Dec. 19, 1933. H. BANSEN ET AL 1,940,341
TREATING IRON BATHS
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Fig. 1.

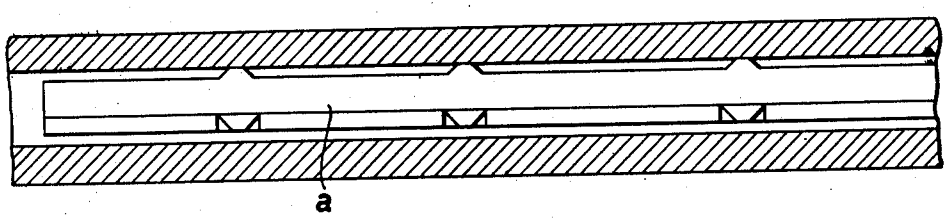


Fig. 2.

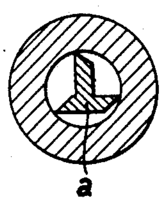


Fig. 3.

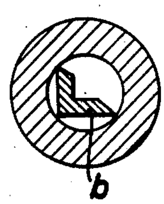


Fig. 4.

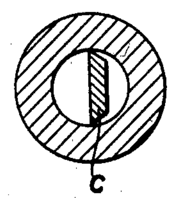
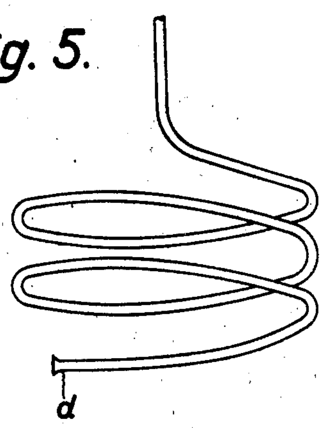


Fig. 5.



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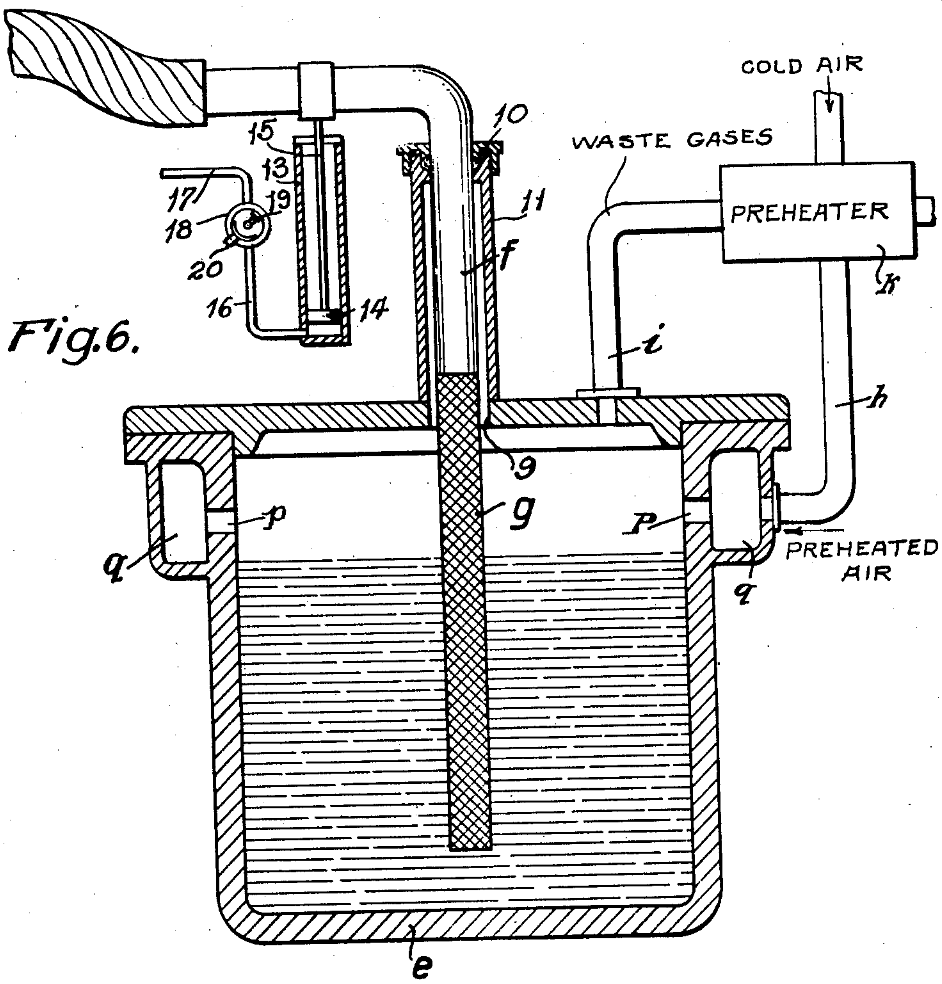

