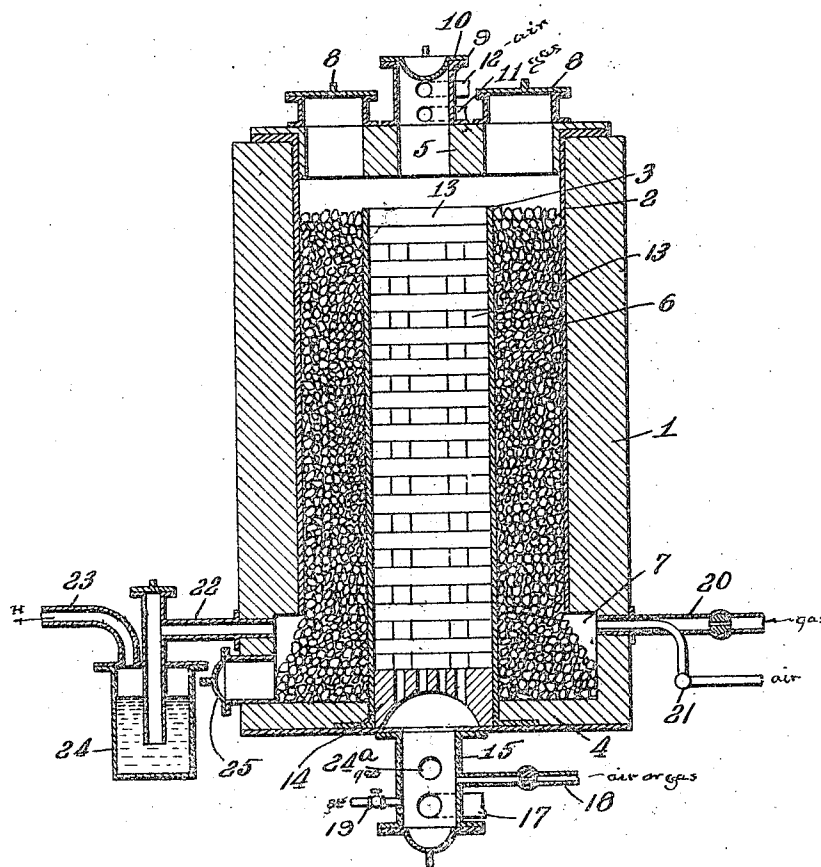


A. MESSERSCHMITT.
 APPARATUS FOR PRODUCING HYDROGEN.

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Patented May 8, 1917.



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APPARATUS FOR PRODUCING HYDROGEN.

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To all whom it may concern:

Be it known that I, ANTON MESSERSCHMITT, a citizen of the German Empire, residing at Stolberg, in Rheinland, Germany, have invented certain new and useful Improvements in Apparatus for Producing Hydrogen, of which the following is a specification.

This invention relates to apparatus for producing hydrogen; and it comprises an apparatus having a central combustion chamber inclosed by an annular casing, a wall of heat insulating or refractory material surrounding said casing and spaced away therefrom to form an annular reaction chamber therebetween; a pervious annular reaction mass within said chamber and supported by said casing and said wall, and connections for introducing steam, reducing gas and air into the combustion chamber and into the reaction mass; all as more fully hereinafter set forth and as claimed.

In the present invention I have devised a type of retort apparatus obviating the disadvantages of heretofore known retorts and securing certain new advantages. In lieu of placing the charge of reaction material in an externally heated cylindrical retort, in which with increase in size the surface area increases less rapidly than the sectional area (which is the heretofore known practice) I use a cylindrical combustion chamber with the reaction material disposed around it in annular arrangement; as a narrow annular column held between the combustion chamber and the furnace walls. In lieu of heating a cylindrical mass by combustion in a fire chamber around it, I heat an annular mass by combustion in a fire chamber inclosed by it. With such an arrangement, with a given lateral thickness of material in the column the ratio between heat-absorbing retort surface and quantity of material is the same whatever the dimensions of the apparatus. And I can use comparatively thin layers with a large quantity of material; a thing impossible with an externally heated cylindrical retort. And with these thin layers a uniform circulation or passage of the various draft currents through the reaction material or mass can be attained and a uniform heating secured, thereby producing many economies. In a shaft or retort of large cross section, the formation of channels and of impervious portions is practically impossible to obviate so that apparatus

of great capacity cannot well be built. There is no limit to the capacity of a single unit under the present invention.

