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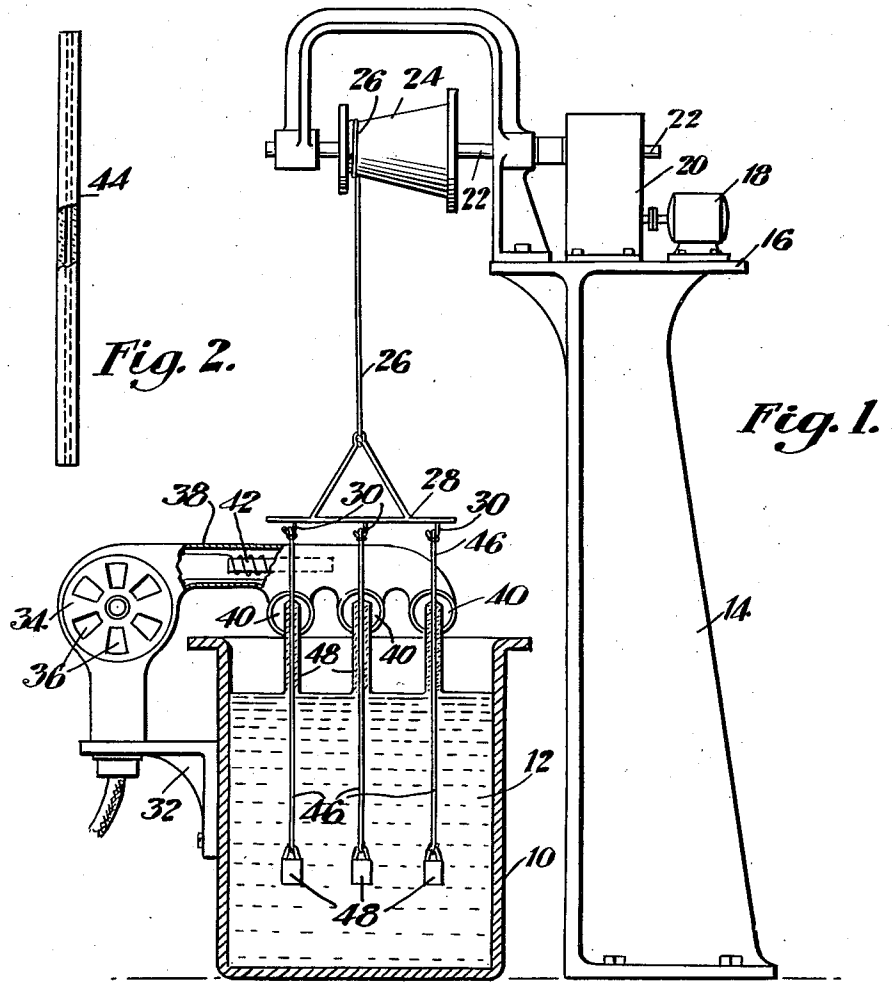


Fig. 2.

Fig. 1.

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MANUFACTURE OF CERAMIC TUBING

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7 Claims. (Cl. 25—156)

The present invention relates to the manufacture of tubing, and more particularly to an improved process for manufacturing thin walled refractory tubing of high heat conductivity and low electrical conductivity.

There is considerable demand for thin walled tubing which can be utilized as insulating conduit to enclose the lead-in wires in electrical heating units such as sad-irons, hot plates and the like. The porcelain tubing and beading which is marketed today is not particularly adapted for this purpose because of its fragile nature, its unsuitability for use at very high temperatures and the fact that the silica and alumina of which it is composed is apparently reduced by some of the alloy metal filaments such as the iron-chromium-aluminum wires which are now being used in electrical heating equipment.

A primary object of the present invention is to provide an improved method for manufacturing thin walled refractory tubing adapted for use as electrical insulating conduit and the like.

Another more particular object of the present invention is to provide a method of manufacturing tubing out of refractory material having insufficient self-bonding properties to make it available in the ordinary extrusion methods of tubing manufacture.

