June 12, 1945. C. F. RAMSEYER ET AL 2,378,157

BUBBLE CAP

Filed July 30, 1943

Fig. 1

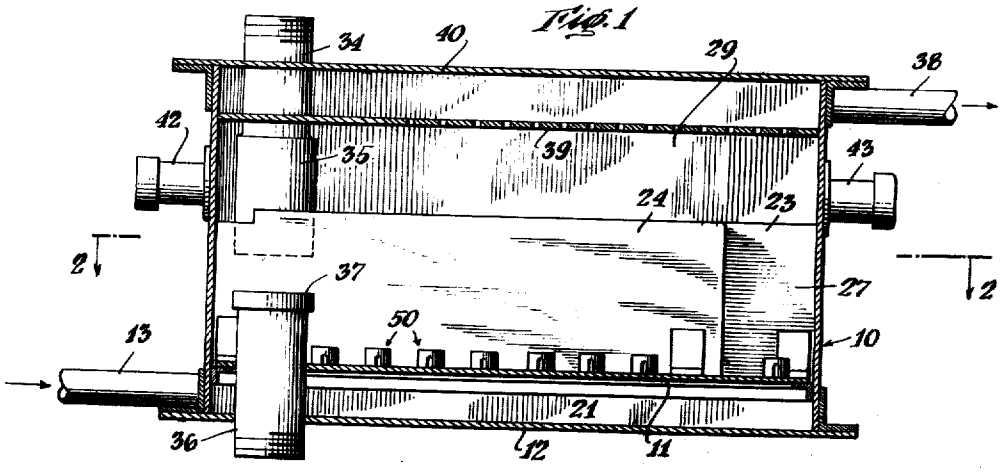


Fig. 2

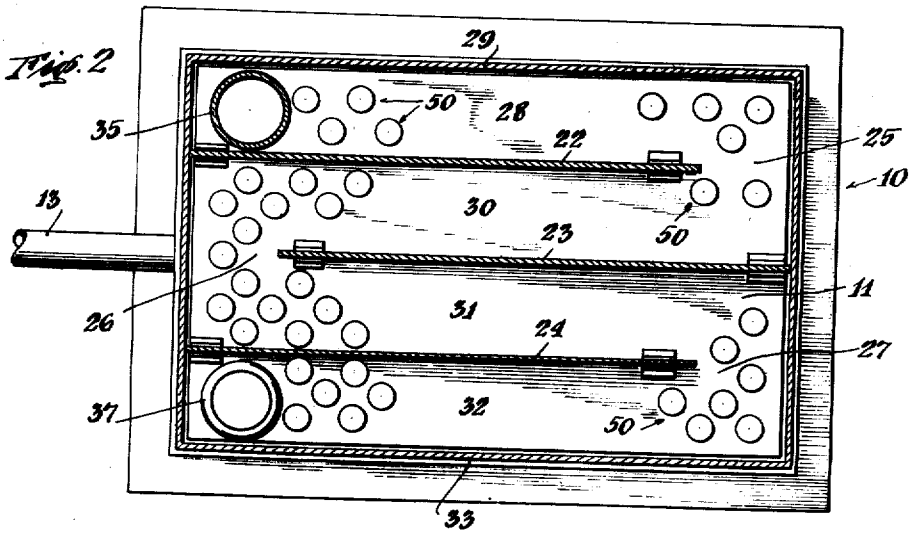


Fig. 3

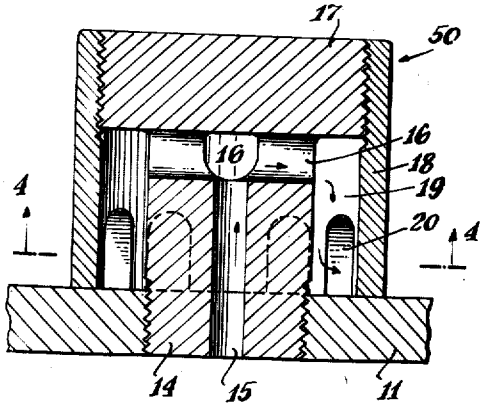
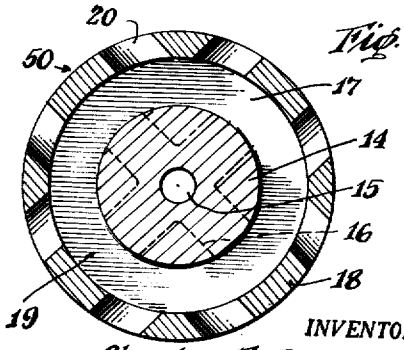


Fig. 4



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Patented June 12, 1945 2,378,157

UNITED STATES PATENT OFFICE

2,378,157

BUBBLE CAP

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Application July 30, 1943, Serial No. 496,732

