Feb. 11, 1941. T. R. BROWN 2,231,249

HEAT EXCHANGE APPARATUS

Filed June 5, 1939

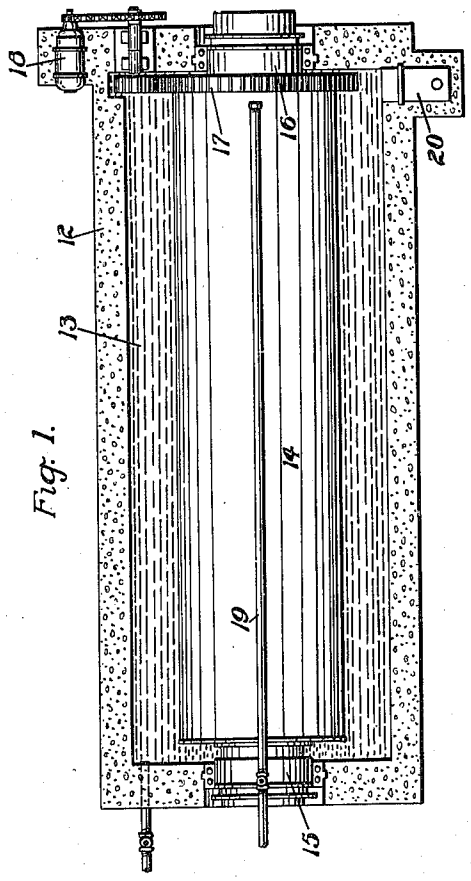


Fig. 1.

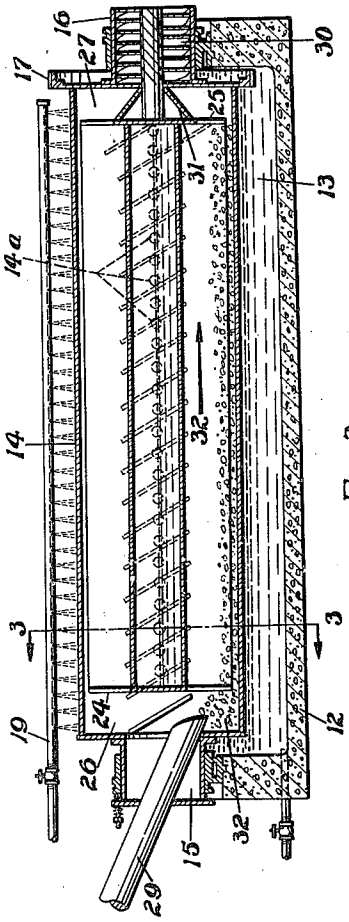


Fig. 2.

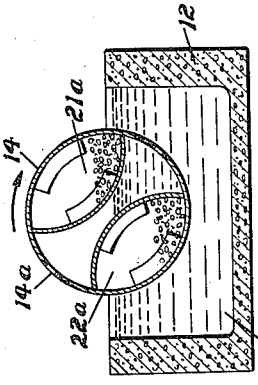


Fig. 4.

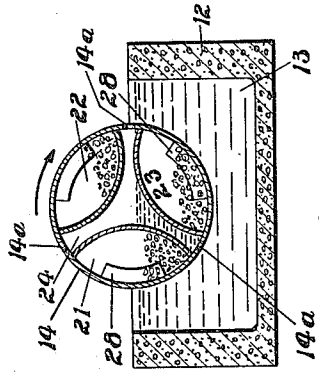


Fig. 3.

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HEAT EXCHANGE APPARATUS

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Application June 5, 1939, Serial No. 277,431

7 Claims. (Cl. 257—90)

This invention relates to an improved means for cooling materials, particularly improvements in means for removing heat from roasted ores or the like.

In certain industrial processes, solid materials in divided forms are heated or roasted as part of their processing and require subsequently to be cooled. This is particularly true in certain mining and milling operations where ores require roasting as a step in the separation and recovery of their valuable constituents. Such ore requires removal of some or all of the heat retained by the ore after leaving the roaster, to facilitate subsequent steps in its reduction and recovery treatment.

Various types of devices have been used for removing excess heat from roasted ores or the like, but the devices of the prior art have been limited in their efficiency by reduced surface contact of the receptacle containing the hot ore, with the cooling medium. Certain prior devices have also been limited in their operating results by lack of provisions for properly stirring and/or tumbling the hot ore so as constantly to bring such ore in contact with or in proximity to surfaces of the ore container that are adjacent the cooling medium.

It is a principal object of the present invention to provide an improved means for removing excess heat from ore or the like, with an unusually high degree of efficiency.

Another and more particular object of the invention is to provide a cooler or heat exchange apparatus having passages for the ore, which present a relatively large surface area to a cooling medium.

Still another object is to provide such passages in a heat exchange device that will hold the material being cooled in heat-exchanging proximity to a cooling medium for a relatively long period of time.

