# United States Patent [19]

**Vorobeichikov et al.**

[11] **3,876,367**

[45] **Apr. 8, 1975**


[54] **ROTARY FURNACE**


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[22] Filed: **Aug. 2, 1973**

[21] Appl. No.: **384,976**

[52] **U.S. Cl.** ..... **432/116;** 432/233

[51] **Int. Cl.** ..... **F27b 7/38**

[58] **Field of Search** ..... 432/233, 237, 238, 103, 432/115, 116, 81; 34/108, 109, 119, 134, 122; 165/89, 90; 98/121 R, 121 A



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*Primary Examiner*—John J. Camby

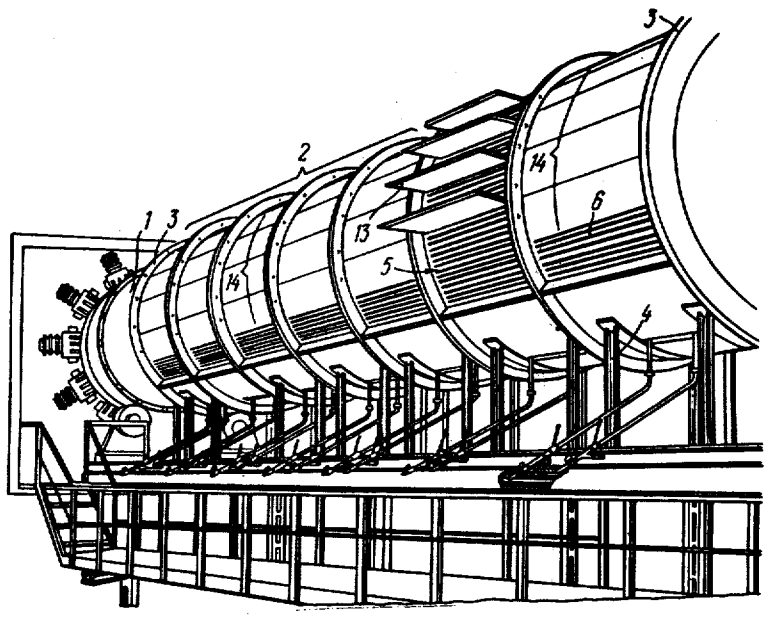
*Assistant Examiner*—Henry C. Yuen



[57] **ABSTRACT**

A rotary roasting furnace operated at high temperature and wherein to cool the furnace casing and thus extend its service life, a system of pipes is arranged concentrically between the shell and the casing of the furnace. The pipe system is mounted on circular ribs enveloping the furnace casing with a gap and resting on respective supports independent of the furnace. The system that mounts the cooling pipes does not interfere with furnace rotation, and this rotation, in turn, does not interfere with the operation of the cooling pipe system.