5 Claims. (Cl. 34—57)

This invention relates to bubble caps for use in an apparatus for effecting contact between gases and finely divided solids, for example, between catalyst particles and reactive vapors or for the reduction of finely-divided metallic ores or other oxides or sulphides, such as iron ore, pyrites, mill scale, and other ferrous oxides, and more particularly to a bubble cap for use in an apparatus of the type set forth in an application of Brassert & Ramseyer for the Production of metals, Serial No. 481,968, filed April 6, 1943, which discloses a furnace having a hearth provided with apertures for supplying preheated reducing gas under pressure to a bed of granular material on the hearth under conditions to suspend the particles of the material in the gas and thus impart a fluid-like state to the bed.

An object of this invention is to provide a means for introducing gas of relatively low pressure and velocity directly into and beneath a bed of loose, finely granular material in an apparatus of the above type, in such a way that the gas will rise up through the bed and activate and keep the granular material in a state of partial suspension or incipient suspension, so that it behaves like a fluid and flows from one end of the hearth to the other.

When a flat horizontal surface area is covered with a bed of finely powdered material from 4" to possibly 20" or 30" in depth it can be uniformly aerated only if the air or gas is introduced into it at numerous points along the bottom of the bed and at velocities which do not cause the gas to blow through the bed or channel at points of gas introduction. It is accordingly another object of the present invention to provide a bubble cap which is constructed to insure this uniform introduction of gas throughout the entire bed without any excessive amount of gas being introduced at any one point as compared with any other point.

In order to accomplish this the bubble cap is provided with a small central bore, the internal diameter of which is sufficiently small to insure a relatively large pressure drop when the volume of gas for which it is designed is passed therethrough. When a plurality of such bubble caps is inserted into the top member of a hollow hearth they will all pass equal amounts of gas due to the high pressure drop, thereby insuring a uniform gas distribution throughout the entire area of the hearth.

In accordance with the present invention the bubble caps are arranged so that the high velocity through the central bore or channel, which may amount to as much as 400 ft. per second or more, is broken down by impact, first against the top of the cap, and secondly against the sides or periphery thereof, before it finally makes a further right angle turn and passes out through the gas exit slots of the cap into the bed of material. The velocity through the exit slots directly in contact with the material is thus reduced to the order of from 1/20 to 1/10 velocity through the central channel itself.

Another feature of the invention resides in so arranging the cap that if the gas pressure should be shut off at any time while the caps are still covered with the bed of material, the particles will not readily force their way into the central bore of the cap which might otherwise easily become plugged up. This is accomplished by locating the top of the bore at a level higher than the top of the peripheral gas exit openings which are in contact with the material.

These features may be embodied in caps of various designs and shapes. A specific embodiment is disclosed herein for purposes of illustration only.

For a more complete understanding of the invention reference may be had to the accompanying drawing in which a specific embodiment thereof is set forth for purposes of illustration only.

In the drawing:

Fig. 1 is a longitudinal section through one type of reducing furnace to which the present invention is applicable;

Fig. 2 is a horizontal section taken along the line 2—2 of Fig. 1;

Fig. 3 is a vertical section through a bubble cap embodying the present invention; and

Fig. 4 is a transverse section through the cap taken on the line 4—4 of Fig. 3.

In the following description certain specific terms are used for convenience in referring to various details of the invention. These terms however, are to be given an interpretation consistent with the state of the art.

Referring to the drawing in detail the furnace 10 (Figs. 1 and 2) comprises a rectangular housing preferably formed of welded 4% to 6% chrome steel or other suitable heat-resistant metal provided with a double bottom formed by a horizontal upper deck 11 spaced above a lower deck or bottom 12 so as to form a sealed chamber into which a reducing gas supply pipe 13 leads. The upper deck 11 forms the horizontal hearth of the furnace and is perforated, the perforations being spaced from two to six inches apart and each containing a plug 14 (Fig. 3) preferably

threaded into the perforation in the hearth 11, as shown, or it may be force-fitted therein.

Each plug 14 is provided with a relatively small central axial bore or channel 15, for example, of ⅛ to ¼ inch diameter, or of a suitable diameter determined by the capacity for which the particular furnace is designed. A pair of cross channels 16 are formed in the top of the plug 14 in communication with the central bore 15. A plate 17 is secured by suitable means, as by welding, to the top of the plug 14 and forms a top closure for the cross channels 16. The plate 17 extends laterally beyond the plug 14 and carries a sleeve 18 which is shown as threaded thereto. The sleeve 18 is of a larger diameter than the plug 14 to provide an annular gas chamber 19 therebetween. The sleeve 18 extends downwardly to engage the hearth 11 and is provided at its lower portion with a plurality of gas exit slots 20. The slots 20 extend upwardly from the hearth 11 and terminate short of the cross passages 16 so as to prevent direct passage of gas therethrough without change in direction.

