Jan. 5, 1932. H. NEUHAUSS 1,839,927

RECUPERATOR OR REGENERATOR USE OF GASES FROM HIGH FREQUENCY FURNACES

Filed Sept. 19, 1928

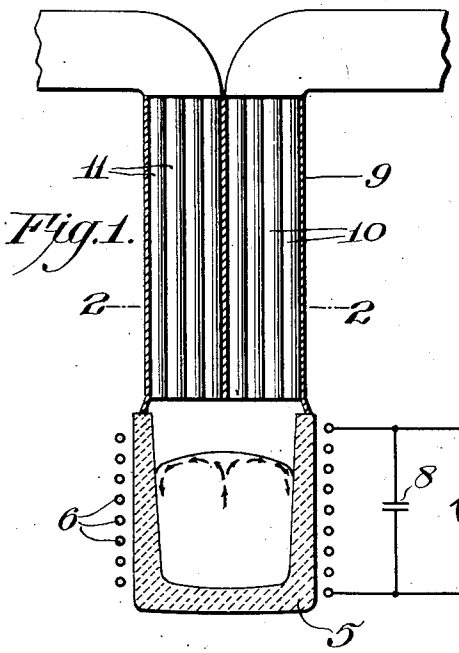


Fig. 1.

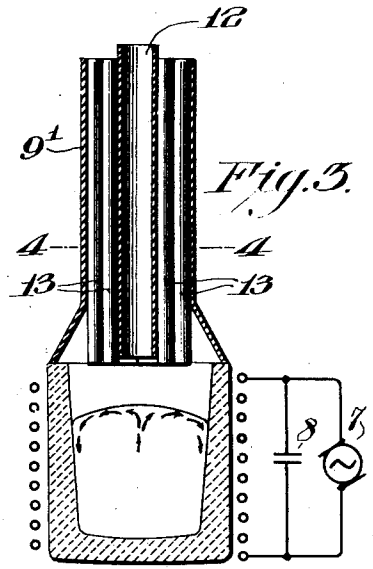


Fig. 3.

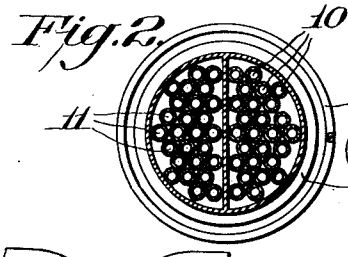


Fig. 2.

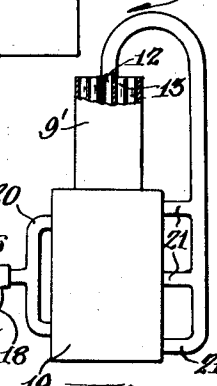


Fig. 5.

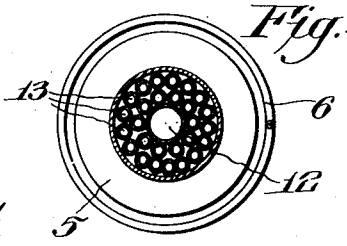


Fig. 4.

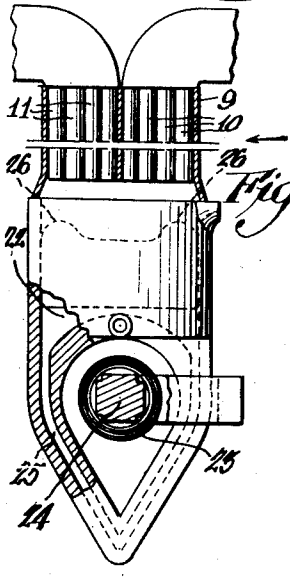


Fig. 6.

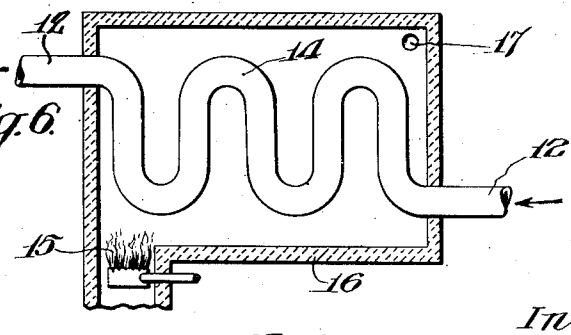


Fig. 7.

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By
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Patented Jan. 5, 1932

1,839,927

UNITED STATES PATENT OFFICE

HEINRICH NEUHAUSS, OF DUSSELDORF, GERMANY, ASSIGNOR TO THE AJAX METAL COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

RECUPERATOR OR REGENERATOR USE OF GASES FROM HIGH FREQUENCY FURNACES

Application filed September 19, 1928. Serial No. 306,819.

