Jan. 31, 1950 C. P. MANN 2,496,170

METHOD OF PRODUCING INVESTMENT MOLDS

Filed Aug. 11, 1944 2 Sheets-Sheet 1

Fig. 1.

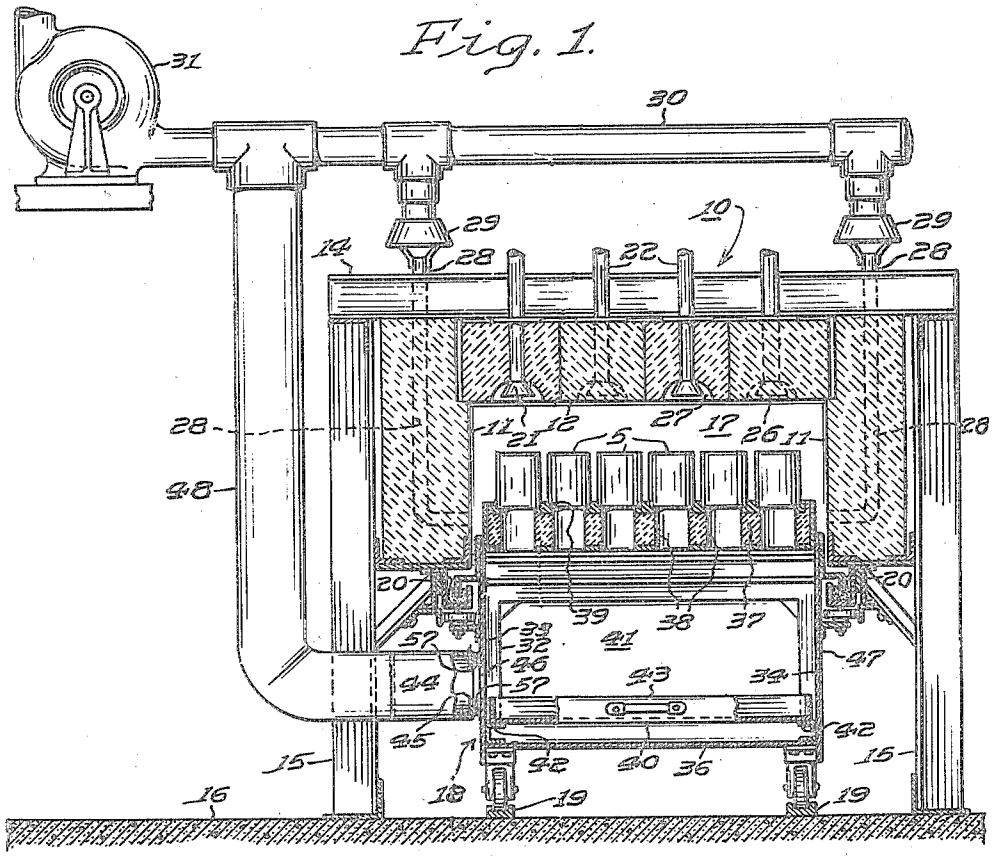
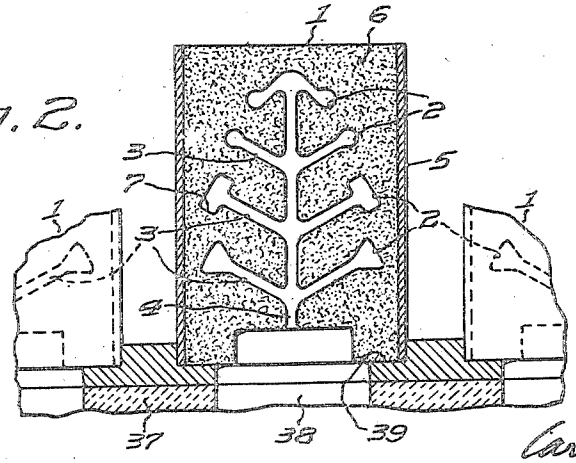


Fig. 2.



