

May 8, 1962

M. T. BAKER ET AL
VACUUM FURNACE

3,033,547

Filed July 1, 1957

3 Sheets-Sheet 1

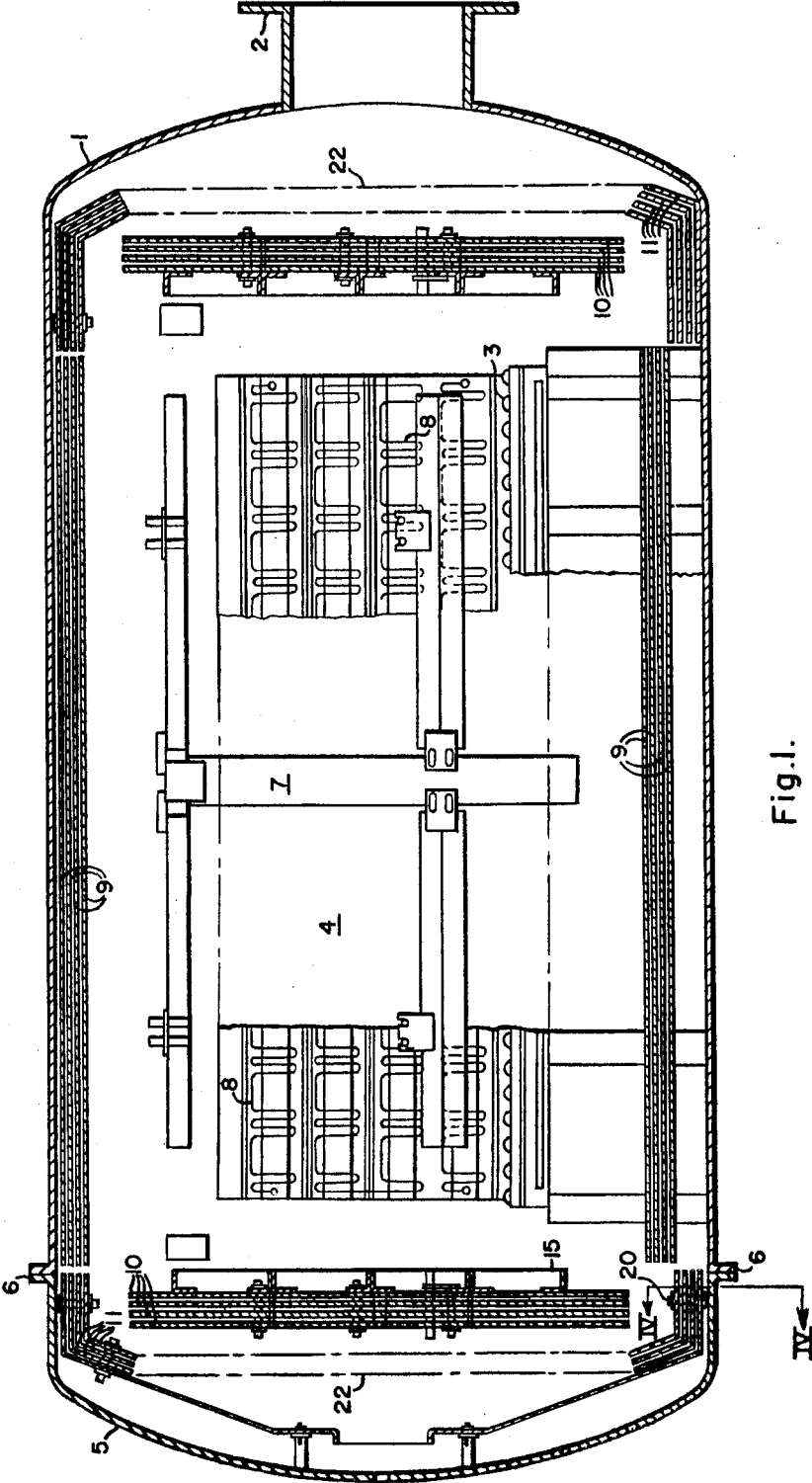


Fig. 1.

