United States Patent [19]

Pavlov et al.

[11] **3,866,673**

[45] **Feb. 18, 1975**

[54] **HEAT EXCHANGER FOR COOLING ORE CINDERS**

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[22] Filed: **Oct. 16, 1973**

[21] Appl. No.: **406,922**

[52] **U.S. Cl.** **165/120,** 34/177, 165/96, 165/104, 165/109, 222/200

[51] **Int. Cl.** **F24h 3/02**

[58] **Field of Search** 165/109, 120, 93, 82, 109, 165/104, 117, 96; 222/200, 197; 34/177

[56] **References Cited**

UNITED STATES PATENTS

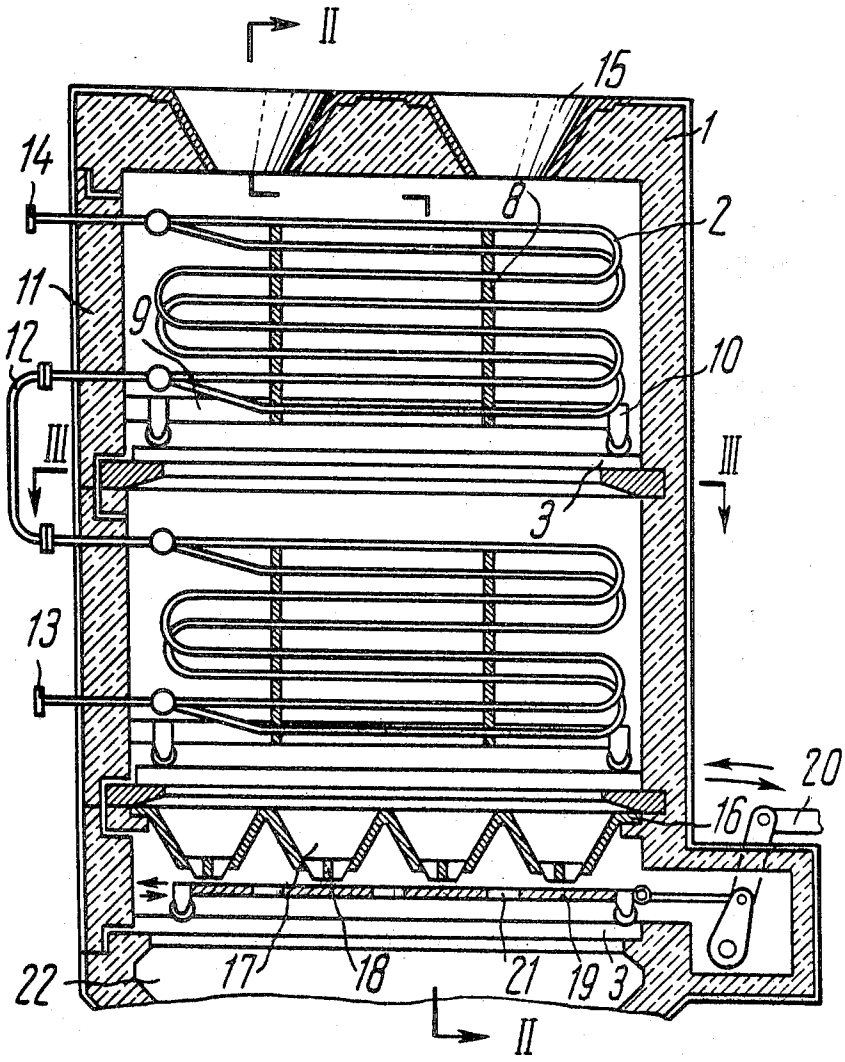
112,118	2/1871	Buckingham	34/177
241,924	5/1881	Buswell	222/200
445,536	2/1891	Brockman	165/96
707,062	8/1902	Heineman	222/197
2,519,148	8/1950	McShea	165/120
3,372,742	3/1968	Forner	165/96

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Assistant Examiner—Daniel J. O'Connor
Attorney, Agent, or Firm—Holman & Stern

[57] **ABSTRACT**

In a heat exchanger for cooling lumpy materials, there is provided a discharging means defined by a plurality of slot-shaped holes formed in the bottom of the heat exchanger and located parallel to each other, and under which holes a perforated plate is installed for a reciprocating motion. A strip is mounted in each slot-shaped hole and along thereof, protruding beyond the lower edge of said hole and pushing the material being cooled to the holes in the perforated plate when the latter is in motion. This ensures uniform discharging of the heat exchanger over its entire cross-sectional area.