INVENTOR
Carl P. Mann
BY E. A. Brander
his ATTORNEY

WITNESS
F. J. Hartman.

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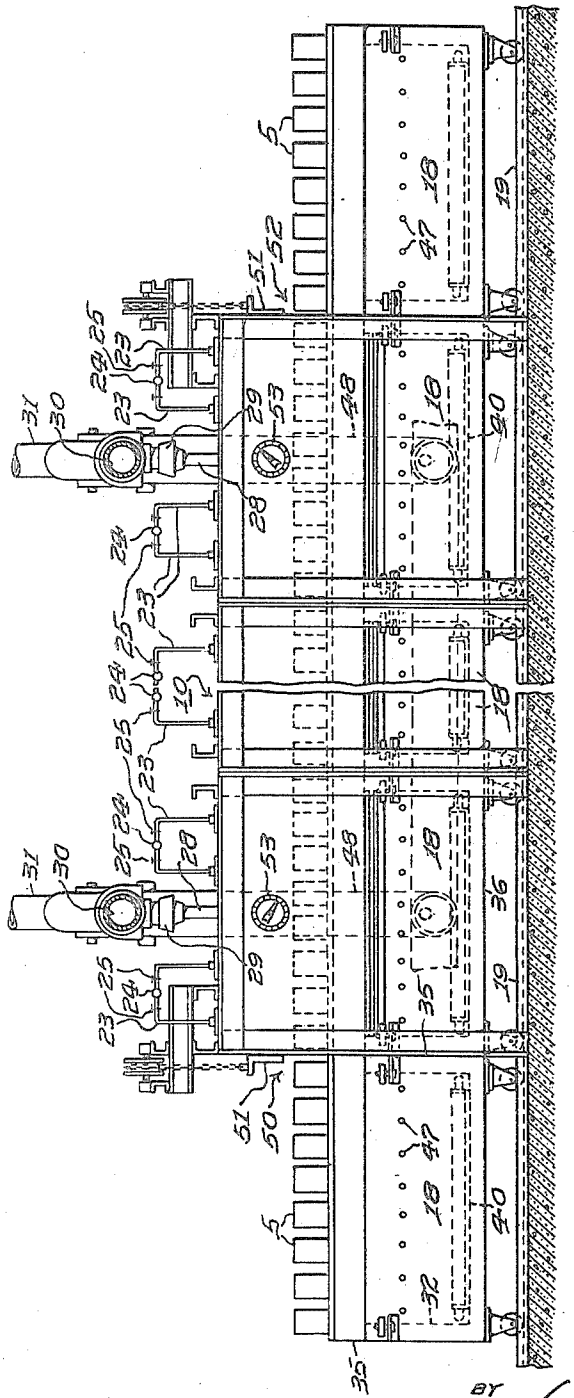


Fig. 3.

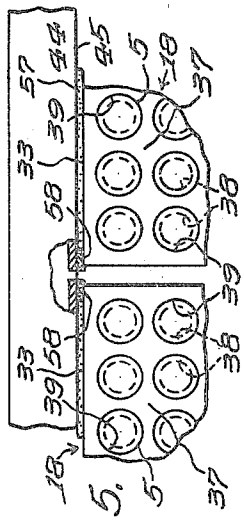


Fig. 5.

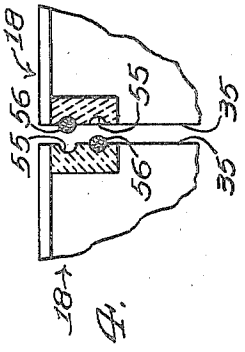


Fig. 4.

INVENTOR
Carl P. Mann
BY E. A. Fenander
his ATTORNEY

WITNESS
F. J. Hartman.