**7 Claims, 7 Drawing Figures**



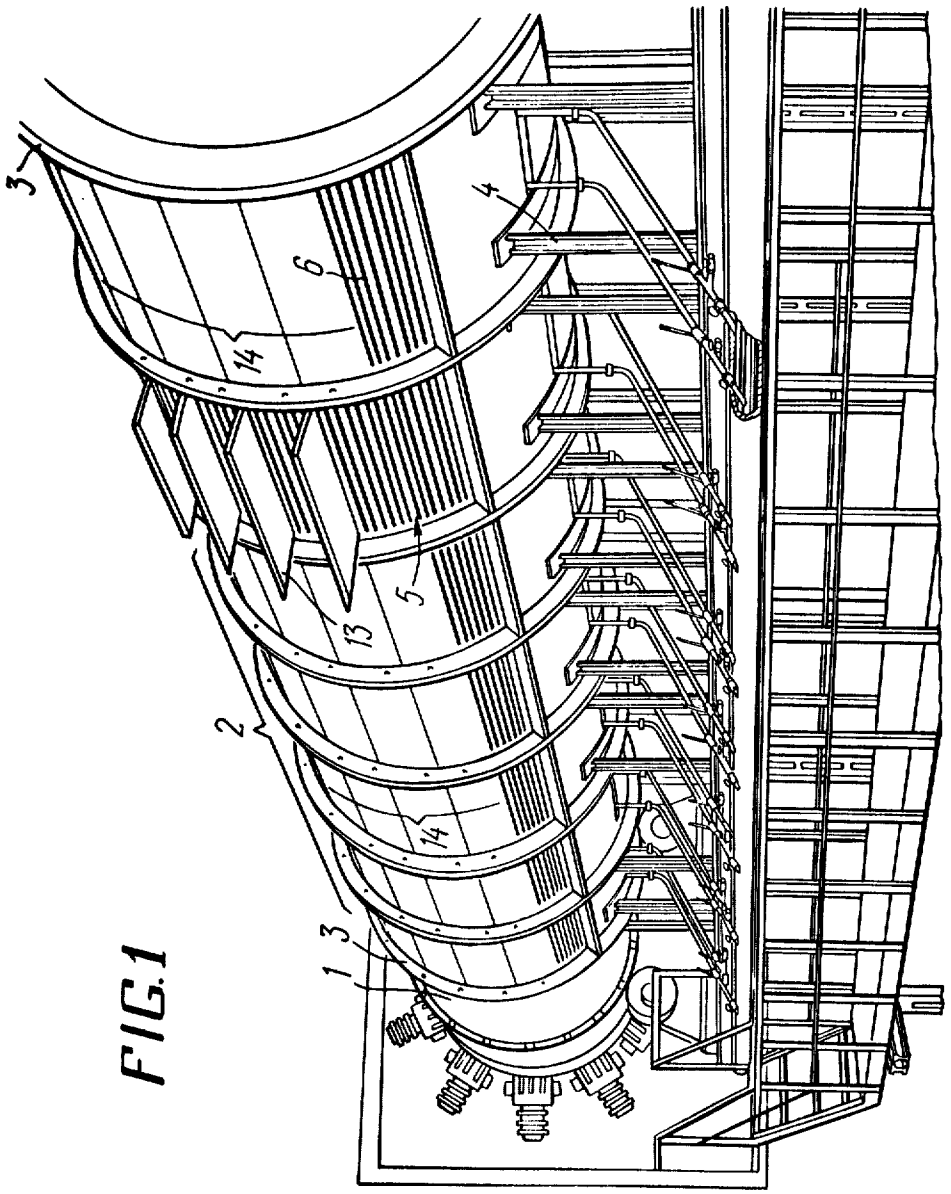



FIG.1

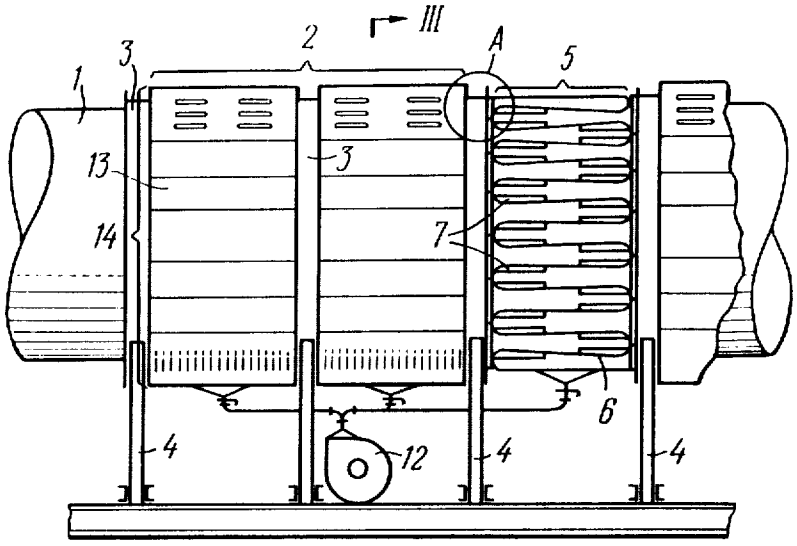



FIG. 2

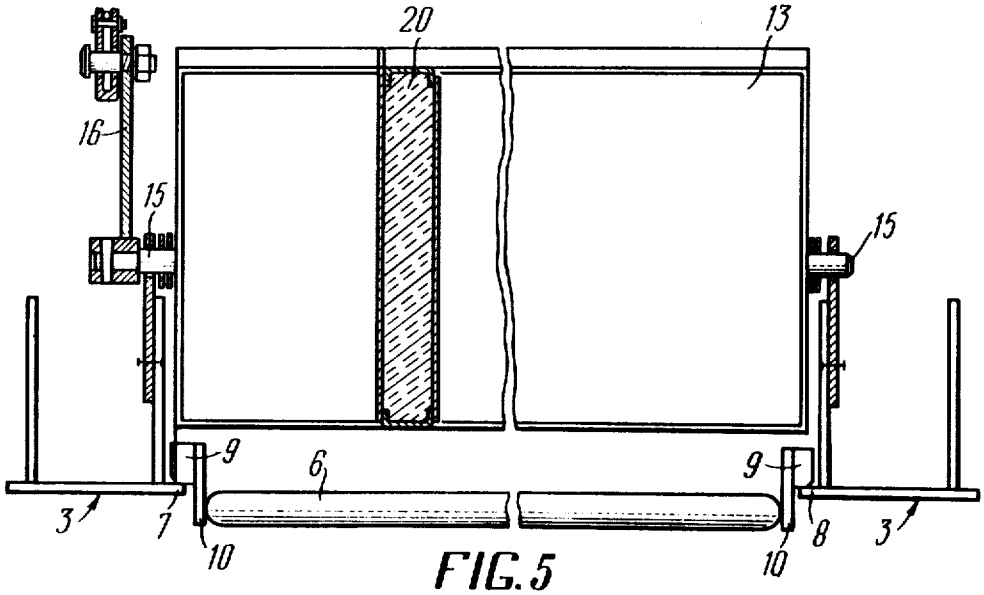



FIG. 5

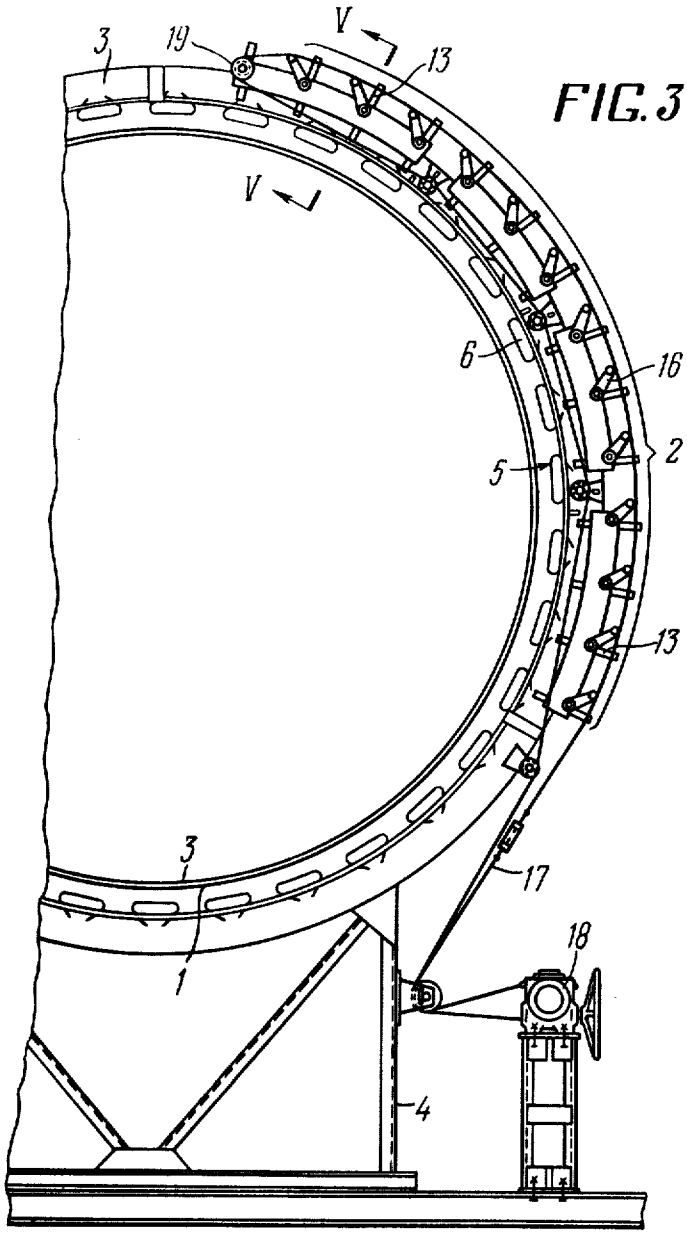



FIG. 3

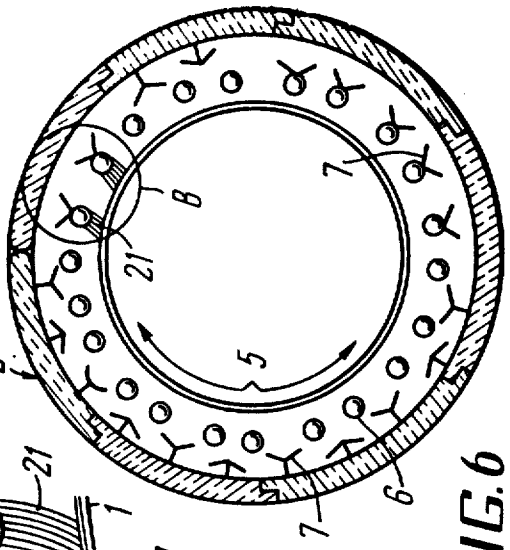



