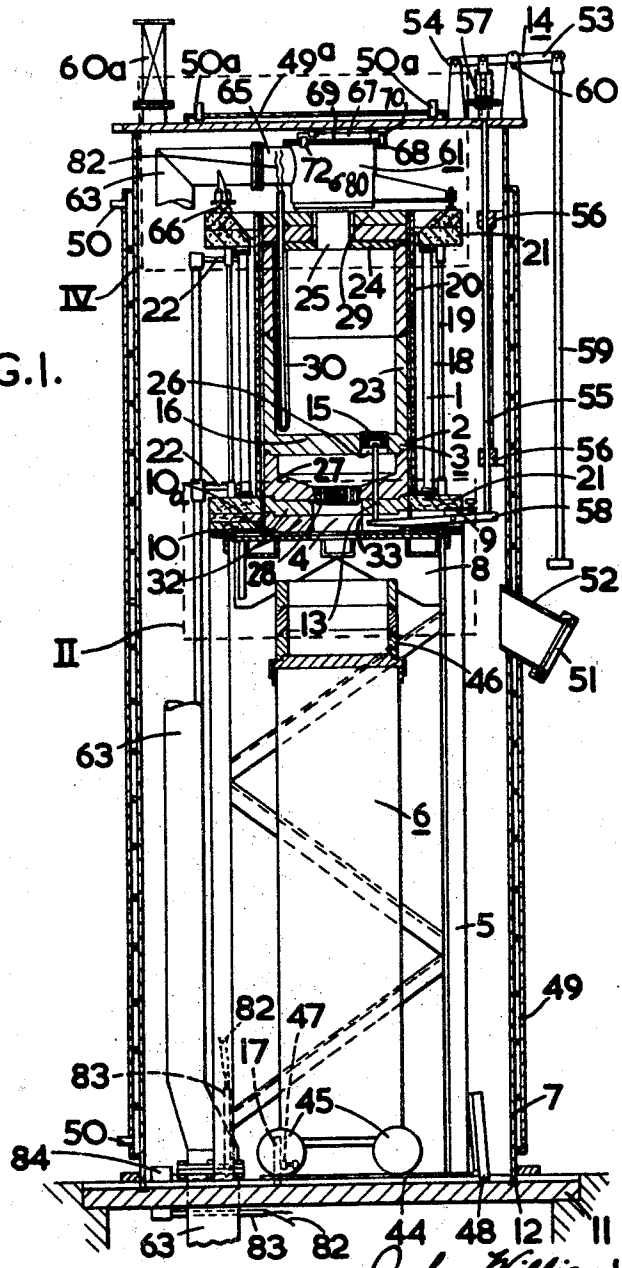
June 15, 1965 J. W. SMURTHWAITE 3,188,702

APPARATUS FOR VACUUM MELTING AND CASTING METALS

Filed Sept. 7, 1960 4 Sheets-Sheet 1

FIG. 1.



