May 5, 1959 E. E. ERNDT 2,884,963

INVESTING APPARATUS

Filed April 27, 1956 2 Sheets-Sheet 1

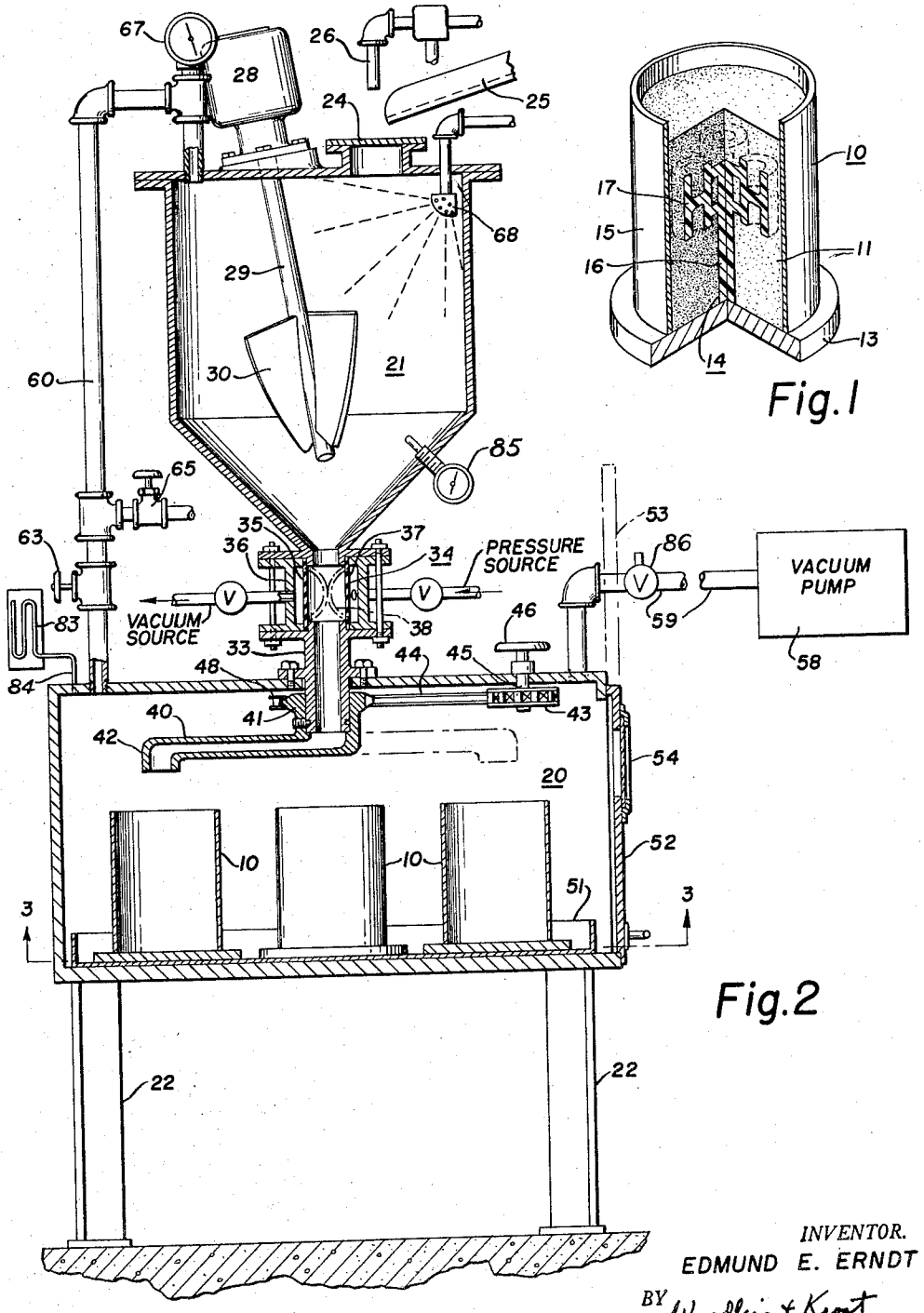

Fig. 1

Fig. 2

INVENTOR.
EDMUND E. ERNDT
BY Woodling & Kroat
Attys

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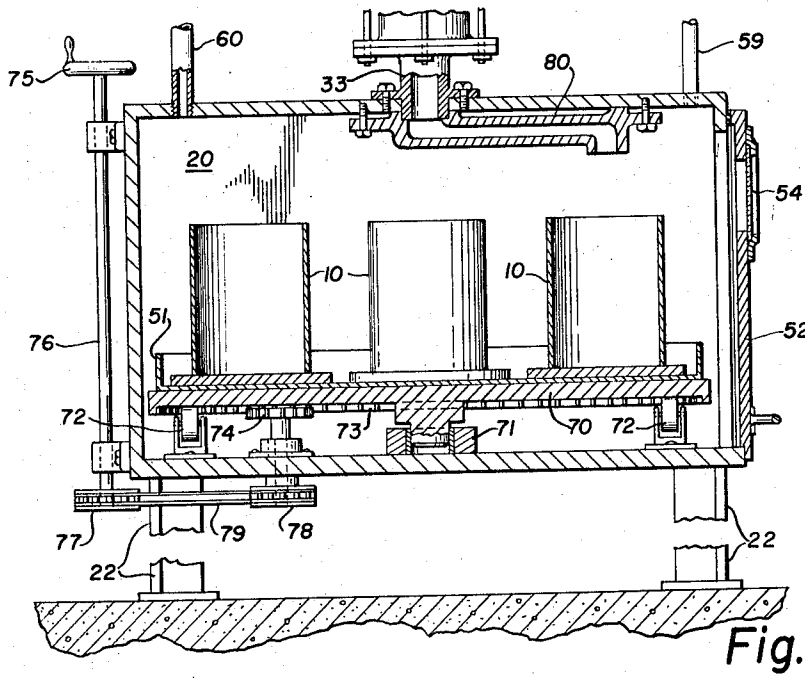

Fig. 4

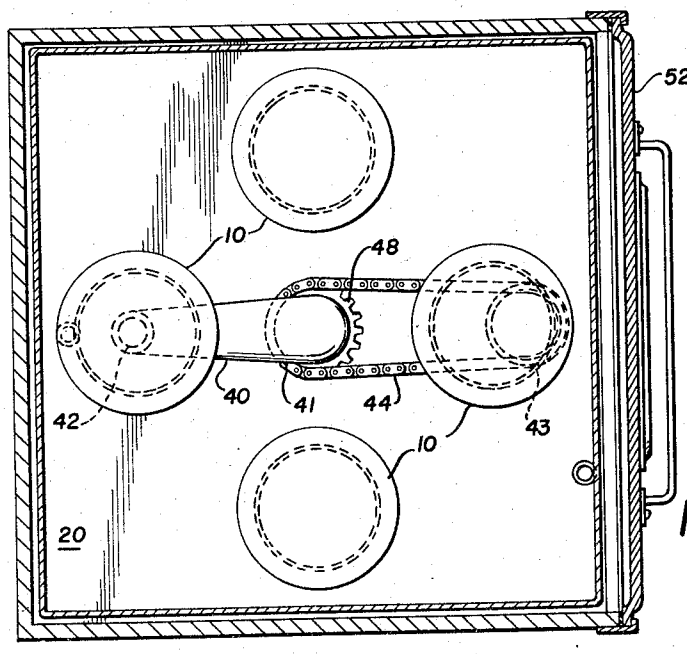

Fig. 3

INVENTOR.
EDMUND E. ERNDT
BY Woodling & Kroot
Attys.

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INVESTING APPARATUS

Edmund E. Erndt, Cleveland, Ohio, assignor to Precision Metalsmiths, Inc.

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6 Claims. (Cl. 141—51)

The invention relates in general to investing apparatus and more particularly to investing apparatus for excluding air and other gases therefrom while the investing process is being carried out.