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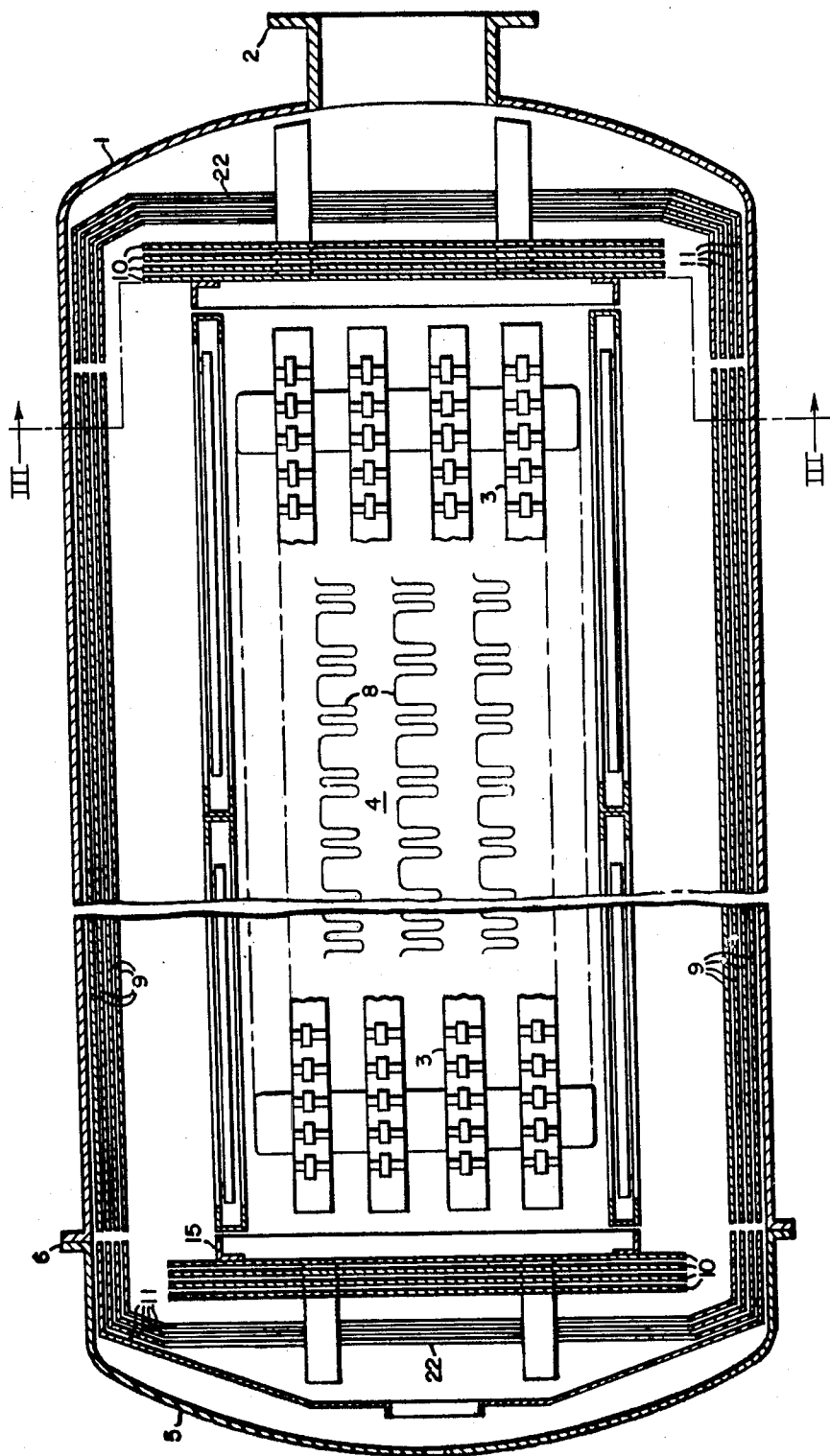


Fig. 2.