FIG. 6

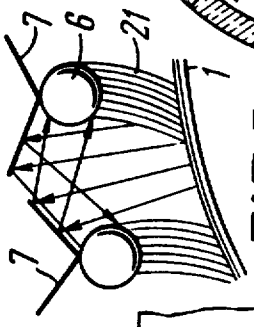



FIG. 7

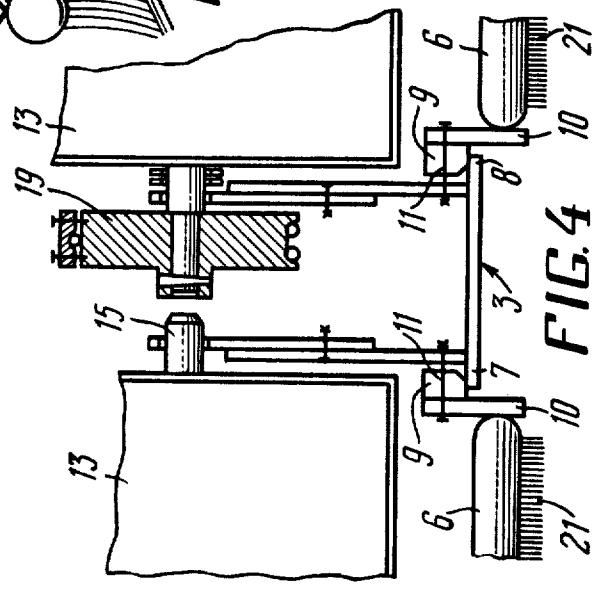



FIG. 4

# ROTARY FURNACE

The invention relates to rotary furnaces employed for high-temperature operations and predominently for roasting. It is well-known that for extending the service life of such furnaces, specifically, their lining, provision is commonly made for external cooling of their casings.

Also known in the art is the air-cooling of such furnaces, achieved by means of ventilating blowers.