A still further object is to provide rotary passages for the reception of material to be cooled, having noncircular cross sections of a particular shape in order to subject the material therein to a desirable tumbling and rolling action while it is being advanced therethrough.

A still further object is to provide in a device of this character, means for supplying and regulating a cooling medium.

Other objects and advantages reside in details of design and construction which will be more fully disclosed in the following description and in the drawing wherein like parts have been similarly designated and in which:

Figure 1 is a plan view of a cooler or heat exchange device that embodies the present inventive concept and is well adapted to perform the present improved method;

Figure 2 is a central longitudinal section of the same;

Figure 3 is a cross sectional view taken along the line 3—3 of Figure 2; and

Figure 4 is a cross sectional view corresponding to Figure 3 and illustrating a modified form of the present invention.

The improved apparatus embodying the present inventive concept includes means for subjecting divided materials to a progressive movement through or along heat-conductive surfaces contacting a fluid heat exchange medium, while simultaneously rotating such surfaces to intermittently submerge the same into the heat exchange medium in a cyclic movement. By virtue of this complete submersion of such surfaces, heat exchange is effected in at least two directions. In addition to the progressive movement and the rotation, the material is subjected to unsymmetrical tumbling or rolling movement so as constantly to present different surfaces of the material toward the heat exchange medium.

While the present inventive concept could be embodied in various types of apparatus, a typical reduction to practice is illustrated and will be explained in detail in order to provide a clearly understandable disclosure. The present example is not intended to express or imply any limitation to the scope of the present invention.

Referring first to Figure 1, reference character 12 denotes a tank-like container for the cooling medium. The tank preferably is made of concrete and the preferred cooling medium is water as indicated at 13. A cylindrical housing or shell 14 is provided with hollow trunnions 15 and 16 which are journaled in suitable bearings at opposite ends of the tank 12 to provide for rotation of the shell 14 within said tank and at least partially submerged in the cooling medium 13. The trunnions are preferably provided with packing glands adjacent their respective bearings in order to prevent the cooling medium from escaping therealong.

The shell may be rotated through the intermediary of a gear 17 thereon, which in turn is driven by a prime mover such as motor 18, through suitable speed reducing mechanism. Preferably, the shell 14 should be rotated at relatively low R. P. M. in order to avoid any centrifugal action upon the material therein that is being cooled.

The water or other liquid cooling medium may conveniently be supplied from any source not shown, through the perforated pipe 19 positioned above the tank 12 and the shell 14. The cooling medium may be sprayed through the perforations of the pipe 19 downwardly onto the rotary shell 14. The cooling medium accumulates in the tank 12 up to a level that may be optionally governed by an overflow weir 20.

In the form of the invention illustrated in Figures 1, 2 and 3, the interior of the cylindrical housing or shell 14 is sub-divided into three longitudinal passages indicated respectively at 21, 22 and 23. The ends of these passages are defined by plates 24 and 25, which close the space between said passages, leaving both ends of all said passages open into the respective end zones 26 and 27 within the shell 14. A series of openings 14a through the cylindrical walls of the shell 14 provide passages whereby the liquid cooling medium 13 may freely enter and leave the space between the passages 21, 22 and 23 that is closed by end plates 24 and 25. No cooling medium whatever is permitted to enter passages 21, 22 and 23 at any place.

As illustrated, the cross sectional shape of each passage 21, 22 and 23 is generally elliptical and is therefore effective for improved results as will be hereinbelow set forth. Each passage 21, 22 and 23 is provided with helical or angular flights indicated generally by reference character 28 so that material may be longitudinally advanced as a result of rotation of the shell 14.

The feed trunnion 15 may be provided with a feed chute 29 and when desired, a stationary end plate may be arranged around the chute in abutting relation to trunnion 15. The discharge trunnion 16 is preferably provided with helical flights 30 to facilitate discharge of material therefrom. The discharge end of the shell 14 is provided with a cone 31 to facilitate discharge of material from the passages 21, 22 and 23 into and through discharge trunnion 16.

Operation

In use, divided ore or other material having excess heat to be removed, is fed through feed chute 29 into end zone 26 within the shell 14, while said shell is being rotated at a relatively low speed by the mechanism hereinabove set forth. Ore or other material being cooled, as represented by reference character 32, advances into the longitudinal passages 21, 22 and 23, particularly as they move in rotation to their lowermost positions. Upon entrance into said passages, the flights 28 therein tend to advance the ore or other material, longitudinally of the shell 14 as indicated generally by arrow 32.

By referring to the passages 21a and 22a of Figure 4 and the passages 21, 22 and 23 of Figure 3, it will be seen that as these passages undergo angular movement due to the rotation of the shell 14, the material 32 therein will be thoroughly rolled and tumbled constantly to present different portions thereof to the inner surfaces of the passages. Obviously, the material of which the shell 14 and the passages 21, 22 and 23 are constructed, preferably is heat-conducting metal such as sheet steel.