1 Claim, 5 Drawing Figures



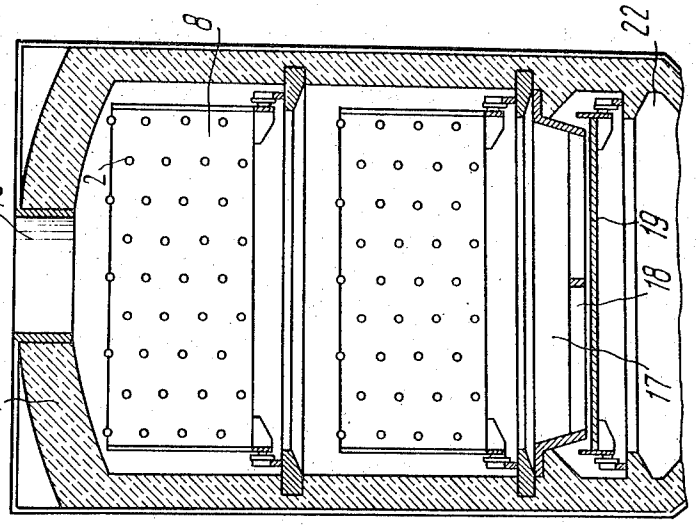

8
22
15
2
19
18
17
1

FIG. 2

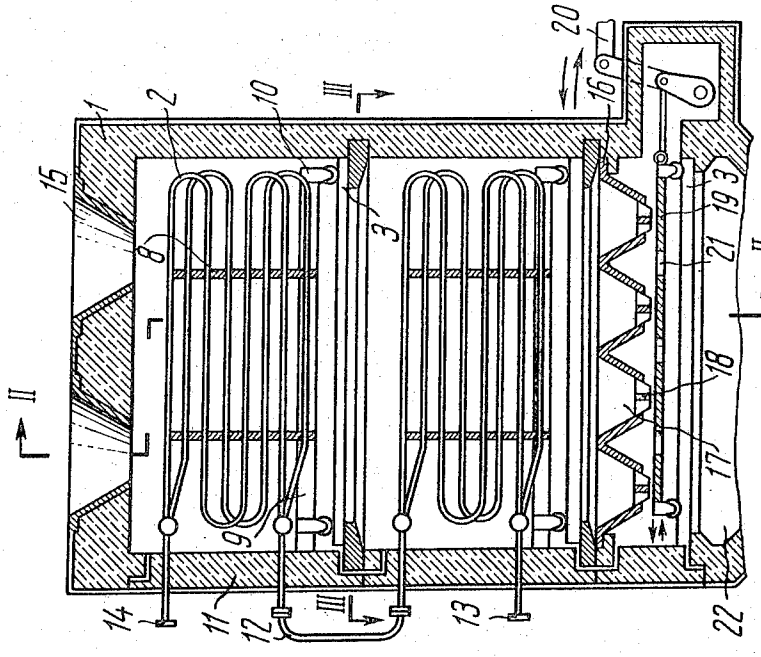

20
16
1
2
10
III
15
8
3
19
21
II
18
17
II
9
14
11
12
III
13
22

FIG. 1

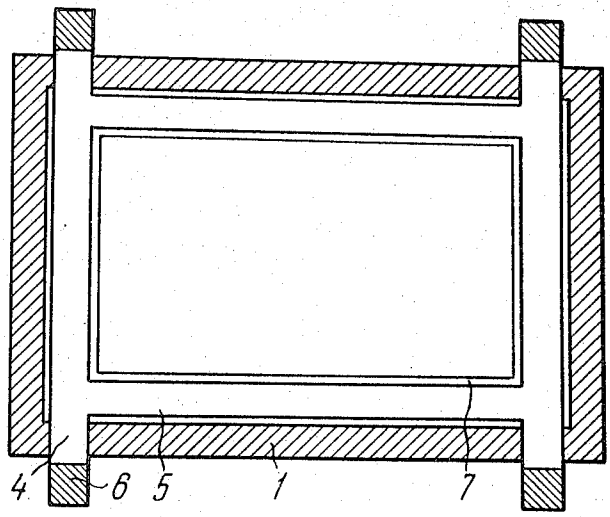


FIG. 3

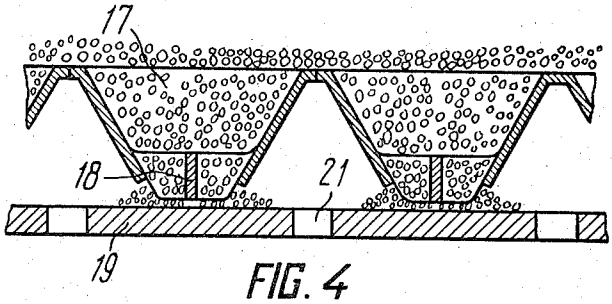


FIG. 4

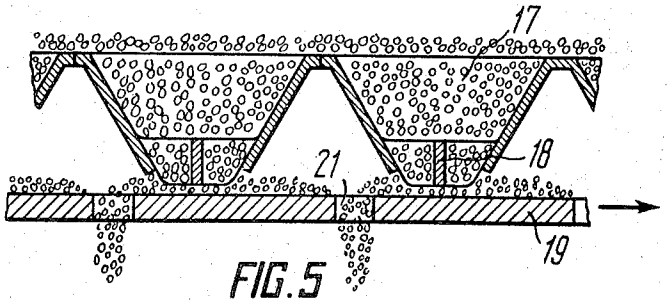


FIG. 5

HEAT EXCHANGER FOR COOLING ORE CINDERS

BACKGROUND OF THE INVENTION

The present invention relates to equipment for cooling hot lumpy materials and more specifically to heat exchangers.

This invention may be utilized in the production of ferrous and non-ferrous metals, in chemical and other industries.

It can be most efficiently used for cooling mercury-containing ores upon their calcination with a possibility for further utilization of the heat of cinders in different industrial applications.

The mercury production technology includes an ore calcination process in fluidized bed furnaces at a temperature of 500°–600°C. The residual product in this process is cinders representing a lumpy material with a lump size up to 30 mm. The temperature of the cinders upon the calcination is 450°–500°C, whereas according to sanitary regulations, the cinders may be conveyed to a dump or further treatment at a temperature not above 150°C to avoid liberation of mercury vapors therefrom. Cooling down the cinders to this temperature makes it possible to utilize borrowed heat in the heat supply system of a plant.

PRIOR ART

Known in the art is a heat exchanger intended for cooling lumpy materials, particularly ore cinders, comprising a housing with tubular sections horizontally located therein and connected to each other by adapters for passing water used for cooling the material fed through charging openings in the upper portion of the heat exchanger and unloaded through a discharging outfit installed in the bottom thereof.

In the known designs of heat exchangers, the discharging outfit represents a hopper used for disposing of the material being cooled. Such a design entails a non-uniform lowering down of the material under its weight inside the housing of the heat exchanger, and an intensive mixing of the material occurring opposite to the discharge opening of the hopper. This results in a heavy wear of the tubes at the places of most intensive movement of the material being cooled. Apart therefrom, stagnant zones are unavoidable in such a discharging outfit, whereby cooling of the material is hampered.

Another disadvantage of the known design is associated with a slight heating of cooling water due to the non-uniform movement of the material.

