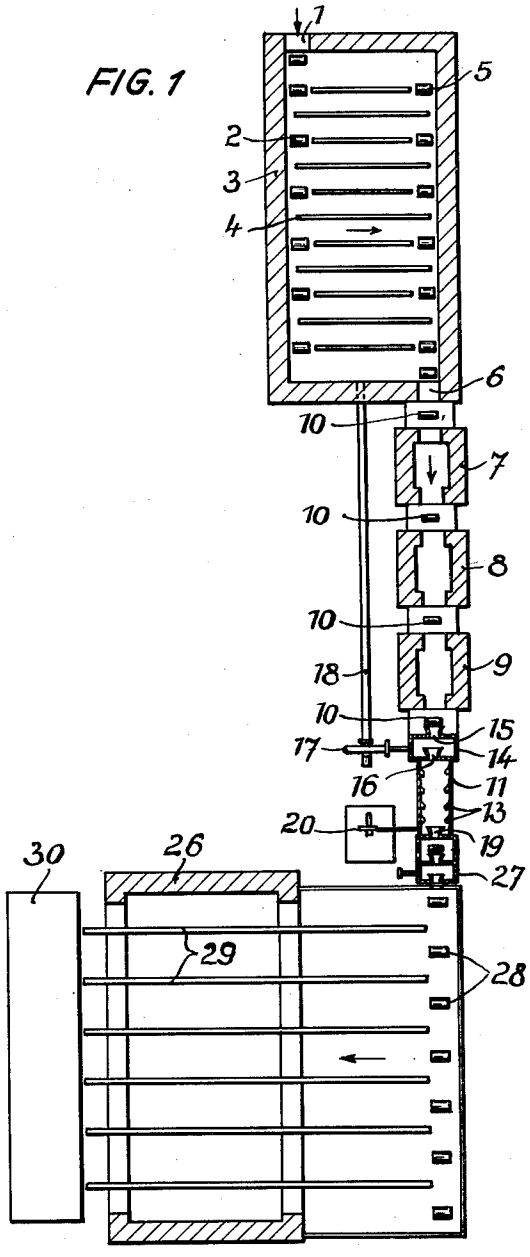
May 29, 1962 F. EISENMENGER 3,036,825

PROCESS AND APPARATUS FOR THE CONTINUOUS HEAT TREATING OF ELONGATED MATERIAL

Filed May 13, 1958 3 Sheets-Sheet 1

FIG. 1



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PROCESS AND APPARATUS FOR THE CONTINUOUS HEAT TREATING OF ELONGATED MATERIAL

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FIG. 2

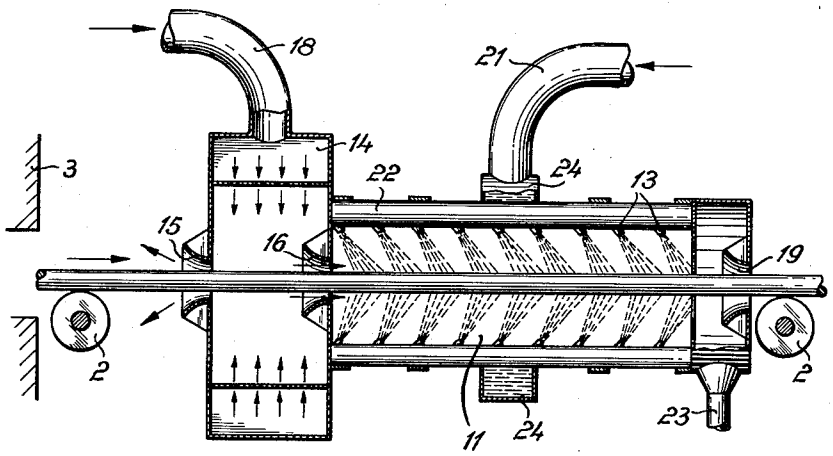
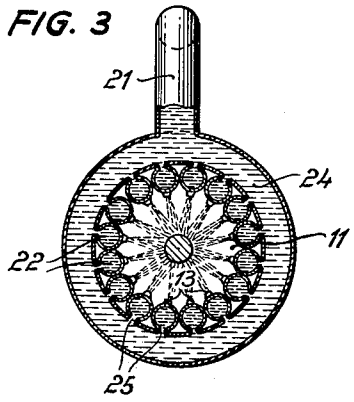


