

- [54] BUNKER-BOILER INSTALLATIONS
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Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 279,224, Aug. 9, 1972, Pat. No. 3,795,987.
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[51] Int. Cl. F26b 17/12
[58] Field of Search 34/86, 165, 168, 169, 34/174-178, 57 A; 432/14, 16, 31, 79, 432/83, 85, 90, 223; 122/7 R, 421, 4 D; 202/228, 227, 229, 230, 150; 201/39

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[57] **ABSTRACT**

An apparatus for cooling a hot material in bulk, such as hot coke limestone, sinter, etc. The apparatus includes an upright bunker having a top end for receiving the material such as hot bulk material and a lower discharge end through which the material is discharged after being cooled. A number of fans may be provided for creating a path of gas flow upwardly through the interior of the bunker and downwardly along the exterior thereof for continuously circulating a cooling gas upwardly through the bulk material in the bunker to extract heat therefrom while cooling the latter material so that the material is discharged from the bunker in a cooled condition. A number of heat exchangers and/or boilers are situated at the exterior of the bunker but in the immediate vicinity thereof, these heat exchangers and/or boilers being distributed about the bunker, and the several heat exchangers and/or boilers communicate with the top end of the bunker to receive the heated gas therefrom, this gas flowing downwardly along the interior of the heat exchangers and/or boilers to be returned to the inlets of the fans by which the gas in cooled condition is returned to the interior of the bunker to flow again upwardly through the hot bulk material therein.

