Dec. 15, 1931. E. SCHUMACHER 1,836,402

UTILIZATION OF THE HEAT OF INCANDESCENT COKE OR THE LIKE MATERIAL

Filed Nov. 1, 1927 2 Sheets-Sheet 1

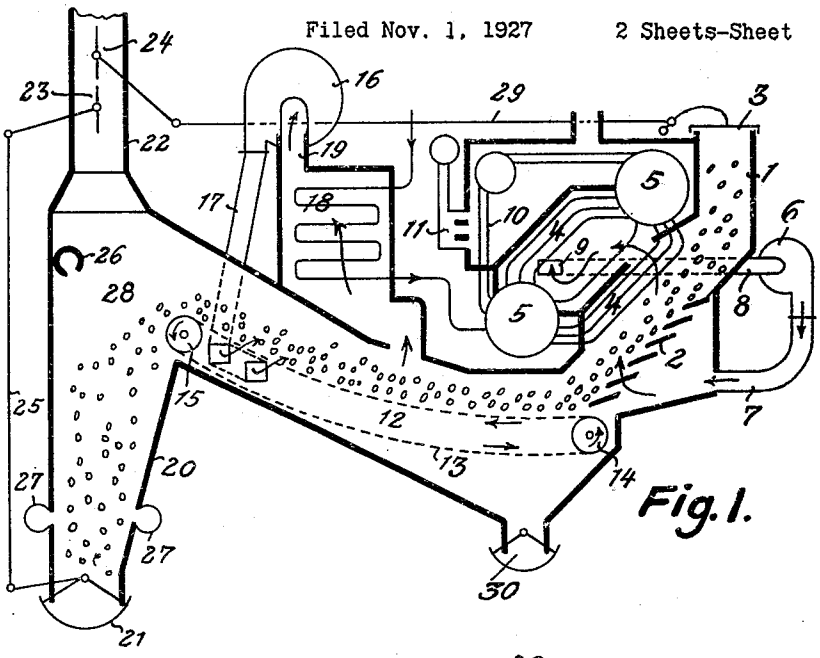


Fig. 1.

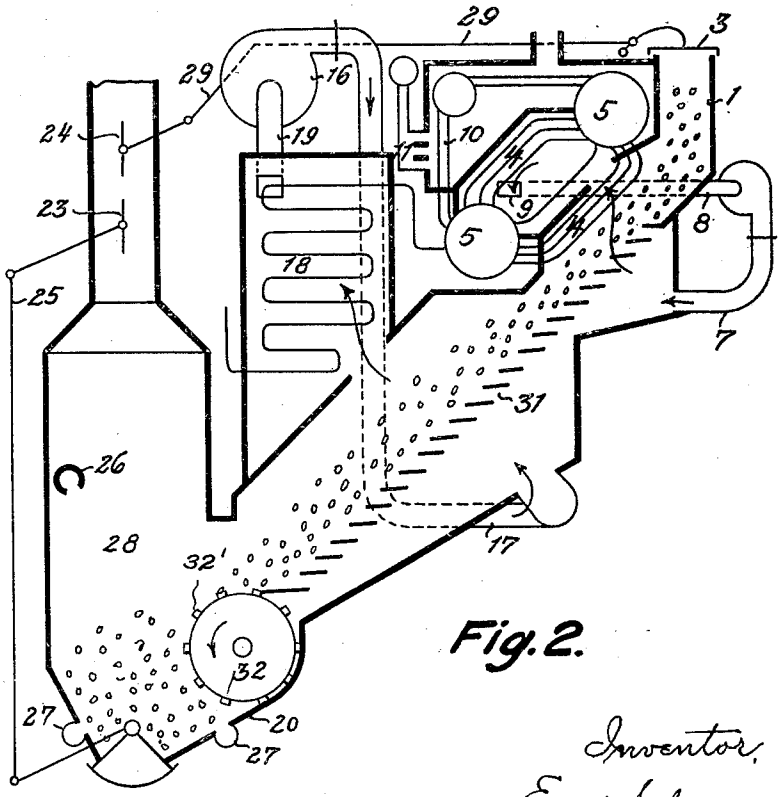


Fig. 2.