FIG. 3



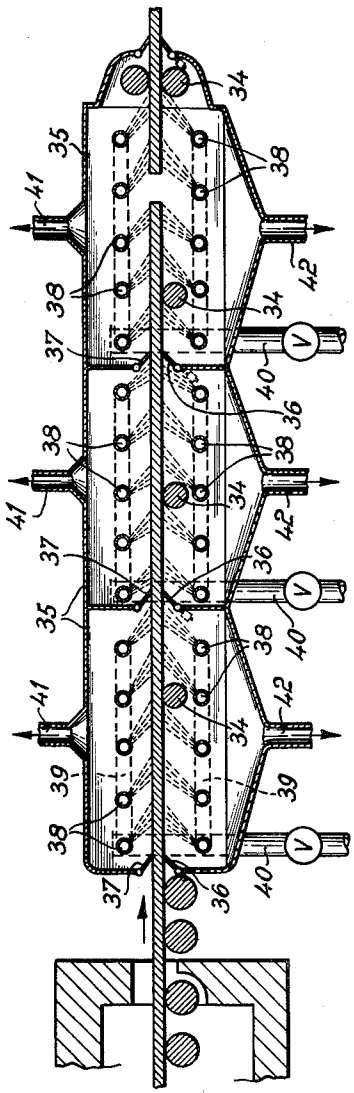
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PROCESS AND APPARATUS FOR THE CONTINUOUS HEAT TREATING OF ELONGATED MATERIAL

Filed May 13, 1958 3 Sheets-Sheet 3

FIG. 4



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United States Patent Office 3,036,825 Patented May 29, 1962

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PROCESS AND APPARATUS FOR THE CONTINUOUS HEAT TREATING OF ELONGATED MATERIAL

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Filed May 13, 1958, Ser. No. 734,924
Claims priority, application Germany May 17, 1957
3 Claims. (Cl. 266—4)

This invention relates to a process for the continuous heat treatment of elongated material, such as bars, tubes, section irons, metal strip and the like, especially consisting of sensitive steels, by heating the material to quenching temperature, thereafter quenching it and then tempering it in a tempering furnace.

It is known to heat bars or tubes rapidly as they pass through sequentially arranged drum-shaped furnaces, to quench them by spraying them with water and to temper them in further furnaces. However, this method is not applicable to sensitive steels which have low thermal conductance at low temperature or are sensitive to sudden thermal action for other reasons, since cracks would appear in the material if it were suddenly subjected to an intense thermal action.

Such steels must therefore be slowly brought to a temperature of about 400° to 500° C., above which a rapid heating of the material to the final temperature is then possible.

It is therefore proposed in accordance with the invention first to bring the material to be heat-treated gradually to a temperature of about 400° to 500° C., above which an accelerated temperature rise of the material is harmless, in a continuously operated pre-heating furnace and then to bring the material to the hardening temperature either in a second furnace zone or in a rapid process, thereafter to quench it during continuous horizontal travel, and finally gradually to temper it in a further heating furnace.

Preferably, the furnaces employed for the pre-heating in the process according to the invention are designed as chamber furnaces having an inlet roller bed, cross feed and a delivery roller bed. In the sequentially arranged rapid heating furnaces, which are preferably drum-shaped, the material is heated to an excessively high temperature in a manner known per se in its passage through the first furnaces in order to transfer the heat to the material in minimum time, and when the maximum temperature has been reached the remaining furnaces serve for the heating-through and temperature equalisation of the material without any appreciable excess of temperature.

The invention further resides in that the tempering of the material is also effected in the pre-heating process as far as the temperature limit at which it is sensitive to cracking, and is rapidly completed to the final temperature, the rapid heating section being, if desired, arranged inversely in relation to the rapid heating section by which the material is brought to the hardening temperature.

A uniform hardening of the workpiece can be effected only if the workpiece is uniformly quenched. However, such a treatment is difficult in the case of elongated material, especially if it is of small cross-section.

On introduction of elongated material, for example bar-shaped or tubular steels, to their full length into a liquid bath, warping readily occurs, which is undesirable for the subsequent treatment. If the material to be treated is extracted from the heating furnace in the longitudinal direction, a temperature difference between the two ends cannot be avoided.

