Nov. 16, 1948. J. KNIVETON 2,454,253

METHOD OF AND APPARATUS FOR HEATING STACKED BODIES

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Fig. 1.

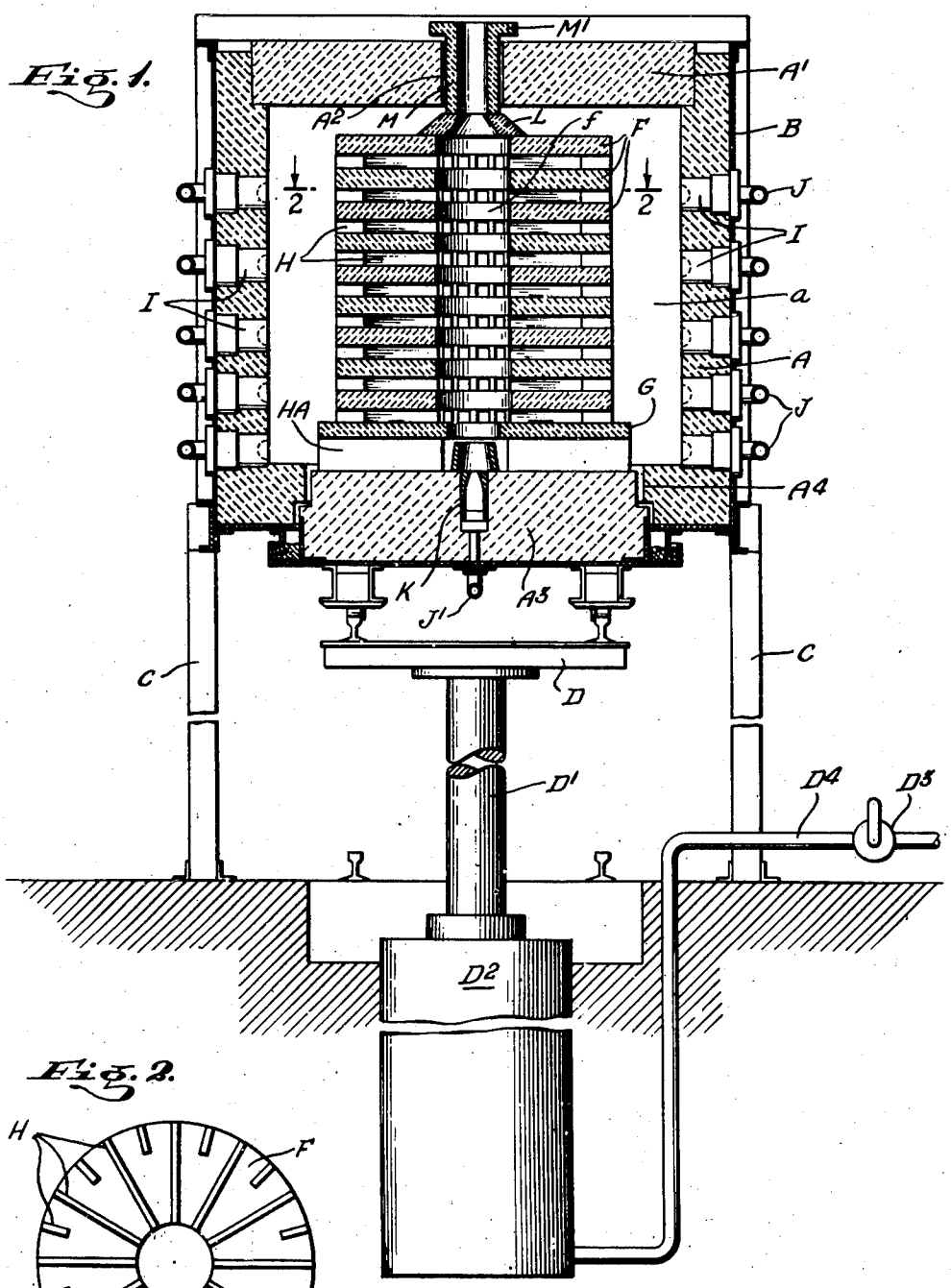

Fig. 2.

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METHOD OF AND APPARATUS FOR HEATING STACKED BODIES

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4 Claims. (Cl. 263—43)

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The present invention relates to gas fired, work heating, furnaces, and particularly to furnaces for heating ceramic bodies to relatively high temperatures such, for example, as temperatures in excess of 2200° F. The general object of the invention is to provide an improved method of, and improved means for heating work bodies in a furnace of the character specified.

A primary object of the invention is to provide a gas fired furnace of the above-mention character with heating means consisting wholly or mainly of furnace wall burners discharging heating gases into the work receiving furnace chamber, and arranged to maintain a desirable circulation of the heating gases sweeping over the surfaces of work bodies arranged in the furnace chamber in a stack formed with heating gas passages extending through the stack and disposed relative to said burners to insure a desirable distribution of heating gas flow through the work stack from said burners to an upper heating gas outlet from the furnace chamber.