This last cooling method permits lowering the temperature of the furnace casing by 40°to 50°C, which is not sufficiently effective. Other disadvantages of the air-cooling method involve untimely failures of ventilating blowers caused by their overheating due to proximity to the furnace proper, difficulty to maintain the ventilation system at high temperatures, and heat deformations in the system of air ducts caused by cutting out of the ventilation system when the furnace is in operation.

Also common in the art is a method of cooling such furnaces by means of wetting their casings.

Unlike air cooling, the wet cooling method is more effective, as it lowers the temperature of the furnace casing by 150°–200°C.

Disadvantages inherent in the wet cooling method are an increased water flow rate, specifically, up to 420 $l/m^2$ per hour as well as considerable corrosion of the furnace casing due to its direct contact with water. Moreover, a sharp temperature difference prevailing between the casing surface and the inner lining surface leads to an elevated thermal stress in the furnace walls, resulting in chipping of of the lining. This largely reduces the service life of the furnace and extends the time that it stands idle on repair.

A disadvantage common to both the air and water cooling of the furnace casing through direct contact with the heat-removing medium lies in unproductive losses of the heat being removed in view of the impracticability of its utilization.

Also known is the cooling of casings of high-temperature furnaces with the aid of a system of heating-removing pipes which circulate a liquid, predominantly water, therein.

The system of heat-removing pipes can be made as a spiral of tubing enveloping concentrically the furnace casing (cf. a rotary furnace according to the Swedish Pat. No. 139318, cl. 80c 1401). Also known in the art are pipe batteries formed by pipes arranged along the casing of a furnace parallel to the longitudinal axis of the latter (cf. a rotary furnace according to the Soviet Author's Certificate No. 255824, cl. 80c).

An advantage offered by the cooling of casings of rotary furnaces by means of the system of heat-removing pipes is the practicability of utilizing the heat removed from the furnace casing. Yet, as seen from related literature, any of the rotary furnaces employing such cooling system fails to provide a successful solution of the problem of their resting in conditions of the furnace rotation, as these pipe batteries cannot rest on the rotating furnace casing; this restricts wide employment of heat-removing pipes for furnace cooling.

A primary object of the invention is to develop a rotary furnace which provides conditions for feasible utilization of the heat removed from the furnace during its cooling.

Specifically, the invention is aimed substantially at solving, for a high-temperature rotary furnace whose



casing is cooled by means of heat-removing pipes, the problem of the support of the system of heat-removing pipes independently of the furnace so that the rotation of said furnace will not interfere with this support and the support members proper do not interfere with the rotation.

Other objects of the invention are to increase the extent of utilization of the heat removed from the furnace, to ensure control of the removal of heat from the furnace depending on the season or for other reasons, e.g., the temperature conditions of the furnace process; accordingly, to extend the service life of the lining and, consequently, the furnace itself through a more rational cooling and a reduced corrosion by excluding the direct contact of the heat-removing medium with the furnace casing; and to reduce the consumption of the heat-removing medium.

The objects of the invention are achieved in a rotary furnace whose casing is cooled by means of a system of heat-removing pipes with a liquid circulating therein and accomodated between the casing of the furnace and its shell, wherein, according to the invention, said heat-removing pipes are mounted on circular ribs enveloping the casing of the furnace with a gap and fitted with their own supports.

The provision of such circular ribs permits making the furnace casing as a louver because in this case it becomes possible to rotatably secure each of the louver flaps on a corresponding circular rib and enable the rotation of these flaps by connecting them with a reversing drive by means of rods. Such arrangement of the casing permits, in to turn, to control of the emission of heat by the furnace casing into a surrounding medium depending on the season of the year, i.e., the ambient air temperature, which reduces the formation of sinter in the furnace and prolongs the service life of the lining, in the long run. Additionally, such shell permits access, when necessary, to the heat-exchanging pipes in different places of the furnace casing and to the casing proper.

Heat is removed most effectively if the system of the heat-removing pipes is constituted as a pipe battery whose coils are tapered, and deflectors are provided above the wider portion of each coil and so sloped that heat emanated onto them from the furnace return to the battery of pipes.

