Oct. 13, 1931. S. WESTBERG 1,827,446

PROCESS OF MAKING REFRACTORY LININGS

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Fig: 1.

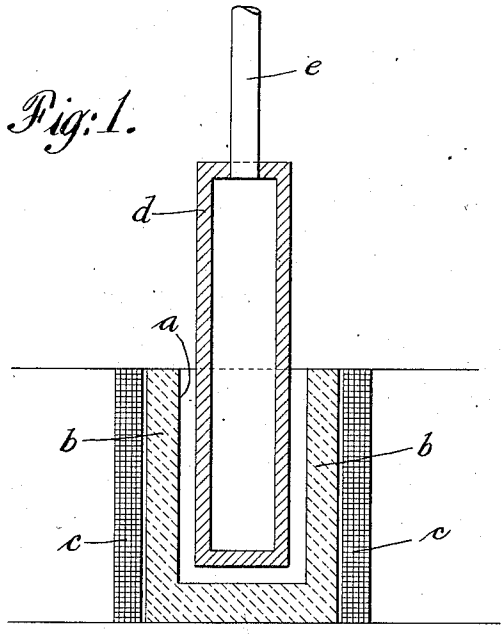
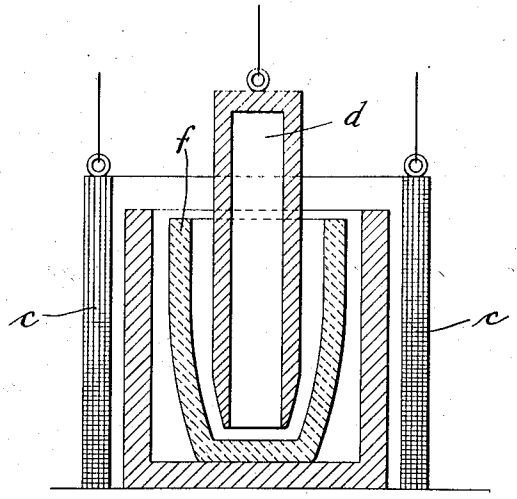


Fig: 2.



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PROCESS OF MAKING REFRACTORY LININGS

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This invention relates to a process for making refractory linings and is particularly useful in lining metallurgical furnaces, crucibles and the like. It is peculiarly adapted to the lining of induction furnaces, and I will, therefore, disclose the invention as applied to this use, although it should be understood that it is not necessarily limited to this field.

Before proceeding to a description of the invention and an enumeration of its objects and advantages, it is desired to refer to some of the difficulties which have to be overcome in making satisfactory refractory linings. For example, in melting metals or alloys in an induction furnace, the lining is subjected not only to the chemically corrosive influence of slags, metals, gases or vapors, but also to the erosive or scouring effect of the molten charge which is given a whirling motion by the electromagnetic action.

Furthermore, in coreless induction furnaces, whether of high, medium or low frequency, it is very important to have the lining as thin as possible in order to secure good coupling and high efficiency.

In addition, the great drop in temperature between the highly heated interior and the air or water cooled induction coil on the outside places exceedingly heavy stresses on the lining which frequently develops cracks with their incidental disadvantages, and often times serious results, such as injury or death to workmen where the molten bath escapes. Interruptions or disturbances of this nature also involve a great loss of metal and materials as well as of time incident to the making of repairs and suspension of operations.

For all of which reasons the use of what, otherwise, is probably an almost ideal method of heating has been limited to induction furnaces of relatively small size and capacity and, even in these, the linings, generally, have stood up for only a comparatively few charges. Again, in large furnaces the danger to workmen from any failure of the lining is materially increased. Also, because the power necessary to maintain the heat balance, is so largely dependent upon the quality of the insulation, this question of a highly resistant and durable refractory lining is of great importance.

The difficulties mentioned occur not only with iron, steel or other metals and alloys of higher melting points, but also with non-ferrous metals such as highly cupriferous alloys, leaded bronzes, and other ordinary commercial alloys. In fact, with many metals and alloys the induction furnace so far has been not only economically questionable, but also technically impossible.

With the foregoing in mind, the primary objects of my invention will be better understood and may be said to involve the provision of a refractory lining which, while still of very reasonable depth or thickness, is far more durable, effective as an insulation, impervious and chemically resistant than heretofore. The invention also aims to make possible the use of larger induction furnaces with a marked decrease in their hazard, as well as to extend the variety of metals and alloys which can be treated therein.

It is also an object of my invention to provide a process of making refractory linings whereby a much higher temperature can be employed in baking the lining than will be encountered when the furnace, crucible or the like is being used to melt a charge. The importance of this will be better appreciated when it is recalled that in present practice the lining is simply baked in by the first charge. My improvement makes possible the use of the finest refractories requiring much higher baking temperatures than are possible where the lining is to be baked by the heat of the first charge. The higher quality refractories have a further advantage for induction furnaces in that a thinner lining can be used which will permit a reduction in the distance between the coil and the charge.

The foregoing, together with such other objects and advantages as may appear hereinafter, or are incident to my invention, are obtained in the following manner, reference being had to the accompanying drawings, which somewhat diagrammatically illustrate two ways of employing the improved process.

