenergized and the timer relay circuit 22 is energized through the normally closed relay contacts 44*a*, the coil of relay 50 and the switch 28*b*. Since relay 50 is energized, its relay contacts 50*b* are opened to deenergize the magnetic clutch 58 to prevent the time indicator 60 from running. When the switches 28*a* and 28*b* are further displaced to the "test" position, the timer starting circuit 24 remains energized and the timer relay circuit 22 remains energized through the holding contacts 50*a* of relay 50. Accordingly, with relay 50 energized the timer contacts 50*b* remain open and the time indicator 60 is stopped.

In the performance of the test, the specimen 18 is heated to its predetermined temperature above the Curie point and dropped into the cage 14. Radiation from the specimen during its motion past the photosensitive element 42 causes a momentary decrease in the resistance of the element and hence the relay 44 is momentarily energized. This causes the relay contacts 44*a* to open momentarily to deenergize the relay 50. Consequently, the timer contacts 50*b* are closed and the clutch 58 is energized to start the time indicator 60 running. At the same time, the deenergization of relay 50 causes its holding contacts 50*a* to open. Following the momentary energization of relay 44, the relay contacts 44*a* reclose but the relay 50 remains deenergized because the holding contacts 50*a* have been opened. The time indicator 60 thus continues to run until the occurrence of the Curie point in the temperature change of specimen 18. At this point, the specimen becomes magnetic and is attracted toward the permanent magnet 66 causing engagement of the cage 14 with the receptacle 10 which completes a short-circuit around the holding contacts 50*a*. Accordingly, the relay 50 is energized causing the timer contacts 50*b* to open and deenergize the clutch 58, thus stopping the time indicator 60. This completes the test and the measurement of elapsed time is recorded by the time indicator 60.

Although the description of this invention has been given with respect to a particular embodiment, it is not to be construed in a limiting sense. Numerous variations and modifications within the spirit and scope of the invention will now occur to those skilled in the art. For a definition of the invention, reference is made to the appended claims.

We claim:

1. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising a movable support member adapted to receive said specimen, a timer including a control circuit for starting and stopping the timer, specimen sensing means adjacent the support member and connected with the control circuit for starting the timer upon entry of the specimen into the member, magnetic means adjacent the support member adapted to cause displacement of the member by a change of magnetic linkage with said specimen upon the occurrence of the Curie point in its temperature change, and circuit means responsive to displacement of the support member and connected with the control circuit for stopping the timer.

2. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising a movable support member adapted to receive said specimen, a timer including a control circuit for starting and stopping the timer, a photosensitive element adjacent the support member and connected with the control circuit for starting the timer upon entry of the specimen into the member, a magnet adjacent the support member adapted to attract said specimen and displace said member upon the occurrence of the Curie point in its temperature change, and circuit means responsive to displacement of the member and connected with the control circuit for stopping the timer.

3. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising a conductive receptacle for containing a quenching medium, a pivotally mounted conductive support member disposed within the receptacle and adapted to receive said specimen, a timer including a control circuit for starting and stopping the timer, a photosensitive element adjacent the support member and connected with the control circuit for starting the timer upon entry of the specimen into the member, a magnet adjacent the support member adapted to attract said specimen and displace said member into engagement with said receptacle upon the occurrence of the Curie point in the temperature change of said specimen, and circuit means including the member and the receptacle and connected with the control circuit for stopping the timer.

4. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising a conductive receptacle for containing a quenching medium, a pivotally mounted conductive support member disposed within the receptacle and adapted to receive said specimen, a timer including an elapsed time indicator, timer control contacts adapted to start and stop said indicator, a timer relay circuit including a relay for actuating said control contacts, a timer starting circuit including a photosensitive element adjacent the support member and adapted to control energization of the relay circuit, a magnet adjacent the support member adapted to attract said specimen and displace said member into engagement with said receptacle upon the occurrence of the Curie point in the temperature change of said specimen, and a timer stopping circuit including the support member and the receptacle and connected with the relay circuit to control energization thereof.

5. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising

a conductive receptacle for containing a quenching medium, a pivotally mounted conductive support member disposed within the receptacle and adapted to receive said specimen, a timer including a motor connected with an elapsed time indicator through a magnetic clutch, timer control contacts connected in circuit with said clutch, a timer relay circuit including a relay for actuating said control contacts, a timer starting circuit including a photosensitive element adjacent the support member and adapted to control the energization of the relay circuit, a magnet adjacent the support member adapted to attract said specimen and displace said member into engagement with said receptacle upon the occurrence of the Curie point in the temperature change of said specimen, and a timer stopping circuit including the support member and the receptacle and connected with the relay circuit to control the energization thereof.

6. Apparatus for measuring the time required to change the temperature of a metal specimen from a predetermined value to its Curie point, said apparatus comprising a conductive receptacle for containing a quenching medium, a pivotally mounted conductive support member disposed within the receptacle and adapted to receive said specimen, a timer including a motor connected with an elapsed time indicator through a magnetic clutch, normally closed timer control contacts connected in circuit with said clutch, a timer relay circuit including a control relay for actuating said control contacts, normally open holding contacts and normally closed starting contacts; a timer starting circuit including a photosensitive element adjacent the support member and including a starting relay for actuating the starting contacts to deenergize the relay circuit when the starting circuit is energized in response to radiation incident upon the photosensitive element from the specimen, a magnet adjacent the support member adapted to attract said specimen and displace said member into engagement with said receptacle upon the occurrence of the Currie point in the temperature change of said specimen, and a timer stopping circuit including the support member and the receptacle and connected across said holding contacts for energizing said relay circuit to open said control contacts and stop said timer.

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