With the above and other objects and features in view, the invention consists in the improved method of manufacturing refractory tubing which is hereinafter described and more particularly defined by the accompanying claims.

The invention will be more particularly described by reference to the accompanying drawing, in which Fig. 1 illustrates in side elevation (with parts in vertical section) apparatus adapted for use in practicing the process; and

Fig. 2 is a view in side elevation, with part cut away, showing a completed tube of the type which is produced by the process.

Referring to Fig. 1 of the drawing, the apparatus therein displayed includes a pot or container 10 suitably dimensioned to hold a bath of refractory mixture 12 of suitable consistency for use in producing the refractory tubes by the process forming the subject of the invention. A supporting frame 14 located at one side of the pot 10 has an elevated platform 16 on which there is mounted an electric motor 18. The drive shaft of the motor is connected by a speed reduction unit 20 to a pulley shaft 22 on which there is mounted a cone pulley 24 in a centrally disposed position directly over bath 12. Attached to the outer periphery of the smaller end of pulley 24 is one end of a cable or cord 26, while the other end of the cord 26 is attached to a frame 28 having a plurality of spaced supporting elements illustrated as hooks 30. On the side of the pot 10 opposite from that on which the frame 14 is located, there is shown a bracket 32 on which is mounted an electric motor-driven air blower 34 having an air inlet 36 and an air discharge manifold 38 which conducts air from the blower to a plurality of air discharge ports 40 mounted around the upper rim of pot 10. Within the manifold 38 an electric resistance heating element 42 is provided for the purpose of heating air which is handled by the blower as the air flows from the blower to the discharge ports 40.

According to the preferred method of practicing the process of the present invention, the pot 10 is filled with a bath 12 of fluid refractory material of a type out of which it is desired to construct the refractory tubing 44 (see Fig. 2). Assuming that the tubing 44 is to be used for insulating alloy metal resistance heating filaments of the type of chromium-iron-aluminum filaments (previously referred to as having a reducing action on silica and alumina refractories at the temperatures at which such filaments are normally operated) the preferred material for use in constructing the tubes 44 according to the process of the present invention comprises a zircon-silicon refractory of the type described in our copending application Serial No. 87,662, filed June 27, 1936. The composition of this preferred refractory consists of about 50 to 60 parts of 75% ferrosilicon (through 80 mesh and on 300 mesh screen); 40 to 50 parts of milled grain zircon through 300 mesh screen; one part of aluminum hydrate through 100 mesh; and 6 parts by weight of orthophosphoric acid. The aforementioned ingredients are mixed together and the mixture is moistened to the proper consistency, that is to about the consistency of thick cream, by addition of water. The mixture is then poured into the pot 10 (or it may be prepared within the pot) and the pot filled with a bath 12 of sufficient depth to produce refractory tubing of the length desired.

The first step in producing the tubing is to select a suitable support as cords 46 of twisted cotton or wool or silk fiber—selecting the cord with a diameter and shape corresponding to the desired inner diameter and shape of the core of the tubing which is to be produced. One end of each cord 46 is attached to one of the hooks 30 on the frame 28, and a weight 48 is attached to

the other end of each cord 46, after which the frame 28 is lowered to a position over the pot at which the cords 46 are immersed to the proper depth in the fluid refractory bath 12. In place of cords 46 of cotton or other carbohydrate material, rods of wood may be suitably employed. It is necessary that the cords or rods 46 shall have a surface to which the refractory adheres.

After immersing the cords 46 in the bath 12, the motor 18 is operated to rotate the cone 24 in a clockwise direction (as illustrated) thereby elevating the rack 28 and the attached cords 46 at a speed which gradually accelerates from an initial speed of preferably about one foot per second. At the same time the fan 34 and heater 42 are placed in operation to blow heated air over the cords 46 as the cords are being gradually elevated out of the bath 12. By heating the air discharged from the ports 40 to a temperature around 150 to 180° F., the refractory coating 48 which adheres to each cord 46 as it emerges from the bath is rapidly dried and solidified. Moreover the pitch or periphery of pulley 24 when properly chosen accelerates the rate of withdrawal of the cords 46 from the bath so that the coating 48 which forms on each cord is hardened to a cylindrical layer of substantially uniform thickness surrounding each of the cords 46. The thickness of the coating on each cord is controlled by controlling the fluidity of the bath 12 and by subjecting the cord to one or more resubmergences in the bath, followed by an air-drying treatment after each submergence.