Briefly described, the steps involved in investment casting include the making of an expendable pattern which is of the configuration that the final molded metal product is to be. This expendable pattern may be of wax, plastic or other suitable expendable pattern material. This expendable pattern is next mounted on a surface support and this assembly is usually referred to as a tree or a setup. A flask which comprises a cylindrically shaped form of metal which may be solid or with perforations therein, and which is open at either end is then placed over the tree with the periphery of one of the open ends resting upon the flat surface of the member which supports the tree. This combination of elements is referred to as a flasked setup. Investment material which basically consists of a refractory material in a slurry form is then introduced into the other open end of the flask and fills the flask and completely surrounds the expendable pattern which is contained therein. These refractory materials vary, of course, depending upon the type of molten metal which is to be finally cast therein, but for the sake of example for metals which melt at around 2000° F. or under, a gypsum-silica refractory material is used. For metals which melt about 2000° F. a phosphate type of refractory material may be used which includes phosphate and a suitable refractory mixture. After the refractory material has been introduced into the flasked setup it is allowed to stand for a suitable period of time until it sets up into a hard state or it may be given a heat treatment to accelerate this hardening process. The next step is that of removing the expendable wax or plastic pattern. This is accomplished by subjecting the flasked setup with the investment material contained therein to high temperatures wherein the expendable pattern is either volatilized or is caused to melt and flow out of the hardened refractory material through the trunk of the tree. After the expendable pattern has been removed from the refractory material a molten metal is poured into the space which the expendable pattern previously occupied and as a result a final finished casting which is the exact shape of the expendable pattern is produced. This casting is removed by breaking the refractory material from around the casting.

Among the various problems which are encountered in producing castings in this manner is that when the refractory material is initially introduced into the flasked setup, to surround the expendable pattern, a great deal of air and other gases are trapped within the mixture. As a result, air bubbles are caused to form at the interface between the expendable pattern and the refractory material. When the expendable pattern is removed from the investment material, a rough surface on the mold results. As a consequence of this, when the molten metal is finally poured into the space which contained the expendable pattern, the metal flows into the space occupied by the air bubbles and the surface of the resulting casting is rough and will not measure up to the standards which are required.

It is therefore an object of the invention to provide an investing apparatus whereby air and other gases are excluded while the investing operation is carried out thereby obviating the entrapped bubbles and thus producing a form from which castings can be obtained which have a superior finish.

Another object of the invention is to provide an investing apparatus whereby investment material may be introduced around an expendable form while air and other gases are substantially excluded from the apparatus thereby preventing air bubbles from forming at the interface of the expendable form and the investment material.

Another object of the invention is to provide an investing apparatus having top and bottom chambers having an air evacuation line interconnecting the two and with a vacuum source connected to the bottom chamber for evacuation thereof whereby the bottom chamber acts as a trap for investment material which may be sucked from the top chamber and through the air evacuation line and thus prevents the investment material from entering the vacuum pump.

Another object of the invention is to provide an investing apparatus with a swingable spout communicating with a top chamber whereby a plurality of flasked setups contained within a bottom chamber may be filled with investment material from the top chamber without moving or handling the setups.

Another object of the invention is to provide an investing apparatus having a rotatable table whereby investment material may be introduced into a plurality of flasked setups without the necessity of moving or handling the flasked setups.

Another object of the invention is to provide a vacuum investing apparatus whereby a plurality of setups may be filled with investment material without the necessity of breaking the vacuum.

Another object of the invention is to provide a vacuum investing apparatus which includes first and second chambers, where the second chamber acts as a trap for material which is accidentally sucked from the first chamber and thereby prevents the material from entering the vacuum pump.

Another object of the invention is to provide a vacuum apparatus including first and second interconnected chambers with a conduit and valving arrangement whereby the second chamber acts as a trap for material contained within the first chamber and whereby the first chamber may be shut off from the vacuum source while the second chamber is still connected to the vacuum source and whereby the first chamber may be vented to the atmosphere or to a pressure source to pressurize the first chamber and force material contained therein into the second chamber.

