Sept. 11, 1928. E. F. NORTHRUP 1,683,986

INDUCTION PRESSURE OR VACUUM FURNACE

Filed Aug. 1, 1925

Fig. 1.

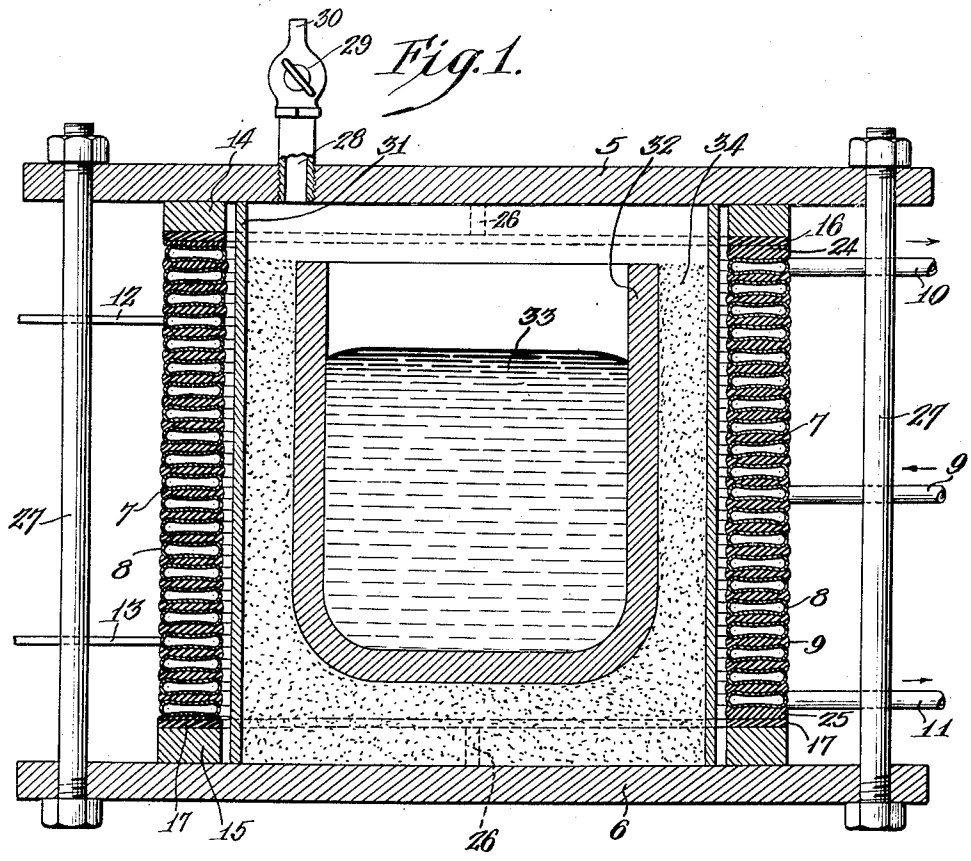


Fig. 2.

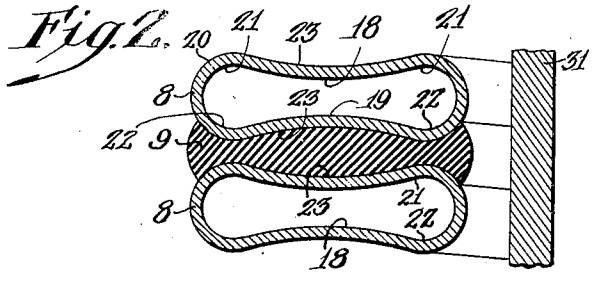
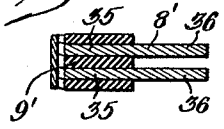


Fig. 2a.



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UNITED STATES PATENT OFFICE.

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INDUCTION PRESSURE OR VACUUM FURNACE.

Application filed August 1, 1925. Serial No. 47,594.

My invention relates to furnaces for melting or heat treating materials under pressure or vacuum conditions.

The purpose of my invention is to use the furnace coil as the basis for the wall of the furnace.