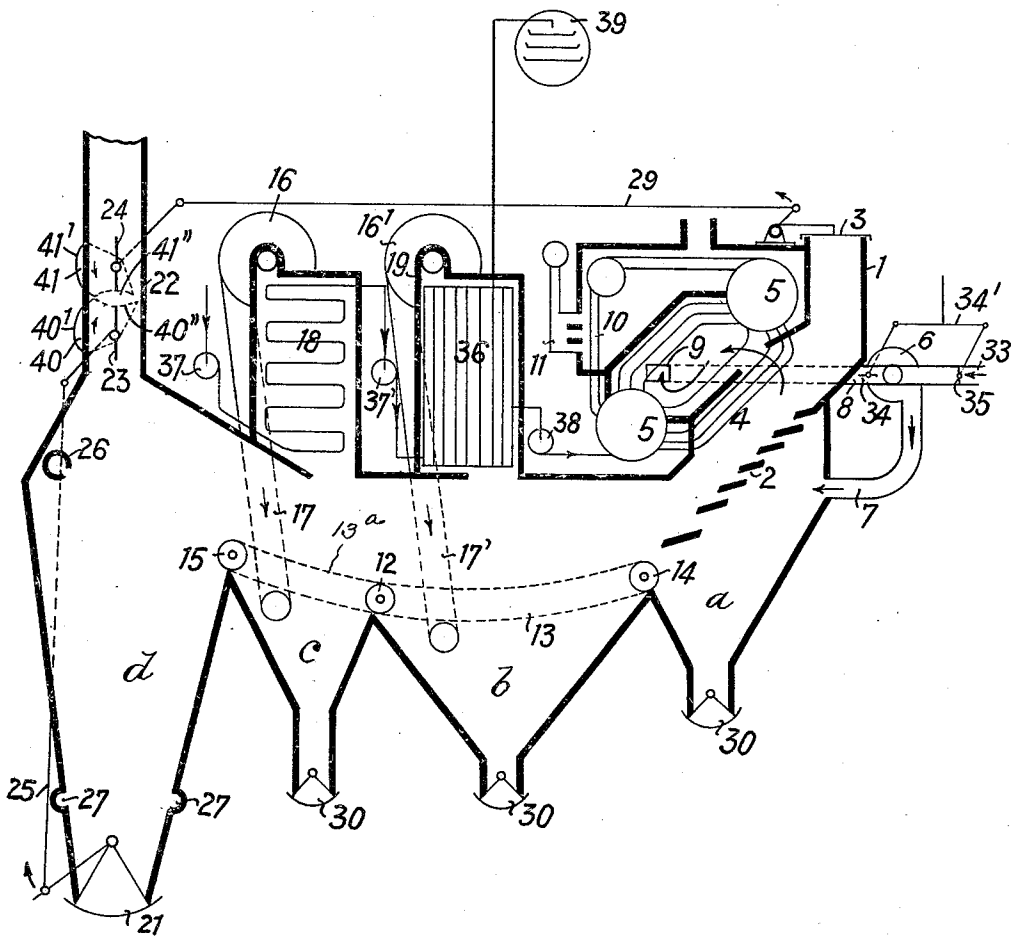
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Fig. 3.



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UNITED STATES PATENT OFFICE

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UTILIZATION OF THE HEAT OF INCANDESCENT COKE OR THE LIKE MATERIAL

Application filed November 1, 1927, Serial No. 230,372, and in Germany November 11, 1926.

This invention concerns improvements in the utilization of the heat of incandescent coke coming from retorts, coking chambers and coking ovens by conducting non-combustible gases over the coke and leading the said gases to a boiler plant.

Since in arrangements of this nature proposed hitherto the entire temperature drop of the coke from 1000° C. to about 200° C. is utilized extraordinarily large quantities of non-combustible gases are necessary for the heat transfer and also very large boiler plants. The high cost of the plant thus arising in great part outbalances, in most cases, the advantages gained by recovering the heat.