The gas which passes through the central passage 15 at high velocity first impinges against the plate 17 and is then caused to make a right angle turn and to pass outwardly through the cross passages 16 from which it impinges upon the inner surface of the sleeve 18. The gas then makes a second right angle turn and flows downwardly to the slots 20, making a third right angle turn and passing outwardly through the slots and into the bed of material on the hearth 11. As the slots 20 are below the level of the cross passages 16 any material which might pass through these slots from the bed would be prevented from entering or clogging the cross passages or the axial bore 15.

The plug 14, plates 17 and sleeve 18 constitute a bubble cap designated at 50 in Figs. 1 and 2. The entire hearth 11 is studded with these bubble caps 50 for supplying gas from a gas chamber 21 beneath the hearth 11.

In the embodiment disclosed the upper surface of the hearth 11 is divided by several parallel vertical partitions 22, 23 and 24. Partition 22 extends from the lefthand end of hearth 11, as shown in Fig. 2, but stops short of the righthand end thereof so as to leave an end passage 25. The center partition 23 extends from the righthand end of hearth 11 but stops short of the lefthand end thereof, leaving an end passage 26. Partition 24, like partition 22, extends from the lefthand end of hearth 11 but stops short of the righthand end thereof, leaving the end passage 27. It will be observed that these partitions provide a zig-zag channel of substantial length within a small space, equivalent to a long tunnel-like furnace. The effective hearth begins with a channel 28 between the partition 22 and the side wall 29 of the furnace, leading through end passage 25 to channel 30 between partitions 22 and 23, leading through end passage 26 to channel 31 between partitions 23 and 24, leading through end passage 27 to channel 32 between partition 24 and side wall 33. It will be understood that this zig-zag channel is supplied through its entire extent by reducing gas from gas chamber 21 through the bubble-caps 50. The partitions 22, 23 and 24 stop short of the top 40 of the furnace and may be welded or otherwise secured to the upper surface of the hearth 11.

Discharging into the closed end of channel 28 is a supply pipe 34 for charging the furnace 10 with the finely-divided oxides to be reduced. Pipe 34 is preferably welded to top 40 of the furnace 10 and its lower end is threaded and carries an adjustable collar 35 which may be raised and lowered and serves the purpose of determining the depth of the oxide bed at the feed end of the hearth 11. By screwing collar 35 upwardly or downwardly on pipe 34, this level may be adjusted.

At the discharge end of the zig-zag channel on hearth 11 is a discharge pipe 36 welded to the bottom 12 of the furnace and extending through the gas chamber 21 above the surface of the hearth 11. The upper end of discharge pipe 36 is also threaded for the reception of one or more collars 37, whereby the level of the bed at the discharge end of the zig-zag passage may be adjusted. The height of the collars 36 may be adjusted to obtain the desired depth of bed at discharge, which is always lower than the depth of the bed at the feed end, so that a head of material is maintained in order that it may flow along the zig-zag channel. The discharge pipe 36 may lead directly to a briquetting machine, not shown, for compacting the reduced material into briquettes.

Leading from the upper end of the furnace 10 is a spent gas discharge pipe 38 which may conduct the gas to a reforming or recovering plant for effecting reuse of the gas. A perforated plate 39 is preferably suspended in spaced relation to the top 40 of the furnace, so that the spent reducing gas diffuses uniformly therethrough and its velocity is retarded so that it does not carry out of the furnace any substantial amount of fines that may result from dusting. Peep tubes 42 and 43 are provided in the two ends of the furnace for observing the operation thereof.

In operation the furnace 10 is supplied with iron ore or other oxide through supply pipe 34, the material being previously ground to 20 to 150 mesh, for example, and concentrated to substantially remove the gangue according to known methods. The depth of the bed at the feed end is determined by the position of the collar 35 on the feed pipe 34 and the depth of the bed at the discharge end is determined by the height of the ring 37 on the discharge pipe 36. A sufficient head of the finely-divided material is maintained between the inlet pipe and the discharge pipe to cause the suspended bed to flow along the zig-zag passage as above specified.

The reducing gas, preferably preheated to have a temperature in the bed of from 1100° F. to 1500° F., is supplied by pipe 12 to the chamber 21, below the hearth 11. At this temperature the gas readily reduces the oxide but is not high enough to cause the particles to agglomerate and frit together, so that they remain separate and distinct throughout the operation and hence retain the aforementioned fluid-like flow when permeated by the gas.