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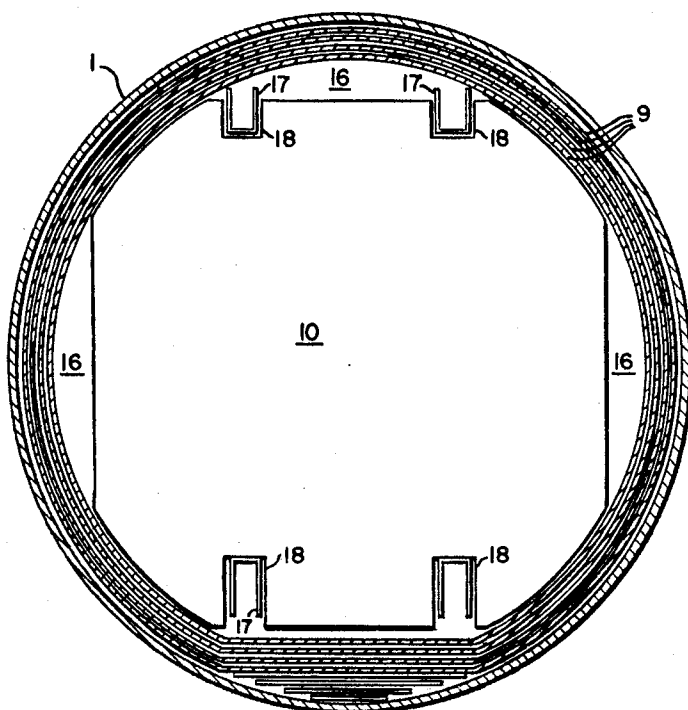


Fig. 3.

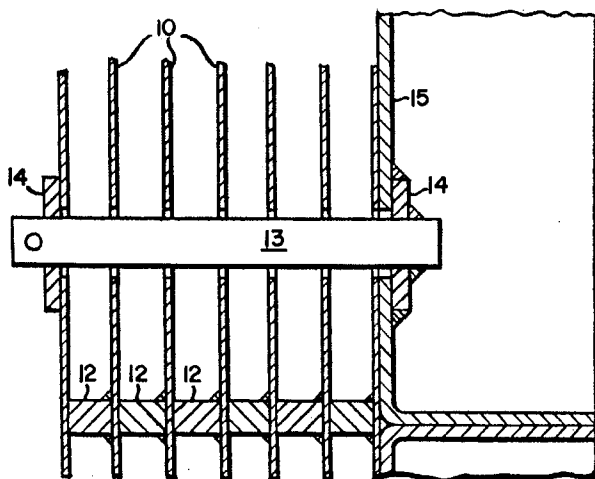


Fig. 5.

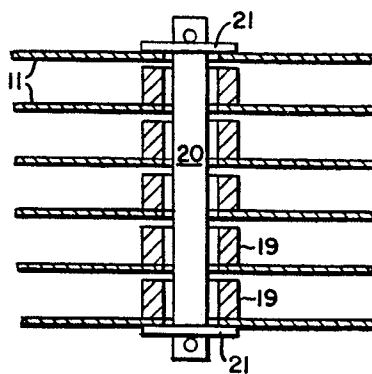


Fig. 4.

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Filed July 1, 1957, Ser. No. 669,037
5 Claims. (Cl. 263-40)

Our invention relates to vacuum furnaces, and more particularly to an arrangement of radiation shields in a vacuum furnace that will facilitate maintaining a high vacuum.

The type of furnace to which our invention relates consists of a housing or outer shell, usually water cooled. Within the housing the work is enclosed by a heating means and radiation shields are disposed between the heating means and the furnace housing for containing and concentrating the heat at the work. Such a furnace operates with a high vacuum within the housing so substantially all the heat generated can be concentrated at the work by reflection from the shields and the housing remains relatively cool.

The vacuum pumping means used to maintain a vacuum within the furnace must continuously pump out a large quantity of impurities in the form of gases that are liberated from within the work itself during the heating cycle. The continuous degassing of the work has been found to be particularly important in the heat treating of titanium and zirconium, as well as other metals. The radiation shields enclosing the work create a problem in the pumping down and degassing of the furnace. If openings are made in the radiation shields for a more efficient pumping system, permitting gas to flow freely out of the housing, the heat losses through the openings would increase to a point where the furnace would be uneconomical to operate. On the other hand if the radiation shields are made continuous with no openings the gases sought to be withdrawn from the housing cannot get out.

The principal object of our invention is to provide a vacuum furnace of the type described above in which the radiation shields are so arranged that minimum impedance to gas flow for pumping down and degassing is accomplishing but at the same time no substantial heat losses are incurred.

Another object of our invention is the reduction of the impedance introduced by radiation shields to the pumping down and degassing of the retort in a furnace of the type described.

Another object of our invention is to provide a vacuum heat treating furnace with an arrangement of radiation shields permitting a more efficient pumping out and degassing without incurring any substantial increase in heat loss through the radiation shields.