Another object of the invention is to provide an investing apparatus having top and bottom chambers and having means for positively forcing investment material contained within the top chamber into the bottom chamber.

Another object of the invention is to provide an investing apparatus whereby increased production results and uniform process controls are acquired by automatically controlling cycling time, temperature, and vacuum thereby eliminating and minimizing human and process variables.

Other objects and a fuller understanding of this invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is an isometric view partially in section of a flasked setup filled with investment material;

Figure 2 is a side elevational view partially in section of the investing apparatus of the present invention;

Figure 3 is a view taken generally along the line 3—3 of Figure 2; and

Figure 4 is a fragmentary side elevational view in section illustrating a modification of the apparatus shown in Figure 2.

Figure 1 illustrates a flasked setup indicated generally by the reference numeral **10** filled with refractory material **11**. This flasked setup is illustrated to show the function which the investing apparatus of Figure 2 performs. The flasked setup **10** includes generally a base **13**, a tree **14** and a flask **15**. The tree **14** includes a trunk portion **16** and the expendable pattern **17** which is attached to the trunk. The tree **14** is initially assembled upon the base **13** by heating and melting the bottom of the trunk **16** and then sticking it to the base **13**. The expendable patterns **17** are attached to the trunk portion **16** by heating and melting a portion of the trunk or patterns and then sticking the two together where they remain in the position indicated in Figure 1. Thereafter the flask **15** is placed over the tree **14** and into engagement with the base **13**. The flask therefore serves as a container for investment material which is introduced therein by the investing apparatus shown in Figure 2. The interface where the flask **15** engages the base is usually sealed by a hardenable paraffin or other suitable material so that the investment material which is introduced into the flasked setup will not escape at this interface.

The investing apparatus shown in Figure 2 includes generally a lower vacuum chamber **20** and a vacuum mixing kettle **21**. The vacuum mixing kettle **21** may also be referred to as a first chamber and the vacuum chamber **20** may be referred to as a second chamber. The vacuum chamber **20** is supported by legs **22** and is adapted to receive a plurality of the flasked setups **10** so that more than one of these setups may be filled with a refractory material in one operation. The vacuum mixing kettle **21** is provided with a port **24** and is adapted to receive a predetermined amount of a refractory material therethrough from a trough **25**, which has been illustrated schematically in Figure 2. Water or other suitable liquid may be introduced into the kettle through a pipe line **26**. As a result the refractory material and water are introduced through the port **24** and are subsequently mixed into a slurry in the vacuum mixing kettle **21**. It should be readily recognized that the refractory material and the water may be introduced into the mixing kettle in other ways and the present embodiment has been shown only by way of illustration and should not be construed as limiting in any manner. Means for mixing the water and refractory material have been provided and include a motor **28** mounted on the mixing kettle **21** and having a shaft **29** connected to a plurality of radially spaced blades **30**. This provides for the mixing of the refractory material and water into a slurry.

A drain member or conduit **33** interconnects the mixing kettle **21** and the vacuum chamber **20** and provides a conduit through which the slurried investment material may pass from the kettle **21** to the chamber **20**. A first valve member **34** is interposed in the drain **33** for alternatively allowing and prohibiting communication therethrough. The valve **34** includes a central annularly shaped member **35** which is made of resilient material, preferably of rubber, and an outer surrounding member **36** made of a suitable metallic material. The position of the two members **35** and **36** forms an annular chamber **37** therebetween. This chamber **37** is connected to both a vacuum source and a pressure source. When it is desired that the valve **34** be closed so that material may not flow through the drain **33** the chamber **37** is connected to the pressure source and the central resilient member assumes the position shown by the dot dash lines **38**. When it is desired that material be allowed to flow through the drain **33**, the chamber **37** is connected to the vacuum source and this opens the valve **34** and causes the central member **35** to assume the position shown by the full line drawing of Figure 2.

