Dec. 7, 1943. W. A. MUDGE 2,336,366

FURNACE

Filed Aug. 3, 1940

Fig. 1.

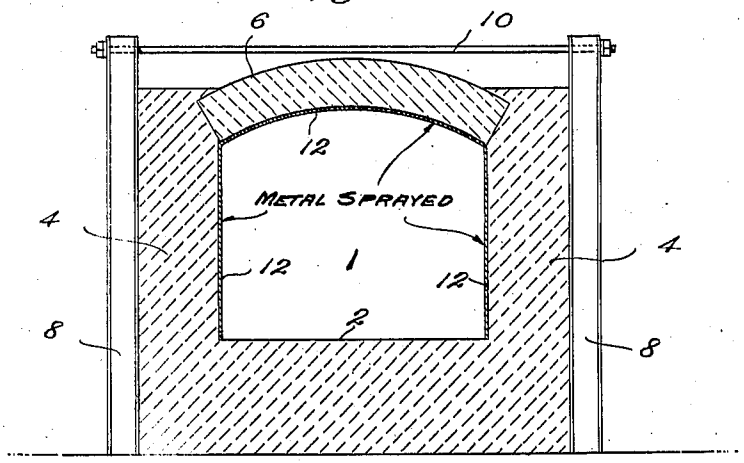


Fig. 3.

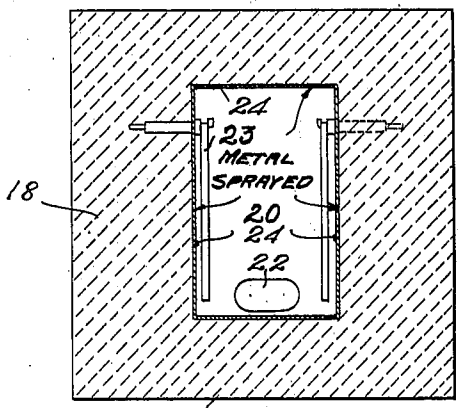
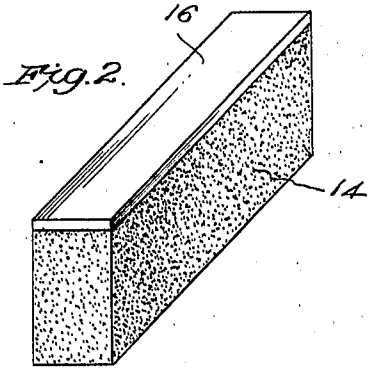


Fig. 2.



INVENTOR.
WILLIAM ALVIN MUDGE
BY
ATTORNEY

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2,336,366

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FURNACE

William Alvin Mudge, New York, N. Y., assignor to The International Nickel Company, Inc., New York, N. Y., a corporation of Delaware

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2 Claims. (Cl. 266—43)

The present invention relates to furnaces having walls, arches and other parts made of refractory material which are exposed in use to elevated temperatures, and which are coated on the exposed surfaces with a protective nickel or nickel alloy layer formed in situ thereo.

The invention is particularly applicable to the improvement of walls, arches, and other parts of reheating furnaces built of refractory material, such as ordinary fire brick or tile, and special fire brick or tile, for example. Such walls and parts deteriorate in use due to spalling and chipping of the refractory bricks and parts. There is also considerable wear in certain reheating furnaces where the objects rub against the refractory walls or other parts during charging or discharging operations or in their movement through the furnace. Such walls and parts do not have a long life.

I have found that the life of furnace walls and parts can be greatly prolonged by spraying a protective layer of nickel or nickel base alloys such as nickel-copper alloys, nickel-chromium alloys and the like on the bricks, or other refractory materials or parts which are exposed in use to the elevated temperatures.

It is an object of the present invention to provide a furnace having walls and parts which are exposed to elevated temperatures, coated with protective metal formed in situ thereon.

It is another object of the invention to provide a method of increasing the life of furnace walls, arches, and other parts, by forming a thin coating of protective nickel or nickel alloy on the exposed surfaces thereof.

A further object of the invention contemplates the provision of refractory material in block form, for example bricks, tile or the like, having the face which is to be exposed coated with a thin protective nickel or nickel alloy layer formed in situ thereon.

The invention contemplates the provision of a furnace having walls and parts coated with a protective nickel or nickel alloy formed in situ thereon, the coated walls and parts being adapted to resist the destructive effect of elevated temperatures, erosion, corrosion, spalling, chipping, and other detrimental and destructive influences.

