The invention relates to the casting of refractory articles, such as fire brick and the like, from solid non-plastic material, possessing the properties of resistance to deflocculation, such for instance as zirconium oxide and zirconium silicate.

Under present practice the commercial production of 100% zirconium oxide or zirconium silicate refractories has been impractical because of the extreme care required in handling the ware through the production process. The present methods of forming such articles comprise pressing, casting and extruding, in all of which methods it is necessary to add a binder so that the pieces may be handled.

If an inorganic binder, such as clay, is used the refractoriness of the brick is materially reduced, the aluminum silicate in the clay forming an eutectic with the zirconium oxide or zirconium silicate, thus lowering the refractory qualities of the brick.

If an organic binder, such as lignin, is used, the same is destroyed during the burning of the brick so that the strength of the burned product is thereby weakened. Furthermore, under present methods where organic binders are used, the bricks thus formed are too fragile to be piled for burning, as the lower bricks in the pile cannot carry the load of the bricks placed thereon so that such bricks must be burned singly further adding to the cost of production.

It is an object of the present invention to overcome these difficulties by providing a practical method for making refractory bricks and the like from zirconium oxide or zirconium silicate in such manner that the bricks will be sufficiently strong to be piled for burning and will not lose any refractory qualities or strength during the burning operation.

Another object is to provide such a method which consists in casting bricks from zirconium oxide or zirconium silicate mixed with a small quantity of a deflocculent and just sufficient water to allow the mixture to flow into a mold, and passing an alternating current through the mixture in the mold, rapidly hardening the same so that it may be handled and dried and burned in the same manner in which dry pressed refractories are set for burning.

A further object is to provide such a method in which the mold is only about half filled with the mixture and the current passed therethrough in the manner above referred to, forming a hollow brick with a large central cavity completely enclosed on all six sides, providing a lightweight brick of considerable strength.

A still further object is to provide a method of lining discharge pipes of jet propulsion engines, and the like, with a layer of desired thickness of zirconium oxide or zirconium silicate.

The above objects together with others which will be apparent from the drawing and description, or which may be later referred to, may be attained by carrying out the improved method in the manner hereinafter described in detail, reference being made to the accompanying drawing, in which:

Figure 1 is a plan sectional view through a mold used for the casting of refractory bricks and the like by the present method, taken as on the line 1—1, Fig. 2;

Fig. 2 a vertical longitudinal sectional view through the mold, taken as on the line 2—2, Fig. 1;

Fig. 3 an end elevation of the mold shown in Figs. 1 and 2;

Fig. 4 a transverse sectional view through the mold, showing the manner in which a hollow brick may be cast therein;

Fig. 5 a longitudinal, sectional view showing the manner in which the discharge pipe of a jet propulsion engine may be coated with zirconium oxide or zirconium silicate in accordance with the invention; and

Fig. 6 is a transverse sectional view, taken as on the line 6—6, Fig. 5.

In carrying out the invention zirconium oxide or zirconium silicate in finely powdered form, preferably finer than 300 mesh, and a small amount of a deflocculent such as sodium silicate, fused sodium phosphate or tri-sodium phosphate, preferably about 1% of 1%, is mixed with just sufficient water, about 10%, to permit the mixture to flow.

This mixture may then be poured into a mold, such as shown in Figs. 1 to 4, comprising the perforate bottom wall 10, side walls 11, end walls 12, which may be hingedly connected to the bottom wall as indicated at 13, and top wall 14 which may be connected at both ends to the upper ends of the end walls as by hinge pins 15.

As indicated in the drawing, all of the walls of the mold may be formed of wood and they are all perforated throughout their entire areas as indicated at 16 with a great multiplicity of small apertures.

The inner surface of the side walls of the mold are covered with metallic screens, indicated at 17, preferably 40 mesh brass screens which in turn are covered by cloth gaskets 18. Similar cloth gaskets 19 and 20 cover the inner surfaces...
of the bottom and top walls of the mold and the inner surfaces of the end walls are similarly covered by cloth gaskets 21.

A wire 22 is soldered, or otherwise electrically connected, to each of the screens 17 and extends outwardly through apertures in the side walls 11 of the mold and these wires are connected to opposite sides of an A.C. circuit.

After the mold is filled and closed, as shown in Figs. 1 and 2, an alternating current is passed back and forth through the mixture within the mold, rapidly hardening the same and driving out surplus moisture therefrom by the creation of an internal pressure within the mixture, the perforated walls of the mold permitting the excess moisture to pass through the same, the cloth gaskets preventing any of the solids from passing out of the mold.

In actual practice the mold was filled with a mixture such as above described and a 220 volt 60 cycle current, drawing 36 amperes, was passed therethrough, and in one minute the cast brick was sufficiently hardened and strong to permit it to be removed from the mold and freely handled, and when dried was placed in a kiln in the manner in which dry pressed refractories are set for burning.

If desired, the zirconium silicate or zirconium oxide of less than 300 mesh may be mixed with grain zircon of larger size, or with zircon gog formed by calcining zircon brick and crushing or grinding to about 3/4" or even larger size, and the method otherwise carried out as above described.