One more disadvantage of this heat exchanger design is a difficult repair procedure in replacing faulty cooling water tubes, because this requires the entire production line to be brought to a standstill.

OBJECTS AND SUMMARY OF THE INVENTION

It is a general object of the present invention to obviate the above disadvantages and provide a heat exchanger permitting a uniform movement and cooling of the material and allowing the borrowed heat to be utilized for industrial needs.

These and other objects are achieved due to the provision of a heat exchanger comprising tubular sections horizontally installed therein and connected to each other by adapters for passing water used for cooling the lumpy material fed through charging openings in the upper portion of the heat exchanger housing and unloaded through a discharging means installed in the bottom thereof.

According to the invention, the discharging means includes a plurality of slot-shaped holes in the bottom of the heat exchanger and located parallel to each other and having their cross section shaped as trapeziums facing with their smaller base down, and a perforated plate mounted with a possibility of reciprocating motion under the holes, and a strip installed in each hole and along thereof and protruding beyond the lower edge of the hole and guiding the material being cooled to the holes in the plate when the perforated latter is moved in a lateral direction in relation to the slot-shaped holes.

With this arrangement, the discharging means of the heat exchanger ensures uniform movement of the material over the entire cross sectional area involved and ultimately the intensive cooling thereof with possible utilization of the borrowed heat.

In order that the invention may be clearly understood the actual design of the heat exchanger will now be fully described with reference to the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal section through a heat exchanger for cooling ore cinders;

FIG. 2 is a section along line II—II in FIG. 1, the view looking in the direction of the arrows;

FIG. 3 is a section along line III—III in FIG. 1, the view looking in the direction of the arrows;

FIG. 4 is a schematic view of a discharging outfit shown in neutral position, and

FIG. 5 is a schematic view of a discharging outfit shown at the moment of discharging ore cinders into the holes made in the plate.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a heat exchanger comprises a housing 1 defined as a vertical rectangular-section well with thermally insulated walls. Installed in the housing 1 are tubular sections 2 with horizontal positioning of tubes within each section. The sections 2 are positioned one above the other. Each section 2 is adapted for being moved into and out of the housing along rails 3 secured to longitudinal beams 4 of a bearing metal structure which takes the weight of the sections 2.

The longitudinal beams 4 and also cross beams 5 of the bearing metal structure rest on support columns 6 installed beyond the housing 1. The above mentioned beams are protected against wear by means of lips 7. The longitudinal beams 4 and cross beams 5 are made of double-tee rolled stock connected in such a way that they have a box cross section to be cooled with water flowing therethrough.

Each section 2 represents a pipeline bent into a coil so that in a cross-sectional view, the tubes are located in a staggered fashion. In addition, the tubes in the coil of each section 2 are supported by two vertical partitions 8. The intervals between the tubes in the coil are chosen so as to allow the passing of five largest lumps of cinder. Each section 2 is located on a rectangular frame 9 assembled of rolled beams in a such a manner that its longitudinal and cross members are box-sectioned. Secured to the frame 9 are rollers 10 and a

thermally insulated flange **11** of the housing **1**. The flange is adapted to close an aperture in the housing **1** after the section **2** is rolled into the housing along the rails **3**.

The tubes of the sections **2** are successively connected to each other by adapters **12** disposed outside the housing **1**. Cooling water is supplied into the coils of the sections **2** through a lower inlet manifold **13** and flows out through an upper outlet manifold **14**. The number of sections **2** installed in a heat exchanger depends on the temperature of the cinders brought into the housing **1** through charging openings **15**, as well as on the amount of cinders brought per time unit and on the diameter and length of the pipeline.

Installed below the lower section **2** is a discharging means comprising a multitude of slot-shaped holes **17** provided in a bottom **16** of the heat-exchanger and having their cross section shaped as trapeziums having their smaller base facing downwardly.

The walls of the holes **17** are inclined at an angle which is equal to the angle of repose for the material being cooled.