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APPARATUS FOR VACUUM MELTING AND CASTING METALS

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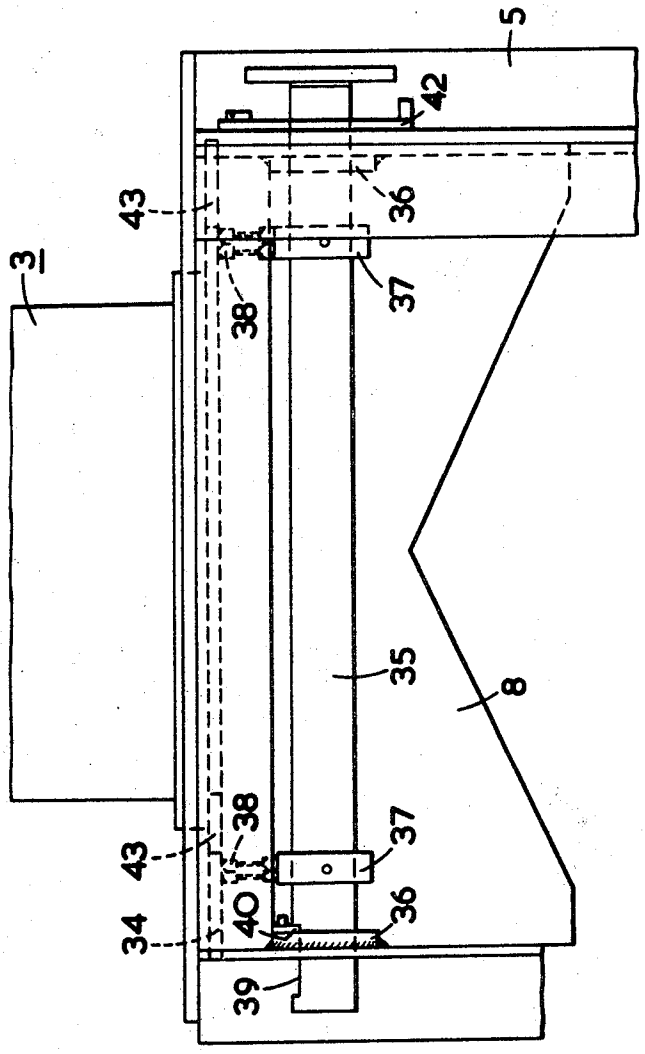


FIG. 2.

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APPARATUS FOR VACUUM MELTING AND CASTING METALS

Filed Sept. 7, 1960 4 Sheets-Sheet 3

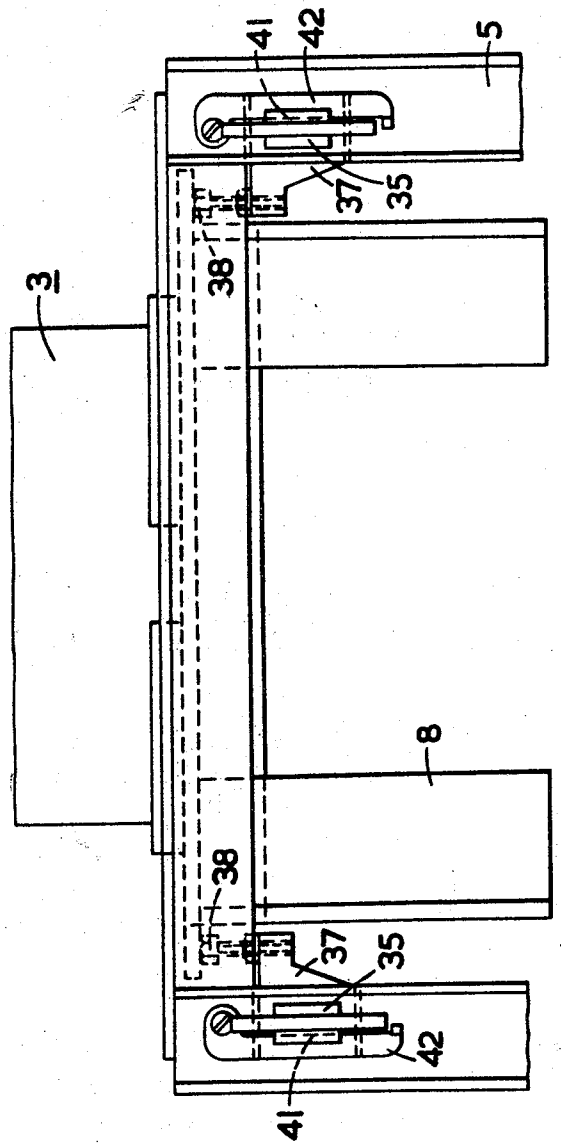


FIG. 3.