After coatings of the desired thickness are built up on each cord, the cords are detached from the hooks 30 and are baked in a furnace at a temperature of 500 to 700° F. so as to char the cellulose or carbohydrate material forming the cord. The baking temperature is then further raised to about 1500° F.–1800° F. at which temperature the material of the cord is completely burned out and the walls of the resultant tubing are permanently set. The charring and baking operations are necessarily conducted in an oxidizing atmosphere.

It will be understood that the terms "cord" and "core" are used in the attached claims to cover both flexible and rigid shapes of wood, cotton, wool or silk textile material to which fluid refractory coatings will adhere and which can be later separated from the hardened coating by burning out at temperatures not adversely affecting the refractory to produce tubing having a central bore corresponding in shape and dimension with the core shape used for the purpose. The burning out of the cord or core is defined in the claims as pyrolysis.

The invention having been thus described, what is claimed as new is:

1. In the manufacture of heat conductant electrically non-conductant tubing, the steps comprising immersing a suitably dimensioned textile cord in a bath comprising a fluid suspension of refractory material, removing the textile cord and adhering refractory coating from the bath at a controlled rate, hardening the coating by maintaining the textile cord in a heated stream of gas as it emerges from the bath, building up the coating to a suitable wall thickness, and baking the textile cord and coating in an oxidizing atmosphere to burn out the textile cord and set the refractory forming the walls of the tubing.

2. The process as defined in claim 1 in which the refractory bath comprises a mixture of substantially equal proportions of milled grain zircon and silicon moistened to a creamy consistency with water and phosphoric acid.

3. The process as defined in claim 1 in which the textile cord is removed from the refractory bath at a rate which is gradually accelerated from an initial rate of about one foot per second.

4. The process as defined in claim 1 in which the textile cord is burned out and the refractory walls of the tubing are set by baking at a temperature in the neighborhood of 1500° F.–1800° F.

5. In the manufacture of heat conductant electrically non-conductant tubing, the steps comprising immersing a suitably dimensioned cellulose cord in a fluid refractory bath comprising 40 to 50 parts of milled grain zircon, 50 to 60 parts of ground ferrosilicon, one part aluminum hydrate and 6 parts phosphoric acid diluted with water to a creamy consistency, removing the cellulose cord and adhering refractory coating from the bath at a controlled gradually accelerated rate, congealing the coating by blowing heated air over the wet cellulose cord as it emerges from the bath, building up the coating to the desired thickness, and baking the cellulose cord and coating in an oxidizing atmosphere to burn out the cellulose cord and set the refractory in the walls of the resultant tubing.

6. In the manufacture of heat conductant electrically non-conductant tubing, the steps comprising immersing a suitably dimensioned cord which is subject to pyrolysis in a bath comprising a fluid suspension of refractory material, removing the aforesaid cord and adhering refractory coating from the bath at a controlled rate, rapidly hardening the coating as it emerges from the bath, building up the coating to a suitable wall thickness, and baking the aforesaid cord and coating at a substantially high temperature to cause pyrolysis of the cord and the setting of the refractory forming the wall of the tubing.

7. In the manufacture of heat conductant electrically non-conductant refractory insulation, the steps comprising immersing a suitably dimensioned support for the refractory insulation to adhere to in a bath comprising a fluid suspension of refractory material, removing the aforesaid support and adhering refractory coating from the bath at a controlled rate, rapidly drying and solidifying the coating as it emerges from the bath, building up the coating to a suitable wall thickness, and baking the aforesaid support and coating at a substantially high temperature to cause the setting of the refractory forming the refractory insulation.

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