Mounted along each hole **17** is a strip **18** protruding beyond the lower edge of the hole and dividing the area of the hole into two equal parts. The minimum cross-sectional area of the hole **17** is chosen with the aim of a free flowing of cinders at both sides of the strip **18**.

Located below the bottom **16** of the heat exchanger is a perforated plate **19** which is equipped with rollers **10***a* and which can be rolled into the housing **1** along rails **3***a*. Upon rolling the plate into the housing, the aperture in the housing **1** is closed by a thermally insulated flange **11***a*.

When installing the plate **19**, the distance between the latter plate and the strips **18** has to be somewhat larger than the maximum size of a cinder lump. The plate **19** is connected by two rods to a drive unit **20** which imparts to the plate a reciprocating motion. The drive unit **20** is preset for a definite value of the stroke of the plate **19** and a certain number of strokes performed per minute.

The drive unit **20** includes an electric motor which is variable within a wide range of speeds and which develops a constant torque at variable rmp speeds.

The plate **19** is placed beneath the slot-shaped holes **17** in such a way that when it is in the neutral position, the holes **21** in said plate are located at an equal distance from the strip **18**. At such mutual position of the holes **17** and the plate **19**, each hole **17** is located above a solid portion of the plate **19**, confined between the holes. The cross-sectional area of each hole **21** in the plate **19** should be at least three times greater the maximum size of a cinder lump.

The stroke value of the plate **19** is matched with the interval between the holes **21** so that when the plate **19** is stopped in its extreme position, the cinders trapped at the angle of repose in the space between the lower edge of the slot-shaped holes **17** and the plate **19** would not flow into the holes **21** in the plate **19**.

Installed below the discharging means is a hopper **22** provided inclined walls. The angle of wall incline in the hopper **22** is equal to the angle of repose of the material being cooled. The hopper **22** is adapted to direct cinders from the heat exchanger housing into the equipment mounted beneath and intended for the further cooling and conveyance of cinders.

The walls of the hopper **22** are covered on the inside with a layer of heat-insulating material fixed by ribs (not shown in the drawing) which are secured laterally to the walls of the hopper **22**. The ribs protrude above the surface of the heat-insulation layer and constantly hold lumps of cinders thereon, thus reducing the abrasive wear of the heat-insulation material.

Installed in the housing **1** of the heat exchanger, above the upper section **2** is a protection arrangement (not shown in the drawing) to protect the tubes against heavy wear in the course of filling the housing **1** with cinders.

The protection arrangement is assembled of V-section rolled members positioned along the upper row of tubes of the upper section **2**, with their apices facing down.

Positioned inside the housing **1** and the hopper **22** of the heat exchanger are level indicators (not shown) to indicate the extreme limits of charged cinders. The normal level is when it is not below the upper row of tubes of the upper section **2**.

A level indicator installed in the hopper **16** transmits a signal when the hopper is fully charged, to prevent seizing of the plate **19**.

The heat exchanger operates as follows:

Cinders at a temperature of 450°–500°C are introduced through the charging openings **15** into the housing **1** to fill the intertube space in the sections **2** and slot-shaped holes **17**. From these holes **17** cinders pour out onto the plate **19** spreading uniformly over the plate on either side of the strip **18** at an angle of repose and occupying the space between the lower edge of the hole **17** and the plate **19**, thus blocking the further outflow of material from the holes **17** and naturally from the intertube space in the heat exchanger, as well.

The housing **1** is charged up to the normal level which is 0.3–0.5 m above the tubes of the upper section **2**. Then, the drive unit **20** is activated and the plate **19** initiates a reciprocating motion on the rollers **10***a* along the rails **3***a*.

During the travel of the plate **19**, cinders are transferred from the housing **1** into the hopper **22**. The travel speed of the plate **19** is chosen in accordance with the rate of charging cinders into the heat exchanger with a view of maintaining a relatively constant level of cinders in the housing **1**.