The invention may be used with especial advantage in firing annular abrasive wheel bodies of relatively large diameters arranged in a stack with the axes of the different wheels vertical and substantially coincident, so that the central wheel apertures form an uprising flue through which the heating gases may pass to a heating gas outlet in the roof of the furnace and with the sides of the wheel bodies spaced apart to form horizontal passages opening into said flue. A specific and practically important object of the invention is to provide a furnace in which said wheel bodies may be stacked as described, and comprising burners in the furnace wall surrounding the wheel bodies, and a burner mounted in the bottom wall of the furnace and arranged to discharge an upwardly directed jet of heating gases into the lower end of the uprising flue in the work stack. The bottom burner is thus arranged to act as an ejector to draw heating gases, supplied by the other burners into the central flue space of the stack through said horizontal inlet passages which are distributed in a manner to insure a desirably rapid and uniform distribution of the heat supply to the goods stack. As will be apparent, work bodies which are not annular but may be of rectangular and other shapes, may be arranged in a stack formed with a central uprising flue and with passages extending horizontally at different levels into the central flue from the space surrounding the stack.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawing and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

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Of the drawings:

Fig. 1 is a sectional elevation of a furnace;

Fig. 2 is a section taken on the line 2—2 of Fig. 1 through the goods stack in the furnace shown in Fig. 1;

In the drawings, I have illustrated an embodiment of the present invention in the form of a ceramic heating furnace having a vertically disposed cylindrical furnace or heating chamber a surrounded by a cylindrical furnace wall A, and closed at its upper end by a horizontal top wall A′ formed with a central heating gas outlet A^2, and having a removable bottom wall A^3. The furnace wall parts A, A′ and A^3 may be formed in accordance with the usual practice of the furnace art, of refractory material, metal sheathing and framework parts B at the outer side of the refractory material. To facilitate the introduction and removal of the work, the furnace is supported by columns C at a level substantially above the floor level, and the removable bottom wall A^3 of the furnace chamber is arranged for vertical movement down from and up into its normal position, shown in Fig. 1.

As shown, the furnace bottom parts A^3 are mounted on a crosshead or platform D carried by the upper end of the plunger D′ of a hydraulic elevator or jack, having its vertically disposed cylinder D^2 below the floor level. By suitable adjustment of a valve D^3 in a fluid supply pipe D^4, air or liquid under pressure may be supplied to the cylinder D^2 to move the bottom wall A^3 into, and maintain it in the position in which it closes the bottom wall opening A^4. At the end of each heating operation, the valve D^3 may be adjusted to exhaust fluid from the cylinder D^2 as required to lower the bottom wall A^3 and withdraw from the furnace the heated goods stacked on the bottom wall A^3, so that these goods may be removed and replaced by goods to be passed into the furnace chamber and heated therein.

In the particular use of the furnace illustrated, the goods stacked on the bottom wall A^3 are annular abrasive wheels or bodies F, stacked one above the other with their axes all approximately coincident with the vertical axis and the central

top wall outlet A^2 of the furnace chamber. The stack of abrasive wheels F is shown as supported by a coaxial annular disc or slab G of ceramic material. As shown, the slab G is slightly larger in external diameter, and slightly smaller in internal diameter than the wheels F, and has its axis coaxial with the vertical axis of the furnace. To permit gas flow horizontally into the central uprising flue space *f* formed by the registering central openings in the wheels F, the latter are spaced apart by spacers H. The latter may be radially disposed generally as shown in Fig. 2. The support G is spaced away from the removable bottom wall part A^3 by spacers HA which may be generally similar in form and arrangement to the parts H. However, as shown, the vertical extent of the space between the underside of the support G and the top of the bottom wall part A^3 is substantially greater than the vertical extent of the spaces between the adjacent wheels F, and the spacer parts HA may advantageously be made thicker than the spacers H.

The major portion of the heat supplied to the chamber A may be furnished by horizontal furnace wall burners I mounted in the cylinder furnace wall A, and suitably distributed both angularly about and longitudinally of the vertical axis of the furnace. The burners I are preferably supplied with a combustible mixture of air and gas by external piping J, and advantageously are of the type disclosed in the patent of Frederic O. Hess, 2,215,079, of September 17, 1940. The burners I may well be mounted in the furnace wall in the general manner disclosed in the Frederic O. Hess patent, 2,215,080, of September 17, 1940. Such a burner is characterized by its capacity to effect substantially complete combustion within the burner structure and to radiate into the furnace chamber a large portion of the heat liberated.

The furnace heating effect produced by the burners I is supplemented, and a desirable distribution of the heating gas flow in the furnace chamber is effected, by means of a gas burner K centrally disposed in the removable bottom wall part A^3 and supplied with air and gas, preferably pre-mixed for substantially complete combustion, through a pipe J' secured to the underside of the furnace bottom wall part A^3. The pipe J' may be connected to the stationary gas supply piping through flexible pipe connections or through pipe couplings which may be closed and opened at the beginning and end of each furnace heating operation as conditions make desirable. The burner K is advantageously of a type adapted to discharge a high velocity jet consisting substantially entirely of highly heated products of combustion. The burner K may well be of the type disclosed in the patent of F. O. Hess, 2,367,119, of January 1945, and characterized by a combustion chamber having a refractory wall and a restricted outlet to which combustible gas mixture is supplied in divided streams to maintain a combustion chamber pressure which may be a pound or two above the pressure of the atmosphere, thereby insuring a high jet temperature and velocity.