According to the present invention the entire temperature fall of the incandescent coke is not utilized at one time but the fall is split into two or more stages. In the first stage which embraces, say, the temperatures from 1000° to 700° C. the heat of the coke may be supplied to a high pressure boiler plant. In a second stage of about 700° to 300° C. the heat may be supplied to a water preheater the water of which serves, if desired, as feed water for the high pressure boiler. The last temperature drop is effected by quenching the coke with hot water or low pressure steam, the resulting steam then serving at the same time to furnish an air-seal and thus prevent the coke burning in the air. The utilization of this final heat sage is in general not in itself worth while.

The economy of this method is materially enhanced by such subdivision into stages of the whole heat drop.

Two embodiments of the invention are illustrated by way of example in the accompanying drawings in which

Fig. 1 shows one embodiment in which the incandescent coke is treated successively on a stepped grate and on a travelling grate,

Fig. 2 a second embodiment in which a stepped grate only is used for the coke, and

Fig. 3 shows an embodiment producing high and low pressure steam.

Referring first to the example illustrated in Fig. 1 it will be seen that a charging hopper 1 is provided from the lower end of which a stepped grate 2 receives the incandescent coke. The hopper 1 is closed in an air-tight manner by a flap or valve 3. The heating tubes 4 of a high pressure boiler 5 are disposed above the stepped grate 2 and a blower or fan 6 having a pressure conduit 7 and return conduit 8 is provided to blow inert gas, of any appropriate nature through the grate, over the incandescent coke and thence to the heating tubes 4. The blower draws away the so cooled gases once more at 9 by way of the return conduit 8. Flue gases from a firing plant may be passed into the blower in order that there shall always be a certain pressure, over and above that of the atmosphere, in the whole cooling system.

If necessary also a part of the heating tubes may be located separately, as at 10, and heated by an auxiliary or additional burner arrangement 11, say by gas burners, when, as occasion demands, forced operation of the high pressure boiler is necessary.

Adjacent the stepped grate 2 is a travelling grate 12 which consists of a chain of bars with plates 13, or a similar construction, running over chain wheels 14 and 15. The second temperature stage is utilized in this grate, again by inert gases being blown by a blower 16 through a conduit 17 and the grate 12 on which the incandescent coke layer is disposed; said gases then flow around a water preheating device 18 and re-enter the blower 16 at 19. Flue gases from a firing plant may also be introduced into the blower of this stage in order that, as before, there shall be a pressure in the cooling system above that of the atmosphere and of the wet quenching chamber, the object being to prevent the unnecessary and even harmful passage of steam from the last stage, that is the wet quenching stage, into the preceding cooling apparatus. The water preheating device may be employed to supply the high pressure boiler with feed water.

The coke next falls from the travelling grate 12 into a bunker 20 which is closed below by a pivoted flap or valve 21. Above the bunker is an outlet pipe 22 in which two flaps 23 and 24 are located. The flap 23 is connected to the flap 21 by a linkage 25 in

such a manner that when the one flap is closed the other is open and vice versa.

Warm water may be sprayed through the nozzle device 26 on to the incandescent coke in the bunker 20 or low pressure steam may be blown by the nozzle 27 through the coke in order to cool it completely. The resulting steam then escapes partly through the outlet pipe 22 but also fills at a certain low pressure the entire space 28 above the bunker 20 and seals the same against the entry of air.

The flap 24 is connected by the linkage 29 with the flap 3, again in such a manner that when the one flap is open the other is closed and vice versa.

The modus operandi is as follows:

The incandescent coke from the retorts or the coking ovens falls, the flap 3 being open, into the hopper 1 and thus onto the stepped grate 2. The fan 6 blows non-combustible gas through the grate and the coke and this gas flows around the heating tubes 4 of the high pressure boiler 5 and gives up its sensible heat to the latter. High pressure steam is thus generated.

On this grate 2 the incandescent coke is cooled from about 1000° to 600° or 700° C. It then falls on to the travelling grate 12, carried on which it is subjected, as before to non-combustible gases blown through it by the blower 16, possibly with the addition of flue gases; the gases flow around the pre-heater tubes and give up their heat thereto. The coke gradually falls from the travelling grate over the chain wheel 15 down into the bunker 20 where it is cooled either by warm water from the nozzles 26 or by low pressure steam from the nozzle 27.

