Feb. 28, 1933. C. R. KUZELL 1,899,161

METALLURGICAL APPARATUS

Filed Nov. 2, 1929 2 Sheets-Sheet 1

Fig. 1

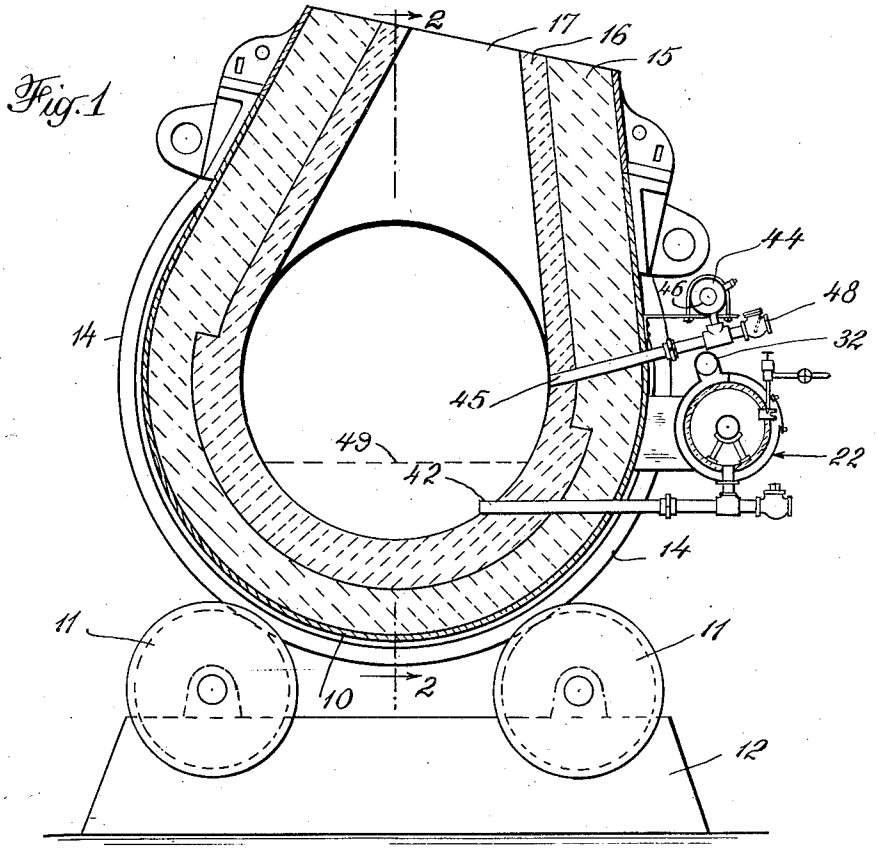
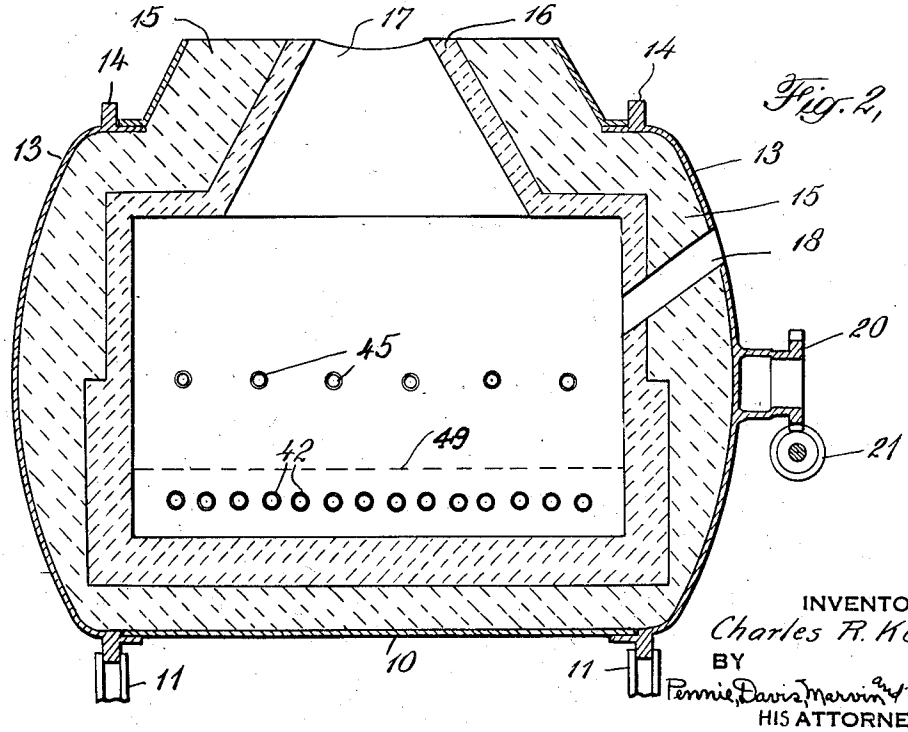