In the preferred construction shown, means are provided to insure that all of the gases passing upwardly through the flue *f* will pass directly out of the furnace chamber through the opening A^2. To this end, a discharge conduit is extended upward from the top of the work stack through the opening A^2. As shown, the conduit comprises an angular body L and a pipe M. The body L

rests on top of the work stack and is in register with the flue *f*, and the pipe M extends through the opening A^2 and normally has its lower end in engagement with the upper end of the annular member L. As shown, the pipe M is provided at its upper end with an out-turned flange M' which is at a level somewhat above the upper side of the furnace top wall A', in the normal operating condition of the apparatus. When the furnace bottom part A^3 is lowered, the parts L and M move down with the work stack until the flange M' of the pipe section M engages the furnace top wall A'. This interrupts the down motion of the pipe M, but the member L continues to move down with the stack until the latter is entirely out of the furnace. The member L may then be removed from the stack of heated work pieces F, and may be put at the top of the next formed stack of work pieces to be heated in the furnace. As the new work stack and the furnace bottom part A^3 are being raised and approach their uppermost positions, the upper end of the annular member L engages the lower end of the pipe section M and the latter shares the final portion of the up movement of the stack. As will be apparent, the members L and M are adapted to act as a chimney extension of the flue *f* throughout the heating operation, notwithstanding such relative expansion of the furnace and work stack as may occur during the operation.

As will be apparent, the invention is adapted for use in heating work bodies of different shapes and formed of different materials, and for subjecting said bodies to different heat cycles. In general, each heating cycle will comprise an initial heating up portion, a soaking or holding portion in which the work is maintained at about the maximum temperature attained in the heating-up operation during a soaking or holding period, and a final cooling portion in which the temperature of the work is gradually reduced to a suitable temperature for removal from the furnace.

By way of example and illustration, it is noted that in forming abrasive wheels of silicon carbide with an external diameter of six feet and an internal diameter of eighteen inches and three inches or so thick, the heating cycle may comprise a heating up portion of 12 hours in which the temperature of the work bodies is progressively raised from the temperature of the atmosphere to a temperature of 2250° F., a holding or soaking period of fifty hours in which the temperature of the work bodies is maintained approximately constant, and a final cooling portion of twenty hours in which the abrasive wheels cool down from their soaking period temperature to a temperature not much in excess of the ambient atmosphere temperature. In some uses of the furnace, the maximum work temperature attained may be even higher than 2250° F., and in others it may be appreciably lower. The duration of each of the heating up, holding and cooling portions of the work cycle may vary with conditions. In particular, with a heating up period of ten hours, the soaking or holding temperature may sometimes be as short as two or three hours, and may some times be one hundred hours or longer. Regardless of the composition and character of the goods, the maximum goods temperature attained, and the lengths of the heating up, holding and cooling periods, the use of the invention makes possible a desirable distribution of the heating gas streams coming into contact with the

work, so that all portions of the work bodies F may be heated with suitable uniformity.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention, as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A method of heating bodies in an enclosed furnace space having a heating gas outlet at its upper end which consists in arranging said bodies in said space in a stack with a vertically disposed central flue in said stack and communicating at its upper end with said outlet, and with horizontal passages extending from the outer side of the stack to said central flue at different levels from the portion of the furnace space at the outer side of said stack, and burning a combustible gas and air mixture in said furnace space portion and thereby radiating heat to said stack and filling said space portion with hot gases, and in burning a combustible gas and air mixture under a pressure higher than that of the atmosphere and thereby producing a jet of highly heated combustion products passing upward through said central flue and thereby aspirating said hot gases into said central flue through said horizontal passages.

2. A heating furnace structure comprising a wall surrounding a heating chamber, a top wall extending over said chamber and formed with an outlet for waste heating gases, and a bottom wall at the bottom of said chamber, spaced furnace wall burners mounted in said vertically extending wall, and a burner mounted in the bottom wall of the furnace to discharge a high velocity hot gas jet upward toward said outlet, and means adapted to cooperate with work pieces to be heated in forming a work piece stack supported by said bottom wall and having an uprising flue space receiving gases discharged by said bottom wall burner at its lower end and passing gases to said outlet from its upper end, and having horizontal passages at different levels distributed about said flue space and leading from the outer surface of the stack to said central flue, whereby the jet discharged by said bottom burner draws heating gases discharged by the first mentioned burners into said central flue at different levels.

3. A furnace structure as specified in claim 2, in which said means includes a pipe mounted in said outlet and adapted to engage said stack and communicate with the upper end of said flue.

4. A furnace structure as specified in claim 3 in which said pipe is movable vertically in said outlet and is adapted to engage and be supported by said stack.

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