Feb. 19, 1957 J. PRESTON 2,782,245

ELECTRIC FURNACE FOR MELTING OF HIGH MELTING POINT METALS OR ALLOYS

Filed March 25, 1955 2 Sheets-Sheet 1

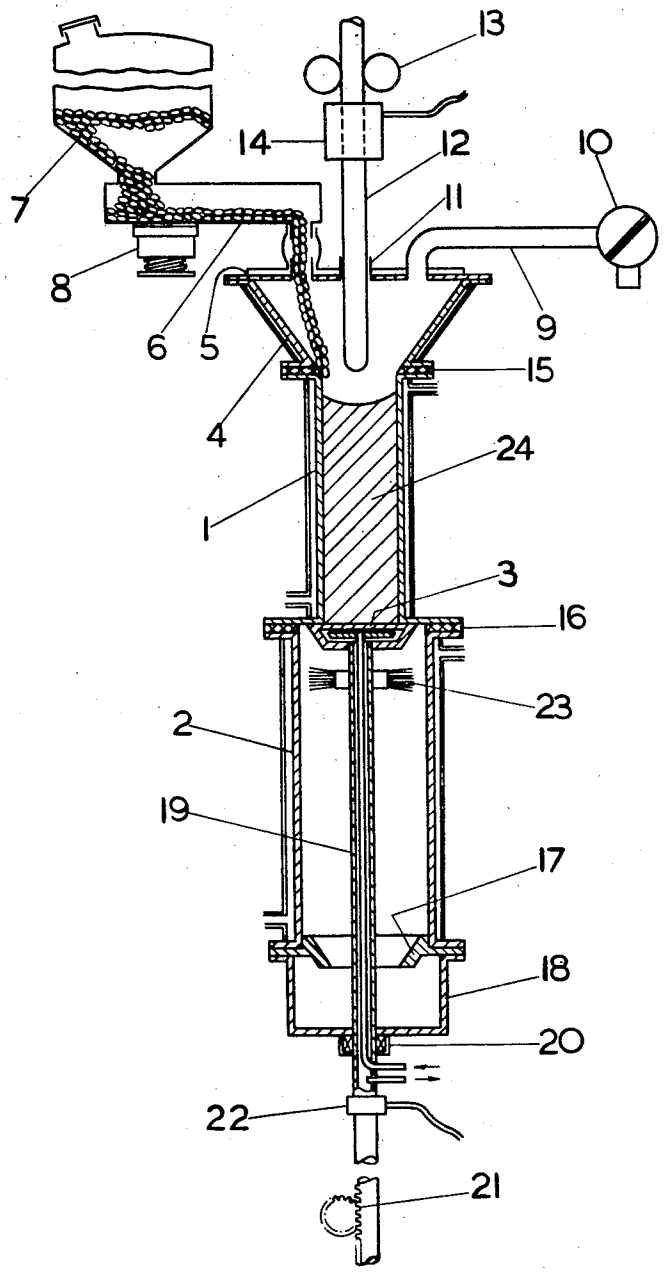


FIG. 1.