Specifically, the battery coils are made tapering so that the relation of the widest portion of a coil to the narrowest one is 3:1.

Such relation provides the most favorable conditions for the effective removal of heat from the furnace casing and, furthermore, the manufacture of such a battery is largely facilitated technologically, as it is possible to bend pipes into coils by a cold method which is convenient and not laborious.

Whenever still further increase of heat removal is necessary, it is preferred to secure metal brushes onto the battery of pipes on the side facing the furnace casing, said brushes being designed to contact said casing. This helps increase the removal of heat by not less than 25 percent.

There follows hereafter, a detailed description of exemplary embodiments of the invention, reference being had to the appended drawings, wherein:

FIG. 1 is a perspective view of a rotary furnace according to the invention;

FIG. 2 shows the same furnace, in side view, part of the shell being removed;

FIG. 3 is a section on enlarged scale taken along line III—III in FIG. 2;

FIG. 4 is a side elevational view, partly in section and on enlarge scale of detail A of FIG. 2;

FIG. 5 is a cross-section of the furnace taken along line V—V in FIG. 3 showing means for the positioning of deflectors;

FIG. 6 is a diagrammatic sectional view through the furnace; and

FIG. 7 is an enlarged view of detail B of FIG. 6.

The furnace comprises a casing 1 enclosed by a heat-insulating shell 2. Supporting the shell 2 are ring-shaped (circular) ribs 3 surrounding the furnace casing 1 with a gap therebetween. Each circular rib 3 has its own support 4, independent of the furnace. Each of the circular ribs 3 is split and consists of several, here three, parts. Such embodiment of the circular ribs makes their assembly easy. The assembly of said circular ribs is started, when the furnace is in rotation, by mounting one of the members of a circular rib on the supports 4. Then, the other members of each circular rib are secured to this portion of the rib by means of bolts.

Said circular ribs 3 support section 5 of heat removing pipes 6. Each section 5 is fashioned as a pipe battery concentrically enveloping the furnace casing 1 so that the coils of a battery of each section are arranged longitudinally with relation to said casing 1. Each coi is tapered as shown in FIG. 2; the relation of the wider portion of the coil to the narrow portion is 3:1 considering the distance between the axes of a pipe that forms a battery coil. Accomodated in the wider portion of each coil in the space between the furnace shell 2 and the sections 5 of the particular battery are deflectors 7 (FIGS. 2, 6 and 7) secured on pipes 6 or on said shell 2. FIG. 6 shows both the variants of securing said deflectors on the pipes 6 and on the shell 2.

The sections 5 of the battery rest on shelves 8 (FIGS. 4 and 5) of the circular ribs 3 by means of junction plates 9 welded to flanges 10 of each section 5. At places where said junction plates 9 are spaced, said flanges 10 are connected with the circular rib 3 by means of bolts 11 (FIG. 4). The deflectors 7 are inclined as shown in FIG. 6 so that heat radiated onto them from the furnace casing 1 will be reflected onto the surfaces of the battery pipes facing the shell. Such arrangement of the battery helps appreciably increase the absorption of the furnace heat by the battery. The most optimal shape of the battery coil is that in which the ratio of the widest portion to the narrowest portion is 3:1. The manufacture of a battery with coils of the abovedescribed form is, simpler as it permits cold bending of the pipes. Since the circular ribs 3 envelop the furnace casing 1 with a gap and have their own respective supports, they do not interfere with the furnace rotation, while the rotation of the furnace does not affect the positioning of the circular ribs 3 and the heat-removing sections 5 secured thereon.

As the heat-removing sections 5 are fixed, it is easy to achieve forced circulation of the liquid inside the heat-removing pipes and the removal of this liquid for the utilization of its heat. For a more effective cooling of the furnace casing 1, it is possible to cool it with air by means of a ventilating blower 12 (FIG. 2).

