

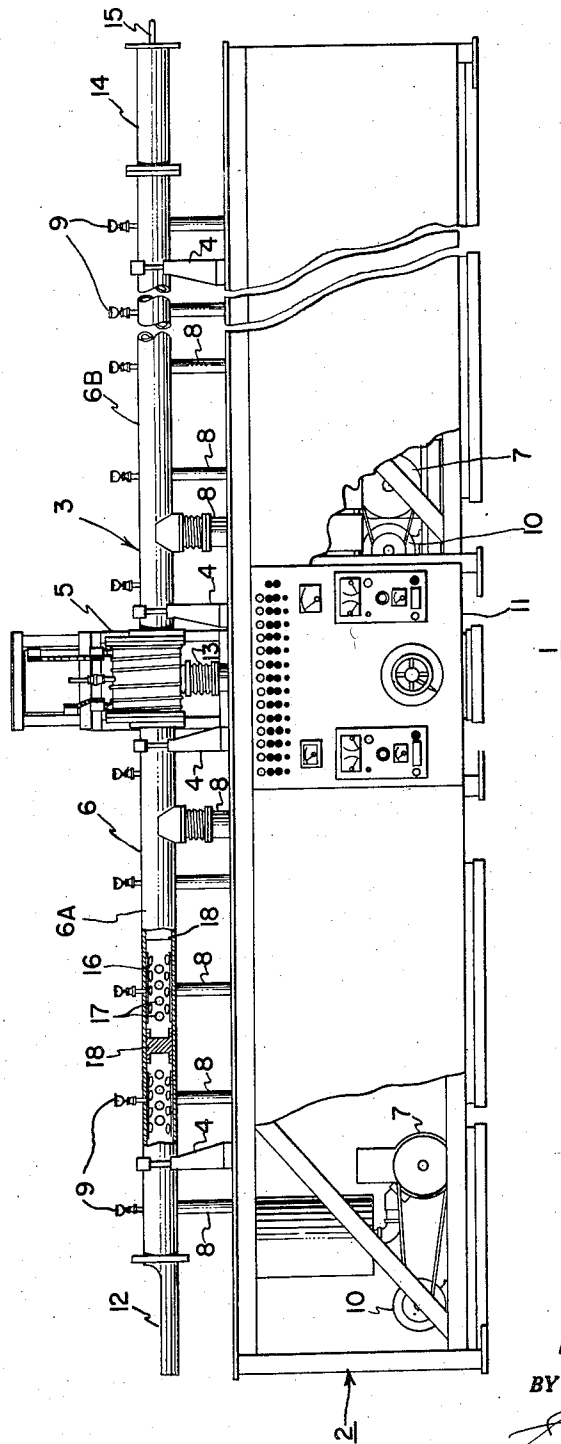
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VACUUM FURNACE

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VACUUM FURNACE

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The present invention relates to vacuum furnaces and more particularly to vacuum furnaces designed for production vacuum treatment of small batches of relatively small parts.

In some applications, for example in the manufacture of electron tubes, it is necessary to heat treat small parts in an evacuated atmosphere. Difficulties exist in obtaining a uniform "high" temperature "hot zone" without detriment to the heating element, and heating and cooling the parts without exposure to atmosphere in as short a time as possible. Most equipment currently available operates "batch" fashion, each batch going through a heating, out-gassing and cooling cycle that may require a considerable period of time. In other words before another "batch" can be started, the one in the furnace has to go through the complete cycle before the furnace can be opened.

The present invention provides means whereby the parts are indexed through the aforementioned cycles at a minimum rate without decrease in actual process time. The parts are started through at one end and move through successive stages having increasing vacuum gradients to the heating section, then through decreasing vacuum gradient stages to the exit. In this manner there is no lost time in evacuating the furnace, bringing it up to temperature and cooling.

It is an object of the invention to provide an improved vacuum furnace.

Another object of the invention is to provide a novel vacuum furnace designed for production vacuum treatment of relatively small parts.

Another object of the invention is to provide a novel vacuum furnace adapted for high production.

The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawing wherein one embodiment of the invention has been illustrated by way of example.

In the drawing:

The single figure is a front view of apparatus, illustrative of and constructed in accordance with the invention.

The apparatus indicated generally by the numeral 1 comprises a relatively stationary structure 2 which supports a high vacuum furnace 3 which is secured to the structure 2 by conventional means 4. The high vacuum furnace 3 comprises a central oven 5 and a cylinder 6 or any other suitable configuration as may be desired. Vacuum pumps 7 are connected by suitable means 8 at intervals along the cylinder 6. Associated with each vacuum pump 7 may be a pressure gauge 9. The vacuum pumps 7 may be driven by conventional electric motors 10. A panel 11 may be provided on the framework 2 for supporting the conventional control mechanism.

The elongated cylinder 6 is a continuous hollow open-ended integral body having a substantially uniform di-

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ameter throughout. At a point along the cylinder 6, the conventional electric oven 5 encompasses the cylinder 6. The oven 5 may be considered, for purposes of description, as a zone of the furnace 3 which in turn effectively divides the cylinder 6 into two sections: a preliminary zone 6A and an exit zone 6B.

Connected with the preliminary zone 6A by conventional means is an entrance section 12. This section 12 is a cutaway semicylindrical section, opening upwards, facilitating access to the furnace 3.

