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(54) **Process for production of gaseous mixture of carbon monoxide and hydrogen and melter-gasifier system for carrying out the process.**

(57) An improved method of removing molten slag from the surface of a molten iron bath (12) in a pressurized melter-gasifier (10) for producing a gaseous mixture of carbon monoxide and hydrogen from coal. The molten slag (14) is continuously removed from the meltergasifier (10) and quenched in a water bath (28). The resulting granular slag is separated from the quenching water (28) and the slag (14) and quenching water are separately removed from the pressurized system. Water economy is achieved by cooling the separated quenching water at atmospheric pressure and then pumping it back into the pressurized system.

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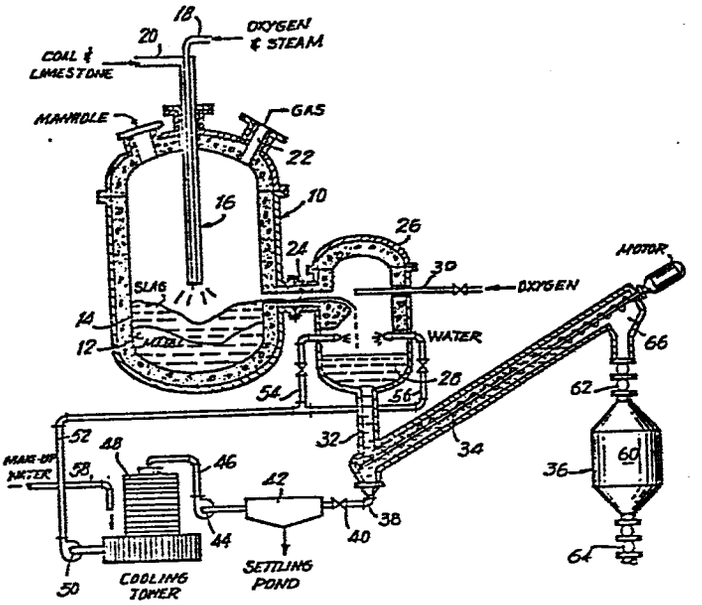
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MAKE-UP WATER
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COOLING TOWER
SETTLING POND

PROCESS FOR PRODUCTION OF GASEOUS MIXTURE OF CARBON MONOXIDE AND HYDROGEN AND MELTER-GASIFIER SYSTEM FOR CARRYING OUT THE PROCESS

This invention relates generally to a continuous process for the preparation of a mixture of carbon, monoxide and hydrogen gases. A melter-gasifier is used in which fossil fuel and oxygen, as well as steam and lime or limestone, are fed to a pressurized molten metal bath to produce the mixture of carbon monoxide and hydrogen gases.

Melter-gasifiers for effecting the partial combustion of the carbon content of fossil fuels in a molten metal bath to produce a gaseous mixture largely composed of hydrogen and carbon monoxide are well known in the art. Such melter-gasifiers are shown, for example, in U.S. Patents Nos. 3,533,739; 3,526,478 and 4,062,657.

More recently it has been recognized that improved efficiency can be achieved in the operation of such a melter-gasifier if the conversion of the carbonaceous fossil fuel is carried out in a pressurized reaction system. However, if a pressurized system is used, the removal from the melter-gasifier of molten slag accumulating on the surface of the molten bath presents a problem. If the operation of the melter-gasifier is interrupted periodically to permit batchwise removal of the molten slag, there will be a discontinuous flow of product gases from the system. The effect of such a discontinuous gas

supply can be mitigated by connecting several units in parallel, but if such a multi-unit system is used gas flow control valves must be employed in contact with the hot gases and such "hot" valves are difficult to maintain. Thus, there is need for an effective and efficient continuous process for removing molten slag from such a pressurized melter-gasifier.

One proposal for removal of slag from a pressurized melter-gasifier is shown in U.S. Patent No. 4,344,773. In accordance with the system there shown, molten slag is withdrawn from the surface of a molten iron reaction bath through a laterally extending channel and is delivered to a body of water in a quenching chamber wherein it is cooled and solidified. The resulting mixture of water and solidified slag is then removed from the system by gravity through a pressure lock-hopper having shut-off valves at the top and bottom thereof.

While such a system permits continuous removal of slag from such a melter-gasifier, it is subject to a number of disadvantages. Thus, in the patented system the shut-off valves at the top and bottom of the lock hopper, which must maintain a tight seal on the pressurized systems, are exposed to a flood of water as the mixture of slag and water enters the hopper and is discharged therefrom. This water tends to wash away lubricants on the valve parts and to corrode them. Also large amounts of cooling water are used because the lock hopper is flooded and discharged during each operating cycle.

It is accordingly an object of the present invention to provide an improved method for continuously removing molten

slag from the surface of the molten metal bath in a pressurized melter-gasifier for producing a reducing gas mixture from fossil fuels. It is another object of the invention to provide effective water cooling of the removed slag while minimizing the amount of water used. It is still another object of the invention to provide a method of this type wherein the solidified slag is removed from the pressurized system through a valved pressure lock that does not come in contact with the quench water. Other objects of the invention will be in part obvious and in part pointed out hereafter.