The entire exterior surface of each passage 21, 22 and 23 is completely immersed in the cooling medium 13 at each revolution of the shell 14, as best illustrated in Figure 3. By the combined effects of the total immersion of the entire exterior surface of each passage 21, 22 and 23, together with the improved rolling and tumbling action of the material therein, extremely high efficiency in heat exchange is effected.

Heat is conducted from the material 32 that is in the passages 21, 22 and 23, through the walls of said passages inclusive of portions of the walls of the cylindrical shell 14, into the cooling medium 13, which constantly may be renewed by controlled input and overflow thereof. The particular elliptical cross sectional shape of each passage 21, 22 and 23 so rolls and tumbles material therein that different portions thereof are constantly being brought into contact with or in proximity to the cooled surfaces of the passages.

The sprays projected from pipe 19 onto the rotary shell 14 may be dispensed with if desired. They are not essential to good cooling results with the present invention, but under some circumstances, they are desirable. Obviously, water sprayed upon the rotating shell 14 absorbs heat therefrom both in equalizing the temperature of the shell with that of the coolant and also by evaporation of the water from the outside surface of the shell, rendering some of the heat latent.

Means other than the perforated conduit 19 may be used for renewing the supply of water in the tank 12. Under some circumstances, the body of water 13 in tank 12 may remain static but ordinarily an input and an overflow are to be preferred.

As the material in the passages 21, 22 and 23 advances longitudinally thereof, it is finally discharged through discharge trunnion 16 for further processing. The percentage of heat removed from the hot ore or other material being cooled, may be varied within reasonable limits by the temperature of the coolant and by the speed of rotation of the shell 14. Obviously, the slower the speed of rotation of the shell, the greater will be the heat exchange. The buoyant effect of the liquid in tank 12 helps to sustain the weight of the shell 14 and its contents, thus relieving the pressure in the bearings. By optionally governing the depth of the liquid in the tank by relative coordination of the fluid input and the fluid discharge at weir 20, this buoyant effect upon the shell 14 may be optionally controlled and the exchange of heat between the shell 14 and the fluid body may be varied within reasonable limits.

Modifications

The modified form of the present invention as illustrated in Figure 4, is generic to the above outlined construction and operating principle, but only two longitudinal passages are sub-divided along the interior of the rotary shell 14 as indicated at 21a and 22a. The cross sectional shape of passages 21a and 22a is similar to that of passages 21, 22 and 23 hereinbefore fully described, and they are provided with internal flights preferably on opposite interior surfaces, to move the ore progressively from the feed end to the discharge end thereof. Obviously, any desired number of longitudinal passages may be provided as desired, those illustrated merely being preferred examples.

In all forms of the cooler, the heat exchange is a function of the area of the heat exchange surfaces, a function of the rolling and tumbling of the material in the cooler, and a function of the length of time the material is in the cooler. The temperature, depth, nature and circulation of the coolant, obviously, are other factors. The apertures 14a through the cylindrical walls of the rotary shell 14 also permit circulation of

atmospheric air into and through the space between the various longitudinal passages. Some heat is absorbed and dissipated by such circulation of air, and the liquid coolant adhering to the interior surfaces may partially be vaporized by coming in contact with the atmosphere thus to further facilitate absorption of excess heat.

The stated objects of the present invention are fully accomplished by the apparatus herein illustrated and described, and while this specification discloses preferred means for reducing the present invention to practice and a preferred embodiment of the invention, changes may occur to those skilled in the art and may be made within the scope of the appended claims, without departing from this inventive concept.

What I claim and desire to secure by Letters Patent is:

1. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive walls dividing the interior of the shell into a plurality of spaced passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

2. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive walls dividing the interior of the shell into two spaced passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

3. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive walls dividing the interior of the shell into three spaced passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

4. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive partitions dividing the interior of the shell into a plurality of elliptical material-conducting passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

5. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive partitions dividing the interior of the shell into a plurality of non-circular material-conducting passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

6. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive walls dividing the interior of the shell into a plurality of spaced passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being a lengthwise extending row of openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

7. Apparatus of the character described comprising a tank for a cooling liquid, a rotary shell at least partly submerged in the cooling liquid, heat-conductive walls dividing the interior of the shell into a plurality of spaced passages having angular extremities in cross section to impart a tumbling action to matter therein during rotation of the shell, means for feeding loose material to be cooled to the respective passages, and means for inducing a progressive movement of the tumbled material therethrough, there being rows of openings in the shell communicating with the space between the passages, said openings being substantially restricted whereby liquid entering through said openings is carried up and circulated across said passage-defining walls during each revolution.

THOMAS R. BROWN.