10 Claims, 2 Drawing Figures

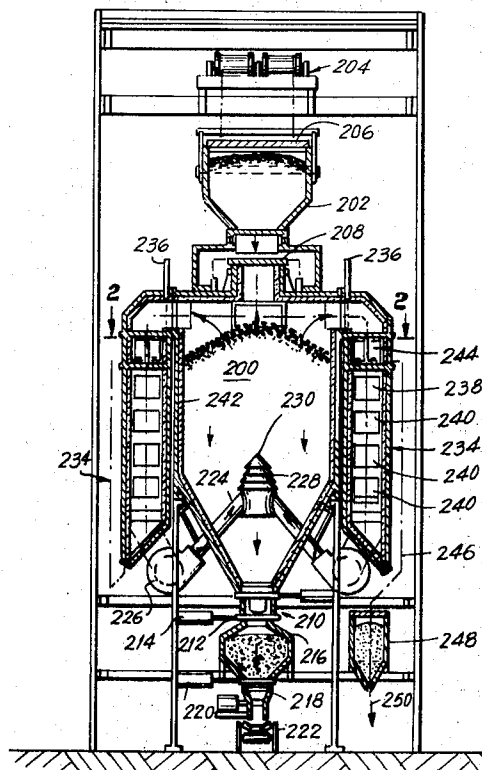


FIG. 2

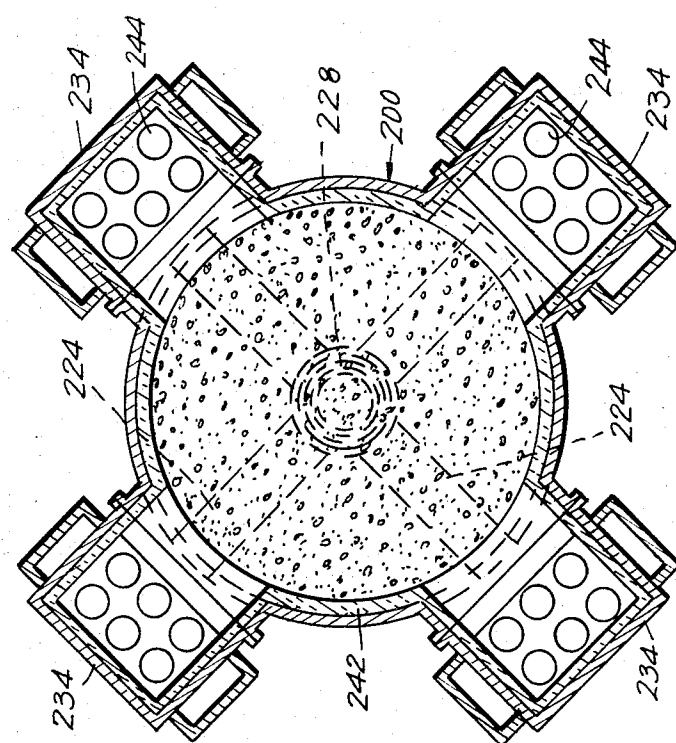
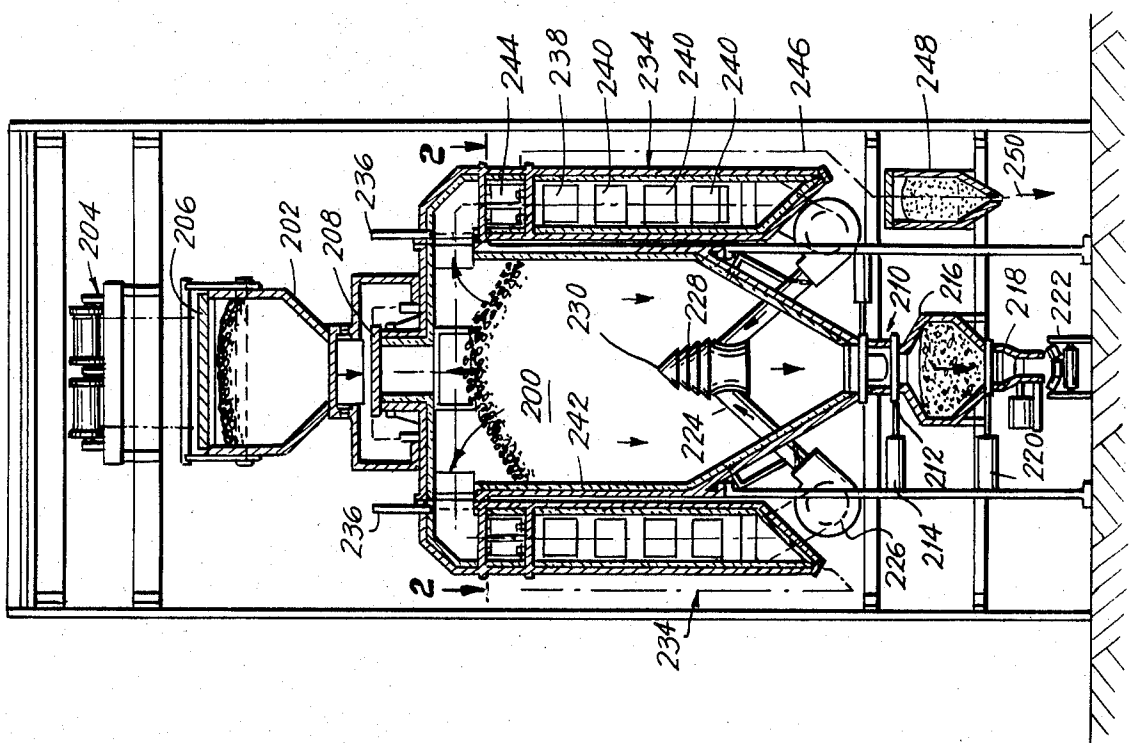


FIG. 1



BUNKER-BOILER INSTALLATIONS**CROSS REFERENCE TO RELATED APPLICATION**

This application is a continuation-in-part of copending application Ser. No. 279,224, filed Aug. 9, 1972, U.S. Pat. No. 3,795,987 and entitled COOLING OR PREHEATING DEVICE FOR COARSE OR BULKY MATERIAL WITH HEAT RECOVERY EQUIPMENT.

BACKGROUND OF THE INVENTION

The present invention relates to devices for cooling or preheating coarse or bulky materials while being provided with heat-recovery equipment.

Devices of this general type are of course known at the present time. For example, in coke plants, it is conventional to situate the hot coke which discharges from the coke ovens in a dry-quenching bunker in which a gas flows upwardly through the hot coke to extract heat therefrom. The cooled coke is discharged out of the bunker and delivered to a suitable screening station, for example, while the hot gas delivers its heat to a heat exchanger or the like before being returned to the bunker so as to continuously circulate in this way.

While attempts have been made in the above-described manner to recover energy extracted from the hot bulk material in the bunker, there are tremendous heat losses resulting from a number of operating factors which cannot be avoided with conventional installations. Thus, a considerable amount of heat is lost directly through the wall of the bunker itself. In addition, heat is lost by way of relatively small parts of the bulky material which are separated from the larger parts thereof and which are carried out to the outer atmosphere, so as not only to pollute the outer atmosphere but also to waste heat which otherwise might be used from combustible materials of this type. In addition, in a closed cycle type of gas-flow system of the above type it is difficult to control the gas flow properly so that the greatest possible amount of energy is extracted from the bulk material which is cooled in the bunker. For example, with conventional systems of the above type it is possible for the bulky material to form a source for fine particles of dust which are carried with the gas through a boiler or the like so as to become deposited on the heating coils and thus reduce the efficiency of operation of the boiler.