Therefore, in the hardening of tubes which are only quenched with water, the tubes leaving the furnace in the longitudinal direction are guided through a cylindrical

chamber in which they are quenched by water sprayed thereon. Such a hardening, however, is not applicable when oil is employed as the quenching medium, because the oil would ignite on the incandescent material being hardened.

According to the invention, the elongated material to be hardened is guided, after leaving the heating furnace, through a closed quenching chamber having only one inlet aperture and one outlet aperture for the material and disposed in front of the delivery end of the furnace, in which chamber it is washed with oil by means of nozzles, the said chamber being provided with means for supplying a protective gas having little or no oxygen content.

The admission of air and consequently ignition of oil on the incandescent material are thus prevented. The quenching may also be effected by flooding, in which case the material to be treated is continuously passed in the longitudinal direction through a channel more or less filled with the cooling medium, the latter being constantly maintained in motion by circulation. By virtue of the fact that the horizontally entering warm material is simultaneously washed by the cooling medium from all sides, warping of the elongated material is avoided. Preferably, the protective gas is flue gas from the heating furnaces, which is sucked in and fed to the quenching chamber by means of a fan.

In accordance with a further feature of the invention, there is provided on the inlet side of the quenching chamber a protective gas chamber which serves as a lock for the material to be hardened and into which protective gas is continuously introduced under superatmospheric pressure.

Depending upon the nature and the sensitivity of the material to be heat-treated, a mixed quenching with oil and water or gaseous media may be effected in consecutive zones. In this case, a change-over from oil to water or to a gaseous medium is also possible.

The quenching of the material may furthermore be so effected in order to avoid excessive length of the hardening arrangement, for example for bar material of relatively large cross-section and high performances, that the travelling material is quenched only to a particular temperature, for example of 600° C., and is then introduced into a bath to complete the cooling. At lower temperatures, the structure is already so far developed that any temperature differences then occurring within the material have no effect on the quality.

In accordance with the invention, the quenching of the material in different zones takes place in a quenching device directly connected to the hardening furnace and having sequentially arranged quenching chambers, which have separate regulatable nozzles for the supply of the liquid or gaseous quenching medium.

A further feature of the invention resides in using as hardening oil water-soluble oil which is removed from the material in a water flushing or spraying device connected on to the quenching chambers. In this case, the water flushing device may simultaneously serve as a further hardening device. In its travel to the tempering furnace, the hardened material is then dried by hot air.

The cooling need be effected only to such an extent that the heat still present in the core of the material is no longer sufficient to vary the structure produced by the hardening, so that only a drying of the material is effected.

In accordance with a further feature of the invention, the sequentially arranged quenching chambers communicate through apertures which are adapted to be closed by appropriate resilient means, such as rocking flaps or the like, in the passage of the material through the chambers.

In the so-called isothermal annealing, the hot material leaving the hardening furnace, which operates as a tempering furnace, is cooled to a temperature of about 550–650° C. by means of air, steam, flue gas or other

suitable gases in a channel-like horizontal chamber through which it passes, and is directly introduced into the annealing furnace through an insulated passage in such manner as to avoid a further temperature reduction. Flue gas is sucked from the tempering furnace through the channel for the purpose of maintaining the temperature of the material, or the channel is kept warm in another manner.

The invention is illustrated by way of example in the accompanying drawings, in which:

FIGURE 1 shows diagrammatically in plan view an installation suitable for carrying out the process according to the invention,

FIGURE 2 shows in longitudinal section an arrangement suitable for quenching the travelling material,

FIGURE 3 is a diagrammatic vertical section through the arrangement according to FIGURE 2, and

FIGURE 4 shows diagrammatically in vertical longitudinal section a further continuous quenching arrangement subdivided into zones.

In the installation illustrated in FIGURE 1, the bars or tubes or other elongated material of sensitive steel to be heat-treated are passed through the inlet aperture **1** on to the roller bed **2** of a preheating furnace **3** designed as a chamber furnace. The bars or tubes are slowly brought to a pre-heating temperature of about 400° to 500° C. while being conveyed in juxtaposition across the furnace to a delivery roller bed **5** by a conveyor device **4** or an inclined grate.

The pre-heated material is introduced through the outlet aperture **6** into a plurality of sequentially arranged rapid heating furnaces **7**, **8**, **9**, in which it is rapidly heated to the hardening temperature. The material is conveyed by the driving rollers **10** disposed in front of the inlet into the first furnace **7** and between the furnaces **7**, **8**, **9**, as also behind the last furnace **9**. In the case of round material, the said driving rollers also rotate the bars or tubes about their axis.