Fig. 1 is a vertical section through an in-

duction furnace illustrating the manner in which I bake the lining, and Fig. 2 is a similar view showing how the invention may be applied to the baking of crucibles.

In Fig. 1 the refractory lining *a* of an induction furnace *b* may be applied, for example, by ramming, or in any other suitable or desired manner, after which a suitable core *d* (preferably a hollow, graphite core) is lowered into position within the lining by any suitable suspending device *e*. The current is then turned on in the coil *c*, which, of course, induces a flow in the core *d*. Graphite, being very heat resistant, while, at the same time, possessing good conductivity, permits the temperature to be carried to extremely high levels, thereby thoroughly baking and even glazing the inner surface of the lining. In the showing the core is free of the walls so that the transfer of heat is chiefly by radiation, which arrangement prevents reactions with the lining material or sticking of the core. However, in some instances the core may be placed in direct contact with the lining.

By using the foregoing method, it is apparent that it is possible to employ extremely high-refractory materials, which sinter or melt at temperatures far above the working temperatures employed with the charge. Any desired temperature or time for baking are readily employed, and the thickness of the lining can be accommodated to the dimensions of the furnace and the drop in temperature from the inside to the outside. Because the baking is from the inside outwardly, the temperature can be forced sufficiently high so that, even with very highly refractory materials, it is possible to obtain a melted coating on the interior which will result in an unusually hard, impervious and resistant inner surface.

The lining can be composed either of pure oxides, as, for instance, magnesia, alumina, zircon-oxide, thoroxide, silica in different sizes of grains and pre-treatment, etc., or of a mixture of oxides, silicates or compounds, which, at the very high heating temperatures employed, produce new formations of crystals or compounds, such, for example, as mixtures of magnesium oxide and alumina to form spinel-compounds, or of zircon oxide and thorium oxide, etc. Or, in cases where such is preferred, carbonaceous linings can be made by adding pitch, tar, etc., or a mixture of carbides, as, for instance, silicon carbide or calcium carbide. In the same way, linings of carbon-clay-paste can also be baked directly in the furnace of a composition such as used for the production of crucible steel.

With the present improvement it is possible to use the compact and resistant refractory materials which are melted and purified in the arc furnace. These can be baked to a structure of very hard, dense composition by using the material preferably in granular condition without the addition of a binder or a flux and then heating it as above described.

The invention enables one to make use of a series of highly refractory materials not heretofore available for similar purposes because of the very high temperatures which they require. Furthermore, the fact that the baking temperature can be so much above the subsequent operating temperature insures the completion of all chemical or physical transformations or changes prior to actual operations, so that no detrimental effects will be encountered from this source during subsequent use of the furnace or crucible.

If cracks develop in the lining after the initial baking operation and subsequent cooling, these can be filled in with more material and the baking repeated, so that a perfectly sound lining can be developed gradually with the inner or final layer or coating of the lining being made of some specially resistant material if desired. This latter feature, of course, saves considerable in the cost over a complete lining of such special material. Unusually pure metals can be produced in furnaces where the lining can be of such improved and resistant characteristics as are herein made possible.

Other core materials can be used such as high-fusible carbides, for example, silicon carbide, or such metals as tungsten, molybdenum, etc., in which case the baking can then be made to take place in a neutral or reducing gas or in a vacuum. Several cores might be used or a core of special shape as desired. A hollow core, such as illustrated in Fig. 1, concentrates the heat at the surface of the lining and permits the use of a pyrometer or optical thermometer to obtain an exact determination of the temperature because the instrument can be visioned against the interior of the hollow core where substantially a black body condition prevails, the observation being made through a suitable opening in the core. In this way a very exact control over the temperature of firing can be had.

With my improvement repairs can be made quickly and easily by grinding or chipping out the damaged portions of the lining and then filling in with sufficient new material to again establish substantially the old contour. This can then be baked as previously described whereby much time and power can be saved, since it is unnecessary to heat up an entire new lining.

Fig. 2 shows how the process can be used for the production of high-refractory crucibles. In this application of the invention the induction coil as well as the core are movably suspended so that the coil can be lifted above or dropped below the crucible and the

core lowered therein. In this way a great number of crucibles can be preformed and baked consecutively in the shortest possible time.

I claim:

1. The inductive baking of refractories at temperatures materially higher than those prevailing during the use for which they are intended.

2. As a new article of manufacture, an inductively baked refractory.

3. As a new article of manufacture, an inductively baked refractory furnace lining.

4. The method of preparing refractories for use in furnaces which includes baking the refractory by placing an induction coil to the outside thereof and a core on the inside, and applying current to the coil.

5. The method of preparing refractory furnace linings which includes baking the lining by placing an induction coil around the lining and a core within, and applying current to the coil.

6. The method of preparing refractory furnace linings which includes baking the lining by placing an induction coil around the lining and a hollow core within, and applying current to the coil.

7. The method of preparing refractory furnace linings which includes baking the lining by surrounding the furnace with an induction coil, suspending a core within the lining and applying current to the coil.

8. The method of preparing refractory furnace linings which includes baking the lining by surrounding the furnace with an induction coil, suspending a hollow core within the lining and applying current to the coil.

9. A method according to claim 4 wherein the core is spaced from the refractory.

In testimony whereof I have hereunto signed my name.

SIGURD WESTBERG.