INVENTOR
JACK PRESTON

BY Cushman, Darby & Cushman
ATTORNEYS

Feb. 19, 1957 J. PRESTON 2,782,245

ELECTRIC FURNACE FOR MELTING OF HIGH MELTING POINT METALS OR ALLOYS

Filed March 25, 1955 2 Sheets-Sheet 2

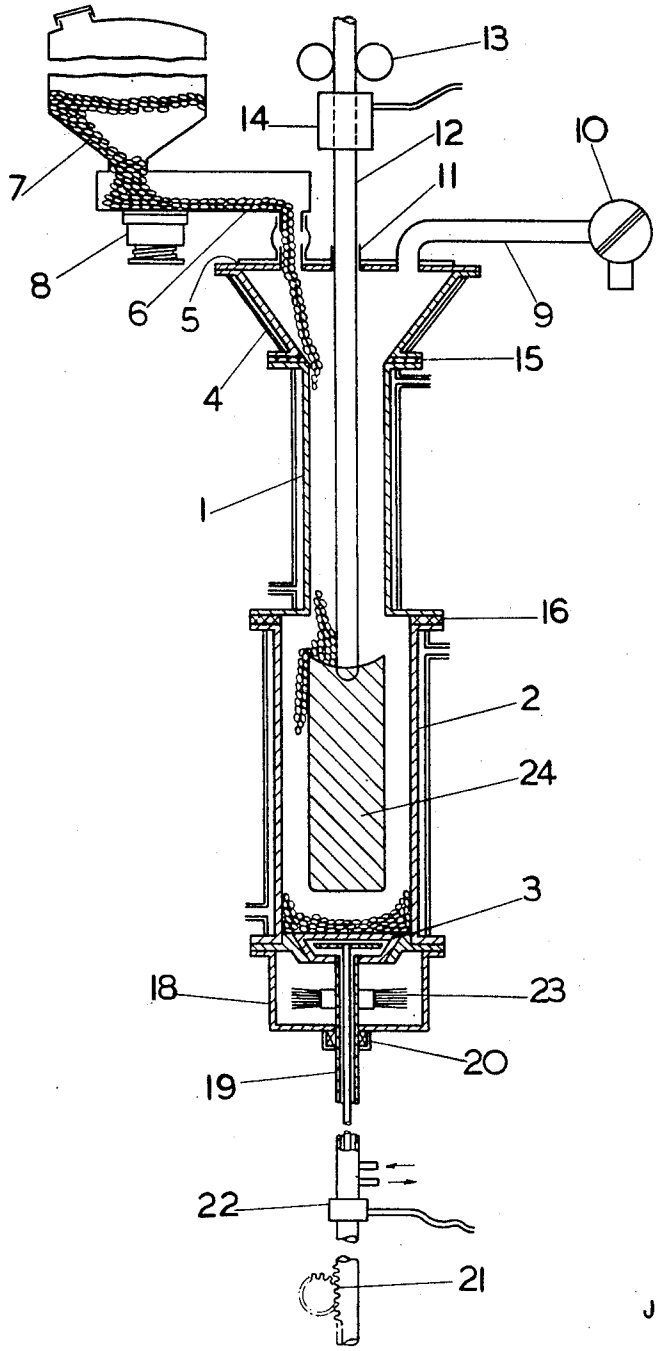


FIG. 2

INVENTOR
JACK PRESTON

BY Cushman, Darby & Cushman
ATTORNEYS

United States Patent Office 2,782,245 Patented Feb. 19, 1957

2,782,245

ELECTRIC FURNACE FOR MELTING OF HIGH MELTING POINT METALS OR ALLOYS

Jack Preston, Hall Green, Birmingham, England, assignor to Imperial Chemical Industries Limited, London, England, a corporation of Great Britain

Application March 25, 1955, Serial No. 496,716

Claims priority, application Great Britain April 2, 1954

5 Claims. (Cl. 13—9)

This invention relates to an improved apparatus for use in the arc-melting of high melting point reactive metals and alloys, such for example as titanium, zirconium, molybdenum, thorium, hafnium, tantalum, chromium and their alloys, and more particularly to apparatus for carrying out a process according to our copending application No. 475,277.

In the specification accompanying the said application we have described a method of arc-melting metals and alloys of the kind described by forming a coherent but incompletely melted mass of metal or alloy by feeding the raw material to the melting chamber of an arc-melting furnace at a higher rate than that consistent with complete melting of the raw material over the whole cross section of the melting chamber, and then employing the so-obtained mass as a consumable electrode to be progressively melted in a second arc-melting furnace having a melting chamber of greater cross section than that of the said electrode, with or without an additional feed of raw material into the melting chamber.

According to the present invention, we provide an apparatus for carrying out the said process which comprises one or more cooled arc-melting crucibles superimposed above a cooled arc-melting crucible of larger cross sectional area and in communication therewith, a longitudinally adjustable cooled base member adapted to serve as a base closure for either the upper or the lower crucibles, means for supplying raw material to the crucible assembly, means for evacuating the said assembly and if desired supplying an inert atmosphere thereto, and a longitudinally adjustable consumable electrode assembly for the upper crucible or crucibles which is adapted to function as electrode stem in the operation of the lower crucible.

The invention is illustrated but not limited by the accompanying drawings in which:

Figure 1 represents a longitudinal section through a combination furnace at the first stage of the process, i. e. the formation of the coherent consumable electrode; the metal to be melted being for the sake of example titanium.

Figure 2 is a similar section but at the second stage of the process, i. e. the commencement of the final melting stage.

Referring to the drawings, the apparatus consists essentially of a water-cooled crucible 1 in conjunction with a second water-cooled crucible 2 of larger cross section, both crucibles being served by a common water-cooled base plate 3.

The top of the furnace is formed by the water-cooled cone 4 carrying in its lid 5 the hopper connection 6, through which raw material in suitable form is fed from the hopper 7 to the furnace at a predetermined rate by means of a vibrator mechanism 8, a vacuum and inert gas connection 9, through which the furnace is evacuated by means of a vacuum pump 10, and then, if desired, filled with an inert atmosphere such as, for example, argon, and a gas seal 11 through which passes the titanium electrode 12. The latter may consist of solid titanium, for example, forged bar, or may consist of a number of units consolidated from the divided metal and welded or otherwise joined together into a suitable length. Controlled vertical movement of the electrode 12 is effected by means of the feed rolls 13, and the electrode is connected to one terminal of the electrical supply by means of suitable contact gear 14. The cone 4 and the crucibles 1 and 2 are electrically insulated from one another by insulating rings 15 and 16.

The crucible 2 is provided with a separable flanged base member 17 having a central aperture with an inclined face conforming to the base 3 and adapted to act as a seating therefor, and the crucible is closed by means of the box 18. The base 3 is of hollow construction and is supported by the hollow stem 19 passing down through the box 18 and gas-tight seal 20. The base has an internal baffle and coolant is supplied to and from it via the stem 19. Longitudinal movement of the base 3 is effected by any suitable mechanical means such as a rack and pinion 21. The stem is connected to the other terminal of the electrical supply by a contact 22. The stem also carries a circular flexible brush 23 for the purpose hereinafter explained.