To obviate oxidation and leakage losses, I can use the method of my copending application, Serial No. 1,444, filed January 9, 1915, as a division of my copending application, Serial No. 706,118, filed June 26, 1912, which comprises using the reducing gases of the reduction phase for heating purposes, sending such gases first through the hot oxidized charge and thence through the heating chamber for combustion therein. This makes retort and combustion chamber substantially one conduit and obviates any material differences in pressure. In the method of the stated application there is the further advantage that the iron retort may be kept deoxidized. The invention can however be used with the ordinary methods of heating and the draft connections usual with ordinary retort apparatus.

All the heating being internal, the heat utilization is good and radiation losses are reduced. The outer furnace walls, which may be heat-insulated if desired, serve mainly to retain heat and to help support the charge of the reaction material. For this purpose, the charge should be directly against the furnace wall. With the charge vertical, as it usually is, this support is an important item since the outward thrust at the base of a column of such heavy material as lump iron ore is sometimes great.

In the accompanying illustration I have shown, more or less diagrammatically, an embodiment of the described invention. In this drawing, the illustration is in vertical section.

Element 1 is a furnace chamber or wall of refractory material and is best cylindrical in shape. It may be made of brick or any other suitable refractory structural material and is best so arranged as to be heat insulating to a large degree. It is best provided with a lining 2 which is illustrated as iron or steel, and may be flanged over the top of the outer wall as shown. This lining is not absolutely necessary but is desirable as adding to the gas tightness of the apparatus. If of iron, its surface plays some part in the reactions being alternately oxidized and reduced. It may be made in sections if desired as this makes replacements and renewals easier and cheaper. At a point within the chamber and spaced away from

the wall is an annular casing 3 which may be made of steel or iron. As shown, this wall makes a gas tight joint with the lower wall or bottom 4 of the furnace chamber and extends upwardly to a point somewhat short of the top 5, the clearance establishing communication between the chamber within it and the annular reaction chamber between it and the wall. This casing is spaced away from the chamber wall to form said annular reaction chamber and the chamber is provided with a pervious column 6 of iron ore, iron oxid, a mixture of iron and manganese oxid, a manganiferous iron ore, or other material capable after reduction of taking up oxygen from steam with liberation of hydrogen and of being reduced in turn by reducing gases (hereinafter referred to as ferruginous material). The presence of manganese in the iron ore facilitates the operation of the charge. Toward the bottom, the outer wall is recessed as shown to form an annular gas channel 7 into which the charge may extend as an angle-of-repose pile. At the top, the apparatus is provided with openings 8 having removable covers which may serve in charging in reaction material. Centrally is another conduit 9 provided with removable cover 10, gas conduit 11 and air conduit 12. The annular casing forms within it a combustion chamber 13 provided with a checkerwork or the like of fire brick or other suitable refractory material. At its base, this combustion chamber may be closed by a perforated bottom 14 serving to support the checker. The perforations open into conduit 15 having a connection 17 to a stack or the like, an air or gas inlet 18 and a steam inlet 19. Entering the annular channel (7) at one side is valved gas conduit 20 and air conduit 21. At another point conduits 22 and 23 with seal pot 24 allow leading the hydrogen away. Removable cap 26 allows venting waste gases. Door 25 permits removal of the reaction mass.