In addition to the above factors with respect to wasting of heat energy and polluting of the atmosphere, there are further drawbacks with respect to safety. Experience has demonstrated that in almost any conventional coke plant there is a considerable danger of explosion.

Furthermore, installations of the above type require a considerable amount of space because the units thereof are relatively large and they must be distributed over a relatively large area, so that the costs involved for plants of the above type are extremely high.

In addition, installations of the above type must be prepared to continue operation when breakdowns occur. It is never known when part of the equipment will be rendered inoperative because of failures which are unexpectedly encountered, and it is therefore customary for installations of the above type to have standby equipment always on hand to be set into operation

when necessary. These factors also contribute to the undesirably high costs involved in conventional installations of the above type.

SUMMARY OF THE INVENTION

It is accordingly a primary object of the present invention to provide an installation capable of handling bulky material in such a way that many of the above drawbacks are eliminated while others are sharply reduced either in the frequency of their occurrence or in magnitude.

Thus, it is one of the most specific objects of the present invention to provide an installation of the above general type which is far more compact than has hitherto been possible while at the same time achieving the same output as conventional larger installations.

Furthermore it is an object of the present invention to provide an installation of the above general type which is capable of continuing operation in a highly effective manner even though part of the installation may be out of operation either for inspection or for repair purposes or the like.

In addition, it is an object of the present invention to recover materials such as combustible dust particles and to be capable of utilizing the energy thereof, with this arrangement also being provided in such a way that the efficiency of heat exchangers or the like is not reduced by possible deposition of particles on coils.

Also it is an object of the present invention to provide an installation of the above type which is far safer than conventional installations particularly with respect to possibility of explosions.

Also it is an object of the present invention to provide an installation of the above general type which is of a relatively light weight, providing considerable savings in foundation costs and the like while at the same time being exceedingly robust so that the strength of the construction is combined with the light weight thereof.

It is furthermore an object of the present invention to provide an installation of the above general type which has convenient and effective controls making it possible to regulate the operation in a manner which will achieve the greatest possible efficiency and heat recovery for the particular conditions which are encountered during operation.

According to the invention an apparatus for cooling a hot material in bulk, such as hot coke, includes an upright bunker means having a top end for receiving the material such as hot coke and a lower discharge end through which the material is discharged after being cooled. A fan means is provided for creating a path of gas flow upwardly through the interior of the bunker means and downwardly along the exterior thereof for continuously circulating a cooling gas upwardly through the bulk material in the bunker means to extract heat therefrom while cooling the latter material so that the material is discharged from the bunker means in a cooled condition. A plurality of separate heat exchangers and/or boiler units are situated adjacent the bunker means at the exterior thereof from a beam distributed thereabout, and these units all communicate with the top end of the bunker means to receive the hot gas therefrom, while the fan means communicates with the lower ends of the heat exchanger and/or boiler units to withdraw therefrom the gas which has given up its heat through suitable coils in the heat exchanger

and/or boiler units to fluids creating in this way steam or the like which may be used for any desired purpose. Thus, the cooled gas is received from the several heat exchanger and/or boiler units by the fan means and then again returned to the bunker means to flow upwardly through the interior thereof. In this way by situating a plurality of heat exchanger and/or boiler units adjacent the bunker means but at the exterior thereof it is possible to have an exceedingly effective arrangement according to which any one heat exchanger and/or boiler unit may be set out of operation, either for inspection or repair purposes, for example, while the remaining heat exchanger and/or boiler units remain in operation, and thus it becomes possible with a compact and relatively simple but robust installation to achieve an output previously required by far more complex installations which are of considerably greater size and which occupy a much larger space. Moreover, by continuously circulating in a closed circuit an inert gas upwardly through the bunker means and downwardly through the several heat exchanger and/or boiler units it is possible to greatly reduce the danger of explosions, as is encountered in connection with conventional installations.

BRIEF DESCRIPTION OF DRAWINGS

The invention is illustrated by way of example in the accompanying drawings which form part of this application and in which:

FIG. 1 is a schematic sectional elevation of one embodiment of the invention; and

FIG. 2 is a sectional plan view taken along line 2—2 of FIG. 1 in the direction of the arrows.