Fig.6.

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UNITED STATES PATENT OFFICE

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TREATING IRON BATHS

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8 Claims. (Cl. 75—27)

The invention relates to a process for treating iron baths in steel producing furnaces.

As well known, the process of fining the material by the action of an oxidizing flame upon the surface of the bath and through the intermediary of the slag cover takes place very slowly when the bath is at rest. Furthermore the heat transmission is very slow. In order to accelerate these processes a mechanical movement of the bath by stirring, rocking or circulating has been employed and, further, an increased contact with oxygen is caused by blowing-in air or supplying ore.

The ore causes a motion of the bath only during the decarburization. Since it is fed intermittently and in irregular size, an utilization of the irregularly developed carbon monoxide by after-combustion is impossible. Furthermore, the government of the charge becomes uncertain in fining by means of ores.

According to the invention water is injected into the bath itself which measure affords several advantages. If the water is injected with sufficient speed, the injection tube is protected. Furthermore, a highly valued oxygen bearer is thus introduced into the bath and, finally, a continuous movement of the bath is caused by the constant violent development of hydrogen gas.

By splitting off the oxygen in this fining operation by water less heat is consumed for 1 kg. of oxygen than in fining by ore. Furthermore, this quantity of heat may be fully converted to useful heat by combustion above the bath and more particularly a great useful heat drop can be produced by preheating the combustion air up to 1200 degrees by the waste heat, the hydrogen being preheated to an average temperature of 1450 degrees C., so that a great portion of the heat is recovered for the process. Finally, the regular supply and uniform distribution of the water makes possible a voluntary control of the charge.

The water may be distributed within the bath in liquid form in such a manner that a violent agitation of the bath takes place, since each cubic meter of water is converted into 1250 cubic meters of steam.

The water may be supplied either through the surface of the bath from the cover or the lateral walls or through the bath from the level of the hearth.

The bath may have any depth and any desired portion of a bath can be brought to seethe so that the process can be employed also in the open-hearth furnace when the charge will not start seething. Furthermore, in applying the process to the Thomas or Bessemer process the charge can be treated as long as desired by heating the bath by the after-combustion of the gases developed and correspondingly regulating the quantity of combustion air. In this manner a notably higher working temperature is obtained than for instance by the after-combustion of the carbon monoxide in a converting process, owing to the dilution of the gas by the nitrogen of the fining air being dispensed with.

The combustion air is to be conducted so as to come to efficacious contact with the gas that escapes from the entire surface of the bath. The water may be fed by the above-mentioned tube in a full jet or the tube may be a double walled structure through the outer jacket of which the water is fed, in order to obtain suitable muzzle velocities.

A particular advantage resides in the voluntary supply of the water both as to quantity and time so that the course of the fining action and of the after-combustion can be exactly regulated and the progress of the charge carefully observed according to the development of the gas.