A swingable filling spout **40** having a connection end portion **41** and a discharge end portion **42** resides within the lower vacuum chamber **20**. The connection end portion **41** of the swingable filling spout **40** is connected to the lower end of the drain **33** for rotation thereabout. Means are provided for swingably moving the spout **40** relative to the drain **33** and includes a sprocket **43** and an endless chain **44**. The sprocket **43** has an axle **45** which extends through the casing of the vacuum chamber **20** and terminates in a handle **46**. The chain **44** extends around the sprocket **43** and also around a series of teeth **48** which are provided upon the connection end portion of the spout **40**. As a result, the spout **40** may be caused to move relative to the drain member by merely turning the handle **46** whereby the discharge end **42** of the spout may be selectively located above each of the flasked setups **10** which are contained within the lower vacuum chamber **20**. The flasked setups **10** are carried upon a tray **51** for more ease in handling and are initially introduced into the lower vacuum chamber **20** by way of a door **52** which is opened to the position indicated by the dot dash lines **53**. The door **52** is provided with a window **54** through which the innerconfines of the vacuum chamber **20** may be viewed during the investing operation.

A vacuum pump or source **58** is provided and is connected to the lower vacuum chamber **20** by way of a first conduit **59**. A second conduit or an evacuation line **60** connects the lower vacuum chamber **20** to the vacuum mixing kettle **21**. A second valve member **63** is interposed in the second conduit **60** for alternatively allowing and prohibiting communication therethrough. As a result, the vacuum source **58** may be disconnected from the mixing kettle while still being connected to the lower vacuum chamber. A third valve **65** is provided in the second conduit **60** between the second valve **63** and the kettle **21** for venting the conduit **60** to the outside atmosphere. The third valve **65** could also be directly connected to the mixing kettle rather than to the conduit **60** which leads therein. This valve **65** might also be connected to a pressure source above atmospheric pressure if such additional pressure might sometime be desired. A pressure indicating valve **67** is interposed in the conduit **60** so that the pressure within the mixing kettle and the conduit **60** may at all times be observed by the operator of the apparatus. The vacuum mixing kettle **21** is provided with a spray head **68** which is in turn connected to a suitable supply of liquid, preferably water, for washing down the inner confines of the kettle after a batch of investment material has been mixed and has been transferred into the flasked setups in the lower vacuum chamber **20**. This, of course, prevents the hardening of investment material upon the walls of the kettle and keeps the kettle clean at all times. Figure 3 of the drawings has been shown to indicate the mechanism for locating the spout **40** and also shows the relative positions of the flasked setups as they reside within the lower vacuum chamber **20**.

Figure 4 shows another mechanism for moving the flasked setups relative to a filling spout **80** so that all of the setups may be filled without interrupting the investing operation. As will be seen in this form of the invention, the tray **51** within which the flasked setups **10** reside is carried by a rotatable table **70**. This table **70** is journalled in a bearing member **71** and a plurality of rollers **72** engage the outer edge portion of the table to give support thereto. The table **70** is also provided with a series of teeth **73** which are adapted to engage with the teeth on a driving gear **74**. The gear **74** is suitably driven by a linkage which extends from a hand crank **75**, through a shaft **76** and sprocket wheels **77** and **78**, respectively, which are interconnected by a chain member **79**. This connection mechanism enables the operator of the ma-

chine to simply turn the hand crank or wheel **75** and he is to be able to move each of the flasked setups beneath the discharge end of the spout **80**. As will be noted, in this modification the spout is indicated as being fixedly attached to the lower vacuum chamber **20**. The rotatable table **70** as well as the floor surface which supports the flasked setups **10** in Figure 2 may be referred to as supporting platform means.