Patented Jan. 31, 1950 2,496,170

UNITED STATES PATENT OFFICE

2,496,170

METHOD OF PRODUCING INVESTMENT MOLDS

Carl P. Mann, Riverton, N. J., assignor to Selas Corporation of America, Philadelphia, Pa., a corporation of Pennsylvania

Application August 11, 1944, Serial No. 548,993

2 Claims. (Cl. 22—196)

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This invention relates to a method of producing investment molds, and it is an object of the invention to provide an improvement for removing from investment material the pattern or model embedded therein which is formed of wax, resin, plastic and like material, as will appear from the following description and accompanying drawings forming a part of this specification, and of which:

Fig. 1 is a vertical sectional view of apparatus embodying the invention;

Fig. 2 is an enlarged vertical sectional view of an investment mold shown in Fig. 1 to illustrate the invention more clearly;

Fig. 3 is a side elevation of the apparatus illustrated in Fig. 1;

Fig. 4 is an enlarged fragmentary vertical sectional view of adjacent cars illustrated in Figs. 1 and 3; and

Fig. 5 is a fragmentary plan view of adjacent cars and a duct alongside of which the cars move.

In casting by the investment method, patterns of the parts to be made may be formed of a suitable material in a metal die or mold. While the material forming the pattern will be specifically referred to as "wax" in the following description and claims, it is to be understood that this term is intended to cover not only waxes but also resins, plastics and like material which are suitable for producing investment molds. The preparation of the wax and injection thereof under pressure into the metal die are controlled to produce accurate patterns that will not be deformed with subsequent handling.

The pattern of the part thus formed is sometimes referred to as a model, and a model may constitute a single pattern of a part to be cast or a plurality of patterns of a number of such parts which are connected by runners and to which are attached one or more sprues. The form and shape that a model may assume is diagrammatically illustrated at 1 in Fig. 2 and may include a number of patterns 2 connected by runners 3 and a sprue 4 which extends to the extreme end of a flask 5 which may be in the form of a metal ring. The runners and sprues of wax are formed separately from the patterns and attached thereto by heating irons in a well known manner.

The model 1 is then embedded in a material referred to as an investment 6 which is inert with respect to the wax of the pattern or model. Ethyl silicate is one example of a chemical binder which is used to provide a suitable liquid mold material which upon standing is converted to solid silicate

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to form the investment. The model 1 is completely enveloped by the investment 6, as illustrated in Fig. 2, and, before the refractory material of the investment has set, the flask 5 may be mechanically agitated or connected to a suitable suction line to remove air from the investment and eliminate voids about the patterns. Before embedding the model 1 in the investment 6, a suitable material may be applied thereto and allowed to dry to cause refractory material, such as an extremely fine sand, for example, to be deposited on the surfaces of the patterns.

The wax is then removed from the investments 6 and the latter cured or baked to prepare the flasks 5 for casting. The metal is poured while the flask is at an elevated temperature to assure fluidity of the metal which preferably is cast under pressure at a temperature considerably above the melting point of the metal, so that proper filling out of the mold is accomplished and sound castings are obtained. The investment 6 is then removed from the flask 5 after which the investment is separated from the casting. The parts cast are then separated from the runners and sprues in any suitable manner and subjected to whatever machining or finishing operations are required.

In accordance with this invention, an improvement is provided for rapidly removing wax from investment molds and for curing or baking the investment material in a single operation and with a minimum amount of handling. This is accomplished by placing the flasks in a high temperature oven space in such a manner that the melted wax, together with the gases evolved from heating of the wax, are discharged to the exterior of and cannot pass into the oven space. In this way, the likelihood of producing in the high temperature oven space an explosive atmosphere of gases resulting from heating of the wax, is avoided. Further, by discharging the melted wax and wax vapors from investment molds to the exterior of the oven space, the liberation of hydrocarbons in the oven space is prevented, and burning or cracking of such hydrocarbons cannot take place in the oven space and form a deposit of free carbon therein.