In the use of the described structure, presuming a steaming and hydrogen producing phase to have been just completed, reducing gas, such as "blue" water gas, may be led in through 20 and a modicum of air through 21. About 10 to 20 per cent. of air admixed with the gas is often a useful proportion, using water gas, though less or more may be used under some circumstances. The gas rises through the column of reaction material 6, reducing the oxid which has been formed by the steam and emerging at the top of the column still freely combustible. During its upward flow a limited amount of combustion takes place with the aid of the admixed air under the influence of the catalytic action of the hot reaction mass, resulting in direct development of heat in such mass. Above the column the gas is

joined by air from 12 and combustion completed in the checkerwork chamber 13, storing up heat in this checker. The waste gases, or products of combustion pass off through 17. The introduction of air through 21 may be omitted when the heating from other sources is sufficient. And it may be used only in the first phase of reduction. At the end of the reduction the air, if not previously shut off, is shut off and then the gas. Column 6 is now filled with reducing gas and checkerwork 13 with products of combustion. At this time steam is admitted at the base of the combustion chamber through 19, and cap 10 is removed. The steam rises through the combustion chamber displacing the products of combustion which escape at 10. When steam appears at 10, the checker is full of superheated steam. Cap 10 is placed in position and the introduction of steam is continued. The superheated steam now passes down through the column displacing the combustible gas ahead of it. This gas escapes through conduits 22 and 23 or it may escape past cap 26. The superheated steam contacting with the reduced reaction material produces hydrogen and this hydrogen finally appears at 22 and 23 when it is led off to a suitable point of use or storage (not shown). When the production of hydrogen begins to diminish the supply of steam is shut off and the reduction and heating up stage once more begins.

In heating up the apparatus in starting, or whenever heating may be desired, direct heating of the checkerwork may be resorted to. For this purpose, gas may be admitted through 24 and air through 18 and combustion allowed to take place in the checker, waste products of combustion being removed at 10. Or, this heating may be from above downward, gas being introduced by 11 and air by 12 and products of combustion removed at 17. The channels in 14 play a useful part in homogenizing the gases passing therethrough and completing combustion.

The introduction of a little air at 21, through at least part of the reducing stage, is useful as enabling the development of heat in the reaction material itself. While small proportions, such as 20 per cent. and under of air in reducing gas do not burn readily, in the presence of the hot checkerwork or of a catalytic such as the reaction material herein described, combustion with development of heat takes place. The iron members 2 and 3 being exposed to reducing gases from time to time do not become permanently oxidized and are of comparatively long life. In the construction shown since combustion chamber 13 and reaction column 6 practically form one conduit, there is no material difference of pressure between the chambers on the two sides of annular wall 3.

The structure shown may be reversed ver-

tically without change of function, the iron or steel cylinder in this event depending to a point short of the bottom instead of standing and extending upward to a point short

5 of the top.
This invention involves certain novel and important embodiments of my inventions as disclosed and claimed in my two copending applications, Serial No. 706,118, filed
10 June 26, 1912, and Serial No. 1444, filed January 9, 1915.

What I claim is:

1. In a hydrogen apparatus, an inner furnace chamber formed by an annular casing,
15 an outer heat insulating wall spaced therefrom to form a chamber to receive an annular pervious column of ferruginous reaction material, firing means for producing combustion in said furnace chamber, means
20 for removing waste gases therefrom, means for passing reducing gases and draft currents of steam alternately into and through said column and means for removing hydrogen produced in steaming.

2. In a hydrogen apparatus, an outer heat insulating furnace wall, an annular casing inclosing a combustion chamber and spaced
25 away from said heat insulating wall to form a reaction chamber adapted to receive a charge of reaction material, said reaction chamber at one end being in communication
30 with the combustion chamber within said casing, means for introducing gas into the combustion chamber within the casing, means for passing draft currents of reducing
35 gases and of steam alternately into and through the said reaction material, and means for removing the hydrogen produced in steaming.

3. In a hydrogen apparatus, a wall of refractory material, a septum spaced away
40 therefrom to form a reaction chamber therebetween, a pervious column of ferruginous material in said reaction chamber, means for producing combustion in proximity to the
45 opposite side of said septum, means for alternately passing draft currents of reducing gases and of steam into and through said column and means for removing the
50 hydrogen produced in steaming.