Any want of heat can be compensated for by addition of fuel.

In carrying out the described process simple iron tubes have been found to be of short life only so that the process might be rendered uneconomical due to the high consumption of these tubes. This short life of simple iron tubes is due to the prevailing conditions of heat transition and heat conduction. For, the heat transition from the agitated bath to the tube is about equal to that of water to the tube wall, that is amounts about to 2000 to 3000 thermal units, and will be near the upper limit, that is 3000, due to the violent motion of the bath and to the volume of the tube being far smaller than that of the bath which thus does not undergo any drop of temperature. If it would be possible in practice to expose the entire length of the tube to boiling water, which would give a heat transition of 4000 to 6000 thermal units, then a long life of the tube would be secured, because in this case the heat conductivity of iron would have an insulating effect owing to the high heat transition prevailing on both sides. Now as the present process provides only the application of a comparatively small quantity of water, this method is not feasible. Hence, the heat transition on the water side is at best equal to that on the side of the iron bath and consequently, the tube will be heated up to the mean of the bath and water temperature or more highly. Therewith the temperature the tube is exposed to arrives in the range where the properties of strength of iron become nearly zero, so that the tube is no longer capable of resisting the water pressure and mechanical stress and soon will burst, its portions no longer cooled melting off.

This drawback can be eliminated by the following four measures.

a. By reducing or rendering more difficult the heat transition from the bath to the tube, this being accomplished by applying special insulating protective means which are adapted to the prevailing conditions.

b. By periodically lowering and raising the tube which is surrounded by an insulating layer, the adhering portions of the bath which are cooled in raising having a further insulating effect.

c. By increasing the heat absorptive capacity of the tube so that the time till its destruction makes possible a practically and economically satisfactory execution of the process.

d. By introducing water without a tube.

In the accompanying drawings are illustrated several embodiments of the means for carrying out the described process, in which drawings

Figure 1 shows a water-injecting tube in longitudinal section,

Figure 2 is a corresponding cross section,

Figure 3 is a cross section through a modified water tube,

Figure 4 is a similar section through another modified tube,

Figure 5 is the elevation of a third modified tube, and

Figure 6 shows an appliance adapted to carry out the process by means of a movable tube.

A protection of the water tube by reducing or rendering more difficult the heat transition from the bath to the tube, as mentioned above under *a* can be obtained in various ways attention being paid to the prevailing special conditions, that is to the expansion of the tube and the violent mechanical stress and blows to which the tube is exposed. So for instance a simple insulation by means of tube-shaped fire bricks has proved unsatisfactory. A good protection, however, is obtained by using a hot sticking thickly liquid slag, which slag coating has to be protected against solidifying and chipping off by preventing it from cooling during the whole operation. To this end the slag coating preferably is applied to the tube as a liquid slag immediately before introducing the tube, and is completed from time to time by raising the tube during the operation so that new slag will stick thereto from the slag cover of the bath. If this protective coating, which in part consists of the content of the bath itself, possesses the right thickness, a state of balance is obtained between the heat supplied and the heat led off, whereby the water supply is secured. Another method may consist in applying to the tube a suitable insulating mass e. g. by means of a spraying gun, or by other means.

Now, as the tube may be heated up to a comparatively high temperature in spite of the described protection whereby its strength may be considerably reduced, it will be of advantage to provide means for protecting the tube from bending down. This may be done by fitting the tube with a reinforcing member on the endangered portion such as an U-iron, L-iron or flat iron, as illustrated in Figures 1 to 4, where an iron bar *a*, *b* or *c* of suitable section is provided within the tube. As such an iron bar permanently remains at the temperature of the water supplied that is below 100 degrees, its strength is maintained. Care must be taken, however, that the iron bar rests on the tube wall only on a few points so that no accumulation of heat and an increased stress of the tube can take place.