Other objects and advantages of the present invention will become apparent from the following description of the present invention, taken in connection with the accompanying drawing in which:

Fig. 1 is a vertical sectional view through a sheet reheating furnace having the arch and vertical walls coated with a layer of protective metal;

Fig. 2 depicts in perspective a refractory brick, having the face to be exposed coated with a layer of protective metal; and

Fig. 3 represents a vertical sectional view of a continuous bright annealing strip furnace, having refractory walls coated on the inner surface with a protective metal.

Generally speaking, the present invention involves the application of a relatively thin layer of protective nickel or nickel alloy to the exposed surface of the furnace wall, arch, or other exposed parts and surfaces. Ordinarily, the protective nickel or nickel alloy is applied by spraying the metal on the parts to be protected. In the case of the refractory bricks and the like, this spraying may be done either before or after laying up the brick in the furnace walls. The present invention may be put into practice with great benefit in existing furnaces, which have been operated without the protective metallic layer of the present invention. In this manner a surface is obtained which is highly resistant to the effects of heat at the high temperatures generally encountered in reheating furnaces for rolling mills, and in other furnaces.

For best results the spraying should be done so as to apply a nickel or nickel alloy coating substantially uniformly and over the entire surface exposed, coating the depressions and elevations, and filling in small surface cracks and the like. In this way the inner surface of the coating conforms substantially to the refractory surface to which it adheres, and is anchored by projections extending into said cracks and the like.

Referring now more particularly to Fig. 1, it will be seen that the furnace comprises a heating chamber 1 formed by a hearth 2, upright walls 4, and an arch 6, built up of refractory materials such as bricks, tiles or the like. The thrust exerted by the arch is taken up by a reinforcing structure known to those skilled in the art as binding, comprising vertical steel buckstays 8, and steel tie rods 10. The furnace illustrated is constructed in conventional manner, with the bricks or tile laid up with or without the use of mortar or the like. The interior or exposed surfaces of the walls and arch, are covered with a coating or film or layer of protective nickel or nickel alloy 12, applied by a spray gun. Satisfactory results have been obtained in practice using a nickel-copper alloy as the protective metal layer or film.

The chamber 1 may be heated by combustion of fuel such as oil, gas, or pulverized coal. These fuels burn in suspension, producing very high temperatures. By reason of the protective metal coating 12, the high temperatures and fine mineral matter including ash in the fuel, do not attack the underlying refractory, or cause slag to form at its surface, as occurs in ordinary furnaces.

Fig. 2 illustrates the application of the invention to separate bricks, before laying them up in the wall. A fire brick 14 has a protective nickel or nickel alloy coating 16, applied to the side or end surface which is to be exposed. The metal coating may extend slightly back from that side or end along the adjacent surfaces, sufficiently to cover the corners of the brick.

The invention may also be applied to continuous bright annealing strip furnaces, such as illustrated in Fig. 3, which comprises refractory walls 18, forming an annealing chamber 20. Metal strips enter and leave the annealing chamber 20, through tubular passages 22, located in the respective ends of the furnace. The passages 22 also serve as inlet and exhaust ports for a non-oxidizing gas, e. g., hydrogen, nitrogen, carbon monoxide, etc., either singly or in combination. Chamber 20 may be heated to the desired temperature, by electric heating units 23. It has not been possible heretofore to bright anneal metals, such as stainless steels and other chromium-containing iron and/or nickel alloys in furnaces of this type. I have discovered that greatly improved results may be obtained, provided the refractory walls forming the annealing chamber are sprayed with nickel or nickel alloy, to form a coating or film 24. For example, a coating about 0.015 to 0.020 inch thick of metal such as the nickel-chromium-iron alloys, sold under the trade name of Inconel, may be sprayed on the refractory walls, by means of a gun for spraying molten metal, e. g., a Schoop gun. The commercially available Inconel, ordinarily contains approximately 80% nickel, 14% chromium, and 6% iron.

For the purpose of giving those skilled in the art a better understanding of the present invention, the following specific example is given.

A sheet heating furnace of the general type illustrated in Fig. 1, that had been in use for some time, and the refractory brick walls of which had already begun to spall, chip and crack, was sprayed over the door arch and side walls with a nickel-copper alloy, sold commercially under the trade-mark Monel. In spraying the arch and walls, special attention was given to the crevices between the bricks and cracked sections in the brick. These were built up and filled in to hold back any loose sections, that might develop subsequent to the coating. The coating applied was from 0.010 to 0.020 inch thick. The thinner portion was sprayed on the section of the arch, where no wear on the brick from charging or removal of the sheets was noticeable. The thicker coating was put on the side walls, where the brick had been badly chipped and worn from charging and removing the sheets. This coating was designed to help prevent wear and chipping, as well as spalling, slagging, etc. After a long period of service under actual operating conditions, inspection of the furnace showed that the metal coating on the refractory was in good condition, that the metal coating adhered tightly to the refractory surface, and that no additional wear, spalling or chipping of the refractory had occurred. A further and highly important advantage of this furnace, was that the amount of slag or refractory contamination of the hot rolled sheets which were reheated in this furnace, had been greatly reduced over a similar furnace which was not provided with the sprayed protective coating of the present invention.