Fig. 2,



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Fig. 3,

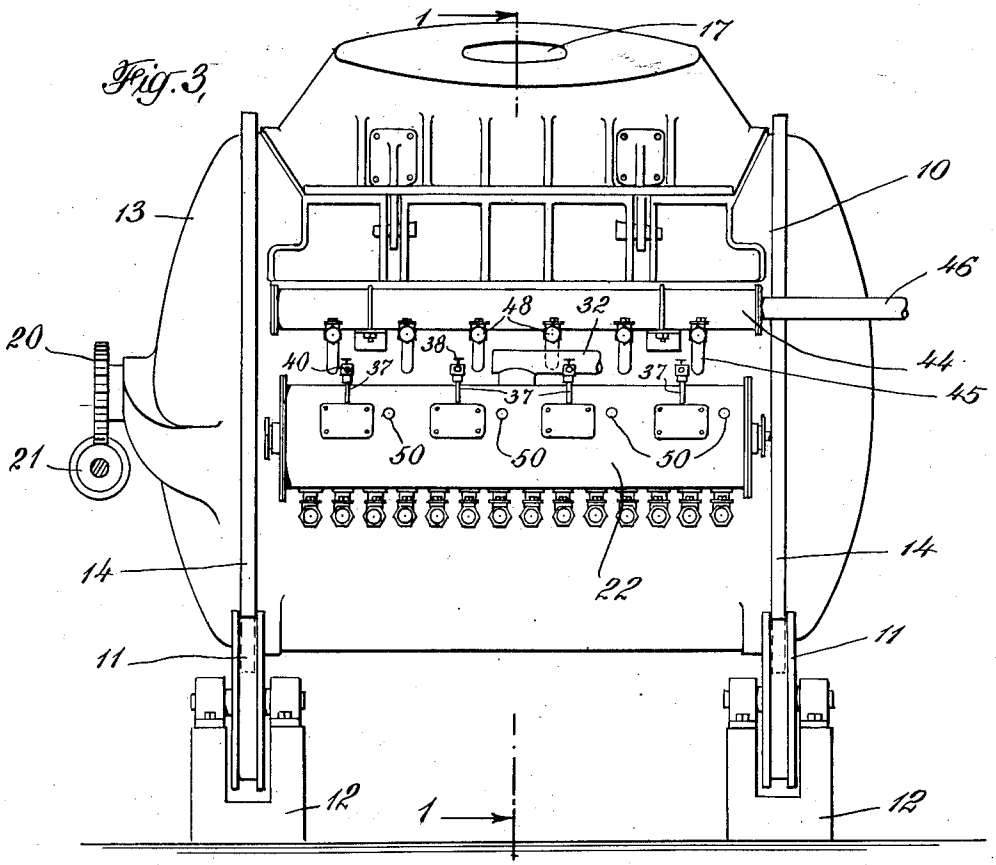


Fig. 4,

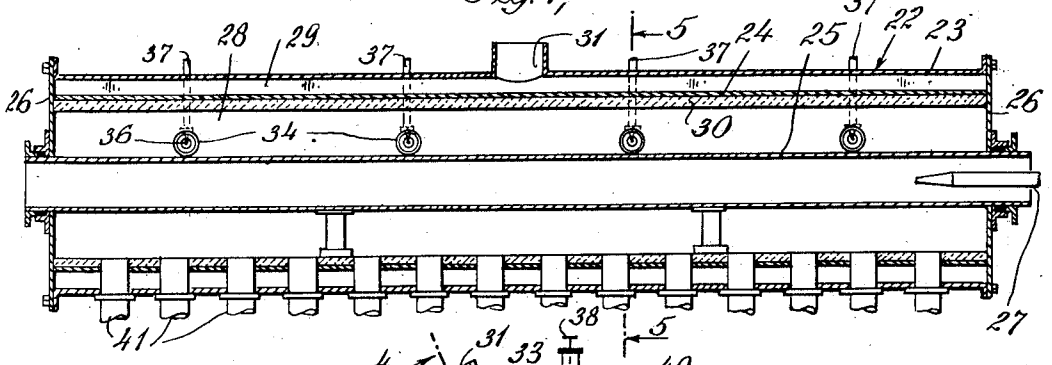
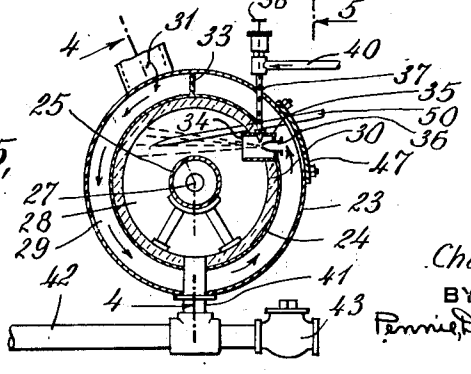