In order to make certain that the wax vapors cannot pass into the oven space in the event of any leakage in the walls forming such space, the melted wax and wax vapors are discharged into a chamber adjacent the oven space which is maintained at a pressure lower than that in the oven space, so that the pressure in the oven space will be positive with respect to the pressure in

the chamber and flow of gas always will take place out of the oven space in the event of leakage about the space. The chamber into which the melted wax flows preferably is provided with a removable tray for holding the melted wax, so that it may be reclaimed and used again.

Referring to the drawings, apparatus which is shown embodying the invention includes an oven or furnace 10 of a direct gas fired type having vertical walls 11 and a roof 12 formed of suitable refractory material. The vertical walls 11 and roof 12 are disposed within a framework or outer shell 14 having a number of legs 15 for supporting the oven 10 on a suitable supporting surface 16.

The flasks 5 to be heated in space 17 within the oven 10 are mounted on cars 18, as will be described presently, which are moved through the oven space 17 on a track 19. A suitable seal, such as, for example, a sand seal, is provided between the lower edges of side walls 11 and opposite sides of the cars 18, as indicated at 20 in Fig. 1.

A number of burners 21 are mounted in and form a part of the roof 12. The burners 21 are disposed alongside of each other in a plurality of rows, the number and disposition of the burners being such that the desired heating is effected of the flasks 5 passing through the oven space 17.

Each burner comprises a molded block of ceramic material having a central passage within which is disposed a burner tube or sleeve 22. As shown in Fig. 3, the outer ends of sleeves 22 are connected by pipes 23 to manifolds 24 to which a gas mixture is delivered from a suitable source of supply. Suitable valves (not shown) may be provided to control the pressure and rate at which the gas mixture is supplied to the manifolds 24, and the supply of the gas mixture for each burner 21 may be individually controlled by valves 25 connected in the pipes 23.

The gas mixture, which may be a mixture of a suitable fuel gas and a combustion supporting gas, such as air, for example, is supplied to each of the burners 21 and subdivided into a plurality of gas streams by a distributor or tip 26 which is fixed to the inner end of the sleeve 22 and terminates at a cup-shaped space 27. The burners 21 are of such a type that combustion of the gas mixture is substantially completed in the cup-shaped spaces 27, whereby flame impingement of the flasks 5 is readily avoided.

The refractory wall surfaces of the cup-shaped spaces 27 are heated to incandescence and constitute high temperature zones or regions from which heat is radiated to the flasks 5. This radiated heat, together with convection heating derived from the heated products of combustion directed toward the flasks 5 and downwardly in oven space 17, provides a heating effect which is readily controlled to effect the desired heating of the flasks 5 during their travel through the oven 10.

The burners 21 are of the kind described and illustrated in Hess Patent No. 2,215,079, granted on June 23, 1942 and assigned to the same assignee as this application. The burners 21 are fully disclosed in the aforementioned Hess patent which may be considered as being incorporated in this application, and, if desired, reference may be had thereto for a detailed description of the burner structure.

A number of vertically extending conduits 28 are incorporated in the side walls 11 for withdrawing products of combustion from the oven space 17. The lower ends of the conduits 28 terminate at the inner surfaces of the side walls 11 adjacent the bottom of the oven space 17, and the upper ends thereof extend upwardly and terminate a short distance from the top of the oven 10. At the upper ends of conduits 28 are provided draft hoods 29 connected to conduits 30 in which are provided blowers or exhaust fans 31. The conduits 28 are provided in both of the side walls 11 and at spaced intervals along the oven 10, as shown in Figs. 1 and 3.

By providing the draft hoods 29 the full effect of the exhaust fans 31 will not be reflected back to the conduits 28 and cause too rapid withdrawal of the products of combustion from the oven space 17. The vertical conduits 28 are of minimum length, so that the draft effect produced by these conduits will be as small as possible and allow the products of combustion to be withdrawn therethrough after substantially all of the useful heat has been given up in the oven space 17. The draft hoods 29 permit atmospheric air to mix with the products of combustion to dilute and cool the exhausted gases, whereby provision need not be made for the conduits 30 and exhaust fans 31 to handle gases at an unduly high temperature.