The coke leaving the travelling grate still has a temperature of about 300° C. and falls at this temperature into the bunker 20. After its cooling to about 100° C. the coke is removed from the bunker 20 by opening the flap 21. When the latter is opened the flap 23 is closed by the linkage 25 so that no air can enter from above. The space 28 is kept filled with steam arising from the hot coke due to the spraying with water or steam, air thus being excluded. A further air seal results from the pressure maintained by drawing in additional gas.

On opening the flap 3 the flap 24 closes and prevents air being drawn in through the opening 22. Similarly this flap 24 may also be connected by a separate linkage with the flaps 23 and 21 so that whenever one flap is opened the two others are always kept closed.

Below the travelling grate 12 there is moreover a further flap 30 whereby resulting coke dust may be withdrawn.

In the embodiment of the invention illustrated in Fig. 2 the arrangement of the first part of the plant is the same; in the latter part of the cooling system, however, the travelling grate is replaced by a similar stepped grate 31 through which inert gas is again blown by means of the blower 16 and conduit 17, flows over the tubes of the pre-heater 18 and re-enters the blower 16 at 19. At the end of this stepped grate 31 is a large drum 32 which rotates slowly in the direction of the arrow, gradually removing the coke from the bottom of the grate and passing it to the bunker 20 the arrangement of which is again the same as in the embodiment according to Fig. 1. The drum 32 may, if necessary, be furnished with grippers 32′ at its periphery in order to convey the coke better.

In both cases the incandescent coke charged in travels slowly over the two grates and gives up its heat in stages to the high pressure boiler and water pre-heating device.

If occasion demand the sub-division may be carried even further by the interposition of a further stage for the generation of low pressure steam between the two above described stages.

It is possible by the stepwise utilization of the heat to produce the heat receiving apparatus in a materially simpler and materially cheaper form than hitherto. Since moreover the cooling of the coke by inert gases is preferably only carried down to about 300–400° C., the blower output is considerably less so that the economical efficiency of the whole plant is substantially higher than is the case when the heat is utilized in one single stage.

The same method and the same device may also be employed for utilizing the sensible heat of hot or incandescent materials, other than coke, discharged from any sort of burning ovens or the like.

The incandescent coke may, if desired, also be fed over the grates by a separate conveyor device.

The cooling of the coke according to this system gives a very good coke because the wet-quenching thereof is only performed at a temperature of about 300° and then with hot water or steam so that the water or the steam cannot exercise any destructive action on the coke.

The quenching in stages may also be sub-divided into high pressure steam generation, low pressure steam generation and wet quenching that is without any hot water production; in this case coke at about 400° is wet-quenched and the feed water for the high pressure boiler is taken from the low pressure boiler. The low pressure boiler may then be coupled directly to a "Ruth" feeder, possibly to an existing one.

In Fig. 3 I have shown such a construction, wherein 1 is the feed hopper provided with a valve or closure 3 connected by rod 29 to valve 24 in the chimney or stack. The apparatus is provided with three chambers or hoppers *a*, *b* and *c* for receiving breeze that is discharged

through valves 30, and a coke receiving hopper *d* that is discharged through valve 21 connected by rod 25 to a second valve 23. On the stem of the valve 23 is a disc 40 having a convex portion 40′ and a concave portion 40″. This disc cooperates with a disc 41 on the stem of valve 24 and has a similar convex portion 41′ and a concave portion 41″. The arrangement is such that when closure 3 for the hopper 1 is opened valve 24 is closed and convex portion 41′ enters the concave portion 40″ of disc 40 and prevents valve 23 from closing and valve 21 connected to it from being opened.

The stationary grate 2 discharges onto the travelling grate 13 guided on rotating guides 12 and 14. The grate 13 discharges onto grate 13ª and is guided on rotating guides 12 and 15, the end of grate 13ª discharging over the guides 15 into the coke hopper or chamber *d*.

The tubes 4 of the drums 5 of a heat exchanger, or a high pressure steam boiler, are located above the stationary grate 2, and non-combustible gases are drawn into the apparatus by blower 6 through pipe 35 controlled by a damper 35 and connected by rods 34′ to a damper 34 on the circulating side of the blower. The blower circulates gases through pipe 7, through the high temperature coke to be cooled, through port 9 in the boiler, pipe 33, back through pipe 7. A burner 11 supplies a gas flame to tubes 10 of the steam generator for forced steam generation, as in Figs. 1 and 2.