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June 15, 1965 J. W. SMURTHWAITE 3,188,702

APPARATUS FOR VACUUM MELTING AND CASTING METALS

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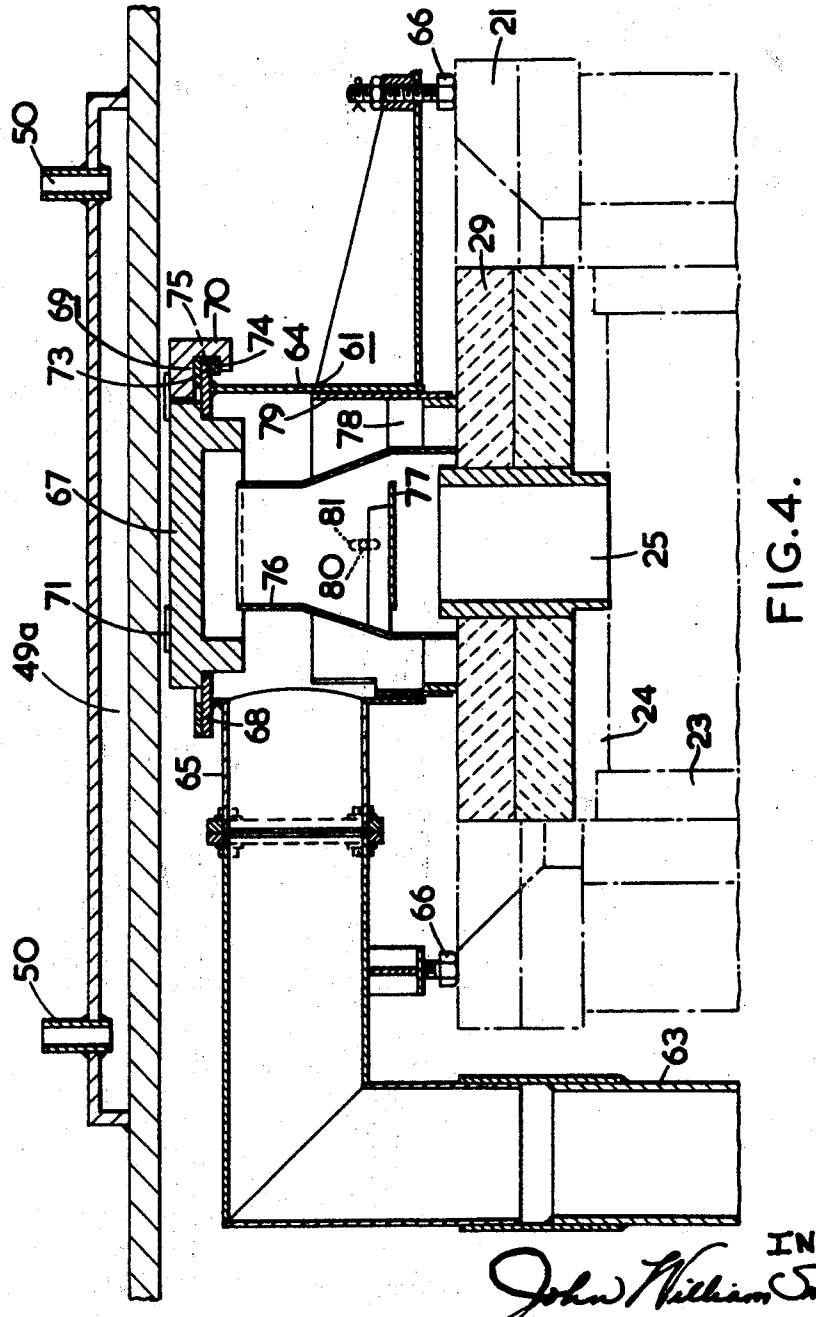


FIG. 4.

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United States Patent Office 3,188,702 Patented June 15, 1965

3,188,702

APPARATUS FOR VACUUM MELTING AND CASTING METALS

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3 Claims. (Cl. 22—73)

This invention relates to apparatus for vacuum melting and casting metals.

