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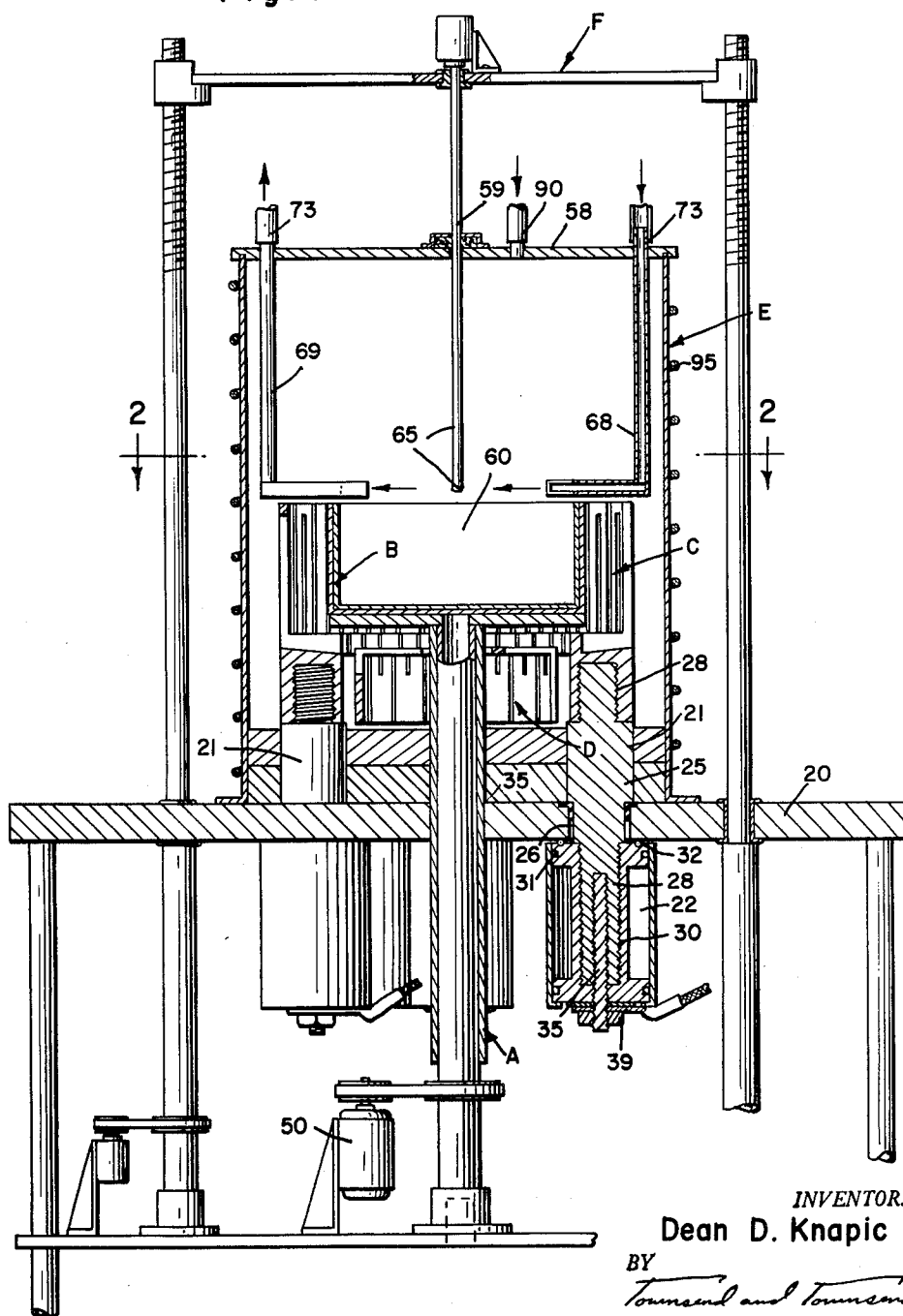
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CRYSTAL GROWING FURNACE

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2 Sheets-Sheet 1

Fig. 1.



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2 Sheets-Sheet 2

Fig. 2.