My invention relates to the treatment of iron by oxygen to burn out the carbon.

The main purpose of my invention is to provide an atmosphere of heated gas containing oxygen as a blast upon the surface of a generally and rather rapidly circulated pool of molten metal.

A further purpose is to accelerate the burning out of carbon from a bath of molten iron subject to a blast containing oxygen by heating the gas, preferably in a regenerator.

A further purpose is to apply methods of oxidation of carbon by gas to the ordinary crucible type of furnace.

Further purposes will appear in the specification and in the claims.

My invention relates to the methods involved as well as to apparatus by which the methods may be carried out.

In the drawings I have shown but two forms of the same invention, using a regenerator in the one form and a recuperator in the other.

Figures 1 and 3 are vertical diagrammatic sectional views showing the application of my invention.

Figures 2 and 4 are sections of Figures 1 and 3 taken upon lines 2—2 and 4—4 respectively.

Figure 5 shows in longitudinal section a preheater by which I may partially or initially heat the air used.

Figure 6 is a side elevation, partly sectioned, showing a second form of furnace.

Figure 7 is a side elevation, partially broken, showing a combination of furnace cooling and air pre-heating.

In the drawings similar numerals indicate like parts.

The Bessemer and the Thomas converters for producing steel apply to special irons only. Each depends upon the presence of one or more essential elements in the iron, such as silicon in the Bessemer form and phosphorus in the Thomas form. These elements are oxidized in order to produce the heat necessary to ignite and burn the carbon. Where the respective essential elements are not present, the Bessemer and Thomas converters fail for lack of sufficient heat. The converters have also been complicated and expensive and the blast through the body of the converter has caused such rapid deterioration of the linings as to add greatly to the expense.

Attempts to burn the carbon by a blast from the top have not met with success. Insufficient circulation has resulted in so slow a change in the surfaces of molten metal exposed at the surface of the bath of molten metal that the rate of combustion has been very low. As a result the time taken has been excessive and the metal has cooled before the operation is completed. The air relied upon to furnish the oxygen for the combustion of the carbon has been cool and has also unduly lowered the temperature of the bath. The excessive length of time required has been costly in labor and in overhead.

I find that the carbon can be burned out successfully and rapidly at low cost by circulating the metal rapidly in an upward direction, getting the best results where the upwardly moving stream of molten metal has come to the surface and has distributed outwardly near the middle of the pool, over a large part of the surface of the pool, and by heating the air blast delivered upon the surface.

I prefer to start with a molten bath poured into my furnace from a blast furnace or cupola furnace, because the cost of melting is low in these furnaces, but may design my furnace to do the melting if desired.

In the drawings the form of furnace best suited to practice my invention is shown in Figures 1 and 3 where the electric furnace 5, is illustrated diagrammatically as of the so-called coreless type, in that the inductor coil 6 surrounds the pool and the coil is free from interthreading of transformer or furnace iron. The circulation in this furnace disturbs the entire surface of the pool, swelling upwardly by pinch effect and motor effect at the center, spreading out ove the surface like the ribs of an umbrella and returning along the sides of the pool.

The heating effect of a current of high frequency passing through a furnace induc-

tor is high as compared with its stirring effect. As the frequency is lowered the heating effect is relatively lowered and the stirring effect is increased.

A furnace may, therefore, be designed to give maximum surface appearance of new metal by suiting the current flow and frequency and the distribution of the coil about the charge to the size and shape of the pool.

It may, however, be designed to give any proportion desired of heating to stirring within wide limits. As I secure the heating effect by burning out the carbon of the bath I desire a high stirring effect and am not so much interested in the heating unless I am dealing with an iron or steel which is too low in carbon for it to supply the required heat by burning of the carbon or unless I desire to use the furnace initially for melting the charge before I begin the operation to which the present invention is primarily directed.

I have discovered that the carbon of a high carbon charge can be oxidized without cooling of a bath, at a high rate of speed and with low expense for labor and overhead, by the application of a heated air blast to the surface of the pool while the pool is stirred upwardly throughout the greater part at least of the surface of the pool, using the heat of the carbon combustion to maintain the temperature of the bath, and that, with lower carbon contents a proportionate part of the heat required can be secured from combustion of the carbon; but chiefly that at the same time the products of combustion can be utilized to heat the blast.