Over the travelling grates 13 and hopper *b* is mounted a second heat exchanger, a low pressure vertical tube boiler 36, provided with a circulating blower 16′ and connected to the low pressure boiler at 19, and circulating the cooling gases through the partly cooled coke on grate 13 through pipe 17′.

A pump 38 feeds water from boiler 36 to a high-pressure boiler drum 5.

The low pressure steam boiler is provided with a "Ruth" feeder 39.

Over discharge grate 13ª and hopper *c* is a third heat exchanger, a feed water heater 18, its circulating blower and circulating pipe being designated 16 and 17 respectively.

A pump 37′ supplies water from the heater to the low pressure boiler 36, and the heater 18 is itself supplied by a pump 37.

A warm water spray pipe 26 and low pressure steam pipes 27 are arranged in the coke hopper *d*, as in Figs. 1 and 2, for quenching.

It will thus be seen that there are four chambers in open communication in series, in which the inert cooling gases are maintained above atmospheric pressure by waste flue gases supplied through pipe 35 to blower 6. The first three chambers or hoppers *a*, *b* and *c* are each supplied with a heat interchanger operating at different progressively lower temperatures in accordance with the abstraction of heat from the moving coke by the cooling gases and the transference of heat to the respective heat interchanging devices by repeated separate circulation.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is.—

1. In a coke cooling apparatus, a plurality of chambers in open communication in series, coke supporting means over which the coke passes through the chambers, heat interchanging devices associated with the chambers, a separate blower associated with each device to circulate gases through different portions of the coke and device, and means to supply inert gases to the chambers and means for wet cooling the coke and simultaneously creating a seal of steam against external atmospheric air and against the inert gases in the drying portions.

2. In a coke cooling apparatus, a plurality of serially connected chambers, a grate for each chamber cooperating to discharge one to the other, a heat interchange device for each chamber, means to supply inert gases to the chambers, a blower associated with each device to circulate gases through the device and its associated grate, a chamber into which the coke is delivered by the grates, means to supply aqueous quenching medium to the coke in said coke chamber, a stack for the coke chamber and dampers in the stack, the steam produced in said chamber acting as a seal against the entrance of air.

3. In a coke cooling plant, a plurality of chambers in open communication in series, coke supporting means over which the coke travels past the chambers, a heat interchanging device associated with each chamber, means to continuously circulate gases through each device and the coke as it travels past the individual devices through the respective chambers, a charging hopper at one end of the series and a closure therefor, a coke chamber at the other end of the series into which said means delivers, means to supply aqueous quenching medium to the coke in the coke chamber thereby forming a steam seal and cooling the coke, a discharge valve for the last chamber, a stack for the coke chamber, two valves in the stack one connected to the discharge valve for alternate operation and one connected to the hopper closure for alternate operation whereby one of the stack valves will be closed when either the stack valve or hopper closure is opened.

4. In a coke cooling plant, a plurality of chambers in open communication in series, means to move hot coke through the series, a high pressure steam boiler in the first chamber of the series arranged to receive heat from said coke, a gas burner to additionally heat the boiler for overload, a heat interchanger in the second chamber of the series,

means to supply the boiler from the interchanger, a blower associated with the boiler to repeatedly circulate gases through the hot coke and boiler, a blower associated with the interchanger to circulate gases therethrough and through the coke that has passed the boiler and first chamber and means for wet cooling the coke after passage through the dry cooling chambers.

5. In a coke cooling apparatus, a plurality of serially communicating chambers through which coke is continually passed, a heat exchanging device associated with each chamber, means for supplying a separate circulation of inert gas through the coke as it passes adjacent each chamber and to the corresponding heat exchange device, whereby a definite temperature gradient in each chamber is attained, the coke being delivered into the last of the serially communicating chambers, and means to supply aqueous quenching fluid in said last chamber to form a protecting seal of steam therein against the entrance of the atmosphere.

In testimony that I claim the foregoing as my invention, I have signed my name this 13th day of October, 1927.

ERNST SCHUMACHER.