The objects and advantages of the present method are achieved in general by providing a system wherein the molten slag is continuously withdrawn from the melter-gasifier and delivered to a body of cooling water in a quenching chamber as described above, but the solidified slag is de-watered before being removed from the pressurized system through a pressure lock. As described below, the quantity of water used can be minimized by withdrawing quench water from the quench chamber and cooling and re-circulating it.

The invention will be better understood and appreciated by reference to the accompanying drawing which illustrates apparatus capable of carrying out a preferred embodiment of the invention.

In this specification and in the accompanying drawing we have shown and described preferred embodiments of our invention and have suggested various alternatives and modifications thereof; but it is to be understood that these are not intended to be exhaustive and that many

other changes and modifications can be made within the scope of the invention. The suggestions herein are selected and included for purposes of illustration and in order that others skilled in the art will more fully understand the invention and the principles thereof and will thus be enabled to modify it in a variety of forms, each as may be best suited to the conditions of a particular use.

Referring to the drawing, the numeral 10 designates a melter-gasifier reactor of conventional construction containing a molten iron bath 12 with a layer of slag 14 floating thereon. Extending downwardly through the center of the reactor there is a feed tube assembly 16 comprising an inner tube 18 and an outer tube 20. A mixture of steam and oxygen from a suitable source is fed to the reactor through tube 18 and a mixture of powdered coal and limestone is fed through the tube 20. Partial combustion of the coal in the presence of steam at the discharge ends of the tubes provides heat to maintain bath 12 and slag layer 14 molten and produces a gaseous mixture largely composed of carbon monoxide and hydrogen which may be withdrawn from the reactor through a discharge port 22. The limestone promotes the formation of a fluid slag containing the residual ash from the combination of the coal and thus facilitates the removal of this residue from the reactor. As indicated above, the reactor is desirably operated at an elevated pressure.

The fluid slag is continuously withdrawn from reactor 10 through a lateral passage 24 which connects the reactor with a quenching chamber 26 containing a body of water 28

for quenching the slag and converting it to solid granular form. Located in the side wall of quench chamber 26 there is an oxygen lance 30 having its discharge end positioned in registry with a passage 24. The oxygen lance is useful in preventing blockage of passage 24 due to solidification of slag therein.

The mixture of granular slag and water in quench chamber 26 flows downwardly through discharge pipe 32 to the outlet end of a screw conveyor 34 which as shown in the drawing extends upwardly and outwardly from pipe 32. At the junction of pipe 32 and conveyor 34 the slag and water are separated. The slag is transported by conveyor 34 to the upper end of a pressure lock generally designated 36 and the quench water flows through pipe 38 containing a back pressure valve 40 to a settling tank 42 wherein suspended solids are moved by sedimentation. The clarified water is transferred by pump 44 through pipe 46 to the cooling tower 48 wherein it is cooled and thence by pump 50 through pipe 52 and branch pipes 54 and 56 back to the quenching chamber 26. Make-up cooling water may be added to the cooling water circuit through pipe 58.

The pressure lock 36 may be of the general type disclosed in U.S. Patent No. 3,710,808. It comprises the hopper 60 and the double valve assemblies 62 and 64. At its upper end the conveyor 34 delivers granular slag to the accumulating hopper 66. From time to time the valves 62 are opened with the valves 64 closed to permit accumulated flag to flow from hopper 66 to hopper 60. Valves 62 are then closed and valves 64 opened to discharge the granular slag from the system.

It should be apparent from the foregoing description that the present invention is capable of achieving the several objetive set forth at the beginning of the specification. Thus, water quenching of the molten slag is carried out in such a manner that separation of the water and slag is achieved before removal of these materials from the pressurized reaction system and the separated materials are separately removed from the system. Hence, the quenching water is kept away from the pressure lock valves. A saving in cooling water is obtained by cooling the quenching water after its removal from the pressurized system, i.e. at atmospheric pressure, and then recycling it to the quenching chamber.

Thus, there has been described an improved continuous method for removing from a melter-gasifier slag that accumulates on the surface of the molten bath.

It is, of course, to be understood that numerous changes can be made within the scope of the invention in the illustrative system described above. For example, as is known in the art some or all of the materials introduced into reactor 10 through the feed tube 16 can, if desired, be fed to the bottom of the reactor below the level of molten bath 12. Other variations within the scope of the invention will be apparent to those skilled in the art.