A further purpose is to space and insulate between adjoining turns of a progressively wound preferably helical furnace coil by a material which at the same time closes the spaces against air passage so as to make the coil available as the wall of a pressure or vacuum furnace, sealing top and bottom to the wall to complete the furnace.

A further purpose is to to use the hollows in the sides of an edgewise wound flattened hollow conductor as seats for sealing material.

A further purpose is to provide and preferably cool a greater length of coil than that used as the inductor.

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

I have preferred to illustrate by invention by one form only with a modification, selecting a form which is practical, efficient and inexpensive and which at the same time well illustrates the principles of my invention.

Figure 1 is a vertical central section of a furnace embodying my invention.

Figure 2 is a fragmentary enlarged section of a portion of the structure seen in Figure 1.

Figure 2[a] is a section corresponding to Figure 2 of a modification.

In the drawings similar numerals indicate like parts.

In using the helical furnace coil as a part of the wall for an electric furnace I greatly conserve space and cheapen the construction as my spacing and insulating material is at the same time the sealing material by which vacuum conditions are maintained reducing the quantity of sealing material required, stiffening and supporting that which is used by the helical conductor and saving the space which would otherwise be required for the sealing medium by spacing it between the turns of the helix.

My furnace comprises top and bottom walls 5 and 6 spaced and sealed between by side walls 7. The greater part of the side walls is taken up by a progressively wound and most desirably helical coil 8 and the spacing insulating and sealing medium 9 between the turns of the coil. Though the coil may obviously be of solid metal, either of such dimension as to require no cooling or projecting beyond the sealing medium for air-cooling as shown in Figure 2[a]. I prefer a water-cooled conductor of the character shown, both because of the highly advantageous cooling effected and because of the assistance which the shape of the coil offers in retaining the sealing medium. With the water-cooled coil shown the water passes through turns of the coil in multiple and for this purpose is shown as entering through pipe 9 and passing out through pipes 10 and 11.

Since the side walls are to be made up largely of the coil, I find it desirable, though not necessary, to use a coil, whether hollow or solid, having greater axial length than that required for the melt. Accordingly in the illustration the electrical connections are shown as made at points 12, 13 intermediate the total length of the coil. Alternating current is applied preferably at a frequency of three hundred or four hundred or more.

At the top and bottom of the coil I apply rings 14 and 15 and sealing and insulating washers 16 and 17.

Where a hollow conductor has been made by flattening a tube as has been found very desirable, the tube can be given the shape shown in the drawing in which the middle portions 18, 19 of the tube 20 lie closer together than the portions 21, 22 of the tubing giving opposite concave exterior faces 23, which very desirably assist in retaining the spacing, insulating and sealing material 9 against pressure whether from the outside where the interior chamber is to be a vacuum chamber or from the inside when pressure is to be applied to the interior. Because of the generation of heat within the melt and the cooling by which no appreciable increase of temperature takes place within the coil itself, good heat insulation sufficiently protects the coil from the melt for it to be possible to insulate by rubber which is itself a good sealing medium. Any good cement will also serve the purpose which is dense enough to prevent passage of air through the cement. Whatever the insulating medium it is carried through between the turns and is extended sufficiently over the top and bottom at 24, 25 to form a flat top surface for cooperation with

the insulating material 16, 17 or with the rings if the insulation between the turns of the coil be extended sufficiently to take the place of the insulators 16, 17. In order to avoid current induction the rings which are preferably metallic but non-magnetic are interrupted at 25. For the same reason the top and bottom are non-magnetic and are either made of non-metallic material or are interrupted to break objectionable continuity of the circuit such as would cause waste of induced current and heating of these plates. The interruption must be filled with a cement or other filler material to maintain the vacuum or pressure conditions. The tube and bottom plates are clamped together as by bolts 27 to hold the plates, rings, insulators and coil together for use and the top plate is removed when access to the furnace is required.

In order to provide for pressure or vacuum within the furnace compartment formed by the structure described a tube 28 is fitted into the upper plate, which tube carries a valve 29 and attachment terminal 30.