A number of cars 18 are provided for movement through the oven 10 on the track 19. Each car 18 includes a box-like frame 32 enclosed by side walls 33 and 34, end walls 35 and a bottom 36 which may be formed of sheet metal. The tops 37 of the cars 18 are formed of refractory material having a number of openings 38 therein which are enlarged at their upper ends to provide cavities 39 adapted to receive the flasks 5, as shown in Figs. 1 and 2.

One end wall 35 of each car 18 is formed with a horizontal slot through which a tray 40 may be moved into and withdrawn from the chamber 41 within the car. The frame 32 of each car is provided with side sills 42 for supporting the tray 40 which is provided with a front plate or cover 43 adapted to fit snugly against the end wall 35 when the tray is in position in the chamber 41.

The cars 18 are maintained close together during their travel through the furnace or oven 10, so that the tops 37 of adjacent cars abut each other and collectively form the bottom or floor of the oven space 17. A horizontal duct 44 is disposed directly beneath one of the side walls 11 and extends lengthwise of the oven 10 alongside the cars 18, as best shown in Fig. 1. The duct 44 is formed with a slot in a vertical side wall 45 which is at the same elevation and in alignment with horizontal openings formed in the side walls 33 of the cars 18, as indicated at 46 in Fig. 1. The side wall 45 of the duct and side walls 33 of the cars 18 are relatively close to each other and the gap therebetween is closed by a suitable seal, as will be described presently.

In order to dilute the hot wax vapors with atmospheric air and also bring down the temperature of the hot vapors immediately upon being discharged into the chambers 41, the side walls 34 of the cars are provided with a number of openings 47 to permit air from the surroundings to pass into the interiors of the cars. A plurality of exhaust flues 48 are connected at their lower ends to duct 44 at spaced intervals corresponding to the spacing of the vertical conduits 28. The upper ends of flues 48 are connected to the conduits 30, whereby the blowers or exhaust fans 31 are also effective to withdraw the mixture of wax vapors and air from the chambers 41 of the cars 18. The mixture of wax vapors and air passes from the upper ends of the flues 48 into the con-

ducts 30 at regions closely adjacent to the inlets of the exhaust fans 31.

In the operation of the apparatus just described the flasks 5, having the wax models 1 enveloped therein by investment material 6, are placed in the cavities 39 formed in the refractory top 37 of a car 18. As shown in Fig. 2, the flask 5 is in what is referred to as an inverted position and the sprue 4 of the model 1 extends downwardly into and communicates with one of the openings 38 in the refractory top 37. The flasks 5 fit snugly and accurately in the cavities 39 to provide a gas tight seal between the flasks and the refractory top 37.

After the flasks 5 have been positioned in all of the cavities 39 of a car 18, the car is then moved to the charging end 50 of the furnace or oven 10, as shown in Fig. 3. The oven 10 may be provided with suitable gates 51 at opposite ends of the furnace which are vertically movable and arranged to be operated by any suitable mechanism. When the oven 10 is being operated a number of cars 18 are in end to end relation between the charging end 50 and discharge end 52, as shown in Fig. 3.

The cars 18 may be manually moved through the furnace 10 at a desired rate or moved intermittently by suitable hydraulically operated driving mechanism at the charging end 50 of the oven 10. Such mechanism may be arranged to move the car 18 at the charging end 50 which in turn pushes the cars 18 ahead of it toward the discharge end 52. The intermittent or step by step movement may be accomplished automatically in steps equivalent to the distance between one or a number of flasks 5, and the mechanism operating the gates 51 may be synchronized with the driving mechanism, whereby the gates will be raised from a position between adjacent rows of flasks 5 to permit the cars to travel for a predetermined short distance and thereafter will be lowered between rows of flasks 5 and rest on the surfaces of the refractory tops 37 to close off the ends of the oven 10 when movement of the cars 18 has stopped.