CLAIMS:

1. A continuous process for the preparation of a mixture of carbon monoxide and hydrogen gases in a pressurized reaction system including a melter-gasifier (10) having a molten metal bath (12) therein, a quench-cooling chamber (26) connected to said melter-gasifier (10) to receive molten slag (14) therefrom and a lock hopper (60) for removing cooled slag from said system and wherein a mixture of particulate fossil fuel, limestone, oxygen and steam is fed to said molten bath (12) to produce said gaseous mixture and a layer of molten slag (14) on the surface of said bath (12), characterized by continuously withdrawing slag (14) from said melter-gasifier (10) into said quench-cooling chamber (26), supplying cooling water (28) to said quench-cooling chamber to cool the slag (14) therein, separating the cooled slag and cooling water and transferring the de-watered slag to said lock hopper (60) for removal from said system.

2. A process accordint to claim 1 wherein the mixture of fuel, limestone, oxygen and steam is fed to the top of said molten bath.

3. A process according to claim 1 wherein the mixture of fuel, limestone, oxygen and steam is fed to the bottom of said molten bath.

4. A process according to claim 1 wherein the water separated from the quenched slag is withdrawn from said pressurized system, cooled and then recycled to said quench-cooling chamber.

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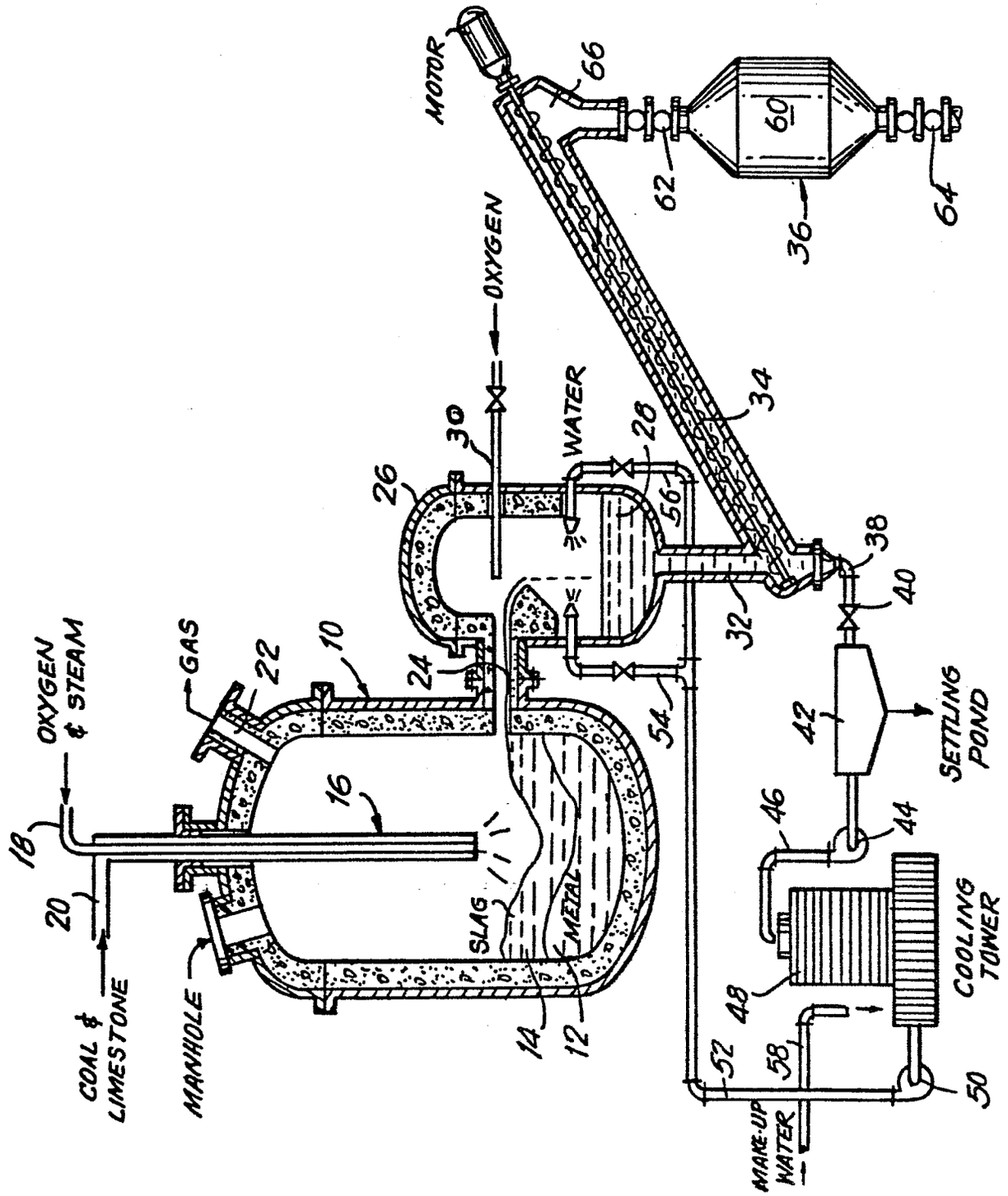
5. A melter-gasifier system adpated to carry out the process of any one of claims 1 to 4.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