In operation the basic steps are to introduce the water and refractory material through the port **24** into the mixing kettle **21** while continuously stirring these materials so that a slurry results. At the same time the tray **51** carrying the flasked setups **10** is introduced into the lower vacuum chamber **20** through the door **52**. The first valve **34** is, of course, all this time in the closed position. The door **52** of the vacuum chamber is closed and the vacuum pump **58** is actuated thereby withdrawing air from the vacuum chamber **20**. The valve **63** at this time is in the open position and the valve **65** is closed. As a result air and other gases are withdrawn from the mixing kettle **21** through the conduit **20** while the stirring is going on. This provides for a more complete removal of entrapped gases and air from the slurried investment material. After the investment material and the water have been mixed for a predetermined period of time, the valve **63** is moved to the closed position thereby cutting off the mixing kettle from the vacuum source **58**. The first valve **34** is then opened and investment material is caused to flow through the drain member **33** through the swingable spout **40** and into a flasked setup **10**. The lower vacuum chamber **20** is continually connected to the vacuum pump during this operation. When one of the flasked setups has been completely filled with investment material the operator closes the valve **34** and moves the swingable spout **40** by turning the handle **46** until the discharge end **42** is located over another flasked setup. Then the operator opens the valve **34** and investment material again flows through the drain member and the spout **40**. This procedure is repeated until all of the flasked setups are filled. After the flasked setups are all filled with investment material they are allowed to remain in the lower vacuum chamber **20** for a short period of time with the vacuum on. The vacuum is released by operating the three-way valve **86** which simultaneously shuts off the chamber **20** from the vacuum source **58** and vents the chamber **20** to atmosphere, and the door **52** is opened and the tray of flasked setups is removed therefrom. The spray head **68** is then actuated and the innerconfines of the mixing kettle are washed down with water or other suitable liquid which flows down the sides of the kettle and into the lower vacuum chamber **20**. From the vacuum chamber **20** the water flows through a suitable drain (not shown in the drawings) and is thereby disposed of.

Although the valves used in the herein described investing apparatus have been shown as hand operated, it should be readily recognized that they may be electropneumatically actuated at predetermined times for predetermined periods over a complete operating cycle.

A mercury manometer **83** is connected to the chamber **20** by means of the tubing **84** whereby the pressure in the chamber may be readily observed on the manometer which is calibrated in millimeters of mercury. A thermometer member **85** is attached to the kettle **21** and extends thereinto so that the temperature of the slurried investment material may at all times be observed.

Basically the same procedure is gone through when using the apparatus shown in Figure 4 with the exception that instead of moving the spout **80** the table **70** is rotated to move each of the flasked setups beneath the discharge end of the spout **80**.

In the investing process which has been described hereinabove the slurry which is produced by mixing the water and investment material at the mixing kettle is quite often of a very heavy consistency and has a definite tendency to remain in the mixing kettle and will not flow through the drain member even when the valve **34** is in the open position. Since this mixture is capable of hardening within a relatively short period of time, it is critical that it be caused to flow from the mixing kettle into the vacuum chamber. In order to cause the slurry, which is of a heavy consistency to flow through the drain **33** the valve **65** has been provided in the second conduit **60** between the valve **63** and the mixing kettle **21**. The valve **65** provides for venting of the conduit **60** to the outside atmosphere. As a result, when the first valve **34** is opened and the slurried investment material will not flow from the mixing kettle **21** through the drain **33** because of its heavy consistency, the valve **65** is opened and the pressure of the outside atmosphere enters the mixing kettle **21** through the conduit **60** and positively forces the investment material through the drain **33**. In the event that this pressure is not sufficient to force the investment material through the drain, the valve **65** and the conduit in which it resides, might be connected to a pump or other suitable means of producing a positive pressure for pressurizing the mixing kettle **21**.