In the first of the rapid heating furnaces **7**, which are generally drum-shaped, the material is heated to an excessive temperature in order to effect a rapid heating. In the last rapid heating furnaces **9**, only a temperature equalisation takes place. The hardening temperature is accurately controlled in the usual manner by means of electric regulating instruments by which the supply of heat to the furnaces is regulated.

On leaving the last rapid heating furnace **9**, the material directly enters a continuous quenching device which, in the case of water hardening, consists in known manner of a plurality of spray nozzles disposed over an appropriate length in a circle around the travelling material.

In FIGURES 2 and 3, the quenching device for oil quenching is diagrammatically illustrated on a larger scale.

The quenching device consists substantially of a tubular housing **11**, at the inlet end of which there is disposed a protective gas chamber **14** provided with a feed duct **18** for protective gas, with an inlet aperture **15** and with an outlet aperture **16**. The apertures **15**, **16** are only slightly larger than the material to be passed therethrough. The quenching chamber **11** has an outlet aperture **19** of the same form. At both ends, and if desired also in the quenching chamber **11**, the material is mounted on rollers **2**, so that it is well guided so as to avoid warping.

In the quenching chamber **11**, the material is sprayed or washed with oil by means of nozzles **13**, the said oil being fed through a duct **21** to an annular chamber **24**, with which tubes **22** communicate through apertures **25**. It is also readily possible to provide, instead of the individual tubes **22**, a chamber in the form of a double jacket, to which the nozzles **13** are connected.

The hardening oil sprayed on to the material is removed through a duct **23** connected to the bottom and, after passing through a cooling arrangement and filters (not shown), is fed back into the supply duct **21** by means of a pump **20**.

The protective gas introduced into the protective gas chamber **14** passes partly through the aperture **15** into the atmosphere and partly through the aperture **16** into the quenching chamber **11**, from which it is discharged into the atmosphere through the delivery aperture **19**, so that the admission of air is prevented.

The protective gas employed is preferably the waste gas from the heating furnace **3**, provided that the latter contains practically no oxygen, and is fed through the duct **18** to the quenching device **11** by means of a suction fan. Alternatively, any other protective gas having little or no oxygen content may be employed.

In the case of water quenching, the material may be directly fed to the tempering furnace **26** after drying by means of a warm air current. In the case of oil quenching, as employed in the constructional example, there is connected on to the delivery end of the quenching device **11**, **14** and oil extractor which consists of a device for spraying washing liquid for the removal of the residual oil, followed by a spraying device for hot water for the removal of the washing liquid.

The material passes from the oil extractor **27** to a roller bed **28**, by means of which it is fed transversely into the tempering furnace **26** designed as a chamber furnace by way of a conveyor device **29** or a corresponding inclined grate. During the introduction of the material from the roller bed **28** into the tempering furnace **26** by way of the conveyor device **29**, the material is dried by a current of warm air. After the tempering of the material in the furnace **26**, in which it is gradually brought to a temperature of about 500° C. or more, the material passes to an extraction point **30**.

If the material is to be tempered at a temperature substantially above about 500° C., it may be desirable to provide, instead of the extraction point **30**, a roller bed corresponding to the roller bed **28**, from which the material is introduced into rapid heating furnaces (not shown) corresponding to the rapid heating furnaces **7**, **8**, **9**, in which it is again rapidly brought to the necessary tempering temperature while continuously passing therethrough.

The quenching device illustrated in FIGURE 4 consists of three interconnected quenching chambers **35**, through which the material is passed on rollers **34**. The quenching chambers **35** have at their ends inlet and outlet apertures **36** which are adapted to be closed, for example, by weight-loaded rocking flaps **37** adapting themselves to the shape of the material. Each quenching chamber **35** is provided with a series of upper and lower cooling medium nozzles **38**, which communicate with one another through ducts **39**. A common supply duct **40** is connected to the communication ducts **39**.

The cooling medium is fed under such a high pressure as to penetrate through the vapour formed. As a result of the uniform cooling due to the application of the liquid to the material from all directions, warping is avoided.