The pressure of the gas supplied to chamber 21 may be about thirty pounds per square inch above the internal furnace pressure, although pressures as high as one-hundred pounds and even higher may be employed, depending upon requirements, such as when the entire operation is under superatmospheric pressure of the order of pressures given, as described in said copending application. For example, if the entire furnace is operated under pressure of say one-hundred pounds per square inch, the pressure of the gas supplied to gas chamber 21 will be sufficiently higher to obtain the desired fluid-like flow of the oxide bed. Thus the gas pressure may be about one-hundred thirty pounds in that case.

The gas flows at high velocity through the passage 15 and impinges against the plate 17 and then against the sleeve 18 as above described, so that the velocity is greatly reduced before the gas passes through the exit slots into the bed of material. Because of the high pressure drop in each of the passages 15 the volume and velocity of the gas flowing into the bed from each bubble cap is substantially the same. Hence the gas is supplied in a uniform manner to the entire bed of material. The gas is supplied in adequate volume to effect reduction at the operating temperature and to produce the desired fluidity of the bed. At the beginning of the operation all of the finely-divided material is located at the feed end of the channel under the feed pipe 34. The fluidity imparted thereto by the gas, however, causes it to flow rapidly along the hearth all between the partitions and to level out until it begins to flow out of the discharge pipe 36.

Because of the uniform gas distribution from the bubble caps 50, the entire bed if maintained in a fluid-like state and each particle is suspended in the gas which reduces it while maintaining it so suspended, the spent reducing gas rising to the top of the bed and being immediately replaced by fresh reducing gas entering the bed from below, so that reduction is rapid and continuous.

The construction of the bubble cap disclosed herein, in which the plug 14 is threaded into the hearth 11 and the sleeve 18 is threaded onto the plate 17, provides a locking means for firmly securing the same in place. It is to be understood, however, that the sleeve 18 may be formed as a part of the plate 17, if desired, and that the parts may be secured together by any suitable means.

Although the invention has been illustrated in connection with a specific furnace, it is to be understood that it is capable of various uses and that the invention is only to be limited in accordance with the scope of the following claims:

We claim:

1. A bubble cap comprising a central plug having an internal bore extending therethrough, cross channels at the top of said plug communicating with said bore, a top plate secured to said plug for closing said cross-channels, a sleeve spaced radially from said plug to form an outer chamber, said sleeve being secured to said top plate and extending downwardly therefrom and having a plurality of peripherally spaced discharge openings displaced below said cross channels and out of registration therewith, whereby the gases change in direction in passing from said bore to said cross channels, from said cross channels to said chamber, and from said chamber through said discharge openings.

2. A bubble cap comprising a central plug having an axial bore extending therethrough, cross channels at the top of said plug communicating with said bore, a top plate secured to said plug for closing said cross-channels, a sleeve concentric with said plug and spaced therefrom to form a concentric annular chamber, said sleeve being secured to said top plate and extending downwardly therefrom and having a plurality of peripherally spaced discharge openings displaced below said cross channels and out of registration therewith, whereby the gases change in direction in passing from said axial bore to said cross channels, from said cross channels to said annular chamber, and from said annular chamber through said discharge openings.

3. In combination with a hearth containing finely-divided material, a plurality of openings in said hearth, bubble caps disposed in registration with each of said openings for supplying gases beneath said material, each of said bubble caps comprising a central plug threaded onto an opening in said hearth and having an inner bore and transverse passages at the upper end of said plug communicating therewith, a top plate secured to said plug in registration with said bore against which the upwardly passing gases impinge, an external sleeve threaded onto said plate and extending downwardly around said plug into engagement with said hearth to form a substantially closed outer chamber in communication with said bore, and a plurality of peripherally spaced discharge openings in said sleeve adjacent said hearth for discharging the gases from said chamber beneath the layer of granular material on said hearth.

4. In combination with a hearth containing finely-divided material, a plurality of openings in said hearth, bubble caps disposed in registration with each of said openings for supplying gases beneath said material, each of said bubble caps comprising a central plug threaded onto an opening in said hearth and having an internal bore communicating therewith, a top plate secured to said plug in registration with said bore against which the upwardly passing gases impinge, an external sleeve threaded onto said plate and extending downwardly around said plug into engagement with said hearth to form a substantially closed outer chamber, transverse passages in said plug connecting said bore with said chamber for discharging the gases laterally into said chamber, said sleeve having walls in registration with said transverse passages against which gases impinge and having a plurality of peripherally spaced discharge openings displaced axially from said transverse passages for discharging gases into the bed of material on said hearth after the gases have reversed their axial direction of flow in said chamber.

5. A bubble cap comprising a plug having a plate at one end extending laterally beyond the periphery of said plug, transverse passages in said plug adjacent to said plate and a bore extending lengthwise from the other end of said plug into communication with said transverse passages, a sleeve secured at one end to said plate and having a plurality of peripherally spaced discharge openings disposed below said transverse passages and out of registration therewith.

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