Fig. 5,



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UNITED STATES PATENT OFFICE

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METALLURGICAL APPARATUS

Application filed November 2, 1929. Serial No. 404,348.

This invention relates to metallurgical apparatus and has for an object the provision of an improved apparatus for subjecting materials to be treated to the action of gaseous reagents. More particularly, the invention contemplates the provision of an improved apparatus for subjecting a molten bath to the action of a reducing agent. The invention further contemplates the provision of an improved apparatus for treating zinc-bearing materials.

According to some heretofore customary practices, gases to be introduced into receptacles containing materials to be treated thereby are generated or produced at points remote from the receptacles. The gases are stored under slight pressure, and when the operations being conducted require the introduction of the gas under considerable pressure it is necessary to provide an additional compressor or blower. While such gases are usually produced at high temperatures, their heat content is dissipated while they are in storage or while they are being conducted from the storage receptacle to the reaction chamber or receptacle. Consequently, not only is considerable heat wasted, but in some types of operations, such, for example, as those involving the introduction of reducing gases into a molten mineral bath, heavy deposition of carbon takes place in the tuyères interfering with the proper operation of the apparatus.

The present invention contemplates the provision of apparatus as a result of which the necessity for blowers or compressors is eliminated and by means of which the heat contained in gases when generated may be saved and utilized.

According to the invention, reducing gas is introduced directly from a gas generator into a reaction chamber or receptacle at temperatures and pressures substantially equal to those at which they are generated.

Apparatus constructed in accordance with the invention comprises a receptacle for the material to be treated having a gas generator mounted thereon or closely adjacent thereto in such a manner that a relatively short conduit may be used for conducting the gas from the generating chamber to the treating chamber.

In one of the preferred forms of the invention, the apparatus consists of a receptacle adapted to hold a molten mineral bath, a reducing gas generator mounted on the receptacle, and suitable tuyères providing means of communication between the gas generator and the interior of the molten bath receptacle. The tuyères communicate with the interior of the molten bath receptacle below the normal bath level, and additional means may be provided for introducing other solid or fluid reagents into the interior of the receptacle at any desired points. The molten bath receptacle may be mounted for rotary movement through any desired arc, and, when the receptacle is so mounted, the generator is preferably movable therewith.

The invention may be used to particular advantage in processes involving the treatment of slags and mattes and similar products resulting from the smelting of ores containing zinc. In the treatment of zinc-bearing materials a converter similar to those ordinarily used in copper smelting may be used. The converter may be stationary, but it is preferably so mounted that it may be rotated or tilted about a horizontal axis to permit charging and removal of the charge. The gas generator is preferably mounted on a side wall of the converter in such a manner that relatively short conduits or tuyères may be used for providing means of communication between the combustion chamber and the interior of the converter. The portions of the tuyères or conduits which are disposed between the gas generator and the outer shell of the converter may be covered with insulating material to prevent heat losses, or the gas generator may be so mounted that the exposed portions of the tuyères or conduits are sufficiently short that the heat losses are negligible. In the treatment of zinc-bearing material, the reducing gas is injected into a molten bath of the material beneath the surface thereof. The gases are introduced into the molten bath at temperatures and pressures substantially equal to those at which they are generated. The apparatus is pref-

erably provided with tuyères for introducing air or other oxidizing gases into the converter at points above the surface of the bath to oxidize any metallic zinc produced, and means are provided for collecting the resulting fume.

The invention will be better understood from a consideration of the following description in conjunction with the accompanying drawings in which is shown one of the preferred embodiments of the invention, and in which

Fig. 1 is a section taken substantially along line 1—1 of Fig. 3 and showing one form of apparatus which may be constructed in accordance with the present invention and which may be used advantageously in treating zinc-bearing materials;

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

Fig. 3 is a front elevation of the apparatus shown in Figs. 1 and 2;

Fig. 4 is a section taken substantially along line 4—4 of Fig. 5 and showing a type of gas generator which may be employed in constructing apparatus in accordance with the invention; and

Fig. 5 is a section taken substantially along line 5—5 of Fig. 4.