Our invention will be more fully understood from the following detailed description, taken in connection with the accompanying drawings, in which:

FIGURE 1 is a vertical longitudinal section of a vacuum heat treating furnace embodying our invention;

FIG. 2 is a horizontal longitudinal section of the vacuum heat treating furnace shown in FIG. 1;

FIG. 3 is a vertical sectional view looking into the end of the vacuum heat treating furnace substantially on a line as shown by the arrows III-III in FIG. 2;

FIG. 4 is a vertical sectional view substantially on a line indicated by the arrows IV-IV in FIG. 1; and

FIG. 5 is an enlarged fragmentary view of a portion of a radiation shield assembly.

FIGS. 1 and 2 show a vacuum heat treating furnace having a furnace housing or shell 1 provided with a means of degassing and pumping down such as a vacuum

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pump (not shown) which may be connected to the flange 2. Tray rollers 3 may be provided at the bottom of the furnace to facilitate the loading and unloading of the furnace heat chamber 4. A shell door 5 provides access to the furnace heat chamber 4 and may be provided with vacuum seal flanges 6 to maintain a proper vacuum-tight seal when the shell door 5 is closed upon the furnace shell 1. A heating rack 7 is utilized for mounting the ribbon heating elements 8 within the heat chamber 4.

Radiation shields are disposed around the heat chamber 4 to contain and concentrate the heat from the heating elements 8 within the heat chamber 4. Generally cylindrical longitudinal shields 9, which may have one side flattened, are located as shown within the furnace shell 1 although shields of any general configuration can be used. End radiation shields 10 of the general configuration illustrated in FIG. 3 are employed at both ends of the work chamber 4. Secondary radiation shields 11 back up the end radiation shields 10 for the purpose described hereinafter. The end radiation shields 10 may be supported in any suitable manner, such as shown in FIG. 5. Small spacers 12 separate the radiation shields 10 one from the other and a pin 13, shown in the figure with collars 14, clamps the entire end radiation shield assembly to the furnace supporting member 15, which may be supported in the furnace in any suitable manner.

As stated previously, the prime difficulty in a vacuum heat treating furnace employing radiation shields is the impedance offered by the radiation shields to the flow of gas to the vacuum pumping means during pump down and degassing of the work chamber 4. Any possible solution of this problem must not result in an increase in the heat loss of the vacuum heat treating furnace to a point that its operation would be uneconomical. Our invention presents a novel arrangement wherein passages of large area are provided for the gas flow but without permitting any substantial heat loss through the radiation shields.

For this purpose the end radiation shields 10 are generally circular to conform to the shape of the longitudinal cylindrical shields 9 but have segmental portions 16 removed to provide large passages for the flow of gas, the configuration being as shown in FIG. 3 with the end radiation shields 10 having means for clearance of the main support members 17 of the furnace herein shown as slots 18. The total cross-sectional area of the segments 16 removed from the end radiation shields 10 preferably approximates the cross-sectional area of the flange 2. In order to prevent direct radiation heat losses through the passages thus formed, the end radiation shields 10 are backed up by the secondary radiation shields 11 which prevent heat loss through the segments 16 removed from the end radiation shields 10. The secondary radiation shields 11 are supported in any suitable manner, such as shown in FIG. 4, wherein the radiation shields are separated by small spacers 19. A pin 20 with a collar 21 at each end holds the entire radiation shield assembly to the furnace shell 1. As shown by FIGS. 1 and 2, the secondary radiation shields 11 are generally cup-shaped, having a cylindrical peripheral portion and a conical section, substantially as shown, with the apex portion of the conical section or a circular area 22 in the center of the cup-shaped shields removed to allow passage of the gases from the work chamber 4 to the vacuum pumping means through the flange 2. The secondary shields 11 extend past the circular segment openings in such a way that there is no straight line path for radiation loss from the heat chamber 4 to the furnace shell 1.

It is now apparent that a large cross-sectional area has been provided for the passage of the gases being

removed by a vacuum pump without any increase in heat loss. The pressure at the vacuum pumping means 2 is closely approximated at the work within the work chamber 4 by providing a cross-sectional area for passage of the gases which is substantially equivalent to the cross-sectional area at the vacuum pumping means itself. In such a manner minimum gas flow impedance and little turbulence results since there is a minimum of change in direction of the gas flow. In addition, through our novel arrangement, we have provided a solution to the difficulties of obtaining a proper rate of degassing for the removal of absorbed gases within the work, thus making it possible to create a high vacuum in an efficient manner.