In order to seal the oven space 17 completely from the car chambers 41, the end walls 35 of the cars 18 at regions adjacent to the tops 37 are provided with refractory wall sections each having a pair of horizontal grooves 55, as shown in Fig. 4. Compressible asbestos rope 56 is secured in any suitable manner, as by screws, for example, in one of the two grooves 55 formed at each end of a car 18. The asbestos rope 56 at each end of a car 18 is at the same elevation as an open groove 55 of an adjacent car 18 so that, when the cars 18 are in abutting relation during movement through the furnace or oven 10, the asbestos ropes will snugly fit into the grooves 55 and form a gas-tight seal between adjacent cars. The seals formed between adjacent cars 18, together with the seals 29 formed between the lower ends of the walls 11 and the sides of cars 18, effectively seal the oven space 17 from the car chambers 41.

In order to seal the openings 46 formed between the horizontal slot in the duct 44 and the openings in the side walls 33 of the cars 18, compressible asbestos strips 57 are secured to the duct side wall 45 at the top and bottom edges of the slot, as shown in Fig. 1. In addition, compressible asbestos strips 58 may be secured to the side walls 33 of the cars 18 at the ends of the cars, as shown in Fig. 5. The strips 58 project or extend beyond the end walls 35 of the cars, and adjacent strips of abutting cars snugly fit against each other when the cars 18 are moved through the furnace or oven 10.

The vertical strips 58 are co-extensive with the openings in the side walls 33 of the cars and terminate at their upper and lower ends at regions closely adjacent to the horizontal strips 57 secured to the duct 45. The strips 57 bear against the side walls 33 of the cars 18 while the strips 58 bear against the side wall 45 of the duct 44. After being in use, the strips 57 and 58 adjust themselves to close the gap between the duct 44 and cars 18 and at the same time allow the cars to move alongside of the duct with no objectionable rubbing taking place between the duct and the cars. The seals formed by the strips 57 and 58 effectively close off and seal the openings 46 formed between the duct 44 and the side walls 33 of the cars 18 and also the regions of the duct slot between abutting cars.

The oven space 17 is maintained at an elevated temperature, such as 1200° to 1400° F., for example, by controlling the operation of the burners 21 with the control valves just described. Suitable recording thermometers 53 may be provided at one of the side walls 11 of the oven 10, as shown in Fig. 3, so that the temperature in different parts of the oven space 17 may readily be determined. If desired, the burners 21 may be controlled responsive to the temperature within the oven space 17, so that the oven space 17 will always be maintained at the desired elevated temperature.

The investment molds are rapidly heated to a desired high temperature by heat derived from the heated products of combustion passing to the flasks 5 from the cup-shaped spaces 27, and by heat radiated from the incandescent wall surfaces forming the cup-shaped spaces, whereby the wax models 1 are melted and the wax flows downwardly by gravity from the investment molds through the openings 38 in the refractory tops 37 into the trays 40 in car chambers 41.

The products of combustion are withdrawn from the bottom part of the oven space 17 through the vertical conduits 28, and such spent gases mix with air drawn into the draft hoods 29 by the exhaust fans 31. The mixture of air and the products of combustion may be discharged by the fans 31 to the exterior of the enclosure in which the oven 10 is installed.

In many instances the wax models 1 may be of such design that all of the wax can be removed from the investment molds simply by melting the wax to cause flow thereof by gravity into the car chambers 41. However, in many cases the wax models are of intricate design and formed with traps 7 from which melted wax cannot freely flow by gravity, as shown in Fig. 2. Any melted wax which is trapped in the investment molds is heated above the flash point temperature during movement of the flasks 5 through the oven space 17, and the wax vapors thus formed pass from the investments 6 through the openings 38 into the car chambers 41. The wax vapors passing into the car chambers 41 are diluted by relatively cool atmospheric air drawn into the car chambers through the openings 47 by the action of the exhaust fans 31. The wax vapors in the car chambers 41 are materially diluted by atmospheric air to produce a gas mixture containing air in an amount considerably above that which would produce an explosive mixture. Further, since the wax vapors are immediately cooled by mixing with relatively cool atmospheric air passing into the car chambers 41, the likelihood of