The furnace in Figures 1 and 2 is surrounded by coil 6 supplied with alternating current from a source 7 and having its power factor corrected by any condensers 8, here shown as in shunt with the source, but not necessarily so arranged.

Above the two furnaces I show two heaters for the air blast, a regenerator 9 and a recuperator 9′, which for my purpose I regard as substantially the same. Each is connected with any suitable means for causing air blast in a quantity and at a pressure such that the air impinges against the surface of the metal properly and supplies the oxygen needed to consume the carbon in the iron.

By reason of the rapidity of the metal circulation obtained and the heat of the blast I am able to consume the carbon and other impurities of the iron so rapidly that I can utilize the hot products of combustion for heating the regenerator or recuperator. This effects a large saving in fuel and is therefore quite important. The combustion also heats the bath.

The regenerator is shown as having the conventional alternative sets of air tubes 10 and 11, through which the inlet air and outlet hot gases reverse at intervals, and the recuperator is shown, also conventionally, as being an inlet air pipe or pipes 12 surrounded by an outlet passage 13.

Even where the heat from the combustion is not sufficient for the purpose I can use it for part of the heat required, partially preheating the air supplied, by means of gas from any suitable source as indicated in Figure 5 where a preheater coil 14 is shown acting upon the air in pipe 12 before it reaches the recuperator. The coil 14, burner 15 and casing 16 with outlet 17 are intended to be typical for any preheater which will perform the heating function.

It will be noted that the hump caused by the circulation insures a clean surface of the metal for oxidation by the blast.

The air for either the regenerator or recuperator can be heated by the furnace itself. This is illustrated in Figure 7 where the structure of the furnace shown in Figure 3 of Northrup Patent No. 1,640,799 for air cooled inductor coil, patented August 30, 1927 is used to heat and stir a pool beneath a recuperator of the type seen in Figure 3. It is, of course, suitable also where a regenerator is used. The air which is heated in cooling the inductor coil is fed to the regenerator or recuperator inlet.

In this illustration the fan 18 supplies pressure for air entering the casing 19 about the inductor through pipes 20 and the heated air from casing outlets 21 is fed to pipe 12, the inlet of the recuperator. The operation of the furnace is the same as that in Figure 3 of the present application or as Figure 3 with partial preheating from a coil as in Figure 5, except that the air is heated by what would otherwise be the waste heat dissipated in and by the inductor.

In Figure 6 a second form of electric furnace is shown, intended to be typical of submerged molten resistor furnaces. The illustration is that of an Ajax-Wyatt furnace seen in Wyatt Patent No. 1,201,671 and provides a pool 22 heated and circulated by a current-carrying coil 23 about one leg 24 of a transformer operating upon a molten loop resistor 25. The circulation here causes humps 26 above the ends of the loop and the vigor of the surface stirring can be increased by making the pool more shallow.

My invention may treat any molten iron or steel containing an excess of carbon with or without other impurities. Ordinarily determination of the frequency will not require consideration of the heating properties of the current since any frequency will add heat enough to the metal to take care fully of the temperature needs of the molten metal in view of the fact that the air supply will be heated by the hot products of combustion. In any event the frequency need not be higher than is desired for heat transfer purposes and is desirably low to secure a maximum stirring effect.

Where the melting and oxidizing are intended to be done in the same furnace the frequency must, however, be sufficient to provide for the necessary melting. The fact that melting by other means is cheaper than that by electric current makes it desirable to treat metal which is charged into the furnace in molten state.

It will be evident that the use of air preheated by the furnace coils so as to utilize for the furnace blast the heat taken up in cooling the inductor of a furnace may be applied not only to the Northrup form of invention shown in the earlier figures, but also to the Wyatt submerged channel form of furnace illustrated.

The transformer preferably does not take up the entire section inside the Wyatt coil and cooling air space may be left also deliberately about or between the Wyatt inductor coil turns to permit of air passage, having the double effect, in application to my invention, as in the Northrup form, of cooling the inductor and preheating the air subsequently used for inlet supply to the surface of the furnace pool. The same application of pressure to this air supply can be utilized with the Wyatt form as with the Northrup form of furnace.

I recognize that my invention will not burn out carbon alone but that along with the carbon it will burn out alloy metals or elements reacting similarly to metals such as manganese or silicon, or impurities such as phosphorus. The reason for the reference in my claims to the burning out of the carbon is that the heat to be derived from burning out carbon makes the invention commercially operative whereas if reliance for heating of the inlet air were rested upon the burning out of the manganese, silicon and phosphorus alone, for example, too little heat would be available in the regenerator or recuperator since the burning of the manganese, silicon and phosphorus would produce an oxide as distinguished from the gas produced by the burning of the carbon. The heating of the inlet air would then be dependent almost wholly upon preheating by using cooling air from the furnace and by separate preheating, making use of a part of my invention only as distinguished from obtaining a fuller benefit from it.