Although this invention has been described with a certain degree of particularity, it is understood that this present disclosure has been made only by way of example and that numerous changes in the details, combination and arrangement of parts may be accomplished without departing from the spirit and scope of our invention.

We claim as our invention:

1. A vacuum furnace having a housing enclosing a work chamber and having an opening therethrough for evacuating gases from the housing, heating means in the work chamber, and main radiation shields between the heating means and the housing, said main shields including generally cylindrical members and end members disposed at each end and adjacent to but spaced from said cylindrical members, and secondary end shield members disposed opposite the spaces between the cylindrical and end members to permit gas to flow therethrough in indirect paths, the total cross sectional area of said spaces being substantially equal to the cross sectional area of said opening, and said main and secondary shield members together defining an essentially closed work chamber except for said spaces whereby said gas flow is essentially only through said spaces.

2. A vacuum furnace having a housing enclosing a work chamber and having an opening therethrough for evacuating gases from the housing, heating means in the work chamber, and main radiation shields between the heating means and the housing, said main shields including generally cylindrical members, substantially flat end members disposed at each end and adjacent to said cylindrical members, said end members conforming generally to the cylindrical outline of the cylindrical members but having their outer portions shaped to provide generally segmental spaces for the flow of gas, and secondary end shield members disposed opposite said spaces and spaced therefrom to permit the passage of gas, the total cross sectional area of said spaces being substantially equal to the cross sectional area of said opening, and said main and secondary shield members together defining an essentially closed work chamber except for said spaces whereby said gas flow is essentially only through said spaces.

3. A vacuum furnace having a housing enclosing a work chamber and having an opening therethrough for evacuating gases from the housing, heating means in the work chamber, and main radiation shields between the heating means and the housing, said main shields including horizontally positioned generally cylindrical members, substantially flat vertically positioned end members disposed at each end and adjacent to but spaced from said cylindrical members, said end members conforming generally to the cylindrical outline of the cylindrical members but having their outer portions shaped to provide generally segmental spaces for the flow of gas, and generally annular-shaped secondary end shield members having a cylindrical peripheral portion and a conical section

with the apex portion of the cone removed, said secondary members being disposed opposite said spaces and spaced therefrom to permit the passage of gas, the total cross sectional area of said spaces for gas flow being substantially equal to the cross sectional area of said opening through the housing, and said main and secondary shield members together defining an essentially closed work chamber except for said spaces whereby said gas flow is essentially only through said spaces.

4. A vacuum furnace comprising a vacuum tight outer shell member, an opening in said shell member for evacuating gases from said furnace, heating means in said shell member for heating said furnace, and heat radiation shields disposed between said heating means and said shell member, said shields defining a work receiving heat treating chamber and comprising a generally cylindrical member and an end closure member at each end thereof, one of said end members being spaced from said cylindrical member to define space therebetween for evacuating gases from the chamber defined by said shields, and means backing up said space for impeding heat radiation through said space comprising a generally annular shaped heat radiating and gas deflecting baffle member which extends from closely adjacent the end of said cylindrical member corresponding to said one end member to behind the outer side of said one end member and in spaced relationship to said outer side, said opening in said shell member facing the outer side of said one end member, the cross-sectional area of said space being approximately equal to the cross-sectional area of said opening, and said space comprising essentially the sole opening in said chamber for evacuating the same.

5. A vacuum furnace comprising a vacuum tight outer shell member, an opening in said shell member for evacuating gases from said furnace, heating means in said shell member for heating said furnace, and heat radiating shields disposed between said heating means and said shell member, said shields defining a work receiving heat treating chamber and comprising a plurality of generally cylindrical members which are concentrically disposed with respect to each other in spaced relationship, a plurality of generally flat superposed spaced and closure members for each end of said cylindrical members, the end members at one end of said cylindrical members being spaced radially inward therefrom to define space therebetween for evacuating gases from the chamber defined by said shields, and means backing up said space for impeding heat radiation through said space comprising a plurality of generally annular shaped superposed spaced heat radiating and gas deflecting baffle members which extend from closely adjacent said one end of said cylindrical members to behind the outer side of said end members at said one end, said annular shaped members being spaced from said outer side to constitute baffle means for evacuating gases from said chamber through an indirect path, said opening in said shell member being located opposite to the central part of said outer side of said end members at said one end, the cross-sectional area of said space being approximately equal to the cross-sectional area of said opening, and said space comprising essentially the sole opening in said chamber for evacuating the same.

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