forming an explosive hydrocarbon gas mixture of the wax vapors is avoided. The mixture of wax vapors and air passes from the car chambers 41 through the openings 46 into the duct 44 and thence through the vertical flues 48 to regions of conduits 30 immediately adjacent the inlets of exhaust fans 31. The mixture of wax vapors and air mixes with the gas mixture entering conduits 30 from the draft hoods 29 which, as previously stated, is discharged from the exhaust fans to the exterior of the enclosure in which the oven 10 is installed.

While practically the full suction effect of the exhaust fans 31 is reflected back through the flues 48 and duct 44 to the car chambers 41, this is not true with respect to the oven space 17 by reason of the draft hoods 29 provided at the upper ends of vertical conduits 26. The pressure in oven space 17 may be maintained at atmospheric or slightly above that of atmosphere while the pressure in chambers 41 will be slightly below the pressure in the oven space 17. In the event of leakage between the oven space 17 and the car chambers 41, therefore, outward flow of gas will always take place from the oven space 17 and wax vapors passing into the chambers 41 from the flasks 5 cannot pass from the car chambers into the oven space.

During the travel of the flasks 5 through the oven space 17, curing and baking of the investment material is effected simultaneously with the removal of the wax from the investment 6. When the flasks 5 reach the discharge end 52 of the oven 10, the refractory investment material has been properly conditioned and cavities are formed therein which are identical in configuration to the wax models 1 removed therefrom as the result of the heating just described.

It will now be understood that an improvement has been provided for removing wax from investment material in which a minimum amount of handling of the flasks is required, and in which a large number of investment molds may be prepared for casting at a relatively fast rate to expedite production. After the flasks 5 are placed on a car 18 and such car is moved through the oven space 17, the flasks 5 after passing through the oven space are ready for casting.

If desired, the oven 10 may include a cooling zone at the discharge end 52. The cooling zone may be contiguous to the oven space 17 and maintained at a temperature lower than that in the oven space, such as 250° to 350° F. for example. In such case the cars 18 pass from the oven space directly into the cooling zone and are then discharged from the heating unit.

Although a single embodiment of the invention has been shown and described, it will be apparent to those skilled in the art that changes can be readily made and that certain features may be used independently of others without departing from the spirit and scope of the invention. While the oven 10 shown is of a direct gas fired type having radiant burners 21 of the kind described, the oven or furnace may be provided with burners other than those described, or the oven may be of an indirect gas fired type or an electrically heated oven. I therefore aim in the following claims to cover all such changes and modifications as fall within the true scope of the invention.

What is claimed is:

1. The art of removing wax from an investment having a cavity therein with a passage extending from the cavity to a surface of the investment comprising converting the wax from a solid to a fluid state by subjecting the investment to a source of heat above the melting point of the wax in a first space, flowing the melted wax downwardly through the passage from the investment in a path of flow which is out of physical contact with the first space and includes a second space below and separated from the first space by a wall, and producing a suction effect in said second space to maintain the pressure in said second space at a value below that of said first space and of the atmosphere whereby atmospheric air can be drawn into said second space to cool the melted wax.

2. In the art of removing wax from investments having cavities opening to exterior surfaces thereof, such wax being held in the cavities and convertible from a solid to a fluid state by heating, the improvement which comprises moving a group of investments through a heating space, heating the investments as they are moving through said heating space by subjecting them to a high temperature source of heat above the melting point of the wax, flowing the melted wax through the openings in the investments downwardly in a path of flow which is out of physical contact with the heating space and includes a second space below and separated from the heating space by a wall, producing a suction effect in said second space to maintain a pressure therein lower than the pressure in said heating space, and controlling the heating of the investments by regulating the heat source at different zones in said heating space.

CARL P. MANN.

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