Apparatus for vacuum melting and casting metals is known wherein a crucible is assembled and charged with an ingot of metal such as uranium at an upper level and discharges molten metal to a mould at a lower level. After completion of the casting operation the crucible is dismantled at the upper level for subsequent cleaning, reassembling and recharging but some difficulty is experienced in the dismantling operation due to the hazard of radiation and toxic uraniferous dust.

Apparatus according to the invention for vacuum melting and casting metals comprises heating means defining a heating cavity, a melting and bottom pouring crucible assembly in said heating cavity, a supporting structure for said heating means and crucible assembly, a casting mould to accept metal poured from the crucible, and a removable vacuum sealing envelope for the combination of heating means, crucible assembly, supporting structure and casting mould, characterised in that the crucible assembly is supported on a carrier so as to be insertable into and withdrawable from the base of the heating cavity on removal of said sealing envelope.

An embodiment of the invention will now be described by way of example with reference to the accompanying drawings wherein:

FIGURE 1 is a sectional view of apparatus for vacuum melting and casting metallic uranium,

FIGURE 2 is a fragmentary elevation of part (designated II in FIGURE 1) of the assembly of FIGURE 1 in the same plane as FIGURE 1,

FIGURE 3 is a view similar to FIGURE 2 but in a plane at right angles to that of FIGURE 2, and

FIGURE 4 is an enlarged fragmentary section of a further part (designated IV in FIGURE 4) of the assembly of FIGURE 1 in the same plane as FIGURE 1.

Referring to the drawings, in the construction shown therein, apparatus for vacuum melting and casting metallic uranium comprises high frequency induction coils **1** defining a heating cavity **2**, a melting crucible assembly **3** disposed within the cavity **2** and having a bottom pouring outlet **4**, a supporting structure **5** for the high frequency induction coils **1** and crucible assembly **3**, a holder **6** for casting moulds which accept poured metal, and a removable vacuum sealing envelope **7** for the combination of heating coils **1**, crucible assembly **3**, supporting structure **5** and holder **6**. An evacuation duct **63** connects a top extract hood **61** to a vacuum source. The crucible assembly **3** is supported on a stillage **8** so as to be insertable into and withdrawable from the base **9** of the heating cavity on removal of the sealing envelope **7**.

In greater detail, the structure **5** is fabricated from rolled steel angle and is capped with a supporting plate **10** upon which the heating coils **1** are carried. An orifice **10***a* in the supporting plate **10** provides access for the crucible assembly to the heating cavity **2** from beneath. A base plate **11** of the structure carries a sealing ring **12** for engagement by the removable vacuum sealing envelope **7**, and a graphite push rod **13**, actuated by means of a lever mechanism **14** mounted on the sealing envelope **7**, is provided to initiate pouring, as will be more particularly referred to hereinafter. The high frequency induction

coils **1** are housed within an annulus **18** defined by an outer sleeve **19**, which serves as a screen against outwardly radiating magnetic flux, and an inner lining **20** of refractory material, for example, monolithic rammed fireclay. The annulus **18** is closed at each end with asbestos insulating board **21** and the induction coils **1** have combined electrical power and water cooling connections **22**. The crucible assembly **3** comprises a graphite crucible **23** and a tundish **27**, the crucible **23** being in two parts and having a graphite cover **24** with a vent **25**. In the base **16** of the crucible **23** and outlet duct **26**, normally sealed by a graphite sealing plug **15**, feeds into the tundish **27** which has a perforated outlet nozzle **28**. The crucible assembly is capped with firebrick **29** through which extends a sheathed thermocouple **30** housed in the crucible **23**, and is supported and thermally insulated by firebrick **32** interposed between the tundish **27** and the stillage **8**. An orifice **33** penetrates the firebrick **32** and the stillage **8**, the latter being supported in the position shown in FIGURE 1 by two sliding bolts **35** carried in brackets **36** attached to the supporting structure **5** and shown in FIGURES 2 and 3.

