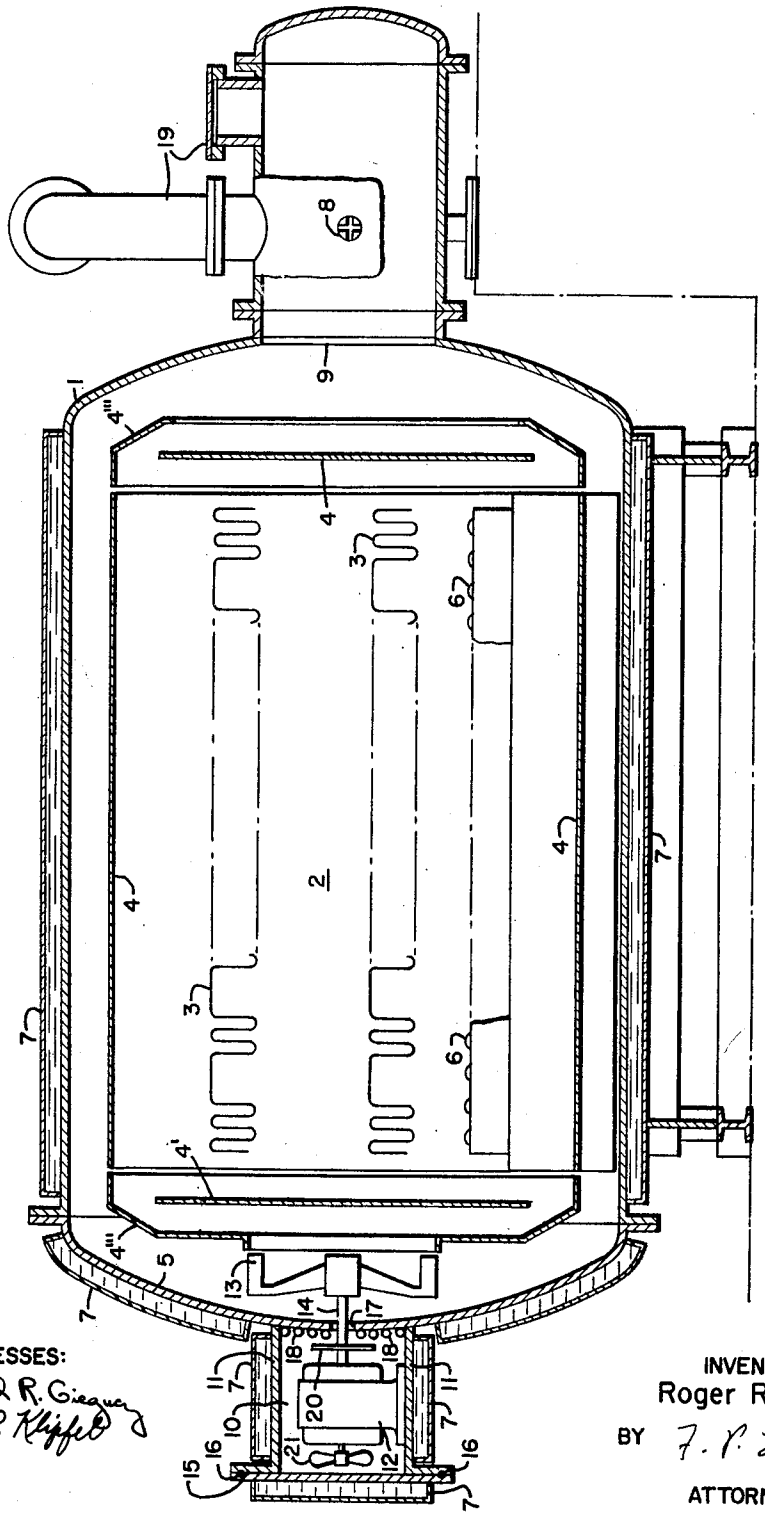
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VACUUM FURNACE

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WITNESSES:

Bernard R. Giegerich

Ernest P. Klipfel

INVENTOR

Roger R. Giler

BY F. P. Lyle

ATTORNEY

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VACUUM FURNACE

Roger R. Giler, Cochranton, Pa., assignor, by mesne assignments, to Sunbeam Equipment Corporation, a corporation of Delaware

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The present invention relates to vacuum heat treating furnaces, and more particularly to a vacuum furnace of the type in which the work charge is cooled by the introduction of coolant gas.

My invention relates to the type of furnace disclosed and claimed in the copending application of M. T. Baker et al., Serial No. 669,036, filed July 1, 1957. Such a furnace consists of a housing or outer shell, usually water cooled, inside of which the work charge is enclosed by a heating means. Radiation shields are disposed between the heating means and the furnace housing thereby containing and concentrating the heat in the work chamber. When such a furnace operates with a high vacuum within the housing, the heat generated therein is effectively reflected to the work charge. A furnace construction that is free from leakage as possible is necessary to maintain the desired vacuum within the furnace.