It will be obvious that I have provided a method and device by which the high speed of circulation of the molten metal in the furnace increases the rate of speed of burning out the carbon to a point where the regenerator or recuperator is practicable with or without additional heating of the inlet air and in which the heating of the air prior to its delivery in the form of a blast is largely contributory to the speed of burning.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. The method of oxidizing molten iron or steel to reduce the carbon content thereof, which consists in electro-magnetically heating the iron or steel by circulating electric current about it, in applying a blast of air to the surface of the molten metal and in utilizing the hot products of combustion from combustion of said air to heat the inlet.

2. The method of oxidizing a molten bath to burn out the carbon, which consists in applying a blast of air to the molten surface through a regenerator or recuperator, using the hot products of combustion to heat the air inlet and at the same time electro-magnetically heating and stirring the bath to maintain the temperature of the bath and to stir it in an upward direction to rapidly change the metal at the surface of the bath to be affected by the blast.

3. The method of burning out the carbon of a molten metal bath, which consists in electro-magnetically stirring the bath rapidly to present fresh metal at the surface and in applying air to the surface thus changed and concurrently heating the air by the hot products of combustion.

4. The method of burning out the carbon of a molten metal bath, which consists in electro-magnetically stirring the bath rapidly in an upward direction to present fresh metal at the surface, in applying air to the surface thus changed, concurrently heating the air by the hot products of combustion and preheating the air applied to make up any difference between the required temperature of the inlet air and that to which it would be raised by the hot products of combustion alone.

5. The method of burning out the carbon of a molten metal bath, which consists in electro-magnetically stirring the bath rapidly in an upward direction to present fresh metal at the surface, in applying air to the surface thus changed, concurrently heating the air by the hot products of combustion, air cooling the electro-magnetic stirring means and utilizing the air heated by the air cooling operation as preheated air to add to the temperature of the air otherwise heated by the hot products of combustion.

6. The method of heating air supplied as a blast to the pool surface of an electric furnace having an inductor heating coil, in which furnace an oxidizing operation is being performed, which consists in utilizing air

to cool the coil and thus concurrently heating the air and applying the air so heated as a supply for the furnace.

7. The process of electro-magnetically heating and stirring a molten metal pool and at the same time oxidizing the metal of the pool, which consists in circulating a current of electricity about the pool to heat it and stir it in vertical planes coincidentally applying a blast of air to its surface, and heating the inlet air by the hot products of combustion and selecting a frequency for the current circulated about the pool not much higher than is required to add the requisite heat to the pool for maintaining the temperature of the pool whereby a maximum stirring effect is secured.

8. The method of heating a blast of air applied to the surface of the pool of an induction furnace and at the same time cooling the furnace inductor coil, which consists in utilizing air heated by cooling the coil as preheated air supply for the blast of air upon the surface.

9. An induction electric furnace adapted to contain a molten bath and providing bath circulation in vertical planes in combination with a regenerator or recuperator supplying air to the surface of the furnace bath and heating the air supplied by the hot products of combustion.

10. The method of burning out the carbon from iron which consists in electro-magnetically giving a vigorous combined pinch and motor effect circulation to the molten metal to drive it upwardly near the center and spill it over about the sides, in supplying a blast of hot air upon the surface of the metal so stirred and in utilizing the waste products of combustion to heat the blast.

11. An electric furnace of inductor type adapted to highly stir the molten metal, means for supplying a hot air blast upon the surface of the molten metal and connections for utilizing the heat of the products of combustion to heat the air supply.

12. An induction electric furnace adapted to contain a molten bath and providing bath circulation in vertical planes, in combination with a regenerator or recuperator which supplies air to the surface of the furnace bath and which applies the heat from the hot products of combustion to the inlet air and a preheater for the air inlet.

13. An induction electric furnace adapted to contain a molten bath and providing bath circulation in vertical planes in combination with a regenerator or recuperator which supplies air to the surface of the furnace bath, and which applies the heat from the hot products of combustion to the inlet air, air-cooling means for the furnace and connections from the air cooling to the regenerator or recuperator supply whereby the air-cooling means of the furnace becomes preheating means for the recuperator or regenerator.

14. An induction electric furnace, air-cooling means for the furnace inductor coil and means for applying the air so heated by cooling the coil as a blast upon the surface of the furnace pool.

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