The sliding bolts **35** are of rectangular cross section and carry supporting brackets **37** with adjustable feet **38** upon which the stillage **8** rests. A notch **39** engaged by a stop **40** determines the extent of sliding travel of each bolt whilst a notch **41** in combination with a pivoted lever **42** constitutes a locking device. Notches **43** in the edges of a bed plate **34** of the stillage **8** provide clearance for the feet **38** during crucible loading operations described in detail hereafter. The casting mould holder **6** is mounted on two guide rails **44** by wheels **45** and has a graphite header **46**. The stops **17** are attached to the base plate **11** and arranged to effect register of the header **46** of the holder **6** with the pouring outlet **4**. Two adjustable stops **47** locate a fork lift loading truck (not shown) employed during loading operations and each rail **44** has a hinge **48** enabling it to be folded to clear the sealing ring **12**. The sealing envelope **7** has cooling water ducts **49** and **49***a* with water connections **50** and **50***a* respectively and includes a sighting window **51** carried by a branch pipe **52**. The lever mechanism **14** comprises a lever **53** pivoted at an end **54** and pivotally connected to striker rod **55** which is slideably carried in lugs **56** mounted on the inner wall of the sealing envelope **7**, passage of the rod **55** through the top of the sealing envelope **7** being sealed by a bellows **57**. The rod **55** is connected to the push rod **13** through a pivoted lever **58** and is actuated by an operating rod **59** depending from the lever **53**. A removable pin **60** is provided to prevent inadvertent operation. The push rod **13** on being moved upwardly serves to displace the plug **15** and initiate pouring.

The top extract hood **61** registers with the vent **25** and is connected to the vacuum source by the evacuation duct **63** (shown broken for clarity in FIGURE 1) which passes through the base plate **11**, a pressure relief valve **60***a* being attached to the top of the envelope **7**. Referring now to FIGURE 4, the hood **61** includes an outer container **64** having a branch **65** connected to duct **63** and is supported on the asbestos insulating board **21** by three adjustable feet **66**. A graphite condensing plate **67** is located by an upper flange **68** of the hood in close proximity to the water jacket **49***a* and is secured to the flange **68** by a clamping ring **69** which comprises three clamps **70**, **71** (FIGURE 4) and **72** (FIGURE 1) attached to a ring **73** at equally spaced intervals about its circumference, the ring **69** being clamped to the upper flange **68** by engagement of clamps **70**, **71** and **72** with clamping wedges (only one of which is shown in FIGURE 4, namely, that in engagement with clamp **70** and designated **74**) attached to the underside of the flange **68**. Three slots **75** (one only of which appears in FIGURE 4) are pro-

vided in flange **68** to permit passage of clamps **70**, **71** and **72** on assembly whereupon the clamping ring is rotated to engage with the wedge **74**. A funnel **76** registers with the vent **25** and includes a thermal baffle **77**. The funnel **76** is attached by three ribs **78** to a sleeve **79** slideably engaged by the outer container **64** and two diametrically opposed screwed retaining pins **80** in the outer container **64** engage with slots **81** in the sleeve **79**. Referring again to FIGURE 1, leads **82** to the thermocouple **30** are accommodated in sheathing **83** and penetrate the base plate of the structure through a vacuum tight terminal box **84**.

Assembly of the vacuum furnace commences with the assembly of the crucible **23**, tundish **27** and bricks **29**, **32** on the stillage **8** and charging of the crucible **23** with metallic uranium. The stillage and crucible assembly are transported by a fork lift loading truck to a position inside the base of the structure **5** preparatory to lifting for installation in the heating cavity. Approximate orientation of the stillage and crucible assembly is provided by the guide rails **44** in combination with guide members on the truck and with the stop **47** in combination with the stillage **8**. The stillage and crucible assembly are then lifted by the fork lift loading truck to a point just below that at which the top of the crucible assembly enters the orifice **10***a* of the plate **10**, whereupon accurate orientation is achieved by manual adjustment of the fork lift loading truck. Lifting is then continued until the crucible is in the installed position when the bolts **35** are engaged and locked. The push rod **13** is inserted and the pivoted lever **58** mounted on the structure **5**, the vacuum pipe **63** and hood **61** are installed and the holder **6** located beneath the crucible assembly pouring outlet **4**. The sealing envelope **7** is lowered over the structure **5** and assembly **3** to enclose them, and the envelope **7** is then evacuated via the duct **63**. When the uranium metal in the crucible has been melted by the heating coils **1**, as indicated by the temperature reading of thermocouple **30**, the push rod **13** is actuated by the lever mechanism **14** to displace the graphite plug **15** (which floats to the top of the melt) thereby discharging the molten uranium via the tundish **27** to the moulds. After the casting operation has been completed the apparatus is dismantled in the reverse order and the crucible assembly transferred to a protected area where it can be dismantled, cleaned and reassembled with adequate protection against radiation and toxic uraniferous dust emitted by residue adhering to the interior of the crucible and tundish.