After the heating cycle, but prior to removal of the work charge, the vacuum heat treating furnace must be cooled so that the work charge does not oxidize when removed from the vacuum furnace. To accomplish cooling of the vacuum furnace and its work charge, an inert cooling gas is usually introduced into the chamber by external means. In the type of furnace disclosed in the aforementioned application a fan or blower system is utilized for circulating the coolant gas within the furnace to absorb heat from the charge and work chamber and to pass across the water cooled outer shell of the furnace to transfer the internal heat out of the furnace, thus using the water cooled shell as a built-in heat exchanger.

In such a furnace, the fan or blower system used to circulate the coolant gas comprises a centrifugal fan disposed within the furnace and a fan driving means. The fan driving means, usually an electric motor located outside the furnace, is connected to the fan within the furnace by a drive shaft which, of necessity, has a rotary vacuum seal which attempts to maintain the vacuum within the furnace.

A serious difficulty is encountered, however, in keeping the desired degree of vacuum within such a furnace because of the leakage of atmosphere into the vacuum furnace through the rotary vacuum seal. Of course, during the cooling cycle, after the coolant gas has been admitted to the vacuum furnace, the problem of sealing the heating chamber is less severe since the pressure differential on the rotary vacuum seal is small. At this same time, the rotary seal is most efficient since the drive shaft is rotating the fan within the furnace. However, the best possible vacuum sealing of the heating chamber is required prior to the start of the cooling cycle since it is during this time that the tightness of the furnace is most crucial. Unfortunately it is the same time when the rotary vacuum seal is least capable of adequately sealing the heating chamber because of the pressure differential on the seal. Rotary seals are to be avoided where possible because of the continual maintenance problem which they present in furnace and other heating applications.

Thus, the basic difficulty is presented of providing an efficient cooling system with a fan and driving means which do not detract from the vacuum required in the furnace during the heating cycle.

The principal object of my invention is to provide a

coolant gas propellent means within a vacuum heat treating furnace in which the heating chamber is effectively sealed from outside atmosphere.

Another object of my invention is to provide a vacuum heat treating furnace capable of undergoing a cooling cycle yet having no rotating vacuum seals.

Another object of my invention is to provide an effective shielding means, in a furnace of the type described, to protect the means driving the fan from the intense heat within the furnace.

Another object of my invention is to provide ready accessibility of the coolant fan propelling means for inspecting and servicing.

My invention will be more fully understood from the following detailed description, taken in connection with the accompanying drawings, the single figure of which is a vertical longitudinal section view of a vacuum heat treating furnace embodying my invention.

From the drawing it will be seen that the furnace housing or outer sheel 1 contains a heating chamber 2 with heating elements 3. The heating chamber 2 is surrounded by radiation shields 4 so as to effectively enclose the heating chamber 2 and allow no direct heat radiation losses. Single radiation shields 4 are diagrammatically shown to represent a plurality of shields and it is to be understood that any selected plurality is intended. The radiation shielding includes a number of coaxial, horizontally extending tubular shields 4 with vertically disposed baffles 4' at the ends thereof to prevent radiation from the ends of the tubular shields. The vertical baffles 4' are spaced from the tubular shields 4 to permit movement of air or gas into or out of the inner chamber within which the heating elements 3 are located. The baffles 4' are backed up by additional baffles which are generally cone-shaped, the right-hand one 4'' providing ingress of coolant gase to chamber 2, and the left-hand one 4''' serving as a fan shroud and providing egress of coolant gas from chamber 2. The members 4 and right-hand members 4' and 4'' can be supported in housing 1 and the left-hand members 4' and 4''' on door 5 by suitable not shown means such as support brackets as will be obvious to those skilled in the art. A suitable access means, shown as a shell door 5, provides entrance to the heating chamber 2 wherein means for supporting the work charge to be heated is shown as tray rollers 6. A water jacket 7 encases the outer shell 1 in heat transfer relation therewith. A port 9 at one end of the furnace serves as a connecting means to the furnace for a pumping system diagrammatically illustrated as ducts 19 through which the furnace is evacuated to any desired degree. For the purpose of cooling the furnace and its charge after the heating cycle, inert cooling gas may be admitted through the same part 9 by means of a valve 8.