An older method of supplying gaseous, vaporous and liquid substances consisted in blowing them in through nozzles provided in a wall of the container, because when the temperature of the bath amounts to considerably more than 1000 degrees, a simple supply through metallic or refractory tubes is impossible in the course of time. This supply through nozzles, however, requires a troublesome tilting or rolling of the entire container and, moreover, the quantity supplied can be varied only within narrow limits. Finally, the supply of a fining means requires special containers or furnaces fitted with the above supplying nozzles.

In contradistinction thereto the present method enables these substances to be supplied to a melting bath of high temperature by means of simple tubes without the container needing be adapted thereto in any way.

The invention resides on the following perception:

In spite of the considerably higher heat transition from a bath to the tube than from the agent passing through the tube, a certain time elapses until the tube is heated to its critical temperaure. Furthermore, the destruction of the tube by melting or burning begins at the place of deepest immersion that is at its muzzle, as here the cooling action upon the tube wall is the feeblest due to the supplied agent on this place already being at higher temperature. On the other hand no danger exists for the tube when dipped only to a certain slight extent, in which case the agent in the tube is not heated to any considerable extent. The present method therefore provides an interruption of this heating and recooling of the tube always shortly before the said critical temperature is reached. This is obtained by so far retiring the tube from the bath while the liquid agent continues to be supplied, that a de-accumulation of the heat of the tube wall takes place and the agent which then has its original low temperature efficaciously cools also the muzzle of the tube. When for instance the agent is supplied in liquid state, the conditions of heat transition in the bath itself are approximately equal on both sides, but above the bath the transition of heat within the tube is 20 to 100 times greater than outside. Hence, a violent cooling of the tube wall takes place very quickly.

In order to protect the tube from destruction, it has therefore to be raised and lowered periodically, the maximum amount of immersion being determined according to the stream velocity of the agent, the dimensions of the tube, the frequency of the periods, and the temperature of the bath.

In raising the tube always portions of the bath will adhere to the tube the heat of which portions will be led off so that the attack of the bath heat first strikes this protective layer whereby a further protection of the tube is obtained. To attain an efficacious protection of this kind that is by a portion of the bath itself, it has proved advantageous to firmly wind asbestos cord around the tube on the portion to be dipped before using it, in order to cause the insulating bath layer more easily to stick.

For instance the supply of the liquid agent to an ordinary melting furnace, the depth of the bath of which permits a dipping stroke of 70 to 80 cm., is established by means of ½″ iron tubes. Asbestos cord of 5 mm. in diameter is wound on these tubes for a length of 1 m., this winding being doubled near the muzzle for a length of 15 cm. With a supply of liquid of at least 35 liters per minute, a stroke of 30 to 40 cm., and a dipping frequency of 25 to 35 per minute the tubes withstand destruction, as tests have proved.

In Figure 6 one form of apparatus for practicing this method is illustrated.

e denotes the vessel containing the metal bath into which the tube *f* is dipped which is provided on its length to be dipped with the insulating mass *g*, such as asbestos or the like. Preheated combustion air is admitted into the space above the bath in the vessel through ports *p* from a channel *q* surrounding the top of the vessel. The preheated air is supplied to the channel *q* through an inlet pipe *h* leading from a preheater *k*. The combustion gases pass off from the vessel through a flue *i* leading through the preheater *k*, where their heat is imparted to the cold air supplied to the preheater. In order to allow the tube *f* to be raised and lowered while preventing the exit of waste gases around the pipe, the opening 9 in the top of the vessel *e* is made large enough to prevent interference with the asbestos and slag on the tube *f* and a stuffing box 10 is mounted at the upper end of a tubular extension 11 surrounding the tube *f*. Any suitable means may be used for raising and lowering the tube with the required periodicity. In Fig. 6 there is shown, by way of example, a hydraulic device comprising a cylinder 13 and piston 14 connected by rod 15 with the tube *f*. A pressure fluid is admitted to the cylinder below piston 14 through pipe 16, 17, in which is inserted a valve 18. The valve has a rotary member which periodically admits the pressure fluid from pipe 17 through port 19 to pipe 16 and alternately exhausts the pressure fluid from pipe 16 through port 20. When the fluid pressure is admitted to cylinder 14 the tube *f* is raised and when the exhaust port 20 is opened, tube *f* is lowered into the bath again.