The nozzles **37** have apertures extending obliquely in relation to the direction of travel of the material. The vapours formed are discharged through a stack **41**. The collecting cooling liquid is fed through an outlet **42** to a collecting receptacle (not shown), from which it is fed back to the duct **40** by means of a pump after filtering and re-cooling.

The material passing through the three quenching chambers **5** illustrated in the constructional example may be quenched therein in accordance with the requirements. For example, in the first quenching chamber, an intensive and rapid cooling to a predetermined temperature may be effected by means of water, while in the second, adjoining chamber a further cooling with oil, for example a water-soluble oil, may be effected, and in the last quenching chamber this oil may be washed off. Alternatively, the cooling may be effected only by means of

water or only by means of oil, or a step-by-step cooling may be effected with a mixture of coolants in the individual stages, depending upon the particular requirements.

Other workpieces, such for example as chop forgings, may be quenched in this manner with a spray device of similar construction, in which case the workpieces to be passed through the quenching arrangement may either be suspended from an overhead trolley conveyor or mounted on another conveyor device.

The nozzles may in such cases be so distributed that in the case of workpieces of unequal thickness, such for example as connecting rods, more cooling medium is fed to the thicker part than to the thinner part.

I claim:

1. In an apparatus for the continuous heat treatment of elongated metallic workpieces, in combination, a heating chamber; a closed quenching chamber having an inlet aperture and an outlet aperture; a lock chamber contiguously adjacent said quenching chamber and communicating therewith by said inlet aperture; conveying means for passing a workpiece having a surface composed of a plurality of surface portions from said heating chamber sequentially along a predetermined path through said lock chamber, said inlet aperture, said quenching chamber, and said outlet aperture; a source of supply of combustible quenching fluid; spraying means in said quenching chamber communicating with said source of supply for discharging quenching fluid against said workpiece being passed through said quenching chamber, said spraying means including a plurality of nozzle means surrounding said predetermined path and arranged so that each of said surface portions of said workpiece is directly sprayed with fluid emanating from at least one of said nozzle means, whereby on said surface formation of heat transfer-impeding gaseous bubbles is avoided and even quenching along the entire surface of said workpiece is achieved; and means for introducing a substantially non-oxidizing gas into said lock chamber for maintaining a substantially non-oxidizing protective atmosphere in said lock chamber and in said quenching chamber.

2. In an apparatus for the continuous heat treatment of elongated metallic workpieces, in combination, a heating chamber; a closed quenching chamber having an inlet aperture and an outlet aperture; conveying means for passing a workpiece having a surface composed of a plurality of surface portions from said heating chamber along a predetermined path through said inlet aperture, said quenching chamber, and said outlet aperture; sealing means secured to said quenching chamber for sealing said inlet and said outlet apertures, said sealing means being yieldable to permit passage of a workpiece through said apertures; a source of supply of quenching oil; spraying means in said quenching chamber communicating with

said source of supply for discharging quenching oil against said workpiece being passed through said quenching chamber, said spraying means including a plurality of nozzle means surrounding said predetermined path and arranged so that each of said surface portions of said workpiece is directly sprayed with fluid emanating from at least one of said nozzle means, whereby on said surface formation of heat transfer-impeding gaseous bubbles is avoided and even quenching along the entire surface of said workpiece is achieved; and means for introducing and maintaining a substantially non-oxidizing protective atmosphere in said quenching chamber only.

3. In an apparatus for the continuous heat treatment of elongated metallic workpieces, in combination, a heating chamber; a closed quenching chamber having an inlet aperture and an outlet aperture; conveying means for passing a workpiece having a surface composed of a plurality of surface portions from said heating chamber along a predetermined path through said inlet aperture, said quenching chamber, and said outlet aperture; rocking flap means secured to said quenching chamber for sealing said inlet and said outlet aperture, said rocking flap means being yieldable to permit passage of a workpiece through said apertures; a source of supply of quenching oil; spraying means in said quenching chamber communicating with said source of supply for discharging quenching oil against said workpiece being passed through said quenching chamber, said spraying means including a plurality of nozzle means surrounding said predetermined path and arranged so that each of said surface portions of said workpiece is directly sprayed with fluid emanating from at least one of said nozzle means, whereby on said surface formation of heat transfer-impeding gaseous bubbles is avoided and even quenching along the entire surface of said workpiece is achieved; and means for introducing and maintaining a substantially non-oxidizing protective atmosphere in said quenching chamber only.

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