It will thus be seen that an investing apparatus has been provided whereby air and other gases are withdrawn and excluded while the investing operation takes place. As a result, air bubbles and other gases are prevented from forming at the interface between the expendable pattern and the refractory material. As a consequence, a mold with a very smooth surface results and the castings which are produced therefrom have a surface finish of a high quality. With the provision of the swingable spout and the modification of the rotatable table, more than one flasked setup can be filled during a single investing operation without the necessity of breaking the vacuum in order that the operator physically reach in and move a flasked setup beneath the spout. Because of the piping and valving arrangement, it will be seen that the lower vacuum chamber **20** acts as a trap for investment material which is accidentally sucked into the air evacuation line **60** from the mixing kettle **21** and thus prevents the investment material from entering the vacuum pump or source **58**. The additional provision of the means for forcing the investment material through the drain **33** when the investment material is of a very heavy consistency, contributes to the conclusion that the combination of elements which have been combined, results in an investing apparatus which has made a very valuable contribution to the art.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. An apparatus for filling a plurality of flasked setups with an investment material comprising a lower vacuum chamber for receiving said setups, a vacuum mixing kettle disposed vertically above said lower vacuum chamber and adapted to receive investment material therein, a drain member interconnecting said kettle and said chamber, a first valve member disposed within said drain member for alternatively allowing and prohibiting communication between said mixing kettle and said lower vacuum chamber through said drain member, said first valve member including an annular rubber member substantially centrally disposed in said drain member, said rubber member and said drain member forming an annular chamber, conduit means connecting said annular chamber to vacuum and pressure sources, a swingable filling spout having a connection end portion and a discharge end portion and residing within said lower vacuum chamber, said connection end portion of said swingable filling spout communicating with said drain member, means for

swingably moving said filling spout relative to said drain member whereby said discharge end of said filling spout may be selectively located above each of said plurality of flasked setups, including a first sprocket on said connection end of said spout and a second sprocket removed from said first sprocket and rotatably mounted by a shaft which extends through said lower vacuum chamber and terminates in a handle, a chain extending between said first and second sprockets, a vacuum pump, a first conduit connecting said vacuum pump to said lower vacuum chamber, a second conduit connecting said lower vacuum chamber to said vacuum mixing kettle, a second valve member interposed in said second conduit for alternatively allowing and prohibiting communication therethrough, a third valve member providing communication between said second conduit and the outside atmosphere between said second valve member and said vacuum mixing kettle, stirring means within said vacuum mixing kettle for stirring the investment material and spray head means within said vacuum mixing kettle for washing down the inner walls of said vacuum mixing kettle.

2. An apparatus for filling a plurality of flasked setups with an investment material comprising a lower vacuum chamber for receiving said setups, a vacuum mixing kettle disposed vertically above said lower vacuum chamber and adapted to receive investment material therein, a drain member interconnecting said kettle and said chamber, a first valve member disposed within said drain member for alternatively allowing and prohibiting communication between said mixing kettle and said lower vacuum chamber through said drain member, said first valve member including an annular rubber member disposed in said drain member, said rubber member and said drain member forming an annular chamber, conduit means connecting said annular chamber to vacuum and pressure sources, a swingable filling spout having a connection end portion and a discharge end portion and residing within said lower vacuum chamber, said connection end portion of said swingable filling spout communicating with said drain member, means for swingably moving said filling spout relative to said drain member whereby said discharge end of said filling spout may be located above each of said plurality of flasked setups, including a first sprocket on said connection end of said spout and a second sprocket removed from said first sprocket and rotatably mounted by a shaft which extends through said lower vacuum chamber and terminates in a handle, a chain extending between said first and second sprockets, a vacuum pump, a first conduit connecting said vacuum pump to said lower vacuum chamber, a second conduit connecting said lower vacuum chamber to said vacuum mixing kettle, a second valve member interposed in said second conduit for alternatively allowing and prohibiting communication therethrough, a third valve member providing communication between said second conduit and the outside atmosphere between said second valve member and said vacuum mixing kettle and stirring means within said vacuum mixing kettle for stirring the investment material.