DESCRIPTION OF A PREFERRED EMBODIMENT

According to the embodiment of the invention which is illustrated in FIGS. 1 and 2, there is a vertically extending bunker 200 which receives the hot bulk material as illustrated in order to cool the latter. In the illustrated example the material which is cooled in the bunker 200 is hot coke delivered to the bunker from a bucket 202. The bucket 202 receives hot coke from a suitable coke oven and is delivered on a suitable car to a crane 204 which travels along suitable tracks so that the crane after raising the bucket 202 is capable of situating the bucket at the location illustrated in FIG. 1 over the top of the bunker 200. The bucket 202 is closed by a lid 206 so that there is no escape of pollutants to the outer atmosphere and so that the heat energy is retained. The bunker 200 has a top seal 208 which is removed in any suitable way preliminarily to dropping of the coke from the bucket 202 into the bunker. Thus, when the top seal 208 is removed, the bottom of the bucket 202 is opened in a known way so that the coke charge carried by the bucket 202 will drop into the bunker, and then the empty bucket is returned to receive another load from another coke oven while in the meantime a further bucket has been filled with coke to occupy the position shown for the bucket 202 in FIG. 1. Once the coke has been delivered from the bucket 202 into the bunker 200, the lid 208 is replaced. These operations can be carried out with suitable power equipment such as hydraulically driven units at the proper times either through manually or automatically operated structure.

The hot coke within the bunker 200 gradually progresses downwardly along the interior thereof so as to reach the bottom sealing assembly 210 which has a gate 212 opened from time to time by the hydraulic structure 214 so that a certain amount of cooled coke will reach the measuring hopper 216 which also has a discharge gate 218 operated from time to time by the hydraulic unit 220. All of this latter structure is supported by a suitable framework as illustrated schematically in FIG. 1. When the gate 218 is opened by the hydraulic unit 220, the measured amount of coke in the hopper 216 will be received by a suitable conveyer structure 222 which conveys the cooled coke away from the bunker so that this coke may then be used in a blast furnace, for example.

In order to cool the coke within the bunker 200, inert gas is circulated upwardly through the hot coke. For this purpose the tapered bottom wall region of the bunker 200 has a plurality of pipes 224 passing therethrough. In the illustrated example, there are four pipes 224 provided with inert gas by four inert gas fans 226 driven by any suitable motors. The fans drive the inert cooling gas upwardly through the pipes 224 into a gas distributor unit 228 which at its top end has a gas distributor nozzle 230, so that from the latter the gas travels upwardly through the coke in the bunker 200, cooling the coke while the gas itself becomes heated.

The gas which flows upwardly beyond the coke in the bunker 200 reaches in the illustrated example four inlets 232 which feed the hot gas into the top ends of a series of heat exchangers and/or boilers 234. In the illustrated example there are four heat exchangers and/or boilers equidistantly arranged around the bunker 200 close to the wall thereof, with the ducts 232 for the hot gas passing through the wall of the bunker 200 at the top end region of the latter. In order to control the flow of gas into the several heat exchangers and/or boilers 234, the bunker 200 carries at its top wall dampers 236 in the form of plates which can be lowered or raised by suitable control structure so as to block the flow of heated inert gas through the several inlets 232 to a predetermined extent which will normally equalize the flow of hot gas into the several heat exchangers and/or boilers 234. Each of the heat exchangers and/or boilers may include banks of coils such as the coils 238 for superheating purposes while lower banks of evaporating coils 240 are also provided. The lowermost bank of coils 240 may serve as a circulation evaporator receiving feedwater from a suitable supply. Thus, the several heat exchangers and/or boilers 234 may be used for generating steam for any desired purpose. With the illustrated arrangement, as is particularly apparent from FIG. 2, any one of the heat exchangers and/or boilers can be put out of operation so that it can be inspected and repaired, if necessary, while the other three heat exchangers and/or boilers can remain operative, and in this case the gas damper plate 236 belonging to the heat exchanger and/or boiler which is not operating is placed in a closed position so that all of the operations in connection with inspection and/or repair of one heat exchanger and/or boiler can go forward without any difficulty with the particular arrangement shown in FIGS. 1 and 2. At the same time, it is possible for the inner surface of the wall of the bunker 200 to be lined with a suitable refractory lining material 242 so that in this way the bunker is capable of withstanding the high temperatures while at the same time the sev-

eral heat exchangers and/or boilers 234 operate very effectively.

After the inert gas has been drawn down through the several heat exchangers and/or boilers into the inlet ends of the several fans 226, the gas which has been cooled in this way so as to generate steam for any purpose is returned to the interior of the bunker through the supply pipes 224 as described above.