In operation of the furnace a vapour, which is beta ray emitting, emanates from the crucible **23**. The vapour is drawn off via the hood **61** and in passage therethrough it comes into contact with the cool surface of the condensing plate **67** to form a sublimate which can subsequently be removed by scraping. The condensing plate is maintained in a cool condition by its close proximity to the water jacket **49***a* of the envelope **7** and by the protection offered by the thermal baffle plate **77** interposed between the molten mass within the crucible and the condensing plate **67**. The feet **66** are adjustable to compensate for irregularities in the upper level of the asbestos insulating board **21** whilst the sleeve **79** in resting on the firebrick **29** provides closure for the joint between the hood and the firebrick.

I claim:

1. Apparatus for vacuum melting and casting of metals, said apparatus comprising means defining a cavity having an access port in the base thereof, heating means surrounding said cavity, a melting crucible assembly insertable into and withdrawable from said cavity through said access port and having a pouring opening in the base thereof, closure means for said pouring opening, a support structure for said means defining a cavity and for said heating means, carrier means for supporting said crucible assembly, releasable securing means for securing said carrier means to said support structure so that said crucible assembly is in operative position in said cavity, said carrier means being movable when released from said support structure for insertion of said crucible assembly into and withdrawal thereof from said cavity, a mould assembly disposable beneath said crucible assembly and movable transversely into and out of operable position beneath said crucible assembly, a removable vacuum sealing envelope for enclosing all of said means for defining a cavity, said heating means, said crucible assembly, said support structure, said carrier means, and said mould assembly, and means for operating said pouring opening closure means from outside said sealing envelope and extending sealingly through an aperture in said sealing envelope.

2. Apparatus according to claim **1** and including a hood which terminates the evacuation duct means and is disposed over the crucible assembly and serves for the collection of gases emitted therefrom, a condensation plate in said hood, and baffle means protecting said plate against direct heat radiation from the crucible assembly.

3. Apparatus for vacuum melting and casting metals, comprising means defining a cavity having an access port in the base thereof and heating means surrounding said cavity; a melting crucible assembly in said cavity; said crucible assembly having a pouring opening in the base thereof; closure means for said pouring opening; said access port in the base of said cavity being of a size and configuration sufficient to enable said crucible assembly to pass therethrough; a support structure for supporting said cavity means and said heating means and for defining a moulding station underneath said cavity; carrier means for supporting said crucible assembly and closure means within the cavity and for supporting the crucible assembly during insertion of the crucible assembly into the cavity and withdrawal therefrom through said access port; said carrier means being demountably supported beneath the cavity by the support structure with the crucible assembly disposed within the cavity; a transversely movable casting mould for receiving molten metal poured from said pouring opening in the base of said crucible assembly; a removable vacuum sealing envelope for collectively enclosing said cavity means, said heating means, said crucible assembly, said support structure, said carrier means, and said transversely movable casting mould; means extending from outside to inside said vacuum sealing envelope and to below said crucible assembly for operating said pouring opening closure means to initiate pouring of molten metal from said pouring opening of said crucible assembly to said mould; and means for creating a vacuum in said envelope.

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