4. In a hydrogen apparatus, a wall of heat insulating material, a septum in proximity thereto and spaced away therefrom to
55 form a reaction chamber therebetween, a combustion chamber on the other side of said septum and in communication with the reaction chamber at one end, a pervious
60 mass of ferruginous reaction material in the reaction chamber, means for producing combustion in the combustion chamber, means for alternately passing draft currents of
reducing gas and of steam into and through said mass and means for removing the hydrogen produced in the steaming.

5. In a hydrogen apparatus, a vertical in-

closing wall, a contained annular casing, a mass of pervious ferruginous reaction material between said casing and said wall, means for producing combustion within said
70 annular casing, means for alternately passing draft currents of reducing gases and of steam into and through said mass and means for removing the hydrogen produced in steaming.

6. In a hydrogen apparatus, a vertical-walled furnace chamber of refractory material, an annular casing within the chamber and spaced away therefrom to form a reaction chamber therebetween, said reaction
75 chamber and the space within the annular casing being in communication near one end of the structure, a pervious mass of ferruginous reaction material within the reaction chamber, means for producing combustion within the annular casing, means
80 for alternately passing draft currents of reducing gases and of steam through said mass and means for removing the hydrogen produced in steaming.

7. In a hydrogen apparatus, a vertical furnace chamber of refractory material, a vertical annulus spaced therefrom and stopping somewhat short of one end of the chamber and forming a fire chamber, the
85 space between the annulus and the chamber wall of refractory material adapted to receive a pervious mass of ferruginous reaction material, a heat storing checker within the fire chamber, means for introducing air
90 into the fire chamber, means for passing steam into the fire chamber, means for alternately passing draft currents of reducing gases and of steam through said mass and means for removing the hydrogen produced
95 in steaming.

8. In a hydrogen apparatus, a vertical casing, means for producing combustion within such casing, an inclosing wall of heat insulating material spaced away from
100 such casing to form a reaction chamber therebetween, means for introducing reaction material into said chamber and means for removing reaction material therefrom, means for passing reducing gas into and
105 through such reaction material, means for passing steam therethrough and means for removing hydrogen produced in the steaming.

9. In a hydrogen generator, an annular mass of ferruginous reaction material, a
120 wall surrounding and supporting the same, connections for introducing combustible gas, air and steam into and through said annular mass, and for removing waste gases and hydrogen therefrom, an annular casing wall
125 within and supporting said mass, and means for producing combustion within an internal chamber formed by said annular wall.

10. A hydrogen generator including a substantially gas-tight casing, an annular wall
130

disposed therein and spaced away there-
from to leave an annular reaction chamber
for the reception of a pervious column of
ferruginous material and spaced from one
5 end of said casing whereby said annular
chamber may freely communicate with the
space surrounded by said annular wall,
checker-work within said space, means for
admitting steam and air and permitting the
10 escape of waste gas at one end of said space,
means for admitting combustible gas and
air to and permitting the escape of hydro-
gen from the same end of said annular re-
action chamber, and means for admitting
15 combustible gas and air at the opposite end
of said casing.

11. A hydrogen generator including a sub-
stantially gas-tight casing, an annular wall
disposed therein and spaced therefrom to
20 leave an annular reaction chamber for the
reception of a pervious column of ferrugi-

nous material and spaced from the upper
end of said casing whereby said annular
chamber may freely communicate with the
space surrounded by said annular wall, 25
checker-work within said space, means for
admitting steam and air and permitting the
escape of waste gas at the lower end of
said space, means for admitting combusti-
ble gas and air to and permitting the escape 30
of hydrogen from the lower end of said
annular reaction chamber, and means for
admitting combustible gas and air at the
upper end of said casing.

In testimony whereof, I affix my signa- 35
ture in the presence of two subscribing
witnesses.

ANTON MESSERSCHMITT.

Witnesses:

MARTHA MESSERSCHMITT,
CARL ANDREAS.