Thus, with this particular embodiment of the invention there is the great advantage of having a series of heat exchangers and/or boilers directly at the exterior of the bunker while at the same time the bunker wall can be lined with refractory material so that it is equal to the high temperatures which are encountered, and in addition the several heat exchangers and/or boilers are capable of effectively utilizing the heat extracted from the hot coke by the circulating inert gas with the possibility of putting one of the heat exchangers and/or boilers out of operation whenever desired so that the operations can continue with the remaining three heat exchangers and/or boilers in the illustrated example. Naturally, with the invention it is not essential to have only four heat exchangers and/or boilers. There can be six or eight heat exchangers and/or boilers at the exterior of the bunker, or there may be three heat exchangers and/or boilers, for example.

According to a further feature the inert gas entering through the inlets 232 first pass through several cyclone separator units 244 situated at the upper end of each heat exchanger and/or boiler 234. In these cyclone separator units 244 dust is separated from the gas before it progresses down through the several banks of coils, and the separated dust is delivered by a common pipe system 246 to a dust collector 248 from which the dust is discharged as shown by the arrow 250. This dust which is a source of considerable energy since it is easily combustible can be delivered to any desired location where the dust can be burned so as to utilize its energy in this way, for instance, for sinter plants or it can be returned to the coke ovens, or to pelletizing plants.

What is claimed is:

1. In an apparatus for cooling a hot material in bulk, such as hot coke, upright bunker means having a top end for receiving the material such as hot coke and a lower discharge end through which the material is discharged after being cooled, fan means for creating a path of gas flow upwardly through the interior of the bunker means and downwardly along the exterior thereof for continuously circulating a cooling gas upwardly through the bulk material in the bunker means to extract heat therefrom while cooling the latter material so that the material is discharged from the bunker means in a cooled condition, and a plurality of heat exchanger and/or boiler means situated at the exterior of said bunker means adjacent thereto and distributed thereabout, said plurality of heat exchanger and/or boiler means respectively having top ends communicating with the top end of said bunker means and bottom ends communicating with said fan means so that the latter draws the gas heated in the bunker means from the top end of the latter downwardly through the plurality of heat exchanger and/or boiler means to be returned to said bunker means after being cooled in said heat exchanger and/or boiler means, so that any one of

said heat exchanger and/or boiler means may be placed out of operation for purposes such as inspection or repair while the cooling of the material in bulk within the bunker means continues with the remaining heat exchanger and/or boiler means.

2. The combination of claim 1 and wherein said fan means includes a plurality of separate fan units respectively communicating with the lower ends of said plurality of heat exchanger and/or boiler means and respectively having discharge ends feeding into the lower end of said bunker means, so that a single fan unit draws the cooling gas downwardly through a single heat exchanger and/or boiler means and then delivers the gas from the latter heat exchanger and/or boiler means to the interior of the bunker means.

3. The combination of claim 1 and wherein a plurality of flow-control means are respectively situated at the connections between the plurality of heat exchanger and/or boiler means and the top end of the bunker means for individually controlling the flow of gas from the bunker means into the several heat exchanger and/or boiler means.

4. The combination of claim 1 and wherein a plurality of dust-separating means are respectively connected with the top ends of the plurality of heat exchanger and/or boiler means for separating dust from the gas issuing from the bunker means before the gas flows downwardly through the several heat exchanger and/or boiler means.

5. The combination of claim 4 and wherein a conveyor means communicates with all of the dust-separating means for conveying the dust collected thereby to a location where the dust, which is combustible, can be burned.

6. The combination of claim 1 and wherein the several heat exchanger and/or boiler means are in the form of elongated vertically extending heat exchangers and/or boilers respectively extending parallel to and located closely adjacent to said bunker means, the latter having an interior refractory lining separate from said heat exchangers and/or boilers.

7. The combination of claim 1 and wherein an inert gas is circulated by said fan means upwardly through said bunker means and downwardly through the several heat exchanger and/or boiler means before being returned to said bunker means.

8. The combination of claim 1 and wherein each heat exchanger and/or boiler means includes in its interior heat exchanger assemblies for extracting heat from the gas while cooling the latter and for utilizing the extracted heat for purposes such as generating steam.

9. The combination of claim 1 and wherein a discharge means is operatively connected with the lower end of said bunker means for discharging the cooled material in bulk therefrom while a supply means communicates with the top end of said bunker means for supplying hot material in bulk thereto.

10. The combination of claim 3 and wherein the dust separating means at the upper end of each heat exchanger and/or boiler means includes a plurality of cyclone separator units for separating dust from the gas prior to flow of the latter downwardly through the heat exchanger and/or boiler means.

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