In applying the method set forth above under c, a satisfactory protection of the tube is obtained by increasing the heat absorbing capacity of the tube by introducing the water into the bath by means of scrap in the form of billet pieces as usually supplied to the bath. To this end these pieces are provided with a suitable bore.

Furthermore, an efficacious protection of the tube is obtained by using a part of or the entire water itself supplied to protect the tube. To this end the portion of the tube to be dipped is provided like a sieve with small bores through which the water enters the bath. In this case the tube is cooled and thus protected chiefly by the great heat required to decompose the water.

The method of fining by water mentioned above under *d* without using tubes may be carried out by moistening any additions to be fed to the bath such as ores or lime, and supplying by them the necessary fining water.

Furthermore the following design of the tube will give a satisfying result more particularly with baths of limited depth. In order to obtain at once a powerful decomposition of the water into hydrogen and oxygen the muzzle *d* of the tube, Figure 5, is so designed that the water jet enters the bath in the shape of a flat enlarging ribbon. Attention has to be paid in this case to the fact that no increase of pressure arises in the tube causing a premature destruction. To this end the contraction coefficient to be applied has to be so determined that the passage area of the tube is not narrowed.

Finally a reduction of the dipping depth of the tube due to burning or melting off can be lessened by giving the tube a coiled shape, as also shown in Figure 5, whereby further a desirable more violent agitation of the bath is obtained due to the water leaving the tube tangentially.

What we claim and desire to secure by Letters Patent is:—

1. Process of treating an iron bath to convert it into steel, which comprises introducing water in liquid state into the bath in such a manner as to cause decomposition thereof, and burning the combustible gases of decomposition by supplying combustion air immediately above the surface of the bath.

2. Process of treating an iron bath to convert it into steel, which comprises introducing water in liquid state into the bath in such a manner as to cause decomposition thereof, and burning the combustible gases of decomposition by supplying preheated combustion air immediately above the surface of the bath.

3. Process of treating an iron bath to convert it into steel, which comprises introducing water in liquid state into the bath in such a manner as to cause decomposition thereof, and burning the combustible gases of decomposition by supplying combustion air immediately above the surface of the bath, and preheating the combustion air by the waste heat of the process.

4. Process of treating an iron bath to convert it into steel, which comprises coating an ordinary iron tube with a hot liquid slag, introducing one end of said tube into the bath before the slag cools, and feeding water in liquid form through said tube into the iron bath.

5. Process of treating an iron bath to convert it into steel, which comprises coating an ordinary iron tube with a hot liquid slag, introducing one end of said tube into the bath before the slag cools, feeding water in liquid form through said tube into the bath, maintaining a covering of slag on the bath, and intermittently renewing the slag coating on said tube by withdrawing the tube from the bath into the covering of slag.

6. Process of treating an iron bath to convert it into steel, which comprises spraying a hot liquid slag coating onto an ordinary iron tube, introducing one end of said tube into the bath before said coating cools, and feeding water in liquid form through said tube into the bath.

7. Process of treating an iron bath to convert it into steel, which comprises injecting liquid water into the bath through a tube inserted into the bath, periodically partially withdrawing the tube from the bath while maintaining the flow of water through the tube, and re-inserting the tube to the full depth after it has cooled.

8. Process of treating an iron bath to convert it into steel, which comprises winding a cord of refractory material around an ordinary iron tube, dipping one end of said tube into the bath, feeding water in liquid form through said tube into the bath, and periodically raising the tube to cause substances from the bath to adhere thereto.

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