It will be seen from the foregoing specific examples, that furnaces treated in accordance with the present invention, exhibit great improvement over similar furnaces with the old style walls, operated under the same conditions and length of time. Similar improved results have been obtained for portions of the walls of furnaces, compared with the unsprayed remainder of the same walls.

The process of the present invention may be selectively applied in special cases, to any portions of the wall, or to the furnace parts which are more exposed to the eroding and destructive tendencies of the flames, or which are exposed to wear during the inserting and removing of sheets, bars and the like, or for other possible reasons. In furnaces having sprayed and unsprayed sections, it has been found that the temperature in the sprayed section is more uniform than in the unsprayed section.

The cost of spraying the furnace walls and parts is very little, only a few cents per square foot of surface. The protective metal coating may be applied by other methods than spraying, although this method of spraying is preferred ordinarily. As stated above, the refractory or other furnace parts, may be coated before or after the furnace is constructed. Handling the brick or other coated part does not damage the coating, because it is firmly attached thereto.

The reason for the greatly increased life of the refractory and other furnace parts, which have been coated in accordance with the present invention, is not thoroughly understood. A contributing factor, is that the coated surface has the strength of the sprayed coat of metal. No sprayed coating, however poorly applied, can be removed from a brick or the like, without taking the outer surface of the refractory with it. The metal coating makes the refractories and other furnace parts, more heat resistant. It appears that the heat resistance may be due to the oxidation of the protective metal coating, the oxide being formed promptly upon the firing or operation of the furnace. It may be that the oxidized metal combines with the bricks or other refractory material, to produce a surface resistant to high temperatures. It will be apparent to those skilled in the art, that similar results may be obtained by applying the coating beforehand to the wall or bricks or other furnace parts, and heating them to a temperature approximately equal to or greater than that to which they will be subjected in use.

The process of metal coating as herein described, may be applied not only to furnace walls in which the bricks are laid up loosely, but also to any style of furnace wall, wherein the brick or other linings are laid up in cement, mortar, or other refractory binding. As those skilled in the art know, the refractory linings of furnaces may be classified as acid (silica), neutral (alumina), or basic (magnesia). The degree of porosity of these refractories varies, the neutral type in general being the most porous, and the basic type being the least porous. The present invention may be applied with advantage to all

types of refractories, provided the operator applying the protective coating takes care to force the metal well into the pores, cracks, and the like in the surface, thereby providing good penetration of the metal into the bricks, tile, etc.

The principle of the present invention applies to the use of nickel and alloys consisting largely of nickel, such as nickel-copper alloys, nickel-chromium, and nickel-chromium-iron alloys. As those skilled in the art know, these metals are capable of forming oxide or other surface films, and that the metals either before or after the formation of such oxide or other surface films, are capable of resisting destruction due to temperature changes, erosion, corrosion, etc. The thickness of the coating, must be at least sufficient to form an impervious coating on the exposed surface it is desired to protect. The maximum thickness which will be used, is largely determined by the cost of the protective coating, the rate of deterioration of the exposed surface in use, the estimated life of the furnace, etc., as those skilled in the art will readily understand. Generally speaking, the thickness of the metal coating, will fall within the range of about 0.01 to 0.06 inch.

Although the present invention has been described and illustrated in connection with certain specific embodiments thereof, variations and modifications may be made by those skilled in the art, without departing from the invention as defined in the following claims.

I claim:

1. A brick, tile or the like, for use in the building of walls of metallurgical reheating furnaces, said brick having a coating of metal from the group consisting of nickel, nickel-copper, nickel-chromium, and nickel-chromium-iron alloys adherently anchored to at least one surface thereof and integral therewith, said coating conforming substantially in contour to said surface to which it adheres.

2. A metallurgical reheating furnace, comprising a wall of refractory material having a surface which is exposed to heat, said wall having a coating of metal from the group consisting of nickel, nickel-copper, nickel-chromium, and nickel-chromium-iron alloys adherently anchored to said surface and integral therewith, said coating conforming substantially in contour to said surface to which it adheres.

WILLIAM ALVIN MUDGE.