A reaction chamber or molten bath receptacle 10, which may be one of the usual types of converters used, for example, in copper smelting, is mounted for movement about a horizontal axis on rollers 11 rotatably supported on a suitable foundation 12. The receptacle 10 comprises a sheet metal shell or casing 13 having annular metal rings 14 mounted thereon adjacent the ends for contact with the rollers 11. The shell or casing 13 is provided with a suitable refractory lining which may comprise a layer of heat insulating brick 15 and a layer of heat refractory material 16. The receptacle 10 is preferably so formed that a restricted opening 17 is provided for charging and discharging and for permitting the egress of fumes. A passage 18 may be provided for permitting inspection or sampling of the contents.

A worm wheel 20 is mounted on one end of the receptacle 10 in axial alignment with the horizontal axis. A worm 21 engages the worm wheel 20, and means (not shown) are provided for rotating the worm 21 to rotate or tilt the receptacle 10.

A gas generator 22 is rigidly attached to the receptacle 19 for movement therewith. The gas generator 22 comprises three telescoping, axially aligned, hollow metal cylinders 23, 24 and 25. The cylinders are of such sizes and so spaced as to provide an annular combustion chamber 28 surrounded by an annular air chamber 29. The centrally disposed cylinder 25 forms an ignition tube which may be heated for starting the operation of the generator. The centrally disposed cylinder or ignition tube 25 is of greater length than the intermediate cylinder 24 and the outer cylinder 23 and its ends project beyond the end edges of the intermediate and outer cylinders. The outer and intermediate cylinders are of the same length, and end plates 26 have central openings engage their end edges. The end portions of the central cylinder or ignition tube 25 extend through the central openings in the end plates 26 and project beyond the outer surfaces thereof. The intermediate cylinder 24 is provided with a heat insulating and refractory lining 30 of asbestos. A pilot burner 27 is removably mounted adjacent an end of the ignition tube and is adapted to be inserted therein for starting the operation of the generator.

The outer cylinder 23 is provided with a central opening 31 in its upper portion which communicates with a source of supply of air under pressure (not shown) through a conduit 32. A partition 33 is disposed in the air chamber 29 between the outer and intermediate cylinders adjacent the opening 31 and extends longitudinally of the cylinders, engaging the end plates 26 and the walls of the intermediate and outer cylinders. A plurality of burners 34 are mounted on the intermediate cylinder 24 on the side of the partition 33 opposite to that on which the opening 31 is located. Each burner comprises a casing 35 having an open end projecting into the interior of the combustion chamber, an air inlet nozzle 36, and an oil inlet nozzle 37. The air inlet nozzle extends through the end wall of the casing 35 and provides means of communication between the combustion chamber 28 and the air chamber 29. The oil inlet nozzle projects downwardly to a point adjacent the inner end of the air inlet nozzle. The adjacent ends of the air and oil inlet nozzles are of restricted cross sections. The oil inlet nozzle communicates with a conduit 40 provided with a suitable control valve and connected to a source of supply of oil (not shown). The oil inlet nozzle is provided with a punching rod 38 for dislodging sediment and other obstructing materials.

A plurality of nipples 41 extend through the outer and intermediate cylinders and communicate with the interior of the combustion chamber. The nipples 41 are connected to tuyères 42 which communicate with the interior of the receptacle 10 adjacent the bottom. The outer ends of the tuyères 42 are provided with valves 43 which permit the insertion of bars for punching purposes.

An air manifold 44 is mounted on and extends along the receptacle above the gas generator. The air manifold is connected to a plurality of tuyères 45 which communicate with the interior of the receptacle above the normal level of the molten bath. For purposes of illustration, the normal bath level

is shown by horizontal dotted lines indicated by the numeral 49 of Figs. 1 and 2. The air manifold is connected by means of a conduit 46 with a source of supply of air under pressure (not shown). The tuyères 45 are provided with valves 48 which permit the insertion of bars for punching purposes.

The outer shell of the gas generator is provided with openings and removable inspection plates 47 immediately adjacent the burners 34. Observation tubes 50 extend through the outer casing and combustion chamber wall into the interior of the combustion chamber. The observation tubes 50 are sealed at their inner ends and they are sufficiently large to permit the insertion of pyrometers.

In the operation of the apparatus the receptacle may be charged with material to be treated, such, for example, as a bath of molten matte containing a zinc compound. For charging and discharging purposes, the receptacle may be tilted to place the charging opening in any desired position. For the treatment of zinc-bearing and other materials from which recoveries of fume are to be made, a hood connected to a suitable suction device and a bag-house (not shown) is provided.