The provision of the fixed circular ribs 3 makes it possible to fashion the furnace shell 2 as a louver whose flaps 13 (FIGS. 1-5) are arranged in circular rows 14 (FIGS. 1 and 2) concentrically enveloping the furnace casing 1. Each of the flaps 13 is mounted in two neighboring circular ribs 3 on shafts 15 (FIGS. 4 and 5), being rigidly connected therewith. In their turn, the shafts 15 of each flap are mounted rotatably in two neighboring circular ribs 3. Secured rigidly on one of the two shafts 15 of each flap 13 is a lever 16 (FIGS. 3 and 5). The levers 16 of all the flaps 13 of one circular row 14 are arranged on one side of the flaps 13. Said levers 16 of the flaps 13 of one circular row 14 are connected, by means of a flexible pull rope 17 (FIG. 3), with a reversing drive 18. The shafts 15 also bear guide rollers 19 (FIGS. 3 and 4) for the pull rope 17. The rope need not necessarily be flexible and in lieu thereof a rigid member can be provided. The drive can not only be manual but of other type as well, e.g., electrical, hydraulic or pneumatic. The flaps 13 are preferably made with a heat-insulating layer 20 (FIG. 5) for better heat insulation and reduced unproductive loss of heat.

The provision of the louver-like shell 2 permits control of the removal of heat from the furnace casing 1, depending on the operating conditions of the furnace and the ambient air temperature. In case of overheating of the casing, heat removal from the casing 1 can be increased by adjusting the size of the openings of the flaps 13 at will. The opening of the flaps can be effected in a local zone or throughout the length of the furnace casing 1. By turning the flaps 13 with the aid of the drive 18 it is possible to control the intensity of heat emanation from the furnace. In winter time, when the air temperatures are low, the flaps 13 are usually closed completely to prevent overcooling of the casing as well as to avoid unproductive loss of heat. In such a case, the utilization of the heat removed from the furnace by means of the heat-removing pipes will prove most effective.

To improve the heat transfer from the furnace casing 1 to the pipes 6 of the battery whenever substantial cooling of the casing is required, it is expedient to provide metal brushes 21 on the pipes 6 at the side facing said casing 1, the length of said brushes being such as to ensure their contact with the furnace casing.

Securing the brushes 21 to the pipes 6 presents no difficulty and can be effected in any suitable manner, e.g., by welding, by means of clamps mounted pipes 6, etc.

What we claim is:

1. A rotary furnace comprising: a rotatable furnace casing, a stationary shell enclosing said casing and including a succession of longitudinal sections surrounding said casing, circular ribs surrounding said casing, said ribs being accommodated between and secured to the sections of said shell, said ribs being spaced from said casing, fixed support means independent of said casing and supporting said ribs, said sections each including a system of cooling pipes extending longitudinally with respect to said casing and having a cooling liquid circulating therein, said pipes being mounted on said circular ribs parallel to the axis of rotation of said furnace casing and concentrically enveloping said casing, said sections of the shell further including louvers with flaps, means rotatably mounting said flaps on said circular ribs and surrounding said cooling pipes, said flaps comprising heat insulative material and actuating means connected to said flaps for varying the angular

position thereof and the degree of opening of the louvers.

2. A furnace as claimed in claim 1 comprising stationary deflector means disposed between said pipes and louvers and surrounding said pipes for reflecting heat radiated from said furnace onto said pipes.

3. A furnace as claimed in claim 2 wherein said deflector means is supported from said pipes.

4. A furnace as claimed in claim 3 wherein said deflector means is supported from said shell.

5. A furnace as claimed in claim 2 wherein said pipes are tapered longitudinally, said deflector means being mounted at the widest portion of the pipes.

6. A furnace as claimed in claim 2 comprising metal cooling brushes secured to said pipes along the lengths thereof and contacting said casing to promote heat exchange.

7. A furnace as claimed in claim 5 wherein the taper of the pipes is such that the ratio of the widest portion of a coil to the narrowest portion is 3:1.

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