After the inert cooling gas is admitted into the furnace, a gas propelling means illustrated as a fan 13, within the heating chamber 2 is rotated so as to draw the coolant gas over and through the work charge in the heating chamber 2. The coolant gas is then directed between the radiation shield 4 and the furnace shell 1 so that heat may be absorbed by the water jacketed shell 7 thereby withdrawing heat from within the furnace, hence returning to the work chamber 2 for recirculation. The flow path of the coolant gas is shown and described in detail in the above-mentioned copending application of M. T. Baker et al., Serial No. 669,036, filed July 1, 1957. The gas propelling fan 13 causes the coolant gas to move longitudinally through the inside of the tubular radiation shields, around the vertical baffle adjacent the fan and thence to the fan. After passing through the fan 13, the air is moved radially outwardly along the inner face of shield door 5 and then longitudinally through the cylindrical space between the shell and the

outermost tubular radiation shield back to the other end of the shell where the coolant gas again enters the tubular radiation shield.

In prior constructions of this type of furnace the fan 13 has been driven by a motor outside the furnace thereby requiring a rotary seal. As previously stated, the basic difficulty encountered in such a furnace supplied with a fan or blower system is maintaining a positive seal of outside atmosphere from the furnace at all times and particularly during the heating cycle where the vacuum within the furnace is most critical.

In accordance with the present invention, an auxiliary chamber 10 is mounted with a vacuum tight seal, such as by welding, on the outside of the shell door 5. A suitable driving means within the auxiliary chamber 10, herein shown as an electric motor 12, is connected to the centrifugal fan 13 within the heating chamber 2 by means of a drive shaft 14. The drive shaft 14 extends through a small opening 17 in the shell door 5 so that the auxiliary chamber 10 communicates with the heating chamber 2.

The driving motor 12 is readily accessible from outside the furnace by means of a removable cover 15 which forms one wall of the auxiliary chamber 10 and which may be fastened thereto in any suitable manner. Standard O-ring type vacuum seals 16, well known in the art, provide efficient vacuum sealing between the removable cover 15 and the auxiliary chamber 10.

It should be noted that the fan motor 12 is energized only during the cooling cycle after coolant gas has been admitted to the heating chamber 2, and therefore, the motor will not operate in a vacuum. The difficulty of cooling the motor 12 in a vacuum so as not to exceed its safe operating temperature limits is thus avoided.

During operation of the motor 12, it may be desirable to recirculate the coolant gas inside the auxiliary chamber 10 by means of a small auxiliary fan 21 to improve the cooling of the motor to ensure its operation within its safe temperature limits. Should the problem of cooling the motor be critical, additional water cooling coils 18 can be disposed within the auxiliary chamber 10. A high temperature vacuum type grease and water cooling of the bearings can be used if necessary to ensure against excessive heating of the motor bearings.

A small radiation shield 20 may be circumferentially mounted on the drive shaft 14 adjacent to the opening 17 in the shell 1 through which the drive shaft 14 protrudes. Such a shield will prevent radiation of heat from the heating chamber 2 to the driving motor 12. Heat transferred to the motor 12 by conduction along the driving shaft 14 may be minimized by using a hollow drive shaft thereby reducing the effective mass capable of transferring heat.

It is now readily apparent that my invention has provided a vacuum heat treating furnace which is effectively sealed from outside atmosphere, while rapid cooling of the furnace during the cooling cycle can be had by a fan within the furnace. Since the fan driving means has been placed inside the vacuum heat treating furnace, the rotary vacuum seal and its attendant difficulties are eliminated.

While I have described my invention with a certain degree of particularity, it is understood that any variations or modificiations within the scope of my invention are meant to be included. It is readily apparent that the auxiliary chamber and the heating chamber can be cooled in many ways. Any type of vacuum tight means capable of enclosing the driving means and providing adequate cooling of the driving means within safe operating temperatures can be utilized. Variations in the auxiliary chamber construction shown may be made and all such modifications are intended to be within the scope of my invention.

I claim as my invention:

1. A vacuum heat treating furnace comprising, an exterior vacuum tight metallic furnace housing, a heat treating chamber within said housing, said chamber being defined by heat radiation plates which are positioned inside said housing and in spaced relationship thereto, heat radiating heaters inside said chamber, and means for cooling said furnace comprising means for supplying a coolant gas into said housing and a fan inside said housing for circulating said coolant gas through said chamber and between said spaced radiation plates and housing, means for driving said fan, an opening formed in said furnace housing, a vacuum tight motor housing mounted on said furnace housing, said motor housing being in vacuum tight communicating relationship with said furnace housing through said opening, said fan driving means comprising a motor in said motor housing, means extending through said opening for connecting said motor and fan in driving relationship, and heat exchange cooling means mounted on the exterior of said furnace housing for extracting heat from said fan circulated coolant gas.

2. In a vacuum heat treating furnace as in claim 1, wherein said means extending through said opening comprises a driving shaft, another heat radiating plate being mounted on said shaft adjacent said opening for protecting said motor from heat radiation from said chamber, said motor housing being metallic, and heat exchange cooling means mounted on the exterior of said motor housing for cooling said motor.

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