The operation of the gas generator is started by heating the ignition tube 25 by means of the pilot burner 27. A pilot burner may be inserted in the ignition tube at each end. Heat from the ignition tube is radiated to and heats the insulating material on the wall of the combustion chamber. Heating is conducted in this manner until the temperature of the combustion chamber wall is at least equal to the ignition temperature of the air and oil mixture to be introduced. Air and oil are then admitted in the proper proportions to provide a reducing gas having the desired qualities. The burners admit the air and oil in the form of a mist in which the air and oil are intimately mixed. The intimate mixture of air and oil enters the combustion chamber between the heated walls of the ignition tube and the combustion chamber and it is immediately ignited. The resulting gas passes through the tuyères 42 directly into the converter at a temperature substantially equal to that at which it is generated.

The gas reduces the zinc compounds in the molten bath to form metallic zinc which is vaporized. The metallic zinc vapor is oxidized by means of air introduced above the bath through the air inlet tuyères 45. The resulting fume containing zinc oxide issues from the converter through the opening 17 and may be collected in any suitable manner.

After the operation of the gas generator has been started, heating by means of pilot burners is discontinued and the open ends of the ignition tube are plugged.

When removal of zinc from a bath has been completed, the converter is tilted to discharge the remaining material and another charge is provided. During the charging and discharging operations the operation of the gas generator may be suspended by cutting off the supply of air and oil. If the discharging and charging operations are conducted rapidly, the gas generator will be sufficiently hot to resume operation without requiring reheating by means of pilot burners. If desired the temperature of the gas generator may be maintained by means of a pilot burner while the reducing operations are suspended.

I claim:

1. Metallurgical apparatus comprising a molten bath receptacle, a combustion chamber, means for introducing a mixture of finely divided carbonaceous material and air under pressure into the combustion chamber, means for controlling the relative amounts of air and carbonaceous material introduced into the combustion chamber, and one or more tuyères providing direct means of communication between the interior of the combustion chamber and the interior of the molten bath receptacle below the normal bath level, the combustion chamber being so disposed with respect to the molten bath receptacle that the gas generated in the combustion chamber is forced into the molten bath receptacle by pressure developed as a result of changes in temperature and physical state of the carbonaceous material during the course of the production of the gas.

2. Metallurgical apparatus comprising a molten bath receptacle, a combustion chamber, means for introducing a mixture of finely divided carbonaceous material and air under pressure into the interior of the combustion chamber, means for controlling the relative amounts of air and carbonaceous material admitted to the combustion chamber, and one or more tuyères providing direct means of communication between the interior of the combustion chamber and the interior of the molten bath receptacle below the normal bath level, whereby gas produced in the combustion chamber may be introduced into the interior of the molten bath receptacle at a temperature substantially equal to that at which it is generated.

3. Metallurgical apparatus comprising a molten bath receptacle, a combustion chamber, means for introducing a mixture of finely divided solid carbonaceous material and air under pressure into the combustion chamber, means for controlling the relative amounts of air and carbonaceous material introduced into the combustion chamber, and one or more tuyères providing direct means of communication between the interior of the combustion chamber and the interior of the molten bath receptacle below the normal bath level, the combustion chamber being so disposed with respect to the molten bath receptacle that the gas generated in the com-

bustion chamber is forced into the molten bath receptacle by pressure developed as a result of changes in temperature and physical state of the carbonaceous material during the course of the production of the gas.

4. Metallurgical apparatus comprising a molten bath receptacle, a combustion chamber, means for introducing a mixture of finely divided oil and air under pressure into the combustion chamber, means for controlling the relative amounts of air and oil introduced into the combustion chamber, and one or more tuyères providing direct means of communication between the interior of the combustion chamber and the interior of the molten bath receptacle below the normal bath level, the combustion chamber being so disposed with respect to the molten bath receptacle that the gas generated in the combustion chamber is forced into the molten bath receptacle by pressure developed as a result of changes in temperature and physical state of the oil during the course of the production of the gas.

5. Metallurgical apparatus comprising a molten bath receptacle, a combustion chamber, means for introducing combustible material and air under pressure into the combustion chamber, means for controlling the relative amounts of air and combustible material introduced into the combustion chamber, and one or more tuyères providing direct means of communication between the interior of the combustion chamber and the interior of the molten bath receptacle below the normal bath level, the combustion chamber being so disposed with respect to the molten bath receptacle that gas generated in the combustion chamber is forced into the molten bath receptacle by pressure developed as a result of oxidation of combustible material during the course of production of the gas.

In testimony whereof I affix my signature.

CHARLES R. KUZELL.