3. An apparatus for filling a flasked setup with an investment material comprising a lower vacuum chamber having supporting platform means for receiving said setup, a vacuum mixing kettle disposed above said lower vacuum chamber and adapted to receive investment material therein, a drain member interconnecting said kettle and said chamber, a first valve member disposed within said drain member for alternatively allowing and prohibiting communication between said mixing kettle and said lower vacuum chamber through said drain member, said first valve member including an annular resilient member disposed in said drain member, said annular resilient member and said drain member forming an annular chamber, conduit means connecting said annular chamber to vacuum and pressure sources, a filling spout having a connection end portion and a discharge end portion, said connection end portion of said filling spout communicating with said drain member, means for moving said filling spout and said supporting platform means relative to each other including a sprocket and chain means, a vacuum pump, a first conduit connecting said vacuum pump to said lower vacuum chamber, a second conduit connecting said lower vacuum chamber to said vacuum mixing kettle, a second valve member interposed in said second conduit for alternatively allowing and prohibiting communication therethrough, and a third valve member providing communication between said second conduit and a pressure source and located between said second valve member and said vacuum mixing kettle.

4. An apparatus for filling a plurality of flasked setups with an investment material comprising a lower vacuum chamber for receiving said setups, a vacuum mixing kettle disposed vertically above said lower vacuum chamber and adapted to receive investment material therein, a drain member interconnecting said kettle and said chamber, a first valve member disposed within said drain member for alternatively allowing and prohibiting communication between said mixing kettle and said lower vacuum chamber through said drain member, a filling spout having a connection end portion and a discharge end portion and residing within said lower vacuum chamber, said connection end portion of said filling spout communicating with said drain member, a platform contained within said lower vacuum chamber and adapted to support said flasked setups, means for rotating said platform whereby said discharge end of said filling spout may be located above each of said plurality of flasked setups, a vacuum pump, a first conduit connecting said vacuum pump to said lower vacuum chamber, a second conduit connecting said lower vacuum chamber to said vacuum mixing kettle, a second valve member interposed in said second conduit for alternatively allowing and prohibiting communication therethrough, a third valve member providing communication between said second conduit and the outside atmosphere between said second valve member and said vacuum mixing kettle, stirring means within said vacuum mixing kettle for stirring the investment material and spray head means within said vacuum mixing kettle for washing down the inner walls of said vacuum mixing kettle.

5. An apparatus for filling a flasked setup with an investment material comprising a lower vacuum chamber for receiving said setup, a vacuum mixing kettle disposed vertically above said lower vacuum chamber and adapted to receive investment material therein, a drain member interconnecting said kettle and said chamber, a first valve member disposed within said drain member for alternatively allowing and prohibiting communication between said mixing kettle and said lower vacuum chamber through said drain member, a swingable filling spout having a connection end portion and a discharge end portion and residing within said lower vacuum chamber, said connecting end portion of said swingable filling spout communicating with said drain member, a platform contained within said lower vacuum chamber and adapted to support said flasked setup, means for rotating said platform whereby said platform may be located at different positions relative to said discharge end of said filling spout, a vacuum pump, a first conduit connecting said vacuum pump to said lower vacuum chamber, a second conduit connecting said lower vacuum chamber to said vacuum mixing kettle, a second valve member interposed in said second conduit for alternatively allowing and prohibiting communication therethrough, a third valve member providing communication between said second conduit and the outside atmosphere between said second valve member and said vacuum mixing kettle.

6. An apparatus for filling a container with a material comprising first and second chambers, a passageway providing communication between said first and second chambers, a first valve cooperating with said passageway

and allowing and preventing communication therethrough, said first valve member including an annular resilient member disposed in said passageway and forming therewith an annular chamber, conduit means connecting said annular chamber to vacuum and pressure sources, a vacuum source, a first conduit connecting said vacuum source to said second chamber, a second conduit connecting said second chamber to said first chamber, a second valve allowing and preventing communication through said second conduit, and a third valve for pressurizing said first chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

2,138,356	Ryan et al.	Nov. 29, 1928
2,355,620	Bower et al.	Aug. 15, 1944
2,453,914	Hollenback	Nov. 16, 1948
2,540,120	Jacobs et al.	Feb. 6, 1951