Up to 50% of either 30 mesh grain zircon or calcined zircon brick gog 3/4" or larger, or both together, may be mixed with the 300 mesh powdered zirconium silicate or zirconium oxide in carrying out the invention. Also, if desired, wood flour or other combustible material may be added to the mixture resulting in light-weight brick when burned.

In order to form a hollow brick by the improved method, the mixture of zirconium oxide or zirconium silicate, deflocculent and a reagent, as above described, is poured into the mold, only about half filling the mold, after which the alternating current is passed therethrough in the manner above described, the internal pressure thus created forcing the material outward against all of the walls of the mold forming a hollow brick, as indicated at 24 in Fig. 4, having a large internal cavity 25 entirely enclosed on all six sides.

Hollow bricks have been formed in this manner weighing only about four pounds, as compared with solid bricks weighing 8.7 pounds formed in the manner shown in Figs. 1 and 2 by entirely filling the mold with the mixture.

The U.S. Air Force is at present interested in lining the discharge pipes of jet propulsion engines with zircon or zirconium, but no practical method has been heretofore available for the same.

In Figs. 5 and 6 is shown the manner in which a discharge pipe 26 may be coated with zirconium oxide or zirconium silicate. In carrying out the invention the pipe 26 serves as one electrode and the other electrode is in the form of a collapsible perforated gasketed metal tube 27 placed within the inside of the pipe and separated therefrom by a thickness of the coating desired, by means of perforated rings 28 of non-conducting material, connected to the headers 29 of non-conducting material which are clamped to opposite ends of the pipe as by the tie bolts 30.

An electric wire 31, connected to one side of an A.C. circuit, is soldered or otherwise electrically connected to one end of the discharge pipe 26, the other wire 32 of said circuit being soldered, or otherwise electrically connected, to one end of the perforate metal tube 27.

The mixture, as described above, is poured into the pipe, around the perforated metal tube, which is held together with a cloth gasket 33, the headers bolted together upon the pipe and the alternating current is passed therethrough, quickly hardening and strengthening the zircon lining so that the perforate tube may be removed therefrom and the coating dried and burned. The burning may be at a temperature of about 2500°F depending upon the metal used for the discharge pipe.

The method thus described not only provides a practical manner of forming refractory articles from zirconium oxide or zirconium silicate, in which the articles are sized in the kiln and burned in the same manner as dry pressed refractories are set for burning, and in which none of the refractory qualities of the brick are lost, but it also provides a more economical method.

The cheapest lignin binder obtainable at present costs about $30.00 for a thousand brick, while with the present method, the electric current used for a thousand brick costs only about 87 cents.

Furthermore, it is pointed out that under present methods the zirconium oxide or zirconium silicate does not bind itself until a temperature of about 2500°F. is reached, while the lignin binder burns out at a much lower temperature probably 300°F. to 400°F. This makes the present method practical for such purposes as lining a discharge pipe where the metal from which the pipe is made cannot be subjected to a temperature of 2500°F.

I claim:

1. The method of casting refractory articles which consists in mixing a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, with a small amount of an inorganic deflocculent and water, pouring the mixture into an inorganic deflocculent and water, pouring the mixture into a perforate mold and passing an alternating current therethrough for about one minute and then hardening the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.

2. The method of casting refractory articles which consists in mixing a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, with a small amount of an inorganic deflocculent and water, pouring the mixture into a perforate mold and passing an alternating current therethrough for about one minute and then hardening the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.

3. The method of casting refractory articles which consists in mixing a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, at least one-half of which is below 300 mesh, with a small amount of an inorganic deflocculent and water, pouring the mixture into a perforate mold and passing an alternating current therethrough for about one minute and then hardening the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.
5. Alternating current therethrough for about one minute to harden the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.

4. The method of casting refractory articles which consists in mixing a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, at least one-half of which is below 300 mesh, the remainder being about 80 mesh, with a small amount of an inorganic deflocculent and water, pouring the mixture into a perforate mold and passing an alternating current therethrough for about one minute to harden the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.

5. The method of casting refractory articles which consists in mixing a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, at least one-half of which is below 300 mesh, the remainder being zircon grog about one-quarter inch size, with a small amount of an inorganic deflocculent and water, pouring the mixture into a perforate mold and passing an alternating current therethrough for about one minute to harden the mixture sufficiently so that it may be immediately removed from the mold, and then firing the molded article in a kiln.

6. The method of coating the interior of a metal pipe which consists in placing a perforate metal cloth gasketed tube within and spaced from the pipe, filling the space between the pipe and the tube with a mixture of a solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, a small amount of an inorganic deflocculent taken from a group comprising sodium silicate, fused sodium phosphate and tri-sodium phosphate and water, and passing an alternating current therethrough said mixture between the pipe and the tube for about one minute to sufficiently harden the mixture so that the tube may be immediately removed and the molded article may be fired in a kiln.

7. The method of casting refractory articles which consists in mixing solid, non-plastic material taken from a group comprising zirconium oxide and zirconium silicate, with a small amount of an inorganic deflocculent and water, pouring a sufficient amount of the mixture in a perforate mold to substantially half fill the mold, and passing an alternating current therethrough for about one minute, so as to produce internal pressure forcing the mixture outward against the walls of the mold to form a hollow brick that is sufficiently hardened that it may be immediately removed from the mold, and then firing the hollow brick in a kiln.

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