The character of crucible or other holder for the material to be melted or heat-treated in the vacuum or under pressure is not controlling as the construction described is capable of operating upon any material placed within it which is electrically conducting whether the charge be placed within an interior container, surrounded merely by sand or be otherwise supported. However, it is quite desirable to supply a heat insulating shell 31 between the charge and the coil.

In order that the illustration may be complete and to show a desirable form of furnace, I show a crucible 32 containing the melt 33 and surrounded by a filler 34, such for example, as pure MgO or zirconium sand which supports and heat insulates the crucible.

In Figure 2ª the coil 8′ may be of the character of that shown in my application for patent intended to be filed concurrently with this, entitled Air cooled inductor coil, or may comprise flat strips 35 of solid metal spaced by a filler 9′ and extended radially solidly (as distinguished from the spaced projections of that application) beyond the filler as at 36 to provide additional conductor material, for this reason heating less and cooling better. The conductor need be no greater in radial depth than is required for sealing against air passage and proper cooling, since the spacing and insulating functions would be abundantly performed by a much shorter radial depth of material than is required to insure against air leakage.

Various changes and modifications of my invention will obviously occur to those skilled in the art in view of my disclosure and it is my purpose therefore to claim herein all such as come 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. A furnace having top and bottom walls and an inductor side wall all vacuum-sealing against air passage, the inductor side wall comprising the sealing part of the side of the enclosure.

2. A furnace having top and bottom walls and a water cooled inductor side wall all sealing against air passage.

3. A furnace having top and bottom walls and an inductor side wall of flat section conductor edgewise wound and all positively sealing against air passage.

4. A vacuum or air pressure furnace having sealing side walls supported by the inductor coil of the furnace.

5. An electric furnace inductor adapted to maintain against interior or exterior pressure comprising a wall wound progressively of hollow conductor presenting axially facing concave outer surfaces and a filling material fitting between and sealing against the facing concave surfaces.

6. A helical furnace inductor coil having spacing and insulating filling protecting against air leakage between the turns of the coil, in combination with a top and a bottom therefor connected with the coil to form a space within capable of supporting pressure or vacuum conditions.

7. An electric induction furnace adapted to maintain pressure or vacuum conditions within the furnace having top and bottom walls and a helical inductor coil between the walls and sealing material between the turns of the coil and between the coil and the top and bottom respectively making the coil a part of the pressure resisting wall of the furnace.

8. An inductor coil having sealing material between the turns of the coil and at the ends of the coil, in combination with a top and bottom for the coil clamping the coil to maintain air tight conditions for the furnace.

9. A pressure or vacuum furnace comprising an air-tight inductor side wall, top and bottom walls, sealing means between and clamping means for holding the latter to the side walls.

10. A furnace having a water-cooled inductor side wall, the end portions of the coil being free from electric current and current taps for the coil connected with the coil at a distance from the ends of the coil.

11. A furnace having a water-cooled inductor side wall of flattened edgewise wound conductor, the end portions of the coil being free from electric current and current taps for the coil connected with the coil at a distance from the ends of the coil.

12. A furnace having a water-cooled inductor side wall of flattened edgewise wound

hollow conductor, the end portions of the coil being free from electric current, current taps for the coil connected with the coil at a distance from the ends of the coil and water connections for passing water through a greater length than electric current in the coil.

13. In an electric induction furnace, a hollow inductor coil having multiple water connections therewith and a portion of the water-cooled coil free from electric current, in combination with current taps for applying the current to the intermediate portion of the coil.

14. In an electric induction furnace, a hollow, flattened, edgewise wound inductor coil having multiple water connections therewith and a portion of the water-cooled coil free from electric current, in combination with current taps for applying the current to the intermediate portion of the coil.

15. In an induction electric furnace, top and bottom walls, a helical coil between them and packing making the coil and the joint between the coil and the top and bottom walls air tight, in combination with current taps for the coil joining it at a distance from the coil ends.

16. In an induction electric furnace, top and bottom walls, a helical coil between them and packing making the coil and the joint between the coil and the top and bottom walls air tight, in combination with current taps for the coil joining it at a distance from the coil ends, and water cooling for the coil including that portion of the coil at the ends beyond the taps.

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