The oven 5 is a conventional electric oven which may be water jacketed to prevent distortion and deterioration of the various vacuum seals required for electrical connections to the heating unit. A vacuum pump 13 is connected with the oven 5 to maintain the highest possible vacuum.

The exit zone 6B of the cylinder 6 lies integrally between the oven 5 and an end or exit section 14. The exit section 14 is integral with the cylinder 6 and cylindrical in shape with a diameter substantially the same as that of the cylinder 6. The exit section 14 is bisected horizontally, the upper half of which may be pivoted upwardly. Further, an additional vacuum pump (not shown on the drawing) may be attached to the end 15 of the exit section 14 and positioned by any conventional clamping device.

A hollow cylindrical jar or piston 16 of a suitable material, such as quartz or alumina, is adapted for passage through the furnace 3. The hollow pistons 16 are shown by way of illustration, in a cutaway section of the cylinder 6 as having an external diameter slightly less than the diameter of the cylinder 6. The pistons 16 are open-ended and may have a plurality of openings 17 around their periphery thereby permitting outgassing.

The open ends of the pistons 16 are closed by nesting them in annular members or sealers 18 which, for example, may be stainless steel counterbored rings having an integral annular flange on the periphery whose outer circumference is slightly greater than that of the pistons 16.

In operation, the pistons 16 are filled with parts to be fired, and after insertion into the sealers 18, are placed in the cylinder 6. Differential pressure against the pistons 16 presses them together as they are indexed through the furnace 3. As a piston 16 is added to the furnace 3 from the entrance section 12, the exit section 14 is capped and the removal of atmospheric pressure on the exit section 14 causes the whole line of pistons contained within the cylinder 6 to shift toward the exit section 14. When the exit section 14, which functions as a cap, is opened, equilibrium is restored to the line of pistons 16 in the cylinder 6 and oven 5, and the piston 16, which was indexed into the exit section 14, may be removed.

As incoming pistons 16 index toward the oven 3 in the preliminary zone 6A, they isolate the vacuum pump inlets from one another and establish a vacuum gradient between the entrance section 12 and the oven 3 in the center. The vacuum is determined by the equilibrium point established by the rate of leakage around the piston 16 and the pumping capacity. As the oven 3 is approached, the atmosphere becomes rarer and a cumulatively decreasing volume of gas leaks past successive pistons 16. As a piston 16 indexes toward the oven 3, it moves into successively lower pressure areas. Hence, when a piston 16 is centered in the oven 3, the ultimate in vacuum occurs.

As a piston 16 is moved by the pistons entering from the zone 6A away from the oven 3 in the exit zone 6B, the treated parts within a piston 16 cool and are moved into higher pressure areas as they go through the furnace. The indexing cycle is arranged so that the parts are sufficiently

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cool before the atmosphere is increased to cause oxidation of the parts.

By using distinct zones for heat treatment, for evacuation for cooling, the oven 5 is utilized only for actual processing time and the entire cycle may be thereby indexed at a minimum time rate without distorting or sacrificing requisite process timing.

Although only one embodiment of the invention has been illustrated and described, various changes in the form and relative arrangement of the parts, which will now appear to those skilled in the art, may be made without departing from the scope of the invention.

What is claimed is:

1. A vacuum furnace comprising an inlet section, a furnace section and an outlet section; a plurality of containers adapted for passage through said sections, a plurality of vacuum pumps connected to said sections, sealer members positioned between said containers and dividing said sections into portions having different vacuum gradients, and means for applying pressure to move said containers through said sections at a predetermined rate.

2. The combination as defined in claim 1 whereby said pressure means for moving said containers through said furnace is a vacuum gradient.

3. A vacuum furnace for heat-treating batches of small parts, comprising an elongated member having a substantially uniform opening extending therethrough, a plurality of vacuum pumps connected at intervals along said member, a plurality of containers adapted for passage through said elongated member, said containers forming dividers to divide said elongated member into zones having progressively increasing vacuum gradients from the ends to the center thereof, a heating element surrounding the center of said member, and means for establishing a pressure differential to move said containers progressively through said elongated member.

4. A vacuum furnace for heat-treating parts, compris-

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ing an elongated cylinder having a substantially uniform diameter, evacuating means connected at intervals along said cylinder, a plurality of containers for said parts, said containers being adapted for passage through said cylinder, a plurality of piston members positioned between said containers and dividing said cylinder into separate evacuated zones in which the evacuation successively increases from the ends of said cylinder towards the center thereof, and a heating element surrounding said cylinder adjacent the center thereof, whereby said pistons may be moved through increasing stages of evacuation to heating and from heating through decreasing stages of evacuation.

5. A furnace for heat-treating parts in the absence of atmosphere comprising an elongated tube having both ends thereof normally open to atmosphere, a plurality of means for removing atmosphere positioned at intervals along said tube, a plurality of containers adapted for passage in said tube, spacer means positioned between said containers and forming barriers to divide said tube into a plurality of sections, said sections having progressively decreasing atmosphere from the ends thereof inwardly, and heating means positioned around the section of decreased atmosphere.

6. The combination as defined in claim 5 and including means for capping one end of said tube whereby atmospheric pressure causes said containers to move in said tube towards said capped end.

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