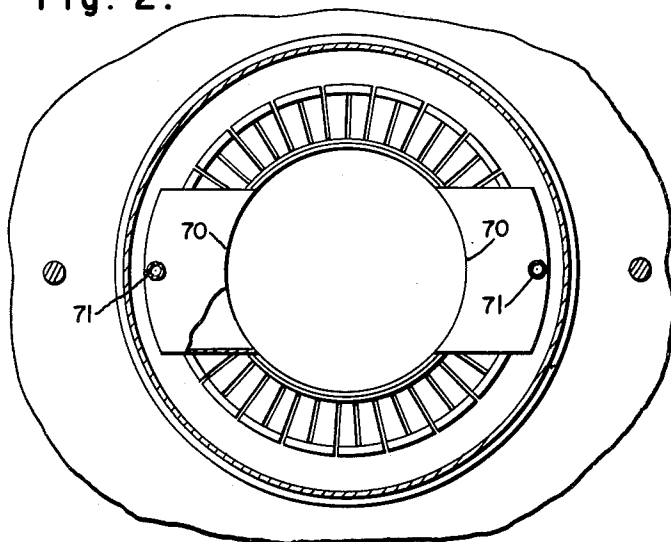
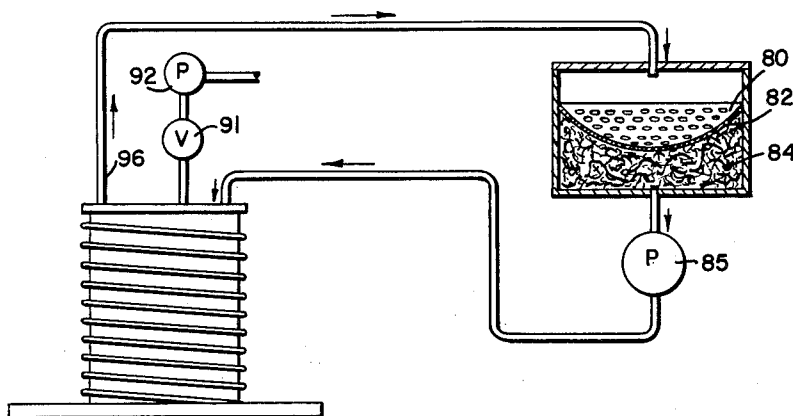


Fig. 3.

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1

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CRYSTAL GROWING FURNACE

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7 Claims. (Cl. 23-301)

This invention relates to a method of and means for controlling the atmosphere in a furnace for growing 10 crystals.

In the growth of crystals from silicon and other similar materials where purity and contaminants are important considerations the entire melt of the furnace is housed within a chamber and the chamber filled with inert gas so that the atmospheric contamination of the melt and crystal will be minimized.

It is the principal object of this invention to provide a device for establishing a hot gas flow across the top surface of the melt and the combination of a gas filtering device to filter out the solid particles within the atmosphere so as to maintain a circulatory flow of gas across the melt which is substantially pure.

Another object of this invention is to provide a method of maintaining a controlled atmosphere by blowing gas across the top face of the melt in such a way as not to disturb the crystal growing characteristics.

A further object of this invention is to provide a complete furnace apparatus including electrode connectors for the furnace, a cooling jacket and a gas chamber for the melt.

Still a further object of this invention is to provide in a gas circulating system the combination of a gas input means to continually add new gas to bring the quantity of gas within the chamber up to a predetermined level.

Other objects of the present invention will become apparent upon reading the following specification and referring to the accompanying drawings in which similar characters of reference represent corresponding parts in each of the several views.

In the drawings:

FIG. 1 is a cross-sectional view of the complete furnace apparatus.

FIG. 2 is a cross-sectional view of FIG. 1 taken at line 2-2.

FIG. 3 is a schematic view showing the path of gas from the furnace.

In the preferred embodiment of the invention there is provided a crystal growing furnace including a pedestal A from which is mounted a crucible B. The crucible is surrounded by a furnace C and is provided on the under-surface with a bottom heater D.

The respective heaters D and C are mounted on a platform 20 by electrodes 21 which have a depending section 22 to allow the electrical connections to be made to the furnace from a point under platform 20.

Furnaces C and D are of conventional picket fence type design wherein electrical current from the electrodes is arranged to pass through the resistance heating elements forming heaters C and D to cause the elements to come up to the temperature of the furnace.

The heating elements and the electrodes are generally formed of a carbon substance which is arranged to conduct electricity and obtain extremely elevated temperatures without mechanical deterioration.

The electrode assembly forms a seal at platform 20 and is formed with a carbon base 25 which depends through an aperture 26 in platform 20. The top portion of base 25 is screwed into the bottom leg of the respective heaters indicated at 28 so as to make a broad face contact with the heaters. Depending leg 28 of the base is threaded

2

as indicated at 30 wherein a coupling unit is screwed over threads 30. The top portion of the coupling unit is flanged at 31 to mate with the bottom of platform 20 wherein O-rings 32 form a seal against the platform which is substantially gas tight. A metal screw is screwed into an inner bore 35 of leg 28 which also makes a broad face contact with leg 28.

An electrical connector 39 connects to the bottom of the fitting to make electrical contact. Thus the electrical contact through electrodes 21 is through bore 35 and outer threads 30 thus making a substantial broad face electrical connection with the connector. This is extremely important where high currents are to be transmitted. In addition the top face of the fitting forms a gas seal against top platform 20.

Pedestal A is rotated by motor means 50 and extends upwardly through platform 20 through a sealing means indicated at 55. The sealing of the atmosphere for crucible B is obtained by a jacket E which has its bottom edges nested on the top of platform 20 to form a complete seal against the platform.

The seed supporting control apparatus F is arranged having a stem which passes through the upper plate 58 of jacket E through a seal 59 so as to allow the seed to be brought into contact with the melt 60 within crucible B. Thus the entire chamber within jacket E is sealed around its peripheral edge by the mating contact with platform 20. Electrodes 21 are sealed by their unique configuration in their passage through aperture 26 and the pedestal is sealed through its passageway through the base plate at 55. Thus the entire chamber in which the seed, indicated at 65, is located is under a sealed atmospheric condition.

Gas vents generally indicated at 68 and 69 forming the gas input and gas output vents respectively are arranged to cause gas to flow across the top face of the melt during crystal growth. This is obtained through the shaping of the gas vents with a concave edge as indicated at 70 in FIG. 2. The vents are relatively fan shaped and hollow and connect to conduit 71 which extends outwardly through top plate 58 as at 73. The gas in the intake vent 68 thus travels through the conduit 71 and into chain shaped outlet 70 wherein in low pressure high volume the gas is directed across the melt. A vacuum is applied on conduit 71 of vent 69 so as to attract the gas from vent 68 and to cause a continuous low velocity high volume flow of gas across the face of the melt. The gas from vent 69, that is the exhaust vent, is directed to a filter unit indicated at 80 in FIG. 3. The filter unit generally comprises an apertured plate 82 which is adapted to filter out major particles which may exist within the gas and through an abrasive or other similar wool filter trap 84 to filter out the minute particles that might exist in the gas. A pump 85 functions to create the recirculating pressure for the gas circulation.

Additional gas is inserted into chamber E through a tube or pipe 90 and a valve system 91 pressurized through a pump 92. The new gas is added in order to keep the basic quantity of gas within the chamber sufficiently high to control the pressure within the chamber relative to atmospheric and to control the pressure for uniformity of crystal growth.

One principal feature of this device is that there is a low pressure high volume gas flow across the melt which is maintained at high temperature in that the filtering system is a closed system allowing for very little cooling. The high volume low pressure is accomplished by the configuration of the gas output and input devices which provide an elongated broad surface which is substantially coincident in shape with the peripheral surface of the melt so as to get a maximum gas flow across the

3

melt. Cooling of the entire chamber, of course, can be accomplished by other cooling devices as indicated by pipes 95.

Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is understood that certain changes and modifications may be practiced within the spirit of the invention as limited only by the scope of the appended claims.

What is claimed:

1. In a furnace for growing crystals from a melt of the type having a crucible, a furnace for heating the crucible and a seed mechanism for dropping the seed into contact with molten material within the melt the combination of a gas tight housing enclosing said melt and isolating said melt from atmosphere, two vent means each positioned on opposite sides of said melt, means to withdraw gas through one of said vent means, and means to force gas through the other of said vent means.

2. In a furnace for growing crystals from a melt of the type having a crucible, a furnace for heating said crucible, and a seed mechanism for dropping a seed into contact with molten material within the melt the combination of a gas tight housing enclosing said melt and isolating said melt from atmosphere, a pair of vent means each located on opposite sides of said melt, said vent means formed with a concave edge formed in a diameter equal to the crucible, means positioning said vent means with the concave edge positioned slightly above the upper edge of the crucible, said vent means forming a vent opening through said outside edge, and means to force gas into one said vent means and to withdraw gas from the other of said vent means.

3. In a furnace for growing crystals from a melt of the type having a crucible, a furnace for heating the crucible, and a seed mechanism for dropping a seed into contact with molten material within the melt the combination of a gas tight housing enclosing said melt and isolating said melt from atmosphere, a pair of vent means each located on opposite sides of said melt, said vent means formed with a concave edge formed in a diameter equal to the crucible, means positioning said vent means with the concave edge positioned slightly above the upper edge of the crucible, said vent means forming a vent opening through said outside edge, and pump means located exteriorly of said housing to force gas into one of said vent means and to withdraw gas from the other of said vent means in a closed circuit.

4

4. A device according to claim 3 and having filter means in the closed system to filter gas withdrawn from said housing.

5. In a furnace for growing crystals from a melt of the type having a crucible, a furnace for heating the crucible, and a seed mechanism for dropping a seed into contact with molten material within the melt the combination of a gas tight housing enclosing said melt and isolating said melt from atmosphere, first and second vents located diametrically opposite each other and slightly above the top surface of the edge of the crucible, a closed gas system connected to said first and second vents, a filter located within said system, and pump means to cause a continual flow of gas through said system from said first vent means across the melt to said second vent means, and means to inject gas into said housing in supplement to the gas within said housing and closed circuit.

6. In an apparatus for growing crystals from a melt of the type having a seed which is progressively removed from the melt the combination of a closed chamber enclosing said melt, vent means to withdraw gas from said chamber from a position adjacent said crucible, means to filter said gas and to return said gas to said chamber under pressure while the gas is retained in a heated condition, and means to inject said gas toward said vent means in a path directly across the melt.

7. A method of growing crystals from a melt having the steps comprising; sealing the melt from atmosphere, introducing a selected gas in the area around the melt, surrounding said melt with a gas, withdrawing said gas from a point adjacent the top edge of the melt, filtering said gas while hot, and forcing said filtered gas over the top edge of said melt while at an elevated temperature.

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