When the plate **19** is moving to the right (as in the drawing), the holes **21** in the plate **19** are moved below the cinders held by the strip **18**, while the cinders located to the left thereof drop into the holes **21**. At the same time, the cinders located to the right of the strip **18** are being shifted to the right from the strip **18** together with the plate **19**. The emptied space between the plate **18** and the cinders shifted together with the strip **19** is then filled with cinders coming down from the slot-shaped holes **17**. During the reverse travel to the left, the strip **18** holds cinders located to the left thereof, whereas the plate **19** when slipping underneath brings the holes **21** positioned to the right of the strip **18**, for cinders to come down.

Simultaneously, cinders from the holes **17** come down onto the plate **19** to the left of the strip **18**, and so on.

Thus, when the plate **19** is in motion, the material is continuously pouring through the slot-shaped holes **17** and holes **21** in the plate **19** from the housing **1** into the hopper **22**.

The slot-shaped holes **17** are arranged uniformly over the entire bottom **16** of the heat exchanger, thus providing a uniform sinking down of the cinders through the cross-sectional area of the housing **1**, i.e., no stagnant zones occur in the intertube space. With this movement of cinders in the intertube space of the housing **1**, the heat-exchanging process between the hot cinders and cooling water flowing in the tubes of the sections **2** is effected most efficiently.

If the travel speed of the plate **19** is insufficient, that is the heat exchanger is discharged slower than charged through the openings **15**, the level of the cinders reaches the extreme permissible upper limit. This is shown by the level indicator and the drive unit **20** is then shifted to a higher operating speed.

If, however, discharging is effected more intensively, the drive unit **20** is shifted to a lower operating speed due to a signal transmitted by the level indicator in the housing **1**.

Speed control is performed either automatically or by an operator from a control post.

In case the hopper **22** is not discharged, the level of cinders therein can reach the extreme permissible upper limit. To avoid seizure of the plate **19** with the cinders, charging the latter into the heat exchanger should be discontinued and the drive unit stopped.

Water used for cooling the cinders which are uniformly sinking down through the intertube space of the heat exchanger housing **1**, passes the following route:

Cooling water is supplied into the hollow longitudinal beams **4** and cross beams **5** of the bearing metal structure of the heat exchanger and also into the beams incorporated in the frames **9** of the sections **2**. Then, water flows to the inlet manifold **13** of the lower section **2**. Water flows through the coil of the lower section **2**, then via the adapter **12** enters from underneath the next section **2** mounted above and so on until the extreme upper section **2** is reached in which via the outlet manifold **14** hot water flows out to be utilized for industrial or domestic purposes. Generally, the temperature of cooling water is raised to 60°–90°C, while the cinders are cooled down to 100°–150°C.

A heat exchanger of the present design can be incorporated in an automatic production cycle in combination with other production equipment.

When two heat exchangers operating in parallel are installed in a production line, small repairs can be performed without stopping the production process. For example, any of the sections **2** can be readily replaced when there is no material at the level of this section. For this purpose, the entire section is merely rolled out from the housing **1** of the heat exchanger along the rails **3**.

The heat exchanger according to the invention eliminates formation of stagnant zones therein, which improves heat-exchanging conditions and increases operational reliability.

What we claim is:

1. A heat exchanger for cooling lumpy material, particularly ore cinders, comprising a housing having an upper portion and a bottom portion; tubular sections located horizontally one above the other in said housing and adapted for passing cooling water; adapters successively connecting said sections to each other; said heat exchanger housing having charging openings in its upper portion; said bottom portion being provided with slot-shaped holes parallel to each other and having their cross section shaped as trapeziums having their smaller base facing downwardly; a perforated plate reciprocably mounted underneath said bottom portion of the heat exchanger being capable of reciprocating motion in a direction perpendicular to the holes in the bottom portion; a strip installed along each hole in said bottom portion and protruding beyond the lower edge thereof and serving for directing the material being cooled to the holes in said perforated plate, when the latter is moving.

* * * * *