In operation, the hopper, cone and crucibles are first evacuated and then refilled with an inert gas such as argon or helium. The base 3 is then moved to the position shown in Figure 1, an initial charge of the divided metal fed into crucible 1 from the hopper and an arc struck between the charge and the electrode 12. After the initial charge is melted, the divided metal in the hopper is fed into the crucible at as fast a rate as possible, consistent with the production of a coherent mass in the crucible. The maximum feed rate is advantageous in that it limits the amount of electrode which is consumed in the operation. When the mass 24 has been built up to a suitable height in the crucible, feeding from the hopper is stopped and a molten pool allowed to form at the top of the mass by maintaining the arc for a further short period, for example, one to three minutes. The electrical supply is then shut off and the electrode 12 immediately moved down into the pool by means of the feed rolls 13. The mass 24 in the crucible is thus joined to and becomes integral with the electrode by the intimate fusing together of the two.

The base 3 is then lowered to the position shown in Figure 2 by means of the retracting mechanism 21. At this stage, a small amount of unmelted divided metal in the base of crucible 1 may fall on to the inner conical surface of the copper seating member 17 and prevent an accurate seating of the base 3 thereon. To obviate this, the brush 23 is secured to the stem 19 so that on lowering the base, the brush passes through the seating aperture into the box 18 and clears any particles from the seating surface.

When the base 3 is in position, the coherent mass 24 now attached to electrode 12 is moved down to the position shown in Figure 2, this movement being facilitated if required by tapering the crucible 1. An initial charge of divided metal is fed into the base of crucible 2 from the hopper and an arc struck between this charge and the mass 24, which is melted into the crucible 2 with or without an additional feed of divided metal from the hopper. When the mass 24 is completely melted, the electrical supply is cut off, the ingot allowed to solidify and removed by lowering the box 18, seating member 17 and base 3. It is essential that crucible 2 should be somewhat larger than crucible 1 in order that the mass may be fully clear of crucible 1 before it approaches the base of the second crucible, thus a fed of divided metal may fall through the first crucible into the second. The latter must also be greater in diameter to ensure that the feed

of divided metal may fall freely between the mass 24 and the walls of crucible 2.

Whilst the invention has been described with reference to one particular apparatus, it will be appreciated that various modifications may be made in the apparatus and are included within the scope of the invention. Thus for example the initial electrode may be totally enclosed together with its feed rolls and contact gear in a gas-tight tubular extension from the furnace lid, or alternatively the electrode may be attached by suitable means to a water-cooled copper stem passing through the seal in the furnace lid. The insulating ring between the upper and lower crucibles may be omitted, but it is preferably included to insure against electrical arcing and short-circuiting between the mass 24 and the upper crucible during the melting of the mass in the lower crucible.

In a further modification, a plurality of separate upper crucibles, for example three, may be used in conjunction with a single lower crucible of sufficiently large diameter. In this way, three electrode masses may be built up and then consumed simultaneously in the formation of a large ingot in the lower crucible.

The apparatus in accordance with the present invention facilitates the formation of a large electrode from divided metal in accordance with the process of our aforementioned co-pending application with the minimum consumption of preconsolidated electrode. Moreover, by the employment of a cooled base which serves for both crucibles it enables the melting of this large electrode to be carried out in the same apparatus and with the minimum time interval between formation and melting.

I claim:

1. Arc-melting furnace which comprises a cooled arc-melting crucible superimposed above a cooled arc-melting crucible of larger cross sectional area, a cooled base member longitudinally adjustable between an upper position where it serves as a base closure for the upper crucible and a lower position where it serves as a base closure for the lower crucible, means for supplying raw material to the crucible assembly, means for evacuating the said assembly and a longitudinally adjustable consumable electrode assembly for the upper crucible adapted also to function as a stem for an electrode formed in the upper crucible for use in the operation of the lower crucible.

2. An arc-melting furnace according to claim 1 wherein said means for evacuating the said assembly is also adapted to supply an inert atmosphere thereto.

3. Furnace in accordance with claim 1, in which the longitudinally adjustable consumable electrode for the upper crucible comprises solid metal.

4. Furnace in accordance with claim 1, in which the longitudinally adjustable consumable electrode for the upper crucible comprises a number of units consolidated from divided metal and joined together into a suitable length.

5. Furnace in accordance with claim 1, in which the electrode for use in the operation of the lower crucible is formed by allowing a molten pool to form at the top of the coherent mass in the upper crucible, moving the end portion of the longitudinally adjustable consumable electrode down into the pool, and allowing the molten metal to cool.

References Cited in the file of this patent

UNITED STATES PATENTS

2,541,764	Herres	Feb. 13, 1951
2,640,860	Herres	June 2, 1953
2,651,668	Southern	Sept. 8, 1